Exploring substance abuse: Factors affecting attentional biases and automaticity.

Wilcockson, Thomas Daniel Webb

Exploring Substance Abuse:

Factors Affecting Attentional Biases and Automaticity

by

Thomas Daniel Webb Wilcockson

BSc (Hons) (Swansea University) 2006

MSc (Swansea University) 2008

Submitted in fulfilment of the requirements for

the degree of Doctor of Philosophy,

Psychology Department, Swansea University.

2013.

Short Abstract

There is a distinction between physiological and psychological aspects of addiction. Both of which are important for the development and maintenance of substance abuse. Within psychological aspects of addiction, attention and learning may play integral roles in substance abuse behaviour. This thesis explores how an environment seems to become increasingly occupied by substance-related stimuli, as a result of substance use (Chapter 5). It is demonstrated how such stimuli are able to initially attract attention (Chapter 2.6) and such attentional biases are difficult to inhibit (Chapter 2). Such attentional biases appear to be robust behaviours which are not overly affected by craving and outcome expectancies (Chapter 3). Moreover, it is discussed how attentional biases may be associated with automaticity development (Chapter 6). This research is performed using a dyslexic population, as dyslexia has been hypothesised as an impairment in automaticity development. Therefore a population potentially impaired in automaticity development may demonstrate different patterns of substance-related attentional bias, compared to control participants (Chapter 6.6). This means that a deeper understanding of how automaticity develops for some stimuli rather than others may be beneficial for the study of substance abuse (Chapter 7). Finally, it is suggested how substance abuse interventions may benefit from closer consideration of the attentional and learning aspects of addiction (Chapter 8).

DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed ....

Date ...29/11/13...

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the correction is clearly marked in a footnote(s).

Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

Signed ....

Date ...29/11/13...

STATEMENT 2

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed ....

Date ...29/11/13...

Extended Abstract

This thesis examines various aspects of substance abuse behaviour. Although the majority of data collected within this thesis is from heavy users, and not abusers, this is a common approach within the literature (e.g. Cox, Fadardi, and Pothos, 2006; Pothos and Cox, 2002) and does bear implications for substance abusing populations. In particular, the topics investigated are attentional biases, cognitive biases, and automaticity. The intention is to illustrate that substance use behaviours are partly maintained by attentional biases and develop through automatic skill learning.

A cognitive bias is a distortion in judgement. This can lead to perceptual misrepresentation. Some cognitive biases can be classified as an attentional bias. An attentional bias is an increase in attention for a certain stimulus. Alcohol-related attentional biases have been found to be important in alcohol abuse. Indeed the strength of attentional bias can be a good predictor of future alcohol use (e.g. Cox, Pothos, Hosier, 2007). Yet are attentional biases a by-product of alcohol abuse, or do they play a causal role? If the latter then understanding attentional biases may help with alcohol abuse treatment. In order to improve understanding in this area, closer consideration was needed to the nature of attentional biases, and the methodologies used in their measurement. In Chapter 2, there is clarification of the distinction between initial orienting of attention and attentional capture. The thesis then considers the problems with eye tracking experiments which manipulate stimulus onset asynchronies (SOA: e.g. Noel *et al.*, 2006) for the measurement of initial orienting of attention. This chapter argues that by manipulating variables associated with attentional capture insights can be gained into inhibitory control over alcohol-related attentional biases. Thus the fixed gaze inhibition task was created using eye tracking technology. This task made use of a gaze-contingency paradigm to measure propensity of inhibition for attentional biases. The results of this novel task suggest that attentional biases for alcohol related information are not just prioritised by the heavy drinker, but may also be compulsory.

So are current attentional bias tasks truly capable of measuring the initial orienting of attention? Experiment 2 in Chapter 2 empirically explores this idea. Initial orienting of attention had previously only been observed in the anxiety attentional bias literature or

(arguably) in abstinent alcoholics. This is considered to be due to the motivational properties that these stimuli would develop within high anxiety populations differing from the motivational properties within heavy drinking populations. This experiment used the same method and data as Experiment 1, but adopted a different approach to analysing the data. Here it was demonstrated that it was the initial orienting of attention that it was possible to measure with this attentional bias task, rather than a delayed disengagement of attention. This distinction refers to the difference between the grabbing and holding of attention. Previously only the delayed disengagement (attentional holding) of attention had been demonstrated within the substance abuse attentional bias literature. The observation of an initial orienting of attention has important implications for craving and substance seeking behaviour.

Within Chapter 2 it is demonstrated that following the development of an attentional bias for alcohol related information, the heavy drinker is unable to inhibit their attention from being distracted by alcohol stimuli. It was also demonstrated that, not only do alcohol-related stimuli hold attention (e.g. Field, Mogg, & Bradley, 2006), but that such stimuli can also grab attention. These results, combined with the knowledge that alcohol-related stimuli can lead to craving and substance seeking (e.g. Tiffany, 1990), would suggest that heavy drinkers in the presence of alcohol-stimuli would have their attention grabbed and would be unable to inhibit such a process. There could potentially be a lack of awareness between the link between seeing alcohol stimuli and substance seeking. This chapter therefore has important implications for the way that substances (e.g. alcohol and cigarettes) are advertised, as mere exposure to substance-related stimuli has the potential to lead to substance seeking, a process that may be unavoidable for some.

Within attentional bias tasks it is standard procedure to compare two groups, e.g., heavy versus light drinkers (see Chapter 2). However, within Chapter 3, a within-subjects design was employed in order to look at the effects of craving and outcome expectancies in order to see whether these factors would have any within-subjects effects upon attentional biases (these are variables which have previously been demonstrated to affect attentional biases). Both alcohol users and MDMA users were examined, as research would suggest that MDMA use leads to varying levels of craving and outcome expectancies. Three different attentional bias measures were used, as well as measures of craving and outcome expectancies. This study potentially demonstrated an attentional bias with MDMA users for the first time. The hypothesis regarding fluctuating attentional biases was not supported. This chapter therefore may demonstrate the potential robustness of attentional bias.

Attentional biases are potentially one aspect of an internal state that has developed through repeated substance administration (review; Field & Cox, 2008). This internal state could lead to a cognitive bias where a number of cognitive faculties would be affected. Associations and expectancies regarding alcohol use have been found to motivate behaviour. Such neurocognitive structures are analogous to memory. Associations and expectancies develop automatically with the abstraction of information from the environment and guide future behaviour. As associations develop, propositional links develop automatically across the network which would lead to biases developing in a sense that positive and salient information regarding behaviour becomes strengthened. The study of memory-based biases may therefore be a measure of both implicit and explicit components of substance abuse, as positive alcohol-associations may intrude on memory (e.g. Rather *et al.* 1992) causing cognitive biases. Tiffany (1990) argued that the alcoholic's environment would become perceived as becoming increasingly occupied by alcohol-related stimuli, due to stimuli becoming increasingly associated with alcohol use. Chapter 4 therefore tested the very basics of Tiffany's (1990) theory by asking participants to report from memory what percentage of an environment (in this case a word list) consisted of alcohol-related words. Thus a distorted memory for the alcohol-related words that were present would be indicative of a cognitive bias. This was validated by creating a food version of the task which was found to correlate with body mass index (BMI). A current concerns version of the task was however unable to produce meaningful results.

Chapter 6 examined the automatic nature of attentional biases by examining a population who are putatively impaired in automaticity development. Dyslexics have been hypothesised to have an automaticity deficit, which would explain how they find automatising skills difficult (Nicolson and Fawcett, 1990). If automaticity development is impaired in dyslexics, then they may potentially demonstrate a different pattern of substance use, due to the automatic nature of attentional bias formation. First it was examined whether dyslexics report different levels of substance use. Second, attentional biases and automaticity development were observed. Thirdly, it was considered whether the automatic nature of priming would have an effect upon craving.

Firstly, a questionnaire study on dyslexics and non-dyslexic controls was performed. The questionnaire consisted of a number of substance use-related questions which mostly examined the quantity of substance use prior to the study. It was found that the dyslexic participants reported significantly less substance use than the non-dyslexic controls. This result was considered in terms of a number of possibilities; however, it was speculated that an automaticity deficit could potentially be the underlying cause.

In order to further test this prediction the next experiment looked at automaticity development and substance use attentional biases within a dyslexic population and compared to non-dyslexic controls. A serial reaction time task and an eye tracking measure were used. It was found that automaticity development did not vary between-groups. However, it was observed that there was a slight difference between-groups for substance use-related attentional biases, but the majority of findings did not support between-group differences. Again the importance of automaticity was discussed.

Priming has been suggested to be able to automatically elicit effects upon cognition, motivation, and emotion, through its influence upon processes operating outside of awareness (see Bargh, 1996). It was considered whether priming would have similar effects upon dyslexics. Dyslexics were compared to non-dyslexic controls on their reported alcohol cravings when they had either been primed with studying or socialising cues within a questionnaire. The results did not demonstrate a difference between groups. This suggests that dyslexics may not be affected in a different manner by primes. This is a result that does not support the automaticity deficit hypothesis of dyslexia. Implications for the importance of automaticity for substance use behaviour is discussed.

The potential importance of automaticity within substance use behaviour was observed. However, why do automatic associations develop for some stimuli and not others? Chapter 7 looked at three different reasons why some stimuli develop automatic associations, whilst others do not. It was considered whether manipulating three aspects of stimuli would have an effect on how effectively associations are learned. Experiment 1 was concerned with the emotional salience of the stimuli. Emotional salience did not appear to impact on learning. Experiment 2 manipulated the perceptual richness of the stimuli, but no differences were identified for any of the test phase dependent variables. Finally, Experiment 3 examined the possibility that thinking about an association might reinforce it. In this case, thinking about an association was found to lead to an improved association between the stimuli. These results are interpreted as demonstrating that deeper processing may lead to stronger representations and associations with positive expectancies. Such a finding may have important implications for the distinction between implicit and explicit processes which are associated with substance abuse development.

The general findings of this thesis would demonstrate the robustness of attentional biases. It would appear that there are a number of factors that influence their development, potentially through automaticity. In the future attentional bias modification may be a useful form of treatment for substance abuse. Such studies have already produced positive results (e.g. Shoenmaker *et al.*, 2010). It was speculated that the inhibition fixed-gaze paradigm from Chapter 2 may be modified in a way that would lead to this task being developed into such a tool. This task is useful as it may be able to be used for training substance abusers to actively engage their attention away from substance-related stimuli.

Table of Contents

Table of Figures

List of Tables

Table of Abbreviations

ADC	Adult Dyslexia Checklist
ADD	Attention Deficit Disorder
ADHD	Attention Deficit Hyperactivity Disorder
AGL	Artificial Grammar Learning
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
APDS	Alcohol Percentage Difference Score
AUDIT	Alcohol Use Disorder Identification Test
BMI	Body Mass Index
cf.	Compare
cm	Centimetre
DAST	Dyslexia Adult Screening Test
DEBQ	Dutch Eating Behaviour Questionnaire
DSM-IV	Diagnostic and Statistics Manuel - 4
e.g.	Example
F	Female
HD	Heavy Drinker
IQ	Intelligence Quotient
LA	Less Attractive
LD	Light Drinker
M	Male

M	Mean
MA	More Attractive
MAST	Michigan Alcohol Screening Test
MD	Mid-level Drinker
MDMA	3,4-methylenedioxy-N-methylamphetamine
MDS	Multi Dimensional Scaling
ml	Millilitre
mm	Millimetre
ms	Millisecond
N	Number of Participants
NAPS	Normative Appetitive Picture System
PET	Percentage Estimation Task
RS	Random-Sequence Difference Variable
RT	Reaction Time
Sec	Second
S+	A reinforced stimulus
SD	Standard Deviation
SOA	Stimulus Onset Asynchrony
SRTT	Serial Reaction Time Task
UEL	University of East London
UK	United Kingdom
WM	Working Memory

Exploring Substance Abuse: Factors Affecting Attentional Biases and Automaticity

Chapter 1: General Introduction

A cognitive bias is a pattern of distortion in an information processing strategy. This can lead to perceptual misrepresentation. Some cognitive biases can be classified as an attentional bias. Attentional biases have been observed in relation to substance abuse (e.g. Cox et al., 2002; Calitri et al., 2010; Field et al., 2004; Mogg et al., 2000; Stacy, 1997). These biases would suggest 'preferential' treatment of substance-related stimuli over control stimuli (that is, stimuli which are unrelated to the abused substance). Such attentional biases have been found to have predictive value both with respect to relapse (Cox, Hoogan, Kristian, & Race, 2002) and changes in the patterns of substance abuse (for alcohol abuse; Cox, Pothos, Hosier, 2007). Substance-related stimuli increase in salience and acquire an inherent ability to 'hold' attention, perhaps due to the repeated exposure to substance-related cues, when abusing a substance (e.g. Tiffany, 1990; Robinson and Berridge, 1993). This attentional bias for substance-related stimuli could be due to the development of automatic associations (Tiffany, 1990) and the development of substance-related behaviours and habits (Wood and Neal, 2007).

1.1: Origin of Attentional Biases

Regular substance abuse has been found to be associated with reactivity to substance-related stimuli. For example, when a heavy alcohol abuser sees or smells an alcoholic beverage then they may react with increased physiological arousal and subjective craving (see Carter and Tiffany, 1999). Such processes are associated with the maintenance of substance abuse and play a role in relapse behaviour. Biases in substance abusers' cognitive processing of substance-related stimuli therefore may play an integral role in substance-seeking, craving, and relapse. However, the preferential treatment and increased priority given to such stimuli, which leads to attentional biases, may develop in a number of ways. This chapter introduces the major theories which describe psychological processes behind substance use behaviour and how they may contribute to the development of attentional biases. It is important to state that such theories are not necessarily disparate and can potentially be integrated.

Tiffany (1990) proposed an attentional approach to substance abuse which emphasised that the learning of associations between the environment and substance abuse is important for subsequent substance abuse. Such associations become automatic and potentially not enacted within awareness. According to Tiffany (1990) the act of substance abuse becomes effortless and difficult to control, once it has been automatised. Such automatic behaviours would lead to cognitive disruption should a behaviour, namely of a non-automatic variety, e.g. trying to abstain, interfere with such automatic processes. Indeed, an alcohol abuser may have many associations between drinking and pleasurable emotions, everyday thoughts, and aspects of everyday routine. These associations occur frequently and will accordingly eventually become automatised. This would result in an alcohol abuser's environment becoming full of stimuli that are associated with alcohol use (see Chapter 5), as stimuli would automatically elicit an associated (cognitive) response. If this were the case then an alcohol abuser would be constantly reminded of the pleasurable nature of alcohol due to the automatised associations between aspects of everyday routine and drinking. This is supported by Rather et al. (1992), who found, using multidimensional scaling (MDS), that for excessive drinkers, alcohol is perceived 'close' (in psychological space) to positive alcohol experience, whereas this is not the case for light drinkers. Therefore, during periods of abstinence, a substance abuser will be constantly reminded of substance-related stimuli and of the pleasurable nature of substance abuse, thus eliciting attentional biases and urges. If this is taken for granted, then this process is likely to lead to the formation of associations related to an abused substance, which are triggered by the presentation of related stimuli. Such processes would facilitate the act of abusing the substance, in the presence of substance-related stimuli. This form of behaviour can be construed as habit learning, and emphasises the importance of automatic skill learning in the maintenance of substance abuse behaviour, potentially through conscious preoccupation with thoughts about drinking. Thus, substance abuse behaviours would tend to be relatively fast and efficient, effortless, elicited by specific substance-related stimuli; and tend to occur automatically, without a need for conscious awareness. However, if behaviours controlled by such substance abuse-related action schemata were to become impeded, then more intensive, effortful, resource-demanding processes would be initiated in order to rectify the current situation and return to automatic processing. Tiffany proposed that such nonautomatic processes underlie substance abuse urges. An accompanying attentional bias would therefore direct processing resources away from ongoing tasks and activities and toward the goal of substance abuse.

The pursuit of goals is the foundation for the next theory of substance abuse behaviour. The theory of current concerns (Klinger, 1975, 1977, 1987, 1996b; Klinger and Cox, 2004) posits that people structure their lives in pursuit of a number of goals. To have a goal is to have a current concern for the achievement of said goal. A current concern is the product of becoming committed to a goal and its eventual attainment or disengagement from; that is, a current concern is a persistent motivational state. This motivational state leads to relevant information within an environment becoming sensitised and increasingly salient. For example, substance abusers would be thought to have a current concern for substance abuse. Therefore, they would have a corresponding attentional bias. A current concern will bias attention towards goal-related stimuli. Salient goal-related cues develop corresponding goal-directed responses. Current concerns have both an implicit and an explicit influence over behaviour: A substance abuser may be distracted by substance-related stimuli, which is the result of having a substance use goal. An abuser will, both consciously and unconsciously, focus his/her attention on goal-related substance-stimuli. Following the establishment of a goal and its current concern, attention towards the addictive substance becomes implicit and unconscious. Further evidence of this implicit motivation, demonstrated by Moors *et al.* (2005) and Winkielman, Berridge, and Wilbarger (2005), is that spontaneous behaviour can be influenced without awareness by motivationally-valued stimuli. This causes the environment to be screened for motivationally salient stimuli. As this salience sensitises early perceptual pathways, awareness may be lacking of the hypersensitivity to concern related-stimuli. Even following active inhibition of goal pursuit, such processes may still influence motivation. This may explain relapse (e.g. Mogg *et al.* 1995). Commitment to a goal initiates an enduring current concern, that although can be inhibited, it cannot be eliminated. Current concerns about substance abuse would contribute to the initiation of addiction-related attentional biases. This attentional bias further motivates substance abuse.

Robinson and Berridge (1993) proposed a model of substance addiction based around the notion of incentive-sensitisation. In this model addictive substances share the ability to produce brain adaptations, these adaptations take place in neural reward systems, neuroadaptations render these systems hypersensitive to substances and substance-related paraphernalia (liking). These systems then become sensitised to mediate a subcomponent of reward (wanting). The model suggests two pathways to addiction; liking, which undergoes tolerance, due to repeated administration - effectiveness of the substance decreases due to a need to increase the dose in order to maintain effectiveness. Whereas wanting, undergoes behavioural sensitisation - increased effectiveness of the substance is observed due to repeated administration.

Substance unconditioned stimulus → Pleasant stimulus → Liking → Pleasure
→ Affective actions

Conditioned stimulus →Incentive Salient Attributor → Wanting → Craving
→ Attraction/attentional bias
→ Consumption

Wanting can occur implicitly and can guide behaviour without a person having conscious awareness of any precursory factors (Winkelman and Berridge, 2004). In addicts, doses of substances that are too low to produce any conscious experience of pleasure can activate implicit 'wanting' as indicated by an increase in substance seeking behaviour (Lamb et al., 1991). There are different brain mechanisms responsible for 'wanting' and 'liking', as hedonic 'liking' is a different psychological process and has its own neural substrate (Berridge, 1996).

Robinson and Berridge (2000) suggest that incentive-sensitisation processes are fundamental to addiction and can cause relapse. When substances are administered repeatedly, some effects undergo tolerance and others undergo sensitisation. There are two major classes of substance effects that are sensitised by addicting substances; psychomotor activating effects and incentive motivational effects. Both classes of substance effects are mediated at least in part by nucleus-accumbens-related circuitry (NAcc), therefore sensitisation of these behaviours is thought to reflect reorganisation and sensitisation of this neural system (Robinson and Berridge, 1993). Nestler and Malenka (2004) suggest that sensitisation may persist because chronic exposure to cocaine has been found to produce extra dendrites to be produced by the neurons in the NAcc. These extra connections may amplify signalling between linked cells with lasting effects, and such heightened signalling may cause the brain to overreact to substance-related cues; suggesting a biological component to attentional biases. Addictive substances can increase arousal, attention, and motor behaviour, producing increased locomotion, exploration, and approach. At high doses psychomotor effects can include intense repetitive stereotyped movements (Wise and Bozarth, 1987). Psychomotor effects are easy to measure and are mediated by brain systems that overlap with those involved in reward (NAcc, dopamine, etc.: Wise and Bozarth, 1987). An important feature of psychomotor sensitisation in substance abuse is its remarkable persistence. In animals psychomotor sensitisation persists for months to years after taking the substance has ceased (Paulson et al., 1991). Thus, if sensitisation is prolonged in humans, then addicts are left susceptible to relapse long after discontinuation of the substance (Strakowski et al., 1996). Context specific sensitisation has been observed in animals. If a substance is administered within an environment which is unusual to the one an animal has previously been exposed to a substance, then psychomotor sensitisation is not expressed (Terelli and Terry, 1998). This explains why addicts, who have abstained for years, can experience craving within a place previously associated with substance administration. Such observations may demonstrate the importance of substance-related stimuli.

Anagnostaras and Robinson (1996) found that rats that were repeatedly given substance treatments in one distinct environment developed psychomotor sensitisation. Subsequent substance administration within a new environment leads to a failure to express behavioural sensitisation, again highlighting the importance of cues. This direct evidence for sensitisation increasing 'wanting' for substance reward can also be seen in other studies. Pierre and Vezina (1998) suggest that sensitisation decreases the threshold dose necessary for rats to learn to self-administer substances. Sensitised rats show increase in 'breakpoint' when treated on progressive ratio schedules and will work harder than normal to get the substance i.e. they want it more (Lorrain et al., 2000). Such findings demonstrate how factors affecting learning can affect motivation to abuse substances.

Dickinson et al. (2000) have consistently found that dopamine antagonists suppress Pavlovian-type effects. These results have important implications for understanding what sensitisation does to the brain systems that generate motivated behaviour. Sensitisation enhances the ability of substance-associated cues to trigger irrational outbursts of 'wanting' for the reward and in human addicts may lead to the compulsive pursuit of substances. The distinction between liking and wanting can result in strange dissociations in addicts, in which goal-directed substance seeking behaviour occurs in the absence of conscious awareness, and wanting is dissociated from ability of substances to produce pleasure. Addicts will pursue substances they do not like, as well as those they do like (Lamb et al., 1991). Even if a person's explicit declarative goal is abstinence, implicit incentive salience attributions, undermine the explicit goals. Therefore suggesting a loss of control regarding substance abuse when in a context associated with substance abuse. Whereas Robinson and Berridge (1993) suggest that a substance becomes increasingly salient, so that craving occurs in the presence of an associated stimulus, Tiffany (1990) suggested that it is in the absence of an associated stimulus, e.g. during a period of abstinence, that would lead to the greatest substance urges, as disruption in substance abuse habits may lead to nonautomatic cognitive processes, which activated in parallel with substance-use action schemata, may affect decision making (e.g. "I need a fix").

In contrast to hedonic/withdrawal views of addiction, Robinson and Berridge's incentive salience model suggests that substance pleasure becomes less and less important during transition to addiction. Incentive motivational consequences of substance-induced alterations in NAcc-related circuitry that mediates incentive salience. Circuitry is activated by implicit S-R associations (Pavlovian conditioning). This results in pathological wanting directed especially to substance-associated cues, incentive salience attributed to these cues, making substance-related cues into effective triggers of relapse (Robinson and Berridge, 1993).

Implicit 'wanting' increased further in some addicts by substance-induced dysfunction in prefrontal cortical systems normally involved in decision-making, judgement, emotional register and inhibitory control over behaviour. An inability to assess future consequences of one's actions and excessive incentive salience due to sensitisation of NAcc-related circuitry, leads to compulsive pursuit of substances out of proportion to the pleasure that substances provide (Robinson and Berridge, 1998). However, evidence of sensitisation in humans is limited due to ethical limitations, in that it is not possible to administer high doses of substances of abuse (Lambert et al., 2006). Incentive-salience suggests that substances become more desired, and not necessarily liked. Following sensitisation to information about a substance, the substances attentional threshold is decreased. This theory would suggest that when a substance abuser performs an emotive-Stroop task then semantic interference should take place.

Cognitive theories of substance abuse maintain that context-response links may form a core aspect of subsequent use, following initial exposures. Robinson and Berridge (1993) suggest that initial 'liking' of a substance may be different to 'wanting' a substance, the latter having more motivational properties and associated more so with repetitive use. Repeated use would therefore entail repeated exposure to stimuli associated with substance abuse, which may lead to the stimulus itself developing enhanced motivational properties. Substances influence the neural system responsible for attributing incentive salience, which causes the transformation of the psychological features of an ordinary stimulus in such a way that it becomes a salient stimulus. Thus, a person abusing a substance would become hyper-sensitive to substance-related stimuli. Exposure to substance-related stimuli would then lead to increased 'wanting', or 'craving', for associated substances (potentially in the absence of liking). Robinson and Berridge note that incentive attribution can influence goal-directed behaviour without an awareness of 'wanting' the substance consciously. Thus, as substance abuse is associated with a lack of awareness, the theory may run in parallel with theories of automatisation. Attentional biases would thus develop for salient stimuli more readily than for stimuli which are not salient.

Franken (2003) extended the theory of incentive salience further. He suggests that craving and relapse can be explained in terms of attentional bias. Incentive motivation is a state triggered by the perception of stimuli associated with unconditioned stimuli (Ikemoto & Panksepp, 1999). Evidence would suggest that substance abusers can experience classically conditioned responses, when presented with substance-related stimuli. These responses can be both physiological and subjective (e.g. craving: O'Brien et al., 1998; Powell et al., 1990). Craving is seen as a central aspect of the continuation of substance abuse and the occurrence of relapse in detoxified abusers (Everitt, 1997). Cognitive processes are therefore seen as an essential link between stimulus, pharmacological processes, and response (Toates, 1998). Of these cognitive processes, attentional biases are thought to play an integral role as such biases are an automatic process that do not require conscious processing of the stimuli (Franken, 2003).

Substance-related stimuli have been found to lead to an increase in dopamine levels in the brain (Robinson & Berridge, 1993). Although dopamine can cause euphoric and pleasurable effects (e.g. Wise & Bazarth, 1985), evidence exists that would suggest that dopamine primarily serves to draw attention to stimuli that would predict or signal reward, such as substance-related stimuli (Schultz, 1998; Wickelgren, 1997). Franken (2003) therefore suggests that within substance abusers, attentional focusing is enhanced for substance-related stimuli. This, he suggests, is the result of dopaminergic activity, which can elicit craving and promote substance abuse.

In order to explain the role of attentional bias in craving and substance abuse relapse, Franken (2003) suggests a model which would predict that attentional biases contribute towards addictive behaviours in three ways. First, addictive-type behaviours would be maintained by an increased probability to perceive substance-related cues within an environment. This would be an automatic process which would explain the enhanced selection of substance cues. Perception of substance-related stimuli in this manner is related to conditioned responses (e.g. craving) that may trigger relapse (O'Brien, 1997). Second, once a substance-related cue has been detected, it is processed automatically, with attention affected in such a manner as to render the drawing away of attention difficult (i.e. attention is 'held'). Memory biases (another form of cognitive bias) may contribute to increases in craving (Franken, et al., 2003). It is also speculated that enhanced attentional processing may lead to explicit cognitive processes such as outcome expectancies for substances. Third, due to attentional limitations, the automatic focussing of attention on substance-related stimuli would lead to fewer attentional resources being available for competing cues. Due to the automatic nature of this, it may be difficult for the substance abuser to allocate attentional resources to cognitive and behavioural avoidance strategies which may have been established in order to reduce substance abuse (Franken, 2003). Therefore, within this model, attentional biases would be seen as a mediating aspect of a classically conditioned association between substance-related stimuli and craving and relapse. This would suggest an automatic aspect to continued substance abuse (Franken, 2003).

Field and Cox (2008) suggest an integrative model of theories of substance abuse and attentional bias by taking this notion further. They suggest that craving and attentional biases have reciprocal and excitatory effects upon each other, which would suggest that attentional biases play an integral role in substance abuse. The strongest of such responses would occur when the substance is perceived as being available to use; responses would be weaker when the substance is deemed unavailable i.e. when substance is unavailable for the substance abuser, substance-related cues will not elicit subjective craving or attentional bias (see Chapter 3). They suggest that attentional focus on substance–related cues would lead to increases in craving strength, and inversely, increasing craving would lead to increased attentional bias. Such phenomenon may increase in intensity until a substance is obtained or administered. Such a system would explain subsequent substance abuse and relapse. However, further investigation of attentional biases and craving is clearly needed as a minority of studies show such associations (e.g. Field and Eastwood, 2005).

Field and Cox (2008) also suggest that impulsive decision-making and poor inhibitory control may be causative factors for substance abuse, but they may also account for the incentive-motivational value that substance abusers attribute to substances and their distraction by related stimuli. They suggest that individuals with poor inhibitory control may lead to a greater sensitivity to the attentional-grabbing properties of substance-related stimuli (see Chapter 2). They also suggest that attentional bias and craving could weaken inhibitory control and contribute to impulsive decision making. Therefore impulsivity would warrant further investigation in terms of attentional biases, as inhibitory control may be important in order to prevent attentional biases from influencing craving and substance seeking. Similarly, Field and Cox (2008) speculate that those who are in treatment for substance abuse may use cognitive avoidance strategies to suppress craving and attentional processing of substance-related stimuli. For some, such strategies could be successful in reducing craving and attentional bias. However, evidence would suggest, that for others, paradoxically, attempted suppression could increase craving and attentional bias (e.g. Klein, 2007; Salkovskis & Reynolds, 1994). Those with better inhibitory controls would therefore fall into the former group as they may be better 'equipped' to overcome previous habits. Such issues may be demonstrative of the idea proposed by Tiffany (1990) who suggested that, when in times of abstinence, an abuser would experience greater craving and subsequent attentional bias. This would be due to the automatic nature of their substance abuse habit, with nonautomatic processes causing urges and attentional biases.

Therefore it would appear that these theories contribute towards explaining attentional biases in terms of their development and their subsequent role in substance abuse. An attentional bias would operate implicitly. It may also develop automatically. The importance of the reward pathways has also been demonstrated. Following an orienting of attention due to an attentional bias, a behaviour could be triggered. Tiffany (1990) would suggest that action schemata are triggered in such circumstances. Robinson and Berridge (1993) may suggest that a conditioned response caused by perception of a stimulus may take place. This form of behaviour could be akin to a habit. A habit could correspond to substance seeking behaviour. It would appear that within the theories of substance abuse and attentional biases discussed above, that perception of a cue could lead to substance seeking. Therefore measurement of cognitive and attentional biases may predict subsequent substance abuse behaviour. Indeed, measures based around such processes have been found to reliably predict substance abuse habits. The use of such cognitive paradigms has enabled a decrease in reliance upon self-report methods of substance abuse and an increase in the use of measures based upon implicit cognitive processes (e.g. Stroop, dot-probe tasks). Such measures have been posited as more robust and better predictors of current relevant behaviour (Cox, Pothos, Hosier, 2007) and a number of different measures are now in use in relation to the study of attentional and cognitive biases.

1.2: Implicit and Explicit Substance Abuse Measures

Research into cognitive and attentional biases, and both implicit and explicit factors which affect them, has resulted in the utilisation of a number of experimental paradigms. Stacy (1997) conducted research into memory biases (a form of cognitive bias). A questionnaire study was performed in order to look at memory associations, outcome expectancies, sensation seeking, and other variables, within cannabis and alcohol users. Participants in a laboratory answered questionnaires on two separate occasions. The questionnaire started with a word association task which included alcohol- and cannabis- related words, as well as 'filler' words. Other memory association items were included, for example relating to outcome associations and object associations, prior to being asked any substance use-related questions. The outcome association task listed 21 short phrases, ten of which were related to either cannabis or alcohol. During the object association task participants were presented with 24 ambiguous pictorial cues (six alcohol and six cannabis). Participants were then asked to provide free associations regarding the objects. Outcome expectancy items (Stacy, Dent *et al.*, 1990), impulsive sensation seeking (Zuckerman *et al.*, 1992), acculturation measures (Marin *et al.*, 1987), and drug use (Stacy, Widaman, Hays, and Di Matteo, 1985) were all also measured using the appropriate question measures. Memory associations were found to significantly predict responses on the subsequent drug use questionnaire. Stacy explained his results using implicit and explicit motivations for drug use. Stacy (1997) proposed that the memory activation/implicit cognition component of drug use would be quick, effortless and automatic. However the outcome expectancy/explicit cognition component would represent a more deliberate decision-making process. The latter would not represent long-term memory associations (Feldman and Lynch, 1988), rather they would be the product of expectancy-judgements which would not necessarily be as robust an indicator of future drug use as a measure of long-term memory associations.

Outcome expectancies may therefore be representative of a distorted perceptual process. Judgment-memory relationships (e.g. Feldman and Lynch, 1988; Wyer and Srull, 1989) could interfere with actual perception of one's own behaviour. Stacy (1997) makes the point that a heavy drinker who completes an outcome expectancy measure about positive outcomes regarding drinking (e.g. relaxation) may readily, but not necessarily correctly, make inferences such as 'I drink a lot, so I must think that drinking is very likely to be pleasant, relaxing, etc.' (Stacy, 1997; p62). Therefore outcome expectancies are not a robust measure of memory association; a better measure would be grounded in implicit processes and measured accordingly. This is related to the distinction between explicit and implicit cognition. These differences are highlighted by studies where memory deficits affect the two memory systems differently (e.g. Schacter, 1985; Shimamura & Squire, 1984; or for a review, see Roediger, 1990; Squire, Knowlton, & Musen, 1993).

The predictive value of these memory associations adds further weight to the argument that implicit cognitive processes are empirically different to explicit processes, yet are an intrinsic part of future drug use behaviour. Explicit measures of alcohol expectancies, such as expectancy scales and questionnaires, have been found to be a useful tool for predicting future drinking behaviour (Reich, Below, & Goldman, 2010). However it is also important that the underlying mental structures of alcohol expectancies are explored. For this to be achieved, it is necessary to use experiments that are concerned with automatic and implicit processing of alcohol-related stimuli.

Implicit cognition has been said to be able to influence behaviour and memory without explicit awareness (Wiers, and Stacy, *et al.*, 2002). The two in effect can be differentiated. Implicit and explicit memory tasks differ due to the difference in task demands (e.g. priming, Stroop, behavioural associates production, homographic identification, and the Implicit Association Test). It is speculated that the retrieval of alcohol-related memories differs between implicit and explicit memory and leads to this dissociation between memory and behaviour. Stacy (2002) suggests that implicit memory tasks are worth further investigation, as they assess cognitions that fuel alcohol-use behaviour, better than explicit tasks.

However, it would be an oversight to suggest that implicit and explicit tasks are distinct in terms of their conscious awareness (e.g. Dulany, 2003). Dienes and colleagues (Dienes, 2004; Dienes & Perner, 1999; Dienes & Scott, 2005) suggested that, during an experimental task, implicit knowledge would be a process where we would feel as if we are guessing, and explicit knowledge would be a process where we would feel we have some degree of knowing. Therefore, it may be more appropriate to consider implicit processing in terms of reflecting passive processing, as implicit knowledge may merely be information unavailable to consciousness at the time of cognition (cf. Reber, 1989; Sun *et al.* 2005). In one situation knowledge may be activated implicitly, whereas in another it may be explicitly activated. Artificial grammar learning (AGL) is used to explore the processes which underlie learning. It is considered a useful paradigm for the measurement of implicit learning. However, there is a debate whether AGL represents a true implicit learning task, or whether it is both implicit and explicit in nature (Pothos, 2007).

The AGL task has been adopted for the study of addiction and may be useful for distinguishing implicit and explicit learning. This, it has been argued, is due to the observation that AGL tasks seem to involve a number of processes, such as associative learning (Perruchet and Pacteau, 1990; Knowlton and Squire, 1996), rules (Dulany *et al.*, 1984; Reber, 1989), and similarity (Brooks and Vokey, 1991; Pothos and Bailey, 2000). AGL is a paradigm which examines the sequence learning of symbols which have become associated with particular rules. The rules specify which symbols can follow preceding symbols. Sequences are therefore legal (grammatical), or illegal (ungrammatical). Typically during AGL tasks, participants witness a training phase where they see grammatical sequences, with instructions only to observe them. During the test phase participants are informed that they witnessed a number of rules in the training phase, and that their task is to decipher which of a number of sequences are grammatical or ungrammatical sequences. A robust finding is that people perform better than chance with this task, suggesting learning is taking place, be it of either an implicit or explicit nature. Thus, as AGL tasks measure a broad range of cognitive processes; an addiction-related AGL task would be able to measure how addiction-related biases manifest within cognition, however, when using the AGL task to study addiction, the implicit/explicit learning distinction is not of interest, as it is the interference caused by the substance-related stimuli that cause discrepancies in results between heavy and light users. Pothos and Cox (2002) demonstrated this to be the case when they found results consistent with a cognitive bias being present in heavy drinkers and not in light drinkers, when the task was modified to include alcohol-related stimuli. They concluded that the cognitive biases observed in the AGL task, like other measures of cognitive bias, could be playing a role in the maintenance of alcohol addiction. Cognitive biases may be mediating alcohol use due to heavy drinkers allocating more attentional resources to alcohol-related cues within the environment (Cox and Klinger, 1990). It would appear that such measures demonstrate cognitive interference. Interference caused by alcohol-related stimuli is indicative of distorted processing which is detrimental for task performance. Such adverse performance therefore indicates that the processes involved in cognitive bias are occurring automatically and once a cognitive bias has been established it will operate to implicitly affect behaviour. Indeed, mere exposure to a cue could initiate automatic habitual responses that guide behaviour.

It would therefore appear that there are a number of different implicit and explicit factors which would affect attentional biases. This thesis considers the appropriateness of existing experimental paradigms (Chapter 2 and 5) and it is suggested that closer consideration of implicit and explicit processes would benefit attentional bias research

(Chapter 3). With consistent conditions and the correct context a cognitive bias and a corresponding attentional bias may develop automatically. Such biases may implicitly affect behaviour and lead to habitual responses. Therefore the study of such processes would be important in order to intervene in substance abuse behaviours.

1.3: Habits and Automaticity

A habit is generally regarded as a learned act which is in response to an associated trigger. This link between act and trigger can be highly automatised, due to its high degree of repetition. Once a link between automatised cue and act has been developed, a habit will be easily and effortlessly carried out. Such 'habitual' behaviour may be the result of situational and cue responses (i.e. responses in the presence of a specific situation or cue, respectively) that have developed automatic associations with certain behaviours, e.g. substance abuse, through repeated 'practice'. Within habit formation, automaticity development for the association between trigger and response would appear to be a key component. Habits can develop for a number of behaviours. For example, habits can be detrimental to health, such as smoking, or have a positive impact on health, such as exercising. These behaviours may persist due to situational cues that become associated with aspects of the behaviour (e.g. Wood and Neal, 2007).

Orbell and Verplanken (2010) performed research into how habits may be analogous to a form of cue-contingent automaticity. They suggest that a high degree of habitual behaviour is due to an automatic component. Through a number of experiments, they found that repetitions of behaviour lead to attentional biases for habit-cues. A participant's stable behavioural responses that had developed through habitual automaticity led to related cues also acquiring attention-grabbing properties. They further make the suggestion that assessing the strength of habitual automaticity may be a good predictor of how well substance abusers will perform in intervention measures designed for changing habits. Therefore the study of how cues develop in relation to habitual responses is an area of research with important potential practical applications (see Chapter 7).

A habit which is repeated frequently will be automatically activated within the correct context. This has been proposed to be the result of learning of associations within a classic behaviourist framework (e.g. Hull, 1943), in that reinforcement and repetition are considered important for habit development. Indeed habits can develop within a consistent environment; then, once established, due to the associations that can develop for habits, features within an analogous context may trigger the habit (Wood and Neal, 2007). It has therefore been suggested that people form context-response links in procedural memory, and these are expressed as habits.

Therefore it can be seen how a substance-related cognitive bias could act as a trigger for a habitual response which would be associated with substance abuse behaviour. These processes are grounded in theories involving automaticity development. Following the development of attentional biases, substance abusers will give higher priority to the processing of addiction-related stimuli over neutral stimuli. Yet, following presentation of a stimulus, a substance abuser may 'experience' difficulty disengaging their attention from this addiction-related stimulus (Mogg, Bradley, Field, De Houwer, 2003). This could be due to the increased automatic nature of processing such a stimulus compared to neutral stimuli. These processes have been termed strategic automaticity (Gollwitzer and Schaal, 1998) and explain the unconscious connection between 'stimulus' and 'behaviour' which leads to the automatic processing of addiction-related stimuli. Here, if X is encountered then behaviour Y is activated automatically. This falls into line with Tiffany's (1990) theory of the importance of automatic action schemas for behaviour. As drinking and substance use behaviour can be highly automatic themselves (e.g., Marlatt, 1985a; Tiffany, 1990), it may be expected that users are unaware of the factors that motivate their substance abuse behaviour (e.g., Wiers, Stacy, *et al.*, 2002). Thus, an abuser may have no control over their attentional bias.

However, if substance abuse is reinforced by the automatisation of the associations between a substance and positive expectancies and/or habits, would there be a *reduced* rate of substance abuse in a population where the automatisation of behaviour is impaired? Cox et al. (2001) found evidence indicating that attentional biases are not just a correlate of substance misuse, but appear to also be a contributing factor. They suggested that the eventual automatisation of associations between a given substance (e.g., alcohol) and positive expectancies (e.g., pleasure), can reinforce the state of addiction. Moreover, Mogg and colleagues found a diminished attentional bias for anxiety-related stimuli when participants were 'cured' of an anxiety disorder (e.g., Mogg, Bradley, Millar, & White, 1995), which demonstrates the role that attentional biases have in the maintenance of such disorders. Dyslexia has been hypothesised as being a condition which is associated with a broader range of deficits rather than just that of reading and writing. Nicolson and Fawcett's (1990) theory for dyslexia involves a component relating to a difficulty with automatising behaviour. They found that dyslexic children were impaired in automaticity experiments, indicating that dyslexia is a broad learning impairment. They have been led to the suggestion that dyslexic children need to consciously compensate when performing a number of tasks, thus causing any secondary task to be adversely affected. From this conclusion, it has been speculated that dyslexia may be partly due to a failure to fully automatise skills. Therefore, from research on attentional biases in substance abuse and research into automatisation problems in dyslexia, an intriguing hypothesis presents itself, namely that persons with difficulty in automatising behaviour (such as dyslexics) may be less susceptible to addiction problems (see Chapter 6).

1.4: Dyslexia Automatisation Deficit

Developmental dyslexia is considered an impairment in reading competency, without impairment in IQ, neurological damage, or when the individual has had adequate educational opportunities. In essence, it is a reading condition that is not the result of intelligence or learned behaviour. However, dyslexia is characterised by much more than just a problem with reading and phonology (e.g. Bradley & Bryant, 1983; Frith, Landerl, & Frith, 1995; Stanovich, 1988). Dyslexia has also been found to be associated with problems in memory (Liberman, Mann, & Shankweiler, 1982), visual processing (Eden & Zeffiro, 1998; Pavlidis, 1991; Stein, 1990), auditory processing (Tallal, 1980), and attention (Casco, Tressoldi, & Dellantonio, 1998; Facoetti, Paganoni, Turatto, Marzola, & Mascetti, 2000).

Sensory delay between visual and verbal processes of reading is an inadequate explanation for the broad symptoms associated with dyslexia, and has been argued to be an unlikely explanation for a lack of fluency (the ability to communicate clearly, readily, and effortlessly) and processing speed in dyslexic readers (Denckla and Rudel, 1976). Furthermore, speed limitations in word identification have been observed within the literature. This suggests that a substantial amount of effort is involved in decoding words, whereas non-dyslexics would execute this step of automatically (Nicolson and Fawcett, 1994b; Yap and van der Leij, 1993). Van der Leij and van Daal (1999) state that speed limitations could be indicating that dyslexic children have difficulty in automatising word recognition skills. This in turn could lead to maladaptive reading processes.

The role of automaticity in reading competence, and so possibly dyslexia, has been the focus of considerable research and is also relevant to the thesis as well. Automaticity with regard to reading is defined as quick, correct and effortless word recognition at the single word level. Comprehension is best predicted by the rate and accuracy with which single words are known (Hook & Jones, 2002). Automaticity, as well as being defined as quick, correct, and effortless, is also defined as the ability to execute a task without placing significant cognitive effort on attention (LaBerge and Samuels, 1974; Logan, 1988). Presumably, when learning to read and write, the learner becomes aware of the connections between orthographic and phonological word units. Following practice, he/she can take advantage of increasing the span of the relevant unit in visual analysis. The learner develops increasing phonetic capability at different stages of reading, moving from the mapping of single graphemes to single phonemes. The learner soon develops the ability to process and comprehend words by recognising letter clusters and eventually whole words. Word familiarity will lead to quicker processing and understanding, and through practice, when the connections between orthographic and phonological aspects of words have been established, word reading becomes automatic.

Many learners with reading difficulties are able to compensate for early reading problems with proper instruction. These learners become good decoders but do not succeed in reaching the level of satisfactory fluency needed to become fast and competent readers. Therefore, the development of skills necessary for increasing automaticity and fluency is vital (Hook & Jones 2002). LaBerge and Samuels' (1974) theory used the concept of automaticity to explain why fluent readers are able to decode and understand text with ease, while beginning readers have difficulty. This would imply that the developing reader will cultivate effective skills, as automaticity develops, to switch attention from decoding in order to devote attention towards comprehension. Specifically, the automaticity of reading, as theorised by LaBerge and Samuels (1974), suggests that a reader's internal attention is limited. As a result, if readers allocate too many cognitive resources on simple reading tasks, like decoding, then there will not be adequate resources left for comprehension. The internal components of attention are considered the most important to the model of automatic information processing in reading. Furthermore, it is assumed that deriving meaning from print involves the following two steps: printed words first need decoding, before the decoded words can subsequently be comprehended. According to this model, the developing reader extracts meaning from reading by switching back and forth between decoding and comprehending. This results in a reading experience that will inevitably be time-consuming, difficult and frustrating. Like the developing reader, the poorer (or dyslexic) reader spends too much time decoding and as a result, comprehension can often be adversely affected. Fluent readers require little internal attention to decode words, as they have developed automaticity for this stage of reading, thus allowing the fluent readers the ability to focus their attention on comprehension (LaBerge & Samuels, 1974).

The idea that dyslexic people may have difficulty with automatising behaviour has been the basis of Nicolson and Fawcett's (1990) theory. Above, a number of ways were demonstrated in which automatising certain processes are crucial for fluent reading performance. Nicolson and Fawcett's (1990) theory for dyslexia would suggest that people with dyslexia have deficits in automatising all behaviours and, specifically, the ones relevant for reading. They observed that when performing automaticity-based experiments, dyslexic children in a dual-task condition (where attention is divided between a primary and a distracter task) were significantly impaired over controls. These results are hard to comprehend on a traditional lexical skills deficit framework, and have led to the suggestion that dyslexic children need to utilise a larger amount of cognitive effort than controls for monitoring balance, thus causing any secondary task to be adversely affected. From this conclusion, it has been speculated that dyslexia may be partly due to a failure to fully automatise skills. This approach to understanding dyslexia has attracted a lot of attention, though not all the reported results are consistent with Fawcett and Nicolson's theory (Beaton, 2002; Bishop, 2002).

Dyslexia has traditionally been described as a reading difficulty, but it has also been described as a learning difficulty (Nicolson and Fawcett, 2008). The automatisation deficit hypothesis is the only major theory to explicitly characterise dyslexia as a deficit in the learning process (Nicolson and Fawcett, 2008). If dyslexia is indeed a problem with automaticity in learning processes, then literacy may not be the only observable effect. Fawcett and Nicolson (1990) suggest that motor skill and balance are also affected by dyslexia. Using a dual-task paradigm, whereby a participant is unable to wholly concentrate on one task, dyslexia leads to impairments in concurrent tasks, for example in balancing. Fawcett and Nicolson suggest that this is an example of how dyslexic children have incomplete skill automaticity, and therefore need to consciously compensate to perform a task that a person without dyslexia could perform without conscious awareness. Deficits for skill automaticity have been found in motor skill, phonological skill, and rapid processing. Dyslexic people have deficits in each of these skills 'across the board', rather than participant-specific areas, as would be suggested by sub-types. This skill fluency problem is found for skills that should become automatic through extensive practice, including reading and writing.

Brindley (1964) suggested that plasticity of the cerebellum and its input and output pathways are associated with behavioural practice and is important in the learning of motor skills due to its connection with the sense organs. Nicolson *et al.* (1999) investigated cerebellar deficit in dyslexics using PET. Brain activation was lower for dyslexics in the right cerebella cortex and left cingulate gyrus. These results suggest abnormalities in cerebellum activation for dyslexics. Lang and Bastian (2001) found that damage to the cerebellum resulted in a diminished ability to turn an attentionally demanding unpractised movement into an automatic movement, which again supports an assumption about the role of the cerebellum in learning.

Although the relationship between dyslexia and rapid automatic naming and fluency is well documented (e.g. Wolf and Bowers, 1999), the evidence for deficits in motor automaticity for dyslexic children is less clear (Savage, 2004). This is a view supported by Raberger and Wimmer (2003) who suggest that poor balancing (an aspect of their task they suggest is demonstrative of motor automaticity) was associated to a greater extent with ADHD than dyslexia, as the balancing of dyslexics did not differ from the non-impaired control group. However, the children with ADHD were found to have intact reading skills. This is contrary to the automatisation/cerebellum deficit hypothesis of dyslexia and would suggest that problems in motor automaticity (i.e. impaired balance) and reading competency are only incidental effects of dyslexia. Raberger and Wimmer (2003) propose that the results of Nicolson and Fawcett (1990) may be due to the accidental inclusion of ADHD children. This suggestion is consistent with Denckla *et al.* (1985), who argued that motor impairments were only found in dyslexics if they also had ADHD. Yet Rochelle, Witton, and Talcott (2009) make the suggestion that even subclinical ADHD symptoms may be able to confound motor automaticity measures between dyslexics and non-dyslexic controls. Nevertheless Giedd *et al.* (2001), in a neuroimaging study, found cerebella abnormalities in subjects with ADHD.

Roughly half of the dyslexic children reported in Ramus, Pidgeon, Frith (2003) were impaired on a battery of motor- and cerebella-function tests. Ramus *et al.* formed the conclusion that cerebella dysfunction is not the cause of phonological and reading impairment in dyslexia. This is further supported by Beaton (2002), who pointed to methodological imperfections in the examination of deficits for dyslexics in relation to cerebella function. He also posits that a deficit in cerebella function does not necessarily suggest a causal mechanism. Bishop (2002) further highlights the notion that cerebella abnormalities may be an effect and not a cause of dyslexia. Also, there has been evidence showing that learning processes of dyslexic people are unimpaired (at least implicit learning), casting doubt on a conceptualisation of dyslexia as a learning problem (e.g., Kelly, Griffiths, and Frith, 2002; Pothos & Kirk, 2004; Roodenrys and Dunn, 2008).

Kelly, Griffiths and Frith (2002) used the serial reaction time task (SRTT) to examine the implicit learning within those with dyslexia. Reaction time during the sequenced elements of the task decreased even in the absence of awareness. This result would suggest that implicit learning was intact in dyslexics. This result is contrary to Vicari, Marotta, Menghini, Molinari, and Petrosini (2003), who found dyslexics to be impaired on an SRTT. They concluded that an implicit learning deficit was evident in dyslexic people. However, whereas Kelly, et al. (2002) asked participants to respond to every item in the sequence, Vicari, et al. (2003) requested that participants only respond to certain elements of the sequence; a task measuring implicit learning, but also, arguably, response inhibition – a potential confound. However, further support for this deficit is provided by Stoodley, Harrison and Stein (2006) who found SRT learning deficits in dyslexic adults. They observed that 42% of dyslexic participants showed learning on the SRTT compared with 86% of controls. This discrepancy within the literature could be due to methodological differences between the SRT tasks used in the different experiments or maybe due to inappropriate screening for dyslexia. It has also been suggested that ADHD measures should also be considered when using a dyslexic population (Germano, Gagliano, Curatolo, 2010). Pothos and Kirk (2004) made similar suggestions regarding dyslexia with respect to implicit learning using an artificial grammar learning task. Stimulus format was found to be an important feature for non-dyslexic learning, but not dyslexic learning. Although dyslexia caused no impairment here, the results do suggest a difference in learning processes, or, as the authors suggest, the results could be due to a motivation factor. This result could imply that implicit learning was intact for dyslexic participants, but explicit strategy discrepancies led to the difference in results between the two groups. The authors suggest that both implicit and explicit learning is necessary for knowledge development, and that dyslexia could lead to problems with explicit strategy formation. It is worth noting from the above studies that the learning of dyslexic participants can be intact, even if the ability to automatise is impaired, as the two processes can be independent.

It can be seen from this review of the dyslexia automatisation deficit hypothesis (Nicolson and Fawcett, 1990) that the development of automaticity could indeed be an underlying cause of dyslexic traits. Therefore if dyslexics are impaired in automaticity development, then it may be possible to explore automatic aspects of substance abuse, e.g. attentional biases, by utilisation of this population.

1.5: Rationale

In summary, attentional bias is significant in substance abuse. In the case of alcohol abuse, for example, the significance of attentional biases is partly related to the fact that they predict clinical outcomes (Cox, Pothos, Hosier, 2007). Intuitively, it is easy to see why attentional bias for alcohol-related stimuli might predict future changes in alcohol abuse. Greater attentional bias for alcohol related stimuli implies that a drinker is more likely to notice alcohol-related information in his/her environment (see Chapter 5) and make links between alcohol and positive alcohol expectancies (cf. Pothos & Tapper, 2010; Tiffany, 1990). It is no surprise that many researchers have sought to explore the intervention potential of these biases (e.g., Fadardi & Cox, 2009; Wiers *et al.*, 2006; cf. Hogarth & Duka, 2006).

Attentional biases are associated with addiction (e.g. Cox, Pothos, Hosier, 2007), but is it possible that they may also be playing a contributing role in substance abuse? Whether attentional biases are a cause or effect of addiction is open to debate but this thesis aims to provide more evidence regarding this issue. The development of attentional biases in substance abusers plausibly involves some processes which are automatic. This is because repeated administration of the substance leads to the association of substance-related stimuli to substance administration. Repeated exposure to such associations would lead to an abuser learning to associate more stimuli with substances. Tiffany (1990) would argue that attentional biases contribute to addiction, as, following automatic associations, attentional biases toward addiction-related stimuli would continuously remind a substance abuser of the pleasurable effects of the substance which is abused. Therefore this would lead to further addiction-related behaviour. Thus, attentional biases for addiction-related stimuli may mediate substance abuse behaviour and, as has been shown, predict relapse. Cox, Hogan, Kristian, and Race (2002) observed that alcoholic patients who were seeking treatment were more likely to relapse post-treatment, if they had an increased alcohol-Stroop interference. Similarly, Cox, Pothos, & Hosier (2007) found that, of alcoholics not seeking treatment, those with a lower attentional bias would drink on fewer days six months after testing. These studies demonstrate the predictive value of attentional biases. The development of attentional biases may be the result of a number of processes, for example, automaticity (Tiffany, 1990), incentive-salience (Robinson and Berridge, 1993), or current concerns (Klinger and Cox, 2004). Within each theory is the same underlying notion that consistent substance abuse will lead to substance-related stimuli leading to corresponding attentional biases. Repeated exposure, or practice, is the precursor of automaticity.

In this vein, this thesis examines novel attentional and cognitive bias measures, suggesting that these tasks could offer a novel insight in relation to the study of substance abuse. Further, the role that automaticity plays in the development of attentional biases is examined. From the literature review above, a number of questions are apparent. Tiffany (1990) suggests that substance abuse reflects a 'loss of control'. Likewise, Field and Cox (2008) suggest that poor inhibitory control may influence craving, substance seeking, and subsequent attentional bias. This thesis therefore aims to examine attentional bias and inhibitory control in Chapter 2 Experiment 1 and specifically explore whether consideration of inhibitory control leads to a more sensitive measure of attentional biases. Franken (2003) suggests that a bias in preconscious processing may not be present in appetitive motivational states. This is a notion examined in Chapter 2 Experiment 2 by presenting stimuli peripherally. Within anxiety research subliminally presented aversive stimuli has been found to be reflected in increasing attention; a result not replicated in substance-related tasks. Therefore the novel task presented in Chapter 2 may be able to explore this further by measuring attentional effects caused by decreased awareness through peripherally presented stimuli rather than subliminally presented stimuli. Such research is important as Field and Cox (2008) suggest that psychological interventions which may minimise attentional biases may reduce craving and substance seeking behaviour. Therefore greater understanding of inhibitory and preconscious processing of cues would be beneficial in this domain. Field and Cox (2008) further make the suggestion that stronger associations between craving and attentional biases would be observed when a substance is perceived as being available. Chapter 3 explores this further by measuring the association between use intention (potentially analogous to availability) and corresponding attentional biases, craving, and outcome expectancies. Here it is possible to further explore the dissociation between Tiffany (1990) and Robinson and Berridge (1993), where the former would predict greater attentional bias when not abstaining as it is habit-congruent whilst the latter would predict greater attentional bias when abstaining due to stimuli being appetitive.

Tiffany (1990) suggests that prolonged substance abuse would lead to the substance abusers' environment being perceived as becoming increasingly occupied by substance-related stimuli. Therefore a direct assessment of this could be performed in order to examine this aspect of Tiffany's theory further (see Chapter 5). For Tiffany's (1990) theory to be supported it would be expected for a HD to misestimate the proportion of alcohol-related cues within an environment. Therefore, the contrary argument would also be true; a person who misestimates the alcohol-related stimuli within an environment, in that they report an inflated amount of alcohol-related stimuli, may therefore be a HD. Such a task may therefore become a useful screening tool (see Chapter 5). In order to further examine automaticity and attentional bias, a population putatively impaired in automaticity may shed new light upon the automatic aspects of substance use. Therefore it is suggested that a dyslexic population be used in order to measure substance use, attentional bias, and priming (in order to look more closely at habits and goal directed behaviours). This thesis does not measure automaticity development. Instead it utilises a population who are putatively impaired in automaticity development. Therefore by using a dyslexic population it may be possible to explore whether a population impaired in automaticity could demonstrate a different pattern of attentional biases related to substance use (see Chapter 6). Chapter 7 explores some factors which may contribute to the speed of learning. This may explore automatic associations between an abused substance and relevant thoughts (cf. Tiffany, 1990). Is frequency, i.e. repeated exposure to substance-related stimuli, primarily the function by which automatic associations develop, or do certain kinds of associations become learned more readily than others? An exploration of these characteristics may therefore help identify what associations are more likely to become automatic. An increased understanding of the automaticity of substance abuse would further the literature and eventually lead to develop a better understanding of the psychological aspects of substance abuse.

Attentional biases, cognitive biases, and automaticity would appear, from the literature, to play integral roles in substance abuse behaviour. This thesis aims to explore the questions that arise out of the literature in order to further understanding of substance abuse and aid in the development of substance abuse intervention.

1.6: Research Questions:

Chapter 2 Experiment 1: Is poor inhibitory control within HDs associated with attentional biases?

A novel gaze contingent eye tracking task is reported which has the potential to measure inhibitory control. It is aimed as a tool to study differences between HDs and LDs in terms of their ability to inhibit attention toward substance-related stimuli. It is hypothesised that heavy drinking will lead to poorer inhibitory control for alcohol-related stimuli.

Chapter 2 Experiment 2: Do alcohol-related stimuli lead to an initial orienting of attention for HDs?

The initial orienting of attention has not convincingly been demonstrated for alcohol-related stimuli. However, reanalysis of the data obtained from the gaze contingency task in Experiment 1 can be interpreted in this manner. This section of Chapter 2 aims to establish whether alcohol-related stimuli can cause an initial orienting in HDs but not LDs. It is hypothesised that HDs will demonstrate an initial orienting for alcohol-related stimuli.

Chapter 3: Are attentional biases robust phenomena, or are they affected by craving, outcome expectancies, and/or use intention?

This experiment aims to establish whether an attentional bias fluctuates in intensity as a result of craving, outcome expectancies, and/or use intention. Attentional bias for alcohol or MDMA will be measured within groups of either HDs or MDMA users on two occasions; when intending to use a substance and when not intending to use a substance. Measures of craving and outcome expectancies will also be taken in both 'use intention' conditions. The attentional bias, craving, and outcome expectancy results can then be compared between 'use intention' conditions. These results can then be compared and contrasted between alcohol and MDMA users. This will enable a deeper understanding of the mechanisms involved in the use of substances which are different in terms of the pattern of their use. It is hypothesised that participants in the alcohol condition will demonstrate a more robust attentional bias than MDMA participants, as alcohol use is different from MDMA use, due to it being more readily available.

Chapter 5: Do cognitive biases reflect in some sense biases in an environment is perceived?

The aim of this chapter is to establish whether substance use can lead to a distortion in how information in a person's environment is perceived. A word list will be administered to both HDs and LDs. Within this list of words a known number of alcohol-related words will be present. It is hypothesised that HDs will overestimate the number of alcohol-related words within the list.

Chapter 6 Experiment 1: Does automaticity, as measured using a population putatively impaired in automaticity development (dyslexics), affect substance use?

The aim of this chapter is to explore the importance of automaticity in substance use by using a population putatively impaired in automaticity development. The first experiment will aim to provide preliminary results regarding the pattern of substance use in dyslexics. A substance use questionnaire will be administered to dyslexic and non-dyslexic controls. It is hypothesised that the dyslexic group will demonstrate a different pattern of substance use compared to the non-dyslexic controls.

Chapter 6 Experiment 2: Do dyslexics have different substance-related attentional biases? What does this suggest about attentional bias in general?

The aim of this chapter is to further explore the importance of automaticity in attentional bias development. A measure of attentional biases for substance-related stimuli in dyslexics and non-dyslexic controls will be performed. Attentional biases may develop through automaticity. Therefore, it is hypothesised that dyslexics will demonstrate a different pattern of attentional biases for substance-related stimuli than non-dyslexic controls.

Chapter 6 Experiment 3: Does goal-directed priming affect dyslexics and non-dyslexic controls in the same way?

The aim of this experiment is to explore the automatic aspects of goal-directed priming by again using a dyslexic population who are potentially impaired in automaticity development. Two questionnaires will be administered to dyslexic and non-dyslexic controls. One of the questionnaires will be designed to prime urges to consume alcohol, whilst the other will be designed not to prime alcohol urges. It is hypothesised that the non-dyslexic controls will be more readily primed to consume alcohol when already demonstrating strong alcohol use behaviour.

Chapter 7: What factors affect the development of automatic associations?

The aim of this experiment is to establish what factors may affect the development of automatic associations. The strength of association between two stimuli will be measured under three different conditions. Emotional salience, richness of representation, and thinking about an association will be examined. Automatic associations will be judged to have developed if memory recall improves. In this way, it is possible that automatic associations will be related to increased emotional salience, more richly represented stimuli, and deeper thinking about the associations.

Chapter 2: Measuring inhibitory processes for alcohol-related attentional biases.

This chapter describes a new experimental paradigm that can be utilised to investigate attentional bias towards alcohol-related visual stimuli, specifically the ability to inhibit the initial orientation of attention toward peripherally appearing stimuli. In this way it is hoped to study a novel aspect of attentional bias. This would hopefully help to understand more about attentional biases and how they relate to substance abuse behaviour. Alcohol-related attentional biases have often been observed within the literature for heavy drinkers. These attentional biases have been found to have predictive value over relapse in abstaining alcoholics. Similarly impaired inhibitory processes have also been found to be associated with heavy drinkers. The experiment presented here introduces a novel eye tracking task which aims to observe inhibitory processes for alcohol-related attentional biases. As far as the author is aware, this is the first such experiment to combine both of these processes within the same eye tracking experimental measure. Results indicate that heavy drinkers do indeed demonstrate impaired inhibitory processes for alcohol-related attentional biases. These results will be discussed in terms of implications for current understanding of attentional bias processes.

