Implicit Priming of Conflicting Motivational States in Heavy Drinkers

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Introductory Chapter: Thesis Overview

This thesis consists of three main sections: a narrative review, an empirical paper and a concluding discussion. Each section, together with how they are linked, is outlined in this Introductory Chapter.

Chapter 1

The narrative review consists of the largest section of the thesis. This chapter aims to provide the reader with a comprehensive background to the current research in several key areas of implicit cognition in relation to addiction. The background context to the study is set by providing the reader with definitions of the terminology used within addiction literature. A description of the key theories and models of motivation, underlying the hypotheses contained within the empirical paper, is offered. The review then moves on to outline the main theories proposed to explain processes involved in implicit cognition, before examining the research evidence to support these theories.

The following section focuses on limitations of previous studies in this area, and some of these issues are revisited and addressed in the empirical paper and concluding section of the thesis. Considerable attention is given to methods of measuring implicit cognition, as this area is pertinent to the empirical paper. These methods comprise three main areas: attentional bias, approach and avoidance motivation, and uncontrolled memory associations. Each of these areas is relevant to the methodology employed in the current study. Attentional bias and approach / avoidance motivation are commonly measured in addiction research. However, uncontrolled memory associations have, to date, received more attention in social cognition research, for example, in measuring racial attitudes. There is evidence to

suggest that the techniques used for this purpose, for example, masked affective priming, can be used to manipulate goal states in addiction. This evidence will be reviewed. In order to establish the best way in which to combine this technique with more established methods of measuring automatic processes in relation to alcohol motivation, a review of previous studies utilising this method will be presented. Finally, the clinical relevance of attempting to manipulate automatic goal states in regard to alcohol motivation will be outlined. This will set the context for the empirical paper, which follows in the subsequent chapter.

Chapter 2

Chapter 2 contains the empirical paper. The paper is intended for publication and is written in the style of the journal identified for submission (PLOS ONE). The paper consists of an abstract, introduction, method, results, discussion and conclusion.

The introduction identifies the area of focus for the research (i.e. the effect of manipulating implicit goal states in regard to motivation for alcohol cues) and describes why this area is important. Key theoretical concepts and models underpinning implicit cognition are also explained, and an outline of previous research findings, and how these will be extended by the current study, is provided. The clinical implications for the treatment of alcohol-dependent patients are discussed. Finally, the aims and hypotheses for the study are clearly stated.

The method section provides a detailed explanation of the participants, measures and procedures involved in the study. Particular emphasis is placed on the masked affective priming element of the procedure, as this forms the cornerstone of the methodology in relation to goal state manipulation. This technique is comprised of several elements, the reporting of all of which is necessary in order to demonstrate

methodological rigour and facilitate potential replication. This section concludes with a description of the preliminary data analysis undertaken (although basic aspects of data screening are dealt with in the Appendices) and provides a description of how the main results were analysed. In the results section, the findings as they pertain to the hypotheses are succinctly presented.

The discussion offers an interpretation and further explanation of the research findings in the context of relevant psychological theory and previous research discussed in the introduction of the paper. Concepts explored in the narrative review chapter are also drawn on for this purpose. Methodological considerations of the study are discussed, as well as implications for clinical practice and future research. The conclusion provides a brief summary of the key findings and implications. This section is expanded upon further in Chapter 3.

Chapter 3

This chapter is divided into three main sections consisting of: an overview of the work carried out and an extended discussion of the research findings, a lay summary, and directions for future research.

Within the first section, an explanation of how the main findings of the study relate to psychological theories and models, as well as previous research, will be provided. Following this, consideration will be given to the methodology of the study, in an attempt to explore possible reasons for the results of the research undertaken. Specific attention will be paid to the measures and procedures employed. The ensuing part of this section focuses on the clinical implications of the study, particularly in terms of developing treatment techniques targeting automatic processes.

The second section is comprised of the lay summary. This is designed to provide feedback to participants who took part in the research. The summary offers a simple overview of the study with an emphasis on the importance and relevance of the research.

The third, and final, section discusses possible directions for future research. This section elaborates on considerations identified in the empirical paper. Suggestions for ways these issues could be addressed in future research to develop the current study are stipulated. Finally, a brief outline of one possible future study is provided, with proposals for the research aims and design. The thesis closes with a standalone summary following Chapter 3.

Chapter 1

Narrative Review

Introduction

This narrative review aims to orientate the reader to the key psychological theories and models underlying current alcohol addiction research. An outline of the methodology used to conduct this narrative review is provided below, following which a definition of terms used within the text, namely 'implicit' and 'explicit' cognition, is given. Recent motivational models, advanced to explain alcohol addiction, will then be described. The models outlined suggest that a number of factors are instrumental in addiction pathways, the combination and course of which varies between individuals. The main contributing factor explored here is implicit cognition. This factor has attracted increasing interest in addiction research and is thought to play a key role in the process of alcohol-dependence. Although research into implicit cognition in the field of alcohol addiction has only recently gained prominence, this body of literature is already substantial. Therefore, the theoretical background underpinning this subject area will be delineated here, followed by a discussion of the research evidence to support these theories and an exploration of the limitations of the existing research. This will be followed by a critical outline of specific implicit measures; namely the visual probe task, stimulus-response compatibility task (SRC), and the masked affective priming paradigm. A substantial section of the review will be dedicated to a discussion of the latter paradigm, in order to evaluate the potential of this technique for use in exploring implicit goal states in alcohol addiction research. This will include a brief summary of the theories underpinning the affective priming literature and an account of the development of masked priming. This section culminates in an exposition of how the two methods have coalesced and their potential utility to explore implicit attitudes in the area of

alcohol use. Following this, the consequent treatment implications of implicit research will be presented.

Methodology

Implicit cognition is a broad topic within which a vast amount of research has already amassed. Since this review aims to discuss several aspects of implicit cognition it was felt this could be achieved most effectively with a narrative review, as opposed to a systematic review. However, elements of systematic methodology were employed to ensure the search was as thorough and inclusive as possible.

Firstly, the following databases were searched: PsychINFO, Web of Knowledge, Science Direct, Scopus, MEDLINE, PsycARTICLES, and Social Sciences Citation Index. Several different searches were performed for relevant sections of the review. The search terms entered were as follows: 'implicit cognition AND heavy drink*', 'implicit cognition AND alcohol*', 'attentional bias AND heavy drink*', 'attentional bias AND alcohol*', 'stimulus response compatibility AND heavy drink*', 'stimulus response compatibility AND alcohol*', 'approach AND heavy drink*', 'approach tendencies AND alcohol*', 'masked affective priming', 'subliminal affective priming', 'unconscious affective priming' and 'implicit affective priming'. Each separate search term yielded results sufficiently narrow to enable a scan of the abstracts, in order to determine whether or not the paper was relevant for inclusion in the review. The initial parameters for these searches included publications from January 2000 to February 2013 as this field is constantly advancing; therefore, recent publications are most informative. Further papers with publication dates outside these parameters were obtained from the reference sections of articles uncovered using the search terms where appropriate, for example, when describing theoretical background for masked and affective priming techniques. Additional references were

also obtained from prominent narrative reviews of relevant areas, for example, attentional bias (Field & Cox, 2008). Finally, eminent addiction researchers were approached by email for any relevant unpublished or 'in press' manuscripts.

Definition of Terms

Explicit Cognition

Explicit cognitions can be defined as thinking processes that are within the conscious awareness of an individual. Explicit cognition involves slow, deliberate and effortful processes (Wiers et al., 2007). Traditionally, there has been a focus on exploring explicit cognitions in relation to alcohol use in addiction research. The majority of current psychological treatments for alcohol addiction focus on changing explicit cognitions using techniques such as cognitive behavioural therapy (Magill & Ray, 2009) and motivational interviewing (Miller & Rollnick, 2002). Within this body of research, explicit cognitions are measured using questionnaires such as the Approach and Avoidance of Alcohol Questionnaire (AAAQ - McEvoy, Stritzke, French, Lang & Ketterman, 2004) and the Alcohol Outcome Expectancy Questionnaire (Leigh & Stacy, 1993).

The AAAQ is a self-report measure consisting of three subscales assessing inclinations to approach and avoid alcohol. The 'inclined / indulgent' subscale explores mild approach tendencies, the 'obsessed / compelled' subscale examines intense approach inclinations, and the 'resolved / regulated' subscale assesses avoidance tendencies. Respondents are asked to rate how strongly they agree with each item on a 9-point Likert scale from 0 (not at all) to 8 (very strongly). There are three versions of the AAAQ: 'past 24 hours', 'past week' and 'right now'. The latter consists of 14 items and is recommended for use in clinical settings and research practice.

The Alcohol Outcome Expectancy Questionnaire is a 34-item self-report questionnaire developed to ascertain whether participants have positive or negative outcome expectancies from alcohol consumption. The questionnaire is comprised of four positive scales (social facilitation, fun, sex, and tension reduction) and four negative scales (social, emotional, physical, and cognitive performance).

The difficulty with the use of self-report measures is twofold. Firstly, self-report methods used to measure explicit cognitions are subject to social desirability biases, and secondly, people may not always be fully aware of the factors driving certain behaviours (Wiers, de Jong, Havermans & Jelicic, 2004). Recently, there has been an increasing emphasis on the role of implicit cognition in the maintenance of addiction processes to investigate why people continue to use substances despite adverse consequences and an expressed desire to stop using.

Implicit Cognition

The term 'implicit' has been described as operating "spontaneously, without the need for deliberation, reflection, or awareness of the process responsible for behavior" (Stacy & Wiers, 2010, pp. 553). However, providing a precise definition of the term 'implicit' has proved problematic. Within the literature various terms, which are difficult to distinguish from 'implicit', (for example, 'automatic') have been used depending on the area of focus for the research. For example, in studies of semantic memory, 'automatic semantic priming' has been employed to investigate how the presentation of one stimulus can affect the processing of another stimulus in the absence of strategic processes (Stacy & Wiers, 2010). It has been argued that lack of awareness of stimuli (i.e. subliminal processing) is not a prerequisite for unconscious processing or implicit cognition (Bargh & Marsella, 2008). They, and others, suggest that implicit processing is not necessarily characterised by a lack of

awareness of the stimuli or the behaviour, but rather of the underlying processes of how one influences the other (Stacy & Wiers, 2010). Moors and De Houwer (2006) describe a variety of ways in which a task could be described as automatic, for example, lack of intentionality, lack of awareness of one or more parts of the process, and efficiency (effective processing in presence of other cognitive demands), amongst others. However, the fundamental distinction between this definition of 'automaticity' and that of 'implicit' provided by Stacy & Wiers (2010) is unclear.

The lack of a common definition for the term 'implicit' suggests that it is a complex phenomenon implicating multiple underlying processes. This suggestion is supported by current neuropsychological evidence (Stacy & Wiers, 2006). The most common feature of implicit cognition is the indirect assessment of the concept. For example, researchers have been able to infer participants' implicit attitudes to alcohol by measuring their reaction times to alcohol-related stimuli. Whilst implicit measures are not subject to the same difficulties as self-report measures, they are not without their own complexities as shall be outlined subsequently.

For the purpose of this review, the definition of implicit cognition suggested by Stacy and Wiers (2010) quoted above will apply. The term 'automatic' is also used here with the same meaning although the author acknowledges that debate exists about whether the concepts of 'implicit' and 'automatic' should be treated as distinct entities. This should be understood as separate from the term 'subliminal', which will be used in this text to mean outside conscious awareness in reference to the masked affective priming technique described elsewhere in the review.

Motivation

Klinger and Cox (2004) define motivation as "the internal states of the organism that lead to the instigation, persistence, energy, and direction of behaviour towards a

goal" (pp. 4-5). In general individuals are motivated towards things that bring them positive gain. This may take the form of tangible objects, for example, producing a good thesis to obtain a doctorate, or may relate to emotional states, such as positive affect. People are also motivated to avoid things that may cause them distress, for example, a person with a fear of public speaking is likely to avoid presentations to large numbers of people. It has long been established in psychological literature that goals constitute a key component of motivation, and that having goals affects several cognitive processes; for example, attention, memory recall, and thought content (Klinger, 1996; Van den Broek, Lorch, Linderholm, & Gustafson, 2001). For instance, the goal of dieting can influence an individual's cognitive processing making them particularly attentive to weight or food-related stimuli.

Until fairly recently models explaining motivational states were uni-dimensional in nature (McEvoy, Stritzke, French, Lang, & Ketterman, 2004). To elaborate, it was purported that when approach motivation was high, avoidance motivation must be low (inversely related). However, multi-dimensional models have since been put forward which view approach and avoidance motivation as separate systems. There is evidence to support the concept of two separate motivational systems in the domains of dieting (Stroebe, Mensink, Aarts, Schut, & Kruglankski, 2008) and mental health (Dickson & MacLeod, 2004). In the alcohol addiction research, studies of the AAAQ (McEvoy et al., 2004) provide support for a distinction between the motivational systems in both alcohol-dependent (Klein, Stasiewicz, Koutsky, Bradizza & Coffey, 2007) and non-dependent groups (Stritzke, McEvoy, Wheat, Dyer & French, 2007). Such studies have also been shown to predict unique variance in drinking patterns between clinical and non-clinical populations (Klein et al., 2007).

Breiner, Stritzke and Lang (1999) put forward the ambivalence model of craving, which proposes that whether or not a person consumes alcohol depends on the balance between motivation to use and motivation to abstain. This model proposes that an individual may fall into one of four categories at a given point in time depending on a variety of factors. To elaborate, those with low motivation to both avoid and approach alcohol are likely to fall within the 'indifferent' quadrant of the model. Light drinkers might fall into this category. In contrast, people with high motivation to approach alcohol and low motivation to avoid it, are likely to fall within the 'heavy drinker' quadrant of the model. Individuals in this group may approach alcohol as they associate it with being relaxed and having a good time. There is research evidence to suggest that this group are quicker to approach rather than avoid alcohol-related cues (Schoenmakers, Wiers & Field, 2008) and this has been shown to correlate with actual drug use (Field, Kiernan, Eastwood & Child, 2008). People with the reverse of this pattern (i.e. high motivation to avoid and low motivation to approach alcohol) may perceive the negative effects of alcohol, for example, calorific content or suffering from a hangover, more strongly than the other groups and are likely to be non-drinkers. Factors which may increase motivation to avoid alcohol have been heavily researched and findings suggest that detrimental effects to the health of heavy alcohol users; both physical (Rolfe, Dalton & Orford, 2005) and emotional (Yeh, Che & Wu, 2009), and alcohol impacting adversely on relationships (Jethwa, 2009), are the most common. Finally, the model suggests a fourth quadrant for those who are said to be ambivalent, that is, highly motivated to both approach and avoid alcohol. There is evidence to suggest that alcohol-dependent patients fall into this category.

The motivational model of substance use put forward by Cox and Klinger (1988, 2004) builds on the work of Breiner et al., (1999) to suggest several distal and proximal factors that influence an individual's motivation to consume alcohol by impacting on the incentive value of alcohol to a person. These factors include, but are not limited to, past experiences (affected by the body's neurochemical response to alcohol), personality factors (such as levels of inhibition control), cultural influences of society (for example, social control theory [Reiss, 1951]), and situational factors (such as whether the person is at work or at a party). Several of these factors are thought to operate implicitly.

Taken together, the models posit that non-abstinent heavy drinkers, for example, are likely to have stronger substance-related goals compared to light drinkers, and that these goals are proportionally related to the incentive valence of alcohol. Therefore, heavy drinkers will demonstrate higher attentional bias in relation to alcohol stimuli than light drinkers (Cox and Klinger, 2004), along with stronger approach biases towards alcohol cues as described above.

