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**Extended Exposure Paradigms and Alcohol-related
Attentional Bias in Light and Heavy Social Drinkers and in
Problem Drinkers**

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Abstract

It is well-established that the attention of alcoholics (as compared to non-alcoholics, or social drinkers) is captured more by alcohol-related than by neutral stimuli. This phenomenon is called an alcohol-related attentional bias (AAB). It is thought to develop through implicit learning from direct and indirect drinking experiences. Its significance is that once acquired, the AAB is likely to make subsequent drinking decisions more likely—and as a result AAB might be a potential treatment target for reducing consumption.

Limited evidence has suggested that, there might be a differential AAB not only *between* alcoholics and social drinkers but also *within* social drinkers, themselves—between those who are heavier/frequent drinkers and those who are lighter/infrequent drinkers. It is thought that at this level of drinking an AAB is also acquired through implicitly learning from drinking experiences and that it could possibly also impact on future (social) consumption levels.

The traditional paradigms for measuring AAB have been the modified Stroop and visual dot-probe paradigms. In terms of representing the “real world”, the use of these paradigms might be criticised as being simplistic in terms of stimuli presented, tasks instructed and time period employed. To address some of these issues—and to increase the number of types of test for AAB—I have adapted the flicker paradigm for induced change blindness paradigm (flicker ICB paradigm) from visual cognition. In the *traditional* use of the flicker ICB paradigm a single change is implemented in a visual scene and then removed. If the change process is masked and the implementation/removal of the change is cycled, the change takes a surprisingly long time to spot. The theoretical underpinning of this phenomenon implies that the change is not detected unless attention is directed to the object carrying the change.

In my own modification of this paradigm, two (not one) changes are simultaneously made and instructions to detect “the change” are given. In this way

and alcohol-related and a neutral change are made to *compete* for attention. Using this paradigm the AAB hypothesis is that those detecting the alcohol-related change will have higher usual consumption than those detecting the neutral change. What makes this paradigm particularly sensitive to AAB, is the novel feature that the alcohol-related and neutral changes simultaneously compete for attention.

In a series of 12 studies, I have shown that social drinkers detecting the alcohol-related change have consumption levels above those detecting the neutral change: a differential AAB within social drinkers. Further, when the object carrying the alcohol-related change is embedded in the neutral group and the neutral object carrying the change is embedded in the alcohol group, the direction of the AAB is reversed. This suggests that the group of objects (i.e., context) in which the changing object is embedded drives the change detection rather than the changing object, itself. A similar conclusion—that the group or context drives change detection not the changing object—is reached when both changing objects are identically-alcohol or identically-neutral. Finally, the role of the context or group in driving change detection—and therefore underpinning this measure of AAB—was confirmed by embedding the alcohol-changing and neutral-changing objects in groups that did not provide differential alcohol-related and neutral information. Under these latter conditions of test, the AAB disappeared.

In the penultimate experiment reported in this thesis continuous eye-movement monitoring over 30 seconds to the same stimuli as described above (but not incorporating changes or masks) was used to measure attention towards alcohol-related objects even more directly. Using this method a differential AAB within social drinkers was shown using this method. Heavier social drinkers made proportionally more fixations to (and spent proportionally more time on) the alcohol group than lighter drinkers. With these two quite different novel measures of AAB, evidence accrues suggesting a differential AAB within social drinking not just between alcohol abusers/dependents and social drinkers, in general.

In a final experiment the more traditional version of the flicker ICB paradigm (containing a single change) was used to explore AAB in drinkers in treatment in

which for the first time it was shown that AAB increased with alcohol problem severity.

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Declaration

I declare that this thesis is my own work carried out under the normal terms of supervision.

A rectangular box with a red border, used to redact the author's signature.

Gillian Bruce

Publications

Chapter 1 has given rise to:

Bruce, G., & Jones, B. T. (2006). Methods, measures and findings of attentional bias in alcohol use, abuse and dependence. In R. W. Wiers & A. W. Stacy (Eds.), *Handbook of Implicit Cognition and Addiction* (pp. 135–149). Thousand Oaks, CA: Sage.

Chapter 5:

Jones, B. T., Bruce, G., Livingstone, S., & Reed, E. (2006). Alcohol-related attentional bias in problem drinkers with the flicker change blindness paradigm. *Psychology of Addictive Behaviors, 20*(2), 171-177.

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Chapter 1

ALCOHOL-RELATED ATTENTIONAL BIAS

Countries that have evolved extensive financial activity around alcohol beverage manufacture, retail and consumption have an obligation to prosecute basic and applied science research designed to address the considerable problems that can develop when such a potentially harmful and addictive drug is consumed at anything other than responsible levels. Although the manufacture, retail and consumption of alcohol beverages is controlled to some extent through the licensing and excise systems, this is not sufficient to guarantee responsible behaviour in each of these areas of activity. Understanding individual differences in alcohol consumption through basic science research will be an important component in beginning to discharge the obligation referred to above and through applying the results of basic research to address alcohol beverage education, problems treatment and health policy development, the harm associated with the consumption of this highly addictive chemical should be reduced.

This thesis adds to the knowledge on explaining individual differences in alcohol beverage consumption: from infrequent/lighter social drinkers, through more frequent/moderate social drinkers and frequent/heavier social drinkers to those who drink to chronic excess and are often called problem drinkers, alcohol abusers or dependents.

A range of different so-called alcohol cognitions are thought to impact on alcohol beverage consumption decisions and alcohol beverage consumption, itself, and these are briefly reviewed below. Of these alcohol-related cognitions, this thesis addresses alcohol-related attentional bias (AAB).

Alcohol Cognitions

Alcohol Cognitions represent those perceptual and cognitive processes that have been used to explain individual differences in alcohol consumption across the complete range of consumption—lifetime abstinence through moderate and heavy social use, misuse and problem use, abuse and dependence. They include Alcohol

Consumption Outcome Expectancies (e.g., Goldman, 1999; Jones, Corbin, & Fromme, 2001a), Alcohol Consumption Outcome Associations (e.g., Gadon, Bruce, McConnochie, & Jones, 2004; Stacy, 1997) and Physiological and Psychological Alcohol Cue Reactions (e.g., Greeley, Swift, Prescott, & Heather, 1993; Schulze & Jones, 1999) and Alcohol-related Attentional Bias (e.g., Cox, Fadardi, & Pothos, 2006). These alcohol-related cognitions are briefly outlined below.

Alcohol Consumption Outcome Expectancies

Alcohol Consumption Outcome Expectancies (ACOE) are thought to represent structures in the long-term memory directly accessible to or comprising conscious thought. ACOEs which are culturally held are identified through a survey of a large number of people (usually as many as 300) who are asked to provide a list of “what happens when I drink alcohol”. These items are then compacted into an expectancy questionnaire of usually approximately 75 items using methods such as factor analysis (Floyd & Widaman, 1995) and the resultant questionnaire is given to individuals to discover what expectancy items they themselves hold. Individuals’ expectancy scores are then related to their self-reported alcohol consumption using correlational techniques and a very large number of cross-sectional studies have identified a positive relationship. This relationship is usually interpreted as “expectancies cause consumption”. Only a few longitudinal studies have tested “cause” properly, however, and those that have provide limited evidence for the causal assumption (see Jones et al., 2001a).

The critical test of the expectancy-consumption relationship is to manipulate expectancies however and measure subsequent consumption changes over the short, medium and long term. But as Jones et al. (2001a) review there are few studies that are designed sufficiently well to test this hypothesis and the evidence for the causal relationship has yet to be consistently found.

Alcohol Consumption Outcome Associations

Alcohol Consumption Outcome Associations (ACOAs) are thought to reside in associative memory where links between representations of an individual's world are made. It might, for example, be a link between feeling relaxed (an outcome) and drinking alcohol (a behaviour)—and that the strength of that link or “association” differs from individual to individual depending on their experiences. In another person the link might be with listening to Mozart rather than drinking.

The important difference between ACOEs and ACOAs is that an individual appears to know which expectancies they hold but does not appear to know which associations they hold—i.e., the former is an explicit construct (available to consciousness) while the latter is an implicit construct (not available to consciousness).

In developing this approach Stacy, Leigh and Weingardt (1994) replaced the standard ACOE questionnaire with questionnaires whose outcomes included either alcohol consumption outcomes (e.g., “feeling relaxed”) or outcomes of quite different behaviours (e.g., “feeling fulfilled”). Importantly, whereas traditional ACOE questionnaires explicitly implicate alcohol through both the title (e.g., An Alcohol Consumption Outcome Expectancy Questionnaire”) and the participants’ instructions (e.g., “Which items apply to you when you drink alcohol?”) Stacy et al.’s and Gadon et al.’s (2004) “Associations Questionnaires” and their instructions (e.g., “What behaviour of your would cause this to occur?”) make no explicit reference to alcohol nor to its consumption.

By coding participants’ responses to each item on the association questionnaire as an alcohol consumption response or not, Stacy et al. (1994) and Gadon et al. (2004) use this implicit methodology to measure the extent to which the semantic content of each item *primes* alcohol-related thought in an otherwise alcohol-neutral context. Exploring the relationship between the extent of the priming and self-reported consumption provides, perhaps, a safer route to understanding consumption variability through memory structures than as outlined

for ACOEs. For, as McCusker (2001, p51) explains “Such methods do not rely on what people “say”; about what they think, but rather make inferences about cognitive processes and structures based on behavioural responses (e.g., on memory, priming, reaction time or perceptual tasks).”

Alcohol Cue Reactions

Alcohol Cue Reactions traditionally measured physiological responses to alcohol-related stimuli in alcoholics. More recently, however, there has been an interest in measuring subjective cue reactivity (feelings, urges and even cravings) putting it more in the area of psychology than physiology. Subjective cue reactivity has been measured by asking participants to rate their desire to drink on an analogue scale following exposure to alcohol-related cues (Greeley et al., 1993), and more recently by Schulze and Jones (1999) by using self-completed questionnaires and relating the responses to different levels of consumption. A little like ACOA research, this research tries to discover what prompts alcohol-related thoughts, drinking decisions and consumption.

Alcohol-Related Attentional Bias

Alcohol-related Attentional Bias (AAB) is thought to be highly influential in causing alcoholics to maintain/return to drinking even when they are aware of the negative consequences of their behaviour (e.g., Cox, Hogan, Kristian & Race, 2002; Lusher, Chandler & Ball, 2004). It has been suggested that AAB causes alcohol-related objects to be more salient than they would otherwise be and as a result they capture attention more, enter consciousness more and therefore impact on drinking decisions and consumption more (e.g., Cox et al., 2006). This raises the questions: What is AAB? How does it arise? In addition it raises the related question: Who has it?

An AAB is said to be present when alcohol-related stimuli have more impact on cognitive life than would otherwise be expected. Using paradigms from cognitive

psychology, (employing alcohol-related and neutral stimuli) the presence of such a bias has been demonstrated as participants with an AAB respond differently to those alcohol-related stimuli than to other categories of stimuli. Depending on the task, performance may be impaired (e.g., in the alcohol Stroop) or facilitated (e.g., in the visual dot probe). This difference in performance is described as an AAB and using a variety of paradigms, several studies have shown this—these will be reviewed later.

AAB refers to the general difference in behaviour towards alcohol-related and non alcohol-related stimuli and has, until recently, been assumed present in alcohol abusers/problem drinkers but not in social drinkers. More recent studies, however, have suggested that an AAB may occur in both alcohol abusers/problem drinkers and also in some social drinkers, but that in social drinkers it is at a diminished level. The occurrence of an AAB in social drinkers is, perhaps, unsurprising as other alcohol cognitions (e.g., ACOEs) have been shown to be present at the social drinking level. Furthermore, as AAB is thought to arise as a result of implicit learning through both direct and indirect drinking experiences and therefore increases as the level of consumption increases, then it might be predicted that an AAB would occur within social drinkers and that it may even vary with the level of habitual social drinking.

Prior to the commencement of this thesis, the occurrence of an AAB in individuals drinking to an abusive/problem level was widely shown (more than 20 studies). Within social drinkers, however, this was not the case—studies which had investigated AAB in social drinkers were both limited in number (less than 10) and inconsistent in their findings. Since then the number of studies investigating AAB at both the abusive/problem and social drinking levels has increased. Taken together with the studies reported in this thesis it would appear that AAB in social drinkers is a robust phenomenon.

The paradigms used to measure AAB (at the alcoholic level and social drinking level) and their strengths and weakness are reviewed below.

Paradigms

Only a small number of paradigms (from cognitive psychology) have been used to explore AAB. By the beginning of my thesis work (2003) they comprised 5 in number: the modified Stroop, the visual dot probe, the Posner, the dual task and the artificial grammar learning paradigms. Within the AAB research using the above paradigms more than 75% has been carried out with the modified Stroop (now called the alcohol Stroop) and more than 75% of the remaining research with the visual dot probe. My undergraduate and postgraduate research has introduced a sixth: the flicker paradigm for induced change blindness (the flicker ICB paradigm). The following section is designed to identify the common principles of the five traditional paradigms for exploring AAB before turning to the details of the findings and subsequently to a discussion of the flicker ICB paradigm and the similarities and differences between it and the more traditional paradigms used to explore AAB. Of the 13 experiments reported in this thesis, 12 were carried out using the flicker ICB paradigm.

The principle behind each of the paradigms traditionally used in AAB research is the same. Namely, that some behaviour is measured on an instructed task. The extent to which that instructed behaviour changes in response to a distracter stimulus is taken as a measure of the extent of the distraction; which, in turn, is taken as a measure of the extent to which attentional resources have been assigned to the distracter. It is not an important point but should nevertheless be noted that different paradigms implement the distracter in different ways and depending on which paradigm is considered, the distracter might be predicted to cause either an increase in performance on the instructed task or a decrease. In general, the change in performance on the instructed task when the distracter is alcohol-related is compared with the performance when the distracter is neutral to alcohol. The extent of this difference represents the extent of the AAB.

This principle will be used to describe each of the traditional paradigms below, before reviewing their findings, and introducing the flicker ICB paradigm.

Stroop Paradigm

Stimuli are presented in different colours and the instructed task is to identify the colour as quickly and as accurately as possible while ignoring all other aspects of the stimulus. The instructions are to respond to the stimulus by saying its colour, or by pressing a corresponding colour coded buttons, or both. Within the general principle outlined above, the colour to-be-named can be called the instructed stimulus.

For an AAB to be manifest, it is predicted that in the presence of alcohol-related stimuli, colour-naming reaction times will be slowed as compared with colour-naming reaction times in the presence of neutral stimuli. Within Stroop research, this change is called an interference effect; from which it is inferred that the semantic content of the stimulus (i.e., its alcohol-relatedness) uses up processing resources that would otherwise be used for colour-naming. This is equated to the capturing of attentional resources. In the Stroop paradigm the semantic content (i.e., its alcohol-relatedness) of the stimulus is the distracter stimulus. The instructed stimulus and the distracter stimulus are spatially co-located in this paradigm.

Visual Dot Probe Paradigm

In the case of the visual dot probe paradigm, and in contrast to the Stroop paradigm, the instructed and the distracter stimuli are spatially dislocated. Typically the instructed task is to detect as quickly as possible the appearance of the instructed stimuli and its location—it is usually a small dot or cross. Immediately prior to its appearance, a pair of distracter stimuli is momentarily and simultaneously deployed—which have to be ignored. Of this pair the semantic content of one stimulus is alcohol-related and the semantic content of the other neutral. For half of the trials the instructed stimulus appears in the location from where the alcohol-related stimulus of the distracter pair disappeared and in the other half in the location from which the neutral stimulus of the distracter pair disappeared.

For an AAB to be manifest it is predicted that reaction times to the appearance of the instructed stimulus when it is in the location from which the alcohol-related stimulus disappears will be quicker as compared with the reaction times to the appearance of the instructed stimulus when it is in the location from where the neutral stimuli disappears. From this difference, it is inferred that attention has been already directed towards the alcohol-related location rather than the neutral location. This is equated to the semantic content of the alcohol-related distracter capturing attentional resources more than the neutral content.

Dual Task Paradigm

In the dual task paradigm there are two tasks each with their own stimuli. In the centrally-presented instructed task there are numerical stimuli which are presented on every trial—the primary instructed task and stimuli. The primary task is to make an *odd* or *even* numerical decision and respond accordingly through coded buttons. Instructions are to fixate on the primary task. In the secondary instructed task, text stimuli are presented, but only on some trials, and in the periphery of the primary task. The secondary stimuli comprise a single word from one of three categories—i.e., alcohol-related, semantically-related, semantically-unrelated—or a non word. The secondary instructed task—while still fixating and carrying out the primary instructed task—is a lexical decision task through a different pair of coded buttons.

For an AAB to be manifest it is predicted that (i) reaction times on the primary instructed numerical decision task will be slowed in the presence of alcohol-related secondary stimuli and also that (ii) on the secondary instructed lexical decision task, that reaction times to alcohol-related stimuli will be less than to other stimuli. This equates to the alcohol-related stimuli capturing attentional resources.

Using the principle outlined earlier in this section, the secondary instructed stimuli act as the distracter stimuli for the primary task. It is less clear how the lexical task, itself, fits into the principle, however.

Posner Paradigm

Similar to the visual dot probe paradigm, in the Posner paradigm the instructed and the distracter stimuli are dislocated. The instructed task requires participants to fixate a central cross and then respond to the instructed stimuli and its location as quickly as possible by pressing a corresponding. Immediately prior to the appearance of the instructed stimuli, a distracter is presented in one of two locations. In common with the Stroop and dot probe paradigms, this distracter may be alcohol-related or neutral. If the instructed stimulus appears in the same location as the distracter stimulus the trial is described as *valid*, if it appears in the other location it is described as *invalid*. Furthermore, on half of the trials the distracter stimulus is displayed for a very brief period (< 200 msec) and on the other half a longer period (> 1000 msec). For invalid trials only, it is predicted that only automatic processes could be responsible for any differences in reaction time to alcohol-related or neutral cues when the distracter stimulus is presented for the short time period, but that voluntary avoidance process may govern the reaction times when the distracter stimulus is presented for long periods.

With respect to the invalid trials, for an automatic AAB to be manifest, it is predicted that when the distracter stimulus is presented for the shorter time period (< 200 msec) participants will show longer reaction times when the distracter stimulus is alcohol-related than when it is neutral.

Furthermore, with respect to invalid trials, for an avoidance strategy to alcohol-related distracter stimuli to be manifest, it is predicted that when the distracter stimulus is presented for the longer time period (> 1000 msec) that reaction times should be greater when the distracter stimuli are neutral than when they are alcohol-related.

Artificial Grammar Learning Paradigm

In the artificial grammar learning paradigm, stimuli comprising sequences of symbols (the distracter stimuli) with a fixed set of grammatical rules indicating legal sequences are presented. Prior to the instructed task participants are presented with several such sequences to observe—a training set. For half of the participants the symbols in the training sequences are alcohol-related and for the other half they are neutral. In the instructed task participants are presented with new sequences (a testing set) and asked to judge whether they are grammatical or not. Participants are given the same type of sequences in training as in testing—i.e., those given the alcohol-related training are given the alcohol-related testing set.

For an AAB to be manifest, it is predicted that participants will show impairment on the task when the sequences of stimuli are alcohol-related compared with when they are neutral. This is equated to the alcohol-related (semantic) symbols of the distracter stimulus being processed rather than the sequencing that give rise to grammatical rule abstraction.

The different studies using the above paradigms in investigating AAB at different levels of alcohol consumption are reviewed below, starting with the Stroop which represents, by far, the majority.

It should be noted that in the following literature review the names used by the authors to describe each group have been retained so that while some studies might use alcohol abusers others might use problem drinkers. This does not reflect any differences in level of use between such groups.

Literature Review

Review of Stroop Literature

In the original Stroop task (Stroop, 1935) participants were presented with a list of colour words (e.g., red, blue, green, etc.) which were printed in different ink colours – e.g., the word red might be printed in blue ink. Participants were asked to name the colour in which the word was presented (blue) while ignoring the meaning

of the word (red)—i.e., they were asked to respond to the perceptual properties of the word whilst ignoring its semantic properties. It was found that when the semantic and perceptual properties were incongruent (e.g., the word red was printed in blue ink) that participants took longer to respond than when the perceptual and semantic properties were congruent (e.g., the word red was printed in red ink). This slowed reaction time has been called a Stroop effect and it has been suggested that it occurs because of a response conflict, as the participants automatic response is to read the word, while the task asks them to colour name it.

In the modified Stroop the colour words are replaced with concern-related words and words which are chosen to be neutral. These are again presented in different ink colours and as in the original Stroop task the participant is told to ignore the content of the word and name the colour in which it is presented. It has generally been shown that participants take longer to colour name words which are related to their current concerns than to neutral words (e.g., Reimann & McNally, 1995) and it has been suggested that this delayed colour naming occurs because attention is captured by the concern related words, in spite of the participants' attempts to ignore the content and attend only to the colour (Williams, Mathews and MacLeod, 1996), in other words because of an attentional bias towards them. Many different "concerns" have been investigated using the emotional Stroop. These include smoking (e.g., Munafo, Mogg, Roberts, Bradley & Murphy, 2003); anxiety (e.g., Mogg, Bradley, Millar & White, 1995), depression (e.g., Hill & Knowles, 1991), anorexia nervosa (e.g., Jones-Chesters, Monsell & Cooper, 1998) and gambling (e.g., Kertzman, Lowengrub, Aizer, Ben Nahum, Kotler & Dannon, 2006).

Alcohol abuse and to a lesser extent social drinking has also been studied using a modified, or alcohol, Stroop. These studies are reviewed below.