2.1: Experiment 1: Introduction

Alcohol abuse leads to attentional biases for alcohol-related information, so that abusers' attention is more readily directed towards alcohol-related information and it is more difficult for them to disengage attention from such information. There is extensive evidence for attentional biases for alcohol-related information. Cox, Fadardi, and Pothos (2006) reviewed 18 studies utilising the alcohol version of the Stroop task, and concluded that alcohol Stroop interference can discriminate between broad categories of drinkers i.e. light and heavy drinkers (in this thesis light drinkers refers to males drinking on average less than 6 alcohol units/week and females less than 4 alcohol units/week (one alcohol unit = 10 ml. of pure alcohol). Heavy drinkers are defined as males consuming more than 21 units of alcohol/week and females more than 14 units/week: this is discussed further in Section 2.2.5). Several other paradigms purport to reveal attentional biases for alcohol-related information, or related cognitive biases, such as the dot-probe task (MacLeod *et al.*, 1986), memory tasks (Jones & Schulze, 2000; Palfai & Ostafin, 2003; Stacy, 1997), and conceptual structure measures (Rather *et al.*, 1992). Moreover, attentional biases for alcohol-related information can predict clinical outcomes. Cox *et al.* (2002) showed that alcoholics in treatment who showed an increased alcohol Stroop bias during the treatment were more likely to relapse three months later. Cox, Pothos, and Hosier (2007) found that alcohol-Stroop bias prospectively predicted a reduction in the number of drinking days in a group of excessive drinkers. Such results suggest an important role for attentional biases in alcohol abuse (Waters & Feyerabend, 2000).

Despite the predictive success of alcohol-related attentional biases, there is ongoing debate whether such biases have a causal role in excessive drinking or are simply a correlational by-product of such behaviour. Resolving this controversy is ultimately linked to corresponding theoretical developments regarding the source of attentional biases for alcohol-related information. In such efforts, each novel task purporting to demonstrate alcohol-related attentional biases offers the promise of some additional insight regarding their nature and role in alcohol abuse. The objective of the present study is exactly this: to report a novel paradigm for the measurement of attentional biases. This novel paradigm is based on eye tracking and, it is argued, provides a unique perspective on the properties of attentional biases for alcohol-related information. Note that the present research is formulated in terms of alcohol abuse and related attentional biases. There are both practical and theoretical reasons for such an approach. From a practical point of view, excessive drinking is a behaviour which is fairly commonplace in the UK, so that recruiting suitable population samples does not pose a challenge. A theoretical reason for researching attentional biases for alcohol-related information is that these biases tend to be robustly present in excessive drinkers (as the meta-analysis of Cox *et al.*, 2006, shows). Thus, in exploring a novel paradigm for attentional biases related to substance abuse, alcohol abuse avoids several methodological and interpretative complications. Having said the above, the theory for attentional biases for alcohol-related information is not actually unique to alcohol abuse and most of it applies to any kind of substance abuse. Indeed, attentional (or cognitive – this is a subtle distinction, which is not relevant to the present chapter) biases have been demonstrated for many kinds of substance abuse, appetitive behaviour, and even certain kinds of psychopathology (e.g., Calitri *et al.*, 2010; Field *et al.*, 2004; Mogg *et al.*, 2000; Stacy, 1997).

To understand the possible utility for an alternative paradigm for attentional biases for alcohol-related information, it is important to briefly consider the currently dominant experimental paradigms and the corresponding supporting theory. The alcohol-Stroop task is by far the most common measure of attentional biases for alcohol-related information. Participants are exposed to words, which are either related to alcohol or neutral (in relation to alcohol). These words are printed in different colours and the objective is to name the colour as rapidly as possible. The robust finding (Cox *et al.*, 2006) is that heavy alcohol drinkers take longer to name the ink colour of alcohol-related words than neutral words and, also, that such a difference is not observed with light drinkers. Note first that interference in the alcohol-Stroop task cannot be explained by the mechanisms postulated to account for interference in the classic Stroop task. In the latter, interference arises from the conflict between the meaning of the word and the ink colour. However, in the alcohol Stroop task there is no conflict between alcohol meaning and ink colour.

Some researchers have suggested that repeated alcohol use increases the incentive salience of alcohol-related stimuli, so that an alcohol abuser becomes hypersensitive to alcohol-related information (Robinson & Berridge, 1993). According to such a view, a lowered attentional threshold for alcohol-related stimuli can make such stimuli more 'attention-grabbing', an implication which translates into a corresponding attentional bias. Klinger and Cox (2004) reached an analogous conclusion, using their theory of motivation based on current concerns. A current concern (i.e., a goal) of, for example, drinking alcohol causes drinkers' attention and other cognitive processes to be focused on stimuli related to attaining the goal. Tiffany (1990) adopted a more cognitive perspective and suggested that repeated alcohol use eventually automatises both schemas related to alcohol consumption (e.g., the sequence of actions leading to obtaining alcohol) and related expectancies. In this way, alcohol-related stimuli are attentionally prioritised because of the several automatic links they generate with other information, and vice versa.

All these perspectives could be employed to understand attentional biases for alcohol-related information in the alcohol-Stroop task. But, there are some interpretative difficulties as well. To appreciate these difficulties, note first that an attentional biases for alcohol-related information could reflect either or both of two attentional effects. First, an effect can be identified of initial attentional orientation, which 'grabs' attention i.e. the ability of the stimuli to spontaneously cause attentional shift toward one stimulus as opposed to another. This initial orientation effect would select out and prioritise alcohol-related stimuli, at the expense of other stimuli. Second, an effect can be considered of attentional engagement, according to which an alcohol-related stimulus captures attention more so than alternative, matched stimuli.

Regarding the alcohol Stroop task, it is already known that the meaning of the word will be processed before its colour (see Cox, Fadardi, & Pothos, 2006). Therefore, it is problematic to appreciate whether an alcohol abuser processing a trial with an alcohol-related word gets captivated by the meaning of the word, because it is alcohol-related (cf. Robison & Berridge, 1993, or Klinger & Cox, 2004) or simply because reading appears to be a process more automatic than ink-colour processing. Accordingly, results from the alcohol-Stroop task tend to be interpreted more as relating to sustained attention, as opposed to initial attentional orientation.

Such considerations in part motivated the development of the dot-probe task (MacLeod *et al.*, 1986), which can eliminate any potential confounds introduced by the reading process. In the dot-probe task, a trial involves two stimuli, typically presented on the left and right part of the distal layout, such that one stimulus is neutral, while the other alcohol-related. The stimuli disappear and a dot appears either at the location of the neutral or the alcohol-related stimulus. The task of the participant is to identify the location of the dot as quickly as possible. Depending on whether the dot replaces the neutral or the alcohol-related stimulus, and the relative speed of responding across trials, the experimenter can establish the presence of an attentional bias for alcohol or not – almost. A complication in the dot-probe task is that participants may attend to say the alcohol stimulus, then to the neutral stimulus, then back to the alcohol stimulus etc. Even if the alcohol stimulus is more salient or attentional grabbing, it would not exclusively occupy a participants' attention, leading to important interpretative difficulties. In practice, dot-probe researchers employ a range of time delays between the presentation of the stimuli and that of the dot. But, some of these interpretative difficulties remain, especially for longer times, since it is not clear how many attentional shifts had occurred prior to the observed attentional focus (cf. Posner & Cohen, 1984; Rafal, Davies, & Lauder, 2006).

Such issues make problematic the use of the dot-probe task for studying sustained attention components of attentional biases. However, they potentially show more promise regarding the initial orientation of attention. Unfortunately, the relevant results still fall prey to ambiguities. For example, Field *et al.* (2004a) demonstrated that heavy drinkers showed an attentional biases for alcohol-related information for delays between the stimuli and the dot (stimulus onset asynchronies – SOAs) of 500ms and 2000ms. Yet, there was no evidence for attentional biases for alcohol-related information for stimuli presented for only 200ms. By contrast, Stormark *et al.* (1997), using a sample of alcohol abusers in a treatment centre, showed an attentional biases for alcohol-related information with a SOA of 100ms and, in fact, avoidance of alcohol-related information at 500ms. This latter result was reflected in Noel *et al.*'s (2006) investigation as well, with abstinent alcohol abusers. But, abstinence from heavy drinking is hard to reconcile with specific predictions regarding attentional biases for alcohol-related information, since there is evidence that whether abstinence is associated with an attentional bias or not would relate to the eventual probability of relapse (e.g., Cox *et al.*, 2002).

Another potential difficulty with such measures concerns agreeing on the SOA which indicates initial attentional orientation. For example, while Bradley *et al.* (2003) interpreted a 500ms SOA as indicative of initial attentional orientation, some researchers have argued that a SOA as long as this is better interpreted in relation to delayed disengagement (e.g., Koster *et al.*, 2005) and that SOAs as brief as 50ms to 200ms would be needed to study initial attentional orientation (Theeuwes, 2005).

Overall, the dot-probe task, with sufficiently many SOA conditions (and perhaps with concurrent eye tracking measurements as well) can provide a good measure of the time course of attentional capture by alcohol-related stimuli, even if the conclusions regarding initial attentional orientation are perhaps not entirely satisfactory. But it could be the case that the question of initial attentional orientation, in the context of the dot-probe task, is not the one most critically relevant in understanding the role of attentional biases for alcohol-related information in excessive drinking anyway. In the dot-probe task, the participant can freely process the alcohol-related stimulus. From the point of view of a participant even vaguely interested in alcohol (and certainly not necessarily an alcohol abuser), the neutral control stimuli would compete only weakly for attentional resources with the alcohol-related stimuli. However, it is worth noting, that some of these issues that are discussed here could be resolved with a closer comparison of time taken processing neutral cues. By calculating a 'difference score', a dot-probe is better able to control for such vague interest in the presented stimuli. It would be possible to compare the initial fixation times for alcohol-related stimuli and neutral stimuli to produce a 'difference score'. This may provide a more accurate account of how attentionally salient each stimulus-type is for each participant. However, this 'difference score' may again merely be demonstrative of a general preoccupation rather than being indicative of an underlying motivational state which has arisen from repeated administration. Once attention has been 'grabbed' by an alcohol-related stimulus, the time course can be measured of attentional emphasis. But, such an approach is less informative regarding the key issue of exactly how *compulsory* is the initial orientation of attention towards alcohol-related stimuli, for alcohol abusers (Field, 2010). In other words, it would also seem pertinent to examine the degree to which an alcohol abuser is unable *not* to process an alcohol-related stimulus. Put more simply, exactly how distracting will an alcohol-related stimulus be for an alcohol abuser?

Current measures of attentional bias do not appear to directly address this critical issue, even though poor inhibitory control is an established theme in research relating to excessive drinking (Cox & Klinger, 2004; Wiers *et al.*, 2007). For example, it has been suggested that elevated impulsivity and diminished inhibition of alcohol abusers could lead to difficulty in controlling responses to alcohol-related stimuli. Field and Cox (2008) further suggested that the presence of an alcohol-related stimulus can lead to a number of interrelated reactions. For example, classical conditioning would lead to alcohol-related stimuli eliciting an expectation regarding the subjective effects of consuming alcohol (see also Wiers & Stacy, 2010). Such expectations could have a mutually excitatory relationship with craving, depending on explicit knowledge of whether a substance is currently available or not. For example, in situations where alcohol is not perceived as available (e.g., within a treatment centre), there would be decreased craving and also decreased attentional bias. Importantly, Field and Cox (2008) make the further suggestion that attempts to control craving and attentional biases could paradoxically lead to increasing both. Individual differences in impulsivity and the ability to demonstrate inhibitory control would also be associated with the degree of attentional biases and craving.

Overall, it is possible to see how Field and Cox"s (2008) model relates attentional biases and craving on the one hand, with a crucial mechanism of inhibitory control in relation to both, on the other hand. The focus of the present study concerns the empirical measurement of failures of inhibitory control, which arise from alcohol-related stimuli. Recently, Weafer and Fillmore (2012) used a go/ no-go paradigm, so as to measure inhibition for alcohol-related stimuli. They found that inhibitory failures were more common after a pre-exposure with alcohol-related stimuli. But, the empirical measurement of such failures in inhibitory control were measured in a task separate to that for attentional biases for alcohol-related information. Clearly, ideally one would want to examine failures of inhibitory control as a direct result of attentional biases for alcohol-related information.

The current study aims to directly link failures of inhibitory control due to alcohol-related stimuli and corresponding attentional biases. A simple attention fixation task was employed, during which participants were instructed to attend to a particular fixation region on a computer screen (the fixation region's location also varied). While the participant was attending to the fixation region, other visual stimuli would appear on various locations on the computer screen. Even though the participant might be aware of the presence of these distractor stimuli (through peripheral vision), his/ her instructions were clearly to only attend to the fixation region. Moreover, if the participant did attend to these peripheral distractor stimuli, the distractor stimuli would disappear, for as long as the participant's gaze was directed away from the fixation region (a minimal corresponding threshold was specified, for the degree to which the participant would need to direct his/ her gaze away from the fixation region, before the distractor stimulus disappeared). With this innovative paradigm, a participant has really no incentive to process the distractor stimuli at all: the instructions clearly indicate he/ she should not. Moreover, even when the participant does attempt to process these distractor stimuli, they actually disappear immediately. Under such circumstances, discouraging as much as possible lapses in attention away from the fixation region, it can be studied exactly how distracting alcohol-related stimuli can be for excessive drinkers, compared to broadly matched neutral stimuli.

Within this experiment eye movements were measured away from the fixation region toward the distractor stimuli. However, fixation counts were measured within the fixation region when in the presence of both neutral and alcohol-related stimuli. Adopting such an approach enabled the measurement of attentional processing irrespective of whether the fixation region's threshold had been breached. Therefore both the participants' ability to attend to the fixation region and the attentional processing of distractor stimuli was measured. Both of which are argued provide a novel insight into attentional biases.

2.2: Method

2.2.3: Participants

48 participants were recruited (6 males; 42 females) aged 18 – 40 years (M= 20.63; SD = 3.98) from the undergraduate population within the psychology department at Swansea University. Participants were recruited using the psychology subject pool, and course credit was offered in return for participation. Participants were not informed of the relation of the study to excessive drinking. The alcohol content of the study was only revealed as participants became aware of the alcohol-related stimuli during the eye tracking task. Instead participants were led to believe they were taking part in a task designed to look at eye movements and dyslexia. Participants were, however, fully debriefed, following the task. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

2.2.4: Apparatus

EyeLink Desktop 1000 eye tracker (SR Research Ltd., Ontario, Canada). Participants wore a target sticker as the camera was on the desktop. The target sticker negates the use of a head clamp and allows the camera to calibrate to the participants' position. Participants sat 55cm away from the monitor, as this gives the clearest eye movement data. Their dominant eye was deciphered by using the Miles test (Roth, Lora, and Heilman, 2002) and tracked accordingly. Experimenter Builder software Version 1.4.128 B (SR Research Ltd., Ontario, Canada) was used to control the stimulus events during the eye tracking task. E-prime software (Psychology Software Tools Inc., Pittsburgh, Pennsylvania) was used to control the presentation of the stimuli during the awareness task.

2.2.5: Data Scoring and Response Definitions

Three eye tracking variables were created: fixation counts - the number of fixations when the stimulus was presented; break frequency – the number of times participants tried to look at the stimulus; binary breaks – whether the stimulus was looked at. These variables were used in order to measure how distracting the distractor stimuli were. In order to obtain a measure of how distracting alcohol distractor stimuli were, relative to neutral ones, for each of these variables the scores were subtracted for the neutral distractor stimuli from the corresponding scores for the alcohol distractor stimuli. Thus, for all three variables, larger positive values indicate greater distractibility of alcohol distractor stimuli relative to neutral ones.

Furthermore, the participants were divided into heavy and light drinkers, on the basis of the Department of Health guidelines (Shenker, Sorensen, and Davis, 2009). Accordingly, light drinkers were defined as males drinking on average less than 6 alcohol units/week and females less than 4 alcohol units/week (one alcohol unit = 10 ml. of pure alcohol)(N=13; Average unit count= 1.32; SD=1.57). Heavy drinkers are defined as males consuming more than 21 units of alcohol/week and females more than 14 units/week (N=23; Average unit count=22.99; SD=9.70). Note that the HD LD distinction used here is based on the department of health guidelines and is a common way to identify LD, MD (mid-level drinkers), and HD groups (e.g. Cox, Fadardi, and Pothos, 2006; Cox, Pothos, and Hosier, 2007; Pothos and Cox, 2002). Field, Duka, Eastwood, Child, Santarcangelo, and Gayton (2007) adopt a similar approach, whereby 'heavy social drinkers' are those who consume more than is deemed 'safe' by the Department of Health (Shenker, Sorensen, and Davis, 2009) guidelines. However, they do not use the same guidelines for an LD category. Note, although according to the Department of Health guidelines (Shenker, Sorensen, and Davis, 2009) the HD category of drinkers consume more than the recommended units per week, their alcohol usage is not necessarily excessive. Likewise, most of the participants recruited during this thesis are from non-clinical populations, and as no dependency measures are used, they cannot be construed as addicts. Yet, the study of non-clinical populations may still be applicable to clinical substance abusing addicts. Within the drinking categories used in this chapter, based on undergraduate consumption norms (see Bewick, et al., 2008), one would broadly expect to find a 50/50 split between HD and low-mid drinkers (e.g. Bewick, et al., 2008, observes that, cross-sectionally, 51% of first year males are LD, whilst the remaining 49% are MD or HD drinkers; 49% of female first years are LD, whilst the remaining 51% are MD or HD). However, as mid-level drinkers were removed from the analyses in this thesis it would be expected to find a distribution of more HD participants than LD participants (e.g. in this chapter HD = 23; LD = 13; following the removal of 12 mid-level drinkers. Bewick, et al., 2008 grouped LD and MD together; if this was performed here then it would be expected to obtain groups of 23 HDs and 25 LD/MDs. This is broadly analogous to the 50/50 split found by Bewick et al., 2008). Therefore the current sample would be analogous with previous research in the field. Note that in subsequent chapters, wherever a HD LD distinction is employed, it is the same distinction as the one described here. Slight variation in HD LD group sizes would be an artefact of the removal of mid-level drinkers and should be expected within a normal population of undergraduate students whose pattern of alcohol consumption varies during their university studies (see Bewick, et al., 2008).

2.2.6: Stimuli

Stimuli consisted of a database of pictures from Hogarth, Dickinson, and Duka (2009). Each picture of alcohol use had a carefully matched control picture. For example, a hand holding a pint of lager would have a corresponding picture showing a hand holding an object with broadly similar shape and colour, but not alcohol related (see Figure 2-1, for an example). The alcohol-related distractor stimuli included pictures of lager or bitter beer, red and white wine, spirits including vodka, whisky, and gin, and alcopops. The neutral distractor stimuli were from a single thematic category, that of office equipment. They included pictures of books, phones, folders, etc. There were 16 pictures in each category and all pictures measured 105mm x 105mm. Distractor stimuli could be presented within any one of six equally-sized regions which the computer monitor was notionally divided into (Figure 2-1). Finally, the visual fixation region the participant was instructed to attend to was as large as the alcohol-related or neutral distractor stimuli and was designed to be visually salient (Figure 2-2).

On each trial the fixation region would appear in one of the six regions of the screen. Alternative array designs may be used, for example, one possibility was to place the fixation region in a consistent place, e.g., in the middle of the screen. But it was decided that having a variable fixation region would make it less likely that participants may suffer lapses of attention due to salient distractors, and so amplify the effect that was being looked for, without reducing the ecological validity of the task. Therefore a configuration is used which employed a number of possible locations for fixation regions and distractor stimuli. This partly enabled an exploration of whether the distance between the fixation region and the distractor stimuli may be a relevant variable. For example, prior to the task, it was not possible to establish whether distractor stimuli closer to the fixation region, or furthest away, would be the most distracting. Therefore, a mixture of distances are employed in order to measure which distance was the most distracting for the participant. Participants were instructed to look at the fixation region centre for each trial. Once participants had attended to the fixation region area for one second, the distractor stimuli would appear (only one distracting picture would appear per trial). Following the presentation of the picture, if the participant's gaze was to leave the fixation region boundary, then the distractor stimuli would disappear instantly. Therefore participants were unable to fixate upon the distractor stimuli. For the distractor stimuli to reappear, participants would need to fixate on the fixation region for 10ms. The fixation region was displayed for five seconds in total, so the maximum duration for which the distractor stimuli could be displayed on the screen was 4 seconds.

Each alcohol-related distractor stimuli and its corresponding neutral distractor stimuli were presented within separate trials within the same location on the screen and the fixation region would also appear in the same location as in the matched trial. An alcohol trial and its matched control trial could never occur consecutively, neither could the same fixation region location and distractor stimulus location follow from each other. Therefore, the participant looked at a different segment of the computer display in each trial. The distance between the distractor stimuli and the fixation region was manipulated in the experiment. There were overall four separate distances which were employed. However, for the purposes of statistical analyses, it is more meaningful to consider a distractor stimulus as being either 'Near' the fixation region (actual distances between distractor stimulus and fixation region were 115mm or 165mm; distances were measured from the centre of the distractor stimuli to the centre of the fixation region) or 'Far' away from the fixation region (distances were 230mm or 265mm). The distractor stimuli were randomly allocated to each of the distance groups. Also, the assignment was randomised of the type of alcohol portrayed by the distractor stimuli, so that for each distance, a variety of alcoholic drinks were displayed.

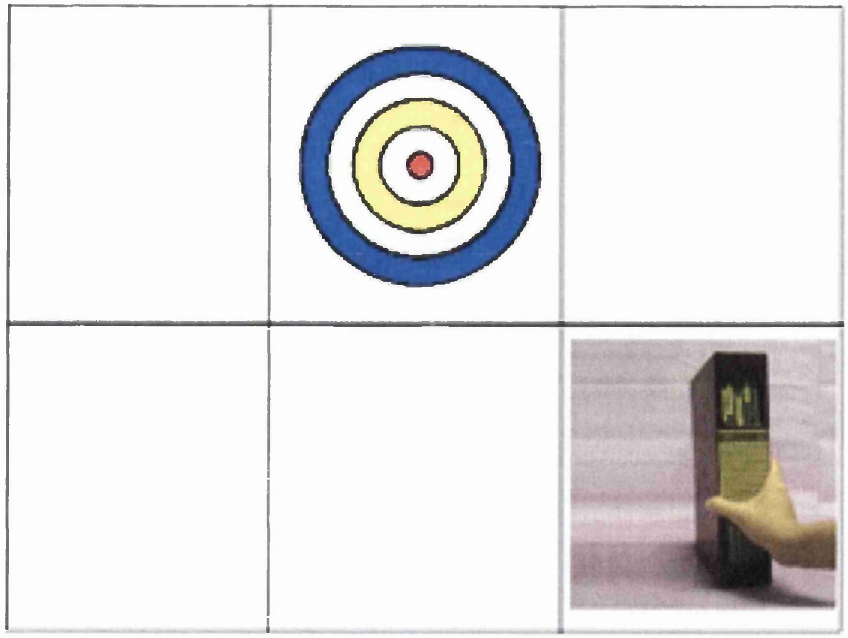


Figure 2-1. Example of fixation region and distractor stimuli. This example of control distractor stimuli depicts a hand reaching for a folder (no grid lines were present in the experiment, they are shown here to represent the 6 sections of the screen which contain the fixation region and distractor stimuli).

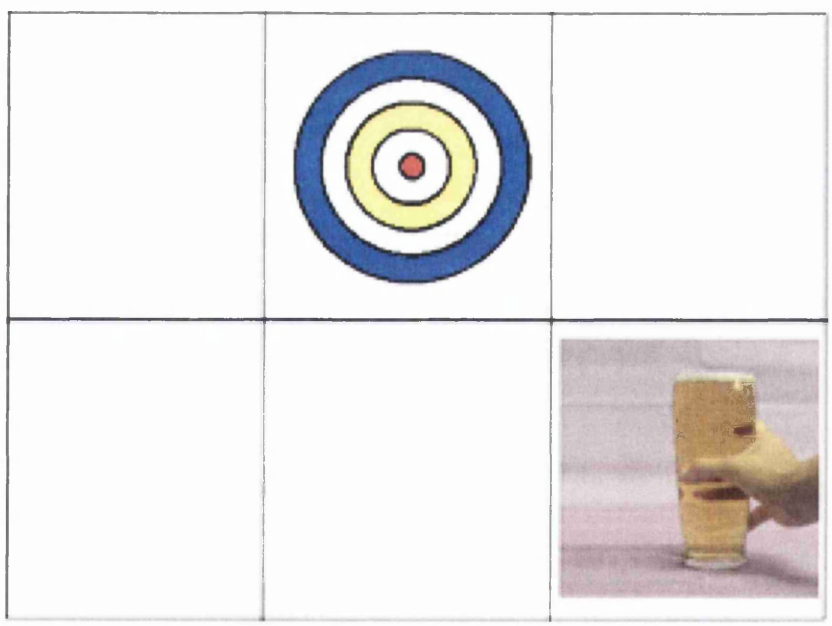


Figure 2-2. Example of matched distractor stimuli. This example of alcohol distractor stimuli depicts a hand reaching for a pint. Note the similarity with Figure 2-1. The matched control and experimental distractor stimuli are subtracted in order to make a 'difference' score. It is this score that is used to create the measures of attentional biases.

Questionnaires – Participants completed a computer-based questionnaire, designed to look like a general questionnaire on health, and which also included questions relating to dyslexia (the dyslexia questions were used to mislead participants: see Appendix A). Within this questionnaire, there was an embedded question related to weekly alcohol consumption. The question which was asked of the participants was 'How many alcohol units do you drink per week?' and an alcohol unit calculator was provided. The purpose of the questionnaire was disguised in this way so as to minimise priming effects. After the eye tracking study, participants also completed a computerised version of Love *et al.*'s (1998) alcohol craving questionnaire, the Desire for Alcohol Questionnaire (see Appendix B). This questionnaire was chosen as it has been argued to be a good measure of craving (e.g., see Love, James, and Wilner, 1998).

2.2.7: Procedure

Participants first completed the general health questionnaire, followed by the Dyslexia Adult Screening Test (Fawcett and Nicolson, 1998), which was added in order to further mislead participants following the alcohol unit question. The alcohol question was presented in this way, in between tasks, so as to minimise a perception of its importance in the experiment, and so reduce possible priming effects (indeed, questions presented first or last would likely be remembered the most, if one considers the well-known recency, primary effects in memory relevant in this context). Therefore, although participants were subsequently debriefed, at this stage of the experiment it was wanted for participants to be blind to the alcohol nature of the study. The DAST consisted of five measures designed to screen for dyslexia; rapid naming task, one minute reading task, two minute spelling task, nonsense passage reading, and the one minute writing task. They then performed the main experimental task, which involved being asked to continuously attend to the fixation region, whilst ignoring any distractor stimuli, which might be presented in their peripheral vision. While participants were carrying out the task, an eye tracker would measure their eye fixations. Specifically, the fixation counts were measured in the presence of the distractor stimuli, as a function of the position of the distractor stimuli, relative to the fixation region. Thus, a distractor stimulus could be either near or far. Recall, when a participant directed his/ her gaze away from the fixation region, towards a distractor stimulus, beyond a certain threshold (the edge of the fixation region), the distractor stimuli would disappear. So, the number of times a participant would break this threshold was measured, again as a function of the type of distractor stimuli and distance. A binary variable of whether a distractor stimulus caused the threshold to be broken was also recorded.

Because the distractor stimuli would vanish as soon as participants directed their gaze towards the distractor stimuli, participants would have very limited opportunity to process the distractor stimuli in any great detail. Therefore, following the eye tracking task, participants completed an awareness task for the distractor stimuli (this was computerised and implemented with the ePrime program). The stimuli in the awareness task were all the images employed in the eye tracking task, and some additional foils. The foils were 28 pictures from the database of Hogarth, Dickinson, and Duka (2009), which were not employed in the eye-tracking task. Therefore, there were 60 pictures in the awareness task. In each trial of this task, participants would see an image on a computer screen and be required to determine whether they had seen it previously and, if yes, how sure they were that they had seen it.

Finally, participants completed Love *et al.*'s (1998) alcohol craving questionnaire.

2.3: Results

It was aimed to measure participants' ability to inhibit their attentional biases. The main dependent variables were the number of fixations within the fixation region when the distractor stimuli appeared, the number of times a participant broke the fixation region threshold, and the binary variable of whether the fixation region threshold was broken or not for each trial (so that for a participant, the break binary variable would be the sum of all the trials for which the threshold was broken at least once). Note that, in all cases these variables were computed in terms of the measure for the alcohol distractor stimuli minus the corresponding measure for the neutral ones. Thus, in all cases larger scores indicate an attentional bias for alcohol-related information. The three independent variables were the type of distractor stimuli (alcohol-related vs. neutral), the distance between distractor stimuli and fixation regions (near vs. far), and the type of participant (heavy drinker vs. light drinker). The first two variables were manipulated as within-participants variables, whilst the last variable is a between-participants one. The first variable is called fixation counts, the second variable break frequency, and the third variable break binary. Note that eye tracking variable scores were excluded from all analyses, which were higher than the 2.5 standard deviations from the corresponding means; this represented excessive artefacts in the recording of eye movements, e.g., the tracker losing the eye due to participants' excessive movements.

The correlation results for the three dependent variables can be seen in Table 1 below. The results demonstrate a high level of consistency in the eye tracking results.

Table 2-1. Correlations between the attentional bias variables obtained using the fixed gaze inhibition task. Each attentional bias variable is created by calculating the 'difference' between alcohol and matched control distractor stimuli. The attentional bias means and standard deviations are also displayed.

		Fixation Counts	Break Frequency	Break Binary
Fixation Counts	Near	1.00**	.469**	.216
	Far	1.00**	.623**	.275
Break Frequency	Near		1.00**	.545**
	Far		1.00**	.332*
Break Binary	Near			1.00**
	Far			1.00**
Mean	Near	-.739	-.496	-.560
	Far	1.106	1.667	.500
Standard deviation	Near	5.013	15.095	1.895
	Far	5.074	11.033	1.278

Note: The Pearson's r values appear in the table. The significance of these values are denoted by *p < .05. **p < .01 (two-tailed).

Fixation Count

For each of the dependent variables, two analytical approaches were adopted, depending on how alcohol consumption was measured. On the one hand, there are the raw reports of alcohol units consumed per week. Alcohol units could be directly related to the dependent variables. On the other hand, there is the distinction between heavy and light drinkers. Also reported are corresponding results regarding the measure of craving.

A linear multiple regression analysis was used to examine whether the fixation counts for each of the distance categories (near, far) could predict reported weekly alcohol unit consumption. Using the enter method, a significant model did not emerge, $F(2, 41) = 2.420$; $p = .102$. However, there were trends consistent with the expectation that higher alcohol consumption is associated with a greater fixation count for alcohol distractor stimuli for both Near distances (corresponding standardised beta, $\beta = .309$, $p = .054$) and Far distances ($\beta = .214$, $p = .176$).

Figure 2-3 demonstrates the average fixation counts for heavy and light drinkers. A mixed ANOVA was carried out for fixation counts, with distance being a within participants variable, and the heavy drinker/light drinker distinction the between participants variable. The analysis yielded a non-significant main effect for distance $F(1, 29) = .523$; $p = .476$, so that there was no difference in fixation counts, depending on whether the distractor stimuli appeared in a Near or a Far location. The interaction between the two variables, distance and participant type, was also not significant, $F(1, 29) = 1.979$; $p = .170$. Crucially, there was a significant between-subjects effect for the type of participant variable $F(1, 29) = 6.505$; $p = .016$. Therefore, the results revealed a significant difference in fixation counts, between light and heavy drinkers.

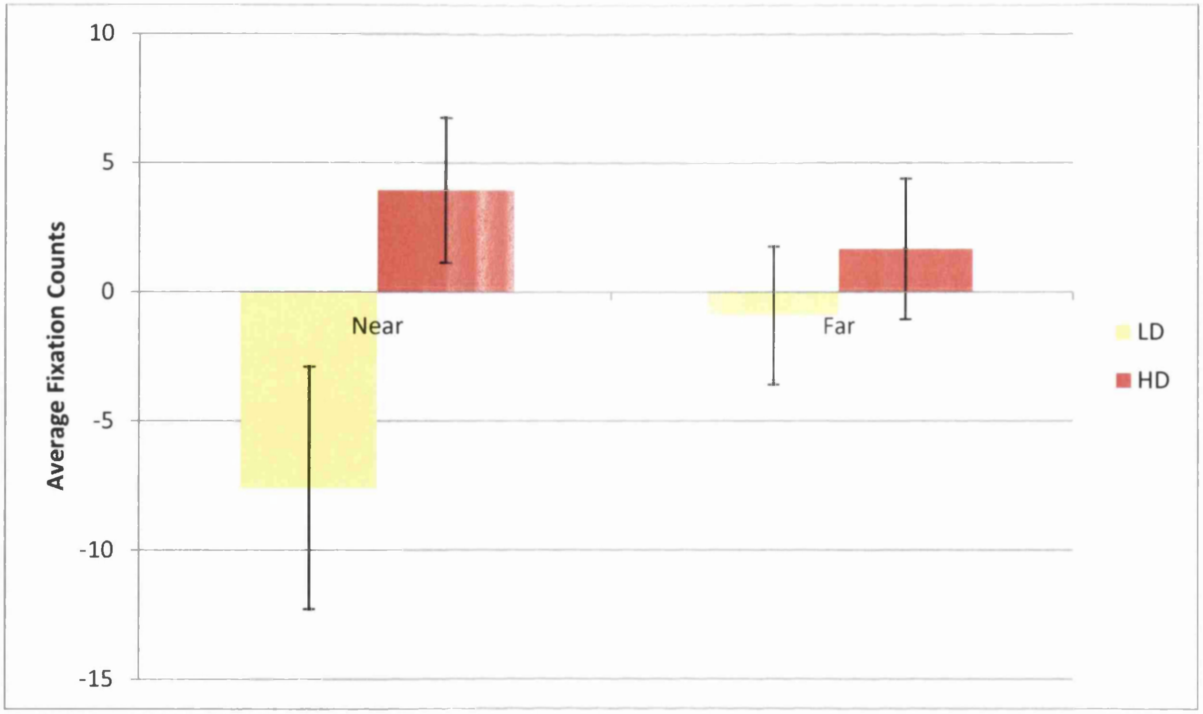


Figure 2-3. Average fixation counts within each distance for heavy drinker (HD) and light drinker (LD) groups. The bars represent the 'difference scores' obtained by subtracting control and alcohol-related stimuli. The error bars show the standard error of the mean.

Next fixation counts were explored in relation to craving. First, a linear multiple regression analysis was performed, with fixation counts for each distance as independent variables, to predict craving scores. The regression model was not significant, however, $F(2, 41) = .741$; $p = .483$. As before, the standardised beta coefficients were consistent with a trend for an association between higher craving and higher fixation counts, though none of the beta even approached significance ((Near: $\beta = .034$, $p = .834$; Far: $\beta = -.181$, $p = .271$).

Finally, it was of interest to examine whether higher fixation counts would be associated with greater awareness. Note that, as the distracting images disappeared every time a participant tried to fixate on them, it cannot be taken for granted that participants were consciously aware of the distractor stimuli. First it was important to consider two tests which do not relate to any of the specific dependent variables. Overall there were 60 images in the awareness task, of which 32 had been presented in the eye tracking task and 28 were novel foils. Therefore, a 50% chance score in the awareness task would correspond to 30 correct responses. The mean of participants' correct responses was 30.29 (SD=2.86) and a single sample t-test did not show this to be significantly different from the chance score of

30, $t(47) = .707$; $p = .483$. Thus, there was no evidence that participants were consciously aware of the distractor stimuli.

The average percentage correct for each item and the average confidence rating for the recognition decision for each item was computed. A high correlation between percentage correct and confidence ratings can be taken as evidence that participants have conscious awareness of the corresponding knowledge (this is the 'zero order' correlation criterion, e.g., Dienes *et al.*, 1995). But, the correlation was not significant, $r(48) = -.007$; $p = .960$. These results together provide evidence that participants were not consciously aware of the distractor stimuli. However, some (obviously reduced) awareness of the distractor stimuli may still have affected the eye tracking variables. Therefore, next to be considered was whether awareness of the distractor stimuli might impact on fixation counts. It was expected that participants were more likely to remember the distractor stimuli, which they attempted to look at more frequently. Therefore a regression analysis was employed to examine whether the fixation counts for each distance could predict the awareness scores. Using the enter method, a marginally significant model emerged, $F(2, 41) = 2.618$; $p = .086$. Adjusted R square =.073. A slight association between fixation count and awareness was thus observed, though this did not differentiate between fixation counts for the Near and Far distances (Near: $\beta = .304$, $p = .056$; Far: $\beta =.246$, $p = .120$).

Break Frequency

Tested first was the possibility that the break frequency variable for the Near distance and for the Far distance could together predict weekly alcohol consumption, using a linear multiple regression, as above. The regression model was not significant, even though standardised betas were consistent with a trend for higher scores on the break frequency variable to be associated with higher alcohol consumption ($F(2, 44) = 1.393$; $p = .260$, Near: $\beta = .229$, $p = .143$; Far: $\beta =.165$, $p = .288$).

Figure 2-4 demonstrates the average break frequencies for heavy and light drinkers. A mixed ANOVA was then carried out for the break frequency variable, with distance being the within participants variable, and the heavy drinker/light drinker distinction the between participants variable. The analysis yielded a non-significant main effect for distance ($F(1, 32) = 2.943$; $p = .096$) and no interaction effect ($F(1, 32) = .531$; $p =.472$). However, the main interest is in whether break frequency scores were different between light and heavy drinkers, and this was the case, as shown by a significant corresponding main effect: $F(1, 32) = 6.529$; $p = .016$.

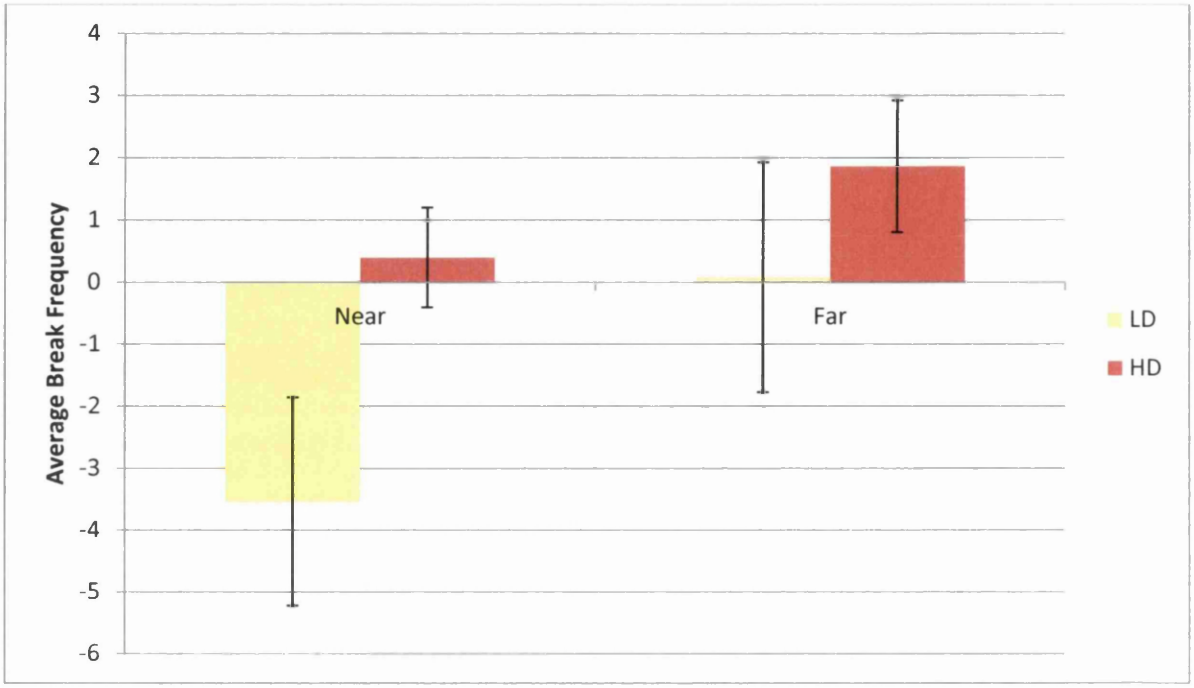


Figure 2-4. Average break frequencies within each distance for heavy drinker (HD) and light drinker (LD) groups. The bars represent the 'difference scores' obtained by subtracting control and alcohol-related stimuli. The error bars show the standard error of the mean.

Also, in this case, higher break frequency scores were significantly associated with higher craving scores, though equally so regardless of the distance between distractor stimuli and fixation region. A regression for craving scores against break frequency scores, for the two distances, was found to be significant, $F(2, 44) = 3.434$; $p = .042$ (Near: $\beta = .241$, $p = .109$; Far: $\beta = -.236$, $p = .116$).

Finally, a regression was used to test whether the break frequency for each distance could predict awareness scores, this was found not to be significant, $F(2, 44) = 1.119$; $p = .336$. Nonetheless, as in the other cases, the standardised betas showed a trend such that higher values on the break frequency variable corresponded to higher awareness (Near: $\beta = .221$, $p = .161$; Far: $\beta = .119$, $p = .447$).

Break Binary

A regression was used to test whether the break binary variable for each distance could predict the reported weekly alcohol unit consumption. Using the enter method, a marginally significant model emerged, $F(2, 44) = 3.038$; $p = .059$. Adjusted R square = .085. The beta coefficients were consistent with the expectation that an increase in break binary frequency would be associated with a greater degree of alcohol consumption (Near: $\beta = .269$, $p = .069$; Far: $\beta = .240$, $p = .104$).

Next to be performed was a mixed ANOVA for this variable, with distance being the within participants variable and the heavy drinker/light drinker distinction the between participants variable. Figure 2-5 demonstrates the average break binary scores for heavy and light drinkers. The analysis yielded a significant main effect for distance $F(1, 31) = 5.812$; $p = .022$, indicating that the break binary variable was much higher for Near distracting images, than for Far ones. The interaction between the two variables was not significant, $F(1, 31) = .208$; $p = .651$. Importantly, as before, there was a significant effect for type of participant $F(1, 31) = 4.351$; $p = .045$, indicating that heavy drinkers had higher scores on the break binary variable, compared to light drinkers.

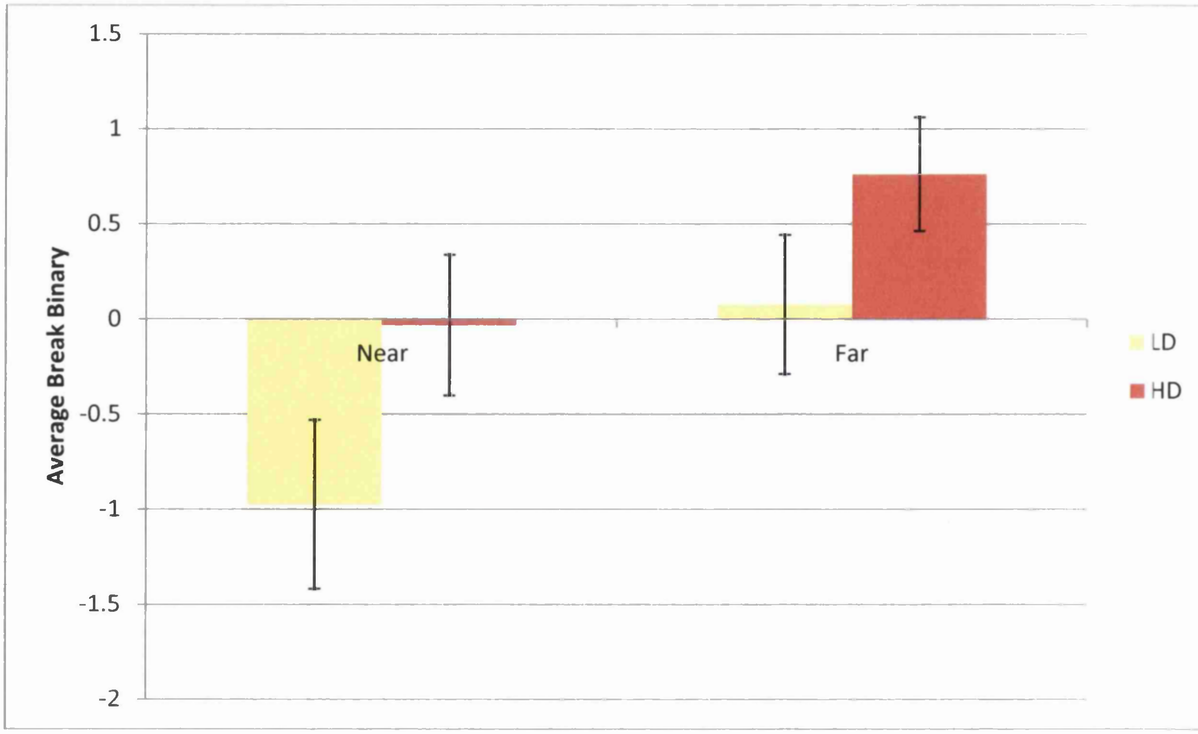


Figure 2-5. Average break binaries within each distance for heavy drinker (HD) and light drinker (LD) groups. The bars represent the 'difference scores' obtained by subtracting control and alcohol-related stimuli. The error bars show the standard error of the mean.

Next, a regression model between break binary scores (as predictors) and craving scores was found to be not significant, $F(2, 44) = 1.388$; $p = .261$ (Near: $\beta = .245$, $p = .109$; Far: $\beta =-.039$, $p = .795$).

Finally, an examination of the association between the break binary variable and the awareness scores was performed. However, the association was not significant, $F(2, 44) = .386$; $p = .682$.

Summary of Results

The most consistent results were identified with respect to the classification of drinkers as heavy vs. light. For all three dependent variables, fixation counts, break frequency, and break binary, a main effect for alcohol usage group was observed. In all cases, heavy drinkers were significantly more distracted by alcohol-related distractor stimuli than light drinkers. This was the key variable of interest. By contrast, significant main effects for the distance variable were not consistently observed, i.e. the distance between the fixation region and the distractor stimuli. There was a significant distance main effect for the break frequency dependent variable, but this was not observed for either fixation counts or the break binary variable. Finally, in no case was a significant interaction between participant type and distance observed.

The results regarding weekly alcohol use and craving were less consistent. It was attempted to predict alcohol use on the basis of fixation counts, break frequency, or break binary, for the two distances, but no model emerged as significant, even though there were trends in the expected direction. Regarding craving, while there was a significant main effect regarding the break frequency variable, this was not the case for fixation counts or break binary.

Finally, regression models looking at awareness against fixation counts, break frequency, and break binary were not significant. This is not surprising, since awareness levels were very low overall in the first place. The single samples *t*-test against chance revealed that participants could not discriminate between the images included in the eye tracker task and the novel foils. This is a very interesting finding, in light of the robust results regarding attentional bias for the alcohol distractor stimuli (i.e., the main effects of participant type, which were observed for all three dependent variables).

2.4: Discussion

Here a novel experimental task for the measurement of attentional biases for alcohol-related information has been presented. The paradigm is based on an eye tracking task. However, all traditional tasks measuring alcohol-related attentional biases with eye tracking techniques rely on the idea that a higher degree of attentional biases for alcohol-related information would be associated with a greater preference of an alcohol-related stimulus, relative to a neutral stimulus. It should be stressed that there is little doubt that this is, most likely, a key aspect of what attentional biases for alcohol-related information are (Field, 2010; Hogarth *et al.*, 2009).The motivation for this proposal is based on the idea that there is, potentially, an alternative facet to attentional biases for alcohol-related information, concerning the extent to which the processing of alcohol-related information is not just prioritised (relative to neutral information), but rather is compulsory for alcohol abusers. Exactly how distracting is an alcohol-related stimulus for an alcohol abuser? Such a perspective to attentional biases for alcohol-related information links well with corresponding theory regarding how alcohol abuse may undermine inhibitory processes, in relation to alcohol use (cf. Field & Cox, 2004; Wiers & Stacy, 2010). Thus, an experimental task was examined in which the participants' task was to focus on a simple fixation region and ignore any presented distractor stimuli. Each trial lasted five seconds. During each trial, a single distractor stimulus would be presented at various distances, relative to the fixation region. Not only were participants told not to attend to this fixation region, but, moreover, if they did attend to it, it would disappear. Thus, it is believed there were excellent incentives for participants to avoid attending to the distractor stimuli. Despite this, the participants who were heavy drinkers produced more fixations to the alcohol distractor stimuli than the neutral ones, relative to light drinkers (all dependent variables in this work were computed as difference scores between a measure for alcohol distractor stimuli and the corresponding measure for neutral images). It is thought that this result provides evidence that attentional biases for alcohol-related information can have a distracting influence for heavy drinkers, over and above the evidence which has been forthcoming from alternative tasks for alcohol-related attentional biases (Cox *et al.*, 2006; Williams *et al.*, 1996).

This research provides encouragement for the use of this novel experimental paradigm for the study of attentional biases for alcohol-related information and also motivates several further directions for future research. One important issue concerns the best way to characterise excessive drinking. These results revealed systematic associations between eye-tracking and alcohol use, but only relative to the distinction between heavy and light drinkers, not the number of alcohol units consumed. Moreover, alcohol craving scores failed to provide a consistent pattern of results across the three dependent variables (i.e., fixation counts, break frequency, break binary). Can it be assumed that the broad distinction between heavy and light drinkers is perhaps more valid than these alternative variables? This is arguably the case, especially for this population sample, which exclusively consisted of university undergraduates. Employing a ratio measure, such as weekly alcohol consumption, assumes that even small differences in the measure (e.g., a weekly alcohol use of 10 units, instead of 12) are meaningful. However, when such differences are not meaningful, they are noise, greatly reducing the power of the corresponding regression analyses or correlations. Given that these participants were university undergraduates, there is a strong expectation that their drinking patterns would be fairly variable and also subject to considerable fluctuation (e.g., depending on work deadlines, holiday periods, etc.). Therefore, while a distinction into heavy and light drinkers is most likely valid, a finer attempt to differentiate members of such a population sample on the basis of weekly scores is unlikely to be successful (note that this is also the reason why a minimalist approach was adopted regarding the measurement of alcohol use, with just a single question). Overall, it was no surprise that the distinction between heavy and light drinkers is the one which led to the most consistent results. Indeed, the intuition that the association between alcohol-related attentional biases and alcohol use is probably best understood in terms of broad distinctions of alcohol users has been expressed for the alcohol-Stroop task as well and with samples of a much greater variety (Cox *et al.*, 2006). Note also that the LD group in the current study has a much narrower range of alcohol use that that of the HD group. The wider variation of units in the HD group could potentially bias results, for example, it is known that unequal sample sizes reduce the power of independent-samples comparisons. However, it is common practise (e.g. Field, Mogg, Zetteler, and Bradley, 2004) to exclude from an analysis those considered to have low-to-median substance usage, rather than use a median-split when creating substance use groups, as this leads to distinct group differences (see Field and Cox, 2008). Indeed, the practice of creating groups by median splits has been intensely criticised in the literature (MacCallum et al., 2002). The use of a suitable control group (e.g. light-users) means that group differences can be unequivocally interpreted as being a result of heavy substance use. Therefore a low range in a LD group could be seen as necessary in order to ensure only light-users are within this control group. Yet, within a wide HD range of usage, extreme scores could potentially be skewing results. Therefore future research which utilises such alcohol-usage conditions may benefit from closer consideration of this issue. Yet, the current sample would seem analogous, in terms of unit consumption, to previous research exploring alcohol use in student populations (see Bewick, *et al.,* 2008). Bewick et al (2008) found similar patterns of substance use in his large sample (N= 5895) where roughly half of the participants were HD; which is equivalent to the current sample HD = 23 out of 48. However, Bewick, et al. (2008) found variability in percentage of HDs dependent upon year of undergraduate study. Within this thesis this information (year of study) was not tracked, in relation to drinking patterns, as it was considered very unlikely that it would affect the relation between the DVs and IVs that were studied.

Demand characteristics may also have influenced results. Even though measures were taken to try to disguise the initial alcohol unit question, some participants may not have been entirely blind to the alcohol-nature of the study (this is important, since participants aware that this is an alcohol study may be show a higher attentional bias, irrespective of alcohol use). This limitation could be addressed in future by asking participants of their alcohol usage following the eye tracking task rather than prior, although of course such a procedure produces the converse possible problem, of having a report on alcohol use influenced by the cognitive tasks.

Note that some of the arguments above apply to craving scores as well. However, the inclusion of craving scores in the study was motivated partly as an attempt to explore whether attentional biases for alcohol-related information in this paradigm could be best characterised by alcohol consumption or craving. The results indicate the former approach leads to the strongest associations.

A related question is which of the three eye tracking variables; fixation count, break frequency, or break binary, is more diagnostic or informative, regarding attentional biases for alcohol-related information. Currently, there is no compelling reason to prefer one variable, as opposed to the others, and this is a significant limitation of the study. But it can be speculated that fixation count may be the most appropriate measure. This is because processing a stimulus and how distracting it is possibly feed into each other. In other words, once a distractor stimulus has appeared, a participant would only be marginally aware of its properties and form. Every time the participant attempts to process it, he/ she would get a fraction more of information about the distractor stimuli (recall, the distractor stimuli would disappear once the participant directs his/ her attention away from the fixation region). It is likely that each such fraction of information actually increases the distractibility of the distractor stimulus, in the simple sense that the more aware a heavy drinker becomes of an alcohol-related stimuli, the stronger the corresponding attentional biases for alcohol-related information – such a prediction seems consistent with several corresponding theoretical approaches (e.g., Cox & Klinger, 1988; Tiffany, 1990; Wiers & Stacy, 2010). Such a perspective is consistent with the idea that attentional biases for alcohol-related information of this kind are best measured by fixation counts. Exploring these (admittedly, currently speculative) ideas in a rigorous experimental setting appears a fruitful avenue for extending this work.

This experimental design also manipulated the distance between the fixation region and the distractor stimuli. There were no strong prior expectations regarding the possible effect of distance on results. It could be the case that stimuli further away from the fixation region would be less distracting than stimuli closer to it. Equally, participants would always be aware of the presence and the approximate nature of the distractor stimuli, so that distance would not matter. These results are more consistent with the latter hypothesis, since there was no interaction between distance and participant group. However, clearly more work is needed before this issue can be settled with certainty, one way or the other. It is a limitation of the current experiment that it is not possible to provide a firmer motivation in relation to the possible impact of distance on the results. Perhaps more careful manipulation of the distance variance, in future research, may reveal results which will help understand the potential role of this variable. At a simple prescriptive level, it can be noted that the distance that results in the strongest effect appears to be the 'near' distance.

Field and Christiansen (2012) state that establishing the internal reliability of tasks intending to measure substance-related attentional biases, such as the emotional-Stroop and the dot-probe is essential for the development of the area. They suggest that reliability of such tasks can be improved if stimulus selection is tailored specifically for each individual. The task reported here, however, would not suffer from such individual stimulus selection, as participants would only look at the pictures that they themselves cannot inhibit their gaze away from. The rest of the stimuli, the experimental stimuli that a participant may not have an attentional bias for (e.g. a heavy drinker who does not have an attentional bias for white wine picture stimuli because they only drink ale), would not affect the attentional bias results, as only the gaze away from the fixation region caused by specific distractor stimuli is being measured. Other tasks, e.g. the dot-probe, would display two pictures on the screen at any one time. So, for example, a HD ale drinker, when presented with a picture pair, one of which being white wine, may not necessarily feel the urge to look at the white wine stimuli at all, giving an impression that they themselves are not a HD. The task above would not suffer from such erroneous results caused by specific consumption habits. Ataya *et al.* (2012) make the point that tasks such as the emotional-Stroop and the dot-probe are used to measure the underlying mechanisms of substance abuse, as well as a predictor of treatment outcomes. Ataya *et al.* (2012) state that such uses of the tasks are motivationally very different, so appropriate tasks should be used in each case. Here inhibitory control was considered. This is argued to be a more robust measure of attentional biases.

Perhaps the most significant extension of the present work concerns an examination of the predictive role of attentional biases for alcohol-related information measured in terms of fixation counts, in relation to changes in alcohol use. Such predictive results in alcohol abuse (e.g., Cox *et al.*, 2002; Cox, Pothos, & Hosier, 2007) and appetitive behaviour in general (e.g., Calitri *et al.*, 2010) have been cornerstones in motivating an understanding of attentional biases for alcohol-related information as having a *causal* role in the corresponding behaviour and related theoretical developments. Will attentional biases for alcohol-related information concerning the distractibility of alcohol-related stimuli produce similar predictive results? This is an exciting challenge for future work.

Summary: Within this experiment it was considered whether a heavy drinker is able to inhibit their attentional bias toward alcohol-related stimuli. A gaze contingency paradigm was used to measure the compulsion to process or attend to alcohol stimuli. Poor inhibitory control is an important aspect of alcoholism. It was found that there was a significant distinction between HD and LD participants in terms of all three eye tracking measures of inhibitory control and attentional bias. Results suggest that attentional bias is not just a process of stimuli becoming prioritised (e.g. Field and Cox, 2008), but also stimuli become compulsory to attend to and process.

2.6: Experiment 2: Rapid Orienting of Attention to Alcohol Stimuli

It was demonstrated that a lack of ability to inhibit an attentional bias once it has been established. Previous literature has shown that attention can be 'held' by alcohol stimuli for heavy drinkers. But, in relation to the initial orienting of attention, the 'grabbing' of attention, the literature is not so clear. Here, a method of analysing the results of the fixed gaze inhibition task is described. Such that it is possible to establish whether there is an initial orienting of attention toward alcohol related stimuli in the HD group. Note that this is a re-analysis of the same study data as Experiment 1.

2.7: Introduction

Of attentional bias tasks, the most commonly used measure is the Stroop task (Stroop, 1935). This classic task involves participants identifying the colour of words, whilst ignoring the meaning of the text. Interference occurs as people automatically read the word, so are therefore impaired in colour naming, when the meaning of the word is in conflict with the ink colour of the word. When the text is replaced by emotional words (e.g. alcohol-related words for heavy drinkers), compared to control words (e.g. transportation-related words), then a delay in reaction time for the emotional words would be expected, as long as the word meaning is relevant to participants. This interference has been suggested to be representative of an attentional bias. This is because the delay is thought to be the result of the meaning of the word capturing the attention of the participant, thus reducing cognitive resources for the concurrent task (that of naming the colour). This interference on the emotional-Stroop task has been found for both addiction-related and anxiety-related words, and in both cases it is assumed to be representative of attentional biases. However, anxiety-related attentional biases are generally assumed to be the result of a negative appraisal of threat-related stimuli. By contrast, for the substance abuse-related attentional bias, the situation is a bit more complicated, as substance abuse-related stimuli may be perceived as either appetitive or aversive, due to a number of issues (e.g. social drinkers compared to abstaining alcoholics). Therefore to merely suggest that the Stroop is a measure of attentional bias would be misleading, as the attentional bias that exists for anxiety and substance abuse is actually different.

The attentional bias associated with threat-related stimuli has been well documented (e.g. Bar Haim *et al.*, 2007). Those who are prone to anxiety problems have been found to have an increased attentional bias for stimuli related to threat compared to those who are typically not anxious (e.g. Mogg and Bradely, 1998). For example, those with specific phobias have demonstrated an attentional bias for stimuli related to their phobia (e.g. an attentional bias for spiders). By contrast, those who have generalised anxiety disorders demonstrate an attentional bias for stimuli that are generally threat-related (see Bar-Haim *et al.*, 2007). Such attentional biases have been found to be a robust phenomenon within populations high in anxiety (e.g. Cisler, *et al.*, 2009). Whether these attentional biases are *toward* the stimulus or *away* from the stimulus is an important issue, and the focus of this chapter, as is discussed below.

As mentioned previously, attentional biases have also been found to be associated with substance abuse (see Field and Cox, 2008). Such biases have been observed between groups (e.g. heavy versus light drinkers) or indeed within groups, e.g. increased craving has been found to be associated with an increase in attentional bias (Cox, Munafo, Franken, 2009). Research has found attentional biases for a number of different substances; alcohol (Cox, Hogan, Kristian, & Race, 2002), nicotine (Waters, *et al.*, 2003), cocaine (Hester, Dixon, Garavan, 2006), and cannabis (Field, Mogg, & Bradley, 2004). Yet, a qualitative difference could potentially exist between threat and substance abuse related attentional biases. Whereas threat stimuli could potentially have inherent motivational properties, e.g. we may have an innate fear of snakes due to our evolutionary past, this same inherent motivational property would presumably be lacking in substance abuse, e.g. cans of lager are relatively new in human evolution! It is therefore assumed that at least some kinds of attentional biases (both for threat and substances) are learnt rather than being innate.

As stated above, Stroop interference studies would suggest that the attentional bias effect seen for both substance abuse and threat related stimuli can be analogous, if the Stroop task is employed. However, the same conclusion is not necessarily reached if other measures of attentional bias are used. Cisler and Koster (2010), through meta-analysis, made the suggestion that there are three forms of attentional bias: facilitated attention, delayed disengagement, and attentional avoidance (attentional avoidance cannot occur concurrently with the other forms of attentional bias). These forms of attentional bias have all been demonstrated within the anxiety attentional bias literature. However, for substance abuse, the results are less clear. First, each form of attentional bias is briefly summarised. For threat stimuli, facilitated attention has been observed. In such cases, attention has been found to be drawn to threat stimuli. This is a process of rapid orienting of attention. Further, threat stimuli are also associated with a delayed disengagement of attention. This is when attention has been captured by threat stimuli, which impairs the switching of attention. Attentional avoidance has been suggested to be the complete contrast of traditional notions of attentional bias, as it is thought that threat stimuli, in some cases, actually cause attention to be diverted away from a threat cue (e.g. Koster, *et al.*, 2006). This entire process, though noting that each component can exist without the presence of the other two, has been thought to be the result of a hypersensitive system for coping under threat. We are rapidly able to locate threat and have trouble removing our attention from it. But, following threat, we remove our attention from the threatening stimulus, perhaps to alleviate anxiety (Cisler and Koster, 2010).

Substance abuse-related attentional biases apparently operate in a different manner. It would appear that abused substances may capture the attention of individuals within the substance abusing population (e.g. Cox *et al.*, 2002) and there is also evidence of an overt gaze away from substance-related stimuli (e.g. Noel, *et al.*, 2006). However, whether or not substance related stimuli can draw attention has not yet been established. Indeed Field (2010) states 'To date, no published studies have used adequate methodologies to convincingly demonstrate rapid orienting of attention toward drug-related stimuli. Instead, substance abusers seem to show a bias in the maintenance or disengagement of attention, in that drug-related cues are able to 'hold', but perhaps not rapidly 'grab', their attention' (Field, 2010; p637). The apparent importance of such an aspect of attentional bias is the focus of this chapter. The implications of such a feature of substance abuse-related attentional biases may suggest that attentional biases are not merely an effect of substance abuse, but may also be involved in the maintenance of such behaviours. As substance abuse related stimuli can trigger urges that lead to substance seeking behaviour (e.g. Tiffany, 1990). So if attention can also be grabbed by such stimuli, then merely being in the presence of substance related stimuli may lead to urges which could subsequently lead to further substance abuse. This is qualitatively different to what is already known about attentional biases and urges, as initial orienting of attention may imply a lack of awareness over attention toward substance –related stimuli. If this is the case then a cycle of initial orienting of attention → urges → substance abuse may initiate prior to awareness, suggesting a loss of control (see Tiffany, 1990).