Research evidence has demonstrated that alcohol-dependent patients show high motivation to both avoid and approach alcohol cues. For example, alcohol-dependent patients display motivation to approach alcohol-related cues on implicit measures whilst simultaneously self-reporting motivation to avoid these cues (Stormark, Field, Hugdahl & Horowitz, 1997). Therefore, in spite of experiencing undesirable consequences of alcohol use, such as poor health, many individuals continue to drink heavily. A proportion of heavy drinkers may also fall in to this category. For example, if alcohol intake is impacting upon work or family commitments. Therefore, alcohol use could be a function of which motivational system is more

activated at any one time (Ostafin, Palfai & Wechsler, 2003) and implicit cognition could play an important role in this process.

Implicit Cognition: Theoretical Background

Several theories have been put forward to explain the role of implicit cognition in addiction. Firstly, the incentive sensitization approach (Robinson & Berridge, 1993) posits that the process of alcohol addiction may begin with an initial 'liking' of the substance but this turns into 'wanting' the substance (despite no longer liking it) with prolonged use. The theory proposes that changes in neurobiological pathways occur with increased substance use via classical conditioning, which has the effect of increasing the salience of alcohol, and alcohol-related stimuli. This theory has been elaborated on by Franken (2003) who also suggests that attentional bias develops through the process of classical conditioning as the substance-related cues become associated with the expectancy of substance availability. This expectancy causes both attentional bias and craving in a mutually excitatory relationship that is likely to result in substance use. It is also possible that the relationship between attentional bias and craving might be mediated by the perceived availability of the substance (Field & Cox, 2008).

Memory network models have also been used to explain automatic processes in addiction (Anderson & Pirolli, 1984). The hypothesis suggests that certain emotional states or environmental cues (for instance, being in a bar) can trigger previous memories associated with the effects of alcohol. It is suggested that this automatic memory retrieval process might then initiate behaviour directed towards obtaining the substance.

Automaticity theory (Tiffany, 1990) expands this hypothesis further. It suggests that, after repeated alcohol use, alcohol-related stimuli (for example, a glass of beer)

may elicit substance-directed behaviour automatically. The theory suggests that this process may occur without the memory retrieval process or presence of the intent to drink alcohol. This differs from incentive sensitization theory in that there is a lack of motivation implicated in automaticity theory (cues automatically elicit the behaviour), whereas incentive sensitization theory proposes that behaviour is driven by enhanced motivation to seek out the substance as neurobiological changes increase the salience of alcohol cues with increased use.

Dual process theories (Wiers et al., 2007) have been interested in the relative contribution of implicit and explicit processes to heavy drinking. It is suggested that alcohol use may begin as a result of explicit processes but then become more implicit with prolonged use as automatic processes are strengthened and controlled processes are weakened (Ostafin, Marlatt & Greenwald, 2008). These theories are in line with incentive sensitisation theory and also fit with the ambivalence model of craving (Breiner et al., 1999) outlined above. Therefore, the balance of implicit and explicit processes could determine the behavioural outcome, i.e. whether alcohol is consumed.

Impulsivity is also thought to play an important role in addiction and has been found to be a predictor of future addictive behaviours (de Wit, 2009; Sher, Grekin & Williams, 2005). Furthermore, the process of addiction is likely to weaken executive control (Stacy & Wiers, 2010; Wiers et al., 2007) and strengthen automatic approach tendencies (Grenard et al., 2008), meaning the relative balance between implicit and explicit processes may become altered during the course of addiction and during the course of a single drinking episode (Field, Schoenmakers & Wiers, 2008; Fillmore & Vogel-Sprott, 2006). Specifically, it has been suggested that substance users' impulsivity or poor executive control could mediate the relationship between craving

and attentional bias by potentially making them more susceptible to both (Field & Cox, 2008). This in turn may increase their impulsivity leading to a reciprocal relationship that could have implications for alcohol consumption.

Research Evidence for Implicit Cognition

Ostafin et al., (2008) found that the Implicit Association Test (IAT), but not an explicit measure of motivation to drink alcohol, predicted subsequent alcohol consumption more strongly when participants' self-control strategies had been depleted by experimental manipulation. Other studies have found that implicit measures predict unique variance in alcohol consumption when other variables have been controlled for (Ames & Stacy, 1998; Houben & Wiers, 2007). However, Reich, Below & Goldman (2010) conducted a meta-analysis which found that explicit measures predicted the majority of the variance in alcohol use, with implicit measures accounting for only a small amount of unique variance. This pattern may vary depending on the population being studied. For example, implicit processes may be more salient for individuals attempting to reduce their alcohol consumption than those who are comfortable with their level of alcohol consumption. Finally, there is evidence that implicit measures predict unique variance in prospective as well as cross-sectional drug use (Kelly, Masterman & Marlatt, 2005; Stacy, 1997).

Incentive sensitization theory (Robinson & Berridge, 1993) is evidenced in the research by heavy drinkers and alcohol-dependent patients showing attentional bias for alcohol cues, as opposed to neutral cues (Field & Cox, 2008), presented for brief durations (50 ms), and being quicker to approach alcohol-related stimuli when measured against reaction times to matched neutral stimuli (Barkby, Dickson, Roper & Field, 2012).

Dual process theories help to explain research findings that alcohol-dependent patients and heavy drinkers display motivation to approach alcohol-related cues on implicit measures whilst simultaneously self-reporting motivation to avoid these cues (Barkby et al., 2012, Stormark et al., 1997).

Many studies have found evidence to support the link between craving and attentional bias (Field, Munafò & Franken, 2009), although others have failed to find the same pattern (Ehrman et al., 2002; Lubman, Peters, Mogg, Bradley & Deakin, 2000). However, experimental manipulations of craving have been shown to lead to increases in attentional bias (Cox, Brown & Rowlands, 2003; Duka & Townshend, 2004; Field, Hogarth, et al., 2011).

Limitations of Implicit Cognition Research

In addition to difficulties with measures of implicit cognition, which are discussed specifically in a subsequent section, further limitations to implicit cognition studies deserve attention. These are briefly outlined below.

Stimuli

In relation to research investigating alcohol misuse, it is common practice for researchers to use a standard set of stimuli for all participants. This might include, for example, a set of pictures depicting different types of alcohol (beer, wine, and spirits). The difficulty with this practice is that some types of alcohol will have more salience for certain participants than for others. Therefore, whilst beer drinkers might show pronounced attentional bias or automatic approach tendencies for pictures of beer, these effects will be lost in the overall pattern of data as they respond to a range of other pictures of alcoholic drinks that do not produce the same effects. However, although some studies have attempted to take this variable into account (by stipulating, for example, that 25% of participants' alcohol consumption is comprised

of beer [Ostafin et al., 2008]), there has been a paucity of research in this area in general. Despite this, a study by Houben and Wiers (2009) found that in a group of regular beer drinkers, a standard IAT (with a range of types of alcohol cues) was unable to predict alcohol consumption, whereas an IAT using beer-specific stimuli could. Further research with individualised stimuli is needed to provide clearer insight into this issue. On the other hand, there are clearly problems associated with trying to recruit specific types of drinkers. This could mean the results of the study are less generalizable and it makes recruitment more difficult.

Population

Much of the addiction research on implicit cognition has utilised undergraduates as participants. However, studies have demonstrated that they may display different patterns on measures of approach / avoidance and attentional bias tasks than alcohol-dependent samples. For example, Field, Mogg, Zetteler, and Bradley (2004) found that when pictures were presented for a stimulus onset asynchrony (SOA) of 500 ms, heavy drinking students showed slowed disengagement of attention, whereas in alcohol-dependent patients, the opposite effect has been found at SOAs of this duration, i.e. attentional avoidance (Stormark et al., 1997; Townshend & Duka, 2007). In this case, SOA refers to the length of time the pictures were presented on the screen before the probe appeared. This raises questions about the generalizability of certain studies to alcohol-dependent groups and suggests that the mechanisms involved in implicit cognition may differ between non-clinical and clinical samples, although some of these result patterns may be explained by lack of reliability of measures. Future research using heavy drinkers should take this into account and attempt to recruit participants who are likely to show similar patterns to alcohol-dependent patients regarding their alcohol consumption, that is, ambivalence. One

way to achieve this might be to recruit a sample of over the age of 25. Such participants are more likely to be conflicted regarding heavy drinking behaviour, as there is a higher probability they will have additional responsibilities, such as work and family commitments, compared to an undergraduate sample.

Measuring Implicit Cognition

To date the research on implicit cognition has focussed on three main areas; attentional bias, automatic approach tendencies, and uncontrolled memory associations. Each of these, along with their limitations, will be discussed in turn.

Attentional Bias

A full description of the methods used to measure attentional bias is beyond the scope of this chapter. The interested reader is referred to Field and Cox (2008) for a comprehensive review. This section will focus specifically on the visual probe task, which has been frequently used to assess attentional bias within addiction research.

The visual probe task has been used extensively in addiction research to explore attentional bias. In the task, two pictures (or words) are presented side by side on the screen. Typically, one picture will be related to the concept being explored, for example, alcohol pictures, whilst the other will be a neutral picture. One of the pictures is then replaced by a probe (commonly an arrow or a small white square). Reaction times to the probe are calculated with attentional bias inferred when reaction times are quicker to probes that replace pictures of alcohol (congruent trials), as opposed to probes that replace neutral pictures (incongruent trials). This is based on the work of Posner, Snyder & Davidson (1980) who discovered that an individual would respond more quickly to probes that are presented in locations where their attention is already drawn. There is now a convincing body of evidence within addiction research to suggest that substance users respond more quickly to

congruent trials, demonstrating an attentional bias for their substance of choice (Field et al., 2004; Field, Mogg & Bradley, 2005). However, this is not the case with non-users (Field, 2006). There is also considerable evidence to suggest that attentional bias displayed may be directly proportional to the frequency and intensity of the substance use (Field & Cox, 2008) This finding is in line with both Cox and Klinger's motivational model (1988, 2004) and Robinson and Berridge's (1993) incentive-sensitisation theory.

There are important considerations to be aware of when selecting the stimuli for visual probe tasks. Firstly, alcohol-related pictures and control pictures should be carefully matched to minimise, as far as possible, the chance of any detected attentional biases being caused by the level of complexity or brightness of the picture, as opposed to its substance-relatedness. It has also been suggested that the emotional valence of the stimuli should be controlled for, with the recommendation that control pictures are selected on the basis of emotional neutrality (Bauer & Cox, 1998) for similar reasons. Different versions of this task have employed a technique whereby one picture is presented on the screen at a time (Stormark et al., 1997); however, the effect sizes have been smaller compared to the more popular version of the task using two pictures.

Previous studies have shown mixed findings when varying the length of time the pictures appear on screen before the probe is presented. This is known as the stimulus onset asynchrony (SOA) as described above. For example, in alcohol-dependent patients, attentional bias for alcohol pictures was found when using an SOA of 100 ms but participants demonstrated attentional avoidance when SOAs of 500 ms were utilised (Stormark et al., 1997). These findings have been replicated elsewhere (Noel et al., 2006; Townshend & Duka, 2007). However, Field et al.,

(2004) found that heavy drinkers showed significant attentional bias for alcohol cues when compared to a control group of light drinkers but only when the pictures were presented for 500 ms. Forestell, Dickter and Young (2012) found attentional bias in a group of 'escape drinkers' (that is, students that drank to avoid negative affect) compared to 'non-escape drinkers' in a sample of college students but only when alcohol cues were presented for 2000 ms as opposed to 500 ms, when no significant differences were found.

Stormark et al. (1997) hypothesise that the results of their study represent motivational ambivalence in alcohol-dependent patients. They suggest that attentional biases at shorter SOAs reflect automatic approach tendencies that are in conflict with explicit processes motivating them to avoid alcohol. Therefore, when SOAs are longer, alcohol-dependent patients have the opportunity to consciously process the stimuli, and will be more likely to show avoidance tendencies to these cues (Field & Cox, 2008). Heavy drinkers who are not in conflict regarding their drinking, by contrast, are more likely to be drawn to these cues when presented for longer durations.

It is posited that attentional biases at shorter SOAs (200 ms or less) reflect an initial orienting bias (which is thought to be automatic) whereas attentional biases at longer SOAs (500 ms and above) reflect slow disengagement of attention (Field & Cox, 2008). The rationale behind this is that a timeframe of 50 ms is required to shift attention to the presentation of a visual cue, and 150 ms is required to disengage attention from one cue to focus on another cue in a different location. Therefore, when a pair of cues is presented together for less than 200ms (as in the visual probe task) any attentional bias is presumed to be a result of initial orienting bias as there is insufficient time for a second shift of attention (Field & Cox, 2008). Although there

is some debate as to whether these subtle differences can be distinguished solely on the basis of varying the SOA.

Koster, Crombez, Verschuere & De Houwer (2004) have addressed these concerns by modifying the visual probe task to enable initial orienting biases to be distinguished from late disengagement biases. They have achieved this by incorporating trials presenting two pairs of neutral pictures side by side, in addition to the usual congruent and incongruent trials described above. Thus, by comparing reaction times on congruent trails (where the neutral and alcohol pictures appear side by side, and the probe replaces the alcohol picture) with reaction times on neutral-neutral trails, initial orienting bias can be determined; and biases in the disengagement of attention can be measured by comparing reaction times on incongruent trials (where the neutral and alcohol pictures appear side by side and the probe replaces a neutral picture) with reaction times on neutral-neutral trials. Koster et al., (2004) found that initial orienting biases did not occur with SOAs of 500 ms or more but slowed disengagement of attention was evident as this SOA. Furthermore, they discovered that the SOA needed to be as short as 100 ms to enable an initial orienting bias to be detected. This study demonstrates the importance of the inclusion of neutral-neutral trials in visual probe tasks. However, the study by Koster et al., (2004) focussed on threat-related information, therefore, further studies must be replicated in the area of addiction research before generalisations can be made.

Reviews of attentional bias tasks such as the visual probe tasks have shown it to have poor reliability in the area of threat-related words (Schmukle, 2005) although this has only recently been investigated in the area of addiction. A study by Spiegelhalder et al., (2011) found low test-retest reliability in a group of low-dependence smokers, as well as poor correlation between attentional bias as

measured by a Stroop test when compared to the visual probe task. However, the sample size used in this study was small and these effects may not generalise to alcohol studies. Ataya et al., (2011) investigated the internal reliability of the visual probe and Stroop tasks by conducting a secondary analysis of data amassed from seven independent studies. The authors found poor internal reliability for both measures but particularly poor internal reliability for the visual probe task. Field and Christiansen (2012) suggest this may be due to the non-individualised nature of stimuli used in the studies examined (a problem common to other measures of implicit cognition as described above). This assertion is supported by the finding that studies using the visual probe task to assess reaction times in smokers (where stimuli, i.e. cigarettes, have less scope for variation) found it to be more reliable (Ataya et al., 2011; Field & Christiansen, 2012). There is evidence that visual probe tasks measuring eye movements may be more reliable (Field et al., 2009; Field & Christiansen, 2012; Friese, Bargas-Avila, Hofmann & Wiers, 2010) but necessitate more rigid testing conditions. This is a concern for on-going research and worthy of further investigation.

Automatic Approach Tendencies

The implicit association test (IAT) designed by Greenwald, McGhee and Schwartz (1998) has been used extensively in social cognition research to infer automatic attitudes to a range of stimuli. In a standard bipolar version of the task, to measure attitudes towards alcohol cues, participants are asked to categorise alcohol-related words, words connected to soft drinks, and positively and negatively valenced words. However, participants are afforded only two response keys as two concepts share one response key. For example, in one block of the task, participants are instructed to press ‘x’ for both alcohol-related and positively valenced words and ‘n’

for both words related to soft drinks and negatively valenced words. In the second block of the task, these instructions are reversed, meaning alcohol-related words share a response key with negatively valenced words and words in the soft drink category share a response key with words of positive valence. A positive association or attitude towards alcohol is inferred if participants' reaction times to alcohol-related words on the first block (where alcohol-related words share a response key with positively valenced words) are faster than on the second block (where they are paired with words of negative valence). Modified versions of this task have replaced the 'positive' and 'negative' concepts with 'approach' and 'avoidance' themes. Such studies have found that, when compared to light drinkers, heavy drinkers show stronger associations between the concepts of 'alcohol' and 'approach' relative to 'alcohol' and 'avoid' (Christiansen & Field, 2013).