Alcohol Abuse

Prior to the first alcohol Stroop study (Johnsen, Laberg, Cox, Vaksdal & Hugdahl, 1994) the Stroop had been used to measure attentional bias in other clinical areas. As it had previously been suggested (Laberg, 1990) that attentional biases

were very important in mediating behaviour when alcoholics were in “high risk situations” and also in predicting the likelihood of relapse it was thought that the Stroop might be of some use as a tool to provide a better understanding of this.

The basic Stroop findings.

To test their hypothesis Johnsen et al. (1994) conducted a Stroop with 18 alcoholic male inpatients and 18 male employees from local community centres who were matched in age. To implement their Stroop task they used 3 categories of stimuli—alcohol-related, neutral and colour words—and four colours—red, green, yellow and blue. Each of the 3 categories comprised 20 words and the alcohol-related and neutral words were matched on character length. These stimuli were presented on a computer monitor and each remained on the screen until a response was made, or 6 seconds had elapsed—i.e., an automated Stroop. A block design was employed in which participants were presented with one category of stimuli, then a second and finally the third (the order of the blocks was counterbalanced across participants). Participants were required to both verbally report the colour in which the stimuli were presented and also press one of four coloured buttons. Reaction times to the vocal response were measured using a microphone and the experimenter noted the response to check for accuracy, although error rates were very low.

Prior to analyses, reaction times greater than 6 seconds were removed. Johnsen et al. (1994) found, as they had predicted, the group of alcoholics’ raw reaction times to alcohol-related stimuli was greater than to neutral stimuli but this difference was not found in controls. This supported their AAB hypothesis and was in line with Tiffany’s (1990) theory, which suggests that when an alcohol-related word is read it triggers another automatic or uncontrolled process, which unlike controlled processes are difficult to inhibit. They reason that through experience with drug use these processes gradually develop.

Stetter, Ackermann, Bizer, Straube and Mann (1995) also point to the previous use of the Stroop in other areas, but not alcohol. They suggest that alcoholics develop a disease-related bias and that this should be visible through

delayed colour-naming of alcohol-related words in a Stroop task. To test this, Stetter et al. used 40 alcoholic inpatients (abstinent for at least 7 days) and 40 social drinking control participants (matched for age and verbal IQ). Stimuli comprised 100 alcohol-related words and 100 neutral words (household terms) presented in a blocked format with the presentation order balanced across participants. In contrast to the previous study, however, Stetter et al. adopted the original method of presentation in Stroop studies in which stimuli were presented on a card—in this case with each card containing 4 columns of 25 words. Participants were asked to read through the entire card, responding verbally to the colour of ink that each word was presented in. The total time to complete each card was measured using a stopwatch.

As in Johnsen et al.'s (1994) study, raw reaction times to the alcohol-related and neutral stimuli were used in analyses. This revealed there to be a significant difference between the alcoholic group and the control group in the time taken to colour name the alcohol-related stimuli but no difference in the time taken to colour name the neutral stimuli—supporting the AAB hypothesis

In addition, a secondary method was used to analyse the data—total response time to the neutral card was subtracted from total response time to the alcohol-related card for each participant. This provided an alcohol interference time for each participant, which differed from the method used in the original analysis in which the alcohol interference time was calculated for each group. Several subsequent studies have employed this method of calculating alcohol interference times (which are also referred to as alcohol interference scores).

In this study a significant difference in the predicted direction was shown in the alcohol interference times between the alcoholics and control group—again supporting the AAB hypothesis. Furthermore, although not significant, even the social drinking controls displayed a decrease in task performance when the stimuli were alcohol-related. This was perhaps the first observation that there might be an AAB in social drinkers.

Stetter et al. (1995) suggest that the AAB towards alcohol-related stimuli in the alcoholics (as shown through the delayed colour-naming of alcohol-related stimuli) occurs as a result of a spreading activation network (Collins & Loftus, 1975) in which there are alcohol-related and neutral nodes. In line with Collins and Loftus' theory, they suggest that as a result of their previous alcohol consumption that alcohol-related nodes will be more easily activated in alcoholics than in control participants and therefore when an alcohol-related word is presented it will activate nodes which are closely-related to it and therefore interfere with the colour naming task. In the controls, however, this would not be the case, thus resulting in greater Stroop interference in the alcoholics. Stetter et al. also propose that although they failed to find a relationship, a correlation between problem severity and amount of alcohol interference should exist—a later experiment in this thesis will refer to this. Their main point was that if the Stroop can reliably measure AABs in alcoholic then it might provide a better method of assessment than self-rating scales as it avoids denial biased responses.

Taken together these two studies show that using two different methods of the Stroop task an AAB can be found in alcoholics as compared with control subjects. What has not been addressed by these two studies however is whether it is the alcohol-relatedness of the alcohol-related words, or their “emotional valence” that is responsible for the Stroop effect.

Emotional valence in the Stroop effect.

To test this possibility Bauer and Cox (1998) conducted a Stroop study in which they used 4 stimulus categories—alcohol-related, positive emotional, negative emotional and neutral—rather than just the usual 2 alcohol-related and neutral categories. The 4 categories were constructed by taking words for each category which were used in previous studies and asking 25 alcohol abusers (not taking part in the study) to rate them on a likert scale for emotional valence. Ten words from each of the 4 categories were then chosen so that the alcohol-related, positive emotional and negative emotional words were equated on emotional valence and the

neutral words were significantly lower on emotional valence. The words were then used to construct a 2 block automated Stroop test in which each block comprised a randomised presentation of each of the 10 words from the 4 categories in each of the colours red, yellow, blue and green (so that each block contained 160 words). Each word was presented until the participant responded or for 1500 msec. The Stroop test was given to 20 male inpatient alcohol abusers, who were recruited 2 weeks after detoxification and 20 male blue-collar workers from the treatment centre who were demographically similar to the alcohol abusers. Following completion of the Stroop the participants were asked to rate the stimuli for emotional valence on a likert scale. This rating revealed there to be an interaction between the rating of the emotional valence of the different types of word and the type of drinker (alcohol abuser or non-abuser). Alcohol abusers rated the alcohol-related words more highly on emotional valence than the positive emotional words and non-abusers rated the positive emotional words more highly than the alcohol-related words. This result suggests that Bauer and Cox's attempt to control for emotionality of the words was not entirely successful.

Prior to analyses, Bauer and Cox (1998) calculated interference times for each of the different groups of words by taking the mean reaction time to neutral words and subtracting this from the mean reaction time to the alcohol-related words, the positive emotional words and the negative emotional words. There were three interference times for each participant. Alcohol interference scores were significantly higher than positive interference scores or negative interference scores both in the alcoholic group and in the control group. From this Bauer and Cox concluded that alcohol-related words were "attention grabbing" to drinkers in general, and that the AAB was not specific to the alcohol abusers. They also suggest that the AAB which has been inferred from previous Stroop studies is likely to have been as a result of the alcohol content of the words and not as a result of the emotional content.

There could, however, be a number of reasons that account for Bauer and Cox (1998) obtaining such results. First, they do not report the drinking level of

their non-abusers, stating only that it was significantly different from that of the abusers. It is therefore, possible that their non-abusers may have been heavy drinkers (no consumption information is provided) which would be in line with subsequent studies which have shown there to be an AAB in heavy social drinkers. Second they employed blue-collar hospital workers as their control group and it is possible that such a population may have developed an AAB for reasons other than their own alcohol consumption (for example, their concern about patients' problems or their own passive exposure to others' problem drinking aspects).

Subsequent to Bauer and Cox's (1998) study, Stormark, Laberg, Nordby and Hugdahl (2000) were also interested in whether the emotional content of the words was responsible for the delayed colour-naming of alcohol-related words in alcoholics. They utilised alcohol-related, neutral, emotional and colour words in their Stroop paradigm. Each category comprised four high frequency words and each of these words was presented four times (once in each of the 4 colours red, green, yellow and blue) so that four blocks of 16 trials was created. The blocks were then counterbalanced across participants and within each block words were randomly presented in an automated Stroop task. Prior to analyses, any wrong responses, or those greater than 4 seconds were discarded. Stormark et al. tested a group of alcoholics ($n = 23$) entering treatment (but before treatment had started) and used a social drinking control group ($n = 23$) which comprised staff and students from the University of Bergen. Using this design, Stormark et al. showed slower colour naming of the alcohol-related words than the neutral words in the alcoholics but not in the controls—a Stroop effect. Furthermore, unlike Bauer and Cox, Stormark et al. showed slower colour-naming of the emotional words than the neutral words in the alcoholic group—a difference not present in the control group and one which would suggest that the AAB towards alcohol-related words might be as a consequence of the emotional component of the alcohol-related words. It is, however, difficult to make direct comparisons between these two studies as they have several differences which may account for Bauer and Cox showing delayed colour-naming in their control group while Stormark et al. did not.

First, and perhaps most importantly, Bauer and Cox (1998) used blue-collar hospital workers as their control group, whereas Stormark et al. (2000) used university students and staff. It is likely, therefore, that the controls in Bauer and Cox's study were exposed to alcohol-related stimuli, concepts and concerns on a daily basis making them much more familiar with them than the controls in Stormark et al.'s study. Consequently they may display a greater AAB than would be expected for their consumption levels.

Second, Bauer and Cox (1998) presented their stimuli randomly, whereas Stormark et al. (2000) used a blocked presentation. There is some evidence that suggests that when stimuli are randomly presented that there might be a carryover effect (e.g. Sharma, Albery & Cook, 2001; Waters, Sayette & Wertz, 2003)) which causes delayed colour-naming to neutral words which follow those with some form of "emotional content" and consequently decreasing the chance of observing an effect. Such a carryover effect may have caused a reduction in the likelihood of finding a difference in AAB in Bauer and Cox's study between the alcoholics and controls. Furthermore it has been suggested that any effects of carryover are augmented when response is made verbally (Sharma & McKenna, 1998).

Third, in Stormark et al.'s (2000) study response was via a button press, whereas Bauer and Cox (1998) asked participants to respond verbally. It has been suggested that a larger Stroop effect is elicited when response is vocal rather than by button press (MacLeod, 1991).

It would therefore appear that several methodological issues may account for the lack/presence of an AAB in the social drinking controls of these two studies and also for the difference in results between these two studies. While some of these aspects are addressed in later studies, the role of the emotional component of the alcohol-related stimuli in the Stroop task remains unclear.

A personalised Stroop and follow-up study.

Cox, Blount and Rozak (2000) set out to investigate the effect of alcohol-related and concern-related stimuli in both abusers and non-abusers of alcohol set

within the Motivational Theory of alcohol use (Cox and Klinger, 1998). They suggest that “concern-related” stimuli are likely to be distracting in the Stroop task. As a consequence they propose that as purchasing and consuming alcohol (for example) represent “long standing personal concern(s)” for alcohol abusers then stimuli which are related to alcohol should result in delayed colour-naming. They propose that in non-abusers, on the other hand, that as other concerns (e.g., financial, family) are more important than those related to alcohol, then delayed colour-naming to such concern-related stimuli should be greater than to alcohol-related stimuli. This was tested this, using an automated Stroop test with alcohol-related, concern-related and neutral stimuli.

To represent their alcohol-related stimuli, Cox, Blount et al. (2000) employed words which were linked to alcohol or its use were chosen and for the neutral stimuli words which were thought to be “lacking in emotional valence were chosen”. For the concern-related stimuli a different procedure was chosen to select words for the alcohol abusers than for the non-abusers. In the alcohol abuser group each participant was asked to complete the Motivational Structure Questionnaire (Klinger, Cox & Blount, 1995) around 1 week prior to taking part in the experiment and, based on the results of this, concern-related stimuli was chosen for each participants. These concern-related stimuli included words such as divorce. For the control group, however, each participant was presented with a list of 8 life areas and asked to identify those which had caused them the greatest concern in the preceding 24 hours. The areas were those used previously by Young (1990) and included, for example, education and finances. For each participant the area which was shown to cause the greatest concern was chosen and the words which had previously been used by Young to represent that concern were employed. For the alcohol abusers, Cox, Blount et al. used 24 words to represent each category and for the non-abusers 10 words to represent each category. These were then used in an automated Stroop task.

Unlike all previous alcohol Stroop studies, Cox et al. (2000) presented two words simultaneously—one from one of the three categories and one colour word.

These were both presented in black letters and had the colour word on the left for 50% of the trials and on the right for the other 50% in a random order. Participants were asked to respond to the colour as quickly as possible by verbalising its name of the colour and by pressing either a button which had the three coloured patches (red, yellow and orange) or a separate button with three other coloured patches (blue, purple and green) depending on the colour word which was presented.

Reaction times were measured and, prior to analyses, interference times were calculated for the alcohol-related stimuli by subtracting the mean reaction time to neutral stimuli from the mean reaction time to alcohol-related stimuli. The same procedure was used to calculate interference times to concern-related stimuli. This showed that, as expected, the interference from the alcohol-related stimuli was significantly greater than from the neutral stimuli in the alcohol abusers. For the non-abusers, however, there was no difference in the level of interference for the alcohol-related or concern words. From this Cox et al. (2000) postulate that alcohol abusers might have a greater level of concern towards alcohol than towards other concerns in their life.

As a result they believe that future studies should perhaps focus on the motivation to drink in alcohol abusers who show alcohol-related and concern-related abusers as this might help with diagnosis and treatment. Accordingly, this study was followed up by Cox, Hogan, Kristian and Race (2002), who returned to the idea of investigating distraction from stimuli related to an individual's personal concerns. Thus similar to the previous study stimuli were personalised for each participant (although unlike the previous study in which only concern-related stimuli were personalised, this time both alcohol-related and concern-related stimuli were personalised).

To personalise the alcohol-related stimuli, participants were each presented with 30 brand name logos of alcohol beverages and asked to rate them on a 10-point likert scale. The top 10 for each participant were chosen. Concern-related stimuli were individualised by asking each participant about important personal concerns in the major areas of life. This included area such Employment and Finances, Health

and Medical Matters, Family, Alcohol-related Matters and Other. The first two mentioned in each category were used for each participant. Neutral stimuli comprised strings of 6 keyboard symbols such as &&&&&&. Within each group each word was presented 3 times in each of the four colours red, green, blue and yellow so that blocks of 120 stimuli were created. These blocks were then used to create an automated Stroop in which the stimuli remained on the screen until a response was made. The order of the blocks was counterbalanced across participants and within each block stimuli presentation was randomised.

On admission to treatment participants were recruited and tested and then tested again prior to discharge (approximately 1 month later). Control subjects were also tested twice with approximately the same length of time between the two testing sessions as the alcohol abusers.

Prior to analyses, interference scores for alcohol-related and concern-related stimuli were calculated by subtracting the mean time to neutral stimuli to the mean time to alcohol-related stimuli and to concern-related stimuli for each participant. Analyses were carried out using both the raw times and the interference times.

Results revealed that alcohol abusers who did not complete treatment had significantly higher interference scores for concern-related stimuli at the initial testing time than alcohol abusers who completed treatment or the control group, while those who completed treatment did not. Moreover, in general, when asked to judge their concerns the alcohol abusers reported more negative concerns than the than control group. Consequently, in accordance with Cox and Klinger's theory of motivation (1998) it is likely that if alcohol abusers are distracted by these concerns then they are less likely to be motivated to remain in treatment.

Furthermore, of the participants who completed treatment, those who were unsuccessful at the 3 month follow up showed an increase in AAB, as measured by alcohol interference score from time 1 to time 2, while those who were successful, like the controls showed little difference. Across the two time periods there was no significant differences in concern-related interference—i.e., concern-related attentional bias—for either group, suggesting that the increase in AAB is linked to

the unsuccessful treatment outcome. Cox et al. (2000) point out that although there was no difference in AAB between alcohol abusers who were successful in treatment and controls, that the controls were heavy drinkers and that they would expect to see a lesser AAB if the control group comprised light social drinkers. Like Bauer and Cox (1998) it is however possible that by recruiting control participants from an alcohol treatment centre, the AAB they show may be as a result of something other than their usual alcohol consumption.

Surprisingly, since this study it would appear that no other studies have measured AAB pre and post-treatment nor have carried out follow-ups.

More recent Stroop replications.

In a return to Stroop studies similar to the first four, Sharma et al. (2001) sought to investigate factors which they believed might have been influential in earlier studies and also some which had not previously been addressed in alcohol Stroop studies. Accordingly, they identified methodological issues from these that they wish to address.

First they suggest that habituation maybe responsible for the usual difference in alcohol interference between problem drinkers and controls and, therefore, that it may be, as suggested by Bauer and Cox (1998), that alcohol-related stimuli are “attention-grabbing” for drinkers in general, but that the social drinker are able to habituate to such stimuli more quickly than problem drinkers.

Evidently unaware of Stormark et al.’s (2000) paper, they also reason that all previous alcohol Stroop studies had used vocal responses (although some also used manual) and as previous studies have shown carryover effects when emotional stimuli are employed, particularly when the response method is vocal (Sharma & McKenna, 1998) then this might reduce interference effects when stimuli are randomly present and vocal responses are employed (e.g., Bauer and Cox, 1998). They also suggest that although previous studies have employed social drinkers as a control group that within social drinkers there is a large range in level of drinking

and that as a result any effect of alcohol interference that might be present in heavier social drinkers may be masked by the performance of the lighter social drinkers.

To investigate these issues, Sharma et al. (2001) conducted the first study which incorporated different levels of social drinker. They employed three groups of drinkers – problem drinkers ($n = 20$), heavier/frequent ($n = 20$) and lighter/infrequent social drinkers ($n = 20$). Problem drinkers were recruited from abstinent problem drinkers who were receiving treatment at a local community alcohol service and social drinkers were recruited from undergraduate psychology students.

Ignoring the issue of emotionality/concern, they used two categories of stimuli – alcohol-related ($n = 25$) and neutral words ($n = 25$). Each of the neutral words was matched to an alcohol-related word for word length and word frequency and no significant difference in word length was observed between the two categories. The alcohol-related words were taken from a previous study and the neutral words, some from a previous study, (McKenna & Sharma, 1995) were tested for their fit within the category of environmental features. To allow for any effect of habituation to be observed, the 25 alcohol-related words were divided so that the first 5 comprised a block, the second five a block and so on until 5 blocks of alcohol-related stimuli had been created. Within each block each word was then presented in each of the four colours, red, green, blue and brown so that each block contained 20 stimuli (which were presented randomly). The same procedure was carried out with the neutral stimuli so that there were 100 alcohol-related stimuli and 100 neutral stimuli in total. Half the participants were presented with all 5 blocks of alcohol-related stimuli followed by all five blocks of neutral stimuli and the other half the neutral stimuli followed by the alcohol-related stimuli. Responses were via a button box with four buttons with the words blue, brown, red and green written on them.

Using mean reaction times rather than interference scores, Sharma et al. (2001) found that both problem drinkers and heavier social drinkers showed an AAB (although at a reduced level than in the problem drinkers), but the lighter social drinkers did not. When however, the analysis only included the heavier and lighter

social drinkers and not the alcoholics, the effect disappeared—i.e., there was no AAB in the heavier as compared with lighter group. In addition, they found no effect of habituation, suggesting that the AAB was not as a result of problem drinkers taking longer than the social drinkers to habituate to the alcohol-related stimuli. Through this, Sharma et al. were therefore the first to show a different AAB at two different levels of social drinking but in a more exacting analysis the different AAB disappeared.

Following Sharma et al.'s (2001) study, Ryan (2002) carried out Stroop a task in which he compared the performance of detoxified alcoholics ($n = 32$) to control subjects ($n = 33$) who were recruited from staff at the alcohol treatment clinic. Ryan chose the control group from the alcohol treatment unit as he reasoned that they would be familiar with the alcohol-words and therefore minimise any difference in the effect of expertise (e.g., Dalgleish, 1995). In line with previous studies Ryan predicted that the alcoholics would show greater interference from alcohol-related stimuli. To test this, he employed a card presentation Stroop in which stimuli comprised 5 alcohol-related words which were chosen from a list generated by staff at an alcohol treatment unit and 5 neutral words which were deemed semantically homogeneous. Each of the 5 alcohol-related words was presented 10 times in each of the four colours, red, blue, green and brown to create card of 50 alcohol-related words. The same procedure was used to create the neutral cards and within each card word and colour order was random. Participants were presented with two alcohol cards followed by two neutral cards (the order was counterbalanced across participants) and asked to read the list of colours in which the words were presented. Response times to each the card was measured using a stopwatch.

An initial ANOVA using raw reaction times revealed that the control group was faster to colour-name both alcohol-related and neutral words. Furthermore, both groups were faster at colour-naming the neutral words than the alcohol-related words. Contrary to Ryan's (2002) predictions, however no interaction was found. Regardless of this, interference times for each participant were nevertheless

calculated by subtracting the time taken to colour name the neutral words from the time taken to colour name the alcohol-related words. As controls' response times were quicker across alcohol-related and neutral words, in other words their responses were faster in general, the interference scores allow for easier comparison of the amount of slowing or interference produced by the alcohol-related stimuli given the different baseline response times of the two groups. In this study when the interference times were compared for the two groups, the difference between them was in the predicted direction (although not significant), with the interference times being greater for the alcoholics than controls. In addition to comparing the interference times across groups Ryan also used in multiple regression analysis to investigate the relationship between alcohol interference and a variety of different variables that the authors thought might be predictive of Stroop interference. This revealed that as problem severity (as measured by the Severity of Alcohol Dependence Questionnaire, SADQ, Stockwell, Hodgson, Edwards, Taylor & Rankin, 1979) increased so to did the interference score. It was also shown that the duration of problem drinking in alcoholics or regular social drinking in controls was positively correlated with interference. Unexpectedly, Ryan found that amount of alcohol consumed on a typical drinking occasion was negatively correlated with interference.