It has however been observed that those seeking treatment for alcoholism may demonstrate rapid orienting of attention (e.g. Noel, *et al.* 2006) and an attentional avoidance (e.g. Townshend and Duka, 2007), yet these findings have not been observed with people not receiving treatment. It may be that those who seek treatment for alcoholism may start to see alcohol as threatening, so any attentional bias becomes more like a threat-related attentional bias, rather than a substance-related attentional bias, as observed in heavy drinkers. Indeed, Noel *et al.* (2006) found that by using 3 different stimulus onset asynchronies (SOAs) on a dot-probe task, only the 50ms SOA resulted in an attentional bias for abstinent alcoholics, whilst 500ms and 1250ms SOAs resulted in attentional avoidance. These results are consistent with the notion that following an initial brief drawing of attention, the stimulus is then actively avoided, potentially due to an implicit desire to reduce anxiety that this stimuli may be causing (the corresponding participants would be alcoholics who may have entered treatment for their problem, so may therefore have a history of bad experience with alcohol, leading to their seeking of treatment). However, such a drawing of attention has not been observed in heavy drinking non-clinical populations, prior to the potential negative appraisal of substance-related stimuli.

However the drawing of conclusions, regarding initial attentional orienting, from the dot-probe paradigm is limited, as reaction times only suggest where the participant's attention was when the probe appeared (e.g. Braddeley, *et al.*, 2004; Field *et al.*, 2004a). Also, Field *et al.* (2004a) found that heavy drinkers and light drinkers did not differ in terms of dot-probe performance with an SOA of 200ms (it is generally assumed that SOAs of 50 – 200ms are required to measure initial orienting: Duncan *et al.*, 1994). This result which may suggest that the dot probe methodology may not be sufficient for measuring initial orienting of attention.

The purpose of the current experiment is to measure whether alcohol stimuli can grab attention within a non-abstaining or treatment seeking population, as this form of attentional bias is seen as empirically different from the holding of attention, which has already been established in previous research. In order to differentiate this experiment from previous attentional bias measures, which may not necessarily be able to measure the initial orienting of attention, a novel paradigm has been developed. Within the current task participants are explicitly told to look at a fixation region and ignore all other (distracting) stimuli on a screen. Should a participant's attention wander from the fixation region, then the distractor stimulus would vanish. Half of the distracting stimuli in this task are alcohol related, whilst the other half are neutral controls. Therefore, participants would not know in advance the content of the distracting stimulus. Following the onset of the distracting stimulus, the time it takes for participants' first break (in terms of attentional focus) away from the fixation region is measured. This time to first break, is hypothesised, to be demonstrative of initial orienting of attention, or 'grabbing' of attention. Each participant's difference between the times for alcohol and control first break is calculated. It is predicted that heavy drinkers will have shorter first break times, than light drinking control participants.

2.7: Method

The actual experiment here is the same one as that reported in Chapter 2. However, the hypotheses and corresponding analyses are distinct and so are discussed in a likewise distinct way. For brevity, a description of the participants and experimental procedure is not repeated. Specifically, the difference here is that a different approach to analysing the data is adopted. Note that, although the data is analysed differently, this experiment is not contradictory to the previous findings, and the results here are complimentary. The reason for presenting this data separately is due to the distinct areas of interest that each sets of results correspond to. Whereas previously inhibition and attentional bias were considered, here it is whether attentional biases reflect a drawing of attention as well.

2.7.1: Data Scoring

The time of the first break away from the fixation region for both the alcohol and the control distractor stimuli was measured. Each participant's average first break time following the onset of the distractor stimulus was calculated for both alcohol and control stimuli. Break time (control) minus break time (alcohol) was computed. Therefore, positive results mean that alcohol stimuli were more attention-grabbing (i.e. shorter times for alcohol would equate to the alcohol distractor stimuli being attended to faster than the non-alcohol stimuli).

2.8: Results

The dependent variable was first break time. The independent variable was the type of participant (heavy drinker vs. light drinker), or the reported weekly alcohol use of the participants. The different independent variables, although both denote alcohol use, were used for separate analyses; t-test and correlation.

An independent samples *t*-test was performed in order to assess the differences between light (M = -1487.54; SD =3750.74) and heavy drinkers (M =615.56; SD =1059.10) for the time of their first break (see Figure 2-6). The difference between the groups was significant, $t(30) = -2.328$; $p = .027$, suggesting that the HD group had shorter first break times for alcohol stimuli.

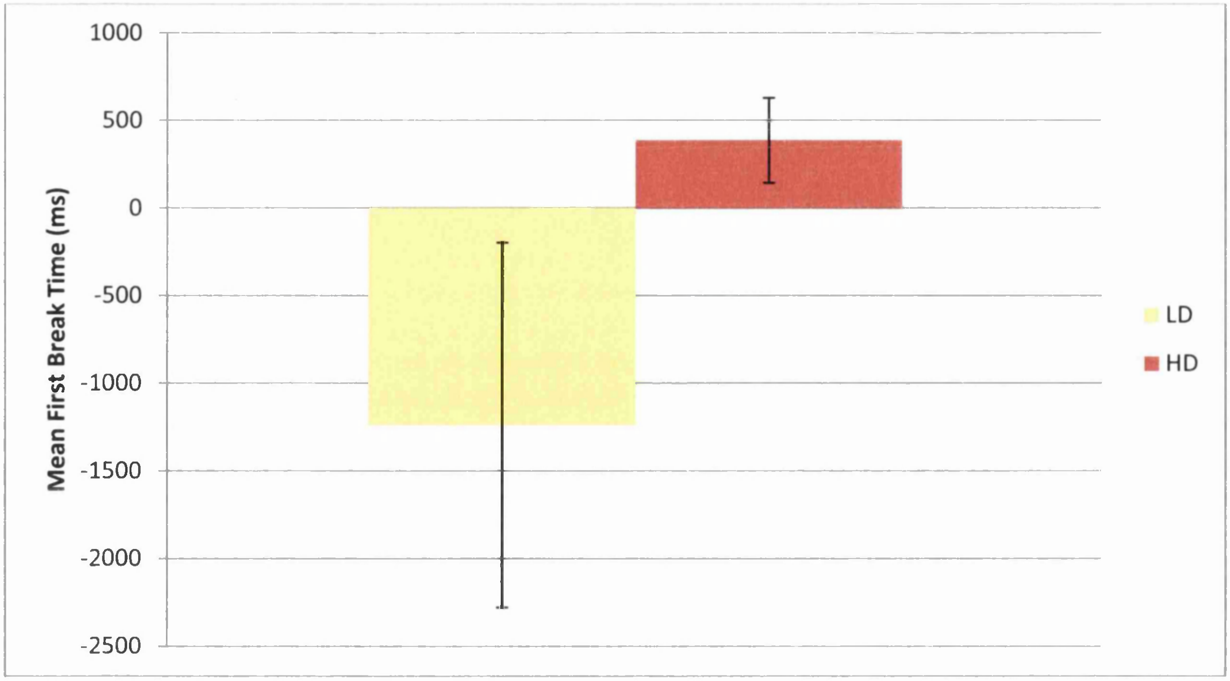


Figure 2-6. Mean first break time for light drinker (LD) and heavy drinker (HD) groups. Mean first break time (ms) is the difference between control and alcohol distractor stimuli first break times. The bars indicate the mean first break time ($p<.05$). Error bars represent standard error of the mean.

A correlation analysis was performed for weekly alcohol use (reported units of alcohol use) and the first break time. The results were found to be significant ($r(42) = .310$; $p = .045$), suggesting that as alcohol use increases the first break time difference between alcohol and control stimuli increases (recall, that a higher value on the dependent variable means shorter first break times for alcohol distractor stimuli, for the same break time for a control distractor stimulus).

This result would imply that a first break time demonstrative of shorter first breaks for alcohol stimuli was found to be associated with weekly alcohol units consumed. There was also found to be a difference between heavy and light drinkers, in terms of their first break time. This suggests that alcohol stimuli were able to grab the attention of heavy drinkers, but not grab the attention, as speedily, of the light drinkers.

2.9: Discussion

This is a clear and conceptually simple demonstration of rapid orienting of attention to alcohol stimuli, within a group of participants who are heavy drinkers, but outside of alcohol treatment. The results would lead to the suggestion that an alcohol stimulus is able to both grab attention, as well as hold attention (much of the existing research on alcohol-related attentional biases can be thought of as relating to the latter).

The grabbing of attention by alcohol-related stimuli within heavy drinkers in this task was measured using the first fixation away from the fixation region toward the distractor stimulus. This therefore means that attention grabbing and not attention holding was being measured, as the distracting picture would vanish, as soon as the visual fixation region threshold was violated (see Chapter 2 Experiment 1, for the full details of the task methodology). This is empirically different from other measures of attentional bias, as tasks such as the dot probe may be measuring the ability of substance related stimuli to hold attention or indeed be merely a measurement of attention when the probe appears (see Bradley *et al.*, 2004).

Franken (2003) suggests that attentional biases, as well as being an effect of substance abuse, may also lead to increased craving and substance seeking behaviour. This may be due to an environment becoming increasingly occupied by stimuli that are associated with alcohol (see also Tiffany, 1990). If this were the case, then unwanted distraction may lead to an inability to devote full attention to coping responses. The potential causative influence of attentional biases has been demonstrated by Field and Eastwood (2005), who found that manipulating attentional bias for alcohol stimuli resulted in a group which received 'high attentional bias' reporting higher levels of craving and consuming more beer, than a control group who, at baseline (prior to attentional bias manipulation), was similar in terms of alcohol use. These results have not been wholly replicated (e.g. Attwood, *et al.* 2008), yet if attentional biases do have a causative influence, or at least are involved in the maintenance of substance abuse, then understanding the mechanism of how alcohol stimuli can 'grab' attention would be important (perhaps in terms of suggestions regarding a loss of control in relating to substance abuse). For example, if attentional biases lead to increases in craving and substance abuse behaviour, and attention can be readily drawn and captured by such stimuli, then attentional biases would form an integral part of addiction.

Attentional bias based interventions have led to some promising results. When attentional biases for alcohol-related stimuli are reduced, then heavy drinkers' drinking behaviour appears to be affected. Fadardi and Cox (2009) demonstrated that an alcohol attentional-control training programme, which was aimed at improving drinkers' inhibitory processes, succeeded in reducing the amount of alcohol consumed. Schoenmakers *et al.* (2010) also reported some encouraging results. They observed that attentional bias training, whereby on a dot probe task the target consistently replaced the neutral stimuli, helped alcoholics remain abstinent for longer than those who had not undergone the attentional bias training. These results demonstrate that attentional biases may be more than just an effect of substance use. However, because Schoenmaker *et al.* (2010) used a dot probe measure, their training task may only impact on the ability of alcohol stimuli to hold attention, rather than grab attention. This initial orienting of attention could potentially be more important for aiding those who are trying to abstain (see Noel, *et al.*, 2006). This, therefore, leads to the suggestion that the method reported in this chapter may lead to interventions which have the potential to modify initial orienting of attention. It is however important to distinguish between eye movements and attention. Sheppard et al. (1986) demonstrated that attention can shift irrespective of eye movement. However, the same was not true of eye movement, where eye movement (in the absence of peripheral stimulation) was found to always lead to a corresponding shift in the focus of attention too. Hogarth *et al.* (2008) suggests that detection of stimuli within the peripheral visual field is sufficient to control behaviour on a substance-seeking task. He therefore suggests that an eye tracker, which measures eye movement fixations as a form of attention, would not be ideal for the measurement of such 'covert attention'. Hogarth et al. (2008) suggest that an orienting of attention toward a stimulus is associated with appetitive motivational properties of substance-related stimuli, which would account for the relationship between attentional bias and treatment outcome (e.g. Cox et al., 2002), and the observation that attentional biases can be modulated by deprivation/satiation of a substance (e.g. Field et al., 2004). However, Hogarth et al. (2009) suggest that such attentional orienting would not play a causal role in substance-seeking behaviour as they found that S+ (a positively reinforced stimulus) could predict substance-seeking behaviour regardless of a lack of eye movement toward S+. They further suggest that peripheral detection is an adequate explanation for substance seeking behaviour. Further research would therefore be required to explore the distinction between overt and covert forms of attentional biases, yet in the meantime it would appear that overt attentional bias research may not provide a sufficient foundation for the treatment of addiction as it is associated to a greater extent with appetitive motivational states. Therefore eye movements should be distinguished from attention, as stimuli may also be attended to that is in peripheral vision, which may operate outside of awareness. This suggests that behavioural effects, e.g., subsequent substance seeking, could be initiated regardless of initial eye movements which are the result of a stimulus.

Within this chapter it was argued that the current measure concerns the initial orienting of attention. The methodology reported here will hopefully illuminate this important aspect of attentional biases and further contribute to the important programme of developing related interventions. However, further research which explores the distinction between covert and overt forms attentional biases is clearly needed.

Summary: Within this experiment the aim was to establish whether a bias could be observed in preconscious processing of stimuli that is associated with a motivational state. The initial orienting of attention had previously only been observed within the anxiety literature. Therefore the aim was to establish if such an attentional bias could be observed within HDs. The data was analysed from Experiment 1 in a different manner by measuring 'first break time'. Doing so enable an association between alcohol units and first break time to be observed, as well as a distinction between LD and HD indicative of HD's displaying shorter break time for alcohol distractor stimuli. The results are interpreted as representing an initial orienting of attention for alcohol stimuli. A loss of control over inhibition, or unwanted distraction, may lead to non-automatic processes. If attentional bias is associated with craving and substance seeking, this may have implications for attentional bias modification training, as alcohol consumed and time abstinent have been found to decrease following such training. However, further research into this field is needed as not all results are consistent. Particularly regarding the role that craving plays in attentional bias; an issue discussed in Chapter 3.

Chapter 3: Are attentional biases affected by craving and outcome expectancies: A within-subjects investigation using MDMA users and alcohol users?

Chapter 2 explored the differences between heavy and light drinkers in terms of their inhibition for attentional biases and initial orienting of attention. The results revealed a difference between the two population groups. The next chapter uses a within-participants design to explore attentional biases further. Evidence would suggest that MDMA (3,4-methylenedioxy-N-methylamphetamine) users' craving and outcome expectancies may vary due to certain variables. As attentional biases can be affected by craving and outcome expectancies, an intriguing situation arises where it may be possible to explore attentional biases within-participants, rather than between, as varying levels of craving and outcome expectancies may have effects upon attentional biases. The following chapter is also the first known study of attentional bias research using MDMA users.

3.1: Introduction

Attentional biases have been observed within heavy drinking alcohol users. This is an orienting of attention toward or away-from a stimulus that has become associated with substance abuse. The strength of attentional biases has been found to have predictive value over future drinking behaviour (Cox, Pothos, Hosier, 2007). Those who drink a high level of alcohol have a correspondingly strong attentional bias (e.g. Field, Mogg, Zetteler, & Bradley, 2004). There are a number of methods used for assessing attentional biases. The emotional-Stroop and dot-probe are the measures that are most widely used (Cox, Fadardi, & Pothos, 2006). Yet eye tracking methods provide more accurate data than reaction time based tasks as reaction time tasks plausibly are subject to extraneous noise due to the comparison of one reaction time (RT) to another (Desroches, Joanisse, & Robertson, 2006). This chapter further explores the applications of the eye tracking inhibition task developed in Chapter 2. This task has the potential to measure both attentional bias and inhibition. Inhibition alongside attentional bias has also been associated with substance abuse.

As well as alcohol attentional biases, previous research would indicate that attentional biases exist for other substances of abuse also. Attentional biases have been observed within heavy users of cocaine, cannabis, heroin, and nicotine. Such observations suggest that attentional biases may be an inherent aspect of all substance abuse behaviour given enough exposure to associated stimuli. Biases for these substances do empirically vary (Field, Munafo, & Franken, 2010), suggesting that several factors may play a role in attentional bias development. If this is the case, then the study of attentional biases alone may not be telling the full story, so an investigation of associated factors, for instance craving and outcome expectancies, are important for further understanding of substance abuse. MDMA use has never been considered in relation to attentional biases. MDMA is an illegal stimulant drug. Its use is associated with feelings of euphoria, intimacy with others, and decreased anxiety. MDMA may have an interesting pattern of attentional bias, as MDMA is unique from other substances. According to McDowell and Kleber (1994), patterns of usage amongst MDMA users suggest usage that is fairly occasional with escalating usage uncommon. Since that study was conducted, a rise in the use of MDMA has been reported. Some studies report average MDMA lifetime consumption between 218 to 371 incidences of use (Reneman *et al.*, 2000; McCann *et al.*, 1998; Parrott *et al.*, 2000) with 13% of British university students reporting taking the substance (Webb *et al.*, 1996). However, Wijngaart *et al.* (1997) reported that 81% of rave attendees had used MDMA. Therefore it would appear that usage may be more prevalent amongst rave-goers and consumption of MDMA may coincide with particular events, e.g. summer music festivals or dance raves, which may be few and far between. Such a pattern of usage may suggest that craving for MDMA is implicitly controlled in such a way that enables the user to wait for appropriate occasions for usage. Therefore craving for MDMA may dramatically increase prior to MDMA usage. Such behaviour may differ from substances, such as alcohol, which are readily available. Craving has been found to be associated with attentional biases, as well as outcome expectancies. Since MDMA may potentially differ from other substances in these domains, attentional biases may vary. If this is the case, it should be possible to measure attentional biases within-participants when intending to use and not intending to use, and measure the corresponding attentional biases.

Craving is an intense desire to consume a substance. It is recognised as being a fundamental aspect of substance abuse. Craving may occur in the presence of substances (Robinson and Berridge, 1993) or in the absence of substances (Tiffany, 1990). Hopper *et al.* (2006) found that MDMA dependence symptoms and cravings only occurred during the few hours prior to planned ecstasy usage (i.e. late on Friday afternoon and early evening if usage was intended later that day). Hence MDMA dependence symptoms are strongly time-related, with minimal symptoms at other times. Indeed Huxster *et al.* (2006) observed that for recreational MDMA users, although craving was generally found to be mild, it was significantly higher in subjects who subsequently used the drug than in those who did not. Powell, Bradley and Grey (1992) suggest that craving may be the result of conditioned responses, which are analogous to opponent-process theory or withdrawal reactions. However, the authors found stronger support for the cognitive model which highlights the role of outcome expectancies, as determinants of both appetitive and avoidance motivations.

Outcome expectancies are a measure of the extent to which a behaviour is motivating, based on the desirability of the behaviour's outcome. Therefore, the decision making process can be affected by outcome expectancies, with behaviours likely to be the result of inflated outcome expectancies. Those who view the consequences of substance abuse as being relatively favourable are more likely to engage in substance abuse than those who view substance abuse consequences negatively. Outcome expectancies are therefore an important aspect of substance abuse. They are potentially able to distinguish between users from non-users. However, concerning MDMA use, this difference may not be quite so transparent. Positive expectancies for MDMA may increase prior to ecstasy use (Engels & ter Bogt, 2004). Therefore, outcome expectancies within MDMA users may differ within-participants dependent upon when usage is planned.

Both craving and outcome expectancies have been found to have an association with attentional biases. Stronger craving has been associated with increased attentional bias (Field and Cox, 2008). Also, those who have more positive outcome expectancies have also been found to have an increased attentional bias (Field and Cox, 2008). Craving and outcome expectancies are thought to vary within MDMA users. If this is the case then, MDMA users may not demonstrate a pattern of attentional bias that is as constant across time as for other substances, e.g. alcohol. This chapter is the first analysis of MDMA-related attentional biases. The aim was to explore any putative biases by adopting a within-participants design, where intended usage is the independent variable. It is then aimed to compare and contrast the results obtained from the MDMA users with corresponding results from alcohol users. Both participant groups will be completing an analogous task, in terms of intending to use and not intending to use.

3.2: Method

3.2.1: Participants

18 participants (MDMA and alcohol users together, see below) completed both sessions of the experiment (3 further participants did not complete both sessions). Participants were 12 males and six females, aged 18-32 (mean age: 23.89 years; SD: 3.83). Participants were recruited using snowball sampling from within Swansea. That is, existing participants helped recruit future participants from amongst their acquaintances. Participants were not explicitly informed that they would be tested on days they would be intending to use the substance and days when they would not, due to ethical considerations. Participants were instead asked to come to the laboratory on at least one Tuesday and one Saturday, since these are days on which MDMA users typically do not intend or intend to use MDMA (see Hopper, *et al.*, 2006). When a participant had been successfully tested on both a day he/ she was and was not intending to use, the participant was told the experiment was over. The day of the week each participant attended the laboratory on the first occasion was counterbalanced. Each participant was entered into a prize draw for £100.

The population sample comprised of alcohol users (N = 10) and MDMA users (N = 8). Alcohol users reported weekly unit consumption ranging between 10 and 55 units (M = 32.90; SD = 15.007). MDMA users reported between 3 and 200 (M= 97.125; SD = 68.649) incidences of MDMA use since they first started consuming the substance. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

3.2.2: Stimuli

Alcohol stimuli were from the Hogarth database also used in Chapter 2. These stimuli were used for both the eye tracking and fixed gaze tasks. For MDMA stimuli, 18 pictures were obtained using a Google image search. The search criteria included 'ecstasy', 'MDMA', and 'rave'. An equal number of pictures were taken from each category. Pictures were verified through a pilot study (see below).

3.2.3: Pilot study: Verification of MDMA Picture Stimuli

The pilot study was run with 6 MDMA users in order to verify the MDMA relevance of each picture. Participants rated each picture out of 5 for its relevance to MDMA use. 44 MDMA-related pictures were rated and the 18 pictures with the highest scores were used in the study. Each picture was a standardised size of 105mm x 105mm. Of the 18 pictures, each of the Google image search criteria were used; 6 were ecstasy-related, 6 MDMA-related, and 6 rave-related.

3.2.4: Materials

A number of questionnaire measures were used, all administered via computer. In order to measure MDMA craving a pre-existing craving questionnaire was used from Parrott *et al.* (unpublished). This consisted of 20 statements with a 5 point Likert response scale (see Appendix C). An MDMA Outcome Expectancies questionnaire was also administered (Engels and Bogt, 2004). This consisted of 35 statements with a 5 point Likert response scale (see Appendix D). The alcohol participants each completed Love *et al.*'s (1998) Desire for Alcohol Questionnaire (see Appendix A). This consists of 36 questions and a 7 point Likert scale. An alcohol outcome expectancy scale was obtained from Leigh and Stacy (1993), which consisted of 34 statements with a 5 point Likert response scale (see Appendix E).

Each participant completed a mood questionnaire (MDMQ) consisting of 30 questions (Stayer *et al.*, 1997) (see Appendix F). Each participant also completed a questionnaire that enquired about their alcohol or MDMA use (see Appendix G & H). This consisted of 32 questions. Importantly, this questionnaire contained questions enquiring about when they next intended to use alcohol or MDMA (depending on the experimental group). In order to assign a participant to the 'intending to use' condition, he/ she would need to have responded with 'today' in the relevant question. For the 'not intending to use' condition participants were to state that they were not intending to use the substance that day. Participants were not explicitly told of the conditions, but until a participant had been tested in both conditions, more testing would be scheduled for another occasion (typically, a Tuesday or Saturday, depending on which condition was still required).

There were three attentional bias measures, implemented in separate tasks for either alcohol or MDMA users. Each task conformed to the exact same template and utilised the same control stimuli (taken from Hogarth *et al.*, 2009). There were two versions of the Stroop task; an alcohol and MDMA version. The neutral test card that was used consisted entirely of tool-related words. The emotional-Stroop cards contained 20 different words repeated twice. Therefore 40 words were read by each participant. Eight different colours were used, but the same colour never appeared consecutively (see Figures 3-1, 3-2 & 3-3).

Screwdriver	Spanner
Bucket	Hoe
Axe	Pliers
Hoe	Nut
Flashlight	Screwdriver
Nail	Rake
Ladder	Axe
Chisel	Screw
File	Flashlight
Nut	Paintbrush
Rake	Ladder
Broom	Tape Measure
Paintbrush	Broom
Spade	Rake
Spirit Level	File
Spanner	Chisel
Pliers	Bucket
Screw	Spirit Level
Tape Measure	Spade
Rake	Nail

Alcopop	Pint
Mixer	Wine
Bar	Tipsy
Lager	Off License
Tipsy	Pissed
Pissed	Home Brew
Off License	Beer
Gin	Lager
Pint	Alcopop
Vodka	Gin
Booze	Tequila
Pub	Mixer
Wine	Drunk
Drunk	Booze
Tequila	Vodka
Hangover	Bar
Home Brew	Cider
Shot	Shot
Beer	Pub
Cider	Hangover

Ecstasy	Snort
Baggy	Gurn
Pills	MDMA
Dab	Trip
MDMA	Come Down
Bomb	High
Snort	Mandy
MadMan	Loved Up
Wrap	Rave
Trip	Dab
Rave	Bomb
Mashed	Ecstasy
Loved Up	Line
Gurn	Wrap
Disco Biscuit	Pills
Euphoric	Euphoric
Mandy	MadMan
Line	Disco Biscuit
Come Down	Mashed
High	Baggy

Figure 3-1, 3- 2, & 3-3. Stroop test cards: neutral (tools), alcohol, and MDMA. By calculating the difference in reaction time between the control and experimental Stroop cards, the Stroop measure of attentional bias was obtained.

The eye tracking task comprised of presenting two pictures simultaneously on the screen (see Figure 3-4). One picture related to substance use (alcohol or MDMA-related) whilst the second picture was of a control stimulus. Control stimuli were matched with specific alcohol or MDMA stimuli and were judged to be of similar complexity and colours. There were 28 events, each consisting of two pictures. Picture presentation was randomised. Pictures were presented for four seconds and were interspersed with a fixation cross. Participants were instructed to fixate on the fixation cross between events. Participants were instructed to study the pictures for a memory test. This ensured that both pictures would be attended to. However, no subsequent memory test occurred.

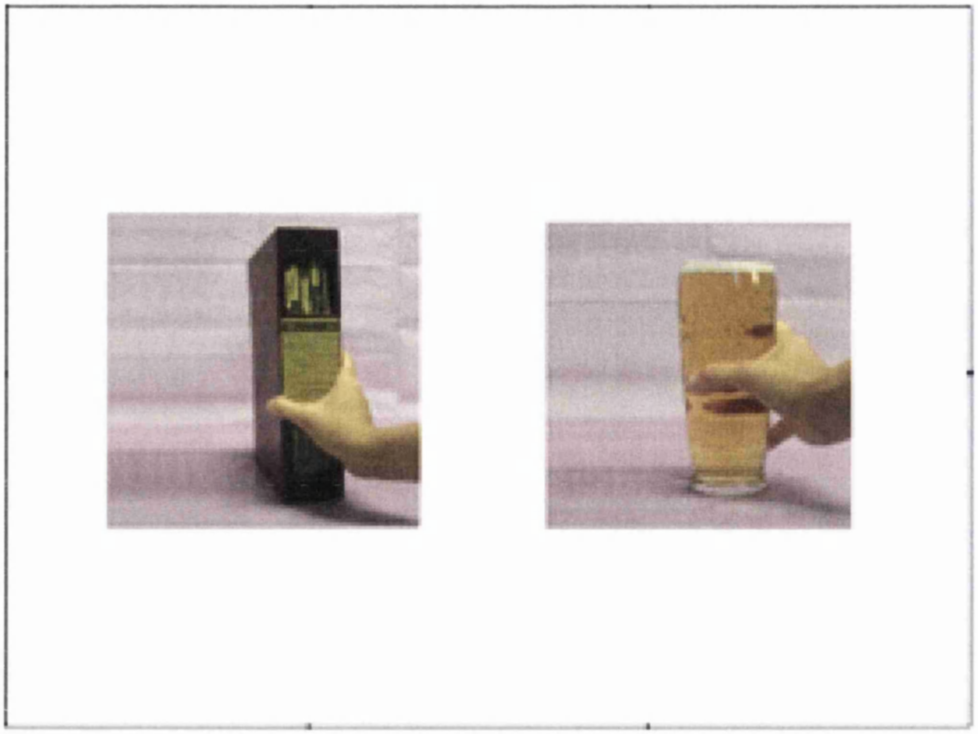


Figure 3-4. Example of a trial in the eye tracking task. The stimulus on the right depicts a hand reaching for a pint of lager. The stimulus on the left is a carefully matched control stimulus which depicts a hand reaching for a folder. Both pictures form separate interest areas which are used to work out a 'difference' score. This score is used to create the measures of attentional biases.

For the fixed gaze task (first reported in Chapter 2), each picture of alcohol use or MDMA use had a carefully matched control picture (see Figures 3-5 & 3-6). Distractor stimuli could be presented within any one of the six equally-sized regions the computer monitor was notionally divided. Finally, the visual fixation region the participant was instructed to attend to was as large as the alcohol-related or neutral distractor stimuli and was designed to be visually salient. Further information on the fixed gaze inhibition task can be found in Chapter 2; however there were some slight alterations. The furthest distance from Chapter 2 was not included in order to make the experiment more concise. The distractor stimulus was either 'Near' the fixation region (actual distance between distracting picture and fixation region was 115mm; distances were measured from the centre of the picture to the centre of the fixation region); or 'Mid' (distance was 165mm); or 'Far' away from the fixation region (distances were 230mm). The distractor stimuli were randomly allocated to each of the distance groups.

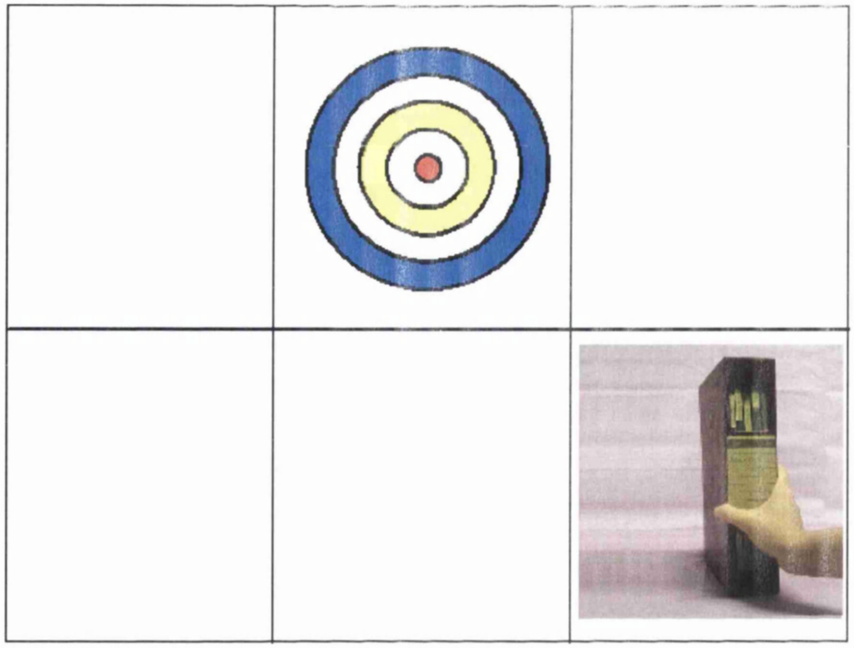


Figure 3-5. Example of fixation region and distractor stimulus. This is a control picture and depicts a hand reaching for a folder (no grid lines were used in the experiment, they are shown here to represent the 6 sections of the screen which contain the fixation region and distractor stimuli).

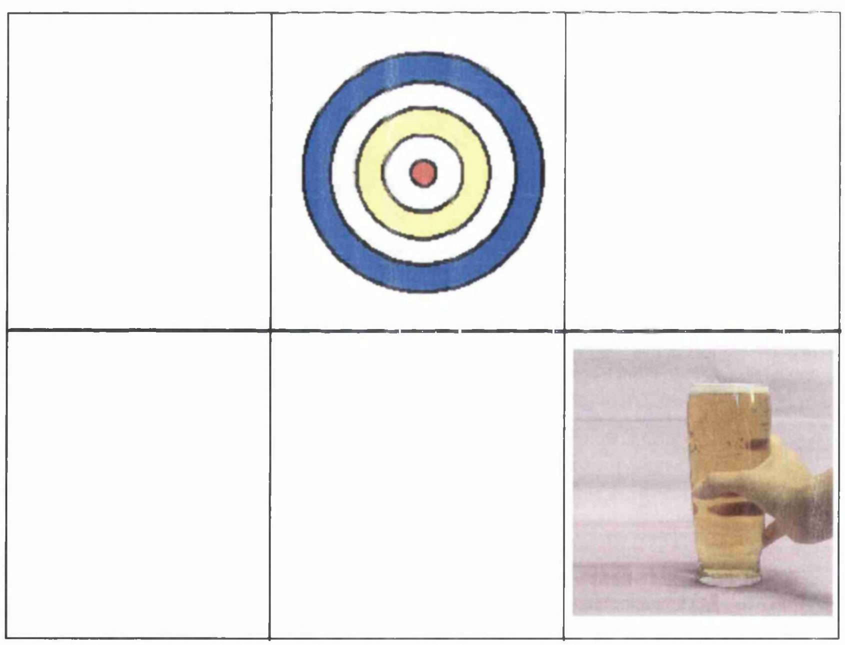


Figure 3-6. Example of matched distractor stimulus. This example of alcohol stimuli depicts a hand reaching for a pint. Note the similarity with Figure 3-5. The matched control and experimental stimuli are subtracted in order to make a 'difference' score. It is this score that is used to create the measures of attentional biases.

3.2.5: Apparatus

This task used the EyeLink Desktop 1000 eye tracker (SR Research Ltd., Ontario, Canada). The eye tracking apparatus was identical to that of Chapter 2.

3.2.6: Procedures

Both groups were administered the test battery on at least two occasions. Under one condition they would intend to use either MDMA or alcohol (dependent on group), and under the other condition they would not intend to use at all. The ordering of conditions was counterbalanced so that the use intention condition varied between participants.

3.2.7: Design

2(Group: Alcohol. MDMA) x 2(Condition: Intended Use. No Use). Group; between-subjects. Condition; within-subjects.

3.2.8: Test Battery Procedure

The ordering of the task procedure was fixed:

1. Craving questionnaire (alcohol or MDMA)
2. Mood questionnaire
3. Stroop tasks (alcohol or MDMA)
4. Drug use questionnaire (alcohol or MDMA)
5. Outcome expectancy questionnaire (alcohol or MDMA)
6. Dot probe and fixed gaze task (alcohol or MDMA)

3.2.9: Data Scoring

The use of three attentional bias tasks was employed, the modified Stroop, an eye tracking task, and a fixed gaze task based on that from Chapter 2 (see Table 3-1). The Stroop task consisted of two test cards, a substance card (either alcohol or MDMA – employed depending on group) and a neutral card (consisting of tool-related words). From the RTs from these two cards, a difference score was calculated. This difference score was the Stroop attentional bias measure. From the eye tracking task a difference score was also calculated by subtracting the interest area scores of the control and substance stimuli. This provided another difference score. The following eye tracking variables were used for the analyses: dwell time, first fixation time, first run fixation count, and first fixation visited count. These variables were selected due to the fact that they measure overall time spent processing a stimulus and also initial attentional orientation for a specific stimulus. Dwell time referred to the amount of time spent looking at each stimulus; first fixation time was the time taken to look at the picture during the first saccade (a rapid eye movement); first run fixation count was the amount of fixations made within the first gaze; first fixation visited count was the amount of times the first stimulus that was looked at was viewed. For the fixed gaze task from Chapter 2, a difference score was again calculated between the control and substance stimuli. Three different distances were used between pictures and fixation regions (note that it was not wanted to use the furthest of the four distances from Chapter 2 when programming the experiment, as the previous results with this distance were less interesting; also, this made the experiment shorter in duration). However, there are now have three distance variables rather than two (recall, previously there were 'Near' and 'Far' picture distance in Chapter 2) as previously it was opted to collapse the four distances, whereas here each of the distances were looked at individually (Near: 115mm; Mid: 165mm; Far: 230mm, where the length refer to the distance between fixation region and distractor stimulus). The variables fixation count, first run fixation count, and break frequency were looked at across the three distances. Fixation count was a measure of how many fixations were made during a presentation of a stimulus. First run fixation count was a measure of the number of fixations made initially following presentation of a stimulus. Break frequency was a measure of how many times the participant attempted to look outside of the fixation region in the direction of the distractor stimulus; something they were explicitly told to avoid.

Table 3-1: A description of the attentional bias dependent variables used within the experiment.

Attentional Bias Measure	Description
Stroop	The difference between control-Stroop interference and MDMA/alcohol-Stroop interference
Eye Tracking	
Dwell Time	Difference between alcohol and MDMA/alcohol time spent looking at each stimulus
First Fixation Time	Difference between alcohol and MDMA/alcohol time taken to look at the picture during the first saccade
First Run Fixation Count	Difference between alcohol and MDMA/alcohol number of fixations made within the first gaze
First Fixation Visited Count	Difference between alcohol and MDMA/alcohol number of times the first stimulus that was looked at was viewed
Fixed Gaze Inhibition	
Fixation Count	Difference between control and MDMA/alcohol number of fixations were made during a presentation of a distractor stimulus at either near, mid, or far distances
First Run Fixation Count	Difference between control and MDMA/alcohol number of fixations made initially following presentation of a distractor stimulus at either near, mid, or far distances
Break Frequency	Difference between control and MDMA/alcohol how many times the participant attempted to look outside of the fixation region in the direction of the distractor stimulus at either near, mid, or far distances

3.3: Results

Whether there is an association between attentional bias and usage is first considered. This represents the traditional measure of attentional bias and establishes if there is an attentional bias within the sample. However, it is also considered whether there is an attentional bias when intending to use or when not attending to use. Next considered is whether there is a distinction between craving, outcome expectancies, and mood when either intending to use or not intending to use. This will demonstrate whether such phenomena are influenced by use intention. Then it is considered whether use intention affects attentional bias by comparing attentional bias measure scores when use is intended and when not. Any statistical significance observed here would be indicative of a fluctuating attentional bias which varies depending upon when next use of a substance is intended.

Finally considered is whether craving or outcome expectancies are associated with attentional biases when either use is intended or not. This would indicate whether reported craving or outcome expectancies could influence attentional bias dependent upon use intention.

Several attentional bias tasks that were employed in this study, and so a number of attentional bias DVs were created, inflating the number of possible correlations in the analysis. Because the number of correlations would be high in this case and, moreover, there was relatively little a priori expectations regarding the genuine associations vs. the accidental, non-significant ones, in this case, to avoid type one errors, Bonferroni adjusted alpha levels were used (although it is noted that concerns have been expressed in the statistics literature regarding the procedure of adopting Bonferroni corrections; e.g., Nakagawa, 2004; Perneger, 1998). In this case, because different sets of cognitive variables arose from different tasks, rather than employ a uniform adjustment in the alpha value (i.e., 0.05/ all possible comparisons), it was considered more appropriate to adjust the alpha in terms of the comparisons for each possible task separately. Thus, it was aimed to achieve a trade-off between an inflated Type I error (that the Bonferroni adjustment was meant to protect against) and an over-inflated Type II error (which is the basis for most criticism for the Bonferroni procedure, Nakagawa, 2004; Perneger, 1998).

The Stroop task led to only one DV, so the alpha level for the correlations involving the Stroop task remained unchanged. The eye tracking task had four DVs and the fixed gaze inhibition task had three distinct distances each leading to three DVs. Therefore, the Bonferroni adjusted alpha levels were: for the eye tracking task an adjusted alpha level of .0125 per test (.05/4); the fixed gaze inhibition task Near distance had an adjusted alpha level of .0167 per test (.05/3); the fixed gaze inhibition task Mid distance had an adjusted alpha level of .0167 per test (.05/3); and the fixed gaze inhibition task Far distance also had an adjusted alpha level of .0167 per test (.05/3). Note that the different distances within the fixed gaze inhibition task were considered separate thematic groups due to the different results obtained at the different distances within Chapter 2.

3.3.1: Attentional bias and usage

First to be considered are the attentional bias measures in terms of substance use, to explore whether an attentional bias was present. The 'use intention' variable was computed depending on when participants intended on using their substance next, information which was available by asking participants if they intended using either alcohol or MDMA (respective of group) later that day. This created a binary variable.

Only participants who completed both conditions of the task were included in the data analyses. Participants had to both be judged to have been intending to use (i.e. going to use MDMA or drink alcohol later that day) and not intending to use (i.e. not using MDMA or drinking alcohol later that day).

Alcohol

Alcohol usage was not found to correlate with the Stroop difference score for either the intending to use condition or the not intending to use condition (see Table 3-2).

The eye tracking measures did not lead to any significant correlations with alcohol usage, when intending to use. However, when not intending to use alcohol, usage correlated first run fixation count (i.e. number of fixations made within the first gaze) ($r(10) = -.844$; $p = .002$) significance established at the adjusted level of .0125. Note that a negative correlation is observed when not intending to use. This suggests that there is an attentional bias away from the alcohol stimuli when not intending to use (see Table 3-2).

The fixed gaze task produced a correlation with alcohol usage, with significance established at the adjusted level of .0167. For the closest and furthest distances, there were no significant correlations when intending to use. But for the mid-distance, break frequency was found to marginally correlate with alcohol usage ($r(10) = .719$; $p = .019$). When not intending to use, fixation counts for the nearest distance were found to correlate negatively with alcohol use ($r(10) = -.918$; $p < .0005$). This was also the case for break frequency within the furthest distance ($r(10) = -.840$; $p = .002$). These results provide partial evidence that an attentional bias was present within the sample. However, the strongest attentional bias would appear when use is not intended.

MDMA

MDMA usage was not found to correlate with the Stroop difference score for either the intending to use condition or the not intending to use condition. Moreover, there were no significant correlations on the eye tracking task.

The fixed gaze task, however, led to many significant correlations at the adjusted level of .0167. When intending to use; the near distance led to a significant negative correlation between usage and break frequency ($r(8) = -.801$; $p = .017$). These negative correlations would suggest that at the near distance, light users were less able to inhibit their attentional bias than the heavy users. The furthest distance correlated positively with first run fixation count ($r(8) = .851$; $p = .007$) and marginally with break frequency ($r(8) = .794$; $p = .019$). This suggests that when picture stimuli are furthest away the heavier users are less able to inhibit their attentional bias than the lighter users. When not intending to use; the mid-distance led to a significant correlation between usage and first run fixation count ($r(8) = -.829$; $p = .011$), fixation count ($r(8) = -.823$; $p=.012$), and break frequency ($r(8) = -.830$; $p = .011$). Again the negative correlation implies that it is the light users that are less able to inhibit their attentional bias, even when not intending to use. These results suggest that, generally, as use increases, attentional biases decrease, especially when not intending to use (see Table 3-2).

Table 3-2. Correlations between either alcohol or MDMA reported usage for the different attentional bias measures when intending to use and not intending to use the substance.

	Intending to use		Not intending to use	
Attentional Bias Measure	Alcohol	MDMA	Alcohol	MDMA
	Usage	Usage	Usage	Usage
Stroop	.396	.159	.245	.293
Eye Tracking				
Dwell Time	-.055	.201	-.693	.357
First Fixation Time	.665	-.092	.044	.145
First Run Fixation Count	-.189	.495	.603	.263
First Fixation Visited Count	.632	.125	-.844**	.164
Fixed Gaze				
Near Distance				
Fixation Count	0.472	-.719	-.918*	-.351
First Run Fixation Count	.497	-.307	-.102	-.239
Break Frequency	-.060	-.801*	-.353	-.287
Mid Distance				
Fixation Count	.431	.412	-.363	-.823*
First Run Fixation Count	.407	.457	-.448	-.829*
Break Frequency	.719ms	.435	.156	-.830*
Far Distance				
Fixation Count	-.298	0.677	.545	.035
First Run Fixation Count	-.156	.851*	.214	.140
Break Frequency	.620	.794ms	-.840*	.192

Note: The Pearson's r values for alcohol (N=10) and MDMA (N=8) users' attentional biases and substance usage (either alcohol or MDMA, respective of group) when intending to use and not intending to use. The significance of these values are denoted by *p<.0167 **p<.0125. These are Bonferroni adjusted alpha levels.

3.3.2: Craving and Outcome Expectancies

These analyses involve the comparison of the measures of craving, outcome expectancies, and mood between the different use intention conditions. Note, the aim is not to try to infer use intention from craving, outcome expectancies, or mood. The hypothesis is that use intention will lead to differences, within-subjects, for craving, outcome expectancies, and mood.

Alcohol

Using questionnaires a number of variables were measured which may have differed between intention to use and intention not to use. Using the craving measure it was found that intended use (M = 146.40; SD =53.048) and non-intention (M =76.00; SD = 58.982) differed significantly in terms of reported craving ($t(9) = 2.618$; $p = .028$), with less craving reported when use was not intended. Mood ($t(9) = -.847$; $p = .419$) and outcome expectancies ($t(9) = .000$; $p = 1.000$) were not found to be affected by use intention. Outcome expectancies and craving were not found to correlate.

MDMA

The responses of MDMA users on the questionnaires were not found to vary due to use intention, as can be seen from the non-significant *t*-tests between intending to use and not intending to use for mood ($t(7) = .259$; $p = .803$), and outcome expectancies ($t(7) = -.250$; $p = .810$). However there was a trend to suggest that intended use (M = 52.00; SD = 17.11) led to differences for reported craving over non-intended use (M = 40.00; SD = 12.57), ($t(7) = 1.686$; $p = .136$), which was in the expected direction. A significant positive correlation was observed between craving and outcome expectancies when intending to use ($r(8) = .830$; $p = .011$), and was marginally significant when not intending to use ($r(8) = .678$; $p = .065$). This indicates that when intending to use, positive outcome expectancies are associated with increased craving.

These results suggest that craving is affected by use intention for alcohol users but not MDMA users. However, the association of outcome expectancies and craving within MDMA users but not alcohol users suggests differences in the pattern of use between the substances. The difference in craving scores can be seen in Table 3-3.

Table 3-3. Mean craving scores for both alcohol and MDMA when use was intended and not. The percentage difference between the mean craving scores is calculated due to the difference between the alcohol and MDMA craving measures. The difference between the craving in the Use Intended condition and the Use Not Intended condition is expressed as a difference in percentage; the Percentage Difference score.

	Use Intended	Use Not Intended	Percentage Difference
Alcohol	146.40	76.00	48.09%
MDMA	52.00	40.00	23.08%

3.3.3: Intention to use and attentional bias

To look at the potential differences in attentional bias that intention to use may have caused, a series of *t*-tests were performed comparing whether use was intended or not for the different attentional bias measures (see Table 3-4).

Alcohol

The alcohol Stroop was administered to participants when they were intending to use and when they were not. A comparison of the means found no significant difference concerning when participants were intending to drink next. The eye tracking measure also found no difference between use intention days. Neither did the fixed gaze task lead to a significant difference between intending to use and not intending to use. These results demonstrate that intention to use alcohol does not affect attentional bias. Each *t*-test can be seen in Table 3-4 below.

MDMA

Intention to use MDMA also did not have a large effect on attentional bias. Of the attentional bias measures, only the eye tracking task showed a significant difference between intending to use (M =1.687 ; SD = 1.112) and not intending to use (M = -.016; SD = .194) for dwell time ($t(7) = 4.774$; $p = .002$) significance established at the adjusted level of .0125. This would suggest a weak difference between intention to use and the eye tracking task. Stroop and fixed gaze task did not reveal a difference caused by use intention.

Table 3-4. *t*-test results for the use intention condition and the non-use intention condition in terms of the attentional bias measures for both alcohol and MDMA participants.

	Intention to use	
Attentional Bias Measure	Alcohol	MDMA
Stroop	.952	1.476
Eye Tracking		
Dwell Time	.444	4.774**
First Fixation Time	-.038	.394
First Run Fixation Count	1.398	-.296
First Fixation Visited Count	.281	.329
Fixed Gaze		
Near Distance		
Fixation Count	2.116	-.735
First Run Fixation Count	.839	.940
Break Frequency	1.461	-.847
Mid Distance		
Fixation Count	2.342	-.833
First Run Fixation Count	1.612	-.836
Break Frequency	1.123	-.844
Far Distance		
Fixation Count	-.881	.153
First Run Fixation Count	.504	.000
Break Frequency	1.718	.612

Note. The t-values in the table are the result of paired-samples t-tests between intention to use and intention not to use for alcohol (N=10) and MDMA (N=8). Each attentional bias measure was performed when intending to use and not intending to use. The table above shows the difference between attentional bias measure when intending to use and not intending to use. The significance of these values are denoted by *p<.0167 **p<.0125. These are Bonferroni adjusted alpha levels, where the adjustment procedure is as discussed in section 3.3. Note that, aside from MDMA dwell time differing between use intention conditions, there was not a distinct difference caused by use intention with regard to performance on the attentional bias tasks for both alcohol and MDMA.

3.3.4: Outcome expectancies, craving, and attentional biases

In order to see whether outcome expectancies or craving were associated with attentional biases, a number of correlations were performed (see Table 3-5). The aim of which was to establish whether there was an association between craving or outcome expectancies and attentional biases. Separate correlations for when a participant was intending to use and not intending to use were performed for both craving and outcome expectancies with each attentional bias measure.

Alcohol

When intending to use alcohol, outcome expectancies did not correlate with any of the attentional bias tasks significantly. Craving was found to significantly correlate with the Stroop score, ($r(10) = .745$; $p = .013$) significance established at the level of .05. Craving, however, did not correlate with the eye tracking measures nor the fixed gaze measures. When not intending to use alcohol, neither outcome expectancies nor craving were found to correlate with any of the attentional bias variables.

MDMA

When intending to use MDMA, outcome expectancies and craving do not correlate significantly with the attentional bias measures. When not intending to use MDMA there are again no significant correlations. However, overall the results suggest that there is no association between outcome expectancies and craving with attentional biases.

Table 3-5. Correlations between craving and outcome expectancies for the attentional bias measures. Positive correlations would indicate that higher craving or outcome expectancy scores were associated with increased attentional biases.

	Intending to use				Not intending to use			
Attentional Bias Measure	Alcohol		MDMA		Alcohol		MDMA	
	Craving	OE	Craving	OE	Craving	OE	Craving	OE
Stroop	.745*	.249	0.499	.358	-0.29	.343	-0.547	-.102
Eye Tracking								
Dwell Time	0.524	.071	0.608	.400	-0.067	.480	-0.266	-.069
First Fixation Time	0.007	.063	0.552	.542	0.005	.245	0.084	-.235
First Run Fixation Count	.639	.087	0.516	.274	0.233	.394	-0.161	-.458
First Fixation Visited Count	0.089	.070	0.516	.545	0.042	.366	0.299	-.145
Fixed Gaze								
Near Distance								
Fixation Count	0.387	.260	0.327	-.012	0.402	-.388	-0.259	-.586
First Run Fixation Count	0.428	.186	0.018	-.401	0.273	-.150	-0.535	-.654
Break Frequency	0.368	-.124	0.258	.017	0.603	-.154	-0.078	-.496
Mid Distance								
Fixation Count	0.117	-.114	-0.314	-.136	-0.063	-.362	-0.132	-.086
First Run Fixation Count	0.039	-.164	-0.476	-.340	-0.19	-.401	-0.049	-.107
Break Frequency	0.344	.212	-0.18	-.005	-0.369	.045	-0.087	-.170
Far Distance								
Fixation Count	-0.006	.116	-0.031	.421	-0.228	.028	-0.155	.575
First Run Fixation Count	-0.054	.335	-0.015	.202	-0.2	-.373	0.581	.641
Break Frequency	-0.049	-.007	-0.096	.310	0.165	-.433	-0.152	.580

Note: The Pearson's r values show alcohol (N=10) and MDMA (N=8) users' correlations between the attentional bias measures and craving and outcome expectancies. The significance of these values are denoted by *p<.05 as only the Stroop score led to a significant r value.

3.3.5: Summary of results

Evidence was observed which may indicate an attentional bias in both alcohol users and, for the first time, within MDMA users as well. The alcohol attentional bias results would appear to correlate with reported alcohol unit consumption more strongly when usage is not intended. Interestingly, the pattern of the MDMA attentional bias is not the same as that typically associated with alcohol use, and appears to be one of attentional avoidance, as shown by the results of the fixed gaze task. This indicates that high MDMA use may be associated with an attentional bias away from the MDMA-related stimuli. However these results are only observed within the near distance when intending to use and the mid distance when use is not intended. At the far distance when use is intended the contrary is also demonstrated i.e. an attentional bias toward the MDMA-related stimuli (see Table 3-2). It was also observed that alcohol leads to greater variability in craving than MDMA, due to a significant difference between alcohol craving when intending to use and not, but not a significant difference between intending to use and not within the MDMA users. This is contrary to the hypothesis made in the introduction. Intention to use was not found to alter attentional biases for the alcohol group of participants but was found to affect the attentional bias of MDMA participants. Outcome expectancies and craving were not found to be associated with attentional biases. It would appear that the inhibition fixed gaze task was the more sensitive measure of attentional bias and usage as this led to the most consistent results.

3.4: Discussion

Evidence was found to suggest an attentional bias within the alcohol users that was associated with unit consumption. When intending to use alcohol a trend was observed showing that heavy drinkers may have a stronger attentional bias than light drinkers when intending to consume alcohol. However, this was a very weak association and a stronger attentional bias was associated with not intending to use. A negative correlation is observed between alcohol usage and attentional bias measures when not intending to use, suggesting that the heavy drinkers were more able to inhibit their attentional biases than the lighter users. Use intention was also found to lead to a difference in reported alcohol craving suggesting that craving increases prior to alcohol consumption. Outcome expectancies were not found to vary as a result of use intention, suggesting that outcome expectancies may not motivate drinking behaviour. Use intention was not found to lead to large differences between attentional bias measures potentially indicating the robustness of attentional biases. The fixed gaze inhibition task did however observe some differences in attentional biases dependent upon use intention, suggesting that inhibition of attentional biases may be affected by use intention. Alcohol also led to a correlation between craving and the alcohol Stroop attentional bias measure, but only when intending to use, suggesting that craving may be associated with attentional biases when use is intended. Outcome expectancies did not correlate with any attentional bias measure.

The alcohol findings provide some support for previous attentional bias tasks. Unit consumption has typically been found to be associated with attentional biases. A positive correlation, albeit weak, was found when intending to use and a negative correlation was observed when not intending to use. This may suggest that when not intending to use, heavy drinkers may display attentional avoidance in an analogous way to anxiety sufferers or abstinent alcoholics avoid 'threatening' stimuli (e.g. Mogg & Bradley, 1999; Noel, *et al.*, 2006). Therefore alcohol-related stimuli may be being implicitly avoided. This would indicate that heavy drinkers, when not intending to consume alcohol, may avoid alcohol-related stimuli. Such a theory could run in parallel with the notion that alcohol-related stimuli can lead to craving (e.g. Field & Cox, 2008). Therefore avoiding such stimuli may be beneficial when remaining abstinent. However, confidence in such claims is undermined by the inability to provide firm evidence of an attentional bias, toward the alcohol-related stimuli when use was intended. It was predicted that craving amongst the alcohol users would remain relatively constant; this was not supported within the task where a significant difference was observed between the use intention conditions regarding reported craving. This result would suggest that prior to alcohol use, craving increases. Craving was also found to significantly correlate with the alcohol Stroop attentional bias measure when intending to use, but the evidence is unable to suggest that alcohol attentional biases are associated with craving due to the number of non-significant correlations with the other attentional bias DVs. The results would suggest that heavy drinkers' attentional biases lead to slight differences depending upon whether use is intended or not. But these differences are not significantly different from each other when comparing between the use intention conditions. This potentially suggests that once attentional biases are formed they are fairly stable and consistent within heavy drinkers. However, it is hard to draw firm conclusions due to the lack of an attentional bias toward alcohol-related stimuli when use is intended. Previous attentional bias research would suggest that an attentional bias should be present under these circumstances (e.g. Cox, Pothos, and Hosier, 2007).

Evidence was found which may suggest that attentional biases may develop for MDMA-related stimuli within MDMA users. The main observation was that the attentional bias dependent variables obtained using the fixed gaze inhibition task indicate that an attentional bias *away* from stimuli was associated with high MDMA use at near and mid distances. Yet an attentional bias *toward* the stimuli was observed at the furthest distance. However, these results are not entirely consistent. It was also observed that use intention did lead to a difference in reported MDMA attentional biases; however this was only observed for one of the attentional bias dependent variables. This is the first known demonstration of the potential existence of attentional biases within MDMA users. Attentional biases have been observed previously for other kinds of abused substances and these have been found to have motivational properties, which perhaps indicates similar processes involved in MDMA abuse. The attentional bias results were observed on the fixed gaze inhibition task alone which leads to the suggestion that contemporary attentional bias tasks may benefit from considering the potential importance of inhibition. The MDMA results for the fixed gaze inhibition task were inconsistent, as both positive and negative correlations are observed, potentially suggesting both an attentional bias toward and away from the MDMA stimuli. However, this may be an artefact of the correlational design of the study. Further research into the fixed gaze inhibition task is needed before any firm conclusions can be made. Craving and outcome expectancies were not found to differ significantly as a result of use intention, which suggests that these variables are not affected by intended MDMA use. But when intending to use, craving correlated with outcome expectancies, which may be indicative of an association between positive motivational properties of MDMA and craving. There was also found to be a slight difference due to use intention for dwell time. However this is the only attentional bias measure that significantly demonstrates a difference between use and non-use intention in terms of attentional bias tasks. Craving and outcome expectancies were also not found to correlate with attentional bias measures when use was intended or not.

As the MDMA attentional bias was only observed on the fixed gaze inhibition task, it would appear that the measurement of attentional bias inhibition may be important when measuring attentional biases within MDMA users. Also, when intending to use, both a positive and a negative correlation is observed. Only a negative correlation is observed when use is not intended. This suggests that, although an attentional bias may be present, there could potentially be differences in whether the stimulus was attentional holding or avoidant. This may be due to the salience of the stimuli used. The attentional bias which may be indicated by the results within the MDMA users may also suggest that as use increases attentional bias toward stimuli decreases when not intending to use. As this result was obtained using the fixed gaze inhibition task, a task associated with attentional bias and inhibition, it may be that prolonged use of MDMA may lead to a better ability to suppress attentional biases to salient MDMA-related stimuli, when the substance is not desired. This may be demonstrative of the mechanisms assumed within the incentive salience account of drug use (Robinson & Berridge, 1993), and relate to implicit attentional strategies to avoid salient MDMA stimuli. By contrast, a 'novice' user may not so readily be able to inhibit their attentional biases for MDMA-related stimuli. The result may reflect a process that was proposed by Parrott (2006a), according to which, as tolerance increases, the number of reported negative effects caused by MDMA increases. This may lead to attentional avoidance, in a way analogous to that for alcohol stimuli for individuals undergoing alcohol treatment (e.g. Noel *et al.* 2006). Therefore attentional avoidance may be associated with stimuli that are no longer liked or for stimuli that substance users are actively trying to suppress attention for. However, this is speculation and cannot be confirmed within the current experiment. The discrepancies observed on the fixed gaze task for the various distances may reflect awareness of the stimuli and how this subsequently affects how distracting the stimulus is. Craving and outcome expectancies were not found to vary, which does not support Hopper *et al.* (2006) who found that craving increased prior to MDMA use. However, Hopper *et al.* (2006) had a much larger participant sample than the experiment reported here. Yet, this result may suggest that craving and outcome expectancies are more consistent than first thought. The correlation between craving and outcome expectancies when intending to use may demonstrate that these phenomena are associated with MDMA use however. Yet it would appear that craving and outcome expectancies have no bearing on attentional biases. Again, however, it is hard to draw firm conclusions about attentional biases as further research is required to establish whether fixed gaze inhibition task truly is a measure of attentional bias.

Theories concerning outcome expectancies and craving would have led to the prediction that it is possible that attentional biases can fluctuate. MDMA use has been found to lead to variations over time of craving and outcome expectancies, depending on when use was intended. Therefore, as these factors have been associated with attentional biases, it was thought that a within-subjects design experiment may lead to differing attentional biases. Also included was a group of alcohol users, as this was deemed a group whose outcome expectancies and craving would not vary so much, as alcohol is readily available. However the results observed could indicate that both MDMA and alcohol attentional biases are not associated with craving and outcome expectancies. This observation may be associated with the distinction between implicit and explicit measures of substance abuse behaviour (see Stacy, 1997). MDMA was however found to indicate a potential development of attentional biases. The reason why the fixed gaze inhibition task worked well with the MDMA users may be because of the difference in the way that MDMA stimuli are regarded by novice and heavy users, as some stimuli were found to lead to attentional avoidance. Similarly, alcohol was also found to lead to an attentional avoidance when not intending to use; however, this differs from the MDMA finding due to the observation that when intending to use, alcohol participants demonstrated an attentional bias towards alcohol-related stimuli, albeit, very weakly. This discrepancy in alcohol attentional bias may also be due to similar processes of trying to avoid the craving that has been associated with substance abuse (cf. Tiffany, 1990).

Within this experiment evidence has been found which may indicate that MDMA attentional biases may be present in MDMA users; it is a promising start, but it is hard to draw firm conclusions from the current experiment, due to the small number of participants. Further research is clearly needed. Regarding the attentional bias results; although not all of the correlations are significant, it would not be expected for all of the measures to be significant. It would also appear that a strong attentional bias was not observed within the alcohol participants when use was intended. This very surprising result may indicate fundamental flaws in the study which may be the result of not utilising appropriate control groups. Future study would benefit from a control group containing low users or non-users; this would therefore replace the correlational design. The correlational design assumes meaningful differences between reported substance use. However, such estimates may be arbitrary. It would therefore be more empirically valid to place participants into broad categories of heavy and light/non-users in order to explore these attentional biases further. However, the correlational design of this study does form a promising start to within-subjects design attentional bias research. It would also appear that the fixed gaze measure of attentional bias may be the stronger of the attentional bias measures used within this chapter. However, more research is needed to validate this new measure of attentional bias before it is possible to draw firm conclusions from the utilisation of this task.

In conclusion, it would appear that evidence has been observed which may indicate an attentional bias for MDMA users. It was also observed that attentional biases could potentially be phenomena which, for substance users, do not fluctuate as a result of external factors such as craving, use intention, and outcome expectancies, suggesting that attentional biases may be fairly stable across time and not transient.

Summary: Within this chapter a within subjects design was used to explore attentional biases further. It was found that attentional biases did not vary to a great degree when use was intended or not. Tiffany (1990) would suggest that greater attentional bias may be observed when use was not intended whilst Robinson and Berridge (1993) would suggest a greater attentional bias when use was intended. The results of this chapter would not support one theory over another as attentional biases were not found to fluctuate to a large degree dependent upon use intention. Craving and outcome expectancies were also not found to be associated with attentional biases, again supporting the idea that attentional biases are a stable phenomenon. Evidence was also observed which may indicate an attentional bias for MDMA in MDMA users, a finding not previously reported.