A difficulty with this task is that it only provides information about the strength of associations between two concepts *relative* to the other two concepts. For example, stronger associations between 'approach' and 'alcohol' may reflect strong automatic approach tendencies for alcohol, or they may reflect weak associations between the concepts of 'alcohol' and 'avoid'. For this reason, the unipolar IAT has been developed. In this task, alcohol-related words might share a response key with positively valenced words on some trials and with neutral words on other trials in one block, whilst in another block, alcohol-related words would share a response key with negatively valenced words on some trials and with neutral words on others. This allows the strength of positive and negative alcohol associations to be assessed independently of one another.

As an alternative to the IAT described above, the SRC task has been used to assess associations between 'alcohol' and 'approach' concepts. Rather than having to

make judgements about how to categorise words as on the IAT, participants carrying out an SRC task must categorise pictures by clicking response keys representing movements towards or away from substance-related cues. There have been several variants of this task but commonly a manikin is presented on the screen with a single picture that is either alcohol-related or neutral. The participant is then told to move the manikin according to the instructions. For example, in the first block the participant might be told to move the manikin towards alcohol-related pictures, and in the second block instructed to do the reverse. An approach bias for alcohol is inferred if participants' mean reaction times to approach the alcohol pictures are quicker than those to avoid them.

The main difficulty with the version of the task described above is that it only allows the researcher to examine the strength of the approach relative to the avoidance tendencies. Therefore, the approach biases could be indicative of strong approach tendencies for alcohol pictures, a weak avoidance of these pictures or a combination of both. More recent versions of the task have tried to overcome this by introducing a sideways movement, which is supposed to represent a neutral movement (i.e. neither approaching or avoiding) in each block. For example, in the first block participants might be directed to move the mannequin towards alcohol pictures and left for neutral pictures, in the second block they could be instructed to move the manikin towards neutral pictures and left for alcohol. This allows the speed of approach relative to a neutral movement to be calculated rather than solely producing an index of the strength of automatic approach tendencies relative to avoidance tendencies. Similarly, in a third block participants might be instructed to move the manikin away from pictures of alcohol and left for neutral pictures; whilst in the fourth block they could move away from neutral pictures and left for alcohol

pictures. This allows the speed of avoidance to be calculated independently of approach tendencies. In this way motivational 'ambivalence' can be captured as distinct from 'indifference'.

There is some evidence suggesting that automatic biases to approach alcohol cues exist in heavy drinkers (Christiansen, Cole, Goudie, & Field, 2012) but not in light drinkers (Field, Caren, Fernie & De Houwer, 2011) or non-drinkers (Field, Kiernan, et al., 2008). Similar effects have been found in a group of smokers (Mogg, Field & Bradley, 2005). In a group of social drinkers, Field et al., (2005) found that those scoring high on an explicit measure of alcohol craving displayed stronger automatic tendencies to approach alcohol on the SRC task.

However, the pattern in relation to alcohol-dependent patients appears different to that described above. Given the findings from previous research, it might be expected that alcohol-dependent patients would display both automatic approach and avoidance tendencies relative to control groups. In a study to explore this, Barkby et al. (2012), contrary to expectation, found alcohol-dependent patients were no quicker to approach alcohol pictures when compared to light drinkers as measured by a SRC task. Furthermore, they found no significant differences in automatic avoidance tendencies, despite alcohol-dependent patients self-reporting both approach and avoidance tendencies indicating motivational conflict. However, Spruyt et al., (2013) used a relevant SRC to explore the relationship between automatic avoidance and approach tendencies and relapse in a group of alcohol-dependent patients and a control group. They found an automatic alcohol avoidance bias in the alcohol-dependent patients that was related to relapse at three-month follow-up. One possible explanation for these findings is that alcohol-dependent patients have developed a strategy for avoiding alcohol cues. This would fit with findings from attentional bias

research showing that clinical populations display attentional avoidance for cues presented above certain durations (Noel et al., 2006; Townshend & Duka, 2007). However, the link found in the Spruyt et al. (2013) study between automatic avoidance bias and relapse at 3-month follow-up is clearly worthy of further investigation. There is also a need for clarification of the motivational processes underlying approach and avoidance biases before firm conclusions can be drawn (Watson, de Wit, Hommel & Wiers, 2012).

The SRC task is not without interpretation difficulties and different variants of the task can be found in the addiction literature as researchers attempt to improve on the design of the task, which can make findings difficult to compare. Other approach-avoidance tasks are available, for example, the approach-avoidance task (AAT) described by Wiers, Rinck, Dictus, and Van den Wildenberg (2009), Wiers, Rinck, Kordts, Houben & Strack, (2010) and Wiers et al., (2011). The AAT directs participants to categorise alcohol and neutral pictures based on whether they are tilted to the right or to the left, by making either an approach or avoidance movement in relation to the picture. Although comparisons between irrelevant feature tasks (such as the AAT), and tasks which involve alcohol-related coding (such as the SRC task), are in their infancy in the addiction literature, the current data suggest that SRC tasks are likely to produce better effect sizes more consistently (Christiansen & Field, 2013).

Uncontrolled Memory Associations

Whilst several implicit measures have been designed to investigate automatic memory associations in the literature, such as the IAT described above, this review focuses on affective and masked priming. These techniques have been used less frequently in addiction research but have the potential to overcome some of the

difficulties associated with other implicit measures. Importantly, they may also be suitable for use in conjunction with existing measures to study the effects of subliminal manipulation of implicit motivational states. Whilst a full review of the affective priming literature is beyond the scope of this text (the interested reader is referred to Klauer and Musch [2003] for a more detailed discussion of this area); a general overview of the affective priming paradigm and theoretical background is provided below.

Affective priming.

In a traditional affective priming task, such as those described by Fazio, Sanbonmatsu, Powell and Kardes (1986), participants complete an evaluative decision task whereby they must make a judgement about whether a target word is positive or negative. The target word is primed by a stimulus with either positive or negative valence. The paradigm is used to infer the underlying attitudes of participants to the target stimulus (Fazio, Jackson, Dunton, & Williams, 1995). For example, Fazio et al., (1995) used pictures of black and white faces as primes to investigate participants' racial attitudes. If participants were quicker to categorise positive target words than negative target words when primed by pictures of black faces, a positive attitude towards black faces was inferred. Fazio et al., (1986) believed that affective priming automatically activated attitudes that had a previously learned set of associations (Otten & Wentura, 1999).

Ostafin et al., (2003) used a modified version of the affective priming task to explore motivational tendencies towards alcohol. They presented participants with primes that were either alcohol-related words, such as 'beer' and 'pint', or neutral words, such as 'boot' and 'tables'. They then presented targets that were either approach or avoidance related (as opposed to the traditional paradigm which uses

positive and negative evaluative targets). Participants had to categorise the target words as belonging to the 'approach' or 'avoid' category. The results showed that weak associations between alcohol primes and avoidance motivation were correlated with problem drinking, for example, more binge episodes. However, no strong associations were found between alcohol cues and approach motivation. It is not clear how generalizable these results are since participants were undergraduates and the definition of 'current drinker' only stipulated consumption of at least one alcoholic drink in the last month. Therefore, participants could range from light drinkers to heavy, or even alcohol-dependent drinkers. Furthermore, the primes may not have tapped alcohol-related valence, as they did not focus on the positive effects of drinking. Finally, the study does not provide evidence about how the affective priming paradigm would influence participants' motivational responses towards alcohol cues. However, the adaptation of the affective priming paradigm to evaluate approach and avoidance categories is an important step forward for addiction research as it facilitates the assessment of affect associations with alcohol cues.

Theoretical background.

A spreading-of-activation account of the mechanisms behind affective priming was the first dominant school of thought in this area. According to this account, each concept activated a certain node, and concepts that were similar in valence created links between nodes. Therefore, the activation of one node might automatically trigger a linked node, leading to a 'spreading-of-activation' across several nodes. Primes with similar affective valence to targets were thought to speed up participant responses to these targets by activating these nodes in readiness to make a response (De Houwer, Teige-Mocigemba, Spruyt & Moors, 2009).

However, this explanation is now thought to account for only a small proportion of affective priming effects. This is because subsequent research was expected to demonstrate that the spreading-of-activation account would mean that primes would not only facilitate responses to affectively congruent targets, but also to sematic properties of the targets (for example, is the target an object or an animal?). However, the research failed to demonstrate such semantic priming effects (De Houwer, Hermans, Rothermund & Wentura, 2002; Klinger, Burton & Pitts, 2000).

Following this, response-activation was put forward as an alternative explanation and this theory is currently regarded as the best explanation for affective priming effects. Response-activation theory suggests that primes facilitate responses as a result of their valence by influencing the selection of the response; as opposed to the spreading-of-activation account, which suggests that, the prime facilitates the processing of the target (De Houwer et al., 2009; De Houwer & Hermans, 1994). For example, if the presentation of a positive target (requiring a positive categorisation) is preceded by a positive prime (i.e. a black face for a person that likes black people) the prime will have a tendency to initiate a positive response, which then facilitates a positive response to the target. However, had the target been negative, this response would be slowed as the participant would have been induced to give a positive response, which they must now inhibit to produce the correct negative response.

Masked priming.

Effects of affective priming have been demonstrated even when the prime has been presented subliminally using a masked priming paradigm (Draine & Greenwald, 1998). Despite initial controversy in the research literature, masked priming is now established as a method of presenting stimuli non-consciously to influence a variety of processes at perceptual and sematic levels (Kouider &

Dehaene, 2007; Van den Bussche, Van den Noortgate, & Reynvoet, 2009). Designing masked priming paradigms to measure non-conscious processing has proved challenging to researchers, provoking debates about how to present stimuli, how to measure responses, and how to demonstrate that stimuli were genuinely undetected, amongst other difficulties.

Marcel (1980, 1983) first provided evidence for semantic priming using visual masking. He demonstrated that the processing of a visible stimulus (a word in this case) is facilitated when it is preceded by a congruent (semantically related) masked prime as opposed to an unrelated masked prime. For example, participants were faster to process the word 'dog' when preceded by the word 'cat' as opposed to being preceded by the word 'book' (Van den Bussche et al., 2009). This work was subsequently replicated with faces and speech perception (Kouider & Dehaene, 2007). However, such studies have been criticised for methodological flaws such as an insufficient number of trials to detect statistical significance (Merikle, 1982), an absence of counterbalancing between control and experimental groups (Fowler, Wolford, Slade & Tassinary, 1981), and the underestimation of prime visibility (Kouider & Dehaene, 2007).

Dehaene et al., (1998) demonstrated semantic masked priming with numbers. Participants were asked to classify numbers from one to nine as smaller or larger than five. They were presented with congruent (where the prime and target should evoke the same response) and incongruent trials. Participants were found to respond faster to congruent trials and this became known as the response-congruency effect. This was also the first study to use neuroimaging techniques that showed neural activity in the motor cortex in response to the subliminal primes. Dehaene et al.,

(1998) suggested this was evidence of participants applying task instructions to the subliminal primes as well as the targets.

However, this study used the same stimuli as targets and primes, therefore, effects could have been due to learned stimulus-response mapping (Kouider & Dehaene, 2007). It has also been hypothesised that the effects in the Dehaene et al., (1998) study may be a result of action-triggers. Kunde, Kiesel and Hoffman (2003) propose that in certain experiments that employ a restricted number of target stimuli (i.e. numbers from one to nine) participants may consciously prepare associations with each possible stimuli in advance.

The issue of whether masked priming reflects genuine semantic activation is still debated. However, there is an important distinction to be made between stimulus-response mapping (which can occur during an experiment) and semantic activation (which is a result of association between primes and targets which existed prior to the research study in question [Kiefer, 2007]). Furthermore, these two processes are thought to be associated with differing underlying neural procedures, although it remains unclear whether they are ruled by the same top-down mechanisms (Van den Bussche et al., 2009).

In a move away from semantic priming, Evett and Humphreys (1981) used masked repetition priming to study visual word recognition. Their design was comprised of four elements: a forward mask (for example, presentation of a random string of letters), lower case prime, upper case target, and a backward mask (letter string). Each element was presented for a brief duration of between 25 to 50 ms. However, this attracted criticism as participants sometimes confused the target and the prime. Forster and Davis (1984, 1991) attempted to improve on this method by introducing a variant of the paradigm consisting of a longer forward mask (500 ms),

short prime presentation (60 ms), and a longer target presentation (700 ms). This method has yielded more consistent priming effects, however, has again been criticised for the absence of prime visibility checks (Kouider & Dehaene, 2007).

Response window technique.

The response window technique was introduced by Greenwald, Draine and Abrams (1996) and Draine and Greenwald (1998) to improve the sensitivity of masked priming paradigms based on the assertion that the effects of subliminal priming are short lived and thus by getting participants to respond more quickly, effects could be improved. Greenwald et al., (1996) used a SOA of 67 ms between presentation of the prime and the target, and gave participants a small window in which to respond to the target stimulus. This technique causes participants to have similar response times which means the influence of the primes is centred on accuracy, thus increasing the priming effects (Klinger et al., 2000). An additional advantage of this technique is that it forces participants to make judgements about targets before they are fully processed which may lead to a stronger effect of primes on judgements about targets. Research suggests that priming that occurs using the response window technique may be different from priming observed in traditional semantic priming paradigms (Klinger et al., 2000).

Greenwald et al., (1996) also used a procedure known as sandwich masking in their experiment. This involves presenting the participant with a forward mask, which precedes the appearance of the prime, following which a backward mask is also presented. The forward and backward masks typically consist of a string of symbols or a random letter sequence. This procedure is similar to that used by Evett and Humphreys (1981) described above. Sandwich masking is shown to be particularly effective when combined with the response window technique.

This technique has been shown to uncover subliminal priming effects across several areas in social cognition, for example, in-group favouritism (Otten & Wentura, 1999), implicit self-esteem (Wentura, Kulfanek & Greve, 2005), and attitudes (Degner, Wentura, Gniewosz & Noack, 2007; Frings & Wentura, 2003; Wentura & Degner, 2010a). Since participants are unaware that an attitude-related prime will be presented, the masked priming paradigm represents an unobtrusive measurement of automatic attitude activation (Frings & Wentura, 2003). In masked affective priming studies that do not use this technique, it is unclear whether results are a reflection of participants emphasising speed (and sacrificing accuracy) or emphasising accuracy (and sacrificing speed). This makes the effect of priming less controlled (Wentura et al., 2005).

Limitations.

It is important to note that research utilising masked affective priming paradigms to assess implicit attitudes is still at an early stage. The majority of studies conducted to date have focussed on a variety of social cognition domains including prejudice, in-group favouritism, self-esteem, and emotion and it is not known whether the effects found will generalise to addiction research. The ways in which they might be utilised to explore implicit cognition are also unclear. Furthermore, the studies outlined used varying timings and elements within their procedures. For example, some studies utilised the response window technique (Custers & Arts, 2007; Degner & Wentura, 2009), whereas others omitted this (Wentura & Degner, 2010b). Moreover, reliable results were not produced with either methodology. Even when comparable timings are used within research, consistent priming effects have been difficult to replicate. This makes it difficult to infer the precise methodology by

which the largest and most reliable masked affective priming effects might be achieved.

Manipulation of Implicit Goal States in Addiction

This review has examined the emerging evidence for a conflict at the implicit level between approach and avoidance motivation in heavy drinkers and alcohol-dependent patients (Noel et al., 2006; Townshend & Duka, 2007). Previous studies have shown it is possible to manipulate goal states at both explicit (Roefs et al., 2006) and implicit levels (Stroebe et al., 2008). The latter study used a masked priming task to subliminally prime a group of dieters with words that were either neutral or related to eating enjoyment. On a subsequent task, the group who had been exposed to the eating enjoyment primes showed significantly slower lexical decision times for diet-related words compared to the control group. This suggests that subliminally priming approach motivation had the effect of suppressing the avoidance goal of dieting. However, little is known about the potential effects of the manipulation of one goal state on another goal state in the field of addiction.