Following on from the Stroop studies described above, all of which have shown an AAB in alcohol abusers—and some of which have shown an AAB to also be present in the control group—Lusher et al. (2004) ran a Stroop study in which they investigated the effect of mood on AAB. Lusher et al. recruited 64 alcohol abusers from those attending an outpatient centre. Control subjects ($n = 64$) were recruited from GP waiting rooms. Alcohol-related ($n = 8$) words were collected during a pilot study from alcohol abusers in treatment and neutral words ($n = 8$) were household words which were matched on length and number of syllables to the alcohol-related words. Lusher et al. avoided using words which are closely related to a colour (e.g., grass, sky) as it has been shown that such words produce interference when the colour of presentation is incongruent to the suggested (e.g.,

green for grass) colour (e.g., Klein, 1964). These were used to create an automated Stroop task in which the 8 alcohol-related and 8 neutral words were each presented twice to create a block. Within the block the words were randomly presented and remained on the screen until a response had been made via one of 4 coloured keys. The colours red, blue, yellow and green were randomly used in the presentation of the words.

Mean correct reaction times were used as the dependent variable in analyses. An ANOVA revealed a significant interaction between Group (alcoholic and control) and stimulus type (alcohol-related and neutral) which, as predicted, showed that when compared to the control groups, the alcoholics spent longer responding to the alcohol-related stimuli than the neutral stimuli—i.e., showed an AAB.

They suggest their results could be explained by Tiffany's (1990) theory as with an increase in drinking an increase in the automatic processing of alcohol-related stimuli occurs—or alternatively their results could be explained by Robinson and Berridge's (1993) incentive sensitization theory which suggests that repeated drug use (in this case alcohol use) leads to neural sensitisation which in turn causes alcohol-related stimuli to be “highly salient”.

Mood information was collected using the profile of mood states short form (POMS-SF, McNair, Lorr & Droppleman, 1981) and alcohol abusers also completed the severity of dependence questionnaire (SADQ, Stockwell et al., 1979). Multiple regression was then carried out using alcohol interference times as the dependent variable. This included group (alcohol vs. control), age, gender, mood and school leaving age as predictor variables. Of these, only group—i.e., alcoholic or control—was a significant predictor of alcohol-related interference.

Finally, within the alcoholic group two sub groups (low, $n = 31$, and high, $n = 33$) were created by performing a median split on the SADQ scores. An ANOVA was then performed to investigate any differences in reaction time to alcohol-related and neutral stimuli by these two groups. As predicted participants spent longer responding to alcohol-related stimuli than to neutral stimuli, but there was no effect of group and no interaction.

While Ryan (2002) found evidence of increased interference with increased problem severity Lusher et al. (2004) did not. This may, however be as a consequence of method of analysis as while Ryan used multiple regression, Lusher et al. employed an ANOVA, dividing the problem drinkers into two groups using a median split method, which is most insensitive.

Social Drinking

The studies described above have consistently shown an AAB in problem drinkers. While some have also shown an AAB—although to a lesser extent—in social drinking controls, to this point, no studies have used to the Stroop to investigate AAB exclusively within social drinkers.

Potentiated AAB using the Stroop.

Cox, Yeates and Regan (1999) became the first to do so. They employed heavy and light social drinkers to investigate whether any differences were present at these two levels. They reasoned that as previous studies have shown evidence of alcohol-related cognitions in some non-problem (i.e., social) drinkers, it might be reasonable to expect Stroop interference differences between at these two levels of drinking.

To test this possibility, Cox et al. (1999) recruited light and heavy social drinkers to participate in their study. The Stroop task comprised 4 blocks of stimuli—an alcohol-related, a music-related and a neutral block and a block containing XXXX. With the exception of the block of XXXX, each of other blocks contained 20 words and the order of the blocks was counterbalanced across participants. Within each block the colours red, green, yellow and blue were each used five times and responses were made via 4 colour-coded buttons. Prior to, and during the Stroop task half of the light drinkers and half of the heavy drinkers were exposed to alcohol-related cues and the other half of each group to music-related cues. Cox et al. found that in the presence of alcohol-related cues, that heavier drinkers showed significantly longer reaction times than any other group of

participants suggesting an AAB in the heavier drinkers but only when they were exposed potentiated by alcohol-related cues.

Jones and Schulze (2000) also employed a Stroop task involving social drinkers and investigating the effect of priming (although this time through sip priming). Unlike Cox et al. (1999) however, Jones and Schulze were not interested in investigating differences in AAB at different levels of social drinking, rather they focussed on using the Stroop as a tool to investigate the use of a recognition paradigm rather than the more usual recall paradigms (e.g., Associations Questionnaires) in investigating the accessibility of positive and negative alcohol expectancies in memory. To do this Jones and Schulze used positive alcohol-related words ($n = 12$), negative alcohol-related words ($n = 12$), positive alcohol-unrelated words ($n = 12$) and negative alcohol-unrelated words ($n = 12$) and a category of XXXX. The words forming each category were chosen based on previous studies and were matched as closely as possible for length, word frequency and emotional impact. Blocks of 120 stimuli, in which each word was presented five times in blue and 5 times in red, were constructed for each category. With the exception of the category of XXXX, which was always presented in third position (i.e., in the middle), the order of presentation of the blocks was counterbalanced across participants in an automated Stroop task in which stimuli remained on screen until response was made via one of two colour coded buttons. In line with previous studies, participants were also asked to verbalise the colour (verbal information was, however, not processed). Jones and Schulze recruited 60 social drinking participants from their local university campus and divided them into two groups—Group A (the alcohol group) and Group S (the soft drink group). Group A were then asked to choose a drink from a selection alcoholic drinks (containing approximately 1 UK unit of alcohol), and Group S were asked to choose from a selection of soft drinks. Participants were told to sip their drinks while providing pre-experimental information, and also to do so during the breaks between blocks of the experimental task, but only to consume half and to keep the other half until after they had completed the task. This meant that the alcohol group had consumed around half a

unit of alcohol by the end of testing. When an analysis was conducted on the median raw reaction times no significant effects were found. As in previous studies, however, when interference scores were calculated and used for analyses a significant interaction was found. This revealed the interference scores for the group of participants who were given the alcohol prime to be greater to the positive alcohol-related stimuli than to the positive alcohol-unrelated, negative alcohol-related and negative alcohol-unrelated. Moreover the interference scores for the group of participants given the alcohol prime were also higher than those of the group given the soft drink prime on positive alcohol-related and positive alcohol-unrelated, but not than negative alcohol-related and negative alcohol-unrelated. This suggests that when primed with alcohol, social drinkers display an AAB to positive alcohol-related but not to negative alcohol-related words which represent alcohol outcome expectancies.

Similar to Jones and Schulze's (2000) study, but not designed to investigate AAB towards positive and negative alcohol-related expectancies in social drinkers who were sip primed, but rather to investigate the effect of priming on AAB at different levels of social drinker Cox, Brown and Rowlands (2003) also employed a Stroop task. To prime their participants, they were told that they would be given a beverage to evaluate and that this might be alcoholic or non-alcoholic. For the alcoholic beverage beer was used because of its "high odour salience", and for the soft drink Lucozade was chosen as it is not related to alcohol and is thought to be desirable to drink. Participants were given either of the above and told to smell it, but not taste it and then asked to complete a questionnaire about the beverage.

Immediately after completing the questionnaire participants were given an alcohol Stroop task in which there were four categories—alcohol-related, non-alcoholic beverage-related, cleaning product-related and XXXXX. Other than the XXXXX category, each category contained 10 brand name and 10 generic words. These were each presented twice in the colours red, yellow, green and blue in a card presentation Stroop. Participants were asked to colour-name each of the words and

the time taken to compete each card was timed using a stopwatch and the order of the cards was randomised across participants.

Cox et al. (2003) hypothesized that there should be a greater AAB in heavier than lighter drinkers and that alcohol cue exposure should increase AAB—using regression techniques a positive relationship was shown between alcohol consumption and AAB, but this was only shown for the participants who were in top third in terms of alcohol consumption when they exposed to the alcohol cues. Like the previous 2 studies this has shown and AAB in heavier over lighter social drinkers, but only when there has been some method of alcohol priming used—i.e., a potentiated AAB.

In the first Stroop study to show two qualitatively different AABs at two different levels of social drinking Kramer and Goldman (2003) employed an alcohol Stroop task to investigate the associational strength of expectancy words. Like Jones and Schulze (2000) they reason that, in line, with cognitive psychology research that implicit measures are most suitable for this as they avoid participant bias. Unlike previous Stroop tasks Kramer and Goldman employed a Stroop task which involved priming participants with alcohol-related or neutral beverage words prior to each word that they had to colour name. The words to be colour named were expectancy words from four different categories—arousing expectancy, sedating expectancy, negative expectancy and positive expectancy (these were taken from previous research) and the paradigm was tested for its ability to detect priming effects. Based on previous research they hypothesised that alcohol primes would cause delayed colour naming of arousing expectancy words in heavy but not light social drinkers and also cause delayed colour naming of sedating expectancy words in light but not heavy social drinkers. Their hypothesis was supported, showing for the first time two qualitatively different AABs—one to arousing and one to sedating expectancy words—at two different levels of social drinker.

An un-potentiated Stroop study.

In the most recent Stroop study investigating AAB at the level of social drinking Bruce and Jones (2004) returned to the more usual automated Stroop without any priming. There was one major difference between Bruce and Jones' study and all previous alcohol Stroop studies, however—stimuli were pictorial rather than lexical. Although new to alcohol, the pictorial Stroop has previously been used (to a very limited extent) in other areas as it has been suggested that pictorial stimuli might be more appropriate/ecologically valid to examine attentional bias (e.g., Thorpe & Salkovskis, 1997; Mansell, Clark Ehlers & Chen, 1999 and Lubman, Peters, Mogg, Bradley & Deakin, 2000). Moreover, further support for this approach may be taken from Townshend and Duka (2001), who, using pictorial and lexical stimuli in a dot probe paradigm found an AAB in social drinkers with the pictorial, but not to the lexical stimuli.

In Bruce and Jones' (2004) pictorial Stroop task, participants were shown pictures which were presented through different filter colours. Similar to the more usual textual Stroop participants were required to name the colour in which the picture is presented as quickly as possible, while trying to ignore the content of the picture.

To implement their Stroop paradigm Bruce and Jones (2004) used both scenes and objects which were alcohol-related (5 scenes, 5 objects) and neutral (5 scenes, 5 objects). The neutral stimuli comprised household scenes and objects which were matched as closely as possible for shape and size to the alcohol-related scenes and objects. Similar to Constantine, McNally and Hornig (2001), who used the pictorial Stroop to investigate snake fear, coloured filters were then used so that the stimuli appeared as if seen through coloured glasses. Each of the ten alcohol-related stimuli and the ten neutral stimuli were presented randomly three times (once in each of the 3 colours, red, green and yellow) to create a block containing 60 trials which was then presented as an automated Stroop in which stimuli remained on the screen until a response was made via one of three coloured buttons. The block was then repeated five times (each time with random order of presentation).

Bruce and Jones (2004) employed 30 participants and performed a median split to create a group of 15 heavier and a group of 15 lighter social drinkers. Alcohol interferences scores were calculated for each participant and it was shown that the interference was greater in the heavier drinkers than in the lighter drinkers, supporting the AAB hypothesis and providing the first Stroop data to show a differential AAB between two levels of social drinker without priming. Moreover, in addition to the differences between the heavier and lighter social drinkers, Bruce and Jones found a positive correlation between interference and alcohol consumption when this was tested for all participants. Although this only reached significance in the 1st block, it adds to the evidence that as alcohol consumption increases so to does AAB—in other words along the continuum of alcohol consumption there is a related continuum in alcohol cognitions. Although this is the only pictorial alcohol Stroop study, taken alongside Townshend and Duka's (2001) dot probe study it suggests that lexical stimuli might, in fact not be not sensitive enough to consistently show an AAB at this level of alcohol consumption.

Conclusions from alcohol Stroop Studies.

It would therefore appear that the Stroop can reliably be used to show an AAB in problem drinkers, but that when used in social drinkers this is not the case. In the studies reviewed earlier with problem drinkers, in which the social drinkers generally served as a control group, some authors have shown an AAB in the social drinking group while others have not. Furthermore, in the three lexical Stroop studies investigating AAB within social drinkers, all have used some method of priming to induce an AAB. Bruce and Jones' (2004) pictorial Stroop is the only alcohol Stroop study to date which shows a differential AAB within social drinkers (although Sharma et al., 2001, show such an effect when three levels of drinker are used—heavy and light social drinker and abuser—the effect disappears when the group of abusers are removed from the analysis). It would therefore appear that consistent with other alcohol cognitions, AAB exists at the social drinking level, but that the Stroop (or at least in its textual form) might not provide the best method of

measuring it. The other paradigms which have been used to investigate AAB will now be reviewed.

Review of Visual Dot Probe Literature

The visual dot probe paradigm was originally developed to investigate attentional bias in emotional disorders (MacLeod, Matthews & Tata, 1986). In the visual dot probe task two words (or pictures) are simultaneously presented. These then disappear and one is replaced by a dot probe to which the participant is required to respond as quickly as possible, usually by pressing one of two buttons which represent the two possible locations. It was reasoned that the visual dot probe task might provide a better method of investigating attentional bias than the Stroop as the target and distracter components of the stimulus could be dislocated. It therefore is postulated that if attention is captured by a certain type of stimuli then response should be quicker when the dot probe replaces that stimuli than when it is in the opposite location to it.

Alcohol Abuse

It would appear that no studies have used the visual dot probe task to investigate AAB in alcohol abusers.

Social Drinkers

Following its success at eliciting an attentional bias to emotional threat words in anxiety patients (MacLeod et al., 1986) and drug-related pictures in opiate addicts (Lubman et al., 2000), Townshend and Duka (2001) employed the visual dot probe paradigm to investigate AAB in social drinkers. All AAB studies to this point within alcohol research had employed textual stimuli. Townshend and Duka extended this and employed both pictorial and textual stimuli in their visual dot probe task. For the pictorial stimuli they used alcohol-related ($n = 20$) and stationery ($n = 20$) pictures (the stationery pictures were matched for complexity with the alcohol-related pictures). They also used a third category of low arousal neutral affect pictures which were taken from the Affective Picture System (Lang,

Ohman & Vaitl, 1988) to serve as neutral stimuli. For the textual stimuli alcohol-related words ($n = 20$, 10 craving-related and 10 relief from withdrawal-related) and stationery-related ($n = 20$) words were used. As with the pictorial stimuli there was a neutral “filler” word category which was matched to the alcohol-related words in frequency, length and syllables.

These stimuli were then used to create 40 pictorial pairs and 40 textual pairs which were each presented four times (each picture appeared on the left and right and the dot probe appeared under each picture in each location) so that the task included a block of 160 textual trials and a block of 160 pictorial trials. The order of the blocks was counterbalanced across participants and the presentation time for the stimuli was 500 msec. Sixteen heavier and 16 lighter social drinkers were then recruited via a campus advert to take part in the experiment. Townshend and Duka (2001) predicted that there would be a greater AAB (both in pictorial and textual stimuli) in the heavier over the lighter social drinkers—i.e., a differential AAB.

Prior to analyses interference scores were calculated by subtracting the mean response time when the dot probe was in the same location as the alcohol-related stimuli from the mean reaction time when the dot probe was in the opposite location than the alcohol-related stimuli. As predicted, Townshend and Duka (2001) found an AAB in heavier social drinkers but not in lighter social drinkers. Unexpectedly, however this was only for the pictorial stimuli and not for the textual stimuli. This may be because, as previously suggested, pictorial stimuli are more appropriate when investigating AAB within social drinkers or it could be that the textual stimuli used by Townshend and Duka was not appropriate for use in social drinkers—the words that they used were craving-related and relief from withdrawal-related words, which are unlikely to be frequently encountered words/concepts in social drinkers and therefore might not be truly representative or meaningful in relation to their experiences with alcohol.

In a later study, also using the visual dot probe, Field et al. (2004) employed pictorial stimuli to investigate both initial orienting to and maintained attention for alcohol-related stimuli in AAB within heavy ($n = 21$) and light ($n = 19$) social

drinkers. They reasoned that although there have been a number of studies investigating attentional bias, little research has been conducted to investigate the “component processes”—in other words the process or processes that result in the observed AAB. To do this they extended Townshend and Duka’s (2001) study to include different stimulus presentation periods—one longer and one shorter—as they suggest that “both initial orienting (see Bradley, Mogg & Millar, 2000) and a tendency to hold attention on the stimuli (see Fox, Russo, Bowles & Dutton, 2001)” may operate at the 500 msec stimulus presentation period used by Townshend and Duka. To examine whether social drinkers show initial orienting and maintained attention Field et al. employed alcohol-related pictures ($n = 14$) and neutral pictures ($n = 14$) which were matched as closely as possible to those which were alcohol-related for their visual dot probe task. In addition 14 pairs of filler pictures were employed. Each pair of alcohol-related and neutral pictures was presented 12 times—four times (twice with the alcohol-related picture on the left and twice with it on the right) at each of the durations 200 msec, 500 msec and 2000 msec, with the location of the probe being equally distributed. The filler pairs were each presented 6 times—3 times at each stimulus duration.

As in previous studies interference scores were calculated for each participant for each stimulus duration by subtracting the mean reaction times to probes which replaced alcohol-related pictures from those which replaced neutral pictures. This revealed an AAB in the heavier drinkers when stimuli were presented for 500 msec and 2000 msec but not when the pictures were presented for 200 msec suggesting that there is no initial orienting bias, but consistent with the previous study (Townshend & Duka, 2001) that a bias exists at longer time periods. Furthermore, when the AAB measure was correlated with alcohol craving measures with AAB, Field et al. (2004) found a positive relationship when the stimuli were presented for 2000 msec, suggesting that craving is related to the maintenance of attention.

In addition to the visual dot probe task, Field et al. (2004) asked participants to rate the alcohol-related and control pictures of a scale of -3 to +3 for pleasantness

and also to rate the alcohol-related pictures on how relevant (on a scale of 1-7) they were to their own drinking behaviour (the order of these two tasks was counterbalanced across participants). As predicted, the heavier drinkers rated the alcohol-related pictures higher on pleasantness than the lighter drinkers, while there was no difference in the control pictures. Heavier drinkers also rated the alcohol-related pictures as being more relevant to their own drinking than the light drinkers.

In a later study, Field, Mogg and Bradley (2005) sought to investigate the effect of cognitive biases in relation to craving. One of the measures that they employed was AAB, and to investigate this they used a visual dot probe task which was very similar to that of the previous study, in which Field et al. (2004) had shown a relationship between AAB and craving when stimuli were presented for 2000 msec. The same stimuli were used as in the previous study, but only two presentation times (500 msec and 2000 msec) were used. They employed two groups—high and low craving and gave both the visual dot probe task. They found that participants with high craving showed a significantly larger AAB at both the 500 msec and 2000 msec time periods than the low craving group.

In what appears to be the most recent visual dot probe study investigating AAB Field and Eastwood (2005) employed the same stimuli as the previous two studies to investigate the effect of AAB on the motivation to drink. To do this they employed a group of heavy social drinkers and manipulated their AAB via attentional retraining either to attend to or avoid alcohol-related pictures. They found that prior to this manipulation participants, as predicted, showed an AAB. Following the attentional retraining the AAB of the group of participants trained to attend to alcohol was higher than it had been in those participants prior to retraining. Furthermore, in the group of participants who were trained to avoid alcohol-related pictures the AAB score was significantly less than it had been prior to retraining.

Although the previous two studies were designed to investigate more complex matters than only looking at differences in AAB at different levels of alcohol consumption, they nevertheless add to the number of studies which have successfully measured AAB using the visual dot probe paradigm.

In the studies reviewed above it would appear that the visual dot probe task provides a reliable method of measuring AAB in social drinkers. It has however, been criticised due to the fact that there are only two locations at which the dot probe can be located which might result in using a “yo-yo” strategy in which attention is constantly moved between the two locations in order to detect the probe (e.g., Fox, 1993).

Review of Dual Task Paradigm Literature

Alcohol Abuse

Critical of the Stroop as it they suggest interference could either result from AAB or from “enhanced schematic processing” (see e.g., Segal & Vella, 1990) and also critical of the dot probe as, in line with Fox (1993) they suggest that the location of the probe is too predictable, Waters and Green (2003) employed a dual task paradigm to investigate AAB. In the dual task paradigm participants are required to perform two tasks almost simultaneously. First, they are required to complete the primary task, in this case making decision on whether a centrally presented number was odd or even. On some but not all trials a secondary lexical decision task was also present. The stimuli for the lexical decision task comprised three categories—alcohol-related ($n = 12$), garden-related ($n = 12$) and neutral ($n = 12$). Each of the 36 words also had corresponding non-word. These were then used to create three blocks (an alcohol-related, a garden-related and a neutral block) of 48 trials in which there was always a number presented centrally and on 24 random trials there was also a word or non-word presented peripherally in one of 24 possible locations. Waters and Green reasoned that as there were so many possible locations for the word stimulus to appear that it would not be possible to adopt a monitoring strategy of the type they criticise the dot probe for allowing.

They recruited alcoholics who were abstinent ($n = 25$) and controls ($n = 24$) to participate in their dual task study. Participants were told that they should fixate on the central numerical task—which involved making a judgement on whether the

number was odd or even. They were also told that they should complete the secondary task—in which they had to make a word/non word decision—“out of the corner of their eye” and respond using one key for word and another for non-word.