Chapter 4: Cognitive Biases

The importance of attentional biases in substance users and how they are involved in the maintenance of continuing substance use have now been considered. Substance use can lead to the allocation of attentional resources being biased. Such biases in the allocation of attention can be seen using tasks such as the Dot-Probe or eye tracking tasks (e.g. Noel, et al., 2006). However, attentional biases are potentially only one aspect of a broader system of biases which can result from substance use. Cox and Klinger (1988; 1990) suggest that substance abuse can lead to a biased internal state that would lead to the facilitation of achieving a goal; in the case of a substance abuser, that goal may be substance seeking behaviour. This may be reflected in the substance abusers' cognitive functioning. Therefore, although attention may be affected, it may also be expected to find influences in higher level cognition as well. Such biases in cognition would therefore utilise different tasks than those employed in attentional bias measurement.

Here, an alternative perspective on attentional bias is sought, in terms of their role in memory activation. Models, such as semantic network theory, may be able to explain drinking decision processes. Substance abuse may lead to an 'accessibility bias', where positive expectancies are more readily available for a substance abuse. This may lead to a positive valuation of a substance, thus this bias would promote further substance abuse. This may be reflective of a more general bias in cognitive processes, rather than limited to a single aspect of cognition, such as that of attention, as would be measured by the emotional-Stroop. This idea is in line with the motivational theory of current concerns (Klinger, 1987), where cognitive experience is structured in a way that leads to the attainment of goals. A person's current concern is their internal state and relates to the goal for which they are striving. This internal state is therefore critical for the achievement of their goal. A current concern would facilitate attention in the environment toward stimuli relevant to the current goal. However the theory postulates that a number of cognitive faculties would be affected; not merely attention. Current concerns for substance abuse could be maintained by biases in semantic memory activation. These cognitive biases may therefore impede on memory in substance abusers, when the task is related to their current concerns.

Representations of addiction-related behaviour (e.g. drinking, smoking) are paired in memory with associated propositions about outcome (e.g. relaxing, stimulating). These associations and expectancies, which can motivate behaviour, reside in neurocognitive structures, which can be broadly characterised as 'memory'. They are thought to develop automatically from abstraction of information from the environment (Tiffany, 1990), and may play a motivationally intrinsic aspect of behaviour, as the associations are likely to be positive and appetitive. The valence attributed to these associations is thought to be consistent with early experiences with the substance in question. The semantic associations between behaviour and outcome becomes strengthened through repeated use of the substance. As an association develops, activation at one point of the 'network' will automatically trigger propositional links across the network. This inevitably leads to an accessibility bias, where positive information regarding the behaviour will become increasingly strengthened.

An accessibility bias would be responsible for the between-group differences observed in positive outcome expectancies made between drinkers and non-drinkers (Meyer and colleagues, 1971; 1987). However, heavy and light drinkers vary in positive and negative endorsements, but also in relation to the reaction time to make these endorsements (Armstrong, 1997). These results suggest that heavy drinkers are more able to access positively motivating behaviour, and light drinkers have better access to more negative and inhibiting behaviours. This would suggest that there are also within-group differences for the accessibility of alcohol associations. Litz *et al.* (1987) observed that smokers were also able to make both negative and positive evaluations about cigarette use; however they were better able to recall the positive ones. These studies are demonstrative of a memory and accessibility bias for positive information regarding specific substance abuse.

As discussed previously, Stacy (1997) proposed that memory activation would be automatic, but outcome expectancies may have a basis in decision making. Stacy makes a distinction between the two processes, claiming that the former is implicit whilst the latter is explicit. However as both are memory processes, an accessibility bias may affect both processes. This would be caused by current concerns leading to a cognitive bias which would have an effect upon memory activation. Stacy's theories could therefore be interpreted in terms of semantic networks. If outcome expectancies were to be organised within semantic networks (explicit), then how this network is accessed could represent automatic/memory activation processes (implicit). Therefore, the study of a memory-based cognitive bias task may help measure the association between the implicit and explicit components of substance abuse.

Rather *et al.* (1992) and Goldman and Rather (1993; 1994) used MDS to look at the organisation of endorsements regarding substance abuse. Endorsements are potentially analogous to outcome expectancies. Results suggested that the 'space' between positive endorsements was more tightly packed in heavy drinkers than light drinkers. This would lead to the suggestion that in light drinkers more negative endorsements are available which are motivationally inhibiting than in the heavy drinkers. These positive associations may therefore be intruding on memory, causing a cognitive bias for drinking behaviour.

Numerous studies using a multitude of tasks have shown that substance-specific stimuli are processed in a manner specific to previous substance use history. A heavy drinker will have a correspondingly high attentional bias for alcohol stimuli, but cognitive biases have also been observed when using substance-related stimuli (e.g. Pothos and Cox, 2001). A number of different measures have been adopted for the measurement of cognitive biases. The modified-Stroop is by far the most common. However, cognitive biases should operate more generally, than just in relation to one aspect of cognition, like attention, as it could be argued that the modified-Stroop is measuring. Chapter 5 therefore attempts to explore whether heavy drinkers have a preferential bias for the *encoding* of alcohol-related information, as measured on a subsequent memory task.

Chapter 5: The Percentage Estimation Task: How Drinking Can Distort Environmental Statistics

5.1: Introduction

The purpose of this chapter is to develop a novel task to explore cognitive biases related to substance use, for example, excessive alcohol consumption. The task, called the Percentage Estimation Task (PET), simply involves presenting participants with a list of words, such that words can be in one of three categories: alcohol-related, a category of neutral related words (e.g., musical instruments), and a category of neutral unrelated words. Participants read the words and were then asked to state estimates for the percentage of words in each category. This simple measure was shown to be sensitive to differences between heavy and light drinkers and, moreover, to differences in BMI, emotional eating, and restraint eating, in an extension of the task related to eating behaviour. The PET is motivated in relation to intuitions regarding both the behaviour of interest and theory of cognitive biases in substance use. A less successful attempt to create a current concerns version of the task is also reported with potential reasons for its shortcomings.

Cognitive biases related to alcohol abuse (and, more generally, substance abuse) have been the focus of extensive research (Cox *et al.*, 2006; Field & Cox, 2008; Hogarth *et al.*, 2008; Williams *et al.*, 1996). In an effort to understand the exact role of such biases in alcohol abuse, researchers have employed different kinds of cognitive tasks (e.g., Jones & Schulze, 2000; Palfai & Ostafin, 2003; Pothos & Cox, 2002; Stacy, 1997; MacLeod *et al.*, 1996; Mogg & Bradley, 2002). All this work has led to several key insights regarding the nature of cognitive biases. For example, in the case of attentional biases, it is now established that a bias can reflect a number of separate (in principle, independent) attentional processes, such as rapid initial attentional orientation and difficulty with disengaging attention. Other researchers have noted that cognitive biases can alter memory processes, so that positive alcohol expectancies or outcomes would be more readily associated with alcohol-related stimuli, for alcohol abusers (McCusker, 2001; Stacy, 1997). Rather *et al.* (1992) argued that the conceptual psychological space of alcohol abusers can be altered, so that positive alcohol outcomes would be more proximal to alcohol-related concepts, compared to negative ones. Such work reveals the multifaceted nature of cognitive biases related to alcohol abuse and the difficulty of explaining these biases comprehensively by reference to a single cognitive process (e.g., attention).

Research in the nature of cognitive biases has revealed several key insights regarding alcohol abuse. For example, if alcohol abusers have difficulty disengaging attention from alcohol-related stimuli (as indeed seems to be the case; Cox *et al.*, 2006), then the additional processing of such stimuli plausibly makes it more likely that thought processes will likewise reflect a corresponding influence. If alcohol abusers have a lower attentional threshold for processing alcohol-related information (and, perhaps equivalently, find alcohol-related stimuli more attention-grabbing; Robinson & Berridge, 1993; cf. Field *et al.*, 2008), then in an array of stimuli including an alcohol-related stimulus, alcohol-abusers will tend to focus on the alcohol-related stimulus. Some researchers hope that it will be possible to utilise such insights so as to develop cognitive-style interventions for ameliorating alcohol abuse problems (e.g., Wiers *et al.*, 2006).

Most of the existing work on cognitive biases has been developed in the context of tasks representative of particular cognitive processes. For example, in order to demonstrate a cognitive bias in attention, a suitable version of the Stroop task has been employed (Cox *et al.*, 2006) and biases in memory have been studied with typical association tasks (e.g., Stacy, 1997; see also the review of McCusker, 2001). The motivation for the present project was to propose a task which might further help reveal insights into how, for example alcohol-related cognitive biases, alter the way an alcohol user perceives the world. In other words, how does the world 'appear' from the eyes of an excessive drinker?

Assuming that heavy drinkers both orient their attention more rapidly towards alcohol-related stimuli and find it hard to disengage their attention from such stimuli, then it would be expected that most cognitive processing will be focused on alcohol-related stimuli, at the expense of other stimuli in the person's environment. Moreover, research with memory paradigms has shown stronger associations between positive alcohol and marijuana outcomes for corresponding heavy users (Stacy *et al.*, 1996), which suggests an increased salience of memory representations in relation to an abused substance (cf. McCusker, 2001; Rather *et al.*, 1992). A related finding of verbal fluency was reported by Goldstein *et al.* (2007), in that participants who had used cocaine within the previous 72 hours were better able to name drug-related words than cocaine users who hadn't used cocaine within the previous 72 hours. Likewise, Bock and Klinger (1986) reported that more emotionally arousing words could be recalled better, following various ratings tasks for these words. A greater degree of recall again suggests that emotionally charged stimuli have increased salience in relation to more neutral ones.

Therefore, existing research overwhelmingly suggests that for, e.g., an excessive drinker, the cognitive processing of individual alcohol-related stimuli is prioritised. An unaddressed, though key question, is whether this enhanced salience of individual stimuli might translate into a distorted perception regarding the availability or frequency of such stimuli in the environment. In other words, is it the case that the perception of alcohol-related stimuli 'crowds' that of unrelated stimuli, to an extent that distorts an excessive drinkers' sense of the relevant environmental statistics? If this were true, there would be potentially significant consequences. It would mean that, from the perspective of a heavy drinker, the frequency of alcohol-related stimuli is inflated. A perception of an increase in frequency would plausibly be linked with a sense of greater availability, further fuelling a desire to consume alcohol.

Interestingly, cognitive psychology research indicates that this may be the case. Goldstone (1993) showed that if a multiply-occurring feature of a stimulus is more salient (e.g., because of higher figural goodness), then its frequency would be overestimated. Goldstone (1993) performed research into 'overestimation biases'. He hypothesised that he could manipulate the salience of a feature by clustering displays or by altering task instructions. A number of slightly differing tasks were used, but the main principle of his experiments involved the presentation of two pictures presented simultaneously. The pictures contained white and black squares. On one of the pictures the white (or black) squares were grouped closer together. This, he observed, led to an increased chance of the participant selecting this image when asked to select the picture with the most white (or black) squares. Participants would overestimate the number of white (or black squares), as the target square would become more salient due to how the stimulus was presented to participants.

'Overestimation biases' can arise in a variety of ways. Goldstone's (1993) paper appears to show two ways, one from figural goodness, and another from basic priming mechanisms. His interpretation of the research led him to suggest that participants fail to search for negative evidence, in that, when hypothesis testing, participants are fairly rigid in trying to support, rather than discredit their hypotheses i.e. a confirmation bias. He suggested that the mechanism taking place involved a participant's attention being directed to regions with larger amounts of confirming evidence. He therefore suggested that there is a perceptual system in place which may be biased by stimuli that are deemed salient. This system would then affect the perception of stimulus density. Goldstone suggests that the results can be interpreted in terms of attention as a spotlight (e.g. LaBerge, 1983). If this 'beam' of attention falls on a region containing features of value, then this will affect results in a manner which corresponds with the number of features within the region. For example, if the region contains mostly black squares, then mostly black will be reported. Due to the framing of how the question is asked, a participant may be directed straight to a certain task-related region (note the similarities here with attentional bias). But when this region contains items that should be negatively appraised, then a lower estimation bias is reported than if the region were free of the stimuli. For example, if the region contains a cluster of black squares with a number of white also within the region, then this may lead to the over reporting of white squares.

These results highlight how attention can be 'modified' during task situations. However, of interest here is whether overestimation biases can arise from the kind of attentional biases which have been postulated in substance use, eating behaviour, and current concerns. Goldstone (1993) suggests a confirmation bias. This form of bias may lead to attentional biases: If somebody's life is organised around alcohol, perhaps he is biased to seek confirmation of the 'importance' of alcohol, by seeking alcohol stimuli in the environment.

A simple task was developed to explore this hypothesis, that is, that for heavy drinkers there is indeed a perception of increased frequency/availability of alcohol-related stimuli in their environment (cf. Tiffany, 1990). The task involves having participants read a list of words so as to subsequently provide an estimate of word frequency in each category. It can be called a Percentage Estimation Task (PET). The objective of this task is twofold. First, of interest is assessing the prediction that, even when the objective frequency of alcohol-related stimuli is matched to that of neutral stimuli, heavy drinkers have an inflated sense regarding the former. Second, the PET can potentially serve as a novel measure of cognitive bias, but which does not require precise reaction time measurement or computer-controlled presentation of stimuli.

As with all research relating to cognitive biases, it is currently unclear what is the range of behaviours over which one would expect cognitive biases. Some approaches would suggest that, as long as there is a particular important goal which causes preoccupation, corresponding cognitive biases would emerge (Cox & Klinger, 1988). Other research ties the emergence of cognitive biases to the biological impact of particular substances (e.g., Robinson & Berridge, 1993). For this first illustration of the PET, excessive drinking was chosen, as corresponding cognitive biases have been robustly demonstrated for even casual heavy drinkers (Cox *et al.*, 2006). Also, methodologically, it is straightforward to identify heavy and light drinkers in a typical sample of university undergraduates. Another behaviour which robustly leads to cognitive biases is eating behaviour (e.g., Calitri *et al.*, 2010; Tapper *et al.*, 2010). Therefore, as an illustration of how this task can be extended to other kinds of behaviour, an example subsequently presented related to eating behaviour, followed by a current concerns version of the task.

5.2: Alcohol task

5.2.1: Methods

5.2.2: Participants

To avoid accidentally priming participants in relation to the hypotheses, recruitment was blind to alcohol use level. Participants believed they were taking part in a reading task; however participants were fully debriefed at the end of the task. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V). 32 participants (28F, 4M) were recruited, all undergraduate psychology students at Swansea University, who participated for course credit (mean age: 21.69 years; SD: 7.28). Participants were assigned to a heavy or light drinkers group, based on their reported weekly alcohol use, on the basis of the Department of Health guidelines (Shenker, Sorensen, & Davis, 2009). Accordingly, light drinkers (LD; N=10; Average unit count=1.50; SD=1.65) were defined as males drinking on average less than 6 alcohol units/week and females less than 4 alcohol units/week (one alcohol unit = 10 ml. of pure alcohol) and heavy drinkers (HD; N=8; Average unit count=26.25; SD=9.04) as males consuming more than 21 units of alcohol/week and females more than 14 units/week. The difference in LD HD group sizes observed here and in Chapter 2 may be reflective of the slightly higher increased average age of participants that participated in Chapter 5. Bewick, et al. (2008) notes that alcohol consumption decreases in undergraduates as they progress in their studies. This may be reflected in the sample size here where there is a larger LD group than HD group. However, it is unlikely that this would affect the relationship between the IVs and the DVs reported here. Note that analysing the results for all participants, perhaps by correlating number of units per week with the dependent variable from the PET task, is not appropriate. A correlational approach would assume that internal differences in weekly alcohol use are meaningful, yet this is extremely unlikely to be the case (both because of the inherent inaccuracy of self-report measures and the relative instability of drinking patterns of university undergraduates). Thus, such a correlational approach would introduce considerable noise in the data. By contrast, the coarse distinction into heavy and light drinkers is more likely to provide an accurate characterisation of drinking patterns, at least in relation to corresponding cognitive biases (cf. Cox *et al.*, 2006).

5.2.3: Materials and procedure

A list was created of 60 words (taken from Cox, Yeates, & Regan, 1999), such that 10 words were presented on each page (see Appendix J). Three word categories were employed: alcohol (e.g., beer, vodka), neutral related (music; e.g., trombone, bass), and neutral unrelated (e.g., carpet, invitation). The category of music words was included so that there would be a category of control words as matched in semantic relatedness as the category of alcohol words (since semantic relatedness can increase attentional bias, e.g., Warren, 1972). The category of unrelated control stimuli was included as a filler category. The stimuli comprising the three categories were almost entirely common, concrete nouns. The order of words on each page was randomised. Participants were simply given the list of words and asked to read them aloud, without any instructions about the task to follow. After the word list, participants were given a sheet of paper, with questions regarding the percentage of words which were related to alcohol, music, or were neutral (see Appendix K). They were also asked whether they played a musical instrument (a variable that was not found to have an effect). Participants finally completed the AUDIT alcohol use questionnaire (Babor, de la Fuente, Saunders, & Grant, (1992) and were asked to estimate their weekly alcohol use (see Appendix I).

5.2.4: Results

The correct percentage response for each word category was 33%. An Alcohol Percentage Difference Score (APDS) was computed as the reported percentage for alcohol words minus those for the two other word categories. For example, if a participant reported there were 30% music words, 40% alcohol words, and 30% neutral words, then their APDS be scored 40-(30+30)=-20. Therefore, participants able to process the frequency information accurately would have APDS scores of -33; also, the more positive the APDS score, the more the bias to overestimate the frequency of alcohol-related words in the list. Note that APDS is an appropriate dependent variable, as opposed for example, to just the estimate produced for the alcohol stimuli, because participants sometimes provided percentage estimates for the different stimulus categories which did not add up to 100%.

A comparison between the APDS scores of heavy drinkers (M=-10.5; SD=33.58) with those of light drinkers (M=-37.00; SD=15.67) was performed. An independent samples *t*-test showed this difference to be significant ($t(16)=-2.223$; $p=.041$). Indeed, on average, heavy drinkers estimated the percentage of alcohol words to be 44.75%, but light drinkers only 32.00%, a striking difference (see Figure 5-1).

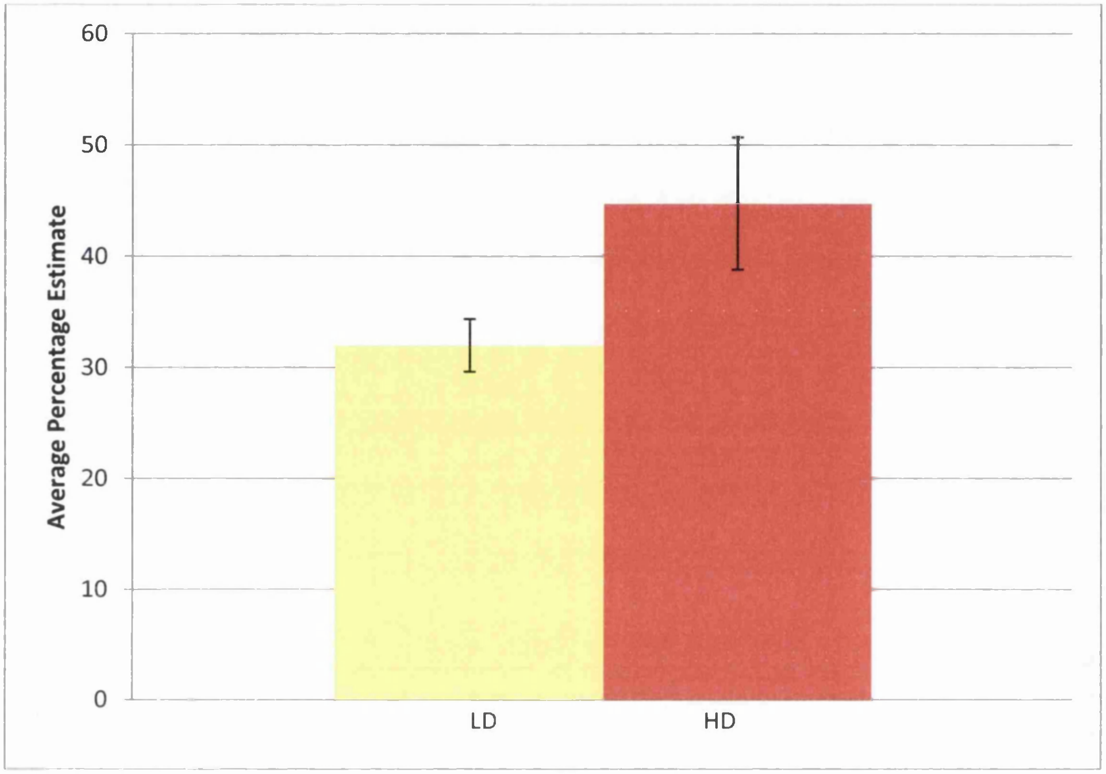


Figure 5-1: Average heavy drinkers and light drinkers percentage alcohol-word estimation. The bars represent the 'difference scores' obtained by subtracting the percentages. The error bars show the standard error of the mean.

5.2.5: Discussion

A comparison of heavy and light drinkers demonstrated a significant difference in percentage scores. These results are consistent with other attentional bias studies in the literature, which often employ the definition of heavy vs. light alcohol use to compare one group of light drinkers against a group of heavy drinkers, rather than rely heavily upon an association between unit counts and a dependent variable (DV). A comparison of heavy and light drinkers within the current task leads to the observation that the two groups do report broad differences within their estimations of alcohol-related words.

The results lead to the suggestion that attentional biases for substance-related stimuli can lead to overestimation biases. The implications of this are that heavy drinkers perceive an increased number of alcohol stimuli within their environment. Goldstone (1993) suggested a confirmation bias in interpreting his overestimation results. In terms of the current research, this confirmation bias could be that a heavy drinker, whose life is organised in a manner where alcohol is important, may seek confirmation within his/her environment to verify the 'importance' of his/her drinking habit. This may be expressed through an attentional bias for alcohol related stimuli which may lead to inflated reporting of alcohol words on the PET. The observation that heavy drinking undergraduates may perceive more alcohol-related stimuli suggests that a cognitive bias may be developing for alcohol. The sensitivity of the current task to make such observations is beneficial, as the previous chapter was unable to find an attentional bias within a similar population.

5.3: Eating behaviour task

Attentional biases related to excessive drinking are straightforwardly associated with the amount of alcohol consumed, the latter being an obvious marker of the degree to which drinking behaviour is problematic. In the case of eating, the distinction between adaptive and maladaptive behaviour is less straightforward and the quantity of food consumed does not necessarily indicate maladaptive behaviour (Brunstrom *et al.*, 2008). The Body Mass Index (BMI) can be an index of maladaptive eating behaviour. The Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien *et al.*, 1986) produces three indices of eating behaviour, external, restraint, and emotion eating, which have been associated with food-related attentional biases (e.g., Tapper *et al.*, 2008) and eating behaviour in general. Therefore, results were explored from a food PET with BMI results and the DEBQ indices.

Cognitive biases for food are thought to operate in a similar manner, as cognitive biases for other substances, as they may reflect a preferential processing for food-related stimuli. There are thought to be a number of contrasting mechanisms which could potentially explain the nature of such preferential processing. Biases may be the result of automatic associations between food and positive food expectancies (cf. Tiffany, 1990), or an increased salience of food stimuli (Robinson and Berridge, 1993), or an increased preoccupation with food (Cox and Klinger, 2004). Although these theories of the underlying mechanism of preferential processing of food stimuli may be contrasting, they all basically suggest that an increase in consumption is associated with a corresponding attentional bias. The link between increased consumption and attentional biases has been demonstrated by, for example, Braet and Crombez (2003) who observed higher interference on the food-Stroop for obese children than non-obese children. This observation could be likened to the effects that are observed in heavy drinkers, who also have a corresponding attentional bias. The way in which food related attention biases could differ from those associated with substance use may be regarding the implicit attitudes that may underlie consumption, however, this is complete speculation. For example, Craeynest *et al.* (2005) observed that obese children were more likely to have positive implicit attitudes towards food, whereas Roefs *et al.* (2005) reported a contrary association (albeit in an anorexia nervosa patient population). This dissociation in results may be the cause of the diminished attentional biases that have been associated with eating behaviour. Indeed Pothos, Tapper, and Calitri

(2009) reported using a number of measures for the assessment of food-related cognitive biases, but were unable to find any reliable association with body mass index (BMI). They made the suggestion that, although cognitive paradigms are well established in substance abuse, extending the application of these paradigms to eating behaviour should be treated with caution.

BMI is seen as a useful variable for establishing whether a person's weight is adaptive or not. High BMI may be associated with preferential processing of food-related information. Such preferential processing may be due to high incentive salience of food stimuli (Robinson and Berridge, 1993), automatic associations between food and positive food expectancies (cf. Tiffany, 1990), or an increase in the preoccupation with food (Cox and Klinger, 2004). The above theories would all predict an attentional bias that is associated with food information.

A useful tool for the measurement of eating behaviour is the DEBQ (Van Strien *et al.*, 1986). The indices obtained from the DEBQ, namely external eating, emotional eating, and restraint, have all been supported as indicators of eating behaviour (Braet and Van Strien, 1997). External eating is eating in response to external food cues, such as sight and smell of food. Emotional eating is eating in response to emotional arousal states, such as fear, anger, or anxiety; therefore, emotional eating can be a coping mechanism. Restraint eating concerns restricting one's food intake.

Research has demonstrated that people characterised by the DEBQ as external eaters, may exhibit a cognitive bias for food-related information, due to the appetitive qualities of food (e.g. Dreyna, 2005; Franken and Muris, 2005; Robinson and Berridge, 1993). Such biases have also been observed in those who aim to decrease their food consumption i.e. restraint eaters (Tapper, *et al.*, 2008). Currently, however, there does not appear to be an association between Stroop performance, attentional bias, and BMI (e.g. Boon, Vogelzang, and Jansen, 2000).

It is hypothesised that the PET task will be associated with the BMI and the three forms of eating behaviour.

5.3.1: Methods

5.3.2: Participants

19 (3M, 16F) participants were recruited, all undergraduates at Swansea University, who took part for course credit. Participants believed they were taking part in a reading task; however participants were fully debriefed at the end of the task. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

5.3.3: Materials and procedure

A food PET was created, such that 20 words were food-related, 20 were related to transport, and 20 were neutral unrelated words (see Appendix L). The food- and transport-related words were taken from Tapper *et al.* (2008). The neutral words were obtained using an online random word generator (http://www.datavis.ca/online/paivio/). Neutral words were matched in terms of length and syllables to the food and transport-related words. Neutral words were also deemed to be of similar frequency to those of food and transport-related words. Following the reading of the list, participants were given a separate sheet on which they were asked to state their estimated percentage for the frequency of each word category (see Appendix M). Finally, participants were asked to complete the DEBQ questionnaire, which included questions to compute the BMI (Van Strien *et al.*, 1986). Information about the weight and height of the participants was based on self-reports.

5.3.4: Results

A Food Percentage Difference Score (FPDS) was computed, in a way analogous to that in Section 5.2.4. Also, external, restraint, and emotional eating indices were computed following Van Strien *et al.* (1986). The distribution of BMIs was approximately normal, so a meaningful dichotomisation in low-BMI and high-BMI participants was not possible. However, for illustration, participants were allocated into groups based on World Health Organisation guidelines, so that BMIs 18.5-25 were assigned to the low-BMI and BMIs of 25-30 to the high-BMI group and participants were divided into these two groups accordingly (N=15 and N=4, respectively). The FPDS value for the high BMI participants (M=-5; SD=37.859) differed significantly from that of the low BMI ones (M=-48; SD=16.125), with high BMI participants overestimating the percentage of food-related words to a greater extent ($t(17)=-3.536$; $p=.003$). Indeed, the average food-related percentage estimation for the high BMI participants was 45.00%, but the low BMI participants estimated 26.33%, again, a striking difference (see Figure 5-2).

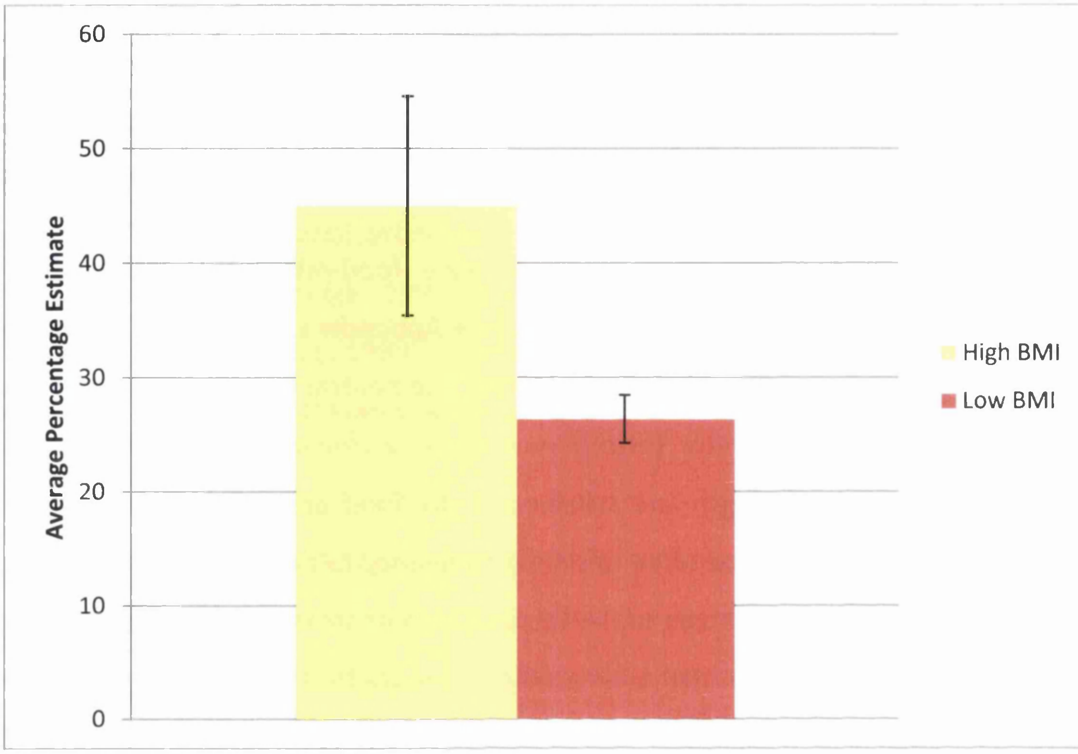


Figure 5-2: Average high body mass index group and low body mass index group percentage food-word estimation. The bars represent the 'difference scores' obtained by subtracting the percentages. The error bars show the standard error of the mean.

Regarding the DEBQ indices, there are no guidelines which can motivate a separation of participants into groups and, moreover, the distribution of scores was approximately normally distributed, thus making an arbitrary dichotomisation inappropriate (MacCallum *et al.*, 2002). Therefore pairwise correlations were computed between the FPDS scores and the DEBQ indices. Significant correlations were identified in the case of restraint eating ($r(19)=.453$; $p=.052$) and emotional eating ($r(19)=.552$; $p=.014$), but not external eating ($r(19)=.130$; $p=.595$). Note that in all cases, a positive correlation means that more positive FPDS scores (which mean a greater overestimate of the frequency of food-related words) were associated with a higher degree of restraint and emotional eating.

5.3.5: Discussion

The results of this version of the PET further demonstrate the PET's usefulness. Correlations between the eating variables and the percentage score demonstrate the association of attentional bias and food stimuli. Previous studies into attentional bias and food-related stimuli have failed to show an association between BMI and attentional bias (e.g. Pothos, *et al.*, 2009). However, this task revealed a significant association here, further supported by comparing overweight to normal-weight participants, with a *t*-test analysis. As a food-related Stroop has failed to predict BMI in previous studies, this result would lead to the suggestion that the current study may be more sensitive at measuring attentional bias than the Stroop.

Emotional eating was also found to correlate with the percentage score. Emotional eating is eating in response to emotional situations, such as feelings of fear or anxiety. Previously, attentional biases have not been found to correlate with emotional eating. One explanation for why it might be significant here is that the PET may be more sensitive than other tasks as a measure of attentional bias. A lack of awareness of reasons for overeating has been observed for emotional eaters (e.g. Bruch, 1973; Van Strien & Ouwens, 2007). Therefore the PET may be more sensitive to the implicit cognitions involved in emotional eating, i.e., if causes for overeating are outside of awareness, then explicit measures may lack the sensitivity for measuring putative implicit causes. Restraint eating was also found to marginally correlate (p = .052) with the percentage score. Restraint eating, when accompanied by being underweight, may be indicative of anorexia nervosa. However, when restraint eating is accompanied by high weight fluctuation, it may be reflective of a rebound type of dieting, where, if one were to abandon dieting, then this may lead to some form of binge eating (potentially leading to bulimia nervosa in some cases). Within the current study the marginal correlation between restraint eating and the PET is consistent with other evidence for a high degree of dieting-behaviour amongst university students (e.g. Forman-Hoffman, 2004).

Within previous research, an attentional bias for external eating has been observed (e.g. Drayna, 2005). However, this result has not been supported when using the PET. This is surprising, as external eating is eating in response to food stimuli. Therefore one would predict that a list of food-related words may elicit a similar response.

It would appear that the PET is sensitive to various indices of eating behaviour. The observation that the PET also correlates with BMI suggests that the current measure may have advantages over other measures when measuring attentional bias for food.

5.4: Current Concerns Task

The theory of current concerns (Klinger, 1975, 1977, 1987, 1996b; Klinger and Cox, 2004) posits that people structure their lives in pursuit of a number of goals. To have a goal leads to a preoccupation about achievement of said goal. A current concern is the product of becoming committed to a goal and its eventual attainment or disengagement from; that is, a current concern is a persistent motivational state. This motivational state may lead to relevant information within the environment to become sensitised and increasingly salient, e.g. substance abusers have a current concern for substance abuse. Therefore, they would have a corresponding attentional bias. A current concern will implicitly bias attention towards goal-related stimuli. Within any population there may be current concerns which are poignant to each individual e.g. educational matters or health matters.

The next step for exploring the PET was to examine undergraduate students' current concerns and examine whether the PET would be able to reveal attentional biases for such concerns. Pilot research was first performed in order to establish current concerns within such a population. Following this, the PET was performed with a number of related categories.

5.4.1: Method

5.4.2: Pilot Experiment

Pilot research was performed in order to ascertain the current concerns most relevant to students. This was performed by first putting together 8 word categories, representative of various current concerns. Categories were taken from Cox and Klinger (2000). Next, words relating to each of these categories were also created. Participants were then asked to decide to which category each word belonged. This pilot study was performed by 12 undergraduate students. Results of the pilot study showed that of the 72 words employed, an average of 4.2 words (5.8% of the word list) were miscategorised by the 12 participants. Participants did not consistently make errors on any word in particular, so no word was changed for the percentage task (see Appendix N). Different participants were used for the main PET.

5.4.3: Main Task

5.4.3.1: Participants

A further 20 undergraduate psychology students were recruited in return for course credit. Eight of which were male. The mean age of the group was 21.9 (4.3). Participants believed they were taking part in a reading task; however participants were fully debriefed at the end of the task. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

5.4.3.2: Materials and Procedure

72 words were used to create the list. There were eight categories of words, each with 9 words. Words and categories were selected through pilot research (see above). They were thought to be categories most related to an undergraduate students' life/current concerns (e.g. household matters, and economic and financial issues).

Following the reading of the words, participants were asked the percentage of words for each of the 8 categories. They were then given a questionnaire about their 'current concerns'. Questions included 'How preoccupied with the following topics have you been over the last week?', 'How important will these areas be to you over the forthcoming week?', 'Typically, how important to you are each of these areas?', and 'How committed are you to increasing your time available for each of the following aspects of your life?' (see Appendix O). Participants responded to each of the questions on a 7 point Likert scale for each of the 8 categories. Participants were also asked for each of the above questions to rate whether this aspect of their life was positive or negative (see Appendix P). These questions were based on similar current concern questions from Klinger, Barta, and Max (1980).

5.4.4: Results

Correlation analyses were performed to observe the association between the percentage estimation scores and the current concerns question responses and the positive/neutral responses. The Household question total significantly correlated with the household percentage score, $r(20) = .447$; $p = .048$. This suggests that there was an association between household current concerns and household percentage estimates. Employment and finances percentage scores marginally correlated the positive/negative score, $r(20) = .461; p = .068$. Recreation percentage score and question total correlated marginally, $r(20) = .388; p = .091$. Age was found to lead to positive correlations with percentage household ($r(20) = .521; p = .018$) and percentage partner, family, and relatives ($r(20) = .477; p = .033$). Interestingly, age was found to be negatively correlated with reported importance of alcohol matters, $r(20) = -.752; p = .0005$. It would appear that this version of the PET, although led to some significant results, did not lead to as robust findings as the alcohol and food PETs.

5.4.5: Discussion

The results from this task have not revealed as many significant associations as previous PETs. Age was found to be associated with a number of variables within the task, perhaps age may be a factor which needs to be manipulated directly in current concern research. Perhaps for older participants the current concerns are more likely to be associated with attentional biases, as current concerns have been in place for longer. Yet, to suggest that the younger undergraduates have no current concerns would be erroneous. It may, however, be that undergraduate students within their first year away from home, are still adjusting to, e.g., household matters and transportation issues. Yet as significance was also not found for other concerns, for example, alcohol related matters and educational matters, issues that most undergraduates (potentially) preoccupy themselves with, then this argument is hard to support.

A small number of significant associations were observed. These could imply that the current concerns PET is sensitive to the current concerns of the participants. If this is the case, then it would appear that the participants within the sample who reported having the most household current concerns also estimated a higher proportion of household-related words than other participants. However, although there are a small number of significant associations, these are outweighed by the associations which are not significant. This may have been because the method for measuring current concerns was not sensitive enough or it may have been that the undergraduate population did not have sufficiently developed current concerns to elicit a cognitive bias.

The previous PETs worked by having two categories, and an 'everything else' category. It could be that significant findings were not observed on the current concerns PET due to the noise created from having too many categories. Participants may have overestimated their current concerns, but then, due to the number of categories, just randomly allocated the remaining percentages between the remaining categories. In future research it may be better to use fewer categories in order to minimise noise when allocating percentages.

The concerns may have also been too general to 'activate' attentional biases. The pilot research may have successfully confirmed that words were associated with their designated categories. However, these words may not have been high enough in current concern-relatedness enough to elicit a cognitive bias. For example, one of the eight words from the 'home and household matters' category was 'laundry'. Now, I may have laundry to do, and it may be a current concern of mine, therefore potentially making the word more salient in the list. But, this does not mean that one word will lead to me scoring highly on a scale of how preoccupied I have been with household matters. This issue of the concerns being too general may lead to the suggestion that if specific tasks were created for participants, based upon a participant's perceived current concerns, then this may result in a more robust attentional bias.

5.5: General Discussion and Conclusions Regarding PET

The purpose in developing the PET was to provide a measure of cognitive bias which can test the intuition that for excessive drinkers alcohol-related stimuli crowds that of other stimuli. Thus, alcohol-related stimuli are not only attended to more rapidly and are harder to disengage attention from, they also appear more *numerous*, in an excessive drinkers' environment (cf. Tiffany, 1990). It is believed this is a novel insight regarding cognitive biases, which informs in an interesting way understanding of how cognitive biases can potentially contribute to a state of substance abuse. Also, the results show that the PET is sensitive to behavioural distinctions (between heavy, light drinkers; restrained, unrestrained eaters; emotional, not emotional eaters). The PET is able to capture how the environment would plausibly appear to, for example a heavy drinker, in terms of a perception of increased frequency/availability of alcohol-related stimuli. One could say that PET bias is the result of a persistent focus on drinking by those who drink too much (and likewise for other behaviours of interest).

From a practical point of view, the increase of interest for cognitive-style interventions (e.g., Wiers *et al.*, 2006) has created a need for easy to administer measures of cognitive bias, which do not require specialised equipment (e.g., a computer with the capacity for measuring reaction times with up to ms accuracy). The PET, if further validated in future research, is an exceptionally easy to administer task and the results are extremely easy to analyse too. The PET can easily produce an index of emphasis for a particular word category, relative to another, even if there are baseline differences in the relative salience of the word categories. Also, significant differences in relation to the behavioural distinctions of interest were identified even with small sample sizes.

Of course, this first presentation of the PET has several limitations, which it is hoped is addressed in future work. Regarding the potential of the PET to serve as a general, easy to administer measure of cognitive bias, it is important to explore its relation to other measures of cognitive bias, such as the emotional-Stroop task. Note that such examinations are not without problems, since within-participant designs with several cognitive bias tasks can result in cross-priming between the tasks, making it hard to extract an objective measure of task relatedness (Pothos *et al.*, 2009). However, this is not a problem for the PET, however, if the task was to be administered within-subjects, then the percentage of words within each list would need to be varied, otherwise the participant may not respond in the anticipated way due to previous exposure. It is also important to explore the PET in relation to other dependent variables regarding the behaviour of interest (e.g., for alcohol, typical vs. atypical alcohol consumption, craving, binge drinking, changes in alcohol use).

It is recommended for future use of the PET that one should use three word categories: an emotional category (e.g. alcohol, food), a control word category (e.g. transport words, musical instrument words), and a collection of random words that do not belong to a category (i.e. an 'everything else' category). This suggestion is due to the non-significant findings obtained using the current concerns task: too many word categories could potentially be a confounding variable. However, such limitations are to be expected when using a new measure such as this one, as there was no prior knowledge regarding the amount of word categories which would need to be utilised in order to obtain the strongest of effects. Yet the exploratory nature of this chapter is beneficial for the development of the PET. It is also suggested that future PET studies contain words of similar syllables between categories and the words should be matched in terms of distinctiveness and frequency of use within the lexicon. Participants should also not be presented with a test card containing no more than 10 words per page. And test card administration should be counterbalanced. It is also recommended that following administration of the test cards, the participant should immediately be given the questions regarding the percentages. It would also seem appropriate that the participant should not be primed to the nature of the study. If they were to understand that the task is regarding e.g. alcohol use, then this may bias results. It would therefore be advised that whatever other measures are used (e.g. AUDIT, DEBQ, etc.) should wait until after the reading list and after the percentage estimation task.

There are more general questions one can ask. For example, does a cognitive bias indexed by the PET exist prior to the relevant drinking or eating behaviour or is it a result of engaging frequently in these behaviours? Is the PET bias perhaps an epiphenomenon of e.g. excessive drinking with no relevance to developing or changing the problem behaviour? These are valid questions, but they apply to any cognitive bias measure, not to the PET bias specifically. Cognitive bias researchers have sought to explore the predictive value of cognitive biases and so imply a causal role of such biases for the behaviours of interest (e.g., Calitri *et al.*, 2010; Cox *et al.*, 2002; Cox *et al.*, 2007; Mogg *et al.*, 2000). Can PET provide a unique perspective to this debate? It is hoped the encouraging results reported here will at least warrant interest in the further investigation of the PET regarding these important questions.

Summary: Within the alcohol task it was found that HDs were more likely to overestimate the number of alcohol words within the 'environment'. Within the food task it was found that those with a high BMI overestimated the number of food words within the 'environment'. A significant correlation was also observed for the percentage estimation and restraint eater scores as well as emotional eater scores. A correlation was not observed for the percentage score and external eater scores. These results are interpreted as being indicative of a cognitive bias. It is suggested that this task may have uses for future screening methods. A current concerns version of the task was not found to lead to as robust findings. This may be due to a flawed methodology.

Chapter 6: Automaticity and Dyslexia

Attentional biases and cognitive biases play an integral role within substance abuse. These biases develop following decisions to use substances on numerous occasions over a prolonged period of time. Tiffany (1990) suggests that for someone who increasingly engages in alcohol use, his/her environment would increasingly become occupied by stimuli related to alcohol. That is, the more someone engages in substance abuse, the more associations are automatically made between substances and other related stimuli which may lead to more of an environment becoming associated with substance abuse. This is arguably what the PET measured in the previous chapter, as the perceived amount of substance related stimuli within an 'environment' was examined, in this case, the word list. This process of forming associations between substances and other stimuli probably occurs automatically. Therefore, automatic skill learning would appear to play an important role in the development of substance abuse and related cognitive and attentional biases.

The following chapter involves automaticity, so begins by reviewing theories associated with automaticity development. Shiffrin and Schneider (1977) proposed a model that differentiated between controlled and automatic processes. They suggested that controlled processes were associated with capacity limitations, required attention, and can be used in circumstances which are not consistent with previous experience. They argued that, through practice, it is possible for automatic processes to develop. These processes differ in that they do not have capacity limitations, do not require attention, and are hard to modify once they have been learned. Indeed within their experiments (Shiffrin & Schneider, 1977), it took nearly 1000 trials of their task for performance to revert back to a level which was associated with the 'unautomatised-level' at the start of the task. This notion of rigidity of automatic processes is integral to the model. However, this approach is more a description than an explanation, as Shiffrin & Schneider (1977) make no attempt to explain how automatic processes develop, other than through the general idea that repetition eventually leads to automaticity. Jansma *et al.* (2001) have tried to elaborate on Shiffrin and Schneider's (1977) model, by suggesting that automaticity development leads to a reduced usage of the central executive.

Logan (1988) suggested that the above approach to automaticity does not indicate clearly enough how practice can lead to automaticity development. Logan's (1988) theory suggests that automaticity is a memory phenomenon, rather than related to resource limitations. 'Automaticity is memory retrieval: Performance is automatic when it is based on single-step direct-access retrieval of past solutions from memory' (Logan, 1988; p493). A skill may become automatic if a stimulus triggers the retrieval of a practiced response from memory. A novice will begin with an algorithm for a specific task. Through experience, he/she would learn specific solutions to specific problems, which are called upon again when a similar situation is encountered. The developing learner will either respond with an algorithm or a solution retrieved from memory. Eventually, through experience, the algorithm will be abandoned, as memory will readily provide the solution; at such a point, the process has become automatic. Automatisation is the transition from algorithm-based performance to memory-based performance.

The theory assumes that each encounter with a stimulus is encoded, stored, and later retrieved. This is assumed to be enacted through a *processing episode*. A processing episode is therefore stored after each encounter (or trial). Such episodes consist of different representations of expressing the stimulus, i.e. the interpretation given to the stimulus, the associated response, and the task goal: If the stimulus were to be encountered again, within the same context as in the previous encounter, then, from memory, aspects of the previous *processing episode* can be retrieved. An observer can then respond on the basis of the retrieved information if it is coherent and consistent with the goals of the current task. Or they can initiate the relevant algorithm and compute a corresponding interpretation and response. Logan (1988) suggests that a person undergoing such a process would, at this point, be able to explicitly 'veto' such responses, but should the stimulus, goal, and response continue to be associated, automaticity would develop.

This theory would allow for automatisation to come into effect after a relatively small number of trials. This is contrary to modal, lack of resources, accounts of automaticity where, often, thousands of trials are assumed to be required to produce automaticity (e.g., Shiffrin & Schneider, 1977). There may be a number of reasons for this difference. First, the definition of automaticity may vary between theories. Indeed, within Shiffrin and Schneider's (1977) theory, the criterion for automatisation was judged on an all-or-nothing basis. By contrast, a memory account may suggest that automatisation is never complete, as subsequent processing episodes could be contributing further to responses. Secondly, the number of trials per session is important in automaticity research, as is the size of the stimulus pool. The latter can have an effect upon memory performance, regardless of whether the rate of learning of individual items. Thirdly, the memorability of the stimuli could have an effect on the rate of automatisation. Those stimuli that are more easily remembered will show a quicker onset of automaticity, whereas stimuli that are hard to remember will become automatised more slowly (Logan, 1988).

The importance of such processes regarding automatic learning is clear. Therefore disruption of these processes may lead to drastically impoverished learning. It is deficits with such automaticity development that some (see Nicolson and Fawcett, 1990) have theorised is what leads to the deficits associated with dyslexia. Reported next are a number of experiments designed to explore attentional biases further, by examining a population impaired in automatic skill learning, i.e. dyslexics. First reported is a questionnaire study designed to measure whether there are differences between dyslexics and controls in terms of substance use.

Chapter 6.1: The Co-morbidity of Dyslexia and Substance Use: Automaticity

The automatisation hypothesis of dyslexia has been thoroughly examined within the dyslexia literature; however, automaticity is a term which also appears within the addiction literature. During the current questionnaire-based study, the hypothesis was that people with dyslexia would demonstrate less substance use than non-dyslexic controls. If dyslexics are impaired in automaticity development, then they may subsequently be impaired in the automatising properties of substance abuse. Automaticity has been found to be important in the development and maintenance of substance abuse through cognitive biases. As dyslexics may be less able to automatically form substance abuse cognitive biases, this, therefore, may lead to less reported substance use. Results supported the hypothesis; dyslexics were found to have used substances less than non-dyslexic controls. These results are interpreted in terms of the automatisation hypothesis of dyslexia and with reference to the cognitive model of substance abuse.

6.2: Experiment 1: The Co-morbidity of Dyslexia and Substance Use: Automaticity

Dyslexia is a condition which is affecting 5 – 17.5% of the population (Shaywitz, 1998). However, there have been very few studies of co-morbidity between dyslexia and other population characteristics. For example, some controversial research appear to suggest that dyslexia has a positive relationship with criminality (e.g. Critchley and Critchley, 1978). Indeed Kirk and Reid (2001) observed that 50% of a sample of young offenders from a young offender's institution in Scotland had dyslexic traits. The presence of dyslexia is higher amongst young offenders than what is typically the case in a non-dyslexic normal population. Of course, in such observations no causal link is implied, nonetheless they are quite important for relevant practice.

Of interest here is the co-morbidity between dyslexia and substance use (the latter broadly defined). In general, substance use has been found to be higher amongst youth offenders than a comparative non-offender sample (Hammersley, Marsland, and Reid, 2003), so perhaps the above observations might lead to an expectation of an association (perhaps weak, overall) between substance use and dyslexia. As demonstrated later, speculative theoretical reasons might lead to the *opposite* prediction as well. Either way, the idea that dyslexia could lead to different patterns of substance use, if supported, would have implications for current clinical practice. As far as the author is aware, there have been no previous examinations between dyslexia and substance use. The main objective is to provide pilot data which bear on this issue, as well as a preliminary theoretical background which can motivate some relevant predictions. It is important to start with a brief overview of relevant theory.

Having reviewed in Chapter 1 some of the relevant literature regarding a putative link between dyslexia and deficits in automatising behaviour, here the thesis considers some further key elements of automatic behaviour (in turn, this would lead to a formulation of a prediction regarding dyslexia and substance use). Bargh (1989) states that automaticity should be defined as a feature of a process which can run to completion once started without the need of conscious monitoring; examples of automatic processes are reading and writing. Conscious monitoring, in this definition, refers to intentionally initiating processing with regard to a goal and the intentional evaluation of its outputs. Thus, accordingly, a process is automatic if it has, due to genetic predeterminism or due to practice, acquired the ability to run without monitoring. Tzelgov (1997b) argued that Stroop-like phenomena and (unintended) processing support this explanation of automatic processing. Once a process has become automatic, it can occur either autonomously or 'intentionally'. Automatic processing is autonomous when it is not part of the task requirements, such as interference in the Stroop effect. It is intentional when it is a component of a more general task which is performed intentionally, like in the case of processing of individual words when a sentence is read for meaning. Yet monitoring (in the case of skilled readers) applies to the processing of the sentence, while the components are processed without monitoring.

Due to a history of substance abuse, substance use is thought to become effortless, with little attention on constituent actions, fast, and triggered by external cues. The substance abuse of an addict eventually becomes associated with automatic processes. By contrast, urges are thought to be the result of nonautomatic behaviour, as they are conscious, slow, intentional, and require effort. These urges will act independently of the automatic processes in relation to substance abuse, and may not necessarily activate substance abuse action plans. Tiffany (1990) suggests that urges are not necessary for substance abuse. Therefore compulsive substance abuse may be an automatised behaviour itself, as substance taking behaviour is, in effect, 'practiced', due to a repetition of substance-specific motor and cognitive actions; 'drug compulsion is the manifestation of automaticity rather than craving' (Tiffany and Carter, 1998; p23).

The above discussion suggests that in the presence of a triggering stimulus, a substance abuser may spontaneously engage in substance abuse behaviour, as this pattern of behaviour has become automatic. But here is an interesting (though of course highly speculative) possibility; if dyslexic people have difficulty in automatising behaviour, then it is possible that dyslexic substance abusers may display less automaticity in relation to substance-taking actions. A dyslexic may be unable to fully automatise action schemata for substance abuse situations, so may therefore not experience the automatic aspect of engaging in substance abuse behaviour.

Moreover, attentional bias is a characteristic of addiction, which is thought to relate to automatically activated information relevant to an abused substance. By the reasoning above, it might be expected that dyslexic participants, because of their difficulty with automatising behaviour, would be less likely to develop attentional biases related to substance abuse. Of course there may very well be other possible explanations for any observed differences between dyslexics and non-dyslexics in substance use, such as motivation, memory deficits, or depression. Previous research into these fields may lead to the suggestion that dyslexics differ to non-dyslexics in a number of psycho-social ways. Therefore it would be unreasonable to attribute any difference in substance use behaviour to automatisation-deficits without first discussing how these psycho-social factors could also explain any observed discrepancies. These issues will be discussed and contrasted to the automatisation hypothesis in due course.

To sum up, 'The scope and coherence of any action plan should depend on the previous learning history of the individual' (Tiffany 1990; p155); this suggests that those with learning disabilities who have difficulty in automatising behaviour may not show the same degree of substance use to those from a non-dyslexic population. Therefore, from research on attentional biases in substance abuse and research into automatisation problems in dyslexia, the hypothesis can be motivated, namely that persons with difficulty in automatising behaviour (such as dyslexics) may be less susceptible to substance use problems.

6.3: Method

6.3.1: Participants

98 participants were recruited (35 dyslexic, 63 non-dyslexic controls; 29 males, 69 female). All participants were university students (mean age for males: 21.5 years, for females 22.3 years). Dyslexic participants were recruited with the help of the Swansea University Disability Office. The dyslexic participants had all been previously diagnosed with dyslexia by an educational psychologist. Controls were obtained by offering psychology students subject pool credit. Dyslexic participants volunteered to take part in the study. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

6.3.2: Materials

The questionnaires were implemented on a computer to ensure consistency of administration and accuracy of data collection.

Substance Use Questionnaire: This was a slightly modified version of the UEL (University of East London) Drug History Questionnaire (Parrott *et al.*, 2000a). This questionnaire asks participants to self-report the frequency with which they have taken a list of substances (see Appendix Q). An advantage of this questionnaire is that it is brief and easy to use. There are however two disadvantages. First, there is no reliability data and, second, Cole *et al.*, (2002) criticises it for not asking participants about potentially dangerously potent dosages, and the dates of when substances were taken. However, for the purposes of the current study, the questionnaire was deemed suitable for collecting information about substance use, as of primary concern was frequency. Also incorporated were some minor modifications. It was decided to include the question 'Have you ever smoked?'. This was included as it was deemed to be distinct from the other smoking question ('Do you smoke now?'). The only other modification was in the 'Other Drug Use' section. This was mostly kept intact, except for the inclusion of a 'Prefer Not to Say' column.

Potential for Alcohol Addiction/ CAGE: The CAGE questionnaire (Ewing, 1984; O'Brien, 2008) is a short, simple but effective measure of alcohol abuse. It consists of four questions: 'Have you ever: a) Felt the need to *cut* down on your drinking; b) Felt *annoyed* by criticism of your drinking; c) Had *guilty* feelings of your drinking; d) Taken a morning *eye* opener?' This questionnaire was designed as a screening tool for drinking, and is used as a measure of potential for addiction to alcohol. The questionnaire may not enquire about quantity or frequency, but it is still useful for establishing some behavioural effects of drinking. Reliability for this questionnaire is generally good. Its sensitivity for lifetime alcohol dependence is 78.0% with a specificity of 76.1% (Ewing, 1984).

Dyslexia Questionnaire: The Adult Dyslexia Checklist (Vinegrad, 1994) was administered. This measure is often used within the literature, as it has been found to correlate strongly with dyslexia (e.g. Turner, 1997). This measure consists of a list of 20 questions which can be answered with either a 'Yes' or 'No' response. 'Yes' responses are associated with dyslexic traits and the overall number of 'Yes' responses indicates a higher likelihood of dyslexia. For example, 60% of dyslexics will respond with four 'Yes' answers, whilst 90% give eight 'Yes' responses (see Appendix R).

6.3.3: Procedure

Participants were emailed the questionnaires and a consent form. The questionnaires were implemented in Excel spreadsheets, and participants recorded their responses within these spreadsheets. The questionnaires took between 5-10 minutes to complete. Upon completion of the questionnaires, participants could either email their responses to the experimenter or print them and send them via mail. Results were calculated on each questionnaire through the use of Excel formulas to ease data collection, but these formulas were not visible to participants.

6.4: Results

Participants who had previously been diagnosed with dyslexia scored differently to controls on the Adult Dyslexia Checklist (Vinegrad, 1994). 'Yes' responses, normally associated with dyslexia, were 11.4 (SD: 3.69) for dyslexics and 3.40 (SD: 2.95) for controls. The difference in mean 'Yes' responses between dyslexics and controls was assessed by an independent samples *t*-test, which was highly significant: $t(96) = 11.754$; $p<0.0005$. This demonstrates the Adult Dyslexia Questionnaires sensitivity to dyslexia.

Participants' substance use patterns were measured in terms of a number of dependent variables. Alcohol use was measured as weekly unit consumption. Participants were asked if they had ever smoked tobacco, which led to a binary variable relating to ever having tried cigarettes or not. Those currently smoking were asked about cigarette use, and this was measured by the number of daily cigarettes smoked. The cannabis variable was a measurement of how many occasions, within a month, cannabis was used. Substance use was measured by providing participants with a list containing 13 types of substances (note, alcohol, cannabis, and nicotine were not included in this list of 13 substances due to the questionnaire considering these substances in more detail in an earlier section of the questionnaire). Participants responded with a 'Yes' or 'No' response, together with an estimate of how many occasions the substances had been taken. This provided information regarding each substance in the list and led to variables for how many substances had been tried, together with corresponding frequency information. The CAGE questionnaire is a measure of potential for alcohol addiction. This is a clinical measure used to screen patients for an addict-type personality, but it may be a useful tool for ascertaining whether a person has the potential for alcohol addiction. The main variable for the analysis was created using the z-score of each of the 13 substance frequencies (individually) and the z-scores of the alcohol, tobacco and cannabis frequencies. The first z-score variable is referred to as 'substance use', whilst the second is referred to as 'casual substance use'. Note that within this chapter these analyses are exploratory. The aim was not to reach a conclusion that non-dyslexic controls have higher levels of substance use than dyslexics. Rather, the aim was to obtain some preliminary results regarding an intriguing, but admittedly ambitious, hypothesis; that dyslexics would report less substance use than controls. Therefore, there are no correction for multiple dependent variables (i.e. the use of Bonferroni corrections) as the aim of this chapter is to gather preliminary evidence of a potentially diminished pattern substance use within dyslexics.

The distinction between dyslexic and non-dyslexic controls was used in order to examine its effect on substance use. This distinction was based on the classification from the Disability Office at Swansea University. Thus, it would not be sensitive to participants with a large number of dyslexic traits, who have not been through the Disability Office, or, conversely, participants who might have been through the Disability Office but have a milder form of dyslexia. Therefore the analysis performed was a mixed design ANOVA, which included a within participants factor of 'substance use' (consisting of the 13 different substance frequencies, which were all measured on the same scale i.e. incidents of use) and also included dyslexia as a between-subjects factor. There is strong evidence to suggest substance use differs between males and females (e.g. Becker and Hu, 2008). Thus, gender was used as a second between-subjects factor. There was a significant interaction between 'substance use', dyslexia, and gender; $F(12, 1128) = 9.272$; $p<.0005$. The main effects of gender ($F(1,96) = 10.075$; $p = .002$) and dyslexia ($F(1,96) = 10.002$; $p=.002$) were significant. Figure 6-1 further demonstrates the interaction of dyslexia and gender on substance use. As Figure 6-1 shows, females showed a similar substance use profile regardless of dyslexia status. By contrast, male dyslexic participants had a much lower substance use pattern than non-dyslexic ones.

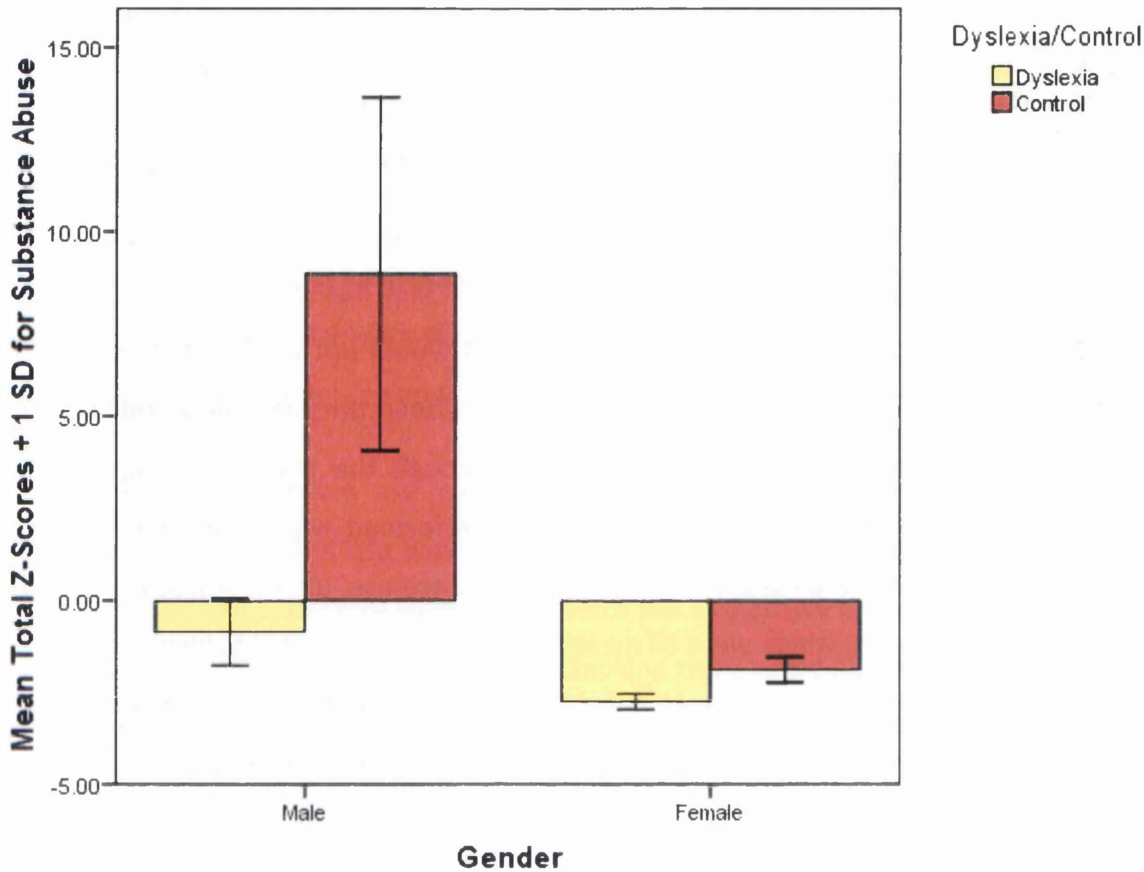


Figure 6-1. The main effects and interaction of gender and dyslexia with substance use. The bars represent the mean total z-scores of the substances for both dyslexic and control males and females. A large positive score would be indicative of higher substance use compared to the other groups. The error bars show the standard error of the mean.