Within the addiction literature, the use of masked priming is very much in its infancy with other methods to assess implicit motivation, such as the SRC and visual probe tasks, outlined above, being favoured. However, when the aim of the research is to determine whether implicit goal states can be manipulated, and the impact of such manipulation on motivation and attentional bias must be assessed, clearly additional methods are called for. Masked affective priming offers a suitable method for this purpose.

Although traditionally participants evaluate a target for positive or negative valence in this paradigm, Ostafin et al., (2003) showed it was possible to substitute this for approach or avoid categorisations. Furthermore, Chen and Bargh (1999)

showed that it was possible for evaluative stimuli to elicit approach and avoidance tendencies in participants. They demonstrated this by asking participants to make a behavioural motor response (flexing the arm to move something closer and extending the arm to move something away). They found that response times were faster for congruent trials (that is, when flexing the arm was paired with a positive stimuli). Taken together, these studies suggest the use of a masked affective priming paradigm to attempt to manipulate approach and avoidance motivation in heavy drinkers, would be an appropriate way to investigate the effects of implicit priming of conflicting motivational states. Particularly, if followed by the administration of visual probe and SRC tasks to measure attentional bias or avoidance, and behavioural approach and avoidance of alcohol-related cues.

Review of Masked Affective Priming Studies

Within social cognition research, there have been a small number of studies to date utilising a masked affective priming paradigm to evaluate a variety of phenomena including implicit self-esteem, in-group favouritism and attitudes. In order to extend the use of this technique into the field of addiction in the most informed way, a critical review of existing studies is necessary. Table 3 (Appendix A) illustrates the studies examined to this end in the narrative below.

The methodology of a masked affective paradigm varies in the literature but is typically comprised of several stages. In designing such a procedure there a number of factors that researchers should cogitate. Typically, the most important of these factors include (but are not limited to) the following; the use of forward masking or sandwich masking (involving both a forward and backward mask), prime duration (length of time the prime is presented), SOA (time between presentation of the prime and the target to be evaluated), the response window, and the number of times the

primes will be presented. Each of these factors is considered in turn below and recommendations for incorporating the technique into future addiction research are suggested.

Forward Masking

Forward masking, as described above, refers to the practice of preceding the appearance of the prime with the presentation of another stimulus, such as a string of letters. Several masked affective priming studies have used a fixation cross as the forward mask (Bauer & Kugel, 2006; Degner et al., 2007; Frings & Wentura, 2008; Murphy & Zajonc, 2003; Suslow, Dannlowski, Ohrmann, Silvestrini & Gendolla, 2011) and the literature does not highlight any difficulties with this. Timings vary across studies from 100 ms to 1000 ms, however, the reasons for this are not widely reported. Alternatively, the technique of sandwich masking as suggested by Greenwald et al., (1996) could provide a further option. This would utilise a forward mask preceding the prime and a backward mask following prime presentation. Appropriate stimuli for this purpose include random strings of consonants (Wentura & Degner, 2010a) or a string of '@' symbols (Wentura et al., 2005).

Prime Duration

In their meta-analysis of masked priming, Van den Bussche et al., (2009) suggest that primes presented for longer than 100 ms are not deemed subliminal. Kouider and Dupoux (2001) assessed prime awareness across different durations within the Forster and Davies (1984, 1991) paradigm and concluded that a prime can be considered as undetectable if its duration is below 50 ms. Furthermore, the majority of the masked affective priming studies reviewed used prime presentations of under 50 ms and most found effects at these durations. In the semantic priming literature,

Greenwald et al., (1996) found effects for primes presented at 17, 33, and 50 ms. In a later study, Draine and Greenwald (1998) found priming effects increase with prime duration, with larger effects found at 50 ms presentation, compared to 33 and 17 ms. However, this study employed the response window technique, therefore, effects may have been caused by forced response times rather than being solely attributable to the prime presentation. Wentura and Degner (2010b) suggest a prime presentation between one to three refresh cycles of the screen, i.e. 12-43 ms. They suggest a random sequence of letters for masking which can arouse less suspicion about the priming event as the participant might assume that the computer is searching for information about the forthcoming trial.

SOA and Response Window

Moors, Spruyt, and De Houwer (2010) report that affective priming occurs with SOAs up to 300 ms but disappears after this (De Houwer, Hermans & Eelen, 1998; Fazio, Lenn & Effrein, 1984, Experiment 2; Hermans, Spruyt, De Houwer & Eelen, 2003). They suggest this may be because prime valence is only active for a restricted amount of time, or it may be because participants do not evaluate the primes with longer SOAs. They also state that short SOAs alone are insufficient; stipulating that studies should have short response times as well, that is, use the response window technique (Draine & Greenwald, 1998). Hermans, De Houwer and Eelen (2001) manipulated the SOA using times of 0, 150, 300, and 450 and found effects only at 0 and 150 ms. Effects disappeared at 450 ms. Based on this, and other independent studies, Hermans at al., (2001) concluded an activation curve of 0 ms, which begins to dissipate at 150 ms.

In semantic priming literature, Greenwald et al., (1996) found that priming effects were much smaller when SOAs exceeded 100 ms than when they were between 67

and 100 ms. They reported that their masked priming effect did not depend on sequence, whereas an explicit control effect did. They found robust priming effects for trials following congruent as well as incongruent trials; however, effects were stronger on trials with congruent predecessors. This points to the use of an SOA of between 67-100 ms, which is in line with the findings above.

Although Draine and Greenwald's (1998) recommendations, described above, were based on a semantic priming study, others have adopted this technique. For example, Custer and Arts (2007) conducted a masked affective priming study where the task was to evaluate words as either 'good' or 'bad'. This study used a SOA of 50 ms and a response window of 450 ms. Frings & Wentura (2003) adopted a procedure identical to that of Custers and Arts (2007) but with a slightly shorter SOA of 42 ms. Again the task was to evaluate 20 words (10 good, 10 bad) as positive or negative. Wentura et al., (2005) followed the same timings as well using participants' initials as primes, and 10 positive and 10 negative adjectives to be judged 'positive' or 'negative' as targets.

Some of the studies found priming effects (Frings & Wentura, 2003; Wentura et al., 2005) and others did not (Degner & Wentura, 2009). As the studies vary in terms of other methodological features it is hard to say whether the failure to find effects in the latter study was due to the response window technique or some other factor. However, overall the technique appears to yield robust effects. One way of utilising the response window technique would be to give participants error feedback if they fail to respond within the allocated window so they learn to speed up on subsequent trials.

Prime Presentation

Silvestrini and Gendolla (2011) reported that exposure to masked sad faces resulted in higher systolic blood pressure, that is, greater effort, during a subsequent attention task than exposure to happy faces. This effect occurred only when faces were presented in a third of the trials, as opposed to when presented in two or three thirds, when the effect disappeared. The authors explain this by the process of habituation. However, they do not report how many trials were administered and 66 of the 75 participants were women, therefore, the findings may not be generalisable. Furthermore, the studies quoted to support their claim are not comparable because they did not use subliminal priming. Wong and Root (2003) also reported that the effect of subliminal facial primes diminished with repetition, however, they had a long backward mask of 3000 ms, which is quite different from the literature highlighting the importance of the SOA.

In contrast, Wentura and Degner (2010b) suggest that masked priming studies should have more trials (100 per block) than studies where the prime is consciously processed as it may take more repetitions of the prime to achieve the effect. They also recommend warm up trials as well as practice trials. Cunningham, Preacher and Banaji (2001) suggest that affective priming experiments should maximise the number of trials included as participants' response latencies fluctuate over trials, which could lead to low reliability. This might be particularly true of tasks that do not require the participant to categorise stimuli, as is the case in the attentional bias task used in this study.

Recommendations

Taking the above findings into account, the following masked priming methodology would seem suitable for the purpose of implicitly priming conflicting

motivational states: A forward mask, in the form of a fixation cross, to be presented on the screen for 500 ms, followed by the prime for 34 ms, a backward mask for 51 ms, giving a SOA of 85 ms in line with the findings presented above. Presentation of the target would then follow, after which a response window could be utilised in line with the response window technique (Draine & Greenwald, 1998). Due to the nature of the visual probe and SRC tasks, the response window will likely vary between the tasks, however, a time-limited response could be required in both cases.

Clinical Relevance

From a review of the current literature, it seems that a full understanding of the term 'implicit' is yet to emerge (Roefs et al., 2011). Despite this, and the difficulties with research studies and implicit measures used to date, there is evidence to suggest that processes of implicit cognition make a unique contribution to the variance in drinking behaviour of heavy drinkers and alcohol-dependent patients. Therefore, targeting implicit cognition is likely to form a useful addition to treatment that is currently heavily focussed on techniques such as motivational interviewing (Miller & Rollnick, 2002). The current research, exploring ways to translate existing findings into clinical practice, is reviewed below, with an emphasis on retraining cognitive biases.

Attentional bias has been shown to predict individual differences in alcohol consumption and alcohol problem severity in both social drinkers (Miller & Fillmore, 2010; Murphy & Garavan, 2011) and the alcohol-dependent population (Jones, Bruce, Livingstone & Reed, 2006). Previous studies have attempted to manipulate attentional bias to investigate whether this has an impact on behaviour and craving in response to substance cues with mixed outcomes. Field and Eastwood (2005) attempted to manipulate attentional bias by allocating a group of heavy

drinkers to one of two groups. Both groups completed an attentional bias task. In the first condition the probe always replaced pictures of alcohol, and in the second condition neutral pictures were always replaced by the probe. In this way the participants in the second condition were trained to avoid alcohol cues. The results showed that compared to a baseline assessment, those in condition one had a significantly larger attentional bias for alcohol cues, whereas those in condition two displayed a significantly lower attentional bias for alcohol-related stimuli. Furthermore, on a subsequent taste test, those in the first condition went on to consume significantly more beer than the other group. This finding suggests that motivation to drink alcohol can be manipulated by retraining attentional bias and this may have important implications for clinical practice if future studies can demonstrate a link between training attentional bias away from alcohol cues and a reduction in motivation to drink alcohol. However, these findings did not generalize to new pictures that participants had not received training on (Schoenmakers, Wiers, Jones, Bruce & Jansen, 2007) and they failed to replicate this finding when they repeated the experiment introducing a more 'neutral' control group relative to the control group used in the first study (Field, Duka, et al., 2007). Furthermore, the motivation for alcohol did not significantly decrease in the second group. However, further research utilising more trials and repeated training sessions may yield more promising results (Wiers et al., 2006).

Fadardi and Cox (2009) developed the Alcohol Attentional Control Training Program (AACTP) to help alcohol misusers overcome their attentional bias for alcohol. The AACTP aims to help trainees become more aware of the unconscious aspects of their drinking behaviour and to gain more control over these processes through a series of exercises. The researchers trained heavy drinkers to control their

attentional bias to alcohol stimuli leading to a reduction in consumption of alcohol at three-month follow-up. However, the utility of the study was compromised by the lack of a control group. Similar effects have been reported elsewhere (Schoenmakers et al., 2010) and represent a positive development for potential future treatment of alcohol-dependent patients.

Wiers et al., (2010) trained a group of hazardous drinkers to either approach or avoid alcohol cues using a version of the AAT. Participants moved a joystick either away from or towards themselves according to whether alcohol and non-alcohol pictures were displayed in landscape or portrait format. The experiment was designed so that those in the 'approach alcohol' group had to pull a joystick towards themselves more often in response to pictures of alcohol, whereas those in the 'avoid alcohol' condition had to move the joystick away more frequently. Results showed that both groups exhibited changes in their automatic tendencies that corresponded to their experimental condition. Additionally, those trained to approach the alcohol stimuli consumed more alcohol on a subsequent tasting test than those in the avoid condition. These effects generalised to new pictures and a separate test using words. This study provides evidence for a link between automatic processes and drinking behaviour in hazardous drinkers, suggesting that, in the future, it might be possible to reduce alcohol consumption by influencing automatic cognitions.

Wiers et al., (2011) conducted cognitive bias modification (CBM) training with a group of alcohol-dependent patients by teaching them to automatically avoid, rather than approach, alcohol-related cues. The results showed that alcohol-dependent patients' approach bias turned into an avoidance bias following the training. This effect also generalised to new pictures that participants had not received prior training on. Wiers et al., (2011) also measured relapse rates at one-year follow-up

and found that the training might have had some impact on the likelihood of relapse. However, action tendencies were not measured at follow-up. Nonetheless, this study is particularly promising as it incorporated two control groups and a large sample size of 214 patients.

Eberl et al., (2012) replicated the effects of alcohol avoidance training in a group of 509 alcohol-dependent patients. Half of their sample received treatment as usual and the other half received CBM. Eberl et al., (2012) discovered that older patients, and those with stronger approach biases for alcohol on pre-test measures, benefited most from the CBM. Although in the case of older patients it is difficult to explain these findings, as there were a number of correlated variables. Lower relapse rates at one-year follow-up were also found, suggesting these training effects may be robust. Future research to clarify the optimal conditions for achieving CBM effects is needed, for example, number of training sessions, as well as the length, spacing and intensity of those sessions.

Houben, Havermans and Wiers (2010) used an evaluative conditioning task to target implicit cognitions in a group of student drinkers. Participants were assigned to one of two groups and asked to respond as quickly as possible to a range of stimuli presented on screen. In the first group alcohol words were paired with negative stimuli and in the control group the same words were paired with neutral stimuli. Implicit and explicit attitudes were measured before and after the evaluative conditioning task. Results showed that those in the experimental condition showed stronger negative implicit attitudes, and consumed less alcohol on a subsequent test, compared to the control group. These results suggest that implicit attitudes can be altered with promising implications for changing drinking behaviour.

Training on how to overcome impulses may help those addicted to substances, as it has done in other clinical populations, for example, children with attention deficit hyperactivity disorder (Stacy & Wiers, 2010; Thush et al., 2008) although further evidence in the form of large-scale randomised control trials is needed before treatment efficacy can be determined. Therefore, gaining a clearer understanding of implicit cognitions and their role within the ambivalence model of craving described above could have important implications for alcohol treatment programmes, as well as ways to target health and social problems connected to heavy drinking.

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Chapter 2

Empirical Paper

Implicit Priming of Conflicting Motivational States in Heavy Drinkers[1]

[1] This manuscript will be submitted to PLOS ONE, author guidelines can be found in Appendix B

Abstract

Background: Theories of motivational conflict are key in understanding alcohol misuse. Research suggests that approach and avoidance motivation are two distinct systems and that level of alcohol consumption depends on which system is most activated at one time. One factor thought to influence this balance is the role of implicit processes. This study aimed to investigate the effects of implicitly priming one motivational system (i.e. approach / avoidance) on the opposing system in regard to alcohol-related motivation in heavy drinkers.

Methods: Heavy drinkers were recruited from a non-clinical community sample to complete a protocol of stimulus response compatibility and visual probe tasks designed to measure implicit motivation by recording reaction times to alcohol cues. Participants were assigned to one of three groups and attempts were made to manipulate implicit motivation using a masked priming paradigm. Measures of explicit attitudes towards alcohol were also administered.

Results: No significant effects of priming were found. The overall sample showed attentional avoidance for alcohol cues presented at 50 ms duration but not at 500 ms. On the SRC task, participants were slower to avoid alcohol cues than neutral cues. Positive correlations were found between attentional bias for alcohol cues presented for 500 ms on the visual probe task and craving and consumption as measured by the Alcohol Approach Avoidance Questionnaire (AAAQ) and the Alcohol Use Disorders Identification Test (AUDIT) respectively.

Significance: Implicit priming of alcohol-related motivational states had no influence on indices of alcohol approach and avoidance motivation or on attentional bias. As an overall sample, heavy drinkers showed automatic attentional avoidance

of alcohol cues presented at short durations (50 ms). This is the first study to find avoidance of alcohol cues presented at this duration in heavy drinkers.