Waters and Green (2003) found that when the peripheral lexical stimulus was alcohol-related that unlike the controls the alcoholics showed delayed reaction times to judge whether the number was odd or even as compared with when the lexical stimulus was from any other category. This is consistent with the alcoholics having an AAB which interferes with the task.

Furthermore, within the alcoholic group, reaction times were also slowed for the lexical task when the stimuli were alcohol-related. Although it may be seen to be against the AAB hypothesis it could be that as the participant is required to complete two tasks that competition for resources slowed their performance on the second task. Additionally, it has been suggested that as the stimuli were presented in a blocked design that the alcoholics may have adopted avoidance strategies.

Social Drinking

This paradigm has not been used to investigate AAB in social drinking.

Review of Posner Paradigm Literature

In the original Posner paradigm (Posner, 1980) participants were asked to fixate a central cross which had a rectangle to its left and another to its right. The border of one of these rectangles lit up to attract the participants' attention followed by the appearance of an asterisk at the centre of one of the rectangles—if the asterisk appeared in the same rectangle as had lit up this was described as a valid cue, if it appeared in the other, it was described as an invalid cue. On invalid cues extra time is needed to shift attention to the new location resulting in a cognitive cost.

Alcohol Abuse

Similar to the original study, there have been several replications in which, rather than using rectangles to attract the attention have used words or pictures in the same way. Stormark, Field, Hugdahl and Horowitz (1997) used such a paradigm to

investigate AAB in alcoholics ($n = 10$) and social drinking controls ($n = 10$). To do this they employed eight alcohol-related and eight neutral words to act as the cues. These cues were then used to create trials, half of which were randomly presented on the left and half on the right and which the target appeared on the same side (i.e., valid trials) two thirds of the time and on the opposite (i.e., invalid trials) one third of the time. Two different time intervals between the onset of the cue word and the appearance of the target were used—a short interval (100 msec) and a long interval (500 msec). These times were chosen as it has been shown that 100 msec is long enough to identify a words but not for any other controlled processing, while 500 msec was deemed long enough to allow participants to control whether to direct their attention towards or away from the cue.

It was predicted that that in the alcoholics, but not the controls, that the reaction times to invalid cues would be slower than to neutral cues when the time interval was short, but faster when the time interval was long. This was supported suggesting initial orienting towards alcohol-related stimuli, followed by disengagement, which has been described as mirroring the approach-avoidance conflict said to be experienced by alcoholics.

Social Drinking

It would appear that AAB has not been investigated in social drinkers using this paradigm.

Review of Artificial Grammar Learning Literature

Alcohol Abuse

In an attempt to test AAB at a higher cognitive level than had previously been done, Pothos and Cox (2002) employed an artificial grammar learning task (AGL). In the AGL participants were required to learn sequences of symbols which, similar to natural language, have a set of rules regarding the order in which they can “legally” occur. Identical to Knowlton and Squire’s (1996) procedure, AGL participants were presented with the sequences of symbols ($n = 23$) and told to

observe them. They were told that the sequences which they had been shown all complied with a set of rules. They were then told that they would see another set of sequences ($n = 32$) and their task was to identify those which were in keeping with the rules (i.e., grammatical) and those which were not (i.e., ungrammatical). If participants correctly identify more sequences than would be by chance, it is said that they have learned some of the rules.

Pothos and Cox (2002) employed two different AGL tasks—an alcohol-related AGL in which the symbols were 23 different drinks served to guests at a party and a neutral AGL in which the symbols were 23 different cities making up airline routes. They used Knowlton and Squire's (1996) layout but replaced their strings of letters with either the alcohol-related or city words so that, for example, each time Knowlton and Squire used the letter V in a sequence Pothos and Cox used either Whisky or Athens.

They then employed heavy ($n = 38$) and light social ($n = 12$) drinkers from undergraduate psychology students to participate. The heavy drinkers were divided so that half received the alcohol-related AGL and half the neutral AGL. This was then repeated with the light drinkers so that half received the alcohol-related AGL and half the neutral AGL.

Pothos and Cox (2002) found that while both the heavy and the light social drinkers performed above chance on the neutral AGL (suggesting they had learned the grammatical rules), only the light social drinkers performed above chance on the alcohol-related AGL, while the heavy drinkers failed to reach chance suggesting that the heavy drinkers could not learn the grammatical rules when the stimuli were alcohol-related. Pothos and Cox suggested that this was as a result of the heavy drinkers processing the semantic properties of the alcohol-related stimulus rather than the stimulus-stimulus relationship.

Social Drinking

It would appear that, to date, no studies have used the AGL to investigate AAB.

A Sixth AAB Paradigm

The five paradigms reviewed above—Stroop, visual dot probe, Posner, dual task and artificial grammar learning (AGL) paradigms—have been employed in an attempt to measure AAB across the levels of alcohol consumption. This thesis moves on to include an additional method in this list of paradigms—the flicker paradigm for induced change blindness, or flicker ICB paradigm—thereby extending the number of ways AAB is being measured and increasing the generalisability and reliability of the AAB findings. Moreover, in addition to adding to the AAB findings in this way, the flicker ICB paradigm has the potential to improve on some shortcomings of the paradigms previously employed.

In each of the five paradigms which have been used to explore AAB, the allocation of attention between two simple, discrete stimuli is measured. In the Stroop and AGL paradigm, these two simple stimuli are co-located in space; whereas in the visual dot probe, the Posner and the dual task paradigms they are not. In this latter group of paradigms the two simple, discrete stimuli are separated a spatial distance. Research within both groups, however raise the question of whether tests that measure the allocation of attentional resources between 2 simple, discrete stimuli are an appropriate test of the operation of attentional biases in the real world—because in the real world, stimuli to which individuals are exposed are not presented in single pairs with discrete simple components. It raises the question of whether principles of attentional bias that the research area is establishing are inappropriate because of the artificially simple experimental environment that is being used. In other words a very small number (2) of discrete stimuli are presented in a contextual vacuum for a very brief period of time (see later). In Psychology research, there are many examples where this apparently defensible approach has caused a problem in the development of theory—i.e., the desire to “start simple” in carrying out experiments has led to a set of artificial principles being derived from an artificial world and which only generalise poorly to the real world. In the conditioning literature, for example, the use of conditioned learning boxes with

masking white sound, evolutionarily neutral stimuli (e.g., a bell) an evolutionarily neutral response (e.g., a bar press) allowed the discovery of evolutionarily neutral learning theory joining stimuli and response that although reliable and repeatable provided poor representations of the learning process in the real world (see Seligman, 1970 for a review of this cul-de-sac). In the same vein, in the vision literature the use of context free, artificially simple shape and figures to help develop theories of vision using computers, led to impossible complex and idiosyncratic solutions to real world vision problems that were only solved when real world stimuli and contexts were employed (e.g., see Marr, 1982, for a review).

The issue of ecological validity has been partially addressed in the Stroop paradigm by Bruce and Jones (2004) who, in a pictorial version of this paradigm included both objects and scenes. In their study, although the instructed task was very simple (i.e., naming a single colour), the distracter was more ecologically valid (i.e., a full real world visual scene, albeit 2D). Furthermore, in the case of visual dot probe research, Lubman et al. (2000, in opiate research) have noted that more ecologically valid approaches are needed and as a result have employed pictorial stimuli. In AAB research, although this has also been partly addressed by the use of pictures (e.g., Townshend and Duka, 2001; Field, Mogg, Zettler & Bradley, 2004) the pictures themselves have been a single simple pair, with two relatively simple and discrete components.

A final feature of the five paradigms used thus far is the artificially short times for which the simple stimuli are presented. Typically, two simple stimuli are presented for less than 2 seconds and more usually approximately 500 msec. The artificial nature of the stimuli, the stimulus set in which they are embedded, the context and the brief time is quite unlike the commerce the attention system has in the real world.

Useful, additional and possibly more ecologically valid knowledge on attentional bias might be gained by extending the research using paradigms that have the following features: First, stimuli should be more complex, better representing

real world environments. Second, the exposure of the stimuli should be for periods of time that more appropriately measure real world experiences.

My pre-doctoral research has involved the use of stimuli whose complexity more appropriately represents the real world environment and whose presentation represents more appropriately real world experiences. Out of this pre-doctoral work the doctoral work reported in this thesis emerged. This newly introduced paradigm—the flicker ICB paradigm—which employs more complex stimuli, in which the same stimulus is presented time and time again (rather than different stimuli each for brief periods) is explained below.

The Flicker Paradigm for Induced Change Blindness

In the flicker ICB paradigm (Rensink, O'Regan & Clark, 1997) a picture is presented on a screen for a brief period of time (e.g., 250 msec) followed by a mask for a very brief period (e.g., 100 msec). The original picture is then re-presented with one change occurring somewhere within it, followed again by the mask. This cycle is repeated until the participant detects the change. Surprisingly, even the very obvious changes are not detected immediately—a phenomenon known as change blindness (see Simons and Ambinder, 2005). Although almost invariably stimulus exposure is only for less than a second (which is typical of the paradigms reviewed above), successive exposures of (to all extents and purposes) identical scenes, in register and of which the view builds up a single visual scene over many seconds.

The dynamics of change blindness and eventual detection under these conditions of test are as follows (see also Jones et al., 2006). Without the presence of the mask, the change between OS and CS (and vice versa) would be almost immediately detected because the local visual transient accompanying the change would signal its presence and attention would be sent accordingly to acquire detail. The involvement of the mask in the change cycle, however, generates a global transient that obscures the local transient and interferes with the sending of attention (e.g., Simons & Ambinder, 2005; Simons & Rensink, 2005). Because, within this

research domain, the detail of the detected change is thought to predicate on the sending of attention to the stimulus carrying the change, any interference with this process will slow down change detection and be responsible for the so-called blindness to the change that this paradigm generates and that has been the focus of much research in vision (e.g., see Hollingworth, Schrock & Henderson, 2001). If the change is *eventually* detected, however (which it, invariably, is), processes other than the local visual transient must be responsible for the sending of attention—processes representing *interest*, have been suggested by, for example, Rensink et al. (1997), Scholl (2000), Simons and Rensink (2005) and Turatto, Bettella, Umiltà and Bridgeman (2003).

B. T. Jones, B. C. Jones, Smith and Copley (2003) and Bruce and Jones (2006) have reasoned that such an interest should be manifest in individuals who are substance dependent or substance users and, consequently, that the flicker ICB paradigm might be a particularly sensitive tool for measuring substance-related attentional bias. Personal concerns (e.g., Jones, Macphee, Broomfield, Jones & Espie, 2005) and the contents of hobbies, pastimes or expertise (e.g., Werner & Thies, 2000) represent some other sources of *interest* that have been tested using the flicker ICB paradigm (see Simons & Rensink, 2005, for a review).

Social Drinkers

B. T. Jones, et al. (2003) conducted a flicker ICB paradigm study in which a table-top visual scene was constructed with a group alcohol-related objects to one side and a group of neutral (office-related) objects to the other (see Figure 2.0.1). Although objects were not matched individually, the overall layout of neutral stimuli was loosely matched in shape, colour and size to the alcohol-related stimuli. One hundred social drinking participants were recruited from the university campus to take part in the study and were randomly assigned to either a version of the flicker paradigm in which the change was alcohol-related ($n = 50$) or to a version of the flicker paradigm in which the change was neutral ($n = 50$). To allow for any effect of the location in which the change occurred, half the participants were presented

with the alcohol-related objects on the right and the neutral on the left, the other half were given the neutral objects on the left and the alcohol-related on the right (although analyses revealed no differences as a result of this). B. T. Jones et al. did not disclose the alcohol-relatedness of the task to their participants (in common with many implicit tasks—see McCusker, 2001) as they felt that this might have implications on how the scene was processed. Furthermore, within substance-related attentional bias research later support for not revealing the nature of such tasks has come from Yaxley and Zwaan (2005) who have shown in a smoking-related study that knowing that the experiment is smoking-related resulted in both the experimental and control group showing an attentional bias, while when the smoking-related aspect was not revealed, only the smokers showed this bias. In other words, the experimental effect can be swamped by the knowledge.

In order to maintain participant naivety with respect to the alcohol-related component of the task, B. T. Jones et al. (2003) were unable to measure participants' consumption levels until the main flicker ICB task had been completed and therefore the group of heavier and lighter social drinkers for use in analyses was retrospectively constructed. As predicted the heavier social drinkers detected the change more quickly when it was alcohol-related than when it was neutral showing an AAB. Furthermore when the change was neutral the lighter social drinkers detected it more quickly than the heavier social drinkers—which B. T. Jones et al. suggest might be as a result of the alcohol-related stimuli capturing the attention of the heavier drinkers and therefore impeding their ability to detect the neutral change. It is this paradigm and further modifications of it that is the main focus of the series of experiments reported in this thesis.

*My modification of the Jones, Jones, Smith and Copley's (2003) Flicker Paradigm
for Induced Change Blindness*

In B. T. Jones, et al.'s (2003) flicker paradigm for induced change blindness (flicker ICB paradigm) which is described above, participants were required to

detect a single change. In one group of participants this change was alcohol-related and in the other group it was neutral. I call this the 1-change flicker ICB paradigm.

In my pre-doctoral thesis (Bruce, 2002; see B. C. Jones, et al., 2002), I have modified this design such that alcohol-related change *and* an equivalent neutral change are *simultaneously* presented within the same, complex stimuli, while intimating to participants that “a change” was being presented (i.e., intimating that there is only 1-change presented). I call this a 2-change flicker ICB paradigm. The work reported in this thesis predominantly uses my modification of the 1-change flicker ICB paradigm—i.e., the 2-change flicker ICB paradigm. The use of this 2-change flicker ICB paradigm has a number of advantages when measuring AAB over the original 1-change version of the paradigm used by B. T. Jones et al. in AAB research and by others in general perceptual research. These advantages are discussed below.

First, although it is intimated to participants that there is only a single change, there are, in fact, two simultaneous changes competing for attention. Since in AAB it is claimed that selective attention to alcohol-related stimuli is being measured and in the 2-change flicker ICB paradigm participants will effectively be detecting one change over another, then it might be said that this added competition or need to select provides a more sensitive measure of measuring AAB.

Second, using the 2-change version of the paradigm rather than the 1-change helps overcome previous difficulties which have arisen in group assignment. In previous paradigms there has been a need to assign participants to one of two social drinking groups (e.g., heavy and light social drinkers). While it is easy to assign drinkers to groups when testing for AAB in alcoholics or problems drinkers as compared with to social drinkers—as the alcoholics/problem drinkers are defined by engaging with treatment while the social drinkers are not—it is much less easy to identify a group of heavy as compared to a group of light social drinkers because there is no consistent definition of these two categories. Furthermore the distinction between alcoholics/problem drinkers and heavy social drinkers is blurred. This issue hasn't arisen before as alcoholics have been defined by their treatment status, but, it

is likely that many engaging with treatment will be drinking less and/or have fewer problems than some of the very heavy drinkers who aren't in treatment.

Consequently, there is a danger when comparing light with heavy social drinkers of actually comparing social drinkers (calling them the light group) with alcoholics/problem drinkers (calling them the heavy group) and as a result it might appear that there is a differential AAB which is, in fact, an artefact of the inclusion of alcoholics/problem drinkers. This has, of course, not gone unrecognised and efforts have been made to define the heavy drinking groups. There are however substantial differences across studies—while Cox et al. (1999) and Pothos and Cox (2002) employed males who drank more than 25 units per week and females who drank more than 16 units per week as their heavy drinkers, Sharma et al. (2001) created their groups based on AUDIT (Alcohol Use Disorders Identification Test, Saunders, Aasland, Babor, Delafuente & Grant, 1993). Such differences in groups may be misleading when comparing the effects found across studies.

One traditional solution to group assignment under these circumstances might be to carry out a median split on all drinkers used and compare the heavier drinkers of a particular study with the study's lighter drinkers. This means however, that the consumption of those at the top of the light group will be comparable to the consumption of those at the bottom of the heavy group which might lessen the chance of finding an effect, or at least causing it to be reduced.

An alternative method is to use an extreme groups split, in which the top and the bottom of the measured group are used with a group of participants from the middle of the group being discarded. This can be done in a number of different ways. It could, for example, be that all drinkers measures are split into 3 groups based on a measure of consumption, and that the middle group is then discarded. Likewise, the two groups could be created by removing a certain number or percentage from the middle of all drinkers measured. The trouble, with the extreme groups split, aside from wasting collected data is, however, that sceptics might suggest that size of the middle group (which has been removed) may have been chosen to be one which produces a significant effect. Moreover, while the size of

the effect might be reduced when the median split method is employed, it may be artificially inflated when an extreme groups method is used suggesting that both of these methods might mask the real difference in AAB between heavier and lighter social drinkers. MacCallum, Zhang, Preacher & Rucker (2002), have also demonstrated the potential loss of power when these methods are employed.

Group assignment problems are avoided, however, when using the a 2-change flicker ICB paradigm because two groups are naturally formed based on which of the two changes is detected. Thus, rather than the traditional AAB hypotheses in which it is postulated that the group of heavier drinkers and the group of lighter drinkers will respond differentially in terms of change detection latency, when the 2-change flicker ICB paradigm is employed the hypothesis is that the usual consumption of the participants who detect the alcohol-related change (and miss the neutral change) will be different to that of the participants who detect the neutral change (and miss the alcohol-related change).

Finally, and perhaps of greatest importance in the choice of which flicker ICB paradigm to use, when using the flicker ICB paradigm only one data point is gathered from each participant. Although it may appear possible to run a series of trials with the flicker ICB paradigm, our pilots have shown that the location of the change in the first trial has an effect on strategies for searching for the change in the subsequent trial. To avoid this source of noise which swamps the AAB measure, each participant is given only a single trial flicker ICB paradigm. This drawback is minimized or even avoided with the 2-change version. This is explained below.

When the 1-change version of the paradigm is employed, the dependent variable is change detection latency and the AAB hypothesis is that as usual alcohol consumption increases change detection latency will decrease. There are, however, other factors not related to alcohol consumption which are likely to play a role the number of flicks taken to detect a change. The time, for example, to detect a change in a totally neutral flicker ICB paradigm will naturally vary across participants. It is possible that this difference may in some ways distort the results, as while alcoholics/problem drinkers may have a pronounced AAB and therefore when

compared to social drinkers the effect of individual differences may be less apparent, when heavier and lighter social drinkers are compared, then it is possible that the difference in AAB is too small to be reliably measured in this way.

In the 2-change version, however, this problem is circumvented as the primary dependent variable is the change that has been detected (i.e., alcohol-related or neutral) with the primary hypothesis stating that alcohol consumption should be higher for participants who detect the alcohol-related change than for participants who detect the neutral change, thus avoiding the issue of the time taken to detect the change. Naturally a secondary dependent variable consisting of the flicks taken to detect the change can be measured, and it would be expected that the time taken to detect the alcohol-related change would decrease as alcohol consumption increased. If, however, the flicker ICB paradigm is not sensitive to reliably capture consumption related differences in AAB at this level then the primary dependent variable has already provided alternative measure of AAB.

Thus both the group assignment/power issues described above and the effect of individual differences would suggest that the 2-change version of the flicker ICB paradigm provides a more reliable method of exploring AAB in social drinkers. It is for these reasons that the 2-change flicker ICB is predominantly employed in this thesis.

The role of theory in Attentional Bias, AB.

The development of theory in AB research is still in its infancy. The principal reason for this is that it is still not clear what AB *is*. For example, AB was first described within the confines of the Stroop paradigm. The description was then extended to the dot probe paradigm and more recently to paradigms that require grammar learning. These paradigms have already been described in this chapter. What becomes clear is that the ‘nature’ of the phenomenon depends very much on the nature of the paradigm within which the phenomenon is being measured and now that an extended exposure paradigm has been added to the list (the flicker ICB

paradigm), the list of the types of descriptions of and, consequently, theories relating to AB, is commensurately increased.

For example, within the Stroop paradigm, AB is regarded as comprising a single component (although Stormark et al., 1997 might be a single exception), yet with the advent of the dot probe paradigm, evidence supporting two components has been produced (e.g. Mogg, Bradley, Field & De Houwer, 2003; Mogg, Field & Bradley, 2005 for smoking research and a single paper for alcohol research, Noel et al., 2006). As will be discussed later in this thesis, these paradigms might be called brief exposure paradigms and once the type of paradigm is extended to include extended exposure paradigms (the flicker ICB paradigm and continuous eye-movement monitoring—both are focal to this thesis), the number of components that might be important in representing AB potentially increases. An important issue is whether a single well-articulated explanation can be fitted to these quite different ways of eliciting the AB phenomenon or whether there might be a number of different ways of explaining the different ABs that have been described using the wide range of different paradigms.

For reasons such as these, identifying competing theories of AB and road testing them to discover the most defensible one might be regarded as premature. Nevertheless, there are two global theories of addiction and dependence that have emerged from the 1980s that need to be referred to and it would be worrying if the data provided in this thesis did not accord with what they might predict and these are described below.

Robinson & Berridge's Incentive-Sensitization Theory

This theory has its precursor in Stewart, de Wit and Eikelboom (1984) and Tomie (1996). Robinson and Berridge (2003) posit that repeated use of potentially-addictive substances leads to a change in dopamine production and take up in the nucleus accumbens (and the mesolimbic dopamine systems associated with the nucleus accumbens). These neurological changes lead to an increase in the incentive value of the substance in question which enters cognitive life as a craving whenever

the substance is encountered (sight, smell, thought etc). Classical conditioning processes (or the cognitive parallel processes) cause the cues in the environment (including the sight, smell etc of the substances themselves but also the non-substance cues that accompany being exposed to them) to become linked to this excess dopamine activity giving rise to learned (conditioned) incentive properties. They called this learned incentive activity, ‘incentive salience’—such a cue with high levels of incentive-salience attracts attention (Robinson & Berridge posit) and such attention attraction represents attentional bias. They distinguish this sort of outcome (they call it ‘wanting’ the drug) from ‘liking’ the drug, the latter of which would normally be represented by, for example, positive ingestion outcome expectancies.