A second mixed design ANOVA was performed with a new factor 'casual substance use'; with weekly alcohol use, daily cigarette use, and monthly cannabis use as the different levels. Dyslexia and gender were the between subjects factors. There was not a significant interaction between 'casual substance use', dyslexia, and gender; $F(2, 188) = 5.897$; $p=.853$. But the main effects of gender ($F(1,94) = 7.639$; $p = .007$) and dyslexia ($F(1,94) = 5.669$; $p=.019$) were significant.

Regarding CAGE, which, recall, measures an individual's potential for addiction, no significant differences were identified between dyslexics and non-dyslexics, $t(96) = .962$; $p=.338$). This may have been due to the clinical nature of the questionnaire, as this measure is usually used for chronic addiction problems, so may therefore not be sensitive enough for detecting differences in the drinking behaviour of undergraduate students.

In summary, it appears that differences in dyslexia and dyslexic traits can lead to different patterns of substance use. It would seem that those with dyslexia or with lower dyslexic-type traits have a decreased likelihood of using substances.

6.5: Discussion

Results from this questionnaire study would suggest that participants with dyslexia did demonstrate a different pattern of substance use compared to controls. This provides some support for the speculative suggestion that an impaired ability to automatise behaviour might also undermine those aspects of substance use which depend on the activation of automatic action sequences (Nicolson & Fawcett, 1990; Tiffany, 1990). Nicolson *et al.* (1990) argued that dyslexia was an impairment in fully automatising behaviour. As Tiffany's (1990) account of substance abuse encompasses a component related to automaticity, it seems in principle possible that dyslexics would show diminished substance use behaviour. This hypothesis of course does not mean that those with dyslexia will not show any substance use. It merely implies that dyslexic substance users are somewhat different to substance users who are not dyslexic. However, these results do not necessarily transfer to other dyslexic populations, such as offenders, but may merely reflect a difference in the student population. It should be acknowledged that the student population adopted in this chapter may have led to this questionnaire study being inherently biased, due to the population not being cross-sectionally representative of dyslexics who have not progressed through education due to, e.g., motivational issues. This assumption is discussed further below.

Dyslexics scored differently to non-dyslexic controls on substance use measures. If it is assumed that this result relates to whichever processes lead to a dyslexic condition as well, then an explanation for this result is possible with Fawcett and Nicolson's theory, based on the automaticity hypothesis, which suggests that dyslexia involves an impairment with automatising behaviour. By contrast, for example, the results obtained from this study could not be comprehended by the traditional lexical skills deficit hypothesis of dyslexia (e.g. Snowling, 1987).

Although the results indicate strongly that dyslexic people report less substance use than non-dyslexic people, the hypothesis that this is due to a difficulty with automatising behaviour may not be the only explanation. It is possible that dyslexic people simply report lower levels of substance use. Perhaps dyslexic people are more self-conscious and so less likely to report socially undesirable behaviours. However, this explanation is unlikely as Frederickson and Jacobs (2001) suggest that the self-perception of dyslexics is the same as their non-dyslexic peers. On a number of tests which measured core beliefs including social acceptance, behavioural conduct, and global self-worth, eight to eleven year old dyslexics were found not to be significantly lower in these self-perception domains. Only in perceived scholastic competence were dyslexics significantly lower than their peers.

It may be that this perceived scholastic competence may also have caused the results of the present study. It is possible that dyslexic people do have lower substance use behaviour. But perhaps instead of this being due to a problem with automatising behaviour, they engage in such substance use behaviour less so because they try harder than their non-dyslexic peers, due to the perceived weakness in their own academic abilities. Therefore dyslexic students may be more motivated than non-dyslexics whilst studying at university, so they would be more likely to consciously avoid substance use (note a broadly analogous conclusion was reached in Pothos & Kirk, 2004). However, Bosworth and Murray (1983) observed a relationship between internal locus of control and achievement motivation in dyslexic children. They suggest feelings of learned helplessness and depression have a negative effect upon a dyslexic's motivation. Motivation to learn foreign languages has been found to be diminished in dyslexics (Csizér and Kormos, 2010; Kormos and Kontra, 2008). Sparks *et al.* (2008), however, found no difference in motivation between dyslexics and non-dyslexics in foreign language learning. Yet children with reading impairments have been shown to have low motivation for reading (van Kraayenoord & Schneider, 1999) and usually attribute their reading failures to personal causes; this being potentially motivationally damaging (Borkowski & Muthukrishna, 1992; Chan, 1994; Palladino *et al.*, 2000). This has also been supported within the dyslexia literature (Humphrey & Mullins, 2002; Thomson & Hartley, 1980; Kavale, 1988; Lamm & Epstein, 1992). The results from the above motivation and dyslexia research would appear to suggest that those with dyslexia would not be motivated to a greater extent than their peers to perform well at university. It would therefore appear that if dyslexics do report lower levels of substance use, then this cannot be explained in terms of increased motivation for higher achievement. However it could also be argued that the population examined in the current study may be extra motivated, as not only do they have dyslexia, they also achieved university placement.

It is also necessary to consider these results with regard to the memory deficits associated with dyslexia (Berninger *et al.*, 2008). It is possible that the results of this task were the product of a maladaptive memory system within the dyslexic population. Those with dyslexia may be less able to recall past incidences of substance use than non-dyslexic controls, therefore the results of this task may be a product of memory alone. However, Maehler and Schuchardt (2009) found a significant difference between memory deficits between controls and two groups of children with reading problems (general learning disabilities and low IQ), but there was no significant difference in memory between the learning impaired and the low IQ group. This suggests that intelligence is a better predictor of working memory deficits than learning ability. Or, at least, this suggests that intelligence is a moderating variable that needs to be considered. However, in the current study university students were used, so it is likely that most of the participants were not of low intelligence, rendering a memory-deficit hypothesis for explaining these results redundant.

Depression can also be discounted as a contributing variable towards the results. Alexander-Passe (2006) did observe a gender difference concerning depression in dyslexics. Females were found to be more likely to suffer from depression than their male equivalents. If depression were to lead to higher substance use (e.g. Davis *et al.*, 2008), then, accordingly, it would be expected that female dyslexics would show more substance use behaviour than male dyslexics (cf. Alexander-Passe, 2006). As this was not found to be the case in the current study, the idea cannot be supported that dyslexia, due to increased depression, leads to more substance use.

The hypothesis that dyslexic people do use substances to a lesser degree than non-dyslexic people, because of a difficulty with automatising behaviour, would thus appear a preferred plausible explanation. The strength of these conclusions, of course, is moderated by the constraints of the pilot investigation that it was possible to carry out. It is important to note that in a limited sample of dyslexic participants it is unlikely that a range of substance use behaviour will be observed rich enough to confidently support a difference between dyslexic and non-dyslexic participants for all types of substance use. The purpose has not been to reach such a conclusion. Rather, the wish was to provide a preliminary exploration of the issue of substance use and dyslexia and a, likewise preliminary, corresponding theoretical perspective.

Further study is required in order to ascertain whether this observed pattern of substance taking behaviour associated with dyslexia is the result of an attentional bias, or due to other variables (e.g. social demographical differences). In order to explore the hypothesis further, attentional bias tasks will need to be included in an experimental protocol similar to the one employed in this study. Only using attentional bias methodologies can truly explore the hypothesis of an automaticity deficit affecting substance use. However, this should not be seen as a limitation of the current questionnaire study, as it was important to establish pilot data relating to the incidences of substance use in dyslexic participants. As substance use seems to be decreased within a dyslexic population, it has thus far been unable to refute the hypothesis of an automatisation deficit affecting substance use.

In conclusion, the results have demonstrated that dyslexia leads to different patterns of substance use in the studied population. This could be attributable to a hypothesised impairment of dyslexic participants with respect to automaticity, but further research is needed to confirm these findings.

Summary: Distinctions between dyslexics and non-dyslexic controls were observed on a substance use measure. The results are interpreted as automaticity development being responsible for the lower reporting of substance use behaviour. This idea is further explored in the next experiment by measuring attentional biases.

6.6: Experiment 2: Attentional Bias for Substance-Related Stimuli in a Population Potentially Impaired in Automaticity: Dyslexia, Automaticity, Attentional Bias, and Substance Use

As discussed above, dyslexia is suggested as being a problem associated with more than merely problems with phonology. It is also suggested as a learning deficit, a view that has been well supported within the literature (Nicolson and Fawcett, 2008). The development of knowledge and skills from the environment often occurs without awareness, and such implicit skill learning can involve the learning of complex information. Compare this to automaticity: automaticity also does not require a great deal of cognitive effort. However, automatic behaviour may occur both implicitly and/or explicitly. When a skill has become automatic, then it is possible to complete the automatised task without placing significant demand on cognitive resources. Dyslexia as a learning deficit has been suggested to be the product of discrepancies in an ability to be able to convert a task, which is highly practised (a key concept relating to the development of automaticity), into an automatic process. This would lead to the suggestion that reading problems in dyslexia are the result of not being able to fully automate the decoding aspect of reading (cf. LaBerge and Samuels, 1974). Within this example, such a skill would normally develop into an automatic process through incidental learning, as continuous practice of reading is generally thought to lead to automatisation of performance with the task (i.e. automatisation in the process of decoding words). Such learning can be incidental, and unavailable to awareness, in nature (Anderson, 1993). Eventually, when presented with a word, as decoding is automatic, the reader would be able to devote their cognitive resources to comprehending the word. According to Nicolson and Fawcett (2008) dyslexia is hypothesised to be the result of a problem in this automatisation process. Therefore dyslexics would have difficulty with being able to automatise reading, as well as any other skill which can normally be automatised. An example of processes which can be automatised relates to attentional biases, and this is the focus of this chapter.

Serial reaction time tasks are often used to measure incidental learning. A sequence is hidden within pseudo-random trials. Incidental learning is reflected by decreased reaction time for the constituent elements of the sequence. Participants have been found to show a decreased reaction time for the constituent elements of the sequence without awareness of the sequence. The SRTT is also used as a measure of implicit learning, due to implicit learning and incidental learning sharing a number of characteristics. As mentioned in Chapter 1, there is evidence to suggest that dyslexics have intact performance on such tasks (e.g. Kelly, Griffiths, and Frith, 2002). However, there is also research to suggest that SRTT performance is impaired (e.g. Vicari, Marotta, Menghini, Molinari, and Petrosini, 2003). In yet another study with the SRTT, Stoodley, Harrison and Stein (2006) reported a discrepancy in implicit learning within dyslexic students. Also, Pothos and Kirk (2004), through their research on AGL and dyslexia, suggest that dyslexics and controls may differ in terms of explicit strategy formation, a finding which may explain such performance differences with the SRTT.

The finding of Pothos and Kirk could be the result of conscious compensation strategies. Data obtained from dyslexics performing dual-task experiments indicate a deficit in automaticity, as the data would suggest that dyslexics have to allocate more cognitive resources than others to perform a primary task, therefore resulting in any secondary task becoming impaired (Nicolson and Fawcett, 1990). However, as previously mentioned, learning and automaticity are not completely analogous, as dyslexics who are impaired in automaticity may still demonstrate intact learning (albeit learning which does not involve a task becoming automatic). Nicolson and Fawcett's (1990) theory for dyslexia would suggest that people with dyslexia have deficits in automatising behaviour.

Automatic skill learning has also been suggested to be an integral feature in appetitive substance abuse (Tiffany, 1990), and may be the mechanism leading to corresponding attentional biases. Therefore an interesting hypothesis arises regarding dyslexia and substance use. Would a population impaired in automaticity, i.e. dyslexics, demonstrate corresponding deficits associated with automaticity in another domain, e.g. substance use attentional biases. Therefore, dyslexic substance users may not show an attentional bias for substance-related stimuli, compared to non-dyslexic matched controls.

Decisions about substance abuse can be highly automatic (e.g. Marlatt, 1985; Tiffany, 1990), with users being unaware of the factors that influence their decisions. Addicts will continue to engage in substance abusing behaviour despite consciously expressed intentions to abstain from, or moderate, the behaviour. This may suggest that these behaviours are partly outside volitional control (McCusker *et al.* 1997; 1999). As suggested previously, self-report of substance abuse may not necessarily be the most reliable of measures, as, due to the nature of automaticity, behaviour may occur without conscious awareness or voluntary control, so a drinker may not be fully aware of how much they are preoccupied about drinking. Sayette *et al.* (1994) interpreted their findings that smokers were distracted by task irrelevant stimuli as an automatic diversion of cognitive resources from intentional activity towards stimuli related to addictive behaviours.

Attentional biases for anxiety have been found to have inherent motivational properties. The properties which lead to attentional bias in anxiety-stimuli are not equivalent to those in addiction-stimuli. This suggests that attentional biases need to be learned. So as attentional biases need to be learned and dyslexia has been suggested to be a deficit in automatising learning (cf. Nicolson and Fawcett, 1990), it is possible substance use behaviour may be diminished.

There is not currently any research exploring the relation between substance use-related attentional bias and dyslexia. Yet if automaticity is impaired in dyslexics, then it would follow that attentional biases for substance-related stimuli would be impaired (that is, not as developed, compared to a control population). Within the previous experiment it was observed that people with dyslexia showed a somewhat reduced pattern of substance use. Perhaps this is due to corresponding attentional bias differences for substance–related stimuli. The aim of the current experiment is to test this assumption directly using an eye tracking attentional bias task with substance-related stimuli and also with an implicit learning measure.

This experiment will explore the differences between dyslexic participants and controls in terms of their substance use and corresponding attentional bias. Whether SRTT performance varies between the two groups will be examined, and if so, whether there is an associated difference with attentional biases. The rationale for this relates to the idea that attentional biases are potentially the product of automatic associations (see Tiffany, 1990). If this is the case then it would be important to measure automaticity development in a group that is potentially impaired in relation to automaticity (i.e. dyslexics). In order to measure automaticity the SRTT has been adopted, as the rate of learning in the SRTT should be a marker of a person's ability to (eventually) automatise processes.

It is predicted that there may be an association between SRTT performance and attentional biases. It is also predicted that those who state that they are heavy substance users will show an attentional bias in the non-dyslexic control group, but not the dyslexic group. The attentional bias for alcohol, cigarettes, and cannabis will be examined. Corresponding attentional biases should be found for the non-dyslexic control participants, but not the dyslexic participants.

6.7: Method

6.7.1: Design

The experiment involved a between-participants factor of group and a within-participants factor of task performance: 2(group: dyslexia vs. controls) x 2(task: SRTT, attentional bias task). A number of psychometric tests were also included (DAST, ADHD questionnaire, ADC, UEL Drug history questionnaire, and AUDIT).

6.7.2: Participants

60 participants were recruited (20 dyslexic (10 male), 40 non-dyslexic controls (8 male)). All participants were university students (mean age for dyslexics: 21.15 years; SD: 4.89, for controls 22.95 years; SD: 5.58). Dyslexic participants were recruited with the help of the Swansea University Disability Office. The dyslexic participants had all been previously diagnosed with dyslexia by an educational psychologist. Controls were obtained by offering psychology students subject pool credit. Dyslexic participants volunteered to take part in the study. Using DAST results, dyslexic participants were removed if they scored lower than 1 ARQ (at risk quotient) and control participants that score over 1 ARQ (cf. Harrison and Nichols, 2005), as higher ARQ scores on the DAST are associated with dyslexia, whilst low scores are associated with normal reading and writing skills. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

6.7.3: Materials/Procedure

UEL Drug History Questionnaire: This was a slightly modified version of the UEL (University of East London) Drug History Questionnaire (Parrott *et al.*, 2000a). The questionnaire used here adopted the same modifications that was used in Experiment 1 in this chapter (see Appendix Q).

AUDIT Questionnaire: The AUDIT has shown to be accurate in detecting alcohol dependence in university students. AUDIT scores were found to correlate well with measures of drinking consequences, attitudes toward drinking, vulnerability to alcohol dependence, negative mood states after drinking, and reasons for drinking. This therefore makes the questionnaire a useful gauge of alcohol use. The questionnaire was again administered on a computer (see Appendix I).

Attention Deficit Hyperactivity Disorder questionnaire: Jasper/Goldberg Adult ADD Screening Examination (Jasper and Goldberg, 1995) consists of 24 items, according to the DSM-IV criteria for ADHD. Items are scored on a Likert scale. This questionnaire was included due to a perceived high incidence of ADHD in dyslexics, as attentional abnormalities may affect results on an attentional bias task. This questionnaire was again administered on a computer (see Appendix S).

Adult Dyslexia Checklist: The ADC was again administered to participants. Details of which can be found in the Experiment 1 in this chapter. This questionnaire was again administered on a computer (see Appendix R).

Dyslexia Adult Screening Test: A second measure of dyslexia was used in order to produce a robust categorisation of dyslexia. The DAST was used to characterise the severity of dyslexia problems for all the participants. The DAST is used as a screening tool for people over 16.6 years old. It is composed of 11 subtests which test fluency and accuracy of reading, writing, and spelling. Five subtests from the DAST were used in this study: the rapid naming task, one minute reading task, two minute spelling task, nonsense passage reading, and the one minute writing task. The ARQ is calculated by obtaining the respective scores from each of the subtests and comparing this to a table of population means for the specific age of the participant. High ARQs are associated with dyslexia, whilst low are not. The ADC and the DAST were found to correlate significantly, $r(53) = .739$; $p < .0005$.

Attentional bias task: The attentional bias task made use of an eye tracking device and was created using EyeLink Experiment Builder. The task comprised of presenting two pictures presented simultaneously on the screen. One picture related to substance use (alcohol, tobacco, or cannabis) whilst the second picture was of a control stimulus. Pictures were obtained from the Normative Appetitive Picture System (NAPS) database (Stritzke, *et al.*, 2004) and Hogarth, Dickinson, and Duka (2009). All pictures measured 105mm x 105mm and picture pairs were separated by 105mm. There were 28 events, each consisting of two pictures. Picture presentation was randomised. Pictures were presented for four seconds and were interspersed with a fixation cross. Participants were instructed to fixate on the fixation cross between events. Participants were instructed to study the pictures for a memory test. This ensured both pictures would be attended to. However no subsequent memory test occurred. The attentional bias variables measured were initial fixations, dwell times, number of fixations, and duration of first fixation. For the eye tracking task, participants sat 550mm from the screen and were placed in a head clamp.

For the analysis the picture stimuli was divided according to whether they were pictures of alcohol (10 pictures), tobacco (10 pictures), or cannabis (8 pictures). Each analysis was then performed separately, i.e. only the attentional bias measures obtained from the alcohol-related stimuli were used for the heavy drinker/ light drinker distinction analysis.

Serial Reaction Time Task: The SRTT was produced using SuperLab and used as a measure of implicit learning. Coloured circles (red, blue, green, yellow) were presented in the centre of the screen, similarly to Vicari *et al.* (2003). Participants had to respond by pressing the correct coloured key (one of four keys) which corresponded to the colour on the screen. Reaction time and accuracy were measured. Ten circles were shown per trial. The first 20 trials were random. The next ten trials were a repetition of a sequence. An example of the sequence can be seen in Figure 6-2. The same sequence was used as the one in Stoodley *et al.* (2006) which was ten circles in length, except that, where Stoodley *et al.* (2006) used numbers, here the use of different coloured circles was adopted. The correct sequence response was yellow, blue, green, red, blue, yellow, green, blue, red, green.

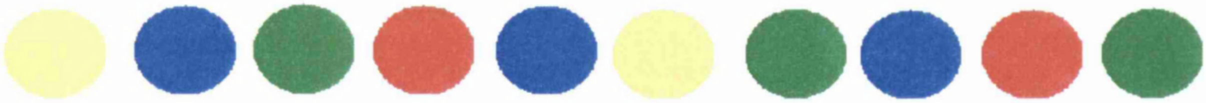


Figure 6-2. The sequence of coloured circles employed in the serial reaction time task. Note, only one colour appeared on the screen at any one time.

The sequence block was shown three times, each time interspersed with 20 random trials. The last ten trials, following the third and final presentation of the sequence, were also random (see Table 6-1 for a representation of the SRTT structure). At the end of each trial, the participant was presented with a screen instructing him/her to wait for the next trial to begin. This lasted 3000ms. Participants were only able to respond by use of the correct response key. Following each correct response there was a brief blank screen (300ms), before the next circle appeared. After the SRTT, participants were immediately asked if they were aware of the sequence; this lead to an 'explicit awareness' variable. Participants were asked if they could recite the 10 digit sequence. If they could recall the first five or more digits in the correct order, then they were deemed to have had explicit awareness of the sequence. This produced a binary variable; those with awareness and those without. This variable was subsequently used to measure any difference between those with explicit awareness and those without, in terms of their performance throughout the entire task.

Table 6-1. Representation of serial reaction time task structure.

Block Number	Number of Trials	Trial Type
1	20	Random
2	10	Sequence
3	20	Random
4	10	Sequence
5	20	Random
6	10	Sequence
7	10	Random

Note. There were a total of 100 presentations of trials. 30 of these presentations involved the same repeating sequence.

6.7.4: Procedure

The experiment components took place in the following order: DAST; attentional bias task; SRTT; ADHD questionnaire; ADC questionnaire; UEL Drug History Questionnaire; AUDIT questionnaire. The entire experiment took between 45 and 60 minutes to complete.

6.7.5: Apparatus

The EyeLink Desktop 1000 eye tracker (SR Research Ltd., Ontario, Canada) was used. The eye tracking apparatus was identical to that of Chapter 2.

6.8: Results

There was a significant difference between dyslexics (M = 1.825; .388) and controls (M= .135; SD = .353) on the DAST, $t(51) = -15.659$; $p < .0005$. This result demonstrates that the distinction between dyslexic and non-dyslexic control groups was supported by the DAST. The previous diagnosis of dyslexia also suggests a difference between dyslexics (M = 50.19; SD = 23.14) and controls (M = 32.78; SD = 17.09) for the ADHD measure, $t(51) = -3.051$; $p = .004$.

6.8.1: SRTT

First looked at were the differences between the dyslexic group and the control group in terms of their SRTT performance. Note that the difference between the number of random and sequence trials was accounted for in the analysis by dividing the random trials by two. This was performed in order to account for the difference in the number of trials between random and sequenced blocks. Figure 6-3 below, shows that for the blocks containing the sequence (S1, S2, S3) average RT decreases over the duration of the experiment, whilst for the random blocks (R1, R2, R3, R4) average RT does not appear to vary. Also the graph shows that the dyslexic group had increased reaction times for each block in relation to the controls.

A mixed ANOVA with two within-participants factors and one between-participants factor was performed. The block-type was the first within-participants factor and had two levels; random or sequence block. Each random block was followed by a sequence block. Therefore the blocks were paired; random block 1 and sequence block 1, random block 2 and sequence block 2, and random block 3 and sequence block 3. This then formed the second within-participants factor, and had three levels: block pair 1, 2, and 3. The between-participants variable was dyslexic/control group. The within-participants main effect for block-type was significant, $F(1, 51) = 2014.335$; $p < .0005$, yet the interaction effect with dyslexia/control group was marginally significant, $F(1, 51) = 3.838$; $p = .056$, suggesting that, although there was a difference between random and sequenced blocks, this difference may have been affected by the dyslexia status of participants. The within-participants main effect for the block pairings (random and sequence 1, 2, and 3) was significant, $F(2, 102) = 10.270$; $p < .0005$, whereas the interaction effect with dyslexic/control groups was again not significant, $F(2, 102) = .157$; $p = .855$. This suggests that the block pairings did differ during the study, but this difference was not specifically associated with the dyslexic/control groups. The between-subjects main effect was also not found significant, $F(1, 51) = 1.901$; $p = .174$, suggesting no difference between the two groups. The interaction effect between block-type and block pairs was significant, $F(2, 102) = 15.637$; $p < .0005$, whereas the interaction effect of block-type, block pairings, and dyslexic/control group was not found significant, $F(2, 102) = .133$; $p = .876$. The results would appear to demonstrate that learning is taking place within the task; however there is no difference between dyslexics and controls.

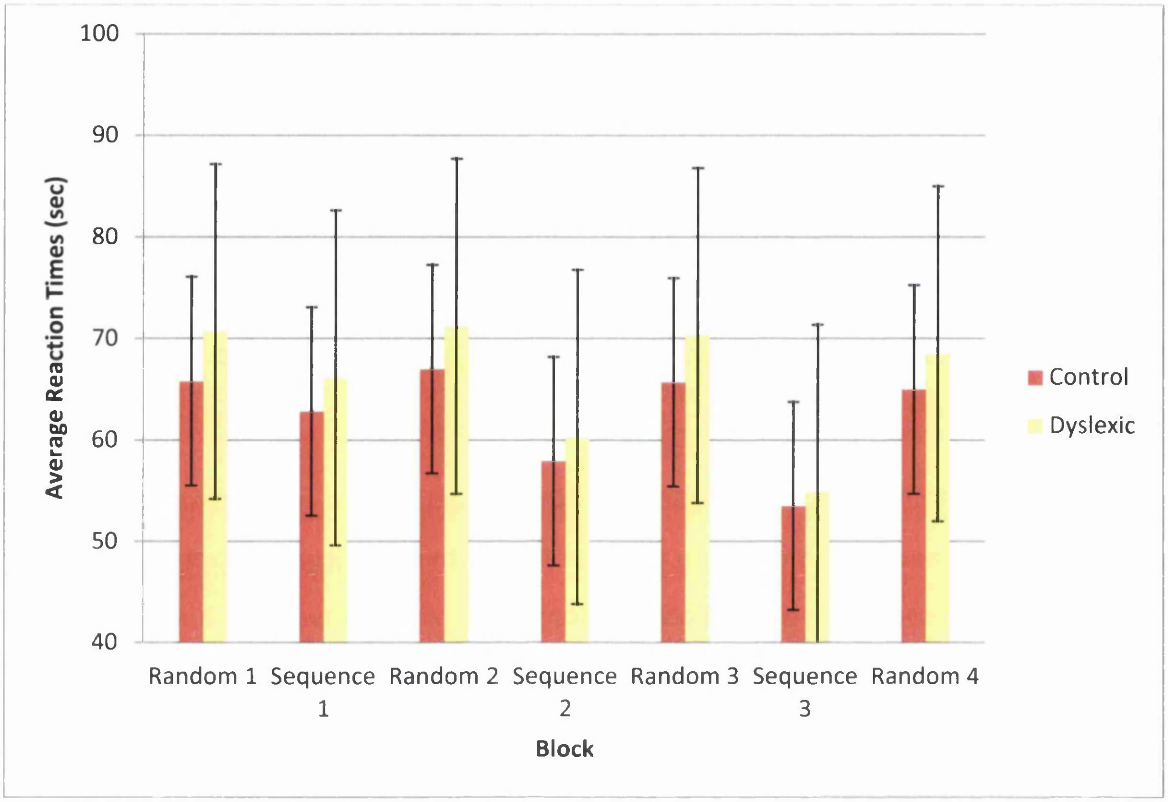


Figure 6-3. Average reaction time during random and sequence blocks for dyslexics and controls during the serial reaction time task. The error bars show the standard error of the mean.

Next considered were the difference between each random block and its corresponding sequence block, i.e. random block 1 paired with sequence block 1, etc. This resulted in the creation of three 'difference' variables (subsequently referred to as the RS difference variables). Note that random block 4 was not included in this analysis. Average reaction times were taken from the 'sequence' blocks and subtracted them from the corresponding random blocks. Thus, the higher the difference, the less the time spent on the structured sequence. Figure 6-4 demonstrates the difference between controls and dyslexics with regard to their difference scores. It appears from the graph as if the dyslexics may have a larger difference between random and sequence blocks. However, a mixed ANOVA with the three differences as a within-subjects variable and dyslexic/control as the between-subjects variable did not yield a significant result for the subjects main effect F(1,

51) = .793; p = .377, nor a significant interaction effect $F(2, 102) = .148$; p =.863. There was a significant within-subjects main effect, however, $F(1, 102) = 19.097$; p < .0005, suggesting that the difference between random and sequenced reaction times did increase for both control and dyslexic participants, across training, as one would expect if learning is taking place.

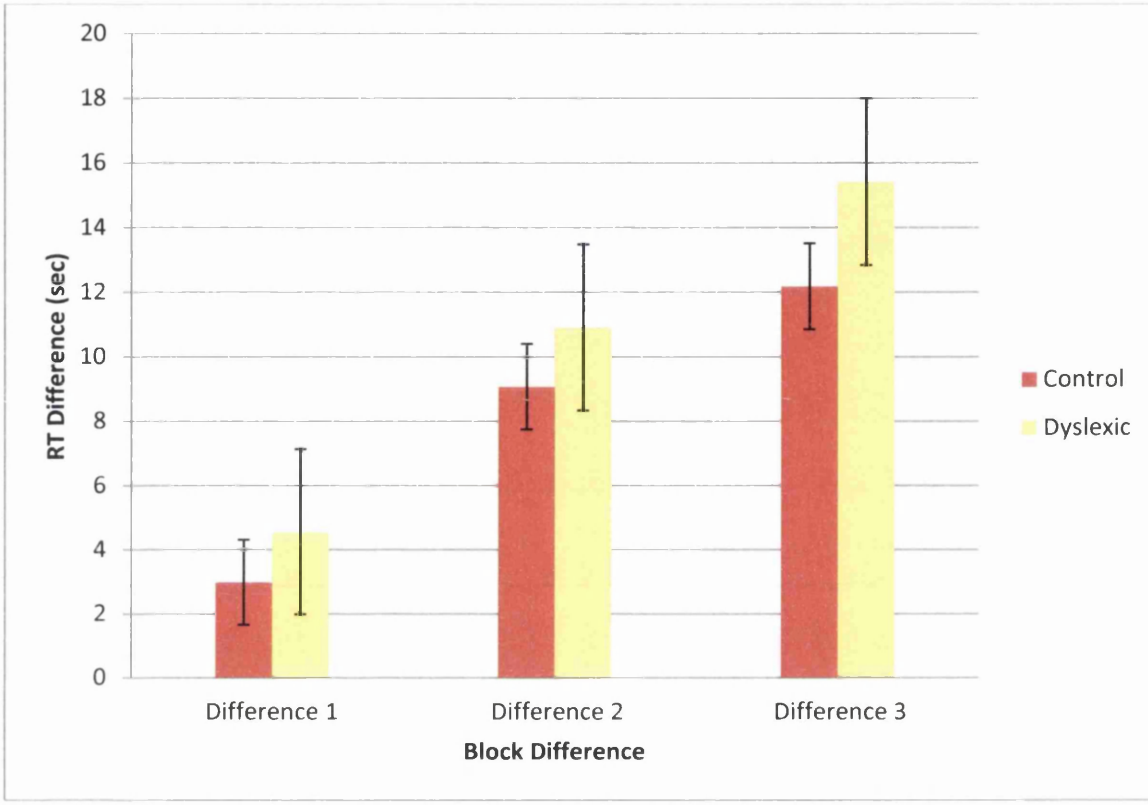


Figure 6-4. Difference between average random and average sequence blocks for both controls and dyslexics. The error bars show the standard error of the mean.

Now the performance on the structured sequence is considered in more detail by examining individual trials. Figure 6-5 demonstrates the average RT of dyslexics and controls over the first occurrences of the sequence. As one can see, there is not much variation. However, dyslexic's RTs seem to be higher. A mixed ANOVA was carried out for the average reaction times for each trial in sequence block one, with trial being the within-participants variable, and dyslexic/control the between-participants variable. The analysis yielded a significant main effect for average reaction time across trials, $F(9, 459) = 10.899$; p < .0005, such that the average time for each trial decreased. The main effect of dyslexic/control was non-significant, $F(1, 51) = .963$; p = .331, such that dyslexics and controls did not perform differently. The interaction effect was also non-significant, $F(9, 459) = .661$; $p = .744$. These results suggest that within the first occurrences of the sequence, learning did not differ between dyslexics and controls.

Figure 6-5. Average reaction times for dyslexics and controls over sequence block 1 trials

Figure 6-6 demonstrates the average RT of dyslexics and controls over the second occurrence of the sequence. A mixed ANOVA was carried out for the average reaction times for each trial in sequence block two, with trial being the within-participants variable, and dyslexic/control the between-participants variable. The analysis yielded a significant main effect for average reaction time across trials $F(9, 459) = 17.404$; $p < .0005$, such that the average time for each trial decreased. The main effect of dyslexic/control was non-significant, $F(1, 51) = .346$; $p = .559$, such that dyslexics and controls did not perform differently. The interaction effect was also non-significant, $F(9, 459) = .565$; $p = .826$. These results are obviously analogous to those above.

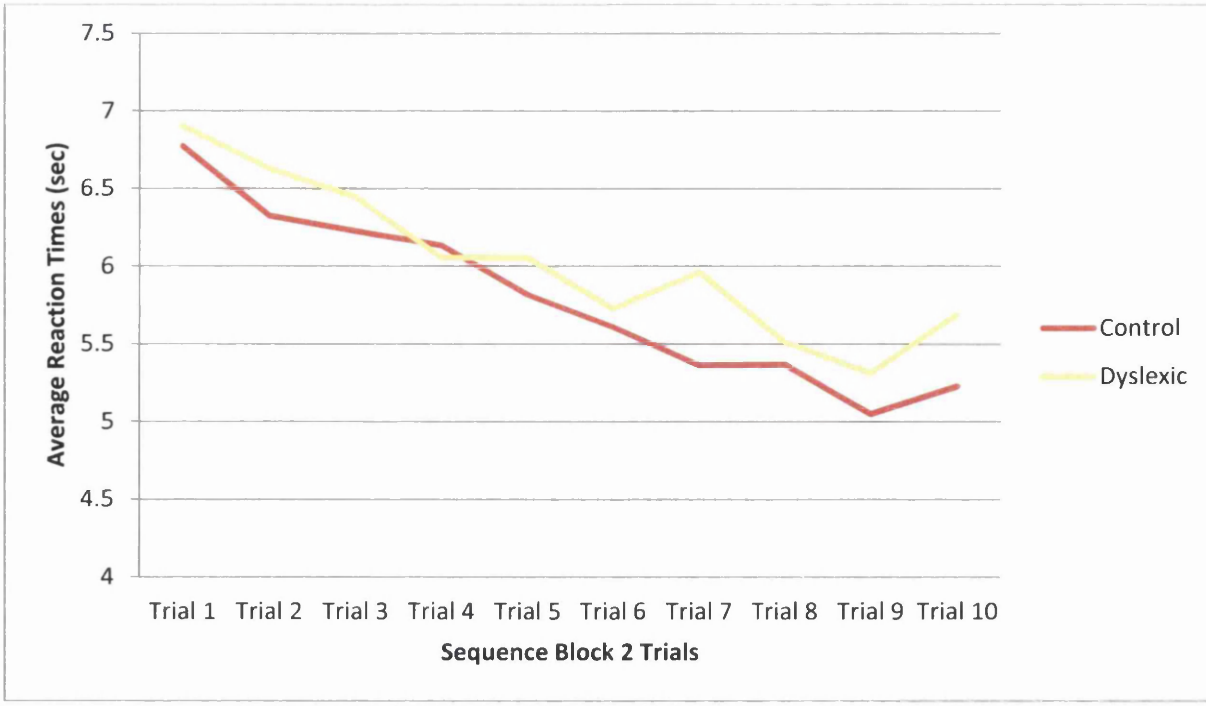


Figure 6-6. Average reaction times for dyslexics and controls over sequence block 2 trials

Figure 6-7 demonstrates the average RT of dyslexics and controls over the third occurrence of the sequence. As can be seen, there is not much difference between RTs for dyslexic and control participants. A mixed ANOVA was carried out for the average reaction times for each trial in sequence block three, with trial being the within-participants variable, and dyslexic/control the between-participants variable. The analysis yielded a significant main effect for average reaction time across trials $F(9, 459) = 17.043$; $p < .0005$, such that the average time for each trial decreased. The main effect of dyslexic/control was non-significant, $F(1, 51) = .075$; $p = .786$, such that dyslexics and controls did not perform differently. The interaction effect was also non-significant, $F(9, 459) = 1.550$; $p = .128$. Again, the results are as above, so that within the third occurrence of the sequence, learning did not differ between dyslexics and controls.

Figure 6-7. Average reaction times for dyslexics and controls over sequence block 3 trials

Now the errors that each participant made during the SRTT is considered. As can be seen from Figure 6-8, on average, dyslexics made more errors than controls for both the random trials and the trials in the structured sequence. However, independent samples *t*-tests do not show any significant differences between the random errors for sequence two ($t(51) = .447$; $p = .656$) and three ($t(51) = -1.069$; $p = .290$) errors. However there is a significant difference between dyslexics (M= 8.0; SD= 7.78) and controls (M= 4.16; SD= 3.87,) regarding errors within the first block when the sequence is encountered, $t(51) = -2.408$; $p = .020$. These results suggest that, thus far in the analyses, dyslexics and controls only differ in terms of the number of errors they produce on the first occurrence of the sequence.

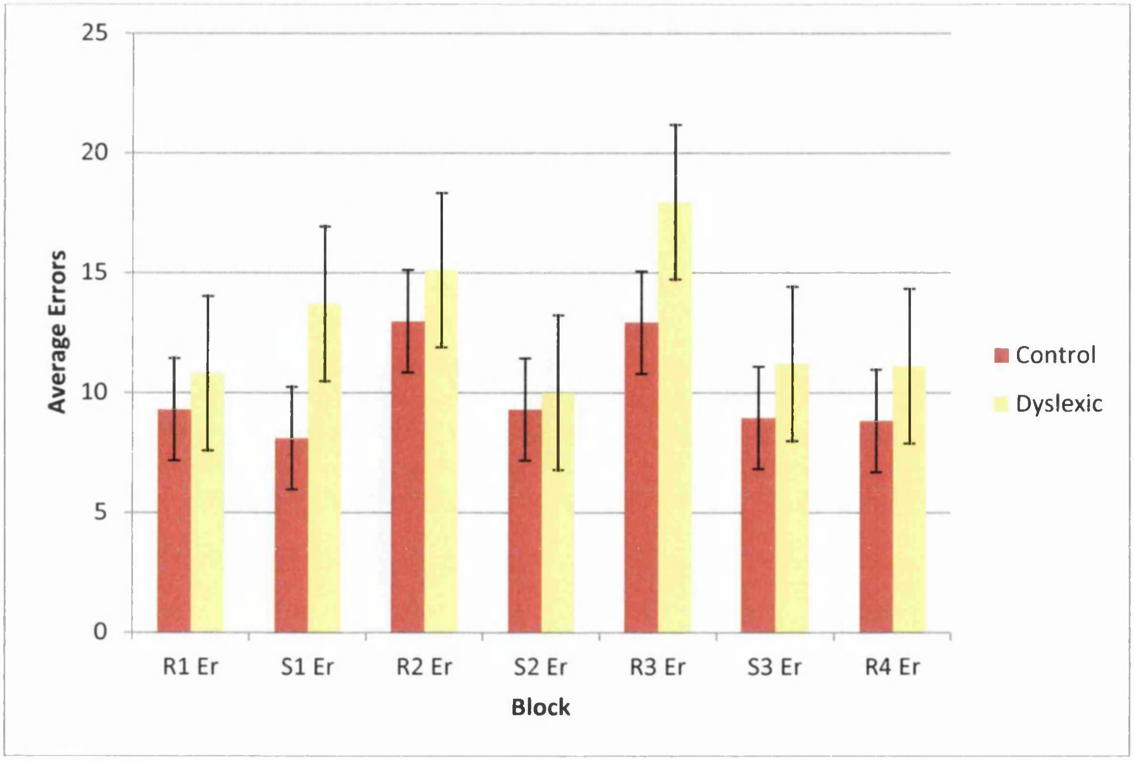


Figure 6-8. Average errors for dyslexics and controls in each block of the serial reaction time task. The error bars show the standard error of the mean.

Next taken into consideration was whether participants become explicitly aware of the sequence, and if so whether dyslexics and controls differ in this regard. Awareness of the SRTT sequence was ascertained by asking participants if they had noticed the embedded sequence. The overall explicit awareness score was found to correlate with the RS difference score for each block. A significant correlation was found between the explicit awareness score and the total RS difference score for block 2 ($r(51) = .351$; $p = .012$) but not the total RS difference score for block 1 ($r(51) = .242$; $p = .087$), and block 3 ($r(51) = .233$; $p = .099$) or the four random blocks. The results may suggest that explicit awareness emerged in the second sequence block. First, an independent samples *t*-test was used in order to see whether dyslexics and controls differed in terms of their explicit awareness of the sequence. It was observed that there was a significant difference between dyslexics (M = .467; SD = .516) and controls (M = .833; SD = .378), in terms of their reported explicit awareness of the sequence, $t(49) = 2.826$; $p = .007$. However, by excluding those explicitly aware of the sequence from the analyses on RTs, no significant differences between dyslexics and controls is observed. The same is true by excluding those who did not become explicitly aware of the sequence. This suggests that, aside from a slight difference in the reporting in explicit awareness, this distinction had no bearing on SRTT performance. A 4-way factorial ANOVA with two within-participants factors (block-number and block pairs) and two between-participants factors (dyslexic/control and explicit awareness) found a significant main effect of block pairs, $F(2, 94) = 7.246$; $p = .001$, as reported above. There was a significant main effect of block-type, $F(1, 47) = 30.101$; $p < .0005$, as reported above. The main effect of dyslexia group was not significant, $F(1, 47) = .116$; $p = .735$, nor was the main effect of explicit awareness, $F(1, 47) = .096$; $p = .758$. The interaction of block pairs and dyslexia group was not significant, $F(2, 94) = 1.120$; $p = .331$. The interaction between block pairs and explicit awareness was, however, significant, $F(2, 94) = 3.290$; $p = .042$, suggesting that performance over the trials was somewhat affected by awareness of sequence. The interaction between block pairs, dyslexia group, and explicit awareness was not significant, $F(2, 94) = .309$; $p = .735$. The interaction effect between block-type and dyslexia was marginally significant, $F(1, 47) = 3.404$; $p = .071$, suggesting a slight difference between dyslexics and controls, with regard to their scores between random and sequenced blocks. The interaction effect between block-type and explicit awareness was significant, $F(1, 47) = 7.487$; $p = .009$, indicating that explicit awareness of the sequence effect was greater for the sequenced scores.

The interaction between block-type, dyslexia group, and explicit awareness was not significant, $F(1, 47) = 1.225$; $p = .274$. The interaction effect of block pairs, block-type, dyslexia group, and explicit awareness was not found to be significant, $F(2, 94) = 2.005$; $p =.140$. The between-subjects interaction between dyslexia group and explicit awareness was found to be marginally significant, $F(1, 47) = 3.390$; $p = .072$, suggesting a trend that dyslexia may be associated with explicit awareness development.

In summary, it would appear that dyslexics and controls demonstrate very similar learning performance. Errors within the first sequence appear to result in the only significant difference between the two groups of participants, yet the lack of significant differences far outweigh the significant results, suggesting that dyslexics and controls do not differ in terms of SRTT performance and potentially learning performance in general. The results regarding explicit awareness, however, suggest that dyslexics may differ, relative to controls, in this respect. Does this perhaps indicate a difference in learning strategies between dyslexics and controls? The present results make plausible this intriguing suggestion, but additional tests would be required to explore it further.

6.8.2: Eye Tracking

The eye tracking variables which are used in these analyses are based on interest area reports from the two stimuli that were presented simultaneously. Each trial contained a substance-related stimulus and a control stimulus. Thus, the difference between fixations between the corresponding areas of interest are the variables that are adopted for these analyses. Specifically, measured here were the differences in the number of fixations for each interest area, dwell time within each interest area, first fixation made (either for a control or substance-related interest area), and first fixation duration for the substance-related interest area.

First to be performed were ANOVA analyses in order to explore the differences between the dyslexics and controls regarding their substance use attentional biases. For any significant dyslexic group main effects observed using an ANOVA the relationship between substance use and attentional bias is examined for substance-related stimuli by examining whether an attentional bias exists within the control and dyslexic population (recall that, according to the hypothesis, it would be expected to observe substance-related attentional biases more so for the control group than the dyslexic one).

6.8.2.1: Alcohol-Related Stimuli

First performed is a comparison of the two groups (control and dyslexic participants) reporting heavy use of a substance. Here a difference is expected. This sequence of analyses is performed for each of the three substance-related stimulus sets separately. Should a significant difference be found between dyslexic and non-dyslexic controls, then a sequence of t-tests is performed in order to establish whether, as predicted, the difference is due to the dyslexics lacking attentional biases whilst the non-dyslexic controls should demonstrate attentional biases.

The analyses are started by considering alcohol use. Participants were assigned to a heavy or light drinkers group based on their reported weekly alcohol use frequency (obtained from their UEL questionnaire responses), on the basis of the Department of Health guidelines (Shenker, Sorensen, and Davis, 2009). Accordingly, light drinkers (LD) were defined as males drinking on average less than 6 alcohol units/week and females less than 4 alcohol units/week (one alcohol unit = 10 ml. of pure alcohol)(N=12; Average unit count=2.241; SD=2.11). Heavy drinkers (HD) are defined as males consuming more than 21 units of alcohol/week and females more than 14 units/week (N=25; Average unit count=22.84; SD=7.61).

A 2 (dyslexic vs. control) x 2 (HD vs. LD) ANOVA was performed for the alcohol-related eye tracking variables. For first fixation duration, the participant type main effect was not significant ($F(1, 31) = .423$; $p = .521$), the drinking group main effect was also not significant ($F(1, 31) = 2.406$; $p = .132$), and there was no significant interaction ($F(1, 31) = .532$; $p = .472$). For differences in number of fixations, the participant type main effect was not found to be significant ($F(1, 31) = .010$; $p = .922$), likewise for drinking group ($F(1, 31) = .094$; $p = .762$), and there was no significant interaction ($F(1, 31) = .539$; $p = .469$). For dwell time, the participant type main effect was not significant ($F(1, 31) = .025$; $p = .874$), likewise for drinking group ($F(1, 31) = .710$; $p = .407$), and there was no significant interaction ($F(1, 31) = .038$; $p = .847$). For first fixation made, the participant type main effect was not significant ($F(1, 31) = .362$; $p = .552$), likewise for the drinking group ($F(1, 31) = .002$; $p = .968$), and there was no significant interaction ($F(1, 31) = 2.450$; $p = .129$). Therefore, it would appear that there was no significant difference between dyslexics and controls regarding this analysis.

The results indicate that dyslexics and controls do not differ in terms of their attentional biases towards alcohol related stimuli.

6.8.2.2: Smoking-Related Stimuli

Participants were asked if they had ever smoked tobacco. First a 2 (dyslexic vs. control) by 2 (current and ex-smokers vs. non-smokers) ANOVA was performed for the tobacco eye tracking variables. For first fixation duration, the participant type main effect was not significant ($F(1, 49) = .188$; $p = .666$), the smoking group main effect was also not significant ($F(1, 49) = .398$; $p = .531$), and there was no significant interaction ($F(1, 49) = .053$; $p = .819$). For differences in number of fixations, the participant type main effect was not found to be significant ($F(1, 49) = .302$; $p = .585$), smoking group was significant ($F(1, 49) = 6.830$; $p = .012$), but there was no significant interaction ($F(1, 49) = .009$; $p = .925$). Suggesting that smokers (current and ex-smokers) differed from non-smokers in terms of number of fixations. For dwell time, the participant type main effect was not significant (*F*(1, 49) = .229; *p* =.634), smoking group was significant (*F*(1, 49) = 4.933; *p* = .031), but there was no significant interaction (*F*(1, 49) = .000; *p* =.985). For first fixation made, the participant type main effect was not significant (*F*(1, 49) = .238; *p* =.628), likewise for the smoking group (*F*(1, 49) = .710; *p* =.403), and there was a no significant interaction (*F*(1, 49) = 1.041; *p* =.313). Therefore, it would appear that there was no significant difference between dyslexics and controls regarding this analysis.

The aim was to explore the differences between dyslexics and controls in terms of eye tracking. However, the previous ANOVA did not reveal any significant differences between the dyslexics and controls. Next a 2 (dyslexic vs. control) by 2 (current vs. non-smokers) ANOVA was performed for the tobacco eye tracking variables. For first fixation duration, the participant type main effect was not significant (*F*(1, 49) =.023; *p* =.881), the smoking group main effect was also not significant (*F*(1, 49) = 153; *p* = .697), and there was no significant interaction (*F*(1, 49) = .048; *p* =.828). For differences in number of fixations, the participant type main effect was not found to be significant (*F*(1, 49) = .345; *p* =.560), smoking group was significant (*F*(1, 49) = 8.675; *p* =.005), but there was no significant interaction (*F*(1, 49) = .365; *p* =.548). Suggesting that current smokers differed from non-smokers in terms of number of fixations. For dwell time, the participant type main effect was not significant (*F*(1, 49) = .053; *p* =.820), smoking group was significant (*F*(1, 49) = 6.613; *p* = .013), but there was no significant interaction (*F*(1, 49) = .025; *p* =.876). For first fixation made, the participant type main effect was not significant (*F*(1, 49) = 2.810; *p* =.100), likewise for the smoking group (*F*(1, 49) = 1.512; *p* =.225), but there was a marginally significant interaction (*F*(1, 49) = 3.518; *p* =.067). Therefore, it would appear that there was no significant difference between dyslexics and controls regarding this analysis. However, for first fixation there appears to be a trend to suggest that dyslexic and control smokers and non-smokers may differ.

The results indicate that dyslexics and controls did not differ in terms of their attentional biases toward tobacco smoking-related stimuli.

6.8.2.3: Cannabis-Related Stimuli

Participants were asked if they had ever been a cannabis user (N=18). First a 2 (dyslexic vs. control) by 2 (current cannabis and ex-cannabis smokers vs. non-smokers) ANOVA was performed for the cannabis eye tracking variables. For first fixation duration, the participant type main effect was not significant ($F(1, 49) = .030$; $p = .862$), likewise for the cannabis smoking group ($F(1, 49) = .348$; $p = .558$), and there was a no significant interaction ($F(1, 49) = .016$; $p = .900$). For differences in number of fixations, the participant type main effect was not found to be significant ($F(1, 49) = .083$; $p = .774$), cannabis smoking group was not significant ($F(1, 49) = 2.061$; $p = .157$), and there was no significant interaction ($F(1, 49) = .432$; $p = .514$). For dwell time, the participant type main effect was not significant ($F(1, 49) = .863$; $p = .358$), cannabis smoking group was marginally significant ($F(1, 49) = 3.091$; $p = .085$), but there was no significant interaction ($F(1, 49) = .405$; $p = .527$). For first fixation made, the participant type main effect was not a significant ($F(1, 49) = .408$; $p = .526$), the cannabis smoking group main effect was not significant ($F(1, 49) = .157$; $p = .694$), but there was a significant interaction ($F(1, 49) = 4.140$; $p = .047$). Suggesting an interaction between cannabis smoking group and participant-type group for first fixation made for cannabis stimuli.

Next a *t*-test was performed on the cannabis users (current and ex-users) from both the control and dyslexic groups, in order to examine the difference between the two cannabis user populations. An independent samples *t*-test showed a significant difference between control cannabis users (M= .118; SD = .364) and dyslexic cannabis users (M= -.188; SD = .313), in terms of whether their first fixation was for the cannabis stimuli or control stimuli, $t(25) = 2.069$; $p = .049$.

First a 2 (dyslexic vs. control) by 2 (current cannabis smokers vs. non-smokers) ANOVA was performed for the cannabis eye tracking variables. For first fixation duration, the participant type main effect was not significant ($F(1, 49) = .025$; $p = .874$), likewise for the cannabis smoking group ($F(1, 49) = .249$; $p = .620$), and there was a no significant interaction ($F(1, 49) = 004$; $p = .950$). For differences in number of fixations, the participant type main effect was not found to be significant ($F(1, 49) = .064$; $p = .801$), cannabis smoking group was significant ($F(1, 49) = 7.155$; $p = .010$), but there was no significant interaction ($F(1, 49) = .000$; $p = .998$). Suggesting that current cannabis smokers differed from non-smokers in terms of number of fixations. For dwell time, the participant type main effect was not significant ($F(1, 49) = .787$; $p = .379$), cannabis smoking group was significant ($F(1, 49) = 3.993$; $p = .051$), but there was no significant interaction ($F(1, 49) = .090$; $p = .766$). For first fixation made, the participant type main effect was significant ($F(1, 49) = 4.115$; $p = .048$), the cannabis smoking group main effect was not significant ($F(1, 49) = .408$; $p = .526$), and there was a significant interaction ($F(1, 49) = 4.247$; $p = .045$). Suggesting that dyslexics and controls have different first fixation durations for cannabis stimuli.

Next a *t*-test was performed on the current cannabis users from both the control and dyslexic groups, in order to examine the difference between the two cannabis user populations. An independent samples *t*-test failed to show a significant difference between control cannabis users (M= -.406; SD = .344) and dyslexic cannabis users (M= .313; SD = .619), in terms of whether their first fixation was for the cannabis stimuli or control stimuli, $t(4) = -1.932$; $p = .126$.

The results indicate that dyslexics and controls did only differ in terms of their attentional biases toward cannabis smoking-related stimuli in terms of the first fixation made.

6.8.3: SRTT and Eye Tracking

The RS difference variable was used as an index of learning in the SRTT. As noted, this measure of incidental learning may have been associated with substance use attentional biases. Correlations were sought between the RS difference variable and all the eye tracking variables, but no significant result was identified, for either dyslexic participants or control ones. Specifically, RS difference did not significantly correlate with the following variables for alcohol related stimuli: first fixation duration ($r(53) = .107$; $p = .446$), number of fixations ($r(53) = -.013$; $p = .927$), dwell time within each interest area differences ($r(53) = .056$; $p = .689$), and first fixation made ($r(53) = -.083$; $p = .553$). Also, RS difference did not significantly correlate with the following variables for nicotine related stimuli: first fixation duration ($r(53) = .048$; $p = .733$), number of fixations ($r(53) = .003$; $p = .985$), dwell time within each interest area differences ($r(53) = -.057$; $p = .683$), and first fixation made ($r(53) = .001$; $p = .996$). Finally, RS difference did not significantly correlate with cannabis related stimuli for first fixation duration ($r(53) = .052$; $p = .711$), number of fixations ($r(53) = -.008$; $p = .955$), dwell time within each interest area differences ($r(53) = 112$; $p = .426$), and first fixation made ($r(53) = -.020$; $p = .888$).

6.8.4: Summary

The results broadly suggest that dyslexics and controls do vary slightly in terms of their attentional bias toward cannabis related stimuli, but not alcohol nor nicotine. However, the results are not consistent enough to allow confidence in a conclusion that there is smaller degree of attentional biases related to substance use between dyslexic and non-dyslexic participants.

6.9: Discussion

This is the first known study that has explored substance use-related attentional bias differences between dyslexics and controls. The second experiment reported in this chapter would indicate that dyslexics are perhaps less susceptible to the substance-related attentional biases, at least under some circumstances. It is uncertain whether attentional biases are a cause or an effect of substance use, but they have been found to have a predictive value. Therefore, if dyslexics are impaired in the formation of substance use-related attentional biases, then it stands to reason that dyslexia may provide an 'advantage' in relation to the susceptibility of substance use behaviour. This suggestion could serve as an explanation of the different pattern of substance use found between dyslexics and controls in the previous experiment, where dyslexics were found to report reduced substance use behaviours, when compared to non-dyslexic controls. Though it is important to stress that any such conclusions largely reflect speculation at this point.

The results of the SRTT would suggest that dyslexics and controls have analogous incidental learning. Reaction times seem to decrease for the sequenced trials to the same degree for both dyslexics and controls. Dyslexics and controls do appear to differ in terms of the number of errors produced on the first sequence presentations. However, it could be argued that this is too early for the onset of incidental learning anyway. Overall, it would appear that incidental learning, and potentially, automaticity development as well, do not differ between dyslexics and controls. Interestingly a slight difference was found in terms of explicit awareness of the sequence between dyslexics and controls. It would appear that, although incidental learning results between dyslexics and controls did not vary, results for explicit awareness of the incidental learning did differ between groups. Dyslexics were found to report less explicit awareness than controls. This may indicate a difference in learning strategy in that dyslexics may learn in a different manner to non-dyslexics. It may be that the same performance is observed between the two groups, but a difference in awareness is apparent due to the dyslexic participants learning the sequence procedurally rather than in a manner that would result in awareness. This idea could be examined further by performing a procedural learning task on dyslexics and non-dyslexic controls. The task could be manipulated in a way that explicit strategy formation would be advantageous. Therefore, accordingly, dyslexics may be impaired on such a task when compared to controls.

The discrepancy in the results on the SRTT in terms of implicit and explicit learning would appear to support Pothos and Kirk (2004) who suggested that dyslexics may be impaired in explicit strategy formation. This idea may not necessarily be contrary to theories of automaticity in dyslexia (cf. Nicolson and Fawcett, 1990), as automatised skills can be both implicit and explicit.

However, the disadvantage that the dyslexic participants displayed concerning explicit awareness demonstrates that learning could indeed be impaired, though at a level which is too subtle for the SRTT to pick up. This, combined with the attentional bias results, would suggest that the automatisation-deficit hypothesis is slightly supported here (cf. Nicolson and Fawcett, 1990). Yet this conclusion is not very robust, as there was very little difference in the learning pattern for dyslexics vs. that for non-dyslexic controls. A deficit was observed in terms of implicit learning on the SRTT, suggesting that, although explicit awareness may be marginally impaired, implicit learning may be intact. However, it is worth noting that SRTT is only one task for examining the development of automatic performance and, moreover, the version employed here was limited in terms of the total number of trials included. Perhaps, differences between dyslexics and controls would have emerged after more trials.

It was wanted to explore the role that automaticity development plays in attentional bias. This was performed by measuring the attentional biases of a dyslexic population, as they are putatively impaired in automatic skill development (see Nicolson & Fawcett, 1990). A comparison was performed of the substance use-related attentional biases of dyslexics and controls who were both users and non-users of substances; alcohol, nicotine, and cannabis. It was found that there was no difference between dyslexics and controls in terms of their attentional biases for alcohol-related stimuli nor nicotine-related stimuli. Dyslexics and controls differed in terms of their attentional biases toward cannabis-related stimuli, but only for the first fixation made DV. This suggests that control cannabis users (current and ex-users) would be more likely to orient their attention toward cannabis-related information at the start of each trial than corresponding dyslexic participants. Overall some limited evidence was found to suggest that dyslexics do differ from controls in terms of attentional biases toward substance-related stimuli. However, the overall impression from the current results was that difference between the two groups was minimal.

Dyslexics and controls were not found to differ in terms of any of the alcohol variables nor with respect to the nicotine DVs. Alcohol attentional biases are thought to be a robust phenomenon, so the lack of a difference between dyslexics and non-dyslexic controls clearly undermines the hypothesis of this study. However, nicotine may not be the clearest measure of attentional bias. Due to the nature of smokers, they may have a varied attentional bias due to the stress-diathesis account of nicotine dependency (Parrott, 2005). Parrott suggests that nicotine can have an adverse effect upon both mood and cognition. In a number of different studies, he has suggested that smoking can cause many forms of psychological distress. Parrott (1999; 2000; 2001) suggests that a smoker's mood would deteriorate between cigarettes and they may only feel 'normal' when replete with nicotine. Therefore, nicotine dependence actually causes a range of mood and cognitive problems, rather than the subjective feeling that the smoker may have of smoking being relaxing. Smokers have been found to have more stress a year after starting to smoke (Parrott, 2004). Nicotine dependence has also been found to be associated with memory problems (Ernst, et al., 2001). Parrott has also observed that smokers have decreased arousal when depleted of nicotine (Jones & Parrott, 1997). Parrott and Garnham (1998) found cognitive skills were also affected in smokers. Whilst Parrott, Thurkle and Ward (2000) suggest that one hour without a cigarette would lead to cognitive discrepancies. Therefore, the very nature of smokers may lead to inconsistent results dependent upon when the smoker last engaged with cigarette use. It is suggested that nicotine-related stimuli may therefore not be a suitable attentional bias measure, due to a number of inconsistencies between smokers which may affect attentional bias. However, this limitation is not specific for this thesis alone, and would apply to all attentional bias tasks which adopt nicotine-related stimuli. Careful measurement and control of cigarette usage and withdrawal-effects is required in order to obtain conclusive nicotine-related attentional bias results. Such control of these extraneous variables was however not performed during this experiment, which therefore would suggest that the nicotine-related aspect of the experiment is unreliable.

For the cannabis trials, first fixation dwell time, number of fixations, and overall dwell time were not found to differ. This would suggest that the vast majority of results would indicate no difference between groups. However, it could be argued that the first fixation made DV that did lead to between group differences for cannabis stimuli is the most robust measure. This is potentially the only true automatic attentional bias DV in this study, as this is the initial orienting of attention following stimuli presentation. Subsequent attentional processes, and indeed the other attentional bias measures in this study, may be influenced by the task instructions to study the picture-stimuli for a memory test. As explicit processes could have overridden any automatic attentional processes. Therefore these results may support an automaticity deficit hypothesis (see Nicolson & Fawcett, 1990), and may also suggest that dyslexics do indeed have diminished attentional bias. This would therefore lead to the suggestion that future attentional bias investigations should screen for dyslexia. However, these results are merely speculation and further research is clearly needed as a completely conclusive result was not observed as a number of DVs, and indeed the nicotine measure, were not significant.

The first fixation made result for cannabis is consistent with the theory of an automaticity deficit hypothesis for dyslexia (see Nicolson & Fawcett, 1990). However, the goal was not to study dyslexia per se, rather it was intended to explore the role that automaticity plays in attentional bias. If it were to be assumed that the automaticity deficit hypothesis of dyslexia is correct, then the results of the current study would demonstrate the importance of automaticity in the development of attentional biases for substance-related stimuli (in this case cannabis stimuli). The results would therefore provide minimal support for Tiffany (1990) who suggests that motivation to abuse substances is maintained by automatic associations that develop between a substance-related stimulus and, e.g., positive expectancies with repeated exposure. Therefore, in a population who have a deficit in automaticity development it would be expected that there would be a decrease in automatic association development and subsequent attentional biases. If this is the case then further study of the factors that affect automaticity development in substance abuse may lead to novel approaches to substance abuse interventions which could target such automatic aspects of substance abuse behaviour.

However, it was a major challenge to recruit a sufficient number of participants who were both dyslexic and using various substances. Thus the number of substance using participants within the study could be improved. The somewhat conflicting conclusions from the various approaches to the statistical analyses simply imply that there is no strong conclusion regarding a difference in attentional bias relating to substance use between dyslexics and non-dyslexic controls. However, clearly the results indicate that further study may be warranted in this area.

The aim of the current experiment was to explore the importance of automaticity in the formation of attentional bias. In order to do this, a population putatively impaired in automatisation development was adopted, dyslexics. However, a more suitable approach to measure automaticity and its effect on attentional bias formation would not rely upon the theory of dyslexia automatisation deficit being correct (Nicolson and Fawcett, 1990). This theory has not been entirely accepted within the literature (e.g. Beaton, 2002; Bishop, 2002). Therefore, the grouping of participants as being good automatisers and bad automatisers, on this basis, might be flawed. A more suitable approach would be to measure automaticity development directly, for example, on a rule learning task, and then look at these results in relation to attentional bias. Attentional biases and automaticity development could then be more directly compared, using this alternative method to measure ability with automaticity, rather than by comparing good automatisers to bad automatisers, on the basis of dyslexia groups. This approach still has the effect of measuring automaticity development and attentional bias, but it does so without the need of involving an assumption that dyslexic participants might have a deficit in automaticity development.