Introduction

This introduction aims to outline motivational models and implicit cognition theories in relation to alcohol addiction research. A brief overview of the current literature in this area will be provided before outlining specific research, which has attempted to manipulate implicit goals states in line with the aims of the current study. Hypotheses in relation to the current study are detailed at the end of this section.

Models explaining motivational states were previously thought to be uni-dimensional in nature [1]. However, recently multi-dimensional models have posited that approach and avoidance motivation are separate systems. The ambivalence model of craving [2] proposes that consumption of alcohol for an individual depends on the balance between motivation to indulge and motivation to refrain, for example, being at a party but having to drive home. Therefore, alcohol use could vary according to which system is more activated at any one time [3]. Evidence to support the concept of two separate motivational systems exists in the areas of dieting [4], mental health [5], and alcohol use [1]. Factors influencing the balance between the two systems are multiple and varied, however, one factor to attract a lot of attention in the research has been the role of controlled and automatic processes.

'Implicit' or 'automatic' processes are said to operate outside conscious awareness and are difficult to control, whereas explicit processes are within conscious awareness [6] and easier to exert control over. The contribution of these two processes to problematic substance use is the basis of dual process theories [7]. It has been suggested that alcohol use may begin as a result of a controlled process but

then become automatic with prolonged use [8]. Incentive-sensitisation theory [9] supports this argument purporting the difficulties with substance use may begin with 'liking' the substance, which then turns into 'wanting' the substance (despite no longer liking it) with sustained use.

Researchers within the addiction field have been interested in three types of implicit cognitions: attentional bias, approach and avoidance tendencies, and uncontrolled memory associations. Attentional bias occurs when an individual shows increased attention for particular stimuli (e.g. alcohol pictures) compared to alternative stimuli, (e.g. pictures of furniture). There are several ways to measure attentional bias, one of the most popular of which has been the visual probe task (VP) [10]. In a typical version of this task, two matched pictures are presented on screen for a brief duration; one of the pictures is then replaced by a probe (e.g. an arrow). The participant's task is to respond to the probe by pressing the relevant key on the keyboard. In such a task involving alcohol and neutral pictures, attentional bias would be inferred if the participant's mean reaction time to probes was quicker when they replaced the alcohol pictures (congruent trials), compared to when they replaced the neutral pictures (incongruent trials). If, however, this pattern were reversed (i.e. participants were quicker to react to incongruent trials) attentional avoidance would be concluded. Several studies have shown that heavy drinkers display attentional bias for alcohol cues [10], [11]. There is also evidence to suggest that there is a positive correlation between the frequency of alcohol use and the magnitude of the attentional bias [12].

Concepts of behavioural approach and avoidance are integral to the ambivalence model and are thought to be able to account, to some extent, for addiction processes. For example, in certain circumstances, such as at a party, heavy drinkers are likely to

be highly motivated to consume (i.e. approach) alcohol if they are able to, whereas their motivation to abstain may be low. Therefore, it is likely they will drink. Alcohol dependent patients, on the other hand, may be highly motivated both to consume alcohol and to abstain, resulting in ambivalence. The stimulus-response compatibility task (SRC) [13] has been used in addiction research to measure implicit approach and avoidance tendencies. Traditionally in this task, a mannequin appears on screen with either an alcohol-related or neutral picture. Participants must move the manikin towards or away from the pictures according to task instructions whilst their reaction times are measured. An approach bias for alcohol is inferred if participants are quicker to approach the alcohol pictures than to avoid them. A problem with this version of the task is that it only allows approach tendencies to be measured *relative* to avoidance tendencies. Therefore, it is difficult to say whether approach biases are the result of strong approach tendencies, weak avoidance tendencies or a combination of the two. There is evidence that heavy drinkers display implicit behavioural approach towards alcohol cues [14].

The ambivalence model, together with dual process and incentive-sensitisation theories, provide an explanation of research findings showing that alcohol-dependent patients and heavy drinkers display both attentional bias, and motivation to approach alcohol-related cues, on implicit measures, such as the VP and SRC tasks [10]-[14], whilst simultaneously self-reporting motivation to avoid these cues [15], [16].

An advantage to exploring automatic attitudes is that they are not subject to the same pitfalls of social desirability biases. They also allow for the possibility that participants are often unaware of biases driving their behaviour [17]. Gaining a clearer understanding of implicit cognitions and their role within the ambivalence model could have important implications for extending the treatment options

available to alcohol-dependent individuals beyond the use of motivational interviewing and cognitive behavioural techniques. For example, attentional bias training has been shown to help participants avoid alcohol cues [18], [19]. Cognitive bias modification (CBM) training [20] and evaluative conditioning tasks [21] have also been trialled with some success, which has demonstrated an impact on drinking behaviour.

Previous research has demonstrated that goal states at both explicit [22] and implicit levels [4] can be manipulated. In the latter study researchers used a masked priming paradigm with a group of dieters. Primes were either neutral or positively associated with eating pleasure, for example, 'tasty'. Following this, the group who had seen the positive primes were slower to categorise diet-related words compared to the control group, suggesting that their avoidance goal of dieting had been suppressed by presentation of primes associated with eating enjoyment, that is, approach motivation. The current study employed a variation of the procedure used by Stroebe et al. [4] known as masked affective priming, which is described below.

The first affective priming paradigm was introduced by Fazio et al. [23]. In a typical version of the protocol participants must categorise adjectives (e.g. 'beautiful') as either positive or negative as quickly as possible. The adjectives are preceded with either a congruent (e.g. 'good') or incongruent (e.g. 'nasty') valenced prime. Typically, participants are faster to categorise adjectives preceded by congruent primes. This technique has yielded priming effects across social cognition research in several areas including self-esteem [24], in-group favouritism [25] and prejudice [26] and has been modified for exploring motivational tendencies towards alcohol [3]. The effect of masked affective priming was first demonstrated by Draine and Greenwald [27] who showed that effects could be found at very brief prime

durations, even when those primes were disguised by a mask. They also discovered effects were maximised via the use of the response window technique, which forced participants to respond to targets within a certain time limit. This combination of techniques is now commonly used to assess attitudes [28]-[30] and is unobtrusive since participants are unaware that attitude-related stimuli are being presented.

The current study aimed to modify and extend the work of Stroebe et al. [4] to explore the effect of implicitly priming one goal state on the opposing state, in relation to approach and avoidance goals for alcohol. We also investigated the relationship between implicit tendencies and explicit measures by asking participants to complete three self-report measures: the Time Line Follow Back (TLFB) [31], the Alcohol Use Disorders Identification Test (AUDIT) [32] and the Approach and Avoidance of Alcohol Questionnaire-Right Now (AAAQ) [1].

Our primary hypotheses were that (i) in relation to both the alcohol-aversive and neutral group, implicitly priming participants with alcohol-appetitive words would: (a) increase early attentional bias and reduce late attentional avoidance; and (b) increase approach bias and reduce avoidance bias; (ii) in relation to both the alcohol-appetitive and neutral group, implicitly priming participants with alcohol-aversive words would: (a) reduce early attentional bias and increase late attentional avoidance; and (b) reduce approach bias and increase avoidance bias.

Our hypotheses in relation to the self-report measures were that there would be a positive correlation between implicit and self-reported approach measures as seen in previous research [11].

Method and Materials

Participants

A non-clinical sample of 110 heavy drinkers (41 male, 69 female, mean age, M = 32.54, SD = 8.01) was recruited from the northwest of England, for example, from local businesses, university campus and from NHS sites where the researcher was working. Participants were randomly allocated to one of three groups; positive, negative and neutral. The groups were well matched on variables of age, employment status and educational achievement.

Positively-Primed Group. Comprised of 38 participants (15 male, 23 female, mean age, M = 32.58, SD = 8.19). Of these, 92% were currently working and 79% were educated to at least undergraduate level.

Negatively-Primed Group. Made up of 36 participants (9 male, 27 female, mean age, M = 33.00, SD = 8.76). In this group 81% were in employment and 80% were educated to at least undergraduate level.

Neutral-Primed Group. Consisted of 36 participants (17 male, 19 female, mean age, M = 32.03, SD = 8.76). Of these, 78% were currently employed and 75% were educated to undergraduate level or above.

Table 1 shows the demographic and questionnaire data for each group. Groups did not differ significantly in terms of gender ratio, χ^2 (2, N = 110) = 3.92, p = .14, level of education ratio, χ^2 (4, N = 110) = .70, p = .95, or employment status ratio, χ^2 (4, N = 110) = 6.33, p = .18. A series of One-Way ANOVAs were conducted with group as the between-subjects variable (positive, negative and neutral) and age, AAAQ-Right Now subscale scores (Inclined, Resolved and Obsessed), AUDIT total score, and TLFB scores (peak consumption, number of units consumed, and number of days

drinking in two weeks) as dependent variables. No significant group differences were found on any of the measures (*p*s > .05).

Inclusion criteria was as follows: (i) aged between 25 and 60 years (this age group are more likely to be in full-time employment or studying, but with family commitments; therefore, should have incentives to limit their alcohol consumption), (ii) English as first language (due to the nature of the tasks), (iii) heavy drinkers (the criteria used to define a heavy drinker was taken from the UK Department of Health guidelines and includes women who consume in excess of 14 units per week and men who consume in excess of 21 units per week), (iv) ability to use a laptop keyboard, (v) normal or corrected-to-normal vision.

Exclusion criteria included: (i) current or past alcohol or substance dependence, (ii) currently suffering from acute mental health difficulties, (iii) positive breath alcohol level.

The study was approved by the University Research Ethics Committee and by NHS Research Ethics Committee as recruitment included NHS staff. Details of ethical considerations can be found in Appendix C. All participants provided written informed consent prior to commencing the study and permission was sought from relevant managers in the work place in regard to displaying posters and recruitment of staff. The recruitment advertisement can be found in Appendix D, the participant information sheet in Appendix E, and the consent form in Appendix F.

Measures

AAAQ-Right Now.

The AAAQ-Right Now [1] is a self-report measure consisting of 3 subscales. This 14-item self-report questionnaire assesses inclinations to approach and avoid drinking. Respondents are asked to rate how strongly they agree with each item, on a

9-point Likert scale from 0 (not at all) to 8 (very strongly), yielding possible scores between 0 and 112. The 'inclined / indulgent' subscale explores mild approach tendencies, the 'obsessed / compelled' subscale examines intense approach inclinations, and the 'resolved / regulated' subscale assesses avoidance tendencies. The subscales have been shown to have high internal consistency ($\propto$ = .90, .86 and .72, respectively) [1]. The internal consistency of the scale in this study was also found to be good ($\propto$ = .85).

AUDIT.

The AUDIT [32] is a ten-item self-report questionnaire measuring alcohol consumption, alcohol dependence, and alcohol-related difficulties. The questionnaire is scored from 0 to 36. Scores of 8 or more in men (7 in women) indicate a high probability that an individual's drinking behaviours are hazardous, whilst a score of 20 or more may indicate alcohol dependence [32]. The psychometric properties of the AUDIT have been extensively researched and it has been shown to have good test-retest reliability and internal consistency [33]-[35]. One validation study [36] reported good internal reliability ($\propto$ = .86) and test-retest reliability ($\propto$ = .90). In the current study the internal consistency of the measure was found to be acceptable ($\propto$ = .73).

TLFB.

The TLFB [31] is a retrospective diary that allows participants to record their alcohol consumption in units over the past fortnight. From this, three figures are calculated; total units consumed, peak consumption (highest number of units in one day) and number of days on which alcohol was consumed. The AAAQ, AUDIT and TLFB measures can be found in Appendix G.

Visual Probe Task.

The visual probe task [11] is an established tool in addiction research and there is considerable evidence suggesting that it is capable of measuring attentional bias in substance users [10], [19]. Standard versions of this task have been described in the introduction of this paper (p. 66). In this version of the task, neutral-neutral trials were included to enable attentional orienting and disengagement to be investigated separately. A set of 10 alcohol-related and 10 neutral pictures used in previous research [10] were employed. Additionally, a set of eight neutral picture pairs (with no alcohol-related content) was interspersed within each block. Pictures on alcohol-neutral trials included bottles of spirits matched with bottles of soft drinks, whilst neutral-neutral trials used pictures of a pencil matched with a picture of a stapler, for example. All pictures measured 95mm x 130mm.

SRC Task – Modified.

The standard SRC task [13] is described above (p.67). In this modified version of the task neutral movements were included and the trials were split into four blocks (rather than the standard two), in order to look at approach and avoidance motivation independently of each other (details in procedure section). Photographs used for the task were seven alcohol and seven matched control pictures. All photographs were 100mm high x 125mm wide and based on a previously validated set [11], [13]. For example, alcohol-related pictures included a female model pouring a beer with a matched neutral picture of the same model stapling pages.

Alcohol pictures in both the SRC and VP tasks depicted a range of beverages including beer, wine and spirits. The images were matched as closely as possible for complexity, colour, brightness, setting, and size of object. Inquisit software (version

2.0; Millisecond Software, 2004) was used to programme the tasks on a laptop with a 15-inch monitor, standard keyboard and a refresh rate of 17 ms per cycle.

Selection of Primes.

Thirty primes were used for the masked priming paradigm: 10 alcohol-appetitive words, (e.g. 'party'), 10 alcohol-aversive words, (e.g. 'nausea'), and 10 neutral words, (e.g. 'bookshelf'). The process for selecting the primes was as follows. A list of 32 alcohol-appetitive and alcohol-aversive words was created based on words validated in previous studies and additional words suggested by the current authors, many of which were taken from the lexicon of alcohol and drug terms published by the World Health Organization [37]. This list was then presented to 22 people (who did not participate in the main study) who were asked to select 10 words from each list that would be most likely to encourage and discourage them from drinking alcohol. The 10 most frequently endorsed words in each category in the pilot study were selected for the main study. A list of 10 neutral words, were then created based on types of furniture. This category was selected due to lack of emotional valence and lack of conflict with the neutral pictures presented in the VP and SRC tasks. All three categories of primes were matched on number of letters and syllables. For further details please see Tables 4 – 6 in Appendix H.

Procedure

Participants were invited to take part in the study via posters displayed in workplace locations and via 'staff announcements' on the University intranet. Those interested were provided with a copy of the participant information sheet at least 24 hours prior to taking part in the study. All participants were tested in a quiet room, individually, either at the University or within the workplace.

Participants began by completing the consent form and screening measure, following which a breathalyser test using a Lion Alcolmeter (Lion Laboratories, Barry, UK) was administered to ensure a zero breath alcohol level, since positive readings could interfere with reaction times. No positive readings were detected. Demographic information was then provided including, gender, age, employment status and education level. Participants were then positioned at a desk with the laptop 50cm in front of them.

Computer-based tasks were then administered, the order of which was counter-balanced for all participants. Verbal instructions were provided before each task and written instructions appeared on screen. Participants were told that their reaction times to stimuli presented on screen would be measured. Presentation of the primes was not mentioned.

Masked Priming Paradigm.

The masked priming paradigm was embedded at the start of each trial for the SRC and VP tasks. The procedure adopted was based on a review of the masked affective priming literature. Firstly, participants were instructed to focus on a forward mask, in the form of a fixation cross, presented on the screen for 500 ms. This was followed by the prime for 34 ms, then a backward mask for 51 ms, giving a stimulus onset asynchrony (SOA) of 85 ms. Research suggests this is optimal timing to maximise priming effects [24], [30], [38], [39]. Presentation of the target followed this sequence, utilising a response window in line with the response window technique [27]. This has also been shown to enhance priming effects. Due to the nature of the visual probe and SRC tasks, the response window varied between the tasks. Please see supplementary information in Appendix I for further details. The inter-trial interval was set at 1000 ms on VP and SRC tasks.

Visual Probe Task Procedure.