Their position makes two predictions: first, the more addicted is a person, the greater attentional bias to the substance in question they should show; second, those who use the substance moderately or not at all show less of attentional bias than those who use to the levels of generating problems and to those who are addicted. Subsequent work reported in this thesis principally addresses the second prediction and to a more limited extent the first prediction.

There are, however, two sets of problems with the application of Robinson and Berridge’s theory to humans. First, although they have considerable supportive evidence for neurophysiology that the nucleus accumbens and associated structures do indeed change as predicted in terms of their neuroanatomy and neurophysiology as addiction advances, all of this work has been carried out with non-human vertebrates and not with the humans themselves. The theory would be much more compelling for a theory of human addiction if such work and similar results had also been found in human. Second, Robinson and Berridge’s theory predicates on finding an increase in ‘wanting’ the drug as addiction advances and a decrease in ‘liking’ the drug. Only one study has tested this prediction and discovered that *both* wanting and liking increase with addiction severity (Willner et al., 2005). In spite of these two problems, however, Robinson and Berridge’s theory (Incentive-Salience Theory) is cited in nearly every AB research report.

Tiffany's Automatised Action Schema Theory (1990)

Whereas Robinson & Berridge's theory has its origins in neurophysiology and neuroanatomy (with a little conditioning theory thrown in), Tiffany's theory is based on the popular psychological concept of action schema from the 1970s onwards. Within such a theory, the searching for, acquiring, manipulating and using of a potentially-addictive substance becomes automatised. This is done through the conscious development of schema or plans that are learned through practice. Through practice, however, they gradually become automatised and can be instantiated without awareness and carried to completion without awareness which is a hallmark of addiction. The preferential processing of substance-related cues in addicts is a manifestation of the automatic instantiation of the learned substance-related schema when appropriate stimuli cue them off. Basically, Robinson and Berridge and Tiffany make similar predictions but they both might be thought of as frameworks rather than precise theories capable of falsification.

Final comment

This thesis represents an attempt to see if the range of behaviour normally described as AB (and particularly AAB) can be extended to what might be different types of AAB and in this sense is designed to add to the research knowledge in this area—rather than take the two principal theories that relate to AB and try and discriminate between them.

Chapter 2

SOCIAL DRINKERS' DETECTION OF COMPETING ALCOHOL-RELATED AND NEUTRAL CHANGES SIMULTANEOUSLY IMPLEMENTED THROUGH A FLICKER ICB PARADIGM.

Abstract

While there is a wealth of published evidence indicating a differential attentional bias between social drinkers and abusive/alcoholic/dependent drinkers and this is used to help explain the latter's maintenance of excessive consumption in the face of escalating problems, there is limited and contradictory evidence of such a bias between light/infrequent and moderate/frequent social drinkers. In this chapter, the evidence in support of an attentional bias in social drinkers is augmented by the results of four related pictorial experiments and one textual experiment.

Four pictorial experiments and one textual experiment are reported using the flicker paradigm for induced change blindness (referred to from here on as the flicker ICB paradigm) in which two simultaneously-implemented changes (one alcohol-related and one neutral) compete for participants' attention when it has been implied that there is only "a" change. In each of the five experiments, the differential attentional bias hypothesis—i.e., that participants detecting the alcohol-related change will have higher levels of self-reported usual consumption than those detecting the neutral change—was supported.

In each of pictorial Experiments 1 and 3 alcohol-related and neutral changes-to-be-detected were implemented through stimulus rotation. In each of pictorial Experiments 2 and 4 the changes-to-be-detected were implemented through object replacement. Textual Experiment A had only a replacement change. All five experiments supported the alcohol-related attentional bias hypothesis: social drinkers who detected the alcohol-related change consumed more alcohol in a typical week than those who detected the neutral change.

The findings of Experiments 1 to 4 and Experiment A also indicated the generalisability of the original findings of an attentional bias between

light/infrequent and heavier/frequent social drinkers found using an incompletely-controlled, two-change version of the flicker ICB paradigm by B. C. Jones, B. T. Jones, Blundell and Bruce (2002).

The possible need to extend the types of stimuli and their layout in testing for attentional bias using the flicker ICB paradigm

B. C. Jones et al. (2002) explored attentional bias in social drinking using a novel two-change version of the flicker ICB paradigm instead of the traditional one-change version (e.g., as in B. T. Jones, B. C. Jones, Smith & Copley, 2003). In the two-change version, they implemented simultaneous alcohol-related and neutral changes so that they *competed* for the attention of social drinkers. In their view, this would be a particularly sensitive measure of detecting attentional bias. The novel version of the “attentional bias” hypothesis that this design demands was that those drinkers who detected the alcohol-related change would have usual consumption levels that were higher than those detecting the neutral change. Figure 2.0.1 shows the type of stimulus layout they adopted—alcohol-related objects were presented on one side of a visual display and neutral on the other. For their study the objects were informally selected and informally positioned to create the table-top scene shown in Figure 2.0.1. In Experiment 1 reported in this chapter, the choice and arrangements of objects was more formally carried out than by B. C. Jones, et al. for several important reasons which are given below.

First, a new set of alcohol-related and neutral objects were chosen, including the two objects carrying the change. This modification would help test whether the attentional bias found by B. C. Jones et al. (2002) with the *particular* set of objects they used would generalise to *another* set of objects. This is important since it is a necessary feature of their use of the flicker ICB paradigm for these purposes that only *one* data point is obtained from a single participant and for each participant this one data point is obtained from a *single* alcohol-related object or a single neutral one embedded in a single context. Because of the “one shot” nature of this design, there remains the possibility that the results obtained by B. C. Jones et al. are the function of the *very* limited stimulus set they employed. Experiment 1 reported in this chapter is designed to test whether or not this is the case by employing a completely different stimulus set to the one used by B. C. Jones et al.

Second, the alcohol-related and neutral objects used by B. C. Jones et al. (2002) were chosen fairly informally. This informal process may have had implications for the results they obtained as some objects may have had more influence in driving change detection than others. Accordingly, in order to minimise any similar possibility, objects for Experiment 1 were chosen to not only be different from those used by B. C. Jones et al. but chosen in pairs so that each alcohol-related object had a *corresponding* neutral object. This was done as follows: alcohol-related objects were chosen from an accumulated pool of such objects in the Alcohol Laboratory and were then matched as closely as possible in shape, size, and colour with a neutral object. In constructing such pairs, it meant that although the *semantic* properties of the objects in each pair would intentionally be quite different (i.e., had alcohol-related connotations or had not), the *physical* properties would be as similar as was practically possible. This would reduce the likelihood of change-detection being influenced by properties of the stimuli other than the alcohol-related or neutral (i.e., the semantic) properties. It should also help reduce the error variance in analyses, providing a more sensitive test of hypotheses.

Third, although in their study, B. C. Jones et al. (2002) used the same overall layout as the one employed in Experiment 1 in this chapter—namely, a visual display with a group of alcohol-related objects to one side and a group of neutral objects to the other—they created their layout informally. They simply positioned objects to create a 3-D table-top scene with alcohol-related objects grouped on one side and neutral objects on the other—thought to be representative of an “everyday” scene—and they roughly arranged the objects so that no one side in particular was eye-catching because of its own layout. In Experiment 1, the bi-lateral layout was retained but more rigorously specified by employing a rectilinear matrix as a framework to more uniformly position the alcohol-related and neutral stimulus pairs referred to above. This rectilinear matrix was used to systematically position the items of the equivalent-looking alcohol-related and neutral pairs in equivalent locations of the stimulus presentation. The precise nature of the choice of alcohol-related and neutral stimulus pairs and how they were systematically deployed within

the rectilinear matrix is described in the appropriate Method section of Experiment 1. Suffice to add at this point that the indeterminacies of the casual 3-D layout employed by B. C. Jones et al. (2002) and captured as a 2-D photograph to present to participants is replaced in Experiment 1 by a more highly-specified 2-D layout.

Finally while B. C. Jones et al. (2002) arranged their chosen objects on a table-top to create the display and then photographed the display, itself, the alcohol-related and neutral objects used in Experiment 1 were individually photographed under controlled conditions and the rectilinear matrix was constructed from these individual photographs using a graphics package (Adobe Illustrator). Constructing the matrix in this way ensures that each photograph can be precisely positioned and manipulated within the matrix to create different and highly-controlled versions of the stimulus display as different purposes emerge from the results of the early experiments. This degree of potential, but highly-controlled, flexibility with respect to the stimuli being created for Experiment 1 is important because it was planned, for example, to incorporate types of changes in some subsequent experiments that were different from the changes employed by B. C. Jones et al. and replicated in Experiment 1. For example, B. C. Jones et al. implemented changes by *rotating* objects (rotating them about a vertical axis) and this was also the plan in the replication in Experiment 1. Replications of B. C. Jones et al.'s design but with changes being implemented by *replacing* objects not rotating them (which is also planned in this thesis), could only be done with difficulty with the table top 3-D scene they employed. With the rectilinear matrix employed in Experiment 1, however, such planned (as well as unplanned) directions could be more easily followed.

The possible need to control for the left-right Locations of Changes-to-be-detected in the Flicker ICB paradigm.

The section above pointed to the possible need to control for the physical properties of the alcohol-related and neutral stimuli, and that this was done through the use of physically similar alcohol-neutral pairs embedded in a rectilinear matrix.

There might also be a need to control for the left-right locations of changes-to-be-detected in the series of experiments reported here and this is explained below.

A perceptual bias towards stimuli located ‘on the left’ has generally been found in investigating judgements made on visual stimuli by non-clinical participants. Such a leftward bias has been demonstrated in a number of quite different tasks—choosing emotive features in chimeric faces (Luh, Rueckert, & Levy, 1991); the “greyscales” task (Mattingley, Bradshaw, Nettleton, & Bradshaw, 1994), where participants are required to judge the brightness of stimuli; tasks where it is necessary to judge the size of stimuli (Nicholls, Bradshaw, & Mattingley, 1999) and numerosity tasks (e.g., Luh, 1995) represent examples of such studies. The most studied task, however, with regard to perceptual bias, is the Line Bisection task in which participants are required to either make judgements on a pre-transected line (e.g., McCourt, & Jewell, 1999) or to mark the midpoint of the line (e.g., Luh, 1995). Such studies have generally shown a leftward bias (e.g., Luh, 1995, McCourt & Jewell, 1999; Sampaio & Chokron, 1992) within non-clinical individuals. This bias, in non-clinical individuals, has been called *pseudoneglect*, *PN*, (Bowers & Heliman, 1980) to distinguish it from *neglect* in clinical individuals. Although some studies have failed to find this effect (e.g., Reuter-Lorenz & Posner, 1990), it has been found by the majority including McCourt (2001), who, having reviewed most studies, evaluated pseudoneglect to be a highly reliable phenomenon.

It was originally suggested (e.g., Manning, Halligan, & Marshall, 1990) that PN occurs as a result of left to right scanning that is required of English readers. This was supported by Chokron and DeAgostini (1995) who found the direction of the bias to be dependent on subjects’ linguistic background—i.e., individuals who read from left to right generally showed a leftward bias, while individuals, such as readers of Hebrew, who read from right to left displayed a rightward bias. These findings were not, however, replicated by others, for example, Speedie et al. (2002), Barrett, Kim, Crucian and Heliman (2002) and Reuter-Lorenz and Posner (1990), suggesting that scanning alone, may not account for PN in individuals who read from left to right.

Furthermore, while Chokron and DeAgostini (1995) found that when they controlled scanning, the direction of the bias was dependent on the direction of the scan, supporting the scanning theory, other authors, for example, Nicholls and Roberts (2002) and McCourt and Olafson (1997) have also controlled scanning and found a leftward bias to be present regardless of scanning direction. Moreover, in order to limit the opportunities for scanning, McCourt (2001) used a forced choice tachistoscopic line bisection task where pre-transected lines were presented for 150 msec and showed that a leftward bias was still present despite the fact that participants were unable to scan. This provides further evidence that scanning is not wholly responsible for PN.

Recent work has, however, provided an alternative explanation for PN suggesting that it is not scanning, but rather *an attentional bias towards the left hemispace, itself*, that accounts for the leftward perceptual bias. This idea originates from Kinsbourne's (1970) work on hemispheric asymmetry, and has been supported more recently by authors such as Mennemeier, Vezey, Chatterjee, Rapcsak and Heilman (1997) who have suggested that as tasks such as judging length, face recognition, etc. are likely to activate the right hemisphere more than the left, then an innate attentional bias to the left hemispace is likely. It is this theory of attentional bias that Nicholls and Roberts (2002) found the most plausible explanation for the leftward perceptual bias, when reviewing literature on the line bisection task and although their review focussed only on the line bisection task, it is possible that an attentional bias may also be responsible for the leftward perceptual bias found in other tasks such as those discussed earlier.

It is difficult to know whether the sort of attentional bias to the left-hemispace described above is likely to impact on change detection in the flicker ICB paradigm. For example, in the studies reported by B. C. Jones et al. (2002) and B. T. Jones et al. (2003) they report no evidence of a bias between changes detected in the left and the right hemispace (to the extent that Jones, Macphee, Broomfield, Jones & Espie, 2005, saw no need to control for location of change in an experiment on attentional bias in insomnia). Nevertheless, because of the pseudo-neglect studies

reviewed above and because stimuli used in the series of experiments reported in this thesis use a rectilinear matrix of 18 different stimuli and because this stimulus arrangement might encourage systematic (conscious or unconscious) strategies of inspection in some individuals, the location of the change-to-be-detected (i.e., left-right) will be controlled, and its contribution to change detection measured.

Experiment 1: Social drinkers' detection of alcohol-related and neutral changes manifest as object rotations.

Experiment 1 was designed to replicate B. C. Jones, et al.'s (2002) two-change experiment with a different stimulus set, different alcohol-related and neutral objects carrying the changes, a better controlled stimulus set of alcohol-related and neutral stimuli and a more systematic layout. Care was also taken to hide the alcohol-related nature of the task from participants. Nisbett and Wilson (1977) and Feldman and Lynch (1988), for example, have questioned whether, when individuals are aware of the purpose or nature of the task they are asked to carry out, their responses will be a valid representation of the processes that would have underpinned the responses had the task been carried out naively. McCusker (2001), in distinguishing between explicit and implicit cognitions, has made clear the need for this naivety in substance use research and more recently Yaxley and Zwaan (2005) have shown in a smoking-related attentional bias study, that like their group of smokers, their non-smokers showed attentional bias to smoking-related stimuli, but only when they were aware that the task was related to smoking. Consequently, to avoid such possibilities the alcohol-related nature of Experiment 1 was not explicitly revealed to participants until the change detection task was complete. The procedures required to ensure this are detailed below.

Method

Participants

A convenience sample of 100 participants (54 males, 46 females; *Mdn* age = 20 years, quartile range = 3.0, range = 17-62) were recruited from university campus traffic for Experiment 1, taken to a quiet testing place on the campus and randomly assigned to one of two testing groups which are described later. Following testing and prior to analyses, participants who incorrectly completed the task ($n = 1$), or had previously been involved in a similar study ($n = 1$), or had consumed alcohol on the day of testing ($n = 0$), or had reported atypical alcohol Consumption in the previous week (the week on which the measure 'usual alcohol Consumption' was based, $n = 11$) were excluded from the analyses. Participants who reported atypical consumption were excluded as the purpose of Experiment 1 (and all subsequent studies reported in this thesis) was to measure AAB and relate this to usual alcohol consumption. Consequently if the previous week's alcohol consumption was either elevated or diminished as compared with normal consumption then this would provide an invalid representation of the very measure (usual typical average consumption) that is required to evaluate AB hypotheses.

Although participants were instructed to detect *the* change, thus suggesting that only one change was present, participants might occasionally report detecting both changes. The data from such participants would also not be included in the analyses. There were no such cases in Experiment 1.

The remaining 87 (43 males, 44 females; *Mdn* age = 20 years, quartile range = 3.0, range = 17-62) were included in the analyses. Surprisingly, these descriptive statistics remained the same when the 13 participants described above were excluded from those who were first recruited.

Paradigm

The flicker ICB paradigm (Rensink, O'Regan & Clark, 1997) was used in Experiment 1. In the flicker ICB paradigm an original stimulus (OS) is presented on a computer screen for a short period of time followed by a brief disruptive stimulus

such as a blank screen or matrix of Xs (the mask, M) which, in turn, is followed by the re-presentation of the original stimulus, but with a version of the original stimulus carrying a single change to one part of it, now called the changed stimulus (CS). Finally, to complete a single cycle of the flicker ICB paradigm, the mask (M) replaces the changed stimulus (see Figure 2.1.1). The cycle is repeated continuously and seamlessly until the participant fulfils the task requirement, which is to detect a single stimulus change as quickly as possible. When an OS and CS are presented in this way (separated by masks) participants take surprisingly more cycles of change than would normally be expected before the change is detected. This surprisingly long delay is said to be due to (or said to *be*) “change blindness” (e.g., Simons & Levin 1997). In practice, Change Detection Latency is not measured in units of the cycle as described above but in units of “change” or, sometimes, elapsed time. The unit of “change” is the OS-M-CS or the CS-OS-M sequence. This unit is often called a “flicker” or “flick” giving the paradigm its name (see Figure 2.1.1). The usual measure of Change Detection Latency is the sum total of OS-M-CS and CS-M-OS sequences completed before detection—the number of flickers or flicks.

A modified version of the flicker ICB paradigm has been developed (B. C. Jones et al., 2002) in which two changes rather than one change is made to the original stimulus (OS) in generating the changed stimulus (CS). B. C. Jones et al. and B. T. Jones et al. (2003) have suggested that this version of the flicker ICB paradigm might be a more sensitive test of attentional bias than the traditional version. Also as discussed in Chapter 1, the adaptation of this version of the flicker ICB paradigm avoids the difficulty of group assignment that would be present had the more usual one-change version been adopted. Their modified, two-change version is employed in the current experiment. One of the two simultaneous changes is made to an alcohol-related part of the stimulus and the other accompanying change to a neutral part. *Since it is intimated to participants that there is “a” change to be detected when there is in fact two, the task might be thought of as the two changes ‘competing’ to be detected by the participants’ attentional processes.* The nature of the stimuli and changes will be described later.

The timings of the presentations of the four stimuli comprising a single cycle of the flicker ICB paradigm employed in Experiment 1 were as follows: OS (400 msec) – M (200 msec) – CS (400 msec) – M (200 msec). The values represent the length of time each stimulus was displayed on the computer screen. There were no inter-stimulus intervals nor inter-cycle intervals (also see Figure 2.1.1).

Design

The three factors comprising the design in Experiment 1 and their two respective levels each are described below. Factor 1 relates to group allocations made at the time of entry to the experiment and prior to administering the change detection paradigm. Figure 2.1.2 graphically displays the details of the factors and levels of the design of Experiment 1.

Factors 2 and 3 relate to group/subgroup assignment after the change detection paradigm had been administered and prior to analysis.

A. Group allocation for proper experimentation - Factor 1, Locations of Changes, had two levels: one, the single simultaneous alcohol-related change made on the left and the single simultaneous neutral change on the right (alcohol left neutral right—ALNR—represents this layout) and, the other, the mirror image reversal of this, the single simultaneous alcohol-related change on the right and the single simultaneous neutral change on the left (neutral left alcohol right—NLAR). Note that the factor is named ‘Locations’ not ‘Location’ because there are two locations at which a change is made. Participants were randomly assigned to one of the two levels of Locations of Changes on being recruited into the experiment. Random assignment to the two levels of Locations of Changes ensured that an equal number of participants were given the ALNR layout and the NLAR layout. This factor was not used in the analysis.

Bi. Group allocation for proper analysis - Factor 2, the Change Detected, had two levels: the alcohol-related change detected (ACD) and the neutral change detected (NCD). In other words level-assignment for the factor Change Detected

was done *retrospectively*, based on which change of the two competing changes (ACD or NCD) a participant detected.

Bii. Group allocation for proper analysis - Factor 3, the Location of Change Detected had two levels: change detected on the left, L, and change detected on the right, R. In common with Factor 2, level assignment for Factor 3 was done *retrospectively* based on whether the change was detected on the left or right. Note that Factor 3 is quite different to Factor 1 despite similar names—i.e., Factor 3 refers to a single location (where the change was detected) while Factor 1 refers to two locations (indicating where the two changes, alcohol-related and neutral, might be found).

Retrospective allocation to the levels of the factor, Change Detected, and the factor, Location of Change Detected (the two factors used in analysis), meant that although participant-assignment to the two levels of the factor Locations of Changes could be done so that an equal number of participants were in each level, once the further (retrospective) assignment of participants from each of the two levels of Locations of Changes to one of the two levels of Change Detected and one of the two levels of Location of Change Detected had been done, the groups of different participants created by the 2x2 design would be likely to be unequal in size. As Figure 2.1.7 shows, the four groups generated by crossing the two factors were Group ACD-L and Group NCD-L (alcohol-related and neutral change detected, respectively, both with alcohol-related and alcohol-neutral stimuli presented on the left) and Group ACD-R and Group NCD-R (alcohol-related and neutral change detected, respectively, both with alcohol-related and alcohol-neutral stimuli presented on the right). Figure 2.1.7 also shows the unequal group sizes generated by the 87 participants included in the analysis (see also below).