Overall, it would appear that attentional biases for substance-related stimuli were in some cases identified within control participants, which were not as readily apparent within dyslexic participants. Between-groups comparisons lend some support to claims that dyslexics are impaired in attentional bias formation. The results of the SRTT would however suggest that the hypothesis that dyslexics are impaired in automaticity formation, the theory that underlies the hypothesis regarding diminished attentional biases within such a population, is not supported. The current experiment may perhaps suggest avenues for further research, such as in relation to explicit awareness discrepancies, potentially small yet meaningful differences in attentional bias for substance use and, together with the results of the previous chapter, substance use in general.

Summary: A further exploration of the affects that automaticity has on substance use was performed by measuring substance-related attentional biases in dyslexics. It was observed on an SRTT that dyslexics have analogous learning rates to controls. However, the results may suggest that dyslexics have a different learning strategy to controls. Learning ability was not found to be associated with subsequent attentional biases. However slight differences were observed between dyslexics and controls regarding substance use-related attentional biases. Yet these results were not robust enough to fully accept the hypothesis that there would be attentional bias differences between dyslexics and non-dyslexic controls. However, the results may suggest that automaticity may be playing a small role within attentional bias formation here.

6.10: Experiment 3: Dyslexia, Priming, and Craving.

As previously discussed in this chapter, dyslexia has been theorised to be a deficit in automatic skill learning (e.g. Nicolson and Fawcett, 1990). This theory may help to explain some of the broad range of problems that have been associated with dyslexia, such as balance, motor skill, phonological skill, and rapid processing. That is, a skill fluency problem is found for those skills that should become automatic through extensive practice, including reading and writing. It is however worth noting that not all the evidence supports this theory (e.g. Beaton, 2002; Bishop, 2002). Yet, if it is indeed the case that an automatisation deficit is evident then the use of dyslexic participants may be beneficial for the study of behaviours which are thought to operate automatically. In the previous experiment, this automaticity deficit was considered in terms of substance use related to attentional biases. However, substance use has also been speculated to be a 'goal' that can be automatically activated when a participant encounters relevant stimuli (e.g. Sheeran *et al.*, 2005). This research normally takes the form of priming tasks and there is a vast body of evidence to support such automatically activated behaviours (see Bargh and Chartrand, 1999, for a review). Therefore, by adopting a dyslexic population who are putatively impaired in automatisation, it is possible to explore this aspect of substance use and goal activation in a novel way.

Certain goals or desired states can be activated automatically from environmental cues; behaviours such as, turning on a light switch when one walks into a dark room or looking for one's glasses when needing to read. These are learned sequences of behaviours that have become automatic in response to certain situations. Aarts and colleagues suggest that habits are a form of goal-dependent automatic behaviour, where the mere activation of a goal in the presence of a triggering stimulus is capable of automatically eliciting an action related to the goal's attainment (e.g., Aarts & Dijksterhuis, 2000a; 2000b; Aarts, Verplanken, & van Knippenberg, 1998; see also Bargh & Gollwitzer, 1994). This chapter aims to explore the idea that such habitual goal-states can be automatically activated by comparing a control group to a group of participants that are potentially impaired in automatic skill development, i.e. dyslexics.

It has been assumed that the situation, goal, and action are mentally represented. The perception of a situation is capable of automatically activating the *representation* of a goal and action. This idea is central to Bargh's model of the perception-behaviour link. Bargh found that mere priming alone could be enough to elicit a behaviour automatically. Behaviour can be non-consciously activated by the external environment. The perception-behavioural link does not rely on a role for conscious choice in the production of behaviour. Automatic perceptual activity itself can be enough to automatically induce a behaviour. Berkowitz (1984; 1997) suggested that such a process is fundamental to the effects of media on behaviour. He observed that exposing someone to a video depicting someone acting in an aggressive manner, led to participants displaying increased likelihood of aggression themselves. This finding was supported by Carver *et al.* (1983) who found increased aggressive behaviour followed the priming of hostility-related words. This finding demonstrates how behaviour can be affected by primes within the environment.

However people are not just passively experiencing the environment. People also have their own goals and motivations. Such goals, as well as the environment, influence behaviours. In this way, environmentally driven influences may be analogous to automatic processes. Bargh (1990; 1997) suggests that the environment itself is able to activate goals, which could themselves be mentally represented. If this is the case then, like other mentally represented characteristics, goals could become capable of being triggered by the environment. Like other forms of automaticity, increased practice and consistent pairing is required for automaticity development between external events and internal responses (Shiffrin & Schneider, 1977). When a behaviour truly becomes automatic, then conscious control for the behaviour can become diminished. In this way the environment may cause a non-conscious behavioural or internal response (e.g. Chartrand & Bargh, 1996). Bargh, Gollwitzer, & Lee-Chai (1999) primed participants with either achievement synonyms or control words using an 'unrelated' initial word search task. They found subsequent performance on a secondary task for those primed with the achievement was greater than those primed with control words. Participants reported no awareness of any potential association between the prime task and the secondary task. These results further demonstrate the potential for behaviour to be automatically affected by the environment; in this case, the automatic effects are in the form of priming.

It would seem apparent from the above research that environmental cues are able to automatically activate goals, which in turn, can automatically elicit behaviour. This process has also been suggested to be extended to habits. Aarts and Dijksterhuis (2000a; 2000b) performed experiments involving priming a goal, which was travel-related. They then measured response latencies to an action word associated with travel, specifically 'cycling'. They suggested that fast response latencies would indicate a higher readiness to engage with the behaviour. Further, the participants were then divided into habitual cyclists and non-habitual cyclists by enquiring about cycle habits. Participants were not aware of the link between these manipulations. The results obtained from the study were consistent with the theory that habits are goal-dependent, as habitual cyclists showed significantly faster response latencies than the non-habitual cyclists, but this effect was only observed for those participants who had been previously been primed to travel in the initial task.

Within habit learning the general consensus is that a habit is the acquisition of actions which are instrumental in the obtaining of a rewarding event. This is a stimulus-response/reinforcement operation (e.g. Hull, 1943). However, it is worth noting that there is a distinction between habits and goal-directed behaviour. When rewarding events are consistent then habits may develop, but when reward is proportional to performance, then actions may become goal-directed (Adams & Dickinson, 1981). However Balleine (2005) would suggest that both habit and goal-directed processes run concurrently, but that any predomination would be due to discrepancies during initial learning. This would therefore suggest that substance-seeking can be accomplished either habitually which would result through a reinforced response by access to a substance (cf. Tiffany, 1990) or by goal-directed actions aimed at achieving specific rewarding events (cf. Robinson & Berridge, 1993).

The nature of alcohol abuse as a goal dependent automatic habit has been studied on numerous occasions. A number of studies have shown that previous drinking behaviour is a better predictor of future drinking behaviour than intentions to drink (e.g. Murgraff, White & Philips, 1999). Such a finding may lead to the suggestion that alcohol abuse could be controlled by habit modification (cf. Verplanken *et al.*, 1998). Within the current experiment university students' drinking habits were studied. Note that a university lifestyle has been found to be associated with excessive alcohol consumption (e.g. Norman, Bennett

& Lewis, 1998). Further evidence would suggest that amongst university students, socialising is seen as a primary goal which is heavily associated with drinking (e.g. Senchak, Leonard, & Green, 1998). Treise, Wohburg and Otnes (1999) observed that amongst university students the goal of socialising with one's friends would lead to increased alcohol consumption, regardless of previous intention to drink. Such research supports the model of habits proposed by Aarts and colleagues and suggests that, for students, socialising is a motivating goal guiding alcohol consumption. Therefore the goal of socialising may automatically prime readiness to drink.

Sheeran *et al.* (2005) investigated whether drinking habits are goal-dependent within a cognitive-motivational model of habit processes. They measured readiness to drink using a response latency paradigm after heavy and light drinkers were either primed with the goal of socialising or not. Participants indicated whether drinking (amongst other words) was an action word or not; faster responses were associated with readiness to drink (Aarts & Dijksterhuis, 2000a,b). They observed an interaction between activation of the goal to socialise and the strength of drinking habits; drinking habits were only increased when the socialising goal was activated; when the unrelated goal was activated, habit was not affected. Socialising goal activation automatically led to an increase in alcohol use behaviour (as measured within the task). This result is intriguing in light of the current chapter, as previously discussed, dyslexics may be impaired in automatic skill development (cf. Nicolson and Fawcett, 1990). Therefore this experiment aims to investigate whether the priming of socialising can automatically lead to an increase in drinking behaviour (as measured in the current study using a craving measure).

The current experiment is a modified version of Sheeran *et al.* (2005). There are two questionnaires. One contains socialising cues, the other studying cues. Sheeran found that when alcohol use was measured, those exposed to socialising cues reported higher alcohol use than the control group. This experiment aims to see if dyslexics are as susceptible to priming as controls. This is because priming is thought to be an automatic process and dyslexics are thought to be impaired in automatising skills. One would therefore expect a lower degree of priming in dyslexic participants.

6.11: Method

6.11.1: Participants and Design

One hundred undergraduates participated in this study. Of these participants 69 were control participants (13 males; mean age = 21.52 years; SD = 4.82) and 31 participants were dyslexic (14 males; mean age = 22.06 years; SD = 7.18). Participants were randomly assigned to prime-type condition and alcohol craving was subsequently measured. The experiment had a 2 (group: dyslexia vs. control) x 2 (prime: study vs. socialising) between-groups design. 15 dyslexic and 37 control participants were in the study prime group. Control participants were psychology undergraduates. Dyslexic participants were identified through the Swansea University Disability Office.

Participants were assigned to heavy or light drinkers group based on their reported weekly alcohol use. Again the Department of Health guidelines were used for the basis of the distinction (Shenker, Sorensen, & Davis, 2009). Accordingly, light drinkers (LD; N= 34; Average unit count=3.27; SD=1.79) were defined as males drinking on average less than 6 alcohol units/week and females less than 4 alcohol units/week (one alcohol unit = 10 ml. of pure alcohol) and heavy drinkers (HD; N= 20; Average unit count=20.98; SD=6.25) as males consuming more than 21 units of alcohol/week and females more than 14 units/week. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

6.11.2: Procedure and Materials

Participants were randomly given one of two envelopes which contained the Adult Dyslexia Checklist (ADC; Vinegrad, 1994), and either of the two questionnaires enquiring about either study habits or socialising behaviour (see Appendix T & U). The ADC was on one A4 page, whilst the priming questionnaire was on a separate one-sided A4 page. The pages were stapled together and participants were instructed to complete the ADC on the front before starting the second page. Participants were given as much time as they required answering the questionnaires, due to the potential problems that dyslexics may have reading the questionnaires. The priming questionnaire was based upon Sheeran *et al.* (2005). The first half of the questionnaire focused on either studying or socialising. The questions in the two questionnaires were matched e.g. 'Do you socialise as much as you would like to?' or 'Do you study as much as you would like to?'. Seven questions were balanced in this manner with the word socialising and studying used interchangeably. It was these seven questions which were based on Sheeran *et al.* (2005), the rest of the questionnaire focused on alcohol use. Alcohol use was also enquired about for each participant on the same side of the questionnaire as the socialising/study prime questions. These questions were the same on each questionnaire and there were four such questions. The questions related to: how often the participant had drank in the last two weeks, how many times they had drunk to excess in the last two weeks, when did they last drink, and how many units they consumed last time they drank. Participants were then presented with a visual analogue scale and told to place an X on the line relating to their typical urge to drink alcohol, ranging from a strong urge to a weak urge. Therefore, a lower score indicated more craving. This scale was measured in millimetres using a ruler after the participant had completed the task.

6.12: Results

Firstly, there was a significant difference between dyslexics and controls in terms of their scores on the ADC ($t(98) = -10.181$; $p < .0005$), showing that the initial dyslexia distinction was supported.

Secondly, there was no difference in drinking behaviour between dyslexics and controls, as measured by the four alcohol questions on the questionnaire: how often the participant had drank in the last two weeks ($t(98) = -.376$; $p = .708$), how many times they had been drunk in the last two weeks ($t(98) = -.445$; $p = .657$), when they last drank ($t(98) = .271$; $p = .787$), and how many units they consumed last time they drank ($t(98) = .485$; $p = .269$). These results suggest that the groups did not differ in terms of drinking behaviour, so any differences in reported urges/craving would be due to prime-type or dyslexia group.

Next the differences were compared for the urges/craving measure between the groups. A 2 (group: dyslexia vs. control) x 2 (prime: study vs. socialising) x 2 (alcohol use: HD vs. LD) between-participants ANOVA was performed with response on the craving scale as the dependent variable. The main effects of group ($F(1,53)=1.461$; $p=.233$) was not significant. The main effect of prime ($F(1,53)=8.201$;$p=.006$) and alcohol use ($F(1,53)=9.122$;$p=.004$) were significant. There was not a significant interaction between group, prime, and alcohol use, $F(1,53) = 1.628; p=.208$. This suggests that dyslexia did not affect performance on the craving scale.

6.13: Discussion

The findings of this experiment were consistent with those of Sheeran et al. (2005), as prime-type and reported alcohol use were found to affect participants' responses. However, contrary to the hypothesis, dyslexia was not found to affect participants' responses. The dyslexia finding either suggests that automaticity is not involved in priming or that dyslexics are not impaired in automaticity development.

It was found that prime-type was found to lead to different craving responses between participants. This suggests that priming a participant can affect their self-reported craving for alcohol. Participants' craving was affected by prime-type. The results suggest that the mere perception of a goal, in this case socialising, is capable of automatically eliciting a behaviour, in this case affecting craving (cf. Bargh and Chartrand, 1999). The work of Sheeran et al. (2005) has been supported by the difference between the prime-type conditions.

The dyslexia results suggest that dyslexics responded the same as non-dyslexic controls on this task. This is contrary to the hypothesis that dyslexics would not be so readily primed. There could be a number of reasons that could explain these results. This may suggest that theories that suggest that goal states can be automatically elicited in relevant situations may be flawed (e.g. Bargh and Chartrand, 1999). However, as the results of the current experiment are consistent with results from the previous experiment in this chapter, it may be that dyslexics are not impaired in automatic skill development. This would suggest that the automatisation deficit hypothesis of dyslexia (Nicolson and Fawcett, 1990) may not apply to a population of dyslexics who attend university, potentially, as they have learnt to consciously compensate to a degree that means their automaticity development skills are analogous with those of non-dyslexics (cf. Pothos and Kirk, 2004). However, the results may also indicate that dyslexics do not suffer from automaticity deficits. A third possibility is that this may not be an automatic process, as priming in this manner may lead to explicitly thinking about drinking, a criticism cited by Sheeran et al. (2005) in their own paper. They suggested that their procedure could have led participants to think explicitly about drinking, which would therefore lead to increased accessibility to the mental representation of drinking behaviour. Such an effect would not be entirely representative of the automatic nature of habits, due to the fact that there may have been an awareness of the goal driving the habitual action. Therefore, explicit awareness of the nature of the task may lead to biased responding. This may be reflected in the manner of the HDs responding, who may have indicated more craving as they knew the nature of the study (cf. Stacy, 1997). However, if the task is not a true measurement of automaticity, then conclusions regarding the automaticity deficit hypothesis of dyslexia (Nicolson and Fawcett, 1990) cannot be fully accepted.

Overall, it would appear that dyslexics are just as susceptible to priming as non-dyslexic controls. This was contrary to the hypothesis. But this result may be due to using a methodology which is potentially flawed, due to its debatable ability to 'capture' automatic processes. However, the results may indicate that dyslexics do not have a deficit in automatisation (cf. Nicolson and Fawcett, 1990).

Summary: As there is automaticity involved in the priming of a goal-state, the effects of this were investigated by measuring whether dyslexics were as readily primed as controls on an alcohol craving measure. It was observed, contrary to the hypothesis, that dyslexics were as readily primed as controls. The results may reflect a dissociation between the automatic nature of habits and an awareness of the goal driving behaviour. As the lack of difference between the groups may be explained by an awareness of the alcohol-nature of the study. However, it may be that dyslexics are not impaired in automatic skill learning.

6.14: Dyslexia Conclusions

The results with the dyslexic participants revealed that automaticity may play a role within substance use. In Experiment 1 it was observed that there are differences between dyslexics and non-dyslexic controls in terms of substance use. These results are attributed to automaticity and attentional bias deficits. This notion was continued with by further investigating automaticity and attentional bias in Experiment 2. Here SRTT and eye tracking techniques were used to expand upon the results of the first experiment. However, although the SRTT did not indicate differences in incidental learning, it did indicate that there may be differences in explicit strategy formation when learning. The eye tracking task results would indicate that there may be differences between dyslexics and non-dyslexic controls in terms of attentional biases for substance related stimuli. However the results were not consistent enough to draw any firm conclusions. It does appear that further research in terms of dyslexia and attentional bias is warranted as cannabis stimuli led to between group differences. Experiment 3 examined whether the automatic process of priming is as apparent in dyslexics as in non-dyslexic controls. It was observed that dyslexics were affected by primes the same as controls. Primes from the environment could potentially trigger automatic responses to take substances, should automatic associations be in place. Therefore, dyslexics would be affected in the same manner as controls by these triggers. These results, when taken together, broadly indicate that an automatisation deficit was not present within the dyslexic sample (cf. Nicolson and Fawcett, 1990). More research is clearly needed in the automatic components of substance abuse. However, the use of a dyslexic population to do this would seem flawed.

Chapter 7: Making Associations Automatic

7.1: Introduction

The contrast between processes which are automatic and ones that are (usually referred to as) controlled or more accurately consciously monitored (Bargh 1992; Tzelgov, 1997) is one of the most influential in psychology. Automatic processes can be carried out while a subject may be simultaneously engaged in some other task and triggering events always elicit the behaviour (Schneider & Shiffrin, 1977). Controlled processes require intentional guidance and conscious monitoring (Bargh 1992, Tzelgov 1997), they are more flexible, but also typically slower, more effortful, and more susceptible to interference. How does automaticity develop? Since the early days, cognitive scientists have emphasised the importance of practice (e.g., Sherington, 1906). Logan's (1988) model for the development of automaticity provides one formalisation for the impact of practice on automaticity. Specifically, he proposed a power law for how practice trials asymptotically reduce the reaction time for a corresponding task. The greater the number the trials, the closer the reaction to its asymptotic limit.

Practice is obviously a key aspect of automaticity. This work, sought to provide an exploratory examination of factors which might affect the development of automaticity, beyond just practice. First a motivation for doing so is provided. Then review some relevant previous research. However, this previous research is limited. Finally, the manipulations in the present work are outlined. Note that, while much of the discussion in this chapter are framed in terms of automaticity, empirically the main dependent variable rather concerns strength of association. This is because it is much easier to measure strength of association between two stimuli (e.g., in terms of reaction time or number of errors) than automatic behaviour as such. However, it is minimally assumed that stronger associations are more automatic than weaker ones – note, the exact distinction between a 'strong' association and an automatic one is not relevant to this discussion.

Theories of automaticity have (fairly) recently played a prominent role in psychopathology and especially in models of substance abuse. An influential proposal is that of Tiffany (1990), according to which habitual behaviour in the context of substance abuse eventually makes many of the corresponding action sequences automatic. Thus, for example, an alcohol abuser going into the kitchen to get some breakfast may instead find himself picking out a bottle of alcohol from a cupboard, without even realising it. Equally, the habitual consideration of positive alcohol expectancies with alcohol may lead to automatic links between the two, so that, for example, for an alcohol abuser, a 'good mood' or 'relaxation', may automatically lead to thoughts of using alcohol and vice versa (cf. Richard, 1997). Convergent results support this perspective. For example, Rather et al. (1992) showed that positive alcohol expectancies were closer to alcohol-related concepts in a psychological space, compared to negative alcohol expectancies, but only for alcohol abusers. Also, memory priming tasks typically reveal stronger associations between alcohol concepts and positive expectancies for alcohol abusers (Jones & Schulze, 2000; Stacy, 1997).

Some researchers have suggested that such development of automatic associations relating to substance abuse is partly what makes such behaviour so resistant to change. Moreover, it has been suggested that automatic associations between, for example, alcohol and positive alcohol expectancies or actions relating to alcohol abuse are partly responsible for alcohol-related attentional biases (Cox et al., 2006; Tiffany, 1990). Attentional biases, in turn, have strongly been implicated in the maintenance and further development of substance abuse behaviour. For example, Cox et al. (2002) showed that alcoholics in a treatment centre who showed an increased alcohol Stroop bias during their treatment were more likely to relapse three months later. Cox, Pothos, and Hosier (2007) found that alcohol-Stroop bias prospectively predicted a reduction in the number of drinking days in a group of excessive drinkers. Similar findings have been reported for corresponding attentional biases for other kinds of psychopathology (e.g., Calitri et al., 2010; Mogg et al., 1995).

Employing the concept of automaticity in substance abuse has, without doubt, led to some very powerful intuitions (Tiffany, 1990). However, a key question concerns the precise mechanism which translates a commonly occurring sequence of actions into an automatically activated and executed schema, as would be the case, for example, for an alcohol abuser obtaining and drinking alcohol. Likewise, questions remain regarding the way associations between, for example, alcohol-related concepts and corresponding positive expectancies or outcomes develop to be automatic. Frequency and practice are unlikely to be the whole story. For example, when we are thirsty, we go through a sequence of actions which would often be very similar (e.g., when we are at home) and there is a particular association between particular cues (being thirsty in general, obviously, but also, for example, having a large bag of crisps or other savoury foods) and a response (e.g., drinking water). Clearly, people, in general, do not have an attentional bias for drinking water. By contrast, seemingly similar circumstances (repeating sequence of actions, consistent associations between cues and responses) in the case of, for example, drinking alcohol can lead to persistent and substantial related attentional biases. Thus, for example, the frequency of going to the kitchen to obtain alcohol (for an alcohol abuser) vs. the frequency of going to the kitchen to obtain water are unlikely to be all that different. Likewise, for the frequency of an association between drinking alcohol and a positive emotional outcome (e.g., relaxation) and the corresponding frequency involving drinking water.

There is however evidence to suggest that attentional biases may fluctuate dependent on a current need-state suggesting that more attention may be paid to goal-congruent cues when deprived/satiated (e.g. Field et al., 2004). However, for an alcohol abuser, once an attentional bias has been established, it is very hard to modify, and may not readily fluctuate to the same degree as an attentional bias borne of a deprived need-state. This chapter therefore explores potential reasons why some attentional biases can become persistent and substantial due to the formation of automatic associations whilst other putative attentional biases may fluctuate dependent upon current consciously monitored need-states.

Overall, let it be accepted that, for example, for an alcohol abuser there are automatic associations between drinking alcohol and positive alcohol expectancies (and correspondingly for the sequence of actions relating to drinking alcohol; Cox et al., 2006; Tiffany, 1990). Then, there is a question as to why it is such associations which become more readily automatised, as opposed to fairly equivalent ones in a person's everyday life, which do not involve, for example, alcohol-related behaviour. Of course, if there is a behavioural difference, then any perception of equivalence may be only superficial.

There is some potentially related work from the extensive research tradition on associative learning. For example, associative learning theory would suggest that a cue more strongly associated with a target will attract more attention (Mackintosh, 1975; Kruschke et al., 2005). Likewise, Tzelgov et al.'s (1997) research suggests that when an association between words and meaning is stronger, then a corresponding Stroop effect would also be stronger. Pothos and Tapper (2010) attempted to systematically examine strength of association in terms of teaching an association between a meaningless label and either a single concept or several related concepts. They observed a stronger attentional bias (as assessed with a Stroop task) in the former case, than in the latter. This finding corroborates the conclusion that a stronger association can lead to a stronger attentional bias (see also Orbell & Verplanken, 2010). It still does not help explain how an association becomes strong in the first place, other than through extensive practice. However, as previously argued, while practice is clearly a key factor, there are reasons to suspect there may be other factors which are relevant as well.

According to Logan's (1988) theory, the transition from controlled to automatic behaviour is a transition from algorithmic-based cognitive processing to processing which depends on the retrieval of previous instances. Thus, for a process which has been automatised, a cognitive agent no longer needs to work through a relevant algorithm, rather it can employ existing memory to retrieve a ready solution. An implication of this account is when a process involves that stimuli which are more memorable, such a process may be easier to automatise (Logan, 1988). In cognitive paradigms, memorability is often manipulated in terms of confusability or perceptual salience of stimuli. In the situations of present interest, stimulus variations which are more pertinent would include emotional salience.

To sum up, the present experiment is concerned with what causes or contributes to the emergence of (apparently) automatic associations for some stimuli (e.g. alcohol) and not others (e.g. water). Why do we not develop an attentional bias for drinking water? No one seems to have automatic links between 'water' and, e.g., pleasurable emotions. It would appear that for some associations, but not others, an increased frequency would lead to automaticity, and a corresponding attentional bias (e.g., Logan, 1988). What are factors that might affect whether links become automatic or not? Three kinds of characteristics of stimuli are explored, which may impact on the degree to which associations between them are learned, all motivated from exploratory intuitions on how excessive drinkers potentially perceive alcohol-related stimuli.

First, perhaps associations are learned more quickly if they involve stimuli which are emotionally more salient (Experiment 1 in this chapter). Perhaps, alcohol-related stimuli are more emotionally salient for an excessive drinker and it is this which enables the putative faster development of automatic associations between such stimuli and positive emotions, everyday concepts etc. For example, MacKay et al.'s (2004) theory assumes that emotional information activates prioritised learning mechanisms. Conversely, Easterbrook's (1959) theory would lead to the expectation that associations involving more emotional stimuli would be learned more poorly, as participants disproportionately focus on the emotional content of the stimuli, at the expense of learning the associations (cf. Murray & Kensinger, 2012). Second, rather than emotional salience, perhaps it is the perceptual richness or complexity of the presented stimuli, which is the critical factor (Experiment 2 in this chapter). Perhaps, an excessive drinker processes alcohol-related stimuli in a more elaborate way, revealing a perceptual richness which is not (or less) obvious to non-drinkers. A third possibility that was examined concerns whether thinking about the associations may speed up the learning of the associations (Experiment 3). Such a possibility can be motivated from the theory of current concerns (Klinger and Cox, 2004), according to which having a goal implies that attentional resources are focused on this goal. While this assumption in the theory of current concerns can be considered in itself sufficient for explaining an attentional bias, there is still a missing link in relation to the Tiffany's (1990) explanation for how attentional biases arise. This third experiment could potentially explain the relation between having a current concern and the development of automatic associations involving an abused substance and related aspects of everyday life.

7.2: Experiment 1: Emotional salience of stimuli

7.2.1: Participants

20 participants were recruited (8 male), aged 18 – 34 years (mean=21.90; SD=4.27), from the undergraduate population within the psychology department at Swansea University. Course credit was offered in return for participation. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

7.2.2: Stimuli and Apparatus

There are several ways in which to potentially manipulate the emotional salience of stimuli. However, a challenge is to identify one which is expected to be as much relevant to the participants as possible. Given that recruitment took place within a university undergraduate population, manipulating emotional salience was opted for in terms of the attractiveness of faces. 84 faces were selected from www.hotornot.com, subject to the criteria that the faces shown would not have any headwear or glasses. The same number of male and female faces were selected. Additionally, to simplify stimulus control, only faces of white persons were selected in order to avoid race effects. Then, a brief pilot study with a sample from the same population as the main study, was carried out to separate out the most and least attractive faces in this selection. Specifically, 19 (8 male) participants, aged between 19-40 (mean=25.58; SD=5.59), rated the attractiveness on a 5-point Likert scale. The 10 most attractive male and female (5 male; 5 female) faces were selected for the main experiment as well as the 10 least attractive male and female (5 male; 5 female) faces. Male and female participants in the pilot were not found to significantly differ in their attractiveness ratings for the faces. For female faces, an independent samples t-test comparing male and female participants in the pilot was not significant ($t(17)=1.075$; $p=.297$) and, likewise, for male faces ($t(17)= -.136$; $p=.893$). Henceforth, the judged attractive and judged unattractive faces are referred to as just attractive and unattractive faces.

The attractive and unattractive faces were arranged into 30 pairs, such that for 15 of which the faces could be considered more attractive (these pairs are labelled as More Attractive, or MA) and for the other 15 pairs the faces could be considered less attractive (these pairs are labelled as Less Attractive, or LA; Figure 6-1 and 6-2). The two faces in each pair would be of equivalent attractiveness (based on the pilot study results) and all pairs involved a male and female face. There were 10 face pairs that formed the basis of the experiment, five LA and five MA. These are the pairs that the participants would see during the training phase. For the test phase, 10 MA and 10 LA distracter face pairs were also created by splitting the original face pairs apart and randomly pairing them with another image from their respective attractiveness group. Therefore, each face was presented in three different pairs: one pair was the correct trained pair and two pairs of distracter faces.

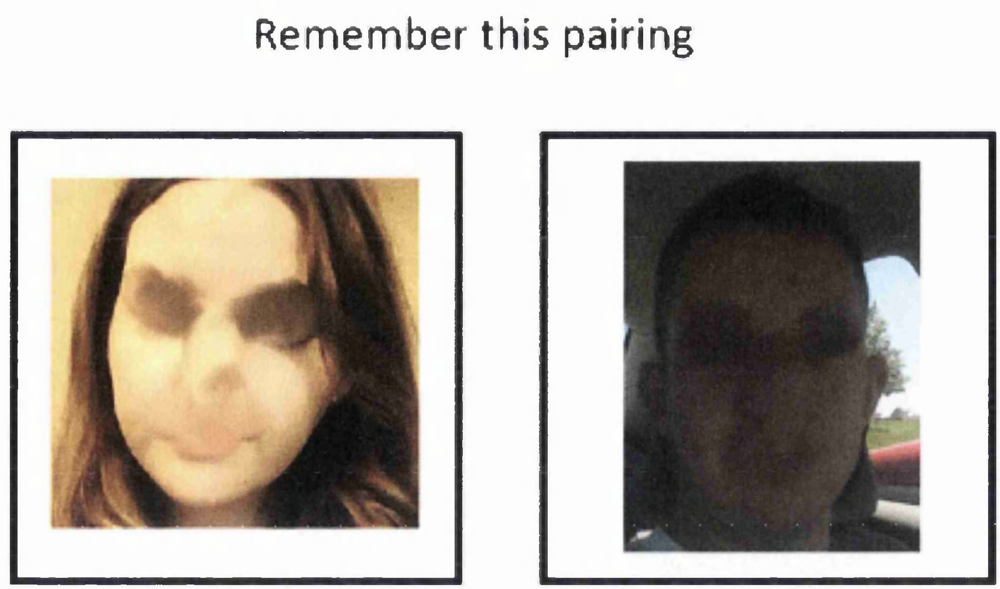


Figure 7-1. An example of and LA face pair in the training phase. The faces are smudged to protect the identity of the individuals, but participants to the experiments saw the pictures intact.

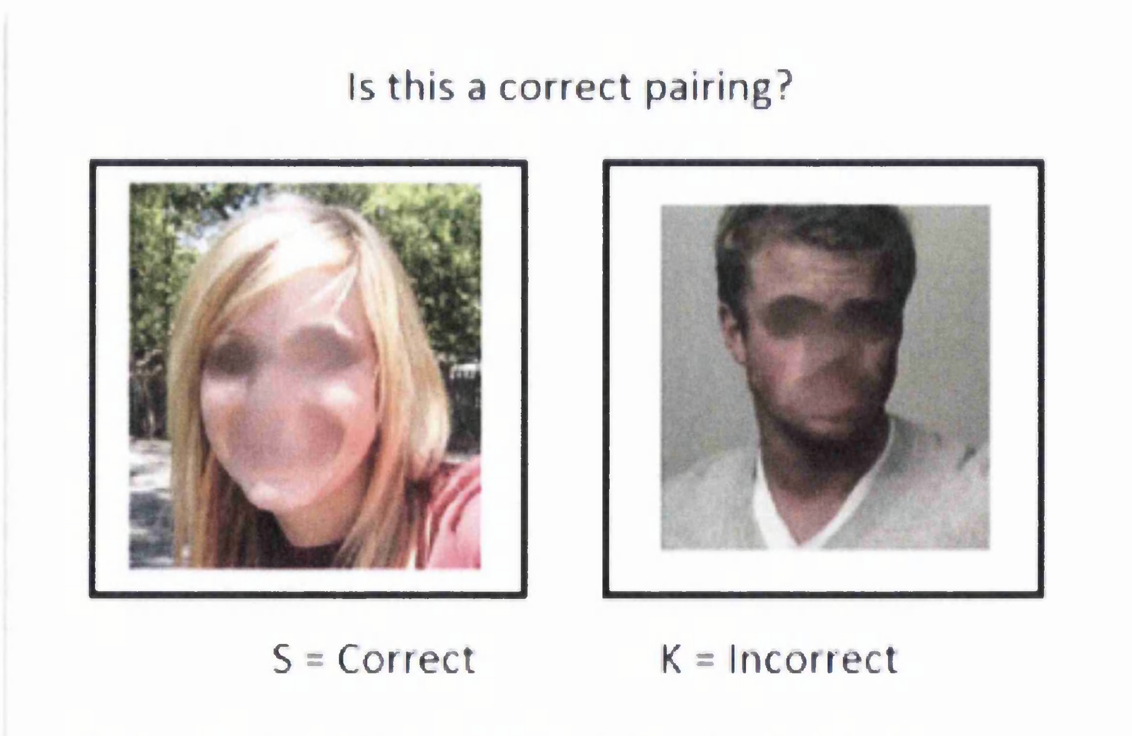


Figure 7-2. An example of an MA pair during the test phase.

7.2.3: Procedure

In the first phase of the experiment, the training phase, the MA pairs were presented in an alternate way with LA pairs. That is, an LA pair would always follow an MA one and vice versa. Participants were instructed that they were about to see several pairs of faces and that they would have to study these pairs. Participants were also informed that there would be a subsequent test phase, in which they would be tested on their knowledge of face pairs. Each trial involved presenting a pair of faces on a computer screen and participants were allowed as much time as they desired to view it. They were instructed to press the spacebar when they were ready to proceed to the next trial. There were 10 trials in the training phase, so that each of the correct MA and LA pairs (five in each category) were presented once.

After the training phase, participants received new instructions (on the computer screen), such that they were told that in the next phase of the experiment they would, again, see pairs of faces. Their task would be to decide whether each presented pair had been studied before or not. Participants were also told to respond as quickly and as accurately as possible. The response keys for correct, incorrect answers were shown on the screen for the duration of the test phase.

The test phase consisted of 30 trials. Each trial involved presenting a pair of faces, which would either be one of the MA, LA pairs in the training phase or a new pair. The pair presentation included the prompt 'Is this a correct pairing?' and participants had to indicate their response by pressing the appropriate key (see Figure 6-2). During test, corrective feedback was provided for participants' responses. Of the 30 trials in the test phase, 10 (5 MA and 5 LA) involved pairings from the training phase and 20 involved new pairings (10 MA and 10 LA). The 20 new pairs were constructed by randomly re-allocating the faces employed in training to each other, so that, as in the training phase, faces of equal attractiveness would be paired together. Therefore the probability of choosing a false face pairing was 2/3. The probability of 2/3 for selecting the wrong face pair by chance, applied to all the experiments reported in this paper

The training and test phase as described were repeated three times. That is, after the first test phase, participants saw instructions on the screen, informing them that the experiment would continue with the training phase they had already seen. They were also instructed that this second training phase would be the same as the original. The training phase was repeated, and then the test phase was repeated etc. In this way, the experiment was composed of three identical training and test phases. Each set of training – test phases are referred to as one session. Note that the structure of Experiment 1 is identical to the structure of the other two experiments in this chapter.

7.3: Results

In all experiments in this work, participant performance can be explored in terms of three dependent variables: reaction times in training; reaction times in test; and correct responses (hits and correct rejections). This variable is equivalent to false responses (false positives and misses), as correct responses (hits and correct rejections) + false responses (false positives and misses) = 15 for LA pairs and 15 for MA pairs. Since the training phase was self-paced, reaction times in training are perhaps indicative of study times. However, some caution is needed in this assumption, since high reaction times may indicate processing of the individual stimuli, rather than the association. An analysis of reaction times was carried out to explore any possible effects of disproportionate processing of the actual stimuli, perhaps at the expense of learning the associations as such (Easterbrook, 1959). All dependent variables are meant to measure the strength of the learned associations. Moreover, by comparing these variables between sessions, it will be possible to consider how the knowledge of associations develops. The main independent variables concerns the stimulus type, in Experiment 1, this would be the MA vs. LA variable. Of course, the frequency of MA and LA pairs is identical. Therefore, it is the differences in how well MA vs. LA pairs are learned which is of interest, which might arise from the (assumed) difference in emotional salience of the stimuli.

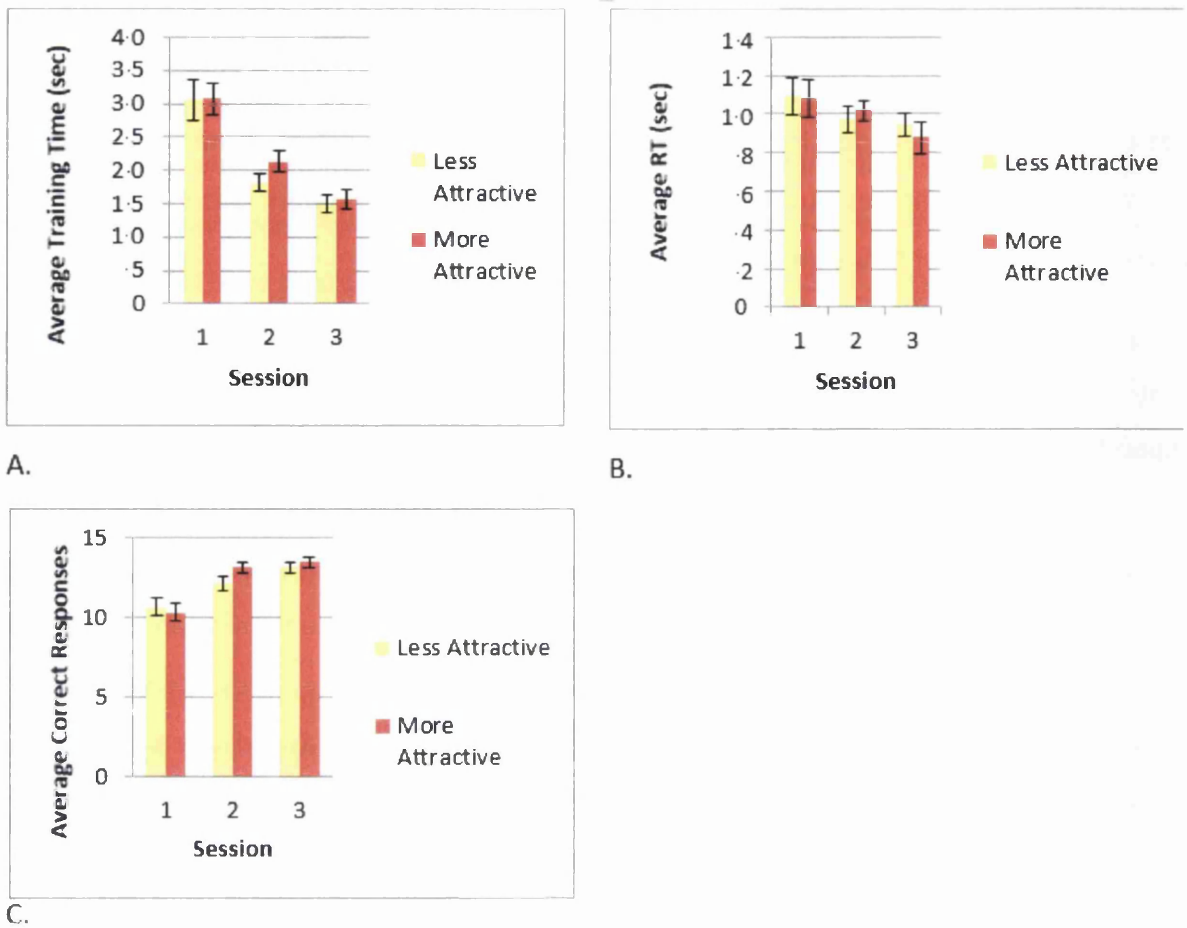


Figure 7-3. Graphs that illustrate the data from Experiment 1. The sessions axis denotes which session the data is obtained from. The vertical axes are indicative of the dependent variable that is currently being considered. A: The average training reaction time for LA and MA face pairs over the three training sessions. B: The average test reaction time for LA and MA face pairs over the three test sessions. C: The average of correct responses during the test for LA and MA face pairs over the three test sessions. The maximum number of possible correct responses for LA and MA pairs was 15 (for a total of 30). The error bars show the standard error of the mean.

7.3.1: Reaction time in training

Figure 7-3A shows that participants tended to spend more time studying the MA pairs, than the LA ones, especially in later sessions. A repeated measures ANOVA was carried out for the average reaction times in training, with session one within participants variable, and stimulus condition another. The analysis yielded a significant main effect for session,

$F(2,38)=23.546$; $p<.0005$, such that the average time spent on each session decreased. The main effect of attractiveness was also significant, $F(1,19)=5.130$; $p=.035$, showing that participants spent more time studying the MA pairs than the LA ones. Finally, the interaction effect was only marginally significant, $F(2,38)=2.986$; $p=.062$.

Paired samples t-tests were performed in order to localise the significant differences. Despite the lack of an interaction effect, these comparisons are carried out for each session separately, as this is an intuitive way to understand the pattern of results. When comparing study times between MA and LA pairs in each session, a significant difference was identified only in the case of the second session, $t(19)=-4.108$; $p=.001$, and not on the first ($t(19)=-.124$; $p=.902$) or third ($t(19)=-.621$; $p=.542$).

7.3.2: Reaction times in test

Here and elsewhere the analyses were carried out only for the correct responses. Response time for each trial in test may well be indicative of the ease or fluency with which participants were able to determine whether a pair was one of the studied one or not. Figure 7-3B reveals a weak trend for LA pairs to be associated with a lower reaction time. A repeated measures ANOVA for reaction times in test, with session being a within participants variable, and stimulus type another within participants variable, showed a significant main effect of session ($F(2,38)=10.539$; $p<.0005$) but not stimulus type ($F(1,19)=.239$; $p=.631$) or an interaction ($F(2,38)=.533$; $p=.591$).

7.3.3: Correct Responses

The number of correct responses during the three different test sessions is a variable highly relevant to assessing the extent to which the MA or LA pairs results in stronger and better learned associations. Figure 7-3C indicates lower error rates for the LA pairs compared to the MA ones. However, a repeated measures ANOVA, with session and stimulus type as the within participants variables, did not confirm this impression. Note first that there was a significant main effect of session, as expected ($F(2,38)=30.565$; $p<.0005$). Importantly, the main effect of stimulus type failed to reach significance ($F(1,19)=2.11$; $p=.163$) and likewise for the interaction effect ($F(2,38)=2.958$; $p=.064$). However, the interaction indicates a trend in the expected direction. These results indicate that any differences in the correct responses between MA and LA pairs were not consistent enough across participants to enable a corresponding significant main effect.

7.4: Discussion

This experiment was motivated from the assumption that pictures of more attractive faces would be more emotionally salient for the population (undergraduate university students). It was believed that this would be appropriate stimuli as evidence suggests that attractive faces activate areas within the orbito-frontal cortex, the nucleus accumbens, or the ventral striatum (Aharon et al., 2001; Ishai, 2007; Kampe, Frith, Dolan, & Frith, 2001; Kranz & Ishai, 2006; O'Doherty et al., 2003). These neural activations are associated with reward systems and can be interpreted as reflecting the emotional valence attached to attractive faces (Senior, 2003). The MA pairs were consistently studied for longer than the LA pairs, which is in line with Easterbrook's (1959) suggestion regarding the attentional impact of emotional stimuli. Also consistently with Easterbrook's (1959) hypothesis, the results indicate that this additional study time did not reinforce knowledge of the presented associations (though note that, strictly speaking, Easterbrook's hypothesis would predict a lower performance for MA pairs, compared to LA ones, which were not observed). There were no main effects of stimulus type (MA vs. LA) for two of the key dependent variables, reaction times in the test trials and the rate of correct responses. Overall, this result in itself does not provide enough confidence to conclude that MA associations were learned more quickly or ended up stronger than LA ones. Murray and Kensinger (2012) also identified no difference in association learning between neutral and emotional stimuli. Note, however, that in one of their conditions (where participants had to imagine the associates in a pair as somehow integrated), under time pressure, a facilitative effect of emotional content was revealed.

7.5: Experiment 2: Richness of representation

7.5.1: Participants

22 (11 male) participants were recruited, aged 18 – 42 (mean= 24.00; SD=6.27), from the undergraduate population within the psychology department at Swansea University. Course credit was offered in return for participation. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

7.5.2: Stimuli and Procedure

It was important to identify stimuli which could be intuitively considered as more perceptually rich, in terms, for example, of the complexity of colour patterns and shapes. A random selection of pictures were obtained from Microsoft Clip Art. Image complexity was then analysed using a program which measured the number of unique colours within each image. The program was created using MatLab. It examined red, green, and blue intensity for each pixel of the image. Each pixel of the image consisted of three numbers between 0 to 255, measuring how red, green, and blue each pixel was. The various RGB pixel numbers were then put in a list and duplicates were removed. The number of unique colours was then counted and a value for each image was produced. Complexity was therefore considered to be based on the number of unique colours in each image. The logarithm of the complexity data was used as the measure of image complexity (see Figure 7-4). From the image it can be seen that there is a distinction between rich and basic pictures in terms of unique colours, and intuitively, complexity.

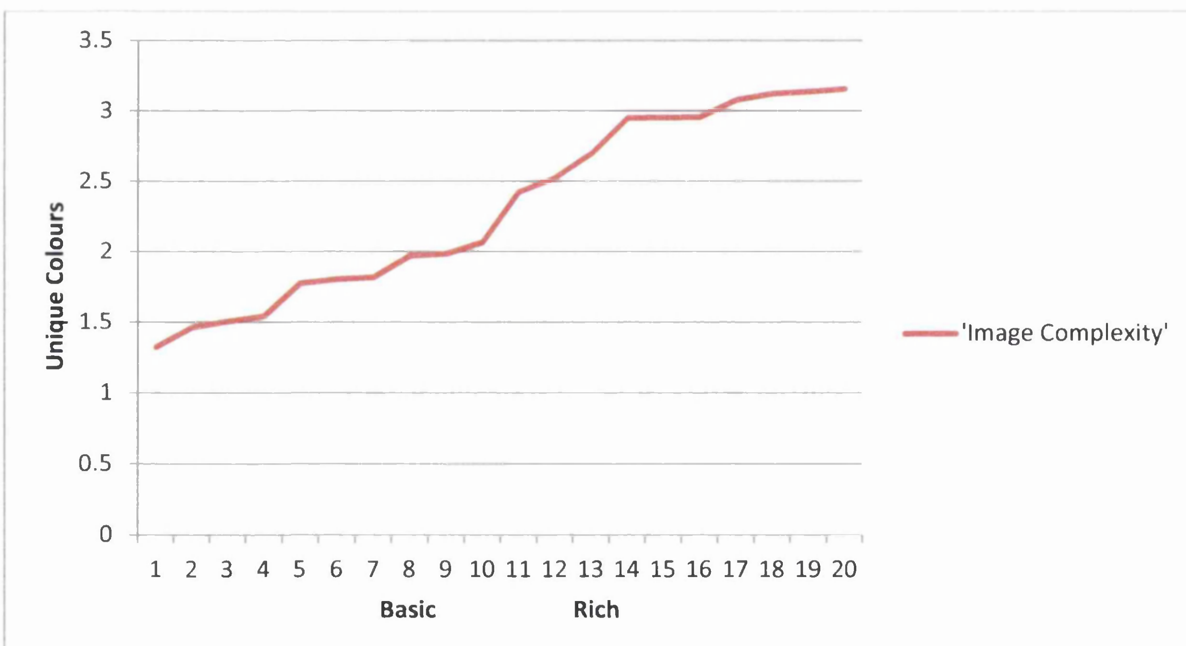


Figure 7-4. Demonstration of the differences between rich and basic stimuli in terms of image complexity. Note, pictures 1 – 10 were considered basic; and 11-20 were considered rich.

In this way, 10 pictures were identified which could be considered perceptually rich (subsequently referred to as 'rich') and 10 pictures which, in comparison, could be said to be perceptually impoverished (subsequently referred to as 'basic'). Rich and basic pairs were formed by randomly assigning two randomly selected rich pictures together or randomly selected two basic pictures together (Figure 7-5 and 7-6). All other aspects of Experiment 2 were as in Experiment 1.

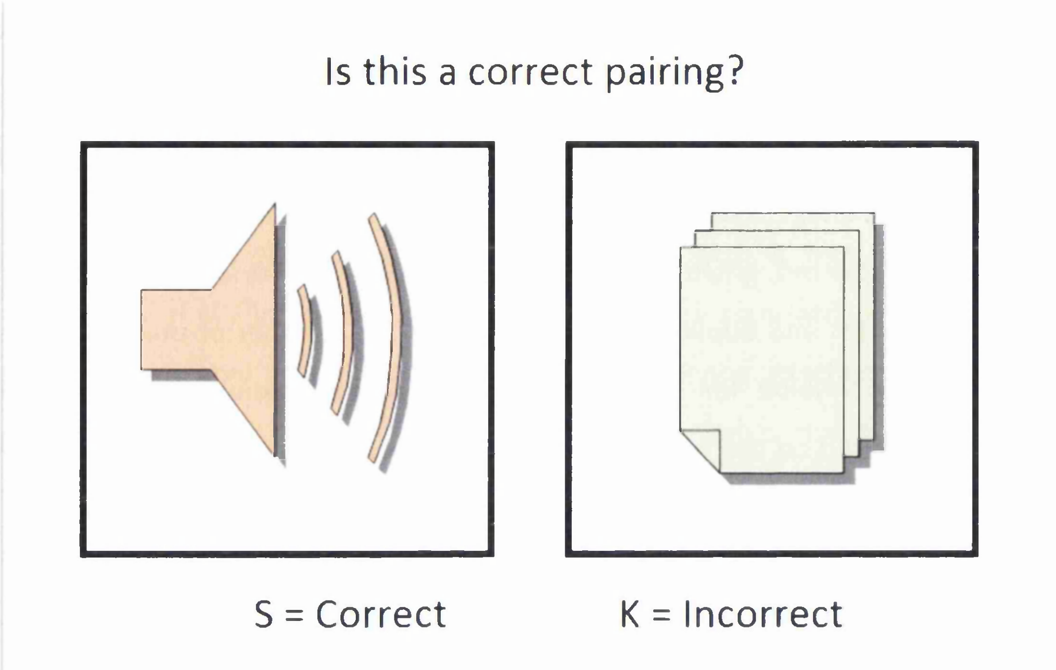


Figure 7-5. Example of basic (least unique colours) picture stimuli.

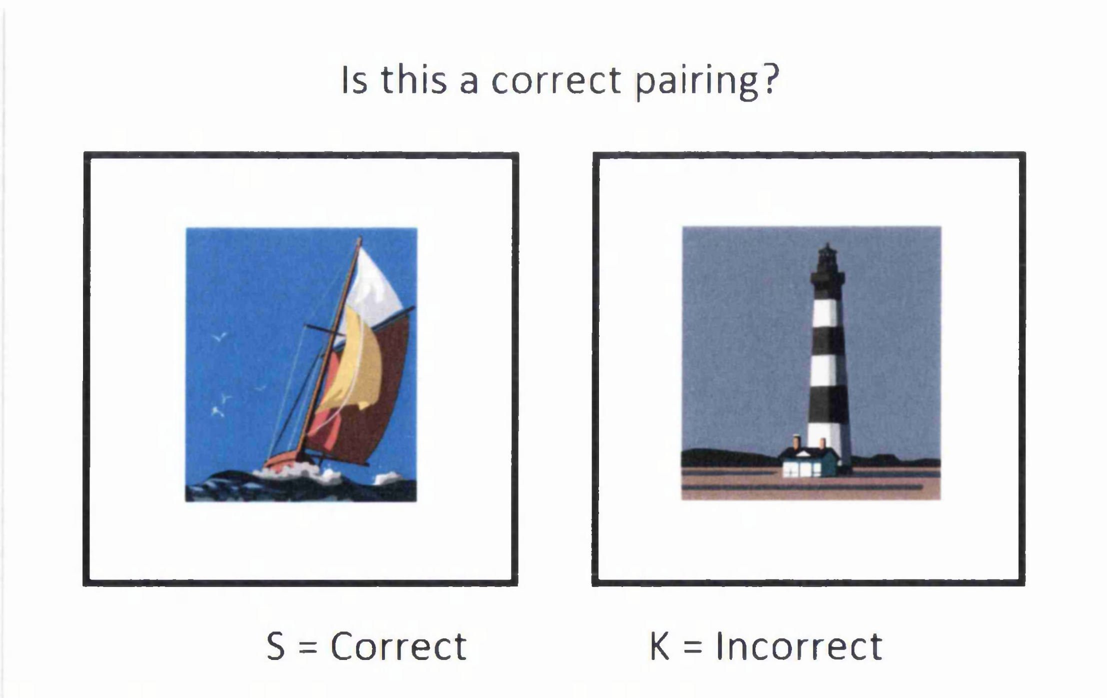


Figure 7-6. Example of rich (most unique colours) picture stimuli.

7.6: Results

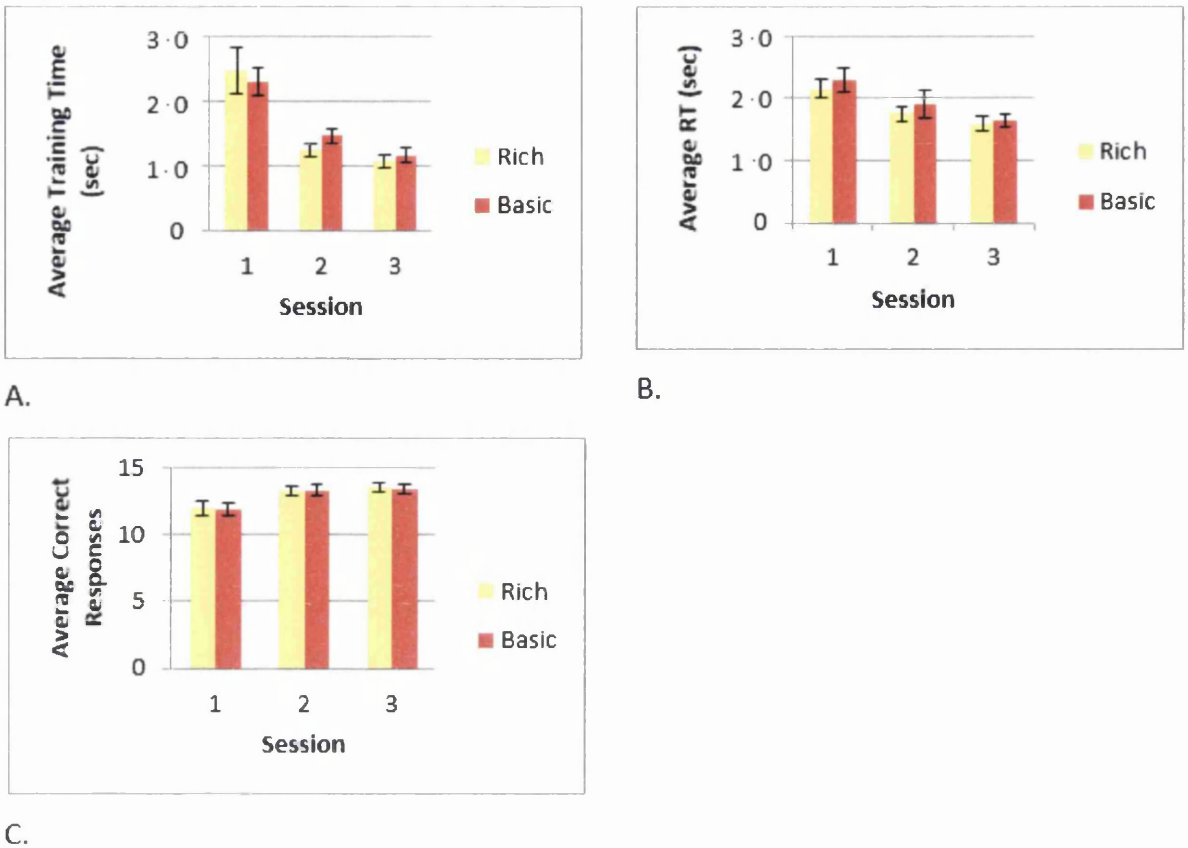


Figure 7-7. The results in Experiment 2. The sessions axis denotes which session the data is obtained from. The vertical axes are indicative of the dependent variable that is currently being considered. A: The difference in average training reaction time between rich and basic picture pairs over the three training sessions. B: The difference in average test reaction time between rich and basic picture pairs over the three test sessions. C: The difference in average correct responses between rich and basic picture pairs over the three test sessions. The maximum number of possible correct responses for rich and basic pairs were 15 for each category. The error bars show the standard error of the mean.

7.6.1: Reaction times in training

Figure 7-7A shows reaction times during training, for the rich and basic stimulus pairs, across the three sessions. As in Experiment 1, a repeated measures ANOVA was performed with session a within participants variable and stimulus type (rich vs. basic) as a within participants variable. The main effect of session was significant ($F(2,42)=16.433$; $p<.0005$), showing that the average reaction time decreased across sessions. However, neither the stimulus type main effect nor the interaction were significant (respectively, F(1,21)=.388; p=.540, F(2,42)=1.878; p=.166). These results show that, at least in the study phases, participants' performance was not differentiated between the rich and basic pairs (at least, as far as this can be established by examining reaction times).

7.6.2: Reaction times in test

Figure 7-7B shows a very slight trend for reaction times to be lower for rich pairs, compared to basic ones. However, a repeated measures ANOVA as above revealed a significant main effect only for session (F(2,42)=10.361; p<.0005) and not for stimulus type (F(1,21)=1.125; p=.281) or an interaction (F(2, 42)=.121; p=.886).

7.6.3: Correct Responses

Accuracy was measured with a dependent variable exactly analogous to that of Experiment 1, so that correct responses (hits plus correct rejections) were tracked. Figure 7-7C indicates that participants make more correct responses in trials involving rich stimuli, than ones with basic stimuli. However, the main effect of stimulus type was not significant (F(1,21)=.047; p=.830) nor was the interaction between stimulus type and session (F(2, 42)=.046; p=.955). The main effect of session was significant, as expected (F(2,42)=16.849; p<.0005).

7.7: Discussion

In Experiment 2 the possibility was explored that perceptual richness of stimuli may impact on the ability to learn corresponding associations more or less easily i.e. representative of more/less elaborate processing of stimuli. In alcohol heavy users perhaps the perceptual properties of alcohol stimuli may be more salient/ processed more extensively. Therefore, this was hypothesised to be analogous to manipulation of the perceptual richness of the stimuli in this task. While for all dependent variables of interest, the expected main effect of session was identified (showing that knowledge of the associations improved across the sessions), there was no evidence for a main effect of stimulus type or corresponding interactions.

7.8: Experiment 3: Thinking about the associations

7.8.1: Participants

20 (3 male) participants were recruited, aged 19 – 31 (mean=23.55; SD=4.136), from the undergraduate population of the psychology department at Swansea University. Course credit was offered in return for participation. Full ethical approval was granted by the Department of Psychology Research Ethics Committee (see Appendix V).

7.8.2: Stimuli and Procedure

In this experiment the actual type of stimuli was not of interest and so randomly selected pictures from Microsoft Clip Art were used, but in this case ensuring that all images were of a similar complexity. Here, Microsoft Clip Art was used to select pictures of a similar style. Instead there were two conditions; one where participants were instructed to name the stimuli (verbalise), and another where participants had to think of a way of associating the pictures (associate). The pictures in the verbalise and associate conditions were then counterbalanced in order to minimise any effects due to the particular pictures themselves. This counterbalancing should ensure that the pattern of results would be due to verbalise vs. associate manipulation only. The critical condition involved a procedure manipulation, according to which for half of the picture pairs in the training phase participants saw the word 'association' written above the stimuli, whilst for the other half the word 'verbalise'. The association label indicated that participants should try to think of, and tell the experimenter, an association between the two stimuli in the pair. Participants were told that any interpretation of the association between the two pictures was acceptable. By contrast, the verbalise label prompted participants to simply say a word which best described each picture. For example, if a picture of a cat and a dog appeared on the screen, participants would have to respond in the verbalise condition, by saying 'cat – dog'. In the association condition, participants could offer a response along the lines of, 'the cat was being chased by the dog' (Figure 7-8). The association vs. verbalise manipulation was counterbalanced, therefore, although all participants associated and verbalised the same number of items, half would associate one half of the stimuli and verbalise the other, whereas the other half of the participants would verbalise and associate the opposite pairs. All other aspects of Experiment 3 were as in Experiment 1.

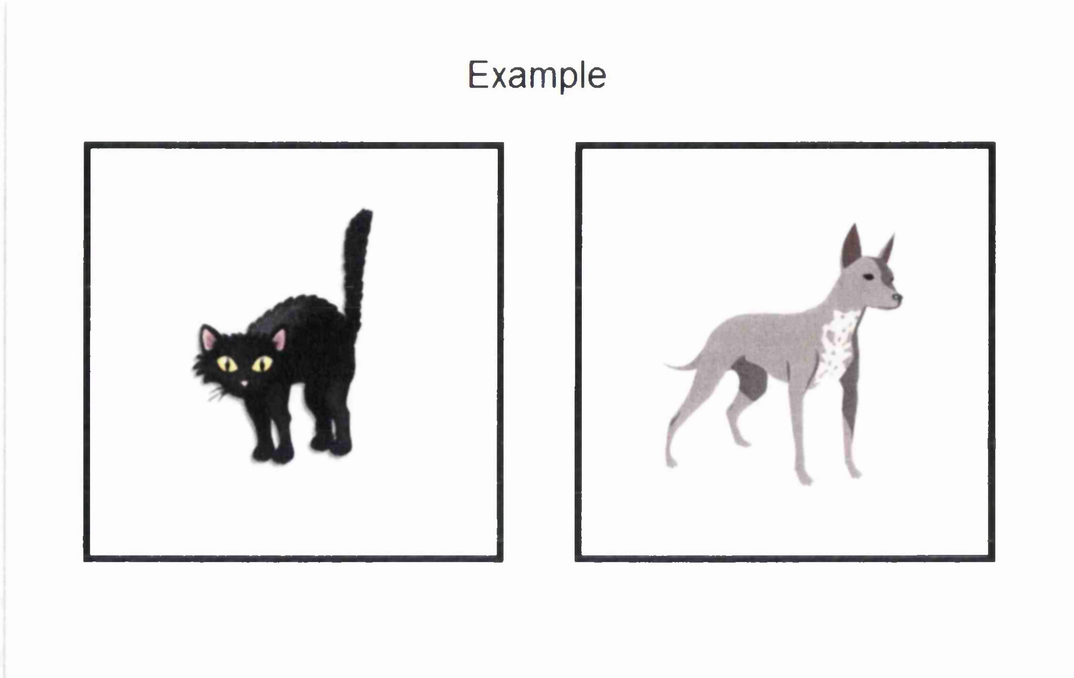
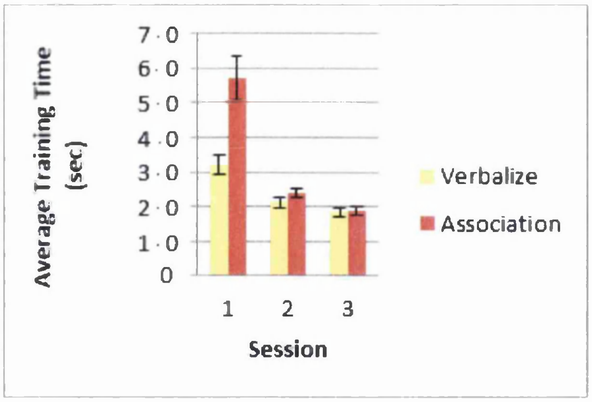
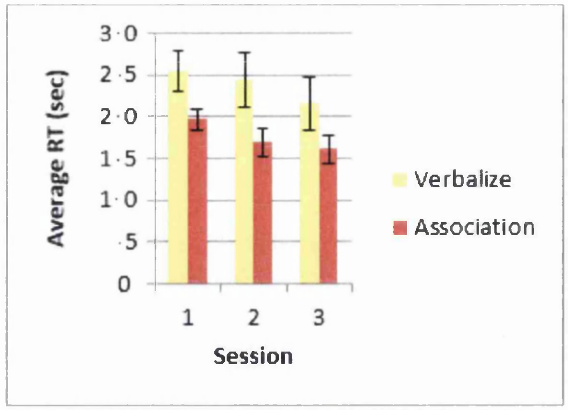


Figure 7-8. Example of stimuli from Experiment 3. Note, that where the text 'Example' is displayed is the location of where the instruction 'association' or 'verbalise' would appear.