Following presentation of the prime, two pictures appeared on screen, side by side, one of which was replaced by a visual probe (small white square). Participants were asked to respond to this probe as quickly as possible by pressing the appropriate button on the keyboard. The task consisted of two blocks, counterbalanced for each participant; one in which cues were presented for approximately 50 ms and another in which cues were presented for 500 ms. This order was also counterbalanced within groups. In each block, there were 100 trials. Each picture pair was presented eight times: four times with the alcohol picture on the left, four times with the alcohol picture on the right, and within this the probe replaced the alcohol picture half the time and the neutral picture the rest of the time. The remaining 20 trials were neutral-neutral trials. Response times were recorded.

SRC Procedure.

The task consisted of four blocks of trials, with 56 trials in each block. The four blocks had different instructions: 1) move the manikin towards alcohol-related pictures and left for stationery pictures; 2) move the manikin towards neutral pictures and left for alcohol-related pictures; 3) move the manikin away from alcohol-related pictures and left for stationery pictures; 4) move the manikin away from stationery pictures and left for alcohol-related pictures. Before each block, participants completed eight practice trials, four of each for alcohol and neutral pictures. On each trial participants were presented with either a picture of an alcohol-related image or a neutral image of stationery. In each block, each picture was presented four times each, twice with the manikin above and twice with the manikin below. The order of the blocks was counterbalanced within each group and within each block; trials were presented randomly. Participants were instructed to respond by pressing buttons on

the keypad to move the manikin either up, down or left according to the instructions. Response times were recorded.

Prime Visibility Measure.

To ensure participants could not detect the primes, a prime visibility measure, in the form of a forced recognition task, was incorporated into the procedure. In each trial the masked prime was presented on screen exactly as it was in the SRC and VP tasks. Following this, two primes appeared on screen, one of which was the prime previously displayed, i.e. the target. Participants were asked to press the left or right key according to which word they think they saw. Positions of the primes were counterbalanced. If participants performed at no better than chance levels it was assumed they did not consciously detect the primes. Each participant completed 20 trials on this block. Their responses were not time limited. Forced recognition tasks are an established method for evaluating prime visibility in masked affective priming literature [28].

Following completion of the computer-based tasks, participants completed the AAAQ-Right Now, AUDIT and TLFB. Finally, they were given a debrief sheet (Appendix J) containing details of the masked priming technique and a factsheet on alcohol use. Administration of this research protocol was between 45 minutes to one hour. Participants were compensated for their time with a £10 high street voucher.

Data Analysis

As a response window was imposed on the tasks, a greater number of errors were expected, therefore, a limit of up to 40% errors was permitted on each block. This resulted in the loss of data from 22 participants in the SRC task, eight from the VP 50 ms task and six from the VP 500 ms task.

Data from trials with reaction times below 100 ms were discarded. To deal with outliers, data were discarded on trials when reaction times exceeded the participants' mean reaction times by three standard deviations. This was done separately for the VP and SRC tasks. The result was that an average of 9.7% of data was lost for the VP 50 ms, 5.7% for the VP 500 ms, and 21.7% for the SRC tasks.

To test the hypotheses, two mixed-design analyses of variance (ANOVA) were performed. In the first, VP block (VP 50 ms and VP 500 ms) and VP trial type (incongruent, congruent and neutral-neutral) were entered as within-subject factors and group (positive, negative and neutral) as the between-subjects factor. Significant interactions were further explored using t-tests (see below for further details).

A second mixed-design analysis of variance (ANOVA) was performed with SRC block ('approach alcohol', 'approach control', 'avoid alcohol', 'avoid control') entered as within-subjects factors and group (positive, negative and neutral) as the between-subjects factor. Significant interactions were again explored using t-tests (see below for further details).

Finally, Pearson's correlations were performed to explore relationships between explicit and implicit measures using the attentional bias scores on both VP tasks, and the approach and avoidance bias scores on the SRC task.

Attentional bias was calculated for each block of the VP tasks (50 ms and 500 ms SOAs) by subtracting mean reaction times on congruent trials (trials where the probe replaces an alcohol picture) from mean reaction times on incongruent trials (where the probe replaces the neutral picture) such that a positive score is indicative of attentional bias for alcohol pictures.

Mean response latencies for each block of the SRC ('approach alcohol', 'approach control', 'avoid alcohol', 'avoid control') were then calculated. Approach bias was

calculated by subtracting the mean reaction times on the 'approach alcohol' condition from the mean reaction times on the 'approach control' condition. Avoidance bias was calculated in the same way, such that positive scores reflect approach and avoidance biases for alcohol pictures.

Table 1.
Demographic and Questionnaire Data for Positive, Negative and Neutral Groups.

		Positive		Negative		Neutral			
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*F*	*p*
Age		32.58	8.19	33.00	8.76	32.03	7.19	.13	.88
Gender	M:F	15:23	-	9:27	-	17:19	-	-	-
Education	S:C:U	1:7:30	-	1:6:29	-	2:7:27	-	-	-
Employment	E:S:U	35:1:2	-	29:4:3	-	28:7:1	-	-	-
AAAQ	Inclined	4.01	2.37	4.41	2.11	4.20	2.21	.30	.74
	Resolved	1.79	1.10	2.02	1.11	2.02	1.22	.50	.61
	Obsessed	0.89	1.29	1.33	1.46	1.21	1.84	.81	.45
AUDIT		9.13	4.24	11.25	4.84	9.83	3.69	2.34	.11
TLFB	1	12.82	9.38	13.81	8.00	12.83	7.59	.17	.85
	2	42.18	29.59	42.22	24.13	44.20	36.10	.05	.95
	3	5.79	3.03	5.83	2.54	6.20	3.20	.18	.84

Note. Education = number of participants who left full-time education after school (S), college / sixth form (C), or university (U); Employment = number of participants who were employed (E), full-time students (S), or unemployed (U); AAAQ = Approach and Avoidance of Alcohol Questionnaire – Right Now; AUDIT = Alcohol Use Disorders Identification Test; TLFB = Time Line Follow Back (diary of alcohol consumption): 1 = Peak consumption (highest number of units in one day over two week period), 2 = Total units consumed in two weeks (1 unit = 8g alcohol), 3 = Total number of days alcohol consumed in two week period.

Results

Data were examined to investigate whether they met the assumptions of normal distribution and homogeneity of variance prior to conducting the analyses. Both assumptions were met. Details of data screening procedures can be found in Appendix K.

Prime Visibility Check

Participants completed 20 trials of the forced recognition task. The range of correct responses was 5 to 17 (M = 10.32, SD = 2.55). A one-sample t-test indicated that performance of this task was at chance levels $t(110) = 1.3$, $p > .05$. Furthermore, none of the participants reported being able to detect the primes.

Visual Probe Task

We performed a 3 x 2 x 3 mixed ANOVA with group (positive, negative and neutral) as the between-subjects factor and VP block (50 ms and 500 ms) and VP trial type (incongruent, congruent and neutral-neutral) as within-subjects factors. Mauchly's test indicated that the assumption of sphericity had been violated χ^2 (2) = 9.95, $p < .01$, therefore, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .95$). However, this made no difference to the output.

The results show there was no significant effect of group $F(2,96) = 0.80$, $p = .45$, $\eta^2_p = .02$. This was counter to expectation. Please see Figures 1 and 2 for mean reaction times in each group. There was a significant main effect of VP block regardless of group allocation or trial type: $F(1, 96) = 9.78$, $p < .01$, $\eta^2_p = .09$. Within-subjects contrasts indicated that participants were quicker to respond to pictures presented for 50 ms than 500 ms. There was also a significant interaction effect between VP block and VP trial type $F(2, 182) = 4.58$, $p < 0.05$, $\eta^2_p = .05$. Further analysis with paired samples t-tests showed that on the 50 ms VP block, participants were significantly quicker to respond to incongruent trials (M = 335.46, SD = 22.39), than to both congruent trials (M = 338.30, SD = 22.85), $t(101) = 2.43$, $p < .05$, and control trials (M = 339.80, SD = 21.45), $t(101) = -3.12$, $p < .01$. This means that, in the 50 ms trials, participants showed attentional avoidance of alcohol pictures, and this was true based on both the classic congruent-incongruent

difference, as well as the difference between incongruent and neutral-neutral trials. Paired samples t-tests showed that on the 500 ms VP block, there were no significant differences between trial types (*p*s > .05). No further significant interactions were found (*p*s >.05).

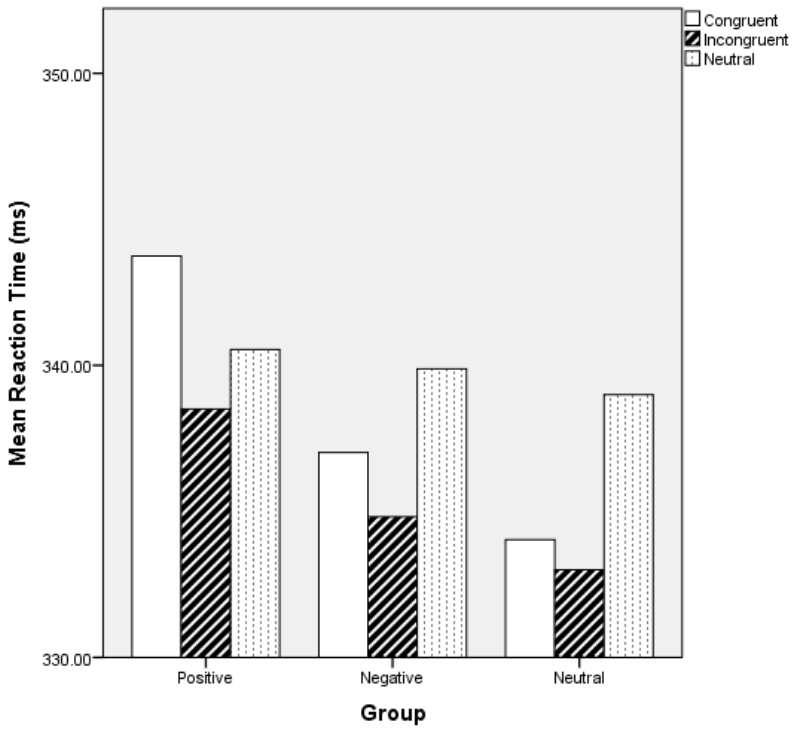

Figure 1.
A bar chart to show mean reaction times to the three trial types of the VP 50ms task by group.

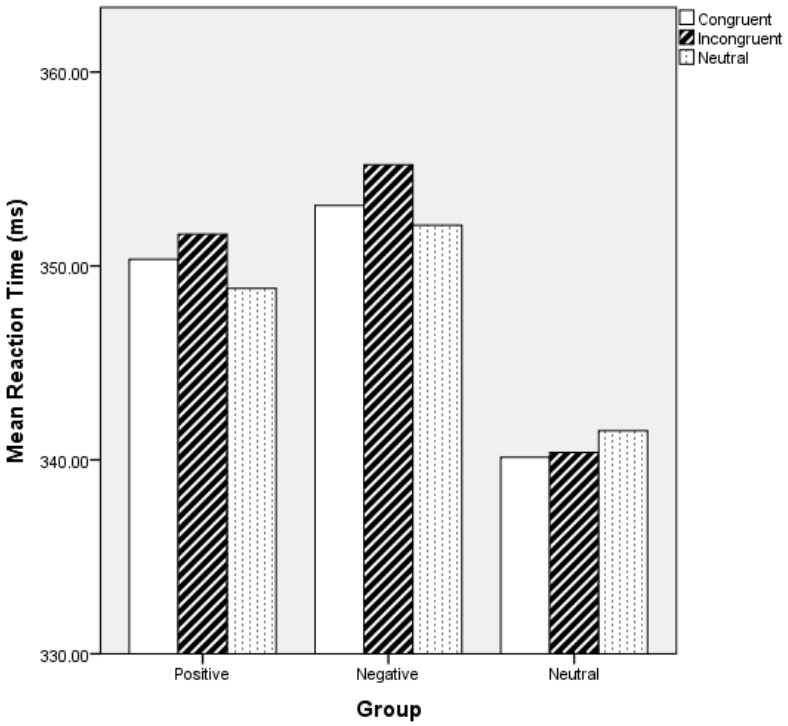

Figure 2.
A bar chart to show mean reaction times to the three trial types of the VP 500ms task by group.

SRC Tasks

We carried out a second mixed ANOVA to investigate whether there were any significant differences between the groups on approach and avoidance tendencies on the SRC task. This time, response type (approach, avoidance) and picture type (alcohol, control) were entered as the within-subjects variables and group as the between-subjects variable. The results show there was no significant effect of group $F(2,85) = 0.62$, $p = .54$, $\eta^2_p = .01$. Please refer to Figure 3 for mean reaction times to each block by group.

There was a significant interaction between response type and picture type $F(1,85) = 6.16$, $p < .05$, $\eta^2_p = .07$. Paired samples t-tests demonstrated that this was reflective of participants being slower to avoid alcohol ($M = 523.1$, $SD = 42.5$) than neutral pictures ($M = 516.90$, $SD = 43.69$), rather than being significantly quicker to

approach alcohol pictures (M = 516.6, SD = 37.4) compared to neutral pictures (M = 520.2, SD = 41.5) $t(87) = 1.86$, $p = .03$.

Finally, there was also a significant interaction between picture type and group $F(2,85) = 3.71$, $p < .05$, $\eta^2_p = .08$. This could have been further analysed using a one-way ANOVA. Firstly, two new variables would need to be created by averaging approach and avoidance times to alcohol and control pictures respectively. These two new dependent variables would then be entered into the ANOVA with group as the between-subjects factor. However, as this interaction is not related to the hypotheses, this was not considered necessary. Instead, the data were viewed in the bar chart (Figure 3). Participants in the neutral group were faster to approach both alcohol and control pictures than participants in the positive and negative groups. Those in the neutral group were also quicker to avoid control pictures than the other two groups and quicker to avoid alcohol pictures relative to the negative group only. No further significant interactions were found (ps >.05).

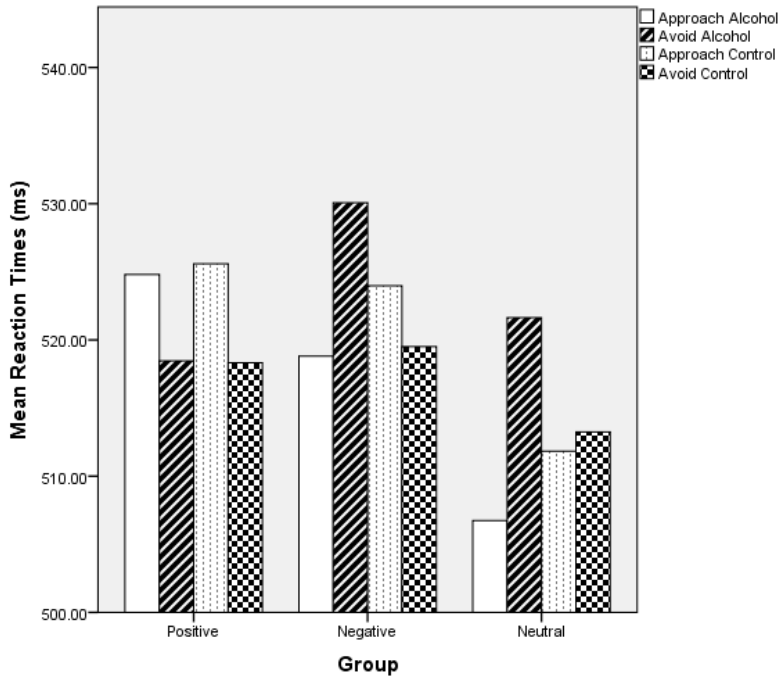

Figure 3.
A bar chart to show mean reaction times to the four conditions of the SRC task by group.