The dependent variable used in the main 2x2 analysis of Experiment 1 (2x2 ANOVA described, above, by crossing Factors 2 and 3), was self-reported alcohol Consumption, measured by the number of units of alcohol consumed in the previous week. A UK alcohol unit contains 8 grams of ethyl alcohol. Participants were only included in the analysis if they had endorsed the box in the drinking details proforma

indicating that the previous week's Consumption was typical, that they had not taken part in other alcohol experiments and had not been treated for problem drinking. Furthermore, only participants who correctly detected a change were included in the analyses. Postulated differences between the four groups of participants were tested using an ANOVA. A main effect for Change Detected was predicted in which participants in the level, alcohol (both Groups ACD), would have higher scores on the dependent variable, Consumption, than those in the level, neutral (both Groups NCD). A null main effect for Location of Change Detected and for the 2-way interaction between Change Detected and Location of Change Detected was expected. Although both B. C. Jones et al. (2002) and B. T. Jones et al. (2003) did not find a main effect for Location of Change Detected nor an interactive effect incorporating Location of Change Detected, the factor was retained as a feature of the design of Experiment 1 because, as discussed earlier in this chapter, it appears there are good grounds for believing there might be a left visual hemispace attentional bias in normal individuals across a range of tasks. The extent of this bias under the current conditions of test and the impact it might have on the dependent variables used in Experiment 1 is currently not known. Consequently, controlling for (and being able to measure) a potential impact in Experiment 1 is important.

Stimuli

In creating the original and changed stimuli (OS and CS) for previous experiments carried out with the flicker ICB paradigm that addressed issues of alcohol attentional bias (B. C. Jones et al., 2002; B. T. Jones et al., 2003), the different objects of the alcohol-related and neutral categories were arranged in two separate but adjoining groups side by side on a table top and collectively photographed (see Figure 2.0.1 for an example). A different procedure was used to create the OS and CS in Experiment 1. In the current experiment, single (not grouped) objects were first photographed individually. Then, the individual photographs were arranged within a software-generated rectilinear matrix in which the 9 alcohol-related objects were formed into a 3x3 matrix on one side of a larger

3x6 landscape matrix and the nine neutral objects were formed into a 3x3 matrix on the other side of the 3x6 matrix. In building the 3x6 matrix, the 18 objects had previously been carefully collected in nine pairs, the details of which are now described below.

The pool of stimulus pairs.

Nine stimuli judged to be explicitly alcohol-related (A) and nine to be neutral (N) were chosen from a pool of objects collected for change blindness experiments in the Alcohol Laboratory. These comprised the 18 objects from which the 3x6 matrix was built. They were chosen in pairs. Each pair comprised an A and an N object and, within the constraints of practicality, the two items of the pair were matched for size, colour and form to minimise the non-alcohol overall competing salience's of the matrix of 3x3 alcohol and 3x3 neutral objects. The nine pairs of stimuli were as follows (see Figure 2.1.3): Pair 1, a yellow lager can and a yellow bleach bottle; Pair 2, a red corkscrew and a red Swiss army knife; Pair 3, a brown beer bottle and a brown sauce bottle; Pair 4, a 4-pack of red beer cans and a 4-pack of red tomato tins; Pair 5, A full, half bottle of whisky and a cafetière full of coffee both with liquid contents of approximately the same colour; Pair 6, a white bottle of alcopop and a white bottle of hair conditioner; Pair 7, a pint of Guinness and pint of milk (not, of course, matched for colour—only shape and size); Pair 8, an empty pint glass and an empty glass cafetière; Pair 9, a green beer bottle and a green bubble bath bottle.

The neutral items of the nine pairs were household items (i.e., found in a typical house and used by a typical household). This follows the recommendation of, for example, Cox, Pothos, Johnsen and Laberg (2001) and Ryan (2002) who have argued that items comprising the neutral group of items in attentional bias paradigms should form a cohesive group just as do the target items, which form the alcohol-related (cohesive) group and although the issue they were addressing in their study

when they did this does not map exactly onto Experiment 1, it is nevertheless a sensible precaution.

Constructing the two Original Stimuli, OS.

Each *individual* object comprising the nine pairs described above was placed in front of a white “cyclorama” background and photographed on its own from a fixed distance using a 3 mega pixel digital camera (set to maximum resolution). The photographs were saved in highest quality jpeg format and the graphics package Adobe Illustrator (8.0) was used to create a 3x6 landscape matrix with a 3x3 A (alcohol-related) matrix on one side of the 3x6 matrix and 3x3 N (neutral) matrix on the other. Once created within Adobe Illustrator, the two versions of the OS (see below) were saved in highest quality pict format.

The original stimulus with the alcohol-related matrix on the left and the neutral matrix on the right was labelled OS-ALNR and the original stimulus with the neutral matrix on the left and alcohol-related matrix on the right was labelled OS-NLAR (see Figure 2.1.4). The latter was a mirror reversal of the former—about a central vertical bisector of the 3x6 matrix and carried out using the Adobe Illustrator reflection function. These two OS corresponded to the two levels of the Factor, Locations of Changes, ALNR and NLAR.

Constructing the two Changed Stimuli, CS.

The changed stimuli were constructed by making a simultaneous change to *each* of the centre items of the 3x3 A matrix and the 3x3 N matrix comprising the 3x6 matrix of the CS. As these items carry the changes-to-be-detected they can be described as the *target* objects. In Experiment 1, the centre or target items of two matrices comprised Pair 5, described earlier, the full half bottle of whisky and the full cafetière. The changes were implemented by rotating each of the centre items on their vertical axes using Adobe Illustrator’s reflection function (see Figure 2.1.5). For the original stimulus OS-ALNR this meant that the label on the whisky bottle and the handle on the cafetière were both changed from facing *left* to facing *right*

(changed stimulus CS-ALNR). For the original stimulus OS-NLAR, the label and handle were both changed from facing *right* to *left* (changed stimulus CS-NLAR).

Finally, a matrix of 48 x 36 Xs (Times New Roman font, 14-point capital letters) was generated to provide the Mask (M).

Apparatus and Proforma

The contingencies and timings of the flicker ICB paradigm used in Experiment 1 were constructed and implemented using Psyscope v1.2.5 (Cohen, MacWhinney, Flatt & Provost, 1993) on an Apple G3 PowerBook running Mac OS 9.1, with a screen size of 28 x 21cm and a viewing distance of approximately 45cm. The PowerBook was placed on a table top in front of the participant and its screen was tilted to an angle that provided maximum clarity for viewing.

An alcohol consumption timeline followback form (TLFB, based on Sobell & Sobell, 1992) was constructed to record daily alcohol consumption in the previous week and to record some other personal details (see Figure 2.1.6). Through the TLFB, participants were asked to record the number, size and type/brand of drinks consumed on the day of testing and on the previous seven days and to state whether or not it represented a typical drinking week. Participants were also asked to record whether they were currently or had ever been treated for problem drinking.

Finally, through the TLFB, participants were asked to provide their age and gender and invited to provide contact details if they wanted to take part in future experiments or wanted detailed feedback about what the current series of experiments had shown (contact details and identity were stored separately from their data, according to ethical guidelines).

Procedure

In common with most “implicit” tasks in which it is desirable to maintain participant naivety with respect to the focal component (alcohol consumption in this case), recruitment for Experiment 1 was conducted outwith the Psychology Department. This was important because some potential participants might have known that alcohol research takes place in the Psychology Department and might

have been oriented towards the alcohol content of the stimuli for that reason rather than “usual consumption” reasons (e.g., see Yaxley and Zwaan, 2005). Participants were approached at various points on the campus and asked to take part in a short experiment purporting to examine differences between laptop and desktop computer use (reference to psychology was avoided). The individuals approached were told that they had been assigned to the laptop group.

Those agreeing to participate were taken to one of several quiet testing areas across the campus, not normally used in psychology experiments, and asked to sign a consent form. Prior to providing their informed consent, it was made clear that they could walk away from the testing (the flicker ICB paradigm) or other data collection (TLFB) at any time. Participants were then placed in front of a PowerBook which displayed on its screen the instructions, “Do not touch the keyboard until you are asked”. It was tilted to the angle that made it most clear and participants were asked if they were in a comfortable position and whether they could see the screen clearly. When this had been done they were asked to press the space bar to view the second of three sets (i.e., three screensful) of instructions, the first of which has been described above and the second of which was as follows:

“Please read this carefully, take your time. You will soon see a photograph of a number of objects appear on the screen. The photograph will appear only briefly before it disappears. When it disappears it will be immediately replaced by a pattern of XXXXXXs. But it will be replaced by a pattern of XXXXXXs for only a brief moment of time. After that brief moment of time, the photograph will then reappear.... to be replaced by the XXXXXXs again..... and then the photograph will reappear.....to be replaced by the XXXXXXs and so on *for a good many cycles*. Your job is a hard one—to spot the change that is made to the picture and to press the space bar as soon as you have spotted it.”

Participants were asked if this was clear and it was emphasized that the space bar should be pressed immediately on spotting the change and then they were to report to the experimenter what the change was. They were then told that if they were still willing to participate that they should press the space bar to continue.

They were told that when they pressed the space bar they would see the third and final set of instructions following which they would be given the actual task. They were also told that there would be no practice task. On pressing the space bar the final instruction screen was displayed as follows:

“OK, so now you have used the spacebar twice you know how hard you need to press it to make it work. You’re now ready to start the experiment. When you see a change in the picture press the spacebar (it might take you a while to spot the change). OK press the spacebar to begin.”

On completion of the change detection task, and if they had successfully identified a change made by reporting it correctly to the experimenter, participants were given the alcohol consumption TLFB form (see Figure 2.1.6) and asked to record details of the previous week’s alcohol consumption as accurately as possible. They were also asked to provide some basic demographic details through the same form (e.g., age, gender). On completion of the TLFB form and after it had been collected by the experimenter, the true nature of the experiment was revealed. Participants were provided with contact details of the experimenter and invited to contact the Alcohol Laboratory for further information in several weeks when the project would have been complete.

All procedures employed in Experiment 1 were agreed by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committee).

Results

Prior to the analyses, the 13 participants providing unsuitable data for inclusion in Experiment 1 were removed using previously established exclusion rules (see the Participants section for details). Data from the remaining 87 participants were analysed. The main hypotheses (Hypothesis 2.1.1) under test were that participants detecting the alcohol-related change (the two Groups ACD) would report higher alcohol Consumption (as measured by the self reported total number of

units consumed in the previous week) than those detecting the neutral change (the two Groups NCD).

Of the 87 participants included in the analysis, 62 detected the alcohol-related change (the two Groups ACD, M Consumption = 21.62 units of alcohol per week, SD = 18.15). Of these 62, 36 did so when the alcohol-related change was on the left (Group ACD-L, M = 24.46, SD = 20.51) and 26 when the alcohol-related change was on the right (Group ACD-R, M = 17.69, SD = 13.69). The remaining 25 of the 87 participants detected the neutral change (the two Groups NCD, M Consumption = 10.1 units, SD = 11.01). Of these 25, 15 detected it when the neutral change was on the left (Group NCD-L, M = 12, SD = 12.63) and 10 when the neutral change was on the right (Group NCD-R, M = 7.25, SD = 7.76). Figure 2.1.7 and contain these details. Directionally, it would appear that participants in the two Groups ACD reported higher levels of Consumption than the two Groups NCD, which supports the main hypothesis.

Positively skewed data

There are signs in the data described above that the sample from which they come is heavily positively skewed—because, with the consumption scale origin at zero, the standard deviations are typically equal to the mean in magnitude (typical of a positively skewed distribution). Coefficients of kurtosis (2.870) and skew (1.459) are also consistent with a distribution that should not be processed with an ANOVA—values above -1 and $+1$ are generally regarded as the limit for defensible processing. Consequently, Experiment 1's data need to be transformed prior to being used in an ANOVA. Keppel and Wickens (2004, page 153) recommend the square root ($x + 0.5$) transformation for measures where the preponderance is at the low end of the continuum and there are found progressively fewer as the one travels along the continuum. This is typical of consumption scores where there is a basement and no ceiling.

The following two factor analysis of variance (ANOVA) was used after the square root ($x + 0.5$) transformation was applied. Once the transformation had been

applied, coefficients of kurtosis (-0.375) and skew (0.299) were within the criterion suggested for a satisfactory distribution (-1 to +1). Following the transformation, Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was carried out. This revealed there to be no significant difference between the groups' variances ($p > .05$).

Note that in discussions when the numerical values of means are referred to rather than their relative or directional properties, the untransformed means are usually used—Keppel and Wickens (2004, page 154) suggest that “results should be discussed in terms of the original scores. In our [i.e., Keppel & Wickens'] example we would talk about the number of errors, not their square root.” For this reason, the means illustrated in figures (i.e., Figure 2.1.7 for the current experiment) are untransformed means.

Analysis of Variance

A 2x2 between participants analysis of variance (ANOVA) was used to test the main hypothesis (Hypothesis 2.1.1)—that participants detecting the alcohol-related change would report higher levels of weekly alcohol consumption than participants detecting the neutral change. The factors were the Location of Change Detected (two levels: left, L, and right, R) and Change Detected (two levels: alcohol-related change detected, ACD, and neutral change detected, NCD). The dependent variable was alcohol Consumption as measured by the number of units of alcohol consumed in the previous week.

The Analysis of Variance Summary table for this analysis is shown in Table 2.1.1. As predicted through the main hypothesis, the ANOVA revealed a significant main effect for Change Detected ($F(1, 83) = 10.702, p < .05$). Namely, participants comprising the two Groups ACD (i.e., those detecting the alcohol-related change) reported higher Consumption than participants comprising the two Groups NCD (i.e., those detecting the neutral change)—transformed $M = 4.28$ and 2.83 units respectively; raw $M = 21.62$ and 10.1 units respectively. There was no significant main effect for Location of Change Detected ($F(1, 83) = 1.999, p > .05$) and no

significant interaction between Change Detected and Location of Change Detected ($F(1, 83) = 0.024, p > .05$).

Effect Sizes

The analysis of variance technique (ANOVA) provides the opportunity to test the significance (i.e., reliability) of differences between means. Such a technique does not provide information on the ‘size’ of the mean difference, however only on its reliability. The *absolute* size of the mean difference is, of course, represented by the simple mean difference but if different mean differences are to be compared, the absolute mean difference can mislead.

To avoid this difficulty, Cohen (1992) and others have developed techniques based on the z-score philosophy. Cohen’s *d* is a statistic that expresses an absolute mean difference in terms of a pooled measure of the standard deviations of the two means. Thus a *relative* mean difference is derived that permits it to be compared with other relative mean differences. The relative mean difference is called an *effect size*. Effect sizes are computed below for the mean differences that were the focus of the ANOVA, above. The effect size (or, rather, the effect size direction), can be tested for reliability using 99% and 95% confidence limits. If, for example, the 95% confidence limits do not enclose the null effect size, then the effect size and its direction are reliable.

Hypothesis 2.1.2 was that a significant effect size would be found representing the difference between the Consumption of participants detecting the A change and the Consumption of participants detecting the N change.

Square root ($x + 0.5$) transformed means and standard deviations were used in effect size calculations. Raw data is included alongside the transformed data but was not used in the effect size calculations. An overall effect size was calculated to test the reliability of the mean difference between the two Groups ACD and the two Groups NCD. Using Cohen’s scheme (in which he described an effect size greater than 0.2 as *small*, greater than 0.5 as *medium* and greater than 0.8 as *large*) this revealed a “medium” effect size for Change Detected (Cohen’s $d = 0.77$; the two

Groups ACD transformed $M = 4.28$, $SD = 1.96$; raw $M = 21.62$, $SD = 18.15$; the two Groups NCD transformed $M = 2.83$, $SD = 1.65$; raw $M = 10.1$, $SD = 11.01$). The 95% confidence limits of d were 0.29 and 1.25 and did not include zero indicating the measure to be reliable. Similarly, the 99% confidence limits did not include zero (0.14 and 1.40) showing the reliability of the measure at this more stringent level.

Summary of Results

The changes referred to below are changes implemented as object rotation.

Hypothesis 2.1.1 Participants who detect the alcohol-related change delivered through the flicker ICB paradigm will typically consume more than those who detect the neutral change. Hypothesis 2.1.1 was confirmed.

Hypothesis 2.1.2 The effect size of the mean difference between the typical Consumption of participants detecting the alcohol-related change and those detecting the neutral change will be reliably in the direction of those detecting the alcohol-related change. Hypothesis 2.1.2 was confirmed.

Preliminary Discussion

The findings of B. C. Jones et al. (2002) are replicated with a different stimulus set of alcohol-related and neutral objects and a different stimulus layout. It seems likely that the attentional bias measured by B. C. Jones et al. was not a function of the idiosyncratic features of the stimulus set but a function of the semantic properties and that their result is generalisable—at least to the new stimuli used in Experiment 1. In particular the bilateral arrangement of alcohol-related and neutral objects within a rectilinear matrix appears a suitable arrangement for measuring attentional bias and that this form of stimulus (that can be readily and systematically modified) can form a base for subsequent experiments.

Evidence was reviewed above showing that there was a general “attentional bias” to the left hemispace and that controlling for side of presentation in this design and side of detection in the analysis might be important in Experiment 1. There

appeared, however, to be no consistent bias in the alcohol-related attentional bias that was found in Experiment 1. Coupled with the null finding by B. C. Jones et al. (2002) in respect of these effects, it is tentatively concluded that the left hemispace attentional bias sometimes found in some other tasks does not extend to change detection tasks used here to explore alcohol-related attentional bias.

Experiment 2: Social drinkers' detection of alcohol-related and neutral objects manifest as object replacements.

Experiment 1 was designed to replicate B. C. Jones, et al. (2002) but with new and more rigorously controlled stimuli. A consumption-related attentional bias was found consistent with B. C. Jones et al.'s finding. Experiment 2 is designed as a further replication of B. C. Jones et al.'s study, with the stimulus set retained from Experiment 1, but with a different type of change to be detected. In Experiment 1, the changes were implemented in a similar fashion to B. C. Jones et al.'s by rotating the changed object about a vertical axis. In B. C. Jones et al. the rotation was from "front to back". In Experiment 1, the change was "side to side". In both cases (B. C. Jones et al. and Experiment 1) the rotational change took place within a hardly changed "outline" of the object carrying the change. The principle change was to the detail inside the "outline" of the object carrying the change. In this sense, the rotations in both experiments were equivalent—or, at least, very similar.

This raises the question of the relationship between the sensitivity to an alcohol-related attentional bias and the nature of the change implemented. Might, for example, some type of change be "better" at measuring attentional bias? If the change is a "big" one, for example, might the *differential* attentional bias between say lighter and heavier drinkers be attenuated because both the alcohol-related change and neutral change are so easily detected? Or might it be augmented because the advantages conferred by an alcohol-related attentional bias is even more of an advantage when the change is readily spotted? Experiment 2 was carried out using a qualitatively different change to rotation, namely object replacement (or object substitution).

Method

Participants

One hundred and four participants (51 males, 53 females; *Mdn* age = 24 years, quartile range = 2.9, range = 54) were recruited from the university campus for Experiment 2. As in Experiment 1, when testing was completed and prior to analyses, participants who incorrectly completed the task ($n = 4$), had previously been involved in a similar study ($n = 0$), had consumed alcohol on the day of testing ($n = 0$), or had reported atypical alcohol consumption in the previous week ($n = 20$) were excluded from the analyses. One participant was excluded on the basis that they detected both changes.

The remaining 75 (36 males, 39 females; *Mdn* age = 23 years, quartile range = 3, range = 49) were retained in the analyses of Experiment 2.

Paradigm

The flicker ICB paradigm (Rensink et al., 1997) was used in Experiment 2. Paradigm details were identical to Experiment 1.

As in Experiment 1 a presentation cycle comprised a single presentation of each of the following: the original stimulus, OS (400 msec) – the mask, M (200 msec) – the changed stimulus CS (400 msec) – the mask, M (200 msec). See Figure 2.1.1 in Experiment 1 for details.

Design

The design of Experiment 2 was identical to that of Experiment 1—with 3 between participants factors each with two levels. Factor 1 represented Locations of Changes (two levels: one in which the alcohol-related change occurred on the left and the neutral change on the right, ALNR, and the other in which the alcohol-related change occurred on the right and neutral change on the left, NLAR). Group assignment using this factor was for proper experimentation. Factor 2 represented Change Detected (two levels: the alcohol-related change detected, ACD, and the neutral change detected, NCD). Factor 3 represented the Location of the Change

Detected (left, L, and right, R). Group assignment using factors 2 and 3 was for proper analysis.

As in Experiment 1, participants were randomly assigned to either level of Factor 1 (ALNR or NLAR) on recruitment into the experiment and retrospectively assigned to the appropriate levels of Factor 2 (two levels: ACD or NCD) and Factor 3 (two levels: L or R) depending on the change that they detected and the location of it within the stimulus matrix. Figure 2.2.1 graphically displays the details of the factors and levels of the design of Experiment 2.

Stimuli

The pool of stimuli pairs and the construction of the two OS and CS were identical to that of Experiment 1, except for the following—while in Experiment 1 the alcohol-related and neutral pair of items located at the centres of the two 3x3 matrices of the OS were *rotated* to create the CS (see Figure 2.1.5), in Experiment 2 the two items in question were *replaced* with a different pair of items (see Figure 2.2.2).

Constructing the two Original Stimuli, OS.

The two OS used in Experiment 2 were identical to the two OS used in Experiment 1 (see Figure 2.1.4 in Experiment 1).

Constructing the two Changed Stimuli, CS.