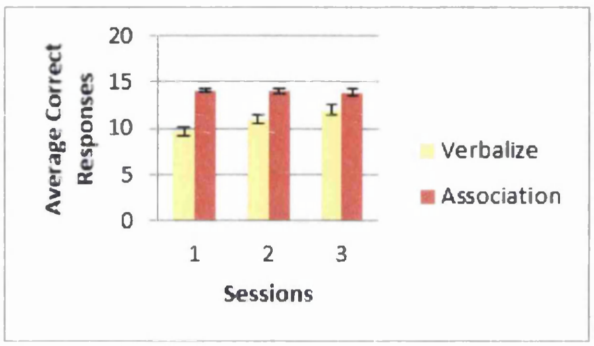
7.9: Results



A.



B.



C.

Figure 7-9. Graphs that demonstrate the results in Experiment 3. The sessions axis denotes which session the data is obtained from. The vertical axes are indicative of the dependent variable that is currently being considered. *A:* The average training reaction time for verbalise and association picture pairs over the three training sessions *B:* The average test reaction time for verbalise and association picture pairs over the three test sessions *C:* The average of test correct responses for verbalise (greatest number possible 15) and association (greatest number possible 15) picture pairs over the three test sessions. The error bars show the standard error of the mean.

7.9.1: Reaction times in training

Figure 7-9A demonstrates an intuitive pattern of results, with the difference between reaction time for the association pairs and the verbalise pairs being very high in the first session (when, presumably, participants require more time to think of an appropriate association), but this difference dropping almost to nothingness in the subsequent sessions.

As in previous experiments, all analyses are based on a repeated measures ANOVA, with session as a within participants variable and stimulus condition (association vs. verbalise) as a second within participants variable. The main effect of session was significant (F(2,38)=57.875; p<.0005), the main effect of stimulus condition was significant (F(1,19)=12.391; p=.002), and the interaction was significant (F(2,38)=17.609; p<.0005).

Independent samples t-tests were employed to explore the main effects and the interaction in more detail. There was a significant difference between verbalise (32.05 seconds) and association (56.93 seconds) picture pairs for the first training session (t(19)=-4.081; p=.001). However, no corresponding difference was identified in the second training session (t(19)=-1.714; p=.103) or the third one (t(19)=-.140; p=.890).

7.9.2: *Reaction times in test*

Figure 7-9B shows consistently lower reaction times for association pairs in the test phases, compared to verbalise pairs. An ANOVA as demonstrated a marginal significant main effect for session (F(2,38)=2.944; p=.065) and stimulus condition (F(1,19)=14.631; p=.001), but no interaction (F(2,38)=.256; p=.776). These effects are more carefully explored with post hoc independent samples t-tests. There was a marginally significant difference between verbalise (2.54, 2.43, 2.15 seconds, respectively) and association (1.97, 1.69, 1.61 seconds, respectively) pairs in all of the three sessions (t(19)=3.210; p=.005, t(19)=2.374; p=.028, t(19)=2.833; p=.011, respectively). Thus, even though the initial study time for association pairs was higher, association pairs were consistently responded to more quickly in all study phases.

7.9.3: Correct Responses

As before, the dependent variable for accuracy of responding was computed as the sum of hits and correct rejections, for verbalise pairs (maximum 15) and association pairs (maximum 15). The reaction time data for the test phases of Experiment 3 show that association pairs were responded to more fluently, indicating better learning for these pairs, compared to verbalise pairs. This conclusion is corroborated by the results on correct responses (Figure 7-9C). A repeated measures ANOVA with session and stimulus condition as a within participants variables, yielded a significant main effect of session (F(2,38)=4.019;

p=.026), a significant main effect of stimulus condition (F(1,19)=72.361; p<.0005), and a significant interaction (F(2,38)=8.332; p =.001).

With post hoc paired samples t-tests significant differences were identified between the association and verbalise stimulus conditions for all three sessions. For the first session, correct responses means were observed for the verbalise and association conditions of 9.65 and 14.05 respectively (t(19)=-8.543; p<.0005), for the second session 10.95 and 13.95 (t(19)=-5.015; p<.0005), and for the third session 12.00 and 13.90 (t(19) =-4.872; p<.0005).

7.10: Discussion

The theory of current concerns (e.g., Cox & Klinger, 2004) might lead to the expectation that thinking more about a particular association (that is, being pre-occupied by it) might reinforce the strength of the association. In this experiment a laboratory approximation of this idea is provided, with the association vs. verbalise stimulus condition. The analyses on all test phase variables consistently showed that the association pairs had been learned better and were responded to more fluently, compared to the verbalise pairs.

7.11: General Discussion

The goal of the present experiments was to explore some factors which may contribute to the speed of learning. The degree of learning of associations was characterised by the speed and accuracy of responding to different stimulus types, across different sessions. Note that the theory for attentional biases motivating the present work (e.g., Tiffany, 1990) concerns automatic associations between an abused substance and relevant thoughts, rather than the issue of whether particular associations can be learned more quickly than others. However, empirically it is much more straightforward to study the latter, rather than the former, due to the ambiguities of establishing whether an association is automatic or not. Moreover, it seems a fairly mild assumption to expect that associations which can be learned more speedily are the ones which become automatic more quickly as well. The key question in the present work is this: is the development of automatic associations primarily a function of (just) frequency, or do certain kinds of associations become learned more quickly than others? For example, in substance abuse automatic associations do not appear to develop for drinking water, to the same extent as they do for drinking alcohol, even the relevant frequencies for the two types of behaviour would always at least be equivalent (even for excessive drinkers). Then, the empirical challenge becomes to identify the characteristics which makes some associations more likely to become automatic (or, more simply, be learned more quickly) than others.

Three aspects of stimuli were explored which may have an effect on how effectively associations are learned. Experiment 1 was concerned with the emotional salience of the stimuli, in terms of the attractiveness of randomly selected faces. Emotional salience did not appear to impact on learning. In Experiment 2 the perceptual richness of the stimuli was manipulated, but no differences were identified for any of the test phase dependent variables. Finally, Experiment 3 examined the possibility that thinking about an association might reinforce it. In this case, the stimulus pairs for which participants had to think of an association were learned much better than the ones for which participants simply had to identify a verbal description.

The perceptual richness hypothesis of Experiment 2 is perhaps the easiest one to reject with confidence. Perceptual richness was manipulated in a fairly objective way, so that for all participants the stimuli intended as perceptual richer should indeed appear so etc. The emotionality hypothesis is more difficult to reject. Inevitably, it is a challenge to identify stimuli which would be emotionally salient (or not) to a fairly uniform degree across all members of a population sample. It was opted to employ pictures of faces which varied in attractiveness, because it is straightforward to identify large collections of eligible images, it was not wished to employ images which might be emotionally salient, but perhaps in an offensive way, and because employing such images would perhaps make the experimental task less onerous. However, the use of attractiveness may have been seen as a limitation, as there may have been a more suited way of manipulating emotionality. With future work, it is hoped to clarify in more detail whether emotional salience can have an effect on learning, but emotional salience is not captured adequately by attractiveness, or that attractiveness can be a relevant variable in this context, but it needs a stronger manipulation. One suggestion for alleviating this limitation is to tailor stimuli to suit individual participants i.e. use stimuli that is personally emotional for each participant e.g. picture stimuli of pets or partners. However, such an approach would require thorough pre-test procedural considerations. Notwithstanding these methodological qualifications, the lack of difference between the (assumed) emotional and non-emotional stimuli is broadly consistent with Easterbrook's (1959) proposal and the empirical findings of Murray and Kensinger (2012).

The advantage of the association vs. verbalise pairs in Experiment 3 is consistent with Craik and Tulving's (1975) proposal, that semantic elaboration of some studied material typically leads to better recall. According to their level of processing theory, a stimulus can be processed in several different ways, which can be characterised in terms of 'levels'. These levels can vary from fairly superficial perceptual analysis (shallow processing) to semantic analysis (deep processing). The resulting memory representations thus occur on a continuum between shallow to deep, so that deep processing results in a stronger and more durable representation. Therefore, by thinking of the association between stimuli, rather than merely verbalising the content of the stimuli, a stronger memory representation emerges. A putative relation between the levels of processing account of memory and the current concerns approach to attentional biases in substance abuse would merit further examination. Perhaps, having a current concern leads to corresponding attentional biases, exactly because this deeper processing leads to stronger representations and associations with positive expectancies.

The finding that thinking of associations led to an improvement in the learning of the pairs is perhaps intuitive, though note that in at least one case (Jacoby & Dallas, 1981), a levels of processing manipulation did not impact on memory performance, which may underlie the emergence of automaticity (as measured in a perceptual identification task, see Logan, (1988). Also, it is interesting that the thinking of associations led to better performance, over and above manipulations involving the emotional salience or perceptual richness of the stimuli, especially given that a higher emotional salience and a greater perceptual richness are both variables plausibly increasing the memorability of associations (regarding the latter, cf. Bock & Klinger, 1986).

Summing up, the issue of how cognitive processes support or underlie the psychological state relevant in substance abuse and addiction is a fascinating question, both because of possible practical implications (e.g., for cognitive-style interventions; e.g., Wiers et al., 2006), but also because of their potential to inform cognitive theory of learning and the automaticity (e.g., which factors other than frequency of practice impact on the development of associations?).

Summary: Within this chapter factors were explored which may affect the development of automatic associations. Three factors were considered which may affect the strength of association between stimuli. Looked at were emotionality, richness of representation, and thinking about the association. The dependent variable was the strength of the association between different stimuli. It was reasoned that stronger associations are more automatic than weaker ones. If something is more memorable then would such a process be easier to automatise? Would a stronger association lead to a stronger attentional bias? First considered was emotionality; would salient stimuli be learnt more readily? However there were no significant differences in the learning between emotionality groups. Then considered was the richness of representation; are readily-automatised stimuli processed in a more elaborate way? Again there was no evidence of this being the case. Finally it was considered whether thinking about an association; would a preoccupation with the stimuli affect memorability? It was observed that associated pairs were responded to more fluently than verbalise pairs. It was reasoned that deeper processing leads to a stronger representation and association with positive expectancies. Therefore a deeper thinking about, or preoccupation with, alcohol rather than, e.g., water, may lead to stronger representations and associations with positive expectancies and may subsequently lead to stronger attentional biases.

Chapter 8: Conclusions and General Discussion

8.1: Motivation

Do psychological aspects of addiction play a causal role in substance abuse, or are they a by-product? Answering this question may aid in the development of effective interventions. Previous research would suggest that substance abuse is maintained by attentional biases. These attentional biases may be due to the development of automaticity for the associations and habits concerned with substance abuse. Such automatic behaviours may operate without awareness. This would have implications for the types of screening measures that would be used to quantify substance abuse behaviours, as implicit measures may be more reliable than measures based on self-report. However, such implicit- and explicit- measure distinctions are not the only disadvantage of some substance abuse tasks, as it was sought to develop methods for measuring substance use and abuse attentional and cognitive biases that were more reliable, as well as capable of measuring different processes.

This thesis looked at attentional bias, cognitive bias, and the nature of the involvement of automaticity in the development of these biases, with the aim of exploring various aspects of psychological addiction. A number of results have been observed that would suggest that attentional biases are associated in the maintenance of substance use through allocating attentional resources toward stimuli. These processes may set into motion automatic processes that lead to substance seeking behaviour.

8.2: Empirical Evidence

The results of this thesis would suggest that attentional biases are not merely a by-product of substance use. It would appear that they may play a role in the development and maintenance of substance use behaviour. However, whether such attentional biases play a causal role is still open for debate. One view is that substance use is indeed (in part) maintained by attentional biases. It was demonstrated within this thesis that following repeated substance use an environment becomes increasingly occupied with stimuli related to substance use. The cause of this may be the increased importance attributed to substance-related stimuli following repeated exposure. This leads to the automatic development of habits and associations, which can then lead to substance-related stimuli gaining increased salience, which would affect how the environment is perceived. This was demonstrated using the PET, where heavy drinkers were found to mis-estimate the amount of alcohol-related stimuli in an environment.

Following the development of the fixed gaze inhibition task, a number of aspects of attentional bias could be explored over and above what could be achieved with previous measures. This task was first used to indicate the compulsory aspect of attentional biases. It was hypothesised that HDs would demonstrate poorer inhibitory control. Here it was found that heavy drinkers are unable to inhibit their attentional biases for alcohol-related stimuli. This suggests that when presented with alcohol stimuli, HDs are compelled to look at substance-related stimuli. Attentional biases were further explored using this measure by looking at the initial orienting of attention when in the presence of substance-related stimuli. Previous measures had not adequately been able to observe this process. Here it was found that HDs will have an initial orienting bias for alcohol stimuli. This result, taken together with the inhibition finding, would suggest that, when in the presence of alcohol stimuli, a HD will have an initial orienting bias for alcohol stimuli, but this bias is also difficult to inhibit. Such a notion would have wide reaching implications, as the mere sight of alcohol stimuli has, within previous literature, been associated with increased craving and substance seeking behaviour. Tiffany (1990) suggested that substance abuse reflects a 'loss of control'. Likewise, Field and Cox (2008) suggest that poor inhibitory control may influence craving, substance seeking, and subsequent attentional bias. This is what the fixed gaze task explored. Although substance seeking was not measured and craving was not found to be associated with the fixed gaze task, it was found that inhibitory failures were associated with heavy drinking. Therefore this chapter supports existing theories of substance use. Whether this task is a more sensitive measure of attentional bias is still open for debate. However, it would appear that measures of inhibition would benefit substance abuse diagnostic tools. A limitation with the fixed gaze task is the confounding distance variable. Further research would be required where varying the distance between fixation region and stimuli is not manipulated but kept constant. But by presenting stimuli peripherally, it was possible to investigate biases in preconscious processing. Franken (2003) stated that biases in preconscious processes were not associated with appetitive motivational states. Therefore, it would appear that this chapter adds to the literature by providing evidence which could indicate such biases, as increased alcohol use leads to further distraction toward congruent peripherally presented stimuli.

Chapter 3 provided evidence that could demonstrate the potential robustness of attentional biases. It was hypothesised that alcohol attentional biases would remain constant, whilst MDMA attentional biases would fluctuate; based on assumptions made regarding consumption habits. Firstly, evidence was found to suggest an attentional bias for MDMA. Second, it was observed that attentional biases do not fluctuate to a large degree as a result of use intention, suggesting that attentional biases may not be transient once they have been established. Thirdly, it was demonstrated that craving and outcome expectancies may not be associated with attentional biases. However this may again be a demonstration of the distinction between implicit and explicit measures. Explicit measures, such as outcome expectancies, may not be as accurate as implicit measures of substance abuse, such as attentional bias measures. This distinction is important in the development of screening tools for substance abuse, since implicit measures may be providing a more accurate measure of the relevant aspects of substance abuse. Use intention was hypothesised to lead to attentional bias fluctuations as Field and Cox (2008) make the suggestion that stronger associations between craving and attentional biases would be observed when a substance is perceived as being available. However, this notion was not supported as attentional biases did not fluctuate as much as predicted. The dissociation between the Tiffany (1990) and Robinson and Berridge (1993) theories can be examined with the findings from this chapter. Within the alcohol condition, it was found that there was greater attentional bias when usage was not intended. This supports Robinson and Berridge (1993) who would predict that greater attentional bias would be observed when abstaining, due to stimuli being appetitive. Further research would be required, due to the limitations of this chapter. However, this finding would have large ramifications for the substance abuse literature if further supported.

With Chapter 5, the aim was to establish whether cognitive biases can affect how the environment is perceived. It was found that this was indeed the case during an alcohol and a food version of the task. The results would suggest that following the development of an attentional bias, an environment is perceived in a manner that reflects such a bias. Therefore, if an environment becomes increasingly filled with substance-related stimuli that one becomes compelled to look at initially and uncontrollably (see Chapter 2), this in-turn may lead to further substance use. If this is the case, then attentional biases may play a causal role in substance use maintenance. These results support Tiffany (1990) who suggested that an environment would seemingly become increasingly occupied by alcohol-related stimuli as alcohol use increases. Such a finding demonstrates the importance of cognitive factors within substance abuse behaviour. If an environment is distorted in a way that constantly reminds a drinker of the positive nature of alcohol, then this will affect future substance seeking. Future PET research would benefit from measures of substance seeking behaviour, as this is an important step in validating any new substance abuse measure.

Also investigated within this thesis were the effects of automaticity development and whether deficits in automaticity development would lead to different patterns of substance use. In order to do this a population was used who are putatively impaired in automaticity development (Nicolson and Fawcett, 1990). Through the use of dyslexic participants it was found that there were differences in the reported substance use of dyslexics and non-dyslexic controls. However, by examining the attentional biases of dyslexics, it was not possible to observe broad differences between dyslexics and non-dyslexic controls. The results, however, would suggest that there were minor differences with regard to attentional biases. Also, within the SRTT it was observed that dyslexics may have different explicit learning strategies. This result may have implications for the automatisation hypothesis of dyslexia. As these results cannot be comprehended in a manner which would provide support for this theory of dyslexia. The priming study may indicate that dyslexics form habits related to substance use in the same way to non-dyslexic controls. This conclusion is supported by the observation that the same pattern of priming results was found for the two populations. Each of these sets of results could arguably be attributable to automaticity not being impaired within a dyslexic population. Such a finding may have wide reaching implications for how dyslexia is diagnosed and treated. It would appear that the automatisation deficit hypothesis of dyslexia (see Nicolson and Fawcett, 1990) was not supported within this thesis. This supports previous research which may indicate that this theory of dyslexia is flawed (i.e. Beaton, 2002; Bishop, 2002). However, this is not the focus of this thesis. The utilisation of dyslexics within this thesis was to explore automatic aspects of substance abuse. However, the lack of significant findings with the dyslexic population does not indicate that automaticity is not important within substance abuse. It was merely observed that dyslexics did not perform as would be expected should they be impaired in automatic skill development. In future, studies of automaticity and substance abuse would benefit from directly measuring automaticity development, rather than rely upon a group being impaired in its automaticity development.

With Chapter 7, the aim was to explore why some stimuli may develop automaticity whilst others do not. It was hypothesised that manipulation of different conditions would improve memory associations. Chapter 7 of the thesis suggests that automaticity develops more easily through semantic elaboration. Deeper processing of stimuli leads to more durable memory associations. This suggests that a deeper thinking about, e.g., alcohol than, e.g., water would lead to an attentional bias. The results provide support for current concern theories for substance abuse (e.g. Klinger and Cox, 2004), as a current concern may be analogous to a preoccupation with substance abuse. Thus attentional bias would be the result of deeper processing of stimuli which leads to stronger representations and associations with positive expectancies. Therefore, a current concern may develop automatically (cf. Tiffany, 1990) should substance use behaviour be repeated.

Within the thesis, it would appear that there are a number of implications for current theories. It would appear that Tiffany (1990) would be supported in terms of an environment becoming increasingly filled with alcohol-related stimuli for the HD and such stimuli automatically lead to an initial orienting of attention; a process which may be difficult to inhibit for the HD. Chapter 3 would indicate that the incentive salience theory of substance abuse (Robinson and Berridge, 1993) may explain attentional biases, as attentional biases are strongest when use was not intended (analogous to when a substance would be seen as unavailable). However, it would appear to be more complicated than that. As Chapter 7 may indicate that a current concern (see Klinger and Cox, 2004) for substance abuse may develop through automaticity (cf. Tiffany, 1990). Further research in this area would be compelling. However, it appears that incentive salience, automaticity, and current concerns theories may all be complimentary and operating in parallel or within different stages of substance use behaviour.

It would appear that the largest limitation within the thesis was the adoption of a dyslexic population in the hope of measuring differences in substance abuse as a result of discrepancies with automatisation development. It would therefore appear that this thesis provides evidence contrary to that of Nicolson and Fawcett (1990), regarding the cause of dyslexia. Yet automaticity would appear to be important for the development of substance abuse. An area for future research would be to investigate how a current concern for alcohol use may develop automatically through a deeper processing of alcohol-related stimuli. However, this is currently speculative. But such an investigation would benefit from providing direct measures of automaticity rather than rely on populations putatively impaired in automaticisation development.

8.3: Closing Remarks

Whether attentional biases play a causal role in substance abuse is inconclusive. However, it would seem that attentional biases play a considerable role in the maintenance of substance abuse behaviour. The fixed gaze inhibition task demonstrated that those who engage in frequent heavy drinking behaviour were unable to inhibit their attentional biases. This, together with the finding that alcohol stimuli are able to both hold and grab attention, suggests that a loss of control is involved in attention when drinking is problematic. This would further suggest that once someone becomes a heavy drinker then he/she loses some voluntary control over his/her drinking behaviour, as the mere sight of alcohol-related stimuli could be enough to lead to craving that could lead to substance seeking behaviour. This research therefore has implications for current UK government issues about policies regarding the removal of tobacco products from visible places, e.g. behind shop counters. This thesis (presuming that the alcohol findings are applicable to nicotine) would suggest that if a cigarette smoker were to see cigarettes then further smoking behaviour may be initiated. Therefore, by removing the stimuli, smoking may decrease. Such suggestions point to the importance of studying the psychological aspects of addiction, as cognitive intervention techniques may have beneficial effects for those who have substance abuse problems.

Attentional biases are theorised to be due to the repeated associations between substance cues and the effects of substances (Robinson and Berridge, 1993). A moderate correlation has been observed between attentional biases and craving (Field *et al.*, 2009b).

This may be explained by a direct effect of attentional bias on behaviour in the absence of craving as a mediator either as a result of habit (Tiffany, 1990) or as a result of incentive salience (Robinson and Berridge, 2001). Attentional bias has been found to be associated with a number of different factors associated with continued substance abuse behaviour. Studies have found an association between attentional bias and craving (Franken, 2003), severity of addiction (Bearre *et al.*, 2007; Fadardi and Cox, 2006), poor treatment outcome (Carpenter *et al.*, 2006), and relapse post-treatment (e.g. Cox *et al.*, 2006). Indeed, amongst heavy drinkers, those with low attentional bias have better treatment outcomes than those with high attentional biases (Cox *et al.*, 2007). Such findings demonstrate the importance of attentional biases within substance use. Therefore attentional bias interventions may be beneficial for those in substance abuse recovery. MacLeod *et al.* (2002) developed an attentional bias modification training computer programme for anxiety. A substance abuse version revealed promising results (Schoenmakers, Bruin, Lux, Goertz, Kerkhof, Wiers, 2010).

Within the current thesis a method has been identified which may be a useful tool for the screening of cognitive biases in the PET. This is an implicit measure of substance use. This task may be beneficial for the screening of substance users and the task may have advantages over other cognitive bias measures which may be merely measuring explicit notions of a user's own substance use. More research is required before such conclusions are of course fully supported. It is suggested that this task be used with other clinical populations, but also within-subjects by varying the percentage of each word category for multiple testing sessions. Within this thesis, also developed, was an inhibition task. This task, although successfully used for screening, may also be useful as a tool for attentional bias modification, so may potentially be able to help with substance use problems. What the fixed gaze inhibition task is able to do is measure inhibition for alcohol stimuli. However, if this were to be adopted as an intervention task, it may be able to teach those with substance use problems to control their distractibility toward substance-related stimuli. This of course is hypothetical. However, it does appear theoretically justifiable, as greater control over an ability to inhibit gaze toward substance-related stimuli could potentially lead to decreases in craving and substance seeking behaviour. It is suggested that further research into the association between performance on this task and substance seeking behaviour be performed. As an orientation of attention is not always necessary for substance seeking behaviour (see Hogarth et al., 2008)

The distinction between implicit and explicit components of substance abuse would also appear to be important for future developments within the field of psychological addiction. It would appear that explicit awareness of stimuli is important for the development of automatic associations involved in substance abuse. Yet for the measurement of cognitive and attentional biases it is implicit measures which are more accurate. This may be due to the loss of control behaviour associated with substance abuse, and that once automatic associations are in place following an initial period of explicit awareness, then substance abuse behaviours may operate outside of awareness. This may suggest that implicit measures of substance abuse may be more accurate than explicit self-report measures. Such distinctions are hypothetical, but highlight that implicit and explicit components of substance abuse need to be considered when developing both screening and intervention techniques for substance abuse.

In conclusion, attentional biases appear to be robust and not transient, and not necessarily reliant upon use intention. They may maintain substance use and they may be involved in substance seeking behaviour. Cognitive biases lead to an environment seemingly becoming increasingly full of substance-related stimuli and this process occurs automatically, potentially outside of awareness. It would also appear that explicitly being aware of an association initiates the initial stage of attentional biases. Greater understanding of these processes has the potential to help people suffering from substance abuse problems.

References

Aarts, H., & Dijksterhuis, A. P. (2000). The Automatic Activation Of Goal-Directed Behaviour: The Case Of Travel Habit. *Journal Of Environmental Psychology*, *20*(1), 75-82.

Aarts, H., Verplanken, B., & Knippenberg, A. (1998). Predicting Behavior From Actions In The Past: Repeated Decision Making Or A Matter Of Habit?. *Journal Of Applied Social Psychology*, *28*(15), 1355-1374.

Adams, C. D., & Dickinson, A. (1981). Actions And Habits: Variations In Associative Representations During Instrumental Learning. *Information Processing In Animals: Memory Mechanisms*, 143-165.

Aharon, I., Etcoff, N., Ariely, D., Chabris, C., O'Connor, E., & Breiter, H. (2001). Beautiful Faces Have Variable Reward Value: FMRI And Behavioral Evidence. *Neuron, 32,* 537–551.

Alexander-Passe, N. (2006). How Dyslexic Teenagers Cope: An Investigation Of Self-Esteem, Coping And Depression. *Dyslexia, 12*(4), 256-275.

Anagnostaras, S. G., & Robinson, T. E. (1996). Sensitization To The Psychomotor Stimulant Effects Of Amphetamine: Modulation By Associative Learning. *Behavioral Neuroscience*, 110, 1397-1414.

Anderson, J. R. (1993). *Rules Of The Mind*. Lawrence Erlbaum.

Armstrong, C. (1997). Automatic And Non-Automatic Processing Of Alcohol-Associations In Heavy Vs. Light Drinkers. In *London Conference Of The British Psychological Society.*

Ataya, A. F., Adams, S., Mullings, E., Cooper, R. M., Attwood, A. S., & Munafò, M. R. (2012). Methodological Considerations In Cognitive Bias Research: The Next Steps. *Drug And Alcohol Dependence.*

Attwood, A. S., O'Sullivan, H., Leonards, U., Mackintosh, B., & Munafò, M. R. (2008). Attentional Bias Training And Cue Reactivity In Cigarette Smokers. *Addiction*, *103*(11), 1875-1882.

Babor, T.F., De La Fuente, J.R., Saunders, J., And Grant, M. (1992) AUDIT. The Alcohol Use Disorders Identification Test. *Guidelines For Use In Primary Health Care.* Geneva, Switzerland: World Health Organization.

Baddeley, A. (2000). The Episodic Buffer: A New Component Of Working Memory? *Trends In Cognitive Sciences, 4,* 417–423.

Balleine, B. W. (2005). Neural Bases Of Food-Seeking: Affect, Arousal And Reward In Corticostriatolimbic Circuits. *Physiology & Behavior*, 86(5), 717-730.

Bargh, J. A. (1990). Goal And Intent: Goal-Directed Thought And Behavior Are Often Unintentional. *Psychological Inquiry*, *1*(3), 248-251.

Bargh, J. A. (1992). Why Subliminality Does Not Matter To Social Psychology: Awareness Of The Stimulus Versus Awareness Of Its Influence. In R. F. Bornstein & T. S. Pittman (Eds.), *Perception Without Awareness* (Pp. 236-255). New York: Guilford.

Bargh, J. A. (1996). Automaticity In Social Psychology. *Social Psychology: Handbook Of Basic Principles*, 169.

Bargh, J. A., & Chartrand, T. L. (1999). The Unbearable Automaticity Of Being.*American Psychologist*, *54*(7), 462.

Bargh, J. A., & Gollwitzer, P. M. (1994). Environmental Control Of Goal-Directed Action: Automatic And Strategic Contingencies Between Situations And Behavior. In Spaulding, William D. (Ed), (1994). Integrative views of motivation, cognition, and emotion. *Nebraska symposium on motivation*, Vol. 41., (pp. 71-124). Lincoln, NE, US: University of Nebraska Press, xii, 265 pp.

Bargh, J. A., Gollwitzer, P. M., Lee-Chai, A., Barndollar, K., & Trötschel, R. (2001). The Automated Will: Nonconscious Activation And Pursuit Of Behavioral Goals.*Journal Of Personality And Social Psychology; Journal Of Personality And Social Psychology*, *81*(6), 1014.

Bargh, J.A. (1989). Conditional Automaticity: Varieties Of Automatic Influence In Social Perception And Cognition. In J.S. Uleman & J.A. Bargh (Eds.), *Unintended Thought* (Pp. 3-51). New York: Guilford Press.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & Van Ijzendoorn, M. H. (2007). Threat-Related Attentional Bias In Anxious And Nonanxious Individuals: A Meta-Analytic Study. *Psychological Bulletin*, *133*(1), 1.

Bearre, L., Sturt, P., Bruce, G., & Jones, B. T. (2007). Heroin-Related Attentional Bias And Monthly Frequency Of Heroin Use Are Positively Associated In Attenders Of A Harm Reduction Service. *Addictive Behaviors*, *32*(4), 784-792.

Beaton, A. A. (2002). Dyslexia And The Cerebellar Deficit Hypothesis. *Cortex, 38*(4), 479-490.

Becker, J.B., & Hu, M. (2008). Sex differences in drug abuse. *Frontiers in Neuroendocrinology*, 29(1), 36-47.

Berkowitz, D. A. (Ed.). (1997). *Social Meanings Of News: A Text-Reader*. Sage Publications, Incorporated.

Berkowitz, L. (1984). Some Effects Of Thoughts On Anti-And Prosocial Influences Of Media Events: A Cognitive-Neoassociation Analysis. *Psychological Bulletin*,*95*(3), 410.

Berninger, V. W., Raskind, W., Richards, T., Abbott, R., & Stock, P. (2008). A Multidisciplinary Approach To Understanding Developmental Dyslexia Within Working-Memory Architecture: Genotypes, Phenotypes, Brain, And Instruction. *Developmental Neuropsychology, 33*(6), 707-744.

Berridge, K. C. (1996). Food Reward: Brain Substrates Of Wanting And Liking. *Neuroscience & Biobehavioral Reviews*, 20(1), 1-25.

Bewick, B. M., Mulhern, B., Barkham, M., Trusler, K., Hill, A. J., & Stiles, W. B. (2008). Changes in undergraduate student alcohol consumption as they progress through university. *BMC Public Health*, 8(1), 163.

Bishop, D. V. M. (2002). Cerebellar Abnormalities In Developmental Dyslexia: Cause, Correlate Or Consequence? *Cortex*, 38(4), 491-498.

Bock, M. & Klinger, E. (1986). Interaction Of Emotion And Cognition In Word Recall. *Psychological Research*, 48, 99-106.

Boon, B., Vogelzang, L., & Jansen, A. (2000). Do Restrained Eaters Show Attention Toward Or Away From Food, Shape And Weight Stimuli?. *European Eating Disorders Review*, *8*(1), 51-58.

Borkowski, J. G. & Muthukrishna, N. (1992) Moving Metacognition Into The Classroom: 'Working Models' And Effective Strategy Teaching, In: M. Pressley, K. R. Harris & J. T. Guthrie (Eds) *Promoting Academic Literacy: Cognitive Research And Instructional Innovation* (Orlando, FL, Academic Press), 477–501.

Bosworth, H. T., & Murray, M. E. (1983). Locus Of Control And Achievement-Motivation In Dyslexic-Children. *Journal Of Developmental And Behavioral Pediatrics, 4*(4), 253-256.

Bradley, B. P., Mogg, K., Wright, T., & Field, M. (2003). Attentional bias in drug dependence: vigilance for cigarette-related cues in smokers. *Psychology of Addictive Behaviors,* 17(1), 66.

Bradley, B., Field, M., Mogg, K., & De Houwer, J. (2004). Attentional And Evaluative Biases For Smoking Cues In Nicotine Dependence: Component Processes Of Biases In Visual Orienting. *Behavioural Pharmacology*, *15*(1), 29-36.

Bradley, L., & Bryant, P. E. (1983). Categorizing Sounds And Learning To Read - A Causal Connection. *Nature, 301*(5899), 419-421.

Braet, C., & Crombez, G. (2003). Cognitive Interference Due To Food Cues In Childhood Obesity. *Journal Of Clinical Child And Adolescent Psychology*, *32*(1), 32-39.

Braet, C., & Van Strien, T. (1997). Assessment Of Emotional, Externally Induced And Restrained Eating Behaviour In Nine To Twelve-Year-Old Obese And Non-Obese Children. *Behaviour Research And Therapy*, *35*(9), 863-873.

Brandstätter, V., Lengfelder, A., & Gollwitzer, P. M. (2001). Implementation Intentions And Efficient Action Initiation. *Journal Of Personality And Social Psychology*, *81*(5), 946.

Brindley, G. S. (1964). The Use Made By The Cerebellum Of The Information That It Receives From Sense Organs. *International Brain Research Organization Bulletin*, 3, 80

Brooks, L. R., & Vokey, J. R. (1991). Abstract Analogies And Abstracted Grammars: Comments On Reber (1989) And Mathews Et Al.(1989). *Journal Of Experimental Psychology. General*, *120*, 316-323.

Brunstrom, J. M., Rogers, P. J., Pothos, E. M., Calitri, R., & Tapper, K. (2008). Estimating Everyday Portion Size Using A 'Method Of Constant Stimuli': In A Student Sample, Portion Size Is Predicted By Gender, Dietary Behaviour, And Hunger, But Not BMI. *Appetite,* 51, 296-301.

Calitri, R., Pothos, E. M., Tapper, K., Brunstrom, J. M., & Rogers, P. J. (2010). Cognitive Biases To Healthy And Unhealthy Food Words Predict Change In BMI. *Obesity*, 18, 2282-2287.

Carpenter, K. M., Schreiber, E., Church, S., & Mcdowell, D. (2006). Drug Stroop Performance: Relationships With Primary Substance Of Use And Treatment Outcome In A Drug-Dependent Outpatient Sample. *Addictive Behaviors*, *31*(1), 174-181.

Carter, B. L., & Tiffany, S. T. (1999). Meta-Analysis Of Cue-Reactivity In Addiction Research. *Addiction*, *94*(3), 327-340.

Carver, C. S., Ganellen, R. J., Froming, W. J., & Chambers, W. (1983). Modeling: An Analysis In Terms Of Category Accessibility. *Journal Of Experimental Social Psychology*, *19*(5), 403-421.

Casco, C., Tressoldi, P.E. And Dellantonio, A., (1998). Visual Selective Attention And Reading Efficiency Are Related In Children. *Cortex* 34, 531–546

Chan, L. K. S. (1994) Relationship Of Motivation, Strategic Learning, And Reading Achievement In Grades 5, 7, And 9, *Journal Of Experimental Education*, 62(4), 319–339.

Chanon, V. W., Sours, C. R., & Boettiger, C. A. (2010). Attentional Bias Toward Cigarette Cues In Active Smokers. *Psychopharmacology*, *212*(3), 309-320.

Chartrand, T. L., & Bargh, J. A. (1996). Automatic Activation Of Impression Formation And Memorization Goals: Nonconscious Goal Priming Reproduces Effects Of Explicit Task Instructions. *Journal Of Personality And Social Psychology, 71*(3), 464.

Cisler, J. M., & Koster, E. H. (2010). Mechanisms Of Attentional Biases Towards Threat In The Anxiety Disorders: An Integrative Review. *Clinical Psychology Review,30*(2), 203.

Cisler, J. M., Bacon, A. K., & Williams, N. L. (2009). Phenomenological Characteristics Of Attentional Biases Towards Threat: A Critical Review. *Cognitive Therapy And Research*, *33*(2), 221-234.

Cole, J. C., Sumnall, H. R., & Wagstaff, G. F. (2002). Methodological problems with ecstasy and the SCL-90. *Psychopharmacology,* 162(2), 215-217.

Cox, W. M., Klinger, E. (1988) A Motivational Model Of Alcohol Use. *Journal Of Abnormal Psychology*. 97, 168-180.

Cox, W. M., Pothos, E. M., Hosier, S. G. (2007) Cognitive-Motivational Predictors Of Excessive Drinkers' Success In Changing. *Psychopharmacology* 192, 499-510.

Cox, W. M., Yeates, G. N., & Regan, C. M. (1999). Effects Of Alcohol Cues On Cognitive Processing In Heavy And Light Drinkers. *Drug And Alcohol Dependence*, 55, 85-89.

Cox, W. M., & Klinger, E. (1988). A Motivational Model Of Alcohol Use. *Journal Of Abnormal Psychology*, 97, 168-180.

Cox, W. M., & Klinger, E. (1990). Incentive Motivation, Affective Change, And Alcohol Use: A Model. *Why People Drink: Parameters Of Alcohol As A Reinforcer*, 291-314.

Cox, W. M., Fadardi, J. S., & Pothos, E. M. (2006). The Addiction-Stroop Test: Theoretical Considerations And Procedural Recommendations. *Psychological Bulletin,* 132, 443-476.

Cox, W. M., Hogan, L. M., Kristian, M. R., & Race, J. H. (2002). Alcohol Attentional Bias As A Predictor Of Alcohol Abusers' Treatment Outcome. *Drug And Alcohol Dependence,* 68(3), 237-243.

Cox, W. M., Pothos, E. M., & Hosier, S. G. (2007). Cognitive-Motivational Predictors Of Excessive Drinkers' Success In Changing. *Psychopharmacology, 192*(4), 499-510.

Craeynest, M., Crombez, G., Houwer, J. D., Deforche, B., Tanghe, A., & Bourdeaudhuij, I. D. (2005). Explicit And Implicit Attitudes Towards Food And Physical Activity In Childhood Obesity. *Behaviour Research And Therapy, 43*(9), 1111-1120.

Critchley, M. And Critchley, E.A. (1978) *Dyslexia Defined.* Heinemann: London.

Csizér, K., And Kormos, J. (2010) A Comparison Of The Foreign Language Learning Motivation Of Hungarian Dyslexic And Non-Dyslexic Students. *International Journal Of Applied Linguistics*, 20 (2). 232-250.

Davis, L., Uezato, A., Newell, J. M., & Frazier, E. (2008). Major Depression And Comorbid Substance Use Disorders. *Current Opinion In Psychiatry, 21*(1), 14-18.

Denckla, M. B., & Rudel, R. G. (1976). Rapid Automatized Naming (Ran) - Dyslexia Differentiated From Other Learning-Disabilities. *Neuropsychologia, 14*(4), 471-479.

Denckla, M. B., Rudel, R. G., Chapman, C., & Krieger, J. (1985). Motor Proficiency In Dyslexic-Children With And Without Attentional Disorders. *Archives Of Neurology, 42*(3), 228-231.

Desroches, A. S., Joanisse, M. F., & Robertson, E. K. (2006). Specific Phonological Impairments In Dyslexia Revealed By Eyetracking. *Cognition,*100(3), B32-B42.

Dickinson, A., Smith, J., & Mirenowicz, J. (2000). Dissociation Of Pavlovian And Instrumental Incentive Learning Under Dopamine Antagonists. *Behavioral Neuroscience*, 114(3), 468.

Dienes, Z., Altmann, G., Kwan, L., & Goode, A. (1995) Unconscious Knowledge Of Artificial Grammars Is Applied Strategically. *Journal Of Experimental Psychology: Learning, Memory, & Cognition* 21, 1322-1338

Dienes, Z. (2004). Assumptions Of Subjective Measures Of Unconscious Mental States: Higher Order Thoughts And Bias. *Journal Of Consciousness Studies*, 11, 25–45.

Dienes, Z., & Perner, J. (1999). A Theory Of Implicit And Explicit Knowledge. *Behavioral And Brain Sciences,* 22, 735–808.

Dienes, Z., & Scott, R. (2005). Measuring Unconscious Knowledge: Distinguishing Structural Knowledge And Judgment Knowledge. *Psychological Research*, 69, 338–351.

Drayna, D. (2005). Human Taste Genetics. *Annual Review Of Genomics & Human Genetics*, 6, 217–235.

Dulany, D. E. (2003). Strategies For Putting Consciousness In Its Place. *Journal Of Consciousness Studies, 10,* 33–43.

Dulany, D. E., Carlson, R. A., & Dewey, G. I. (1984). A Case Of Syntactical Learning And Judgment: How Conscious And How Abstract?. *Journal Of Experimental Psychology: General*, *113*(4), 541.

Duncan, C. C., Rumsey, J. M., Wilkniss, S. M., Denckla, M. B., Hamburger, S. D., & Odou-Potkin, M. (1994). Developmental Dyslexia And Attention Dysfunction In Adults: Brain Potential Indices Of Information Processing.*Psychophysiology*, *31*(4), 386-401.

Easterbrook, J. A. (1959). The Effect Of Emotion On Cue-Utilization And The Organization Of Behavior. *Psychological Review*, 66, 183-201.

Eden, G. F., & Zeffiro, T. A. (1998). Neural Systems Affected In Developmental Dyslexia Revealed By Functional Neuroimaging. *Neuron, 21*(2), 279-282.

Engels, R. C., & Ter Bogt, T. (2004). Outcome Expectancies And Ecstasy Use In Visitors Of Rave Parties In The Netherlands. *European Addiction Research*, *10*(4), 156-162.

Ernst, M., Moolchan, E. T., & Robinson, M. L. (2001). Behavioral And Neural Consequences Of Prenatal Exposure To Nicotine. *Journal-American Academy Of Child And Adolescent Psychiatry*, *40*(6), 630-641.

Everitt, B. (1997). Craving Cocaine Cues: Cognitive Neuroscience Meets Drug Addiction Research. *Trends In Cognitive Sciences*. *1*(1), 1-2.

Ewing, J. A. (1984). Detecting Alcoholism - The Cage Questionnaire. *Jama-Journal Of The American Medical Association, 252*(14), 1905-1907.

Facoetti, A., Paganoni, P., Turatto, M., Marzola, V., & Mascetti, G. G. (2000). Visual-Spatial Attention In Developmental Dyslexia. *Cortex, 36*(1), 109-123.

Fadardi, J. S., & Cox, W. M. (2009). Reversing The Sequence: Reducing Alcohol Consumption By Overcoming Alcohol Attentional Bias. *Drug And Alcohol Dependence, 101*(3), 137-145.

Fawcett, A. J., & Nicolson, R. (1998). *Dyslexia Adult Screening Test (DAST).* Pearson Psychcorp, Sydney. Available From Http://Www.Pearsonpsychcorp.Com.Au

Feldman, J. M., & Lynch, J. G. (1988). Self-Generated Validity And Other Effects Of Measurement On Belief, Attitude, Intention, And Behavior. *Journal Of Applied Psychology*, *73*(3), 421.

Field, M. (2010). Can't Take My Eyes Off Of You. *Psychologist* 23(8), 636-639.

Field, M., & Cox, W. M. (2008). Attentional Bias In Addictive Behaviors: A Review Of Its Development, Causes, And Consequences. *Drug And Alcohol Dependence* 97(1), 1-20

Field, M., Mogg, K., Bradley, B. P. (2004). Eye Movements To Smoking-Related Cues: Effects Of Nicotine Deprivation. *Psychopharmacology* 173, 116-123

Field, M., Mogg, K., Zetteler, J., Bradley, B. P. (2004a). Attentional Biases For Alcohol Cues In Heavy And Light Social Drinkers: The Roles Of Initial Orienting And Maintained Attention. *Psychopharmacology* (Berl.) 176, 88–93

Field, M. (2005). Cannabis' Dependence and Attentional Bias For Cannabis-Related Words. *Behavioural Pharmacology*, *16*(5-6), 473-476.

Field, M., & Christiansen, P. (2012). Commentary On, 'Internal Reliability Of Measures Of Substance-Related Cognitive Bias'. *Drug And Alcohol Dependence*. *124*(3), 189-190

Field, M., & Eastwood, B. (2005). Experimental Manipulation Of Attentional Bias Increases The Motivation To Drink Alcohol. *Psychopharmacology*, *183*(3), 350-357.

Field, M., Kiernan, A., Eastwood, B., & Child, R. (2008) Rapid Approach Responses To Alcohol Cues In Heavy Drinkers. *Journal Of Behavior Therapy And Experimental Psychiatry*. *39*(3), 209-218

Field, M., Mogg, K., & Bradley, B. P. (2004). Cognitive Bias And Drug Craving In Recreational Cannabis Users. *Drug And Alcohol Dependence; Drug And Alcohol Dependence.*

Field, M., Mogg, K., Zetteler, J., & Bradley, B. P. (2004). Attentional Biases For Alcohol Cues In Heavy And Light Social Drinkers: The Roles Of Initial Orienting And Maintained Attention. *Psychopharmacology, 176*(1), 88-93.

Field, M., Munafò, M. R., & Franken, I. H. (2009). A Meta-Analytic Investigation Of The Relationship Between Attentional Bias And Subjective Craving In Substance Abuse. *Psychological Bulletin, 135*(4), 589.

Forman-Hoffman, V. (2004). High Prevalence Of Abnormal Eating And Weight Control Practices Among US High-School Students. *Eating Behaviors, 5*(4), 325-336.

Franken, I. H. (2003). Drug Craving And Addiction: Integrating Psychological And Neuropsychopharmacological Approaches. *Progress In Neuro-Psychopharmacology And Biological Psychiatry, 27*(4), 563-579.

Franken, I. H., & Muris, P. (2005). Individual Differences In Reward Sensitivity Are Related To Food Craving And Relative Body Weight In Healthy Women. *Appetite,45*(2), 198-201.

Frederickson, N., & Jacobs, S. (2001). Controllability Attributions For Academic Performance And The Perceived Scholastic Competence, Global Self-Worth And Achievement Of Children With Dyslexia. *School Psychology International, 22*(4), 401-416.

Frith, U., Landerl, K., Frith, C., 1995. Dyslexia And Verbal fluency: More Evidence For A Phonological Deficit. *Dyslexia* 1, 2–11

Giedd, J. N., Blumenthal, J., Molloy, E., & Castellanos, F. X. (2001). Brain Imaging Of Attention Deficit/Hyperactivity Disorder. *Adult Attention Deficit Disorder, 931*, 33-49.

Goldman, M. S., & Rather, B. C. (1993). Substance Use Disorders: Cognitive Models And Architecture. *Psychopathology And Cognition*, 245-295.

Goldstein, R. Z., Woicik, P. A., Lukasik, T., Maloney, T., & Volkow, N. D. (2007). Drug Fluency: A Potential Marker For Current Cocaine Abuse. *Drug And Alcohol Dependence* 89, 97-101.

Goldstone, R. L. (1993). Feature Distribution And Biased Estimation Of Visual Displays. *Journal Of Experimental Psychology: Human Perception And Performance*, 19, 564-579.

Gollwitzer, P. M., & Schaal, B. (1998). Metacognition In Action: The Importance Of Implementation Intentions. *Personality And Social Psychology Review*, *2*(2), 124-136.

Hammersley, R., Marsland, L., & Reid, M. (2003). *Substance Use By Young Offenders: The Impact Of The Normalisation Of Drug Use In The Early Years Of The 21st Century.* Home Office Research Study 261. London: Home Office Research And Statistics Directorate.

Harrison, A. G., & Nichols, E. (2005). A Validation Of The Dyslexia Adult Screening Test (DAST) In A Post-Secondary Population. *Journal Of Research In Reading*, *28*(4), 423-434.

Hester, R., Dixon, V., & Garavan, H. (2006). A Consistent Attentional Bias For Drug-Related Material In Active Cocaine Users Across Word And Picture Versions Of The Emotional Stroop Task. *Drug And Alcohol Dependence*, *81*(3), 251-257.

Hillebrand, J. (2000). New Perspectives On The Manipulation Of Opiate Urges And The Assessment Of Cognitive Effort Associated With Opiate Urges. *Addictive Behaviors, 25,* 139-143.

Hogarth, L., & Duka, T. (2006). Human Nicotine Conditioning Requires Explicit Contingency Knowledge: Is Addictive Behaviour Cognitively Mediated? *Psychopharmacology, 184*(3-4), 553-566.

Hogarth, L., Dickinson, A., & Duka, T. (2009). Detection Versus Sustained Attention To Drug Cues Have Dissociable Roles In Mediating Drug Seeking Behavior. *Experimental And Clinical Psychopharmacology,* 17(1), 21.

Hogarth, L., Dickinson, A., Janowski, M., Nikitina, A., & Duka, T. (2008). The Role Of Attentional Bias In Mediating Human Drug-Seeking Behaviour. *Psychopharmacology,* 201(1), 29-41.

Hogarth, L., Dickinson, A., Janowski, M., Nikitina, A., Duka, T. (2008) The Role Of Attentional Bias In Mediating Human Drug Seeking Behaviour. *Psychopharmacology* 201, 29–41.

Hook, P.E., & Jones, S.D. (2002). The Importance Of Automaticity And Fluency For Efficient Reading Comprehension. *Perspectives*, 28(1), 9-14

Hopper, J. W., Su, Z., Looby, A. R., Ryan, E. T., Penetar, D. M., Palmer, C. M., & Lukas, S. E. (2006). Incidence And Patterns Of Polydrug Use And Craving For Ecstasy In Regular Ecstasy Users: An Ecological Momentary Assessment Study. *Drug And Alcohol Dependence*, *85*(3), 221-235.

Hull, C. L. (1943). 2: Principles of Behavior. *Readings For An Introduction To Psychology*, 5.

Humphrey, N. & Mullins, M. P. (2002) Personal Constructs And Attribution For Academic Success And Failure In Dyslexia, *British Journal Of Special Education*, 29(4), 196–203.

Huxster, J. K., Pirona, A., & Morgan, M. J. (2006). The Sub-Acute Effects Of Recreational Ecstasy (MDMA) Use: A Controlled Study In Humans. *Journal Of Psychopharmacology*, *20*(2), 281-290.

Ikemoto, S., & Panksepp, J. (1999). The Role Of Nucleus Accumbens Dopamine In Motivated Behavior: A Unifying Interpretation With Special Reference To Reward-Seeking. *Brain Research Reviews*, 31(1), 6-41.

Ishai, A. (2007). Sex, Beauty And The Orbitofrontal Cortex. *International Journal Of Psychophysiology, 63*(2), 181–185.

Jacoby, L. L., & Dallas, M. (1981). On The Relationship Between Autobiographical Memory And Perceptual Learning. *Journal Of Experimental Psychology: General*, *110*(3), 306.

Jansma, J. M., Ramsey, N. F., Slagter, H. A., & Kahn, R. S. (2001). Functional Anatomical Correlates Of Controlled And Automatic Processing. *Journal Of Cognitive Neuroscience*, *13*(6), 730-743.

Jasper, L., Jasper, G. I., & Goldberg Adult, A. D. D. ADHD Screening Quiz. 2008. *Adopted From The Printed Edition Of The Jasper/Goldberg Adult ADD Screening Examination For Electronic Distribution*.

Jones, B.T. & Schulze, D. (2000) Alcohol-Related Words Of Positive Affect Are More Accessible In Social Drinkers' Memory Than Other Words When Sip-Primed By Alcohol. *Addiction Research 8*, 221-232

Jones, M.E.E, Parrott, A.C. (1997). Stress And Arousal Rhythms In Smokers And Nonsmokers Working Day And Night Shifts. *Stress Medicine, 13*, 91-9

Jones, B. T. & Schulze, D. (2000). Alcohol-Related Words Of Positive Affect Are More Accessible In Social Drinkers' Memory Than Other Words When Sip-Primed By Alcohol. *Addiction Research*, 8, 221-232.

Kampe, K., Frith, C., Dolan, R., & Frith, U. (2001). Reward Value Of Attractiveness And Gaze. *Nature,* 413, 589.

Kavale, K. A. (1988) The Long-Term Consequences Of Learning Disabilities, In: C. M. Wang, C. M. Reynolds & G. H. Walberg (Eds) *Handbook Of Special Education: Mildly Handicapped Conditions,* Vol. 2 (Oxford, Pergamon), 303–337

Kelly, S. W., Griffiths, S., & Frith, U. (2002). Evidence For Implicit Sequence Learning In Dyslexia. *Dyslexia, 8*(1), 43-52.

Kirk, J., & Reid, G. (2001). An Examination Of The Relationship Between Dyslexia And Offending In Young People And The Implications For The Training System. *Dyslexia, 7*(2), 77-84.

Klein, A. A. (2007). Suppression-Induced Hyperaccessibility Of Thoughts In Abstinent Alcoholics: A Preliminary Investigation. *Behaviour Research And Therapy*, 45(1), 169-177.

Klinger, E., Cox, W. M. (2004) Motivation And The Theory Of Current Concerns. In W. M. Cox & E. Klinger (Eds.), *Handbook Of Motivational Counseling: Motivating People For Change* (Pp. 3–23). Chichester, United Kingdom: Wiley

Klinger, E. (1975). Consequences Of Commitment To And Disengagement From Incentives. *Psychological Review, 82*(1), 1.

Klinger, E. (1977). The Nature Of Fantasy And Its Clinical Uses. *Psychotherapy: Theory, Research & Practice*, *14*(3), 223.

Klinger, E. (1987). Current Concerns And Disengagement From Incentives.*Motivation, Intention, And Volition*, 337-347.

Klinger, E. (1996). Emotional Influences On Cognitive Processing, With Implications For Theories Of Both. *The Psychology Of Action: Linking Cognition And Motivation To Behavior*, 168-189.

Klinger, E., Barta, S. G., & Maxeiner, M. E. (1980). Motivational Correlates Of Thought Content Frequency And Commitment. *Journal Of Personality And Social Psychology*, *39*(6), 1222.

Knowlton, B. J., & Squire, L. R. (1996). Artificial Grammar Learning Depends On Implicit Acquisition Of Both Abstract And Exemplar-Specific Information. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *22*(1), 169.

Kormos, J., & Kontra, H. (2008) *Language Learners With Special Needs : An International Perspective.* Multilingual Matters, Bristol.

Koster, E. H. W., Verschuere, B., Crombez, G., & Van Damme, S. (2005) Timecourse Of Attention For Threatening Pictures In High And Low Trait Anxiety. *Behaviour Research and Therapy.* 43, 1087–1098

Koster, E. H. W., Crombez, G., Verschuere, B., & De Houwer, J. (2006). Attention To Threat In Anxiety-Prone Individuals: Mechanisms Underlying Attentional Bias. *Cognitive Therapy And Research*, *30*(5), 635-643.

Krank, M., Wall, A. M., Stewart, S. H., Wiers, R. W., & Goldman, M. S. (2005). Context Effects On Alcohol Cognitions. *Alcoholism: Clinical And Experimental Research*, *29*(2), 196-206.

Kranz, F., & Ishai, A. (2006). Face Perception Is Modulated By Sexual Preference. *Current Biology, 16,* 63– 68.

Kruschke, J. K., Kappenman, E. S., Hetrick, W. P. (2005) Eye Gaze And Individual Differences Consistent With Learned Attention In Associative Blocking And Highlighting. *Journal Of Experimental Psychology: Learning Memory And Cognition, 31*, 830-45

Laberge, D., & Samuels, S. J. (1974). Toward A Theory Of Automatic Information Processing In Reading. *Cognitive Psychology, 6*(2), 293-323.

Lamb, R. J., Preston, K. L., Schindler, C. W., Meisch, R. A., Davis, F., Katz, J. L., ... & Goldberg, S. R. (1991). The Reinforcing And Subjective Effects Of Morphine In Post-Addicts: A Dose-Response Study. *Journal Of Pharmacology And Experimental Therapeutics*, 259(3), 1165-1173.

Lambert, N. M., Mcleod, M., & Schenk, S. (2006). Subjective Responses To Initial Experience With Cocaine: An Exploration Of The Incentive–Sensitization Theory Of Drug Abuse. *Addiction*, 101(5), 713-725.

Lamm, O. & Epstein, R. (1999) Specific Reading Impairments: Are There To Be Associated With Emotional Difficulties?, *Journal Of Learning Disabilities*, 25(9), 605–615

Lang, C. E., & Bastian, A. J. (2001). Additional Somatosensory Information Does Not Improve Cerebellar Adaptation During Catching. *Clinical Neurophysiology, 112*(5), 895-907.

Leigh, B. C., & Stacy, A. W. (1993). Alcohol Outcome Expectancies: Scale Construction And Predictive Utility In Higher Order Confirmatory Models.*Psychological Assessment*, *5*(2), 216.

Liberman, I. Y., Mann, V. A., Shankweiler, D., & Werfelman, M. (1982). Childrens Memory For Recurring Linguistic And Non-Linguistic Material In Relation To Reading-Ability. *Cortex, 18*(3), 367-375.

Litz, B. T., Payne, T. J., & Colletti, G. (1987). Schematic Processing Of Smoking Information By Smokers And Never-Smokers. *Cognitive Therapy And Research*, *11*(3), 301-313.

Logan, G. D. (1988). Toward An Instance Theory Of Automatization. *Psychological Review,* 95, 492-527.

Lorrain, D. S., Arnold, G. M., & Vezina, P. (2000). Previous Exposure To Amphetamine Increases Incentive To Obtain The Drug: Long-Lasting Effects Revealed By The Progressive Ratio Schedule. *Behavioural Brain Research,* 107(1), 9-19.

Love, A., James, D., & Willner, P. (1998). A comparison of two alcohol craving questionnaires. *Addiction,* 93(7), 1091-1102.

Maccallum, R. C., Zhang, S., Preacher, K. J., & Rucker, D. D. (2002). On The Practice Of Dichotomization Of Quantitative Variables. *Psychological Methods*, 7(1), 19-40.

Mackay, D. G., Shafto, M., Taylor, J. K., Marian, D. E., Abrams, L. & Dyer, J. E. (2004). Relations Between Emotion, Memory, And Attention: Evidence From Taboo Stroop, Lexical Decision, And Immediate Memory Tasks. *Memory & Cognition*, 32, 474-488.

Mackintosh, N. J. (1975) A Theory Of Attention: Variations In The Associability Of Stimuli With Reinforcement. *Psychological Review*, 82, 276-298

Macleod, C., Mathews, A, & Tata, P. (1986). Attentional Bias In Emotional Disorders. *Journal Of Abnormal Psychology*, 95, 15-20.

Macleod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective Attention And Emotional Vulnerability: Assessing The Causal Basis Of Their Association Through The Experimental Manipulation Of Attentional Bias.*Journal Of Abnormal Psychology*, *111*(1), 107.

Maehler, C., & Schuchardt, K. (2009). Working Memory Functioning In Children With Learning Disabilities: Does Intelligence Make A Difference? *Journal Of Intellectual Disability Research, 53*, 3-10.

Marin, G., Sabogal, F., Marin, B. V., Otero-Sabogal, R., & Perez-Stable, E. J. (1987). Development Of A Short Acculturation Scale For Hispanics. *Hispanic Journal Of Behavioral Sciences*, *9*(2), 183-205.

Marlatt, G. A. (1985). Relapse Prevention: Theoretical Rationale And Overview Of The Model. *Relapse Prevention: Maintenance Strategies In The Treatment Of Addictive Behaviors*, 3-70.

Mccann, U. D., Wong, D. F., Yokoi, F., Villemagne, V., Dannals, R. F., & Ricaurte, G. A. (1998). Reduced Striatal Dopamine Transporter Density In Abstinent Methamphetamine And Methcathinone Users: Evidence From Positron Emission Tomography Studies With [11C] WIN-35,428. *The Journal Of Neuroscience, 18*(20), 8417-8422.

Mccusker, C. G. (2001). Cognitive Biases And Addiction: An Evolution In Theory And Method. *Addiction,* 96, 47-57.

Mccusker, J., Bigelow, C., Vickers-Lahti, M., Spotts, D., Garfield, F., & Frost, R. (1997). Planned Duration Of Residential Drug Abuse Treatment: Efficacy Versus Effectiveness. *Addiction, 92*(11), 1467-1478.

Mcdowell, D. M., & Kleber, H. D. (1994). MDMA: Its History And Pharmacology.*Psychiatric Annals, 24*(3), 127-130.

Meyer, D. E., & Schvaneveldt, R. W. (1971). Facilitation In Recognizing Pairs Of Words: Evidence Of A Dependence Between Retrieval Operations. *Journal Of Experimental Psychology, 90*(2), 227.

Mogg K, Bradley BP, Dixon C, Fisher S, Twelftree H, Mcwillians A (2000) Trait Anxiety, Defensiveness And Selective Processing Of Threat: An Investigation Using Two Measures Of Attentional Bias. *Personality And Individual Differences* 28, 1063-1077

Mogg, K., Bradley, B. P., Field, M., & De Houwer, J. (2003). Eye movements to smoking-related pictures in smokers: relationship between attentional biases and implicit and explicit measures of stimulus valence. *Addiction,* 98(6), 825-836.

Mogg, K., & Bradley, B. P. (1998). A Cognitive-Motivational Analysis Of Anxiety.*Behaviour Research And Therapy, 36*(9), 809-848.

Mogg, K., & Bradley, B. P. (2002). Selective Processing Of Smoking-Related Cues In Smokers: Manipulation Of Deprivation Level And Comparison Of Three Measures Of Processing Bias. *Journal Of Psychopharmacology*, 16(4), 385-392.