Explicit Motivation

Pearson's correlations were used to investigate the relationship between reactions to implicit and explicit variables. The attentional and approach / avoidance bias scores were utilised for this purpose. Analysis revealed a weak correlation between attentional bias for cues presented at 500 ms and total scores on the AUDIT, $r = .20$, ($N = 104$), p (one-tailed) $< .05$, and on the obsessed / compelled subscale of the AAAQ-Right Now, $r = .18$, ($N = 104$), p (one-tailed) $< .05$. This indicates that higher scores on the AUDIT and obsessed / compelled subscale of the AAAQ were weakly associated with greater attentional bias for alcohol cues presented at 500 ms. There was also a weak correlation between approach bias on the SRC task and peak consumption recorded on the TLFB, $r = .18$, ($N = 88$), p (one-tailed) $< .05$, indicating that tendencies to approach alcohol pictures on the SRC task are associated with total number of units consumed on one occasion. One-tailed p values are reported here due to the nature of the hypotheses, however, it is noted that two-tailed p values were not significant. Furthermore, when using Bonferroni's test to correct for multiple comparisons a p value of 0.002 would be required to achieve statistical significance. There were significant correlations between all the subscales of the AAAQ-Right Now and total scores on the AUDIT as well as TLFB scores. The AUDIT also showed significant correlations with peak consumption and total units consumed on the TLFB. Please see table 2 for further details.

Table 2.
Pearson's correlations and significance levels between explicit measures for the overall sample.

	TLFB Peak Consumption	TLFB Total Units Consumed	TLFB Total Number of Days Alcohol Consumed	AUDIT
AAAQ – Inclined	.28**	.42**	.36**	.48**
AAAQ – Resolved	.27**	.33**	.17*	.47**
AAAQ – Obsessed	.22**	.43**	.30**	.56**
AUDIT	.60**	.55**	-	-

N = 110
** Correlation is significant at the 0.01 level (1-tailed)
* Correlation is significant at the 0.05 level (1-tailed)

Discussion

The results indicate that there was no significant effect of masked priming on attentional bias and attentional avoidance, or on approach and avoidance bias. As an overall sample, participants were slower to avoid alcohol than control pictures on the SRC task. However, on the 50 ms block of the visual probe task, participants were significantly quicker to respond to incongruent, compared to congruent or control trials, indicating an automatic attentional avoidance bias for alcohol pictures at this exposure duration. Correlational analysis indicated that higher scores on the AUDIT and the 'obsessed / compelled' subscale of the AAAQ-Right Now were weakly associated with greater attentional bias for alcohol cues presented at 500 ms.

These findings were not entirely in line with expectations and make it difficult to draw conclusions about whether automatic approach and avoidance motivation comprise two distinct systems. Furthermore, a group of heavy drinkers would be expected to be quicker to approach and attend to alcohol cues compared with neutral cues as predicted by incentive-sensitisation theory [9] and in line with previous findings [11], [13], [14]. Whilst an element of the findings on the SRC task fit with

the ambivalence model of craving [2] (in that we would expect a group of heavy drinkers to show weak avoidance of alcohol cues compared to neutral cues); in general, the findings appear to fit more closely with the 'indifferent' quadrant of this model, that is, low motivation to both approach and avoid alcohol. This is further supported by the weak attentional bias scores for probes presented for a duration of 500 ms, which is contrary to previous findings showing heavy drinkers display attentional bias for alcohol cues presented at this duration [10], [12]. However, the positive, albeit weak, correlation of attentional bias at 500 ms with the self-reported consumption and craving, on the AUDIT and AAAQ respectively, fits with previous research [11].

Finally, our results suggest that heavy drinkers display attentional avoidance of alcohol pictures presented at 50 ms. Attentional avoidance has been found in alcohol-dependent patients at longer cue durations [40], [41]. However, to the authors' knowledge, this is the first study to find such an effect in a heavy drinking population. Field et al., [10] found attentional bias for alcohol cues shown at 500 ms and 2000 ms, but failed to find attentional bias at the shorter duration of 200 ms in heavy drinkers. The results of this research extend these findings further. Possible explanations for these results are explored below.

There are several factors that may have contributed to this pattern of results. Firstly, to the authors' knowledge, the procedure of incorporating a masked priming paradigm into the SRC and VP tasks has not been attempted previously. Therefore, the timings for this element of the design were arrived at following a critical summary of the available literature on masked affective priming. However, due to the nature of the SRC and VP tasks, some elements of the paradigm had to be modified, for example, the length of the response window recommended in previous

studies [27]. This, together with subsequent task complexities, may have impacted on priming effects. It is noteworthy that previous studies in the area of social cognition have found effects using the masked priming technique with no response window [25], [30]. Furthermore, the studies that have used the response window technique have largely used pictures as primes, rather than words as in the current study, to yield significant effects [28], [29]. It is possible that the use of words as primes in this study, together with the masked priming technique, attenuated priming effects. The use of pictures as primes was not considered feasible here due to concerns about confounding the SRC and VP tasks and the difficulties in finding alcohol-appetitive and alcohol-aversive pictures. Unfortunately, whilst the mechanisms underlying priming effects remain unclear, it is difficult to draw firm conclusions for the lack of effects found in this study, therefore, these explanations are tentative.

Thirdly, the reliability of the SRC and VP tasks must be considered. The standard SRC has been criticised in the past for only allowing approach motivation to be investigated relative to avoidance motivation. For this reason, the standard SRC task was modified for the purpose of this study in order that approach and avoidance motivation could be investigated independently of one another. This allowed us to determine that the interaction between picture type (alcohol / neutral) and response type (approach / avoid) was due to participants being slow to avoid alcohol pictures relative to neutral pictures, rather than faster to approach alcohol pictures. However, this modification increased task length and complexity, which may have impacted on the ability of the task to detect effects. Whilst the standard SRC has been able to capture approach and avoidance biases in previous research [13], [14], the reliability of the modified SRC is less well established.

The reliability of the visual probe task has also been questioned within addiction research. Attaya et al. [42] performed secondary analysis on data collected from seven independent studies using the dot probe task and concluded that the task had poor internal reliability. Participants may adopt certain techniques to make the task easier (such as staring at the blank space beneath the pictures until the probe appears as was reported by two participants in this study). It may be that task instructions need to be modified to counteract this. More recently, eye movement tracking software has been utilised and evidence seems to suggest this may be a more reliable method [43]-[45], although this has practical implications.

Additional factors that may have contributed to the unexpected results for the overall sample will now be considered. Firstly, the study was underpowered. A power analysis was performed using G*Power (version 3.1.0) to determine the sample size needed for this study. Based on Cohen's (1988) recommendation, the researchers aimed to recruit sufficient numbers in order to detect at least a medium effect at a power of .80, with an alpha of .05. For the ANOVA to detect a medium effect of $f = .25$, 53 participants per group were required. Therefore, it is possible that the sample size in this study was too small for significant effects to be obtained.

Secondly, due to error rates, missing data and outliers, some participants were necessarily excluded from the analysis. Whilst this still left data from over 30 participants per group on the VP tasks, data from only 27 participants in the negative group was used to perform the analysis on the SRC task. It may have been that this sample size was too small to detect any effects.

Thirdly, consideration of the mean total units consumed as recorded on the TLFB is warranted. This figure only just exceeded the minimum inclusion criteria to the study. It might be possible that this sample is not representative enough of a heavy

drinking population. For example, one previous study showing attentional bias effects at 500 ms cue durations specified participants must consume as much as 25 units, on average, per week to fulfil inclusion criteria [46]. They reported mean units of alcohol consumption per week at 37.9 (compared to 21.4 in the current study). However, another study of attentional bias in heavy drinkers using a VP task [10] had comparable means for weekly alcohol consumption to the current study (28.6) and found attentional bias for alcohol cues presented at 500 ms and 2000 ms. A separate study investigating the relationship between craving and cognitive biases [11] also found attentional bias in social drinkers with high reported cravings, despite mean weekly alcohol consumption being at a lower level than in the current study. Furthermore, considering the possibility that participants underestimated their true consumption when completing the TLFB, and the fact that the sample was predominantly female (and the inclusion criteria regarding number of units was lower for women than for men), it seems unlikely that mean total units as measured by the TLFB could explain the lack of attentional bias. Similarly, in previous studies of approach and avoidance tendencies as measured by an SRC task [45], heavy drinkers were quicker to approach alcohol cues than light drinkers despite a mean weekly alcohol consumption of 22.38 units and a mean total AUDIT score of 12.32 (comparable with 10.07 in the current study).

Fourthly, it is also possible that the modified version of the SRC tasks was too confusing for participants as they had to contend with evaluation of the target, a choice between movement in one of three possible directions, a time limit imposed on the task, and three rule changes for each new block. This, in addition to completing two blocks of the VP task, may have resulted in cognitive overload for

participants, leading to loss of concentration or even disengagement from the task. The amount of missing data from participants lends some support to this suggestion.

Finally, the alcohol-related stimuli, used in both the SRC and the VP tasks, depicted a range of alcoholic beverages. Thus it is likely that some pictures would have more salience for certain participants than for others. For example, beer drinkers may show attentional bias for pictures of beer but these effects could get lost when they are exposed to a range of other types of beverage, which hold less salience for them [47].

Future Research

Future research should consider whether to modify the masked priming paradigm in light of these null findings. One method by which this could be achieved might involve presenting the prime for a slightly longer duration or removing the sandwich masking technique used in this experiment, which may have caused primes to be too heavily obscured. Another might be to consider revising the version of the SRC task used within the protocol, or to substitute the SRC for a less demanding measure, for example, an approach-avoidance task [48], although no measure is without its set of difficulties. Finally, if the experiment were to be repeated, the length of the protocol could be reduced to minimise fatigue effects and enhance the quality of the data.

Conclusions

In conclusion, the results of this study show that implicit priming of alcohol-related motivational states had no influence on indices of alcohol approach and avoidance motivation or on attentional bias. However, this is the first study to find that heavy-drinkers show automatic attentional avoidance of alcohol cues presented at short durations (50 ms). Significant interactions between response type and picture type on the SRC task were reflective of participants being slower to avoid alcohol

cues than control cues, as opposed to being quicker to approach alcohol. Finally, greater attentional bias at a cue duration of 500 ms was positively correlated with higher scores on the AUDIT and the obsessed / compelled subscale of the AAAQ, although these associations were weak.

These findings were not fully in line with expectations based on previous theories, research, and the ambivalence model of craving. Possible explanations for this pattern of results include the novelty of the task designs, complexity of task demands potentially attenuating priming effects, and the reliability of measures. Future research should attempt to address these issues in order to understand the role of implicit processes in the field of addiction. If implicit motivation can be manipulated as previous work suggests [20], [21] this could have important implications for treatment provision.

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Chapter 3

Concluding Discussion

Introduction

The concluding chapter of this thesis is comprised of three main sections. The first section will provide a general overview of the work carried out and the research findings. Following this there will be an extended discussion relating the findings of the study to theories outlined in both the narrative review and the introduction section of the empirical paper. Explanations for the pattern of results will then be detailed with a particular emphasis on methodological considerations, such as the timings of the masked priming paradigm, the complexity of tasks, and the adequacy of the measures. Subsequently, the clinical implications of this study will be addressed.

Section two will consist of a lay summary. The purpose of this summary is to provide a format through which this piece of research could be disseminated to participants recruited to the study. For this purpose, the current study will be described in a concise and meaningful way, with particular attention paid to the language and terms used to describe the key concepts of the research. The importance and relevance of the study will be made clear.

In the third and final section, the question of future research will be addressed. The main aim of this section is to critically evaluate and further develop this piece of research. This section will include a summary of the areas identified as worthy of further exploration and will outline suggestions for ways in which future studies might attempt to do this. Particular prominence will be given to the design of the masked affective priming paradigm and the combination of this procedure with implicit measures well established in the addiction research, such as the SRC and VP tasks.

General Overview

Research into alcohol addiction has been interested in the relative contribution of approach and avoidance motivation to drinking behaviour. The ambivalence model of craving (Breiner, Stritzke & Lang, 1999) suggests that approach and avoidance motivation are separate systems and that the balance between the two systems determines the level of alcohol consumption. Automatic processes are thought to play an important role in this balance. However, research in this area is relatively new and there are several aspects of these processes, for example, underlying mechanisms, which are not yet fully understood.

The aim of this study was to attempt to manipulate automatic goal states in regard to alcohol-related goals and to investigate the effects of doing so on the opposing motivational system. A non-clinical community sample of 110 heavy drinkers was randomly allocated to one of three groups: positive, negative and neutral. The SRC task (Field, Kiernan, Eastwood & Child, 2008) was used to measure approach and avoidance motivation and attentional bias was recorded using a visual probe task (Field, Mogg, Zetteler & Bradley, 2004). In order to manipulate automatic goal-states, participants were presented with a word before each trial of the SRC and VP tasks. The word was shown very briefly to avoid conscious detection using a technique called the masked priming paradigm (Draine & Greenwald, 1998). Participants in the positive group were shown alcohol-appetitive words, those in the negative group were presented with alcohol-aversive words, and those in the neutral group were shown words related to furniture. Alcohol consumption and craving were also measured using the AAAQ (McEvoy, Stritzke, French, Lang & Ketterman, 2004), AUDIT (Saunders, Aasland, Babor & Grant, 1993) and TLFB (Sobell & Sobell, 1992) questionnaires.

It was hypothesised that participants in the positive group would be faster to approach, and slower to avoid alcohol, than the other two groups; it was also hypothesised that those in the positive group would show early attentional bias and late attentional avoidance relative to the other two groups. It was postulated that individuals in the negative group would be slower to approach, and faster to avoid alcohol cues than the other two groups; and that they would show reduced early attentional bias and increased late attentional avoidance relative to the positive and neutral groups. However, the results showed that masked affective priming of alcohol-related motivational states had no impact on approach and avoidance motivation, or on attentional bias for alcohol cues. The overall sample showed attentional avoidance for alcohol cues shown for 50 ms, but not for 500 ms. Participants were slower to avoid alcohol cues than neutral cues on the SRC task in line with expectations. Higher scores on consumption (as measured by the AUDIT) and craving (as measured by the obsessed / compelled subscale of the AAAQ) were weakly associated with greater attentional bias for alcohol cues presented at 500 ms. This finding was in the predicted direction.

Possible explanations for the lack of priming effect are discussed under the methodological considerations section below. The finding that heavy drinkers as an overall sample were slower to avoid alcohol pictures relative to neutral pictures fits with previous findings exploring avoidance relative to approach for alcohol pictures in heavy drinkers (Field et al., 2008); with the ambivalence model of craving (Breiner et al., 2004); and with incentive-sensitisation theory (Robinson & Berridge, 1993). However, the lack of approach bias for the overall sample was surprising and contrary to previous results (Christiansen, Cole, Goudie & Field, 2012; Field, Mogg & Bradley, 2005; Field et al. 2008). Similarly, weak attentional bias scores for

alcohol pictures presented at 500 ms do not fit with previous research demonstrating that heavy drinkers show both initial orienting and slow disengagement bias at these durations (Field et al., 2004; Field & Cox, 2008).

Previous attentional bias research has shown attentional avoidance in clinical populations when cues are presented above certain durations, for example 500 ms (Noel et al., 2006; Townshend & Duka, 2001). However, to our knowledge, this is the first study to show the same effect for cues presented to a non-clinical sample at the shorter duration of 50 ms. Field et al., (2004) found that heavy drinkers showed attentional bias for alcohol pictures presented at 500 ms and 2000 ms, but not at the shorter duration of 200 ms. The results of the current study extend these findings further by suggesting that heavy drinkers can show attentional avoidance of alcohol cues presented at 50 ms. This could represent a conflict between explicit and implicit processes as suggested by dual-process theories (Wiers et al., 2007) as the result did not correlate with any of the explicit measures. However, given that the direction of this conflict is contrary to previous research findings (which show that automatic attentional bias for alcohol-cues conflicts with controlled attentional avoidance), this theory is put forward tentatively.