The two CS in Experiment 2 were constructed in a similar way to the two CS in Experiment 1, in which a simultaneous change was made in the two centre items of the 3x3 A matrix and the 3x3 N matrix of the OS. The only difference from Experiment 1's changes was that whereas in Experiment 1 the change was created by *rotating* the two target objects, in Experiment 2 the two target objects were *replaced* by different items which, during the stimulus construction phase were judged to be reasonably similar in shape, colour and form to the items of the OS being replaced. For the original stimulus OS-ALNR the full half bottle of whisky was replaced by a hip flask and the cafetière was replaced by a personal stereo player creating the

changed stimulus, CS-ALNR. The reflect function of Adobe Illustrator was used to generate a mirror image of CS-ALNR to create CS-NLAR (see Figure 2.2.3).

As in Experiment 1, a matrix of 48 x 36 Xs (Times New Roman font, 14 point caps) was generated to provide the Mask (M).

Apparatus and Proforma

These details were identical to those of Experiment 1. An Apple G3 PowerBook (OS 9.1) with Psycope v1.2.5 (Cohen et al., 1993) was used to construct and implement a flicker ICB paradigm. Demographic and alcohol consumption details were collected using the alcohol consumption timeline followback form (TLFB, based on Sobell & Sobell, 1992).

Procedure

The procedure of Experiment 2 was identical to that of Experiment 1— participants were recruited from cross campus traffic and taken to quiet testing areas outwith the Psychology Department. The task was described and participants asked if they wanted to continue. Those who agreed were seated in front of the PowerBook and were given the flicker ICB task and then asked to provide consumption and demographic details using the TLFB form. Participants were then debriefed and invited to contact the Alcohol Laboratory for results of the experiment. All procedures employed in Experiment 2 were agreed by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committee).

Results

The same rules as were used in Experiment 1 were employed to remove participants ($n = 25$) who did not provide suitable data for inclusion in Experiment 2 (see Participants section of Experiment 1 for details of the criteria and the Method section of Experiment 2 for the details of the numbers excluded). Data from the

remaining 75 participants were analysed. The main hypothesis in Experiment 2 (Hypothesis 2.2.1) was that reported alcohol consumption would be higher in participants who detected the alcohol-related change (the two Groups ACD) than in participants who detected the neutral change (the two Groups NCD).

Of the 75 participants included in the study, 42 detected the alcohol-related change (the two Groups ACD, M Consumption = 30.36 units of alcohol per week, $SD = 22.33$) and 33 detected the neutral change (the two Groups NCD, M Consumption = 10.42 units, $SD = 12.46$). Twenty two of the 42 participants who detected the alcohol-related change did so when it was located on the left of the stimulus matrix (Group ACD-L, $M = 34.5$, $SD = 30$) and the other 20 detected the alcohol-related change when it was on the right of the stimulus matrix (Group ACD-R, $M = 25.8$, $SD = 13.2$). Seventeen of the 33 participants who detected the neutral change did so when the neutral change was on the left of the stimulus matrix (Group NCD-L, $M = 9.47$, $SD = 8.64$) and the remaining 16 detected the neutral change when it was on the right of the stimulus matrix (Group NCD-R, $M = 11.44$, $SD = 15.8$). Figure 2.2.4 provides a graphical representation of these details.

As predicted by Hypothesis 2.2.1, it would appear that participants detecting the alcohol-related change (the two Groups ACD) report higher alcohol consumption than participants detecting the neutral change (the two Groups NCD). This observation was formally examined using an analysis of variance (ANOVA).

As was the case with Experiment 1, mean and standard deviation information along with coefficients of kurtosis (2.870) and skew (1.459) indicate that the distribution of scores is heavily positively skewed and inappropriate for carrying out ANOVAs. Also as was the case in Experiment 1, a square root ($x + 0.5$) is indicated. This was carried out prior to the analyses below and revealed coefficients of kurtosis (-0.485) and skew (0.506) which lie within the satisfactory range of -1 to +1. Following the transformation, Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was carried out. This revealed there to be no significant difference between the variances of the groups ($p > .05$).

Analysis of Variance

A two factor between participants ANOVA was carried out for Experiment 2. The first factor represented Location of Change Detected and had two levels (left, L, and right, R) and the second factor represented Change Detected and also had two levels (alcohol-related change detected, ACD and neutral change detected, NCD). Table 2.2.1 shows the Analysis of Variance Summary table.

It was predicted (Hypothesis 2.2.1) that reported alcohol Consumption would be higher in participants who detected the alcohol-related change (the two Groups ACD) than in participants who detected the neutral change (the two Groups NCD). Hypothesis 2.2.1 was supported—the ANOVA revealed a main effect for Change Detected ($F(1, 71) = 27.523, p < .0001$) showing that mean Consumption was higher in participants detecting the alcohol-related change, the two Groups ACD (transformed $M = 5.19$; raw $M = 30.36$ units), than in participants detecting the neutral change, the two Groups NCD (transformed $M = 2.90$; raw $M = 10.42$ units). Neither the main effect of Location of Change Detected ($F(1, 71) = 0.051, p > .05$) nor the interaction between Location of Change Detected and Change Detected ($F(1, 71) = 0.621, p > .05$) were significant. In common with Experiment 1 the size of the effect (Cohen's d) representing attentional bias was estimated as well as its reliability (ANOVA). Cohen's d is calculated below.

Effect Sizes

In common with Experiment 1, it was predicted (Hypothesis 2.2.2) that a significant effect size would be shown for the 19.94 unit mean difference in reported Consumption between participants detecting the alcohol-related change (the two Groups ACD, transformed $M = 5.19, SD = 2.01$; raw $M = 30.36, SD = 22.33$) and participants detecting the neutral change (the two Groups NCD, transformed $M = 2.9, S.D = 1.61$; raw $M = 10.42, S.D = 12.46$). Hypothesis 2.2.2 was supported—a “large” effect size ($d = 1.24$) was shown, using Cohen's 1992 scheme, for the mean difference in Consumption between participants detecting the alcohol-related change and participants detecting the neutral change. The 95% confidence limits of d were

0.73 and 1.72 which did not include zero indicating the measure to be reliable. Furthermore, the 99% confidence limits also did not include zero (0.57 and 1.88) showing the measure to be reliable at the higher level.

Summary of Results

The changes referred to below are changes implemented as object replacement.

Hypothesis 2.2.1 Mean Consumption of participants who detect the alcohol-related change will be higher than mean Consumption of participants who detect the neutral change. This was supported.

Hypothesis 2.2.2 The effect size of the mean difference in Consumption between participants who detect the alcohol-related change and participants who detect the neutral change will be significant. This was supported.

Preliminary Discussion

Experiments 1 and 2 were identical in all respects except for the nature of the alcohol-related and neutral changes to be detected. In Experiment 1, the alcohol-related and neutral changes were both made by *rotating* the target objects on a vertical axis—the changes were ‘rotations’, whereas in Experiment 2 the target objects were each *replaced* by a different object to make the change—the changes were ‘replacements’. Although both experiments reveal a differential attentional bias in lighter versus heavier social drinkers, the fact that two methods of implementing change were used raises the question of which type of change is more effective in revealing it. This is not simply an idle question because if one method is more sensitive to attentional bias than the other, it would be the method we would want to employ when exploring the properties of the attentional bias or even of the flicker ICB paradigm, itself, in subsequent experiments.

In comparing the two methods of implementing change, the ANOVAs show that the main effect of Consumption (the measure of differential attentional bias employed) is more reliable when the change is a replacement (Experiment 2, $p <$

.000) than when it is a rotation (Experiment 1, $p < .005$). They also shows that when the change is a replacement (Experiment 2), evidence for an attentional bias is found whether the change is detected on the left side of the stimulus presentation field or whether it is detected on the right. When the change is a rotation, however, (Experiment 1) evidence for an attentional bias is only found when the changes detected are on the left. In some sense this might suggest that there is a somewhat ‘stronger’ effect for replacement than for rotational changes. However, strength of effect is not best (or even appropriately) represented by the reliability of the measure of attentional bias obtained which is what is being referred to above. Rather, it is most appropriately measured by ‘effect size’. The measure of effect size employed in Experiments 1 and 2 was Cohen’s d .

When effect size is used to compare the attentional bias found when the change is a rotation with the attentional bias found when the change was a replacement, the effect size of the attentional bias measured through rotations was “medium” (Experiment 1) using Cohen’s scheme, but “high” when measured through replacements (Experiment 2). The replacement paradigm, therefore, appears to deliver a higher measure of attentional bias than does the rotational paradigm. This is only a safe conclusion, however, if the participants in both experiments are equivalent in terms of their typical alcohol Consumption—i.e., the variable in both experiments that is the basis of the effect size calculations. For example, if there are more heavier drinkers in Experiment 2 (the replacement experiment) than in Experiment 1 (the rotational experiment) and if these participants detected the alcohol-related change rather than the neutral (which we predict), then the effect size of the replacement experiment would be larger than the rotational experiment because the replacement experiment had more heavy drinking participants than the other. Of course, if this group of participants detected the neutral change, the effect size would be smaller. The problem is that we cannot be sure what they will detect, and for this reason a proper comparison of effect size of attentional bias between Experiment 1 and 2 only comes when both experiments have participants who drink equivalently. This is a difficult criterion however to build into the design of

Experiments 1 and 2 and into the recruitment of participants into Experiments 1 and 2, but a retrospective test can be actioned. For this reason, the difference between the means of typical weekly consumption of the participants of Experiment 1 and 2 were tested, retrospectively, and this is reported below.

Subsidiary combined analyses of Experiments 1 and 2

A 2x2x2 totally between participants ANOVA was carried out after the root ($x + 0.5$) transformation was applied: Factor 1, Experiment (two levels: Experiment 1 and Experiment 2); Factor 2, Location of Change Detected (two levels: left and right); Factor 3, Change Detected (two levels: alcohol-related change and neutral change). Table 2.2.2 shows the Analysis of Variance Summary Table for this analysis. The critical comparison for the current purpose was the main effect of Experiment. First, though, as might be expected from the combined analysis of Experiment 1 and 2, the main effect for Change Detected was significant: participants detecting the alcohol-related change had a mean weekly typical Consumption of 4.65 transformed units or 25.15 raw units while those detecting the neutral change had 2.87 transformed or 10.28 raw units ($F(1,154) = 35.872, p < .000$). This reflects the combination of the main finding from the independent analyses of Experiment 1 and 2. The main effect for Experiment was not significant, however: the mean weekly typical Consumption of participants in Experiment 1 was 3.86 transformed units or 18.31 raw units and for Experiment 2, 4.182 transformed units or 21.58 raw units ($F(1,154) = 3.039, p > .05$ and none of the interactions reached significance. This indicates that the participants in Experiment 1 (the rotational experiment) did not consume alcohol significantly differently from those in Experiment 2 (the replacement experiment). Other effects in this comparison ANOVA were not interpreted.

This does suggest that the apparent superiority of the replacement change-to-be-detected (Experiment 2) over the rotational change (Experiment 1) for eliciting an attentional bias might not simply be the result of the mean Consumption of those in

the former group being higher than the latter—i.e., the possibility that was raised above.

Preliminary Conclusion of Experiments 1 and 2

On these bases it seems reasonable to conclude that the use of the flicker ICB paradigm delivers a larger measure of attentional bias when the change is implemented as an object *replacement* rather than an object *rotation*—when the two sets of participants self-report their typical weekly drinking as being equivalent. This also suggests that implementing the change as an object replacement might be a more sensitive device to measure attentional bias than implementing it as an object rotation.

In both Experiments 1 and 2, although the main hypotheses were supported and a main effect for Changed Detected was found, it is possible that Change Detection was driven by or at least, influenced by certain properties (other than the alcohol-related or neutral properties) of the actual objects carrying the changes. It could, for example, be that, in spite of carefully matching the target objects in shape, size and colour, that one might contain certain properties causing it to be more “attention grabbing” than the other.

Consequently, to test the generalisability of the findings of Experiments 1 and 2, Experiments 3 and 4 were designed. These represented direct replications of Experiments 1 and 2, but employed new single alcohol-related and neutral objects to carry the changes—in Experiment 3 the change was implemented by rotating the new target objects and in Experiment 4 the change was implemented by replacing the pair of alcohol-related and neutral target objects with new pairs of objects. Both the rotation and replacement method of change implementation were repeated to examine whether the findings of Experiments 1 and 2, in which it would appear that the replacement method of change implementation is better at eliciting an attentional bias in social drinkers than the rotation method, would remain. It was hypothesized

that the attentional bias that was shown to be present in both Experiments 1 and 2 would extend to Experiments 3 and 4.

Importantly, Experiments 3 and 4 also serve to further test the generalisability of the attentional bias finding from Experiments 1 and 2. For although the findings of Experiments 1 and 2 were consistent with B. C. Jones et al.'s (2002) findings, all these experiments employed what some might describe as a limited "one shot" design.

Experiment 3: Social drinkers' detection of alcohol-related and neutral changes manifest as object rotations—a generalisation test of Experiment 1's findings with new target stimuli.

Experiment 3 was designed to investigate whether the difference between the level of Consumption of participants who detected the alcohol-related change and that of participants who detected the neutral change in Experiment 1 would be replicated when new objects were employed carry the change. Accordingly, in Experiment 3 the changes were implemented through object rotation, and, except for the introduction of a single new alcohol-related object and a single new neutral object to carry the rotational changes, Experiment 3 was identical to Experiment 1.

Method

Participants

One hundred participants (54 males, 46 females; *Mdn* age = 21.6 years, quartile range = 3, range = 42) were recruited from university campus traffic for Experiment 3. As with previous Experiments, participants who incorrectly completed the task ($n = 3$), had previously been involved in a similar study ($n = 2$), had consumed alcohol on the day of testing ($n = 1$), or had reported atypical alcohol Consumption in the previous week ($n = 32$), or detected both changes ($n = 0$) were removed prior to analyses. Suitable data was obtained from the remaining 62

participants (26 males, 36 females; *Mdn* age = 21 years, quartile range = 3, range = 39) and was included in the analyses of Experiment 3.

Paradigm

The flicker ICB paradigm (Rensink et al., 1997) was used in Experiment 3 and paradigm details were identical to Experiment 1—a presentation cycle consisted of a single presentation of each of the following: the original stimulus, OS (400 msec) – the mask, M (200 msec) – the changed stimulus CS (400 msec) – the mask, M (200 msec). A graphical representation of these paradigm details is shown in Figure 2.1.1.

Design

The design of Experiment 3 was identical to that of Experiment 1 and comprised 3 between participant factors. Factor 1, Location of Changes had two levels (one in which the alcohol-related change occurred on the left and the neutral change on the right, ALNR, and the other in which the alcohol-related change occurred on the right and neutral change on the left, NLAR). Group allocation using this factor was for proper experimentation. Factor 2 represented Change Detected and had two levels (the alcohol-related change detected, ACD, and the neutral change detected, NCD). Factor 3 represented the Location of the Change Detected and had two levels (when the change detected was located on the left, L, and when the change detected was located on the right, R). These two factors were to ensure proper analysis.

Participants were randomly allocated to one of the two levels of Location of Changes when they entered the study and, following testing, were assigned to appropriate levels of Changed Detected and Location of Change Detected based on the change that they reported and whether that change had been present on the left or the right of the stimulus matrix. The design of Experiment 3 is presented graphically in Figure 2.3.1.

The dependent variable used in the analyses, Consumption, represented the self-reported total number of alcohol units consumed weekly using the timeline followback method (Sobell & Sobell, 1992).

Stimuli

The stimuli pairs used in Experiment 3 were identical to those used in Experiment 1 except that a new pair of objects was introduced to carry the changes: in Experiment 1 a half bottle of whisky was located at the centre of the 3x3 A matrix and a cafetière at the centre of the 3x3 N matrix to carry the rotational changes; in Experiment 3 two miniature alcohol bottles and two make up bottles were used in their place to carry the rotational changes (see Figure 2.3.2).

Constructing the two Original Stimuli, OS.

Except for the introduction of the two new target objects, the two OS used in Experiment 3 were identical to the two OS used in both Experiments 1 and 2—a 6x3 landscape matrix was constructed with 3x3 alcohol-related objects to one side of the centre and 3x3 neutral objects to the other. Within these matrices the stimulus pairs were positioned in identical positions to those of Experiments 1 and 2. The OS of Experiment 3 are displayed in Figure 2.3.3.

Constructing the two Changed Stimuli, CS.

The two CS in Experiment 3 were constructed by simultaneously rotating the centre (target) object of the 3x3 A matrix and the centre (target) object of the 3x3 N matrix by 90 degrees on their vertical axes. This was done using the reflection function of Adobe Illustrator. The two CS are displayed in Figure 2.3.3.

The Mask (M), which comprised a matrix of 48 x 36 Xs (Times New Roman font, 14-point caps), was identical to that of previous experiments.

Apparatus and Proforma

The flicker ICB paradigm was implemented and run using Psyscope v1.2.5 (Cohen et al., 1993) on an Apple G3 PowerBook (OS 9.1). Consumption and basic demographic information was obtained using the timeline followback form (TLFB,

based on Sobell & Sobell, 1992) used in Experiments 1 and 2. An example of the TLFB is provided in Figure 2.1.6, and full details of the Apparatus and Proforma are located in the Apparatus and Proforma section of Experiment 1.

Procedure

The procedure of Experiment 3 was identical to the procedure of Experiment 1—participants were recruited from public places across the university campus and taken to quiet testing places on campus but outwith the Psychology Department. The task was explained and individuals who agreed to participate were placed in front of the PowerBook and asked to read the instructions on it. Participants were then given the opportunity to either continue with the change detection task or to leave. On finishing the change detection task participants were asked to complete the timeline followback form and provide some demographic information. The purpose of the task was then fully explained and participants were told that they could contact the Alcohol Laboratory at a later date to learn of results if they so wished. All procedures employed in Experiment 3 were agreed by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committee).

Results

The same strategy as was employed in previous experiments was repeated in Experiment 3 to identify participants providing data unsuitable for inclusion in analyses ($n = 38$). Full details of the exclusion criteria are provided in the Participants section of Experiment 1 and the numbers are included in the Method section of Experiment 3.

Following the removal of participants who did not provide suitable data, 62 participants were included in the analyses. Of these 62, 27 participants detected the alcohol-related change (the two Groups ACD, M Consumption = 23.35 units of alcohol per week, $SD = 15.86$) and 35 detected the neutral change (the two Groups NCD, M Consumption = 12.27 units of alcohol per week, $SD = 15.34$). Of the two

Groups ACD, 12 detected the change when it occurred on the left of the stimulus matrix, (Group ACD-L, $M = 23.21$, $SD = 19.94$), and 15 detected it when it occurred on the right (Group ACD-R, $M = 23.47$, $SD = 12.43$). Of the two Groups NCD, 19 detected the change when it occurred on the left of the stimulus matrix (Group NCD-L, $M = 13.26$, $SD = 13.36$) and the remaining 16 detected the change when it occurred on the right, (Group NCD-R, $M = 11.09$, $SD = 18.37$). This information is provided graphically in Figure 2.3.4. It would, therefore appear that, as predicted by the main hypothesis, weekly alcohol Consumption was higher in participants who detected the alcohol-related change than in participants who detected the neutral change. The ANOVA, reported below, tested the reliability of this. Prior to analyses, however, as was the case in Experiments 1 and 2, square root ($x + 0.5$) transformations were applied changing the coefficients of skew (1.506) and kurtosis (1.202) to more acceptable values of -0.103 and -0.515 , respectively. Following the transformation, Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was carried out to test for equal variance between each group used in the following ANOVA. This revealed there to be no significant difference between the groups ($p > .05$).

Analysis of Variance

The main analysis of Experiment 3 was carried out using a two factor between participants ANOVA. The first factor, Location of Change Detected, had two levels—left, L, and right, R. The second factor, Change Detected also had two levels—alcohol-related change detected, ACD, and neutral change detected, NCD. The independent variable was self-reported weekly alcohol Consumption measured obtained from the alcohol timeline followback. The Analysis of Variance Summary table is shown in Table 2.3.1.

The main hypothesis, Hypothesis 2.3.1, predicted that self-reported weekly alcohol Consumption would be higher in participants who detected the alcohol-related change, the two Groups ACD, than in participants who detected the neutral change, the two Groups NCD. This was supported—a significant main effect for

Change Detected was shown ($F(1, 58) = 29.515, p < .05$)—the mean weekly alcohol Consumption of participants who detected the alcohol-related change, the two Groups ACD (transformed $M = 4.57$ units; raw $M = 23.35$ units) was greater than the mean weekly alcohol Consumption of participants who detected the neutral change, the two Groups NCD (transformed $M = 31.4$ units; raw $M = 12.27$ units).

The main effect of Location of Change Detected did not reach significance ($F(1, 58) = 0.180, p > .05$) and neither did interaction between Location of Change Detected and Change Detected ($F(1, 58) = 0.292, p > .05$).

Effect Sizes

Hypothesis 2.3.2 predicted that there would be a significant effect size for the mean difference in Consumption between participants who detected the alcohol-related change, the two Groups-ACD and participants who detected the neutral change, the two Groups-NCD. This was supported—a “large” effect size using Cohen’s (1992) scheme ($d = 0.81$) was shown for the difference in Consumption between the two Groups ACD (transformed $M = 4.57, SD = 1.77$; raw $M = 23.35, SD = 15.86$) and the two Groups NCD (transformed $M = 3.14, SD = 1.72$; raw $M = 12.27, SD = 15.34$). The 95% confidence limits of d were 0.28 and 1.33 and the 99% confidence limits were 0.12 and 1.49 neither of which include zero indicating the measure to be reliable be reliable at both the 95% and 99% levels.