Mogg, K., Bradley, B. P., & Williams, R. (1995). Attentional Bias In Anxiety And Depression - The Role Of Awareness. *British Journal Of Clinical Psychology, 34*, 17-36.

Mogg, K., Bradley, B. P., Dixon, C., Fisher, S., Twelftree, H., & Mcwillians, A. (2000). Tait Anxiety, Defensiveness And Selective Processing Of Threat: An Investigation Using Two Measures Of Attentional Bias. *Personality And Individual Differences*, 28, 1063-1077.

Mogg, K., Bradley, B. P., Millar, N. & White, J. (1995). A Follow-Up Study Of Cognitive Bias In Generalized Anxiety Disorder. *Behaviour Research And Therapy,* 33, 927-935.

Mogg, K., Field, M., & Bradley, B. P. (2005). Attentional And Approach Biases For Smoking Cues In Smokers: An Investigation Of Competing Theoretical Views Of Addiction. *Psychopharmacology, 180*(2), 333-341.

Moors, A., De Houwer, J., Hermans, D., & Eelen, P. (2005). Unintentional Processing Of Motivational Valence. *The Quarterly Journal Of Experimental Psychology Secton A, 58*(6), 1043-1063.

Murgraff, V., White, D., & Phillips, K. (1999). An Application Of Protection Motivation Theory To Riskier Single-Occasion Drinking. *Psychology And Health,14*(2), 339-350.

Murray, B. D. & Kensinger, E. A. (2012). The Effects Of Emotion And Encoding Strategy On Associative Memory. *Memory & Cognition*, 40, 1056-1069.

Nakagawa S. (2004). A farewell to Bonferroni: the problems of low statistical power and publication bias. *Behavioral Ecology*, 15, 1044-1045.

Nestler, E. J., & Malenka, R. C. (2004). The Addicted Brain. *Scientific American*, 290(3), 78-85.

Nicolson, R. I., & Fawcett, A. J. (1990). Automaticity - A New Framework For Dyslexia Research. *Cognition, 35*(2), 159-182.

Nicolson, R. I., & Fawcett, A. J. (1994). Comparison Of Deficits In Cognitive And Motor-Skills Among Children With Dyslexia. *Annals Of Dyslexia, 44*, 147-164.

Nicolson, R. I., Fawcett, A. J., Berry, E. L., Jenkins, I. H., Dean, P., & Brooks, D. J. (1999). Association Of Abnormal Cerebellar Activation With Motor Learning Difficulties In Dyslexic Adults. *Lancet, 353*(9165), 1662-1667.

Nicolson, R.I. & Fawcett, A.J. (2008). *Dyslexia, Learning And The Brain.* MIT Bradford Press.

Noel, X., Colmant, M., Van Der Linden, M., Bechara, A., Bullens, Q., Hanak, C., Verbanck, P. (2006) Time Course Of Attention For Alcohol Cues In Abstinent Alcoholic Patients: The Role Of Initial Orienting. *Alcoholism: Clinical and Experimental Research* 30, 1871–1877

Norman, P., Bennett, P., & Lewis, H. (1998). Understanding Binge Drinking Among Young People: An Application Of The Theory Of Planned Behaviour. *Health Education Research*, *13*(2), 163-169.

O'Brien, C. P. (2008). The CAGE Questionnaire For Detection Of Alcoholism. *JAMA: The Journal of the American Medical Association,* 300(17), 2054–2056.

O'Doherty, J., Winston, J., Critchley, H., Perret, D., Burt, D., & Dolan, R. (2003). Beauty In A Smile: The Role Of Orbitofrontal Cortex In Facial Attractiveness. *Neuropsychologia,* 41, 147–155.

O'Brien, C. P. (1997). A Range Of Research-Based Pharmacotherapies For Addiction. *Science,* 278(5335), 66-70.

O'Brien, C. P., Childress, A. R., Ehrman, R., & Robbins, S. J. (1998). Conditioning Factors In Drug Abuse: Can They Explain Compulsion?. *Journal Of Psychopharmacology*, 12(1), 15-22.

Orbell, S., & Verplanken, B. (2010). The Automatic Component Of Habit In Health Behavior: Habit As Cue-Contingent Automaticity. *Health Psychology*, *29*(4), 374.

Palfai, T. P. & Ostafin, B. D. (2003). Alcohol-Related Motivational Tendencies In Hazardous Drinkers: Assessing Implicit Response Tendencies Using The Modified IAT. *Behavior Research And Therapy*, 41, 1149-1162.

Palladino, P., Poli, P., Masi, G. & Marcheschi, M. (2000) The Relation Between Metacognition And Depressive Symptoms In Preadolescents With Learning Disabilities: Data In Support Of Borkowski's Model, *Learning Disabilities Research And Practice*, 15(3), 142–149

Parrott A.C., Thurkle, J., & Ward, M. (2000). Nicotine Abstinence: Time Course Of The Mood And Cognitive Performance Changes Over 3 Hours. *International Journal Of Neuropsychopharmacology,* 3, s325.

Parrott, A. C. (1999). Does Cigarette Smoking Cause Stress?.*American Psychologist, 54*(10), 817.

Parrott, A. C. (2000). Cigarette Smoking Does Cause Stress. *The American Psychologist, 55*(10), 1159.

Parrott, A. C. (2004). Heightened Stress And Depression Follow Cigarette Smoking 1. *Psychological Reports, 94*(1), 33-34.

Parrott, A. C. (2006). MDMA In Humans: Factors Which Affect The Neuropsychobiological Profiles Of Recreational Ecstasy Users, The Integrative Role Of Bioenergetic Stress. *Journal Of Psychopharmacology, 20*(2), 147-163.

Parrott, A. C. (2006). Nicotine Psychobiology: How Chronic-Dose Prospective Studies Can Illuminate Some Of The Theoretical Issues From Acute-Dose Research.*Psychopharmacology, 184*(3), 567-576.

Parrott, A. C., Sisk, E., & Turner, J. J. D. (2000). Psychobiological Problems In Heavy 'Ecstasy' (MDMA) Polydrug Users. *Drug And Alcohol Dependence, 60*(1), 105-110.

Paulson, P. E., & Robinson, T. E. (1991). Sensitization To Systemic Amphetamine Produces An Enhanced Locomotor Response To A Subsequent Intra-Accumbens Amphetamine Challenge In Rats. *Psychopharmacology,* 104(1), 140-141.

Pavlidis, G. T. (1991). Diagnostic Significance And Relationship Between Dyslexia And Erratic Eye Movements. In J. F. Stein (Ed.), *Vision And Visual Dyslexia* (Pp. 263-270). London: Macmillan

Perneger, T. V. (1998). What's wrong with Bonferroni adjustments? *British Medical Journal,* 316, 1236-1238.

Perruchet, P., & Pacteau, C. (1990). Synthetic Grammar Learning: Implicit Rule Abstraction Or Explicit Fragmentary Knowledge?. *Journal Of Experimental Psychology: General*, *119*(3), 264.

Pierre, P. J., & Vezina, P. (1998). D1 Dopamine Receptor Blockade Prevents The Facilitation Of Amphetamine Self-Administration Induced By Prior Exposure To The Drug. *Psychopharmacology,* 138(2), 159-166.

Posner, M.I., Cohen, Y. (1984) Components Of Visual Orienting. In *Attention and Performance* Vol. X (Bouma H, Bouwhuis D, Eds), Pp. 531–556, Erlbaum

Pothos, E. M. & Tapper, K. (2010). Inducing A Stroop Effect. *Applied Cognitive Psychology,* 24, 1021-1033.

Pothos, E. M. (2007). Theories Of Artificial Grammar Learning. *Psychological Bulletin*, *133*(2), 227.

Pothos, E. M., & Bailey, T. M. (2000). The Role Of Similarity In Artificial Grammar Learning. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*,*26*(4), 847.

Pothos, E. M., & Cox, W. M. (2002). Cognitive Bias For Alcohol-Related Information In Inferential Processes. *Drug And Alcohol Dependence,* 66(3), 235-241.

Pothos, E. M., & Kirk, J. (2004). Investigating Learning Deficits Associated With Dyslexia. *Dyslexia, 10*(1), 61-76.

Pothos, E. M., & Tapper, K. (2010). Inducing A Stroop Effect. *Applied Cognitive Psychology, 24*(7), 1021-1033.

Pothos, E. M., Calitri, R., Tapper, K., Brunstrom, J. M., & Rogers, P. J. (2009). Comparing Measures Of Cognitive Bias Relating To Eating Behaviour. *Applied Cognitive Psychology*, *23*(7), 936-952.

Powell, J. H., Gray, J. A., Bradley, B., Kasvikis, Y., Strang, J., Barratt, L., & Marks, I. (1990). Cue Exposure As A Treatment For Opiate Dependence: A Theoretical Overview And Some New Data. *Addictive Behaviour*, 15, 339-354.

Powell, J., Bradley, B., & Gray, J. (1992). Classical Conditioning And Cognitive Determinants Of Subjective Craving For Opiates: An Investigation Of Their Relative Contributions. *British Journal Of Addiction*, *87*(8), 1133-1144.

Raberger, T., & Wimmer, H. (2003). On The Automaticity/Cerebellar Deficit Hypothesis Of Dyslexia: Balancing And Continuous Rapid Naming In Dyslexic And ADHD Children. *Neuropsychologia, 41*(11), 1493-1497.

Rafal, R., Davies, J., & Lauder, J. (2006) Inhibitory Tagging At Subsequently Fixated Locations: Generation Of "Inhibition Of Return" Without Saccade Inhibition. *Visual Cognition* 13, 308-323

Ramus, F., Pidgeon, E., & Frith, U. (2003). The Relationship Between Motor Control And Phonology In Dyslexic Children. *Journal Of Child Psychology And Psychiatry, 44*(5), 712-722.

Rather, B.C., Goldman, M.S., Roehrich, L., & Brannick, M. (1992) Empirical Modelling Of An Alcohol Expectancy Memory Network Using Multidimensional Scaling. *Journal Of Abnormal Psychology* 101, 173-183

Rather, B. C., & Goldman, M. S. (1994). Drinking-Related Differences In The Memory Organization Of Alcohol Expectancies. *Experimental And Clinical Psychopharmacology*, *2*(2), 167.

Rather, B. C., Goldman, M. S., Roehrich, L., Brannick, M. (1992). Empirical Modeling Of An Alcohol Expectancy Memory Network Using Multidimensional Scaling. *Journal Of Abnormal Psychology,* 101, 173-183.

Reber, A. S. (1989). More Thoughts On The Unconscious: Reply To Brody And To Lewicki And Hill. *Journal of Experimental Psychology, 118(3),* 242-244.

Reich, R. R., Below, M. C., & Goldman, M. S. (2010). Explicit And Implicit Measures Of Expectancy And Related Alcohol Cognitions: A Meta-Analytic Comparison. *Psychology Of Addictive Behaviors*, *24*(1), 13.

Reneman, L., Booij, J., Schmand, B., Van Den Brink, W., & Gunning, B. (2000). Memory Disturbances In" Ecstasy" Users Are Correlated With An Altered Brain Serotonin Neurotransmission. *Psychopharmacology, 148*(3), 322-324.

Rickard, T. C. (1997). Bending The Power Law: A CMPL Theory Of Strategy Shifts And The Automatization Of Cognitive Skills. *Journal Of Experimental Psychology: General*, 126(3), 288-311.

Robinson, T.E., & Berridge, K.C. (2003). Addiction. *Annual Review of Psychology,* 54, 25–53.

Robinson, T.E. & Berridge, K.C. (1993). The Neural Basis Of Craving: An Incentive-Sensitization Theory Of Addiction. *Brain Research Reviews*, 18, 247-291.

Robinson, T. E., & Berridge, K. C. (2000). The Psychology And Neurobiology Of Addiction: An Incentive–Sensitization View. *Addiction,* 95(8s2), 91-117.

Rochelle, K. S. H., Witton, C., & Talcott, J. B. (2009). Symptoms Of Hyperactivity And Inattention Can Mediate Deficits Of Postural Stability In Developmental Dyslexia. *Experimental Brain Research, 192*(4), 627-633.

Roediger, H. L. (1990). Implicit Memory: Retention Without Remembering.*American Psychologist*, *45*(9), 1043.

Roefs, A., Stapert, D., Isabella, L. A. S., Wolters, G., Wojciechowski, F., & Jansen, A. (2005). Early Associations With Food In Anorexia Nervosa Patients And Obese People Assessed In The Affective Priming Paradigm. *Eating Behaviors*,*6*(2), 151-163.

Roodenrys, S., & Dunn, N. (2008). Unimpaired Implicit Learning In Children With Developmental Dyslexia. *Dyslexia, 14*(1), 1-15.

Roth, H.L., Lora, A.N., & Heilman, K.M. (2002) Effects Of Monocular Viewing And Eye Dominance On Spatial Attention. *Brain* 125, 2023–2035

Salkovskis, P. M., & Reynolds, M. (1994). Thought Suppression And Smoking Cessation. *Behaviour Research And Therapy*, 32(2), 193-201.

Savage, R. S. (2004). Motor Skills, Automaticity And Developmental Dyslexia: A Review Of The Research Literature. *Reading And Writing: An Interdisciplinary Journal*, 17, 301–324.

Sayette, M. A., & Hufford, M. R. (1994). Effects Of Cue Exposure And Deprivation On Cognitive Resources In Smokers. *Journal Of Abnormal Psychology*, *103*(4), 812.

Schacter, D. L. (1985). Multiple Forms Of Memory In Humans And Animals.*Memory Systems Of The Brain: Animal And Human Cognitive Processes*, 351-379.

Schneider, W. & Shiffrin, R. M. (1977). Controlled And Automatic Human Information Processing: I. Detection, Search, And Attention. *Psychological Review*, 84, 1-66.

Schoenmakers, T. M., De Bruin, M., Lux, I. F., Goertz, A. G., Van Kerkhof, D. H., & Wiers, R. W. (2010). Clinical Effectiveness Of Attentional Bias Modification Training In Abstinent Alcoholic Patients. *Drug And Alcohol Dependence*, *109*(1), 30-36.

Schultz, W. (1998). Predictive Reward Signal Of Dopamine Neurons.*Journal Of Neurophysiology,* 80(1), 1-27.

Senchak, M., Leonard, K. E., & Greene, B. W. (1998). Alcohol Use Among College Students As A Function Of Their Typical Social Drinking Context.*Psychology Of Addictive Behaviors*, *12*(1), 62.

Senior, C. (2003). Beauty In The Brain Of The Beholder. *Neuron,* 38, 525–528

Shaywitz, S. E. (1998). Current Concepts - Dyslexia. *New England Journal Of Medicine, 338*(5), 307-312.

Sheeran, P., Aarts, H., Custers, R., Rivis, A., Webb, T. L., & Cooke, R. (2005). The Goal-Dependent Automaticity Of Drinking Habits. *British Journal Of Social Psychology*, *44*(1), 47-63.

Shenker, D., Sorensen, N., & Davis, C. (2009). All Party Parliamentary Group On Alcohol Misuse. *The Future Of Alcohol Treatment Services*. London: Alcohol Concern.

Shepherd, M., Findlay, J. M., & Hockey, R. J. (1986). The relationship between eye movements and spatial attention. *The Quarterly Journal of Experimental Psychology*, 38(3), 475-491.

Sherington, C. S. (1906). *The Integrative Action Of The Nervous System*. Yale University Press.

Shiffrin, R. M., & Schneider, W. (1977). Controlled And Automatic Human Information Processing: II. Perceptual Learning, Automatic Attending And A General Theory. *Psychological Review, 84*(2), 127.

Shimamura, A. P., & Squire, L. R. (1984). Paired-Associate Learning And Priming Effects In Amnesia: A Neuropsychological Study. *Journal Of Experimental Psychology: General, 113*(4), 556.

Snowling, M. (1987). Developmental Dyslexia - A Cognitive-Developmental Perspective. *Bulletin Of The British Psychological Society, 40*, A23-A23.

Sparks, R., Patton, J., Ganschow, L., Humbach, N., & Javorsky, J. (2008). Early first-Language Reading And Spelling Skills Predict Later Second-Language Reading And Spelling Skills. *Journal Of Educational Psychology*, 100, 162–174.

Squire, L. R., Knowlton, B., & Musen, G. (1993). The Structure And Organization Of Memory. *Annual Review Of Psychology, 44*(1), 453-495.

Stacy, A. W. (1997). Memory Activation And Expectancy As Prospective Predictors Of Alcohol And Marijuana Use. *Journal Of Abnormal Psychology*, 106, 61-73.

Stacy, A. W., Ames, S. L., Sussman, S., & Dent, C. W. (1996). Implicit Cognition In Adolescent Drug Use. *Psychology Of Addictive Behaviors*, 10, 190-203.

Stacy, A. W., Dent, C. W., Sussman, S., Raynor, A., Burton, D., & Flay, B. R. (2006). Expectancy Accessibility And The Influence Of Outcome Expectancies On Adolescent Smokeless Tobacco Use. *Journal Of Applied Social Psychology,20*(10), 802-817.

Stacy, A. W., Widaman, K. F., Hays, R., & Dimatteo, M. R. (1985). Validity Of Self-Reports Of Alcohol And Other Drug Use: A Multitrait-Multimethod Assessment.*Journal Of Personality And Social Psychology, 49*(1), 219.

Stanovich, K. E. (1988). Explaining The Differences Between The Dyslexic And The Garden-Variety Poor Reader - The Phonological-Core Variable-Difference Model. *Journal Of Learning Disabilities, 21*(10), 590-&.

Stein, J. (1990). Unstable Binocular Control And Poor Visual Direction Sense In Developmental Dyslexics. In G. Hales (Ed.), *Meeting Points In Dyslexia*. Reading, England: British Dyslexia Association.

Steyer, R., Schwenkmezger, P., Notz, P., & Eid, M. (1997). *Der Mehrdimensionale Be Ndlichkeitsfragebogen [The Multidimensional Mood Questionnaire].* Göttingen: Hogrefe.

Stoodley, C. J., Harrison, E. P., & Stein, J. F. (2006). Implicit Motor Learning Deficits In Dyslexic Adults. *Neuropsychologia, 44*(5), 795-798.

Stormark, K.M., Field, N.P., Hugdahl, K., & Horowitz, M. (1997) Selective Processing Of Visual Alcohol Cues In Abstinent Alcoholics: An Approach-Avoidance Conflict? *Addictive Behavior*. 22, 509–519

Strakowski, S. M., Sax, K. W., Setters, M. J., & Keck Jr, P. E. (1996). Enhanced Response To Repeated D-Amphetamine Challenge: Evidence For Behavioral Sensitization In Humans. *Biological Psychiatry*, 40(9), 872-880.

Stritzke, W. G., Breiner, M. J., Curtin, J. J., & Lang, A. R. (2004). Assessment Of Substance Cue Reactivity: Advances In Reliability, Specificity, And Validity.*Psychology Of Addictive Behaviors, 18*(2), 148.

Stroop, J. R. (1935). Studies Of Interference In Serial Verbal Reactions.*Journal Of Experimental Psychology, 18*(6), 643.

Sun, R., Slusarz, P., & Terry, C. (2005). The Interaction Of The Explicit And The Implicit In Skill Learning: A Dual-Process Approach. *Psychological Review, 112*(1), 159.

Tallal, P. (1980). Auditory Temporal Perception, Phonics, And Reading Disabilities In Children. *Brain And Language, 9*(2), 182-198.

Tapper, K., Pothos, E. M., & Lawrence, A. D. (2010). Feast Your Eyes: Hunger And Trait Reward Drive Predict Attentional Bias For Food Cues. *Emotion*, 10, 949-954.

Tapper, K., Pothos, E. M., Fadardi, J. S., & Ziori, E. (2008). Restraint, Disinhibition And Food-Related Processing Bias. *Appetite*, 51, 335-338.

Theeuwes J, (2005) Irrelevant Singletons Capture Attention. In: Itti, L., Rees, G., Tsotsos, J.K. (Eds.), *Neurobiology Of Attention*. Elsevier Academic Press, London, Pp. 418–424

Thomson, M. E. & Hartely, G. M. (1980) Self-Concept In Children With Dyslexia*, Academic Therapy*, 26, 19–36

Tiffany, S. T. (1990). A Cognitive Model Of Drug Urges And Drug-Use Behavior: Role Of Automatic And Nonautomatic Processes. *Psychological Review*, 97, 147-168.

Tiffany, S. T., & Carter, B. L. (1998). Is Craving The Source Of Compulsive Drug Use? *Journal Of Psychopharmacology, 12*(1), 23-30.

Tirelli, E., & Terry, P. (1998). Amphetamine-Induced Conditioned Activity And Sensitization: The Role Of Habituation To The Test Context And The Involvement Of Pavlovian Processes. *Behavioural Pharmacology*, 9(5-6), 409.

Toates, F. (1997). The Interaction Of Cognitive And Stimulus–Response Processes In The Control Of Behaviour. *Neuroscience & Biobehavioral Reviews*,22(1), 59-83.

Townshend, J. M., & Duka, T. (2007). Avoidance Of Alcohol-Related Stimuli In Alcohol-Dependent Inpatients. *Alcoholism: Clinical And Experimental Research,31*(8), 1349-1357.

Treise, D., Wohburg, J. M., & Otnes, C. C. (1999). Understanding The "Social Gifts" Of Drinking Rituals: An Alternative Framework For PSA Developers. *Journal Of Advertising, 28*, 17-31.

Turner, M. (1997) *Psychological Assessment Of Dyslexia*. London: Whurr, Chapter 11.

Tzelgov, J. (1997). Specifying The Relations Between Automaticity And Consciousness - A Theoretical Note. *Consciousness And Cognition, 6*(2-3), 441-451.

Tzelgov, J. Porat, Z. Henik, A. (1997). Automaticity And Consciousness: Is Perceiving The Word Necessary For Reading It? *American Journal Of Psychology*, 110, 429-448.

Van De Wijngaart, G. F. (1997). Drug Problems Among Immigrants And Refugees In The Netherlands And The Dutch Health Care And Treatment System. *Substance Use & Misuse, 32*(7-8), 909-938.

Van Der Leij, A., & Van Daal, V. H. P. (1999). Automatization Aspects Of Dyslexia: Speed Limitations In Word Identification, Sensitivity To Increasing Task Demands, And Orthographic Compensation. *Journal Of Learning Disabilities, 32*(5), 417-428.

Van Kraayenoord, C. E. & Schneider, W. E. (1999) Reading Achievement, Metacognition, Reading Self-Concept And Interest: A Study Of German Students In Grade 3 And 4, *European Journal Of Psychology Of Education,* 14, 305–324

Van Strien, T., Frijters, J.E.R., Bergers, G.P.A. & Defares, P.B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) For Assessment Of Restrained, Emotional And External Eating Behavior. *International Journal Of Eating Disorders*, 5, 295-315.

Verplanken, A. (1998). Van Knippenberg, & Moonen (1998) B. Verplanken, H. Aarts, A. Van Knippenberg, A. Moonen. *Habit, Information Acquisition, And The Process Of Making Travel Mode Choices, British Journal Of Social Psychology,37*, 111-128.

Vicari, S., Marotta, L., Menghini, D., Molinari, M., & Petrosini, L. (2003). Implicit Learning Deficit In Children With Developmental Dyslexia. *Neuropsychologia, 41*(1), 108-114.

Vinegrad, M. (1994) A Revised Adult Dyslexia Checklist. *Educare No.* 48, Pp. 21-23, March 1994

Warren, R. E. (1972). Stimulus Encoding And Memory. *Journal Of Experimental Psychology,* 102, 151-158.

Waters, A.J., & Feyerabend, C. (2000) Determinants And Effects Of Attentional Bias In Smokers. *Psychology Of Addictive Behaviors* 14, 111-120

Waters, A. J., Shiffman, S., Bradley, B. P., & Mogg, K. (2003). Attentional Shifts To Smoking Cues In Smokers. *Addiction*, *98*(10), 1409-1417.

Weafer, J., & Fillmore, M. (2012) Alcohol-Related Stimuli Reduce Inhibitory Control Of Behavior In Drinkers. *Psychopharmacology:* 1-10

Webb, K. S., Baker, P. B., Cassells, N. P., Francis, J. M., Johnston, D. E., Lancaster, S. L., ... & White, S. A. (1996). The Analysis Of Lysergide (LSD): The Development Of Novel Enzyme Immunoassay And Immunoaffinity Extraction Procedures Together With An HPLC-MS Confirmation Procedure. *Journal Of Forensic Sciences*, *41*, 938-946.

Weinstein, A., & Cox, W. M. (2006). Cognitive Processing Of Drug-Related Stimuli: The Role Of Memory And Attention. *Journal Of Psychopharmacology*,*20*(6), 850-859.

Wickelgren, I. (1997). Getting The Brain's Attention. *Science*, 278(5335), 35-37.

Wiers, R.W. & Stacy, A.W. (2010) Are Alcohol Expectancies Associations? Comment On Moss And Albery (2009). *Psychological Bulletin* 136, 12-16

Wiers, R.W., Bartholow, B.D., Van Den Wildenberg, E., Thush, C., Engels, R.C.M.E., Sher, K.J., Grenard, J., Ames, S.L., Stacy, A.W. (2007) Automatic And Controlled Processes And The Development Of Addictive Behaviours In Adolescents: A Review And A Model. *Pharmacological Biochemical Behavior*. 86, 263–283

Wiers, R. W., Cox, W. M., Field, M., Fadardi, J. S., Palfai, T. P., Schoenmakers, T., & Stacy, A. W. (2006). The Search For New Ways To Change Alcohol-Related Cognitions In Heavy Drinkers. *Alcoholism: Clinical And Experimental Research*, 30, 320-331.

Wiers, R. W., Stacy, A. W., Ames, S. L., Noll, J. A., Sayette, M. A., Zack, M., & Krank, M. (2002). Implicit And Explicit Alcohol-Related Cognitions. *Alcoholism: Clinical And Experimental Research*, *26*(1), 129-137.

Williams, J. M. G., Mathews, A., & Macleod, C., (1996). The Emotional Stroop Task And Psychopathology. *Psychological Bulletin*, 120, 3-24.

Williams, R. J., & Ricciardelli, L. A. (1996). Expectancies Relate To Symptoms Of Alcohol Dependence In Young Adults. *Addiction*, *91*(7), 1031-1039.

Winkelman, P., & Berridge, K. C. (2004). Unconscious Emotions. *Current Directions In Psychological Science,* 13, 120-123.

Winkielman, P., Berridge, K. C., & Wilbarger, J. L. (2005). Emotion, Behavior, And Conscious Experience. *Emotion And Consciousness*, 335.

Wise, R. A., & Bozarth, M. A. (1985). Brain Mechanisms Of Drug Reward And Euphoria. *Psychiatric Medicine,* 3(4), 445.

Wolf, M., & Bowers, P. G. (1999). The Double-Deficit Hypothesis For The Developmental Dyslexias. *Journal Of Educational Psychology, 91*(3), 415-438.

Wood, W., & Neal, D. T. (2007). A New Look At Habits And The Habit-Goal Interface. *Psychological Review, 114*(4), 843.

Wyer Jr, R. S., & Srull, T. K. (1989). *Memory And Cognition In Its Social Context.* Lawrence Erlbaum Associates, Inc.

Yap, R., & Vanderleij, A. (1993). Word-Processing In Dyslexics - An Automatic Decoding Deficit. *Reading And Writing, 5*(3), 261-27

Zuckerman, M. (1992). What Is A Basic Factor And Which Factors Are Basic? Turtles All The Way Down. *Personality And Individual Differences, 13*(6), 675-681.

Appendix

A – Disguised alcohol-use questionnaire from Chapter 2

B – Alcohol craving questionnaire used in Chapter 2 and Chapter 3.

C – MDMA craving measure from Chapter 3 – Parrott (unpublished).

D – Outcome expectancies measure from Chapter 3 – Engels and Bogt (2004).

E – Alcohol outcome expectancies measure from Chapter 3 – Leigh and Stacy (1993)

F – Mood question from Chapter 3 – Stayer et al (1997)

G – Alcohol use questionnaire from Chapter 3

H – MDMA use questionnaire from Chapter 3.

I – AUDIT questionnaire from Chapter 5 and 6.

J – Alcohol PET stimuli from Chapter 5.

K – Alcohol PET questions from Chapter 5.

L – Food PET stimuli from Chapter 5

M – Food PET questions from Chapter 5.

N – Current Concerns word verification pilot. Including: Word stimuli and Categories.

O – Current concerns questions from Chapter 5.

P – Current concerns questionnaires from Chapter 5

Q – UEL substance abuse questionnaire used in Chapter 6 – Parrott (200a).

R – ADC Dyslexia questionnaire used in Chapter 6 – Vinegrad (1994).

S – ADHD questionnaire used in Chapter 6 – Jasper and Goldberg (1995).

T – Priming questionnaire from Chapter 6 – Studying.

U – Priming questionnaire from Chapter 6 – Socialising.

V – Ethics Approval Forms

Appendix A

'General health' questionnaire used in Chapter 2 in order to covertly inquire about alcohol usage.

Questionnaire

Read the questions carefully and be as honest as you can when answering them.

Please tick **Yes** or **No** to each question by using the number '1'. Don't miss any questions out. If in doubt tick the answer that you feel is true most often.

You will encounter some questions that cannot be answered by either 'yes' or 'no'. For these questions, answer in the box provided.

Place a number '1' in either YES or NO.		
	Yes	**No**
EXAMPLE:	1	
1. Do you find difficulty telling left from right?		
2. Is map reading or finding your way to a strange place confusing?		
3. Do you dislike reading aloud?		
4. Do you take longer than you should to read a page of a book?		
5. Do you find it difficult to remember the sense of what you have read?		
6. Do you dislike reading long books?		
7. Is your spelling poor?		
8. Is your writing difficult to read?		
9. Do you get confused if you have to speak in public?		
10. Do you find it difficult to take messages on the telephone and pass them on correctly?		
11. When you say a long word, do you sometimes find it difficult to get all the sounds in the right order?		
12. Do you find it difficult to do sums in your head without using your fingers or paper?		
13. When using the telephone, do you tend to get the numbers mixed up when you dial?		
14. Do you find it difficult to say the months of the year forwards in a fluent manner?		
15. Do you find it difficult to say the months of the year backwards?		

16. Do you mix up dates and times and miss appointments?		
17. When writing cheques do you frequently find yourself making mistakes?		
18. Do you find forms difficult and confusing?		
19. Do you mix up bus numbers like 95 and 59?		
20. Did you find it hard to learn your multiplication tables at school?		
21. Do you consider yourself to be under stress?		
22. Have you ever had surgery?		
23. Have you ever broken any bones?		
24. Do you experience stiff, swollen or painful joints?		
26. Do you experience fatigue or lack of energy?		
27. What is your current weight?		
28. How many hours do you spend in front of a computer per day?		
29. How many hours sleep do you get everyday?		
30. How many hours exercise do you get per week?		
31. How many alcohol units do you drink per week? (Please use the calculator below)		
Alcohol Calculator	How many per week	
Alcopop		
Lager, Bottle		
Wine, Small Glass		
Wine, Large Glass		
Spirit (eg Vodka, Whiskey, Gin, etc.)+ Mixer		
Pint		
Shot (eg. Tequila, sambuca, etc.)		
	TOTAL:	0
32. What is your Daily Dietary Intake for the following:		
No. of cups of coffee		
No. of cups of tea		
Glasses of Coke/Soda		
Glasses of milk		
Glasses of water		
Portions of vegetables		
Amount of sugar		
Chocolates		
Sweets		
Portions of fruit		

Appendix B

Alcohol craving questionnaire used in Chapter 2 and Chapter 3.

Questionnaire

Read the questions carefully and be as honest as you can when answering them.

Please state how strongly the statements relate to your own behaviour by using the number '1'. Don't miss any questions out. If in doubt tick the answer that you feel is true most often.

	Strongly Agree	Agree	Somewhat agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
EXAMPLE		1					
I would accept a drink if it was offered to me now							
Drinking now would make the good things in my life appear even better							
I am missing having a drink now							
It would feel as if the bad things in my life had completely disappeared if I drank now							
I could easily limit how much alcohol I would drink if I had a drink now							
I need a drink now							
My desire to drink now seems overwhelming							
Even major problems in my life would not bother me now if I drank							
I am making plans to drink now							
Drinking now would make me feel on top of the world							
Drinking now would make me feel less tense							
Drinking would be satisfying now							
I would do almost anything to have a drink now							
Drinking now would make the bad things in my life seem less bad							
I crave a drink now							
I would feel more in control of things if I drank							

now							
I would consider having a drink now							
Drinking would be wonderful now							
I might like a drink now							
Nothing would be better than drinking now							
Drinking now would make me feel good							
If I drank now, the small daily hassles would feel less important							
If I had the chance to use alcohol now, I think I would drink							
I have an urge to drink now							
I want a drink so much, I can almost taste it							
Drinking would be pleasant now							
I would feel less worried about my daily problems if I drank now							
I have a desire to drink now							
I am thinking of ways to get alcohol							
I would like a drink now							
Drinking now would make me feel less stressed							
I will have a drink now, whatever gets in the way							
Drinking now would make things seem just perfect							
I am going to drink as soon as I possibly can							
If I started drinking now, I would be able to stop							
All my tension would disappear if I drank now							

Appendix C

MDMA craving measure from Chapter 3 – Parrott (unpublished). When calculating a participant's score, a 'not at all' response would be assigned a value of 0. Also, 'slightly' to 'very strongly' responses received values from 1 to 4 respectively. Therefore, a high craving score would indicate stronger craving.

Self-Report Measure of Craving for MDMA/ecstasy

Place a '1' in the appropriate box

	Not at all	Slightly	Moderately	Strongly	Very strongly
EXAMPLE				1	
1. I crave ecstasy right now.					
2. Sometimes I want to take ecstasy – even in situations where it is not really possible.					
3. If I used ecstasy now, I would feel more accepted by everyone.					
4. When dancing or partying – I need to take ecstasy.					
5. I would feel more emotionally aware if I used ecstasy now.					
6. When on-ecstasy I feel more energetic.					
7. I have an urge to use or take some ecstasy.					
8. When on-ecstasy everyone generally is much nicer.					
9. Taking ecstasy would make me feel better right now.					
10. When planning to take ecstasy - my desire for it gradually becomes stronger.					
11. If a friend offered me some Ecstasy right now – I would take it.					
12. Nothing is better than being-on ecstasy.					
13. I would love some ecstasy right now.					
14. When partying I cannot really enjoy myself without taking ecstasy.					
15. I want some ecstasy now - and do not care how pure it is.					

16. I plan my weekends around when and where I can get ecstasy.					
17. I would like to score some ecstasy right now.					
18. Handling the pills is part of the enjoyment of using ecstasy.					
19. I want to be with friends now - all of us on ecstasy.					
20. I love the build-up of anticipation before taking ecstasy					

Appendix D

Outcome expectancies measure from Chapter 3 – Engels and Bogt (2004).

Which of the following do you associate with ecstasy/MDMA use?

Place a '1' in the appropriate box

	Not at all	Slightly	Moderately	Strongly	Very strongly
EXAMPLE				1	
get into music totally					
makes everything more beautiful					
dance endlessly					
more fun with others					
having in-depth discussions with others					
more sensitive					
makes me a better lover					
confusion					
lack of control					
suspiciousness					
touching is nicer					
nausea					
fear					
edginess					
makes it easier to communicate					
self insight					
depressive/feeling low,					
fainting					
cuddly ('feeling to urge to cuddle')					
headache					
euphoria					
more open for others					
joyfull					
full of energy					
nice to dance with others					
have better sex					
getting into a fantastic mood					
making love is nicer					

get to know oneself better					
kissing is nicer					
dancing is so nice					
dizziness					
feeling incredibly well					
makes me a nicer person					
aggression					

Appendix E

Alcohol outcome expectancies measure from Chapter 3 – Leigh and Stacy (1993)

Alcohol Questionnaire

Here is a list of some effects or consequences that some people experience after drinking alcohol. How likely is it that these things
happen to you when you drink alcohol? Please circle the number that best describes how drinking alcohol would affect you.

(If you do not drink at all, you can still fill this out: just answer it according to what you think would happen to you if you did drink.)

Place a '1' in the appropriate box.

	When I drink alcohol: ___________?"	**No Chance**	**Very Unlikely**	**Unlikely**	**Likely**	**Very Likely**	**Certain to Happen**
0	EXAMPLE				1		
1	I become clumsy or uncoordinated						
2	I am less alert						
3	I feel less stressed						
4	It takes away my negative moods and feelings						
5	I get a headache						
6	I feel more social						
7	I feel ashamed of myself						
8	I am more sexually assertive						
9	I feel guilty						
10	It is fun						
11	I have problems driving						
12	I have a good time						
13	I feel happy						
14	I am more sexually responsive						
15	I am more outgoing						
16	I am friendlier						
17	I feel sick						
18	I feel pleasant physical effects						
19	I feel good						
20	I am able to talk more freely						

21	I become more sexually active						
22	It is easier for me to socialize						
23	I get mean						
24	I have problems with memory and concentration						
25	I enjoy the buzz						
26	I feel sad or depressed						
27	I get a hangover						
28	I get into fights						
29	I can't concentrate						
30	I am able to take my mind off my problems						
31	I experience unpleasant physical effects						
32	I have more desire for sex						
33	I am more accepted socially						
34	I become aggressive						

Appendix F

Mood question from Chapter 3 – Stayer et al (1997)

MOOD QUESTIONNAIRE

Place a '1' in the appropriate box

		Definitely Not	Not	Not Really	A Little	Very Much	Extremely
0	EXAMPLE					1	
1	content						
2	rested						
3	restless						
4	bad						
5	worn-out						
6	composed						
7	tired						
8	great						
9	uneasy						
10	energetic						
11	uncomfortable						
12	relaxed						
13	highly activated						
14	superb						
15	absolutely calm						
16	sleepy						
17	good						
18	at ease						
19	unhappy						
20	alert						

21	discontent						
22	tense						
23	fresh						
24	happy						
25	nervous						
26	exhausted						
27	calm						
28	wide awake						
29	wonderful						
30	deeply relaxed						

Appendix G

Alcohol use questionnaire from Chapter 3

	Male	Female				
Sex						
	Years					
Age						
	Yes	No				
Dyslexia						
	Yes	No				
Seaking drug/alcohol treatment?						
	Yes	No				
Currently employed?						
	Yes	No				
Currently studying?						
	GCSE	ALEVEL	DEGREE	PostGrad		
What is your highest level of education?						
	Today	Tomorrow	This week	Next week	This month	Longer
When do you next intend to have a drink?						
	Today	Tomorrow	This week	Next week	This month	Longer
When do you next intend to get drunk?						
	Today	Yesterday	2 days ago	3 days ago	Week ago	Longer
When did you last have a drink?						
	Today	Yesterday	2 days ago	3 days ago	Week ago	Longer
When did you last get drunk?						
	0- 5 units	6-10 units	11-15 units	16-20 units	21- 25 units	26 + units
Typically, how much alcohol would you drink on a nightout?						
	< 10 units	11-20 units	21-30 units	31-40 units	41-50 units	> 51 units
Typically, how much alcohol do you drinker per week?						
	Yes	No				

Do you use mix your drinks on a nightout?						
	Beer	Lager	Cider	Wine	Spirits	Alcopops
What drinks do you consume on a typical night?						
	Weeks	Months	Years			
How long have you been getting drunk? (insert estimated numbers)						
	Total					
How many occasions have you ever been drinking in the last 30 days? (rough estimate)						
	Yes	No				
Do you go on nights out without drinking?						
	almost never (not	Sometimes (quite difficult)	Often (very difficult)	Always/n early always (impossib		
Do you think that your use of alcohol was out of control?						
Does the prospect of not drinking make you feel anxious or worried?						
Do you worry about your use of alcohol?						
Do you wish you could stop drinking alcohol?						
How difficult do you find it to stop or go without alcohol?						
	Yes	No				
Do you use alcohol weekly?						
Have you had a recent alcohol binge?						
Experienced social problems						
Experienced financial problems						
Experienced legal problems						
Experienced work problems						
Vomited due to alcohol?						

Accessed health services (first aid, ambulance, hospital, or GP) due to alcohol use		
Accessed talk therapy (counsellor, social worker, or psychiatrist) due to alcohol		

Alcohol Units Guide:

Alcopop	1.4
Lager, Bottle	1.7
Wine, Small Glass	1.5
Wine, Large Glass	2.1
Spirit + Mixer	2.0
Pint	2.5

Appendix H

MDMA use questionnaire from Chapter 3.

	Male	Female				
Sex						
	Years					
Age						
	Yes	No				
Dyslexia						
	Yes	No				
Seaking drug treatment?						
	Yes	No				
Currently employed?						
	Yes	No				
Currently studying?						
	<GCSE	GCSE	ALEVEL	DEGREE	PostGrad	
What is your highest level of education?						
	Today	Tomorrow	This week	Next week	This month	Longer
When do you next intend to use ecstasy/MDMA?						
	Today	Yesterday	2 days ago	3 days ago	Week ago	Longer
When did you last use ecstasy/MDMA						
	1 pill	2 pills	3 pills	4 pills	5 pills	6 + pills
Typically, how much ecstasy would you use on a nightout?						
	Less than 1/4 gram	1/4 gram	1/2 gram	3/4 gram	1 gram	More than a gram
Typically, how much MDMA would you use on a nightout?						
	Yes	No				
Do you use ecstasy/MDMA with other drugs on a nightout?						
	Cocaine	Amphetamine	Cannabis	Poppers	Ketamine	LSD
What other drugs do you use?						
	Weeks	Months	Years			

How long have you been taking ecstasy/MDMA? (insert estimated numbers)				
	Ecstasy	MDMA		
How many occasions have you taken ecstasy/MDMA?				
	Yes	No		
Do you go on nights out without taking ecstasy/MDMA?				
	Never/ almost never (not difficult)	Sometimes (quite difficult)	Often (very difficult)	Always/ nearly always (impossible)
Do you think that your use of ecstasy was out of control?				
Does the prospect of missing a dose make you feel anxious or worried?				
Do you worry about your use of ecstasy?				
Do you wish you could stop using ecstasy?				
How difficult do you find it to stop or go without ecstasy?				
	Yes	No		
Do you use ecstasy weekly?				
Have you had a recent drug binge, where you haven't slept for over 48 hours?				
Experienced social problems				
Experienced financial problems				
Experienced legal problems				
Experienced work problems				
'Overdose' attributed to ecstasy				
Accessed health services (first aid, ambulance, hospital, or GP) due to ecstasy use				
Accessed talk therapy (counsellor, social worker, or psychiatrist) due to ecstasy				

Appendix I

AUDIT questionnaire from Chapter 4, 5 and 6.

Alcohol Use Questionnaire

Read the questions carefully. Record your responses carefully in the box provided.

Place the appropriate answer number in the box at the right.

1. How often do you have a drink containing alcohol? (0) Never [Skip to Qs 9-10] (1) Monthly or less (2) 2 to 4 times a month (3) 2 to 3 times a week (4) 4 or more times a week	☐
2. How many drinks containing alcohol do you have on a typical day when you are drinking? (0) 1 or 2 (1) 3 or 4 (2) 5 or 6 (3) 7, 8, or 9 (4) 10 or more	☐
3. How often do you have six or more drinks on one occasion? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily Skip to Questions 9 and 10 if Total Score for Questions 2 and 3 = 0	☐
4. How often during the last year have you found that you were not able to stop drinking once you had started?	

(0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	
5. How often during the last year have you failed to do what was normally expected from you because of drinking? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	
7. How often during the last year have you had a feeling of guilt or remorse after drinking? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking? (0) Never (1) Less than monthly (2) Monthly (3) Weekly	

9. Have you or someone else been injured as a result of your drinking? (0) No (2) Yes, but not in the last year (4) Yes, during the last year	
10. Has a relative or friend or a doctor or another health worker been concerned about your drinking or suggested you cut down? (0) No (2) Yes, but not in the last year (4) Yes, during the last year	

Appendix J

Alcohol PET stimuli from Chapter 5.

Flute	Shorts	Bongos	Bitter
Trombone	Bar	Window	Cello
Trumpet	Invitation	Alcopops	Piano
Queue	Building	Whiskey	Violin
Lager	Mirror	Bassoon	Beer
Card	Telephone	Clarinet	Mouse
Viola	Shoe	Oboe	Read
Brandy	Gin	Chain	Pint
Floor	Off-licence	Keyboard	Vodka
Drink	Bass	Drums	Bagpipes
Booze	Pan	Carpet	Watch
Box	Lamp	Recorder	Maracas
Alcohol	Windshield	Guitar	Stout
Key	Banjo	Wine	Cape
Sherry	Boots	Pub	Spirits

Appendix K

Alcohol PET questions from Chapter 5.

Questions

What percentage of the word list was music related? _______________%

What percentage of the word list was alcohol related? ______________%

What percentage of the word list was neither music nor alcohol related?

______________%

Do you play a musical instrument?

YES/NO

Appendix L

Food PET stimuli from Chapter 5

Road	Cheese	Pastry	Source
Railway	Available	Station	Bus
Lentils	Legislate	Principle	Ticket
Method	Contract	Airport	Train
Milk	Export	Journey	Proceed
Individual	Process	Parking	Indicate
Bicycle	Period	Cake	Concept
Boat	Chips	Potato	Chocolate
Traffic	Data	Candies	Butter
Passport	Grapes	Rice	Onion
Salad	Tram	Car	Sugar
Airplane	Grease	Section	Driving
Taxi	Area	Apples	Assume
Vary	Burgers	Moped	Beans
Estimate	Bread	Similar	Ship

Appendix M

Food PET questions from Chapter 5.

Questions

What percentage of the word list was transport related? ________________%

What percentage of the word list was food related? _______________%

What percentage of the word list was neither transport nor food related?

_______________%

Appendix N

Current Concerns word verification pilot. Note that these are the word stimuli and concerns categories used within the task within Chapter 5.

	Home and Household Matters	Employment and Finances	Health and Medical Matters	Partner, Family, and Relatives	Alcohol Related Matters	Educational Matters	Recreation Matters	Transportation Matters
Partner								
Job								
Kids								
Husband								
Laundry								
Mother								
Employer								
Drugs								
Car								
Party								
Bank								
School								
Gardening								
Grade								
Pub								
Hangover								
Pain								
Bicycle								
Traffic								
Argument								
Nightclub								
Investments								
Ironing								
Bus								
Lecture								
Sport								
Revision								
Moped								
Cleaning								
Music								

Train								
Study								
Drink								
Depression								
Plane								
Television								
Coursework								
Teacher								
Shopping								
Wine								
Theatre								
Relationship								
Illness								
Debt								
Cooking								
Money								
Vodka								
Loan								
Surgeon								
Friendship								
Cinema								
Skate								
Exam								
Walk								
Vacuuming								
Pint								
Pharmacy								
Career								
Bar								
Quiz								
Dentist								
Doctor								
Weight								
Medication								
Polishing								
Sex								
Library								
Washing								
Gym								
Whiskey								
Girlfriend								

Interview								

Appendix O

Current concerns questions from Chapter 5.

Questions

What percentage of the word list was related to:

(Do not worry if your percentages do not exactly add up to 100%)

- Home and Household Matters ________________%
- Employment and Finances ________________%
- Health and Medical Matters ________________%
- Partner, Family, and Relatives ________________%
- Alcohol Related Matters ________________%
- Educational Matters ________________%
- Recreation Matters ________________%
- Transportation Matters ________________%

Appendix P

Current concerns questionnaires from Chapter 5

CURRENT CONCERNS

Place a '1' in the appropriate box.

	How preoccupied with the following topics have you been over the last week?						How do you feel about this area of your life?	
	Not at all	**Very little**	**Slightly**	**Sometimes**	**Frequently**	**Completely**	**Positive**	**Negative**
EXAMPLE				1			1	
Home and Household Matters								
Employment and Finances								
Health and Medical Matters								
Partner, Family, and Relatives								
Alcohol Related Matters								
Educational Matters								
Recreation Matters								
Transportation Matters								

	How important will these areas be to you over the forthcoming week?							
	Not at all	**Very little**	**Slightly**	**Sometimes**	**Frequently**	**Completely**	**Positive**	**Negative**
Home and Household Matters								
Employment and Finances								
Health and Medical Matters								
Partner, Family, and Relatives								
Alcohol Related Matters								
Educational Matters								
Recreation Matters								
Transportation Matters								

	Typically, how important to you are each of these areas?							
	Not at all	**Very little**	**Slightly**	**Sometimes**	**Frequently**	**Completely**	**Positive**	**Negative**
Home and Household Matters								
Employment and Finances								
Health and Medical Matters								
Partner, Family, and Relatives								
Alcohol Related Matters								
Educational Matters								
Recreation Matters								
Transportation Matters								

	How committed are you to increasing your time available for each of the following aspects of you life?							
	Not at all	**Very little**	**Slightly**	**Sometimes**	**Frequently**	**Completely**	**Positive**	**Negative**
Home and Household Matters								
Employment and Finances								
Health and Medical Matters								
Partner, Family, and Relatives								
Alcohol Related Matters								
Educational Matters								
Recreation Matters								
Transportation Matters								

Appendix Q

UEL substance abuse questionnaire
used in Chapter 6 – Parrott (200a) and
CAGE (Ewing, 1984).

Drug Use Questionnaire

1. Alcohol, Tobacco and Cannabis Use

Please indicate your answer by pressing the number '1' in the appropriate box.

EXAMPLE:		1

	NO	YES	
Have you ever smoked tobacco?			
Do you smoke tobacco now?			
If YES, how many cigarettes do you smoke per day on average?			
Do you drink alcohol?			
If YES, how many units of alcohol do you drink in a typical week?			
Do you smoke cannabis?			
If YES, how many times do you smoke per month of average?			

2. Other Drug Use

Which of the following drugs have you taken (indicate with a number '1'), and approximately how many life time?

EXAMPLE:		1	12	

	NO	YES	How many times?	Prefer not to say
Ecstacy/MDMA				
Amphetamine				
Cocaine/Crack				
LSD				

Cannabis				
Barbiturates/ Benzodiazepines (eg Valium)				
Opiates (Heroin, Morphine)				
Magic Mushrooms				
Anabolic Steroids				
Solvents				
Poppers				
Ketamine				
Prozac				

Others (Please specify and indicate how often used, as above): ____________________

____

____

____

____

3. Alcohol Use

Each item of this questionnaire is a question that a person may either agree with or disagree with.
For each item, indicate how much you agree or disagree with what the item says.
Please respond to all the items; do not leave any blank.
Choose only one response to each statement. Please be as accurate and honest as you can be.

Choose from the following four response options:

Very true for me	Somewhat true for me	Somewhat false for me	Very false for me
1	2	3	4

Question	**Your Response**
Have you ever felt the need to cut down on your drinking?	
Have you ever felt annoyed by criticism of your drinking?	
Have you ever had guilty feelings of your drinking?	
Have you ever taken a morning eye opener?	

Appendix R

ADC Dyslexia questionnaire used in Chapter 6 – Vinegrad (1994).

Dyslexia Questionnaire

Look at the questions in the checklist. The questions are all related to different areas of dyslexia.

Read the questions carefully and be as honest as you can when answering them.

Please tick **Yes** or **No** to each question by using the number '1'. Don't miss any questions out. If in doubt tick the answer that you feel is true most often.

Place a number '1' in either YES or NO.		
	Yes	**No**
EXAMPLE:	1	
1. Do you find difficulty telling left from right?		
2. Is map reading or finding your way to a strange place confusing?		
3. Do you dislike reading aloud?		
4. Do you take longer than you should to read a page of a book?		
5. Do you find it difficult to remember the sense of what you have read?		
6. Do you dislike reading long books?		
7. Is your spelling poor?		
8. Is your writing difficult to read?		
9. Do you get confused if you have to speak in public?		
10. Do you find it difficult to take messages on the telephone and pass them on correctly?		
11. When you say a long word, do you sometimes find it difficult to get all the sounds in the right order?		
12. Do you find it difficult to do sums in your head without using your fingers or paper?		
13. When using the telephone, do you tend to get the numbers mixed up when you dial?		
14. Do you find it difficult to say the months of the year forwards in a fluent manner?		
15. Do you find it difficult to say the months of the year backwards?		
16. Do you mix up dates and times and miss appointments?		

17. When writing cheques do you frequently find yourself making mistakes?		
18. Do you find forms difficult and confusing?		
19. Do you mix up bus numbers like 95 and 59?		
20. Did you find it hard to learn your multiplication tables at school?		

Have you ever been diagnosed with dyslexia?		

Appendix S

ADHD questionnaire used in Chapter 6 – Jasper and Goldberg (1995).

Attention Deficit Questionnaire

Instructions: The 24 items below refer to how you have behaved and felt **DURING MOST OF YOUR ADULT LIFE**. If you have usually been one way and recently have changed, your responses should reflect **HOW YOU HAVE USUALLY BEEN**. For each item, indicate the extent to which it is true by checking the appropriate box next to the item.

Place the appropriate answer number in the box provided.

1. At home, work, or school, I find my mind wandering from tasks that are uninteresting or difficult.
   - 0 Not at all
   - 1 Just a little
   - 2 Somewhat
   - 3 Moderately
   - 4 Quite a lot
   - 5 Very much

2. I find it difficult to read written material unless it is very interesting or very easy.
   - 0 Not at all
   - 1 Just a little
   - 2 Somewhat
   - 3 Moderately
   - 4 Quite a lot
   - 5 Very much

3. Especially in groups, I find it hard to stay focused on what is being said in conversations.
   - 0 Not at all
   - 1 Just a little
   - 2 Somewhat

3 Moderately
4 Quite a lot
5 Very much

4. I have a quick temper... a short fuse.
   0 Not at all
   1 Just a little
   2 Somewhat
   3 Moderately
   4 Quite a lot
   5 Very much

5. I am irritable, and get upset by minor annoyances.
   0 Not at all
   1 Just a little
   2 Somewhat
   3 Moderately
   4 Quite a lot
   5 Very much

6. I say things without thinking, and later regret having said them.
   0 Not at all
   1 Just a little
   2 Somewhat
   3 Moderately
   4 Quite a lot
   5 Very much

7. I make quick decisions without thinking enough about their possible bad results.
   0 Not at all
   1 Just a little
   2 Somewhat
   3 Moderately
   4 Quite a lot
   5 Very much

8. My relationships with people are made difficult by my tendency to talk first and think later.
   0 Not at all

1 Just a little
2 Somewhat
3 Moderately
4 Quite a lot
5 Very much

9. My moods have highs and lows.
   0 Not at all
   1 Just a little
   2 Somewhat
   3 Moderately
   4 Quite a lot
   5 Very much

10. I have trouble planning in what order to do a series of tasks or activities.
   0 Not at all
   1 Just a little
   2 Somewhat
   3 Moderately
   4 Quite a lot
   5 Very much

11. I easily become upset.
   0 Not at all
   1 Just a little
   2 Somewhat
   3 Moderately
   4 Quite a lot
   5 Very much

12. I seem to be thin skinned and many things upset me.
   0 Not at all
   1 Just a little
   2 Somewhat
   3 Moderately
   4 Quite a lot
   5 Very much

13. I almost always am on the go.
0 Not at all
1 Just a little
2 Somewhat
3 Moderately
4 Quite a lot
5 Very much

14. I am more comfortable when moving than when sitting still.
0 Not at all
1 Just a little
2 Somewhat
3 Moderately
4 Quite a lot
5 Very much

15. In conversations, I start to answer questions before the questions have been fully asked.
0 Not at all
1 Just a little
2 Somewhat
3 Moderately
4 Quite a lot
5 Very much

16. I usually work on more than one project at a time, and fail to finish many of them.
0 Not at all
1 Just a little
2 Somewhat
3 Moderately
4 Quite a lot
5 Very much

17. There is a lot of "static" or "chatter" in my head.
0 Not at all
1 Just a little
2 Somewhat
3 Moderately
4 Quite a lot

5 Very much

18. Even when sitting quietly, I am usually moving my hands or feet.
    0 Not at all
    1 Just a little
    2 Somewhat
    3 Moderately
    4 Quite a lot
    5 Very much

19. In group activities it is hard for me to wait my turn.
    0 Not at all
    1 Just a little
    2 Somewhat
    3 Moderately
    4 Quite a lot
    5 Very much

20. My mind gets so cluttered that it is hard for it to function.
    0 Not at all
    1 Just a little
    2 Somewhat
    3 Moderately
    4 Quite a lot
    5 Very much

21. My thoughts bounce around as if my mind is a pinball machine.
    0 Not at all
    1 Just a little
    2 Somewhat
    3 Moderately
    4 Quite a lot
    5 Very much

22. My brain feels as if it is a television set with all the channels going at once.
    0 Not at all
    1 Just a little
    2 Somewhat

3 Moderately
4 Quite a lot
5 Very much

23. I am unable to stop daydreaming.
 0 Not at all
 1 Just a little
 2 Somewhat
 3 Moderately
 4 Quite a lot
 5 Very much

24. I am distressed by the disorganized way my brain works.
 0 Not at all
 1 Just a little
 2 Somewhat
 3 Moderately
 4 Quite a lot
 5 Very much

Appendix T

Priming questionnaire from Chapter 6 – Studying.

Please answer each question in turn within the spaces provided next to or beneath each question. (Please keep answers brief)

1. How important to you is studying?

2. Do your friends ever pressure you into studying?

3. Which night(s) do you normally study during a regular week?

4. Do you study as much as you would like to?

5. Do you study better alone?

6. Where do you normally study?

7. Is studying normally a highlight of your week?

8. How many times have you been out drinking in the last two weeks?

9. How many times have you been drunk in the last two weeks?

10. How long is it since you last went drinking? (in days),

11. How many units did you consume the last time you went drinking (1 unit = 1/2 pint or one shot)?

12. On the line below mark (with an X) how strong your typical urge to drink alcohol is:

Strong urge Weak urge

←---→

Appendix U

Priming questionnaire from Chapter 6 – Socialising.

Please answer each question in turn within the spaces provided next to or beneath each question. (Please keep answers brief)

1. How important to you is going out to socialise?
2. Do your friends ever pressure you into socialising?
3. Which night(s) do you go out to socialise during a regular week?
4. Do you socialise as much as you would like to?
5. What things do you usually do with your friends when socialising?
6. Where do you normally socialise with your friends?
7. Is socialising normally a highlight of your week?
8. How many times have you been out drinking in the last two weeks?
9. How many times have you been drunk in the last two weeks?
10. How long is it since you last went drinking? (in days)
11. How many units did you consume the last time you went drinking (1 unit = 1/2 pint or one shot)?

*12. On the line below mark (with an X) how strong your typical urge to drink alcohol is:

Strong urge   Weak urge

←--→

Department of Psychology

ETHICS COMMITTEE

Memo

To: Thomas Wilcockson

From: Professor Ian Thornton
for Departmental Ethics Committee

Copy: Dr. Emmanuel Pothos

Date: 27th October, 2010

Re: Inhibition for Alcohol Stimuli: An Eye Tracking Study

Your proposed study, "Inhibition for Alcohol Stimuli: An Eye Tracking Study", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Subject Pool):**

1. Leave a copy of this approval letter in the folder outside Dr. Irene Reppa's office (room 915b)
   AND
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Thomas Wilcockson**
	Student Number 292017
From:	**Professor Ian Thornton**
	for Departmental Ethics Committee
Copy:	**Dr. Emmanuel Pothos and Professor Andy Parrott**
Date:	**14th April, 2011**
Re:	**Ecstasy and Attentional Bias**

Your proposed study, "Ecstasy and Attentional Bias" has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Thomas Wilcockson**
From:	**Professor Ian Thornton**
	for Departmental Ethics Committee
Copy:	**Dr Emmanuel Pothos**
Date:	**2nd December 2010**
Re:	**New alcohol attention bias measure: The percentage estimation task**

Your proposed study, "New alcohol attention bias measure: The percentage estimation task", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Subject Pool):**

1. Leave a copy of this approval letter in the folder outside Dr. Irene Reppa's office (room 915b)
   <u>AND</u>
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Thomas Wilcockson**	**Student No. 292017**
From:	**Professor Ian Thornton**	
	for Departmental Ethics Committee	
Copy:	**Dr. Emmanuel Pothos**	
Date:	**14th February, 2011**	
Re:	**New Attention Bias Measure: The Percentage Estimation Task[(1)]**	

Your proposed study, "New Attention Bias Measure: The Percentage Estimation Task", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Subject Pool):**

1. Leave a copy of this approval letter in the folder outside Dr. Irene Reppa's office (room 915b)

   <u>**AND**</u>

Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Thomas Wilcockson**	**Student No.**	**292017**
From:	**Professor Ian Thornton**		
	for Departmental Ethics Committee		
Copy:	**Dr. Emmanuel Pothos**		
Date:	**14th February, 2011**		
Re:	**New Attention Bias Measure: The Percentage Estimation Task(2)**		

Your proposed study, "New Attention Bias Measure: The Percentage Estimation Task", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Subject Pool):**

1. Leave a copy of this approval letter in the folder outside Dr. Irene Reppa's office (room 915b)

   AND

Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Thom Wilcockson**
From:	**Professor Ian Thornton**
	for Departmental Ethics Committee
Copy:	**Dr. Emmanuel Pothos**
Date:	**Tuesday, 6th January, 2009**
Re:	**The co morbidity of dyslexia and substance abuse**

Your proposed study, "The co morbidity of dyslexia and substance abuse", has now been reviewed. Provided the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, it was agreed that no substantive ethical issues are raised and you may therefore proceed with your study. Please note that the study is approved subject to comments contained in my email to you dated 18th December 2008.

Please ensure that the signed copy of your Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Subject Pool):**

1. Leave a copy of this approval letter in the blue folder outside Dr. Phil Tucker's office (room 811)
   AND
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Please note that because the EMS system has been modified, an EMS Approval Code and Date of Expiry are no longer required.

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Thom Wilcockson**
From:	**Dr. Jo Saunders**
	for Departmental Ethics Committee
Copy:	**Dr. Emmanuel Pothos**
Date:	**Wednesday, 20th January, 2010**
Re:	**The development of automaticity and attention bias**

Your proposed study, "The development of automaticity and attention bias", has now been reviewed. Provided the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, it was agreed that no substantive ethical issues are raised and you may therefore proceed with your study.

Please ensure that the signed copy of your Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Subject Pool):**

1. Leave a copy of this approval letter in the folder outside Dr. Irene Reppa's office (room 915b)
   <u>**AND**</u>
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Please note that because the EMS system has been modified, an EMS Approval Code and Date of Expiry are no longer required.

O

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Thomas Wilockson**
From:	**Dr. Steve Stewart-Williams**
	for Departmental Ethics Committee
Copy:	**Dr. Emmanuel Pothos**
Date:	**Monday, 23rd August, 2010**
Re:	**Priming and dyslexia**

Your proposed study, "Priming and dyslexia", has now been reviewed. Provided the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, it was agreed that no substantive ethical issues are raised and you may therefore proceed with your study.

Please ensure that the signed copy of your Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Thomas Wilcockson**	**Student No. 292017**
From:	**Professor Ian Thornton**	
	for Departmental Ethics Committee	
Copy:	**Dr. Emmanuel Pothos**	
Date:	**28th March, 2011**	
Re:	**Making Associations Automatic**	

Your proposed study, "Making Associations Automatic", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Subject Pool):**

1. Leave a copy of this approval letter in the folder outside Dr. Irene Reppa's office (room 915b)

   AND

2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).