Methodological Considerations

There are several aspects of the methodology used in this study that may have contributed to the pattern of results found. Firstly, it is possible that our masked priming technique was ineffective. However, this seems unlikely as a comprehensive review of published masked affective priming techniques was undertaken in an attempt to design a protocol that would replicate previous significant findings (see Table 3, Appendix A). Whilst critical reviews of masked affective priming (Van den Bussche, Van den Noortgate, & Reynvoet, 2009) suggest that it is crucial that the

elements of prime duration, stimulus-onset asynchrony (SOA - refers to the time between the cessation of the backward mask and the target being presented), and use of a response window (Draine & Greenwald, 1998) fall within specified parameters, it is noteworthy that there is considerable variability in the designs used in previous studies in terms of these factors. Clearly, the lack of a set protocol makes designing new research problematic.

However, in the current study, the use of the SRC and VP tasks necessitated a longer response window than was recommended by Draine and Greenwald (1998). Please see Appendix I for full details. This did not pose a significant difficulty for the VP tasks, however, for the SRC tasks, which have more complicated instructions, considerable data was lost due to errors and a failure to respond in time. Although attempts were made to ensure the task was still manageable with the response window (i.e through a pilot study), ultimately this design feature appears to have compromised accuracy. Again, there is no ideal solution to these difficulties, especially when attempting to combine methodologies for the first time.

Furthermore, even when these factors are kept relatively constant, significant effects are not reliably produced. For example, studies by Degner, Wentura, Gniewosz & Noack (2007) and Degner and Wentura (2009) both employed the response window technique and adopted similar protocol timings; the first study found significant priming effects and the latter did not. Therefore, it is difficult to know which elements to replicate in future research.

Whilst the masked affective priming technique has been shown to produce significant effects when words are used as primes (Wentura & Degner, 2010), the majority of reviewed studies, that utilised the response window technique, used pictures as primes. It may be that the use of words attenuated priming effects in the

current study due to variations in the way words and pictures are processed. However, the use of pictures was not possible due to potential for interference with the subsequent SRC and VP tasks.

Another potentially relevant factor connected to the choice of primes is the type of words used. Whilst the words were chosen based on endorsements from a pilot study, we cannot assume that the associations of the pilot group are necessarily representative of the general population, or of our participant sample. For example, the word 'party' has more than one meaning; therefore, the associations produced might not necessarily be alcohol-related depending on the individual's interpretation of the word.

Tasks demands in previous studies demonstrating priming effects have involved less complexity than the current procedure. For example, in a standard affective priming task (Fazio, Sanbonmatsu, Powell & Kardes, 1986), participants are presented with the prime and then asked to make a decision about which category a target word belongs to. The reviewed studies had variants of this basic protocol. However, in this study, participants were required to complete two different tasks, one of which (SRC) involved complicated (and changing) instructions requiring intense concentration. It is likely that this caused cognitive overload, or at the very least, fatigue effects amongst participants, which may have resulted in task disengagement. Whilst it is difficult to say what impact this might have had on priming effects without knowing the underlying mechanisms involved, it seems plausible that complex task demands and a lengthy protocol may have attenuated priming effects.

Finally, much of the previous research exploring the effects of masked affective priming has been conducted in the areas of prejudice, in-group attitudes, and self-

esteem. The use of the technique in addiction research is relatively new. To the author's knowledge, this is the first time an attempt to combine the masked affective priming technique with the SRC and VP tasks has been made. Therefore, the methodology used was exploratory in nature. If priming effects are as narrow, brief and context-specific as some researchers have suggested (Shanks et al., 2013), it seems likely that further modification will be needed if priming effects are to be produced in addiction research. However, if priming effects are as robust as others claim, it would not be unreasonable to expect them to withstand variations in protocol. If they are unable to do so this reduces the chance of researchers being able to understand the underlying mechanisms by which they exert their effects.

Other possibilities for the results are discussed within the final section of the empirical paper of the thesis and do not require further elaboration here. In summary, these included problems with the reliability of the SRC and VP tasks, questions about whether the sample were representative of a heavy drinking population, and lack of sufficient power due to sample size and data lost due to errors and slow response times.

Clinical Implications

The finding that participants as an overall sample were slower to avoid pictures of alcohol, compared to neutral pictures on the SRC task, was in line with expectation and lends support to the ambivalence model of craving (Breiner et al., 1999), and to interventions that aim to target automatic attitudes, such as cognitive bias modification (CBM) training (Eberl et al., 2012; Wiers et al., 2011). However, the lack of approach bias on the SRC found in this sample, together with the attentional avoidance for alcohol pictures presented at 50 ms on the VP task, was more surprising and not in line with previous research. Clearly further research is needed

to validate these findings and it would be unwise to infer implications for practice at this stage. However, it is nonetheless worth considering what a replication of these findings could mean in terms of treatment provision.

If heavy drinkers show an automatic attentional avoidance bias for cues presented at short durations, this challenges incentive-sensitisation theories (Robinson & Berridge, 1993) and automaticity theory (Tiffany, 1990), as well as motivational models of substance use (Cox & Klinger, 1988; 2004). Attentional avoidance of alcohol cues has been found in alcohol-dependent patients previously using a dot probe task (Townshend & Duka, 2007). It has been suggested that this avoidance has developed as a result of a perceived 'loss of control' over drinking behaviour. Spruyt et al. (2013) compared approach and avoidance bias of a group of abstinent alcoholics and a group of controls using a relevant-SRC task. They found an avoidance bias amongst the abstinent alcoholics that was associated with relapse at three-month follow-up. This finding suggests a conflict between automatic avoidance tendencies and consumption of alcohol (controlled approach). However, perhaps this finding could also be understood in the context of Townshend and Duka's (2007) explanation. If participants in the Spruyt et al. (2013) study also perceived a loss of control over their drinking, this could explain why they relapsed despite having automatic avoidance tendencies for alcohol cues. This explanation could extend to the sample in the current study as a 25-60 age group was deliberately targeted as it was felt this group might mirror alcohol-dependent patients more closely than other heavy drinking populations, such as undergraduates. However, the level of consumption as recorded by the AUDIT and TLFB suggests that this may not be the case and that there are likely to be other factors involved. Further research could explore the relationship between automatic attentional avoidance and level of alcohol

consumption in heavy drinkers to extend the research of Spruyt et al., (2013). Such studies raise questions about whether techniques like cognitive bias modification training (Eberl et al., 2012; Wiers et al., 2011), which attempt to induce an avoidance bias, should be a major focus of future treatment and research. However, Fadardi and Cox (2009) developed the Alcohol Attentional Control Training Program (AACTP) to train participants to overcome their attentional bias for alcohol cues and found that this training was associated with a reduction in alcohol consumption at three month follow-up. Jones and Field (2013) explored the effects of cue specific inhibition training in heavy drinkers. They found that inhibition training in the presence of alcohol-related cues could reduce alcohol consumption in the laboratory. However, effects were short-lived and only seen when motor inhibition was targeted. Furthermore, at one-week follow-up, no reduction in alcohol consumption was found.

There are some promising developments in treatment techniques used to target automatic processes. However, there is also much that remains unknown about the mechanisms by which automatic processes operate and the degree to which they contribute to relapse in heavy drinkers and alcohol-dependent individuals. Until clarity on these issues is afforded through further research, it is difficult to draw clear implications for clinical practice.

Lay summary

This summary is intended to provide feedback to those participants expressing an interest in the results of the study at the time of recruitment. This piece of research aimed to explore the processes involved in alcohol addiction. It is thought that several factors may contribute towards heavy drinking and alcohol dependence. One of these factors is the balance between how motivated an individual is to consume

alcohol and how motivated they are to avoid it. Again, this balance may depend on several variables, for example, context (alcohol is more likely to be consumed whilst at a party compared to at work), social expectations (people are less likely to drink if driving), and mood (some people might drink to cope with negative feelings, e.g. after a stressful day at work). All of these factors are within the conscious awareness of the individual. However, there is a growing body of research suggesting that additional processes, operating outside conscious awareness, may also play a role in the decision to consume (or abstain from) alcohol. It is these processes that are thought to offer some explanation as to why alcohol-dependent patients continue to drink alcohol despite reporting a desire to abstain, and in spite of experiencing severe physical health problems due to alcohol dependency (Stormark, Field, Hugdahl & Horowitz, 1997). Theories behind this phenomenon suggest that changes may occur in the neurological pathways in the brain with increased alcohol use (Robinson & Berridge, 1993) that predispose an individual to prolonged use. These processes are said to be automatic as they occur spontaneously without conscious processing. It is these automatic processes that were explored in the current study.

The specific aim of the study was to investigate whether automatic processes could be altered by experimental manipulation, and, if so, what effect this would have on participants' motivation to consume and motivation to avoid alcohol. Previous research has shown that it is possible to manipulate these processes (Stroebe et al., 2008) in the field of dieting, however, this is relatively unexplored in the field of alcohol addiction. Current treatments for alcohol addiction focus on techniques such as motivational interviewing (Miller & Rollnick, 2002) and cognitive behavioural therapy (Wells, 1997). These techniques focus on challenging thoughts and beliefs around alcohol use. However, these approaches have shown

mixed success. Recently a new body research is emerging providing preliminary evidence that new techniques, specifically targeting unconscious aspects of drinking behaviour, can have the effect of reducing alcohol consumption (Houben, Havermans and Wiers, 2010; Wiers et al., 2010). It is hoped that this study can add to the current research in this area by attempting to alter automatic processes and measuring the effects on participants' motivation to approach and avoid alcohol.

To test our aims, we recruited 110 heavy drinkers from the local community to take part in a series of computer-based tasks. Participants were divided into three groups and attempts were made to manipulate automatic processes by presenting participants with alcohol-appetitive, alcohol aversive, or neutral words before each task, dependent on group allocation. The words were presented briefly in order to evade conscious detection and participants' reaction times to the tasks were measured.

The results showed that the experimental manipulation did not have an effect on participants' motivation. There are several possible explanations for this finding. For example, this is the first time this type of manipulation has been combined with these computer tasks. Therefore, there are elements of the experimental design that may need to be modified in order to demonstrate effects. Nonetheless, this study makes an important contribution to advancing researchers' understanding of how automatic processes might be investigated further. Some of these ideas are outlined below.

Future Research

The current study was the first attempt to alter automatic goal states in relation to motivation to approach and avoid alcohol cues using a masked affective priming paradigm, with the aim of examining the effects of such a manipulation on the opposing goal state. No effects of this manipulation were found on attentional bias,

or approach and avoidance motivation. The outcome of the study has raised several questions that could be explored further in future research to extend this work.

One avenue for exploration might be to test whether it is possible to manipulate automatic goal states by making modifications to the current protocol. In order to examine this, separate studies might be conducted to look at effects on attentional bias and approach and avoidance motivation. This would avoid a lengthy protocol (which was suspected to have been problematic in the current study) thereby reducing the potential for cognitive overload and fatigue effects.

Another possible goal might be to consider the use of pictures as primes, instead of words. Many of the reviewed social cognition studies utilised pictures and found significant priming effects (Degner et al., 2007; Frings & Wentura, 2003). It might be that the words used in the current study failed to evoke the necessary motivational state due to lack of salience. Although finding pictures that evoke motivation to approach and avoid alcohol may be more difficult, a set of 10 (five to promote approach, e.g. club or party scenes, and five to promote avoidance, e.g. scenes depicting the negative consequences of drinking) may suffice. Care would need to taken to ensure that these pictures did not conflict with those in the visual probe task, i.e. the primes should not directly picture alcohol.

A further design might involve varying the timings of the response window, or other aspects of the masked priming protocol, such as prime presentation time or stimulus onset asynchrony (the time between presentation of the prime and the target) between different groups, to determine whether there is an optimal priming protocol to be used in conjunction with tasks measuring attentional bias and approach and avoidance motivation.

It might be that, due to its complexity combined with the potentially short-lived effects of priming, the modified SRC task used in this study is not the most suitable measure to be employed in conjunction with a masked affective priming procedure. Therefore, alternative ways of measuring approach and avoidance motivation to alcohol cues, such as the Approach Avoidance Task (Wiers, Rinck, Dictus & Van den Wildenberg, 2009) may need to be considered.

Finally, future studies could incorporate taste tests (an experimental design incorporating alcohol consumption, Field and Eastwood, 2005) to determine whether automatic priming impacts on drinking behaviour, rather than measuring self-reported craving alone.

What follows below is a brief outline of a potential future study investigating whether a masked affective priming paradigm, using pictures as primes, is able to manipulate automatic attentional bias for alcohol.

Aim

To investigate whether it is possible to manipulate automatic goal states in relation to attentional bias for alcohol cues.

Prediction

Those primed with pictures promoting alcohol use will show an increased attentional bias for alcohol cues relative to the other two groups. This will manifest in early orienting bias toward, and slow disengagement from, alcohol cues presented at both 50 ms and 500 ms. Those primed with alcohol-aversive images will show the reverse pattern, i.e. reduced early attentional bias and increased late attentional avoidance.

Design

A cross-sectional between-groups design, comparing three groups of heavy drinkers. Group one will be primed with alcohol-appetitive scenes, group two with alcohol-aversive scenes and group three with neutral scenes (e.g. furniture). Eye movements to a visual probe test will then be recorded to determine attentional bias scores.

Method

Participants.

Heavy drinkers could be recruited from local community sites; for example, amateur sports clubs, and stringent inclusion criteria should be applied for level of alcohol consumption (for example, a certain score on the AUDIT or TLFB could be stipulated and those scoring below this criteria could be excluded from the study).

Measures.

Visual Probe.

A visual probe task tracking eye movements could be used to measure attentional bias in order to minimise some of the difficulties with the reliability of the version of the task used in the current study. Two counterbalanced versions of the task (50 ms and 500ms) could be incorporated to determine whether the results of the current study, which shows attentional avoidance for cues at 50 ms, could be replicated. Both tasks should incorporate congruent, incongruent and control trials in order that initial orienting biases can be distinguished from slowed disengagement.

Masked Priming.

The prime will be presented before each trial of the VP task. The protocol could be similar to that used in the current study but with a varied SOA. For example, presentation of a fixation cross, followed by the prime (34 ms), followed by a

slightly shorter backward mask (17ms) and then presentation of the target pictures, giving a reduced SOA of 51ms. This is in line with the recommendations of Hermans, De Houwer and Eelen (2001). As the response window on the visual probe task used in the current study did not result in too many errors, similar timings are recommended.

Analysis.

A mixed-design ANOVA could be used to analyse the data with group (alcohol-appetitive, alcohol-aversive and neutral) as the between-subjects factor and block type (50 ms or 500 ms) and trial type (congruent, incongruent or control) as within-subjects factors.

Thesis Summary

The overarching aims of this thesis were to: (i) provide the reader with a critical review of psychological theories and models underlying alcohol addiction, with a specific focus on processes of implicit cognition; (ii) to outline the clinical relevance of this topic; (iii) to augment the existent body of research in this area.

Understanding the role of automatic processes could have important implications for the treatment of alcohol-dependent patients within the healthcare service. For example, there is emerging evidence that implicit cognitions can be targeted and altered through treatments such as cognitive bias modification and that this may have an impact on drinking behaviour (Wiers et al., 2011).

The empirical paper explored implicit processes involved in motivation to approach or avoid alcohol in a non-clinical sample of heavy drinkers. Specifically, the researcher explored whether implicit approach and avoidance motivation are two separate systems, or whether experimental manipulation of one system influences the other. In order to investigate this, participants were randomly allocated to one of three groups and implicitly primed with either alcohol-appetitive, alcohol-aversive or neutral words using a masked priming paradigm. The results showed that there were no significant effects of priming, suggesting that experimental manipulation failed. Therefore, conclusions about whether implicit approach and avoidance processes operate as two separate systems could not be drawn. However, the study did find a significant attentional avoidance bias for alcohol cues presented at 50 ms in the overall sample. This finding was not predicted and attempts to replicate this could provide an avenue for future research. Explanations for the pattern of results were offered, with particular attention paid to methodological considerations.

This research has highlighted issues with the adequacy of current measures used to investigate implicit cognition in addiction. The study has also pioneered a new methodology, by incorporating the masked affective priming paradigm technique into recognised implicit addiction measures, in an attempt to manipulate automatic goal states. Future research could endeavour to refine aspects of this unique design in order to explore its potential use within the field of addiction.

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