Summary of Results

The changes referred to below are changes implemented as object rotation.

Hypothesis 2.3.1 The weekly mean Consumption will be higher in participants who detect the alcohol-related change than in participants who detect the neutral change. This was supported.

Hypothesis 2.3.2 The effect size of the mean difference between the Consumption of participants who detect the alcohol-related change and participants who detect the neutral change will be reliable. This was supported.

Preliminary Discussion

The main results of Experiment 3 replicate those of Experiment 1—a significant difference was shown in self-reported weekly Consumption between participants who detected the alcohol-related changes and those who detected the neutral changes. This suggests that change detection in Experiment 1 was not driven by any specific perceptual properties of the two single objects used to carry the change—increasing the evidence of the generalisability of the original “rotational” finding of B. C. Jones et al.’s (2002) attentional bias in social drinkers also found in Experiment 1.

Experiment 4: Social drinkers’ detection of alcohol-related and neutral changes manifest as object replacements—a generalisation test of Experiment 2’s findings with new target stimuli.

Experiment 4 was designed to test the generalisability of the findings of Experiment 2 using the two new objects that were introduced in Experiment 3 to carry Experiment 3’s rotational the changes. Unlike in Experiment 3, however, but as in Experiment 2, the change in Experiment 4 was implemented by simultaneously replacing these two single alcohol and single neutral target objects with objects which were similar in shape, size and colour that had not been used in previous experiments. The primary purpose of replicating Experiment 2 in this way was to test whether the significant difference in Consumption that was present between participants who detected the alcohol-related change and those who detected the neutral change in Experiment 2 would remain when new target objects were introduced to implement the change. A secondary purpose, however was to investigate the difference between object replacement and object rotation as methods of change implementation—in Experiments 1 (object rotation) and 2 (object replacement) a larger effect size was present in Experiment 2 than Experiment 1, suggesting that a greater differential attentional bias is found when the changes are implemented through object replacement than through object rotation.

Method

Participants

One hundred participants (46 males, 54 females; *Mdn* age = 22.1 years, quartile range = 3, range = 30) were recruited from the university campus for Experiment 4. As in Experiment 2, when testing was completed and prior to analyses, participants who incorrectly completed the task ($n = 2$), had previously been involved in a similar study ($n = 1$), had consumed alcohol on the day of testing ($n = 1$), or had reported atypical alcohol Consumption in the previous week ($n = 36$), or detected both changes ($n = 0$) were excluded from the analyses.

The remaining 60 participants (29 males, 31 females; *Mdn* age = 21 years, quartile range = 3, range = 29) provided data suitable for inclusion in the analyses of Experiment 4.

Paradigm

The flicker ICB paradigm (Rensink et al., 1997) was used in Experiment 4. Paradigm details were identical to Experiment 1 in which a presentation cycle consisted of a single presentation of each of the following: the original stimulus, OS – the mask, M – the changed stimulus, CS – the mask, M. The OS and CS were each presented for 400 msec and the Mask was presented for 200 msec. Figure 2.1.1 contains a graphical representation of these paradigm details.

Design

A three factor between participants design was used in Experiment 4 in which Factor 1 represented Locations of Changes and had two levels (one in which the alcohol-related change occurred on the left and the neutral change on the right, ALNR, and the other in which the alcohol-related change occurred on the right and neutral change on the left, NLAR). Factor 2 represented Change Detected and had two levels alcohol-related change detected, ACD, and neutral change detected, NCD). Factor 3 represented the Location of the Change Detected and again had two levels (left, L, and right, R)

In common with the earlier experiments, there were procedures for group allocation that were different for proper experimentation and proper analysis. Random assignment to one of the two levels of Factor 1 (ALNR or NLAR) took place on recruitment into the study. Participants were then retrospectively assigned to one of the two levels of Factor 2 (ACD or NCD) and to one of the two levels of Factor 3 (L or R) based on the change that they detected and its location within the stimulus matrix. The design of Experiment 4 is presented graphically in Figure 2.4.1.

The dependent variable used in the analyses was the self-reported weekly number of alcohol units consumed (Consumption). This was measured using the same alcohol timeline followback, TLFB, as was used in previous experiments (see Figure 2.1.6 for an example).

Stimuli

The same pool of stimuli pairs as used in Experiments 1 and 2 were used to construct the two OS and the two CS in Experiment 4 with the only difference being that the two new objects that were introduced in Experiment 3 were included and were positioned at the centre of the 3x3 A matrix and at the centre of the 3x3 N matrix of the two OS. These “new” objects are shown in Figure 2.3.2.

Constructing the two Original Stimuli, OS.

The two OS used in Experiment 4 were identical to the two OS used in Experiment 3 in which a 6x3 landscape matrix was constructed with 3x3 alcohol-related, A, objects to one side of the centre and 3x3 neutral objects, N, to the other.

Constructing the two Changed Stimuli, CS.

The two CS used in Experiment 4 were constructed in an identical way to the two OS described above, except that the centre (target) object of the 3x3 A matrix and the centre (target) object of the 3x3 N matrix were simultaneously replaced new objects. The new objects which were chosen to replace the target objects were a bottle of water to replace the neutral target object and a cocktail shaker to replace the alcohol-related target object.

The two OS and two CS used in Experiment 4 are graphically represented in Figure 2.4.2 and the two new stimuli introduced to Experiment 4 are shown in Figure 2.4.3

As in Experiment 2, a matrix of 48 x 36 Xs (Times New Roman font, 14-point caps) was generated to provide the Mask (M).

Apparatus and Proforma

These details were identical to those of Experiment 2—Psyscope 1.2.5 (Cohen et al., 1993) was used to implement the paradigm on an Apple G3 (OS 9.1) PowerBook and Consumption information was collected using an alcohol timeline followback (based on Sobell & Sobell 1992).

Procedure

The procedure of Experiment 4 was identical to the procedure of previous Experiments and full description is available in the Procedure section of Experiment 1. All procedures employed in Experiment 3 were agreed by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committee).

Results

An identical strategy to that used in previous experiments was employed in Experiment 4 to remove participant's data that was unsuitable for inclusion in analyses ($n = 40$). Full details of the exclusion criteria are contained in the Participants section of Experiment 1 and the numbers for Experiment 4 are contained in the participants section of Experiment 4. The remaining 60 participants provided data suitable for inclusion in analyses. Of the 60 participants, 31 detected the alcohol-related change—the two Groups ACD, M Consumption = 19.82 units of alcohol per week, $SD = 19.38$, and 29 detected the neutral change—the two Groups NCD, M Consumption = 10.95 units of alcohol per week, $SD = 10.07$. Within the two Groups ACD, 16 detected the change when it was located on the left of the

stimulus matrix, (Group ACD-L, $M = 21.75$, $SD = 19.94$) and 15 detected the change when it occurred on the right on the stimulus matrix, (Group ACD-R, $M = 17.77$, $SD = 10.44$) and within the two Groups NCD, 13 participants detected the change when it was located on the left of the stimulus matrix (Group NCD-L $M = 9.35$, $SD = 10.24$) and 16 detected the change when it was located on the right of the stimulus matrix (Group NCD-R. $M = 12.25$, $SD = 10.42$). These details are represented graphically in Figure 2.4.4. Directionally, it would appear that as predicted in Hypothesis 2.4.1, participants who detected the alcohol-related change reported higher weekly alcohol Consumption than participants who detected the neutral change. This is formally examined in the following ANOVA—after square root ($x + 0.5$) transformations had been applied which changed the coefficients of skew (1.448) and kurtosis (1.806) to more acceptable values of 0.364 and -0.49 , respectively. Following the transformation Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was carried out to test for equal variance between each group used in the following ANOVA. This revealed there to be no significant difference between the groups ($p > .05$).

Analysis of Variance

A two factor between participants ANOVA was carried out for Experiment 4 in which Factor 1 represented Location of Change Detected and had two levels (left, L, and right, R) and Factor 2 represented Change Detected and also had two levels (alcohol-related change detected, ACD and neutral change detected, NCD). The above Factors and their respective levels are graphically display in Figure 2.4.4. Table 2.4.1 shows the Analysis of Variance Summary table.

It was predicted in the main hypothesis (Hypothesis 2.4.1) that participants who detected the alcohol-related change (the two Groups ACD) would report higher levels of weekly Consumption than participants who detected the neutral change (the two Groups NCD). This was supported—the ANOVA revealed a one-tailed main effect for Change Detected ($F(1, 56) = 3.858$, $p > .05$ two-tailed—but $p = .055/2 = .028$ for a one-tailed test, see next paragraph for explanations) showing the mean

weekly Consumption to be higher in participants detecting the alcohol-related change, the two Groups ACD, (transformed $M = 3.95$ units; raw $M = 19.82$ units) than in participants detecting the neutral change, the two Groups NCD, (transformed $M = 2.96$ units; raw $M = 10.95$ units). Neither the main effect of Location of Change Detected ($F(1, 56) = 0.008, p > .05$) nor the interaction between Location of Change Detected and Change Detected ($F(1, 56) = 1.163, p > .05$) were significant.

Returning to the main effect for Change Detected: this just failed to be significant with a two-tailed test ($p = .055$). However, it is defensible to make a one-tailed prediction in this case for two reasons. First, previous attentional bias research suggests an attentional bias might be found. Second, more informatively, Experiments 1-3 have also found an attentional bias in circumstances equivalent to Experiment 4. Keppel and Wickens (2004) outline the rationale for one-tailed tests with the F-distribution—they start their explanation with the t-distribution—and this is explained below.

In the case of a t-test, the two rejection regions for a two-tailed test reside at each end of the t-distribution. They can both be compacted at one end if a one-tailed prediction can be made. In which case the alpha changes from .05 at each end to .1 at the one end. In other words, there is a significant one-tailed outcome if $p < .1$. An equivalent one-tailed prediction can be made with the F-distribution but it is a little more difficult to conceptualise because there only is one rejection region under the F-distribution. Rather than in the case of a t-test in which the two .05 rejection regions under the t-distribution are compacted at one end and which generates an alpha of .1 at that end, the single rejection region under the F-distribution is doubled for one-tailed tests. In other words, the critical alpha of .05 (for two-tailed tests) is doubled to .1 for one-tailed tests with the F distribution and [you] “only reject the null hypothesis when the observed means are in the direction specified by the alternative hypothesis.” Keppel and Wickens (2004, Footnote 4, page 74).

Effect Sizes

Hypothesis 2.4.2 was that a significant effect size would be present for the mean difference in weekly consumption between participants detecting the alcohol-related change (the two Groups ACD, transformed $M = 3.95$, $SD = 2.21$; raw $M = 19.82$, $SD = 19.38$) and participants detecting the neutral change (the two Groups NCD, transformed $M = 2.96$, $SD = 1.67$; raw $M = 10.95$, $SD = 10.07$). Using Cohen's (1992) scheme, a "medium" effect size (Cohen's $d = 0.50$) was shown. When 95% confidence limits were employed, these included zero (-0.02 and 1.01) suggesting the effects size shown for the mean difference in Consumption between participants detecting the alcohol-related change and participants detecting the neutral change to be unreliable. When, however, 90% confidence limits were employed (i.e., a one-tailed test of the hypothesis was conducted) these did not include zero (0.07 and 0.93).

Summary of Results

The changes referred to below are changes implemented as object replacement.

Hypothesis 2.4.1 Mean Consumption of participants who detect the alcohol-related change will be higher than mean Consumption of participants who detect the neutral change. This was supported.

Hypothesis 2.4.2 The effect size of the mean difference in Consumption between participants who detect the alcohol-related change and participants who detect the neutral change will be significant. This was supported.

Preliminary Discussion

The purpose of Experiment 4 was to replicate Experiment 2 using new target stimuli with replacement changes to investigate whether the differential attentional bias shown in Experiment 2 would exist when new target objects were used. Similar to Experiment 2, weekly Consumption was significantly higher for participants who

detected the alcohol-related change than for participants who detected the neutral, suggesting that the attentional bias found in Experiment 2 was not driven by the particular target objects used but could be replicated using new target objects and therefore supporting the generalisability of the flicker ICB paradigm for eliciting an alcohol-related attentional bias in social drinkers.

In Experiments 1 and 2 both the ANOVAs and the effect size calculations suggested object *replacement* to be superior to object *rotation* in eliciting an attentional bias—while the effect size (according to Cohen’s scheme) was “medium” in Experiment 1 (rotation), it was “large” in Experiment 2 (replacement). For reasons discussed in the Preliminary Discussion of Experiment 2, before making comparisons between the effect sizes of the two Experiments it was necessary to ensure that there was no difference in level of Consumption between the participants in Experiment 1 and those in Experiment 2. Consequently, and in a similar vein, before any formal judgement can be made regarding the “medium” effect sizes found both in Experiments 3 and 4 it is necessary to test for any difference in Consumption across the two experiments. If, for example, Consumption in Experiment 4 was found to be significantly lower than in Experiment 3, then it might not be reasonable to conclude on the basis of the two “medium” effects sizes in Experiments 3 and 4 that the rotational and replacement methods of implementing the change were equivalent in their ability to elicit an attentional bias. The comparison of overall consumption is reported below.

Subsidiary Combined Analysis of Experiments 3 and 4.

A three factor totally between participants ANOVA was carried out for Experiments 3 and 4. Factor 1 represented the Experiment and had 2 levels—Experiment 3 and Experiment 4. Factor 2 represented Location of Change Detected and had 2 levels—left, L, and right, R. Factor 3 represented Change Detected and also had 2 levels—alcohol-related change detected, ACD, and neutral change detected, NCD. The Analysis of Variance Summary table for this analysis is shown in Table 2.4.2.

As a main effect of Change Detected was present in the independent analyses of Experiments 3 and 4, it was expected that this would extend to the combined analysis. This was the case—the main effect of Change Detected was significant ($F(1, 114) = 43.450, p < .05$). Similarly, as there was no significant main effect of Location of Change Detected in the independent analyses of Experiment 3 or of Experiment 4, a similar result was expected in the combined analyses—this was shown, the main effect of Location of Change Detected failed to reach significance ($F(1, 114) = 0.047, p > .05$).

The main reason for carrying out this analysis, however, was to investigate whether any difference in mean weekly Consumption was present between Experiments 3 and 4—i.e., to investigate the main effect of Experiment. The main effect of Experiment was not significant ($F(1, 114) = 1.400, p > .05$) and neither were any of the interactions suggesting that there was no difference in the weekly mean Consumption between the participants of Experiment 3 (rotation, transformed $M = 3.76$ units; raw $M = 17.10$ units) and those of Experiment 4 (replacement, transformed $M = 3.47$ units; raw $M = 15.53$ units). Other effects in this ANOVA were not interpreted.

As there was no difference in weekly overall Consumption between Experiments 3 and 4 it seems plausible that any difference between the two methods of implementing the change—i.e., rotation and replacement—was not driven by differences in overall Consumption between the two Experiments, but rather by the method of change implementation.

When comparing the effect size for the mean difference in Consumption between participants who detected the alcohol-related change and participants who detected the neutral change a “large” effect size (according to Cohen’s scheme) was present in Experiment 3 (rotation), while in Experiment 4 (replacement) the effect size was “medium”, but only significant at the one-tailed level. Thus it would appear that when the effect sizes are compared then Experiment 3 (rotation, $d = 0.81$) appears to provide a better method of eliciting an attentional bias than Experiment 4, (replacement, $d = 0.50$) as not only is the effect smaller in Experiment

4, but also is only significant at the 90% level. This differs from Experiments 1 and 2, where a larger effect size was shown when the change was implemented by replacement (Experiment 2), than by rotation (Experiment 1).

If tentative conclusions are to be drawn from Experiments 1-4 about the most “sensitive” method to elicit an attentional bias in social drinkers and if this is based on effect size, then the same comparison of overall Consumption as carried out between Experiments 1 and 2 and Experiments 3 and 4 needs to be carried out between Experiments 1, 2, 3 and 4. Consequently a three factor between participants ANOVA was performed in which Factor 1 represented Experiment (4 levels, 1, 2, 3, 4), Factor 2 represented Location of Change Detected (2 levels, Left, L and Right, R) and Factor 3 represented Change Detected (2 levels, alcohol-related change detected, ACD and neutral change detected, NCD) to further investigate whether there was any difference in overall alcohol Consumption between Experiment 1 (transformed $M = 3.86$ units; raw $M = 18.31$ units), Experiment 2 (transformed $M = 4.18$ units; raw $M = 21.59$ units), Experiment 3 (transformed $M = 3.76$ units; raw $M = 17.10$ units) and Experiment 4 (transformed $M = 3.47$ units; raw $M = 15.53$ units). The ANOVA showed there to be no main effect for Experiment ($F(1, 268) = 0.205, p > .05$) and that none of the interactions involving Experiment (or any other interactions for that matter) reached significance showing there to be no difference in overall Consumption between the four experiments and therefore suggesting that any differences in attentional bias between the experiments was not as result of differences in Consumption between Experiments 1-4. Other effects of the ANOVA were not interpreted. The Analysis of Variance table for this analysis is shown in Table 2.4.3.

Preliminary Conclusion

On these bases it would appear that when the self-reported weekly alcohol Consumption of the participants of Experiments 3 and 4 is equivalent then a larger measure of AAB is measured using the flicker ICB paradigm when changes are implemented through object rotation (Experiment 3) rather than object replacement

(Experiment 4). This differs from Experiments 1 and 2, in which object replacement (Experiment 2) delivered a larger effect than object rotation (Experiment 1).

Experiment A: Social drinkers' detection of alcohol-related and neutral changes manifest as word replacement—a generalisation test of Experiment 1's findings using textual stimuli.

Experiment A was designed to investigate whether the consumption related attentional bias originally found in B. C. Jones et al. (2002) and in Experiments 1-4 would extend to lexical stimuli. There is some evidence suggesting that pictorial stimuli might be more appropriate than lexical stimuli at eliciting an attentional bias in social drinkers—Townshend and Duka (2001), for example, have shown an attentional bias when using pictorial, but not lexical stimuli in the dot probe task. Experiment A attempts to provide a direct replication of Experiment 1 with lexical rather than pictorial stimuli. This is reported below.

Method

Participants

One hundred participants (46 males, 54 females; *Mdn* age = 21.5 years, quartile range = 3, range = 17-53) who were native English speakers were recruited from public places throughout the university campus to take part in Experiment A. Identical to previous Experiments, participants were excluded following testing and prior to analyses if they incorrectly completed the task ($n = 2$), had previously been involved in a similar study ($n = 2$), had consumed alcohol on the day of testing ($n = 1$), had reported their alcohol consumption in the previous week to be atypical ($n = 8$), or detected both changes ($n = 2$). Participants would also have been excluded if they reported that they were currently, or had ever been, treated for problem drinking, but no such participants took part in this study. The remaining 85 participants (36 males, 49 females; *Mdn* age = 20 years, quartile range = 3, range = 17-53) were included in the analyses of Experiment A.

Paradigm

As in Experiment 1, the flicker ICB paradigm (Rensink et al., 1997) was used in Experiment A. There was, however, one important difference—namely while in previous Experiments pictorial stimuli were employed, lexical stimuli were used in Experiment A. Aside from the differences in the stimuli, the paradigm was identical to that of previous experiments with the exception of the presentation time of the mask (which was extended). A presentation cycle consisted of a single presentation of each of the following: the original stimulus, OS (400 msec) – the mask, M (500 msec) – the changed stimulus CS (400 msec) – the mask, M (500 msec). While in previous experiments the mask was presented for 200 msec, this was considered to be too short when lexical stimuli were used and as a result a presentation time of 500 msec was used. Full paradigm details are available in the Paradigm section of Experiment 1 and a graphical representation of these paradigm details is shown in Figure 2.1.1. Note the timings in figure 2.1.1 are slightly different than those employed in Experiment A.

Design

An identical design to that of Experiment 1 was employed in Experiment A—namely a 2x2x2 entirely between participants design in which factor 1 represented Location of Changes and had 2 levels (ALNR, in which the alcohol-related change occurred on the left and the neutral change on the right, and, NLAR, in which the neutral change occurred on the left and alcohol-related change on the right). Factor 2 was Change Detected and had two levels (ACD, alcohol-related change detected, and, NCD, neutral change detected). Factor 3, Location of the Change Detected also had two levels (left, L, in which the change detected was located on the left, and right, R, in which the change detected was located on the right).

On entering the study, participants were randomly allocated to one of the two levels of Location of Changes. Based on their response each participant was, subsequent to testing, assigned to the appropriate levels of the each of Factors

Change Detected Location of Change Detected. A full explanation of the design is available in the Design section of Experiment 1 and a graphical representation of the design of Experiment A is provided in Figure 2.A.1.

The dependent variable used in the analyses was Consumption. This represented the total number of UK alcohol units consumed in the previous week and was measured using the alcohol timeline followback (Sobell & Sobell, 1992).

Stimuli

Unlike all previous experiments in which pictorial stimuli were employed, Experiment A employed lexical Stimuli. The overall layout of the stimuli was, however, the same as that used in previous experiments in which the stimuli comprised a 3x3 matrix of alcohol-related objects (in this case words) to one side of the centre and overall 6x3 landscape matrix of stimuli, and 3x3 neutral objects (again in this case words) to the other (see Figure 2.A.2).

The pool of stimulus pairs.

Similar to the construction of the pairs of pictures used in previous experiments (see Stimuli section of Experiment 1 for a detailed explanation) pairs of words that were judged to be explicitly alcohol-related (A) or neutral (N) were chosen. Furthermore, so that their physical appearance was similar the two members of each pair, were as far as possible matched on length and were presented in capital letters (36 point, Courier font). Capital letters were used to eliminate any ascenders or descenders—this was done to avoid any differences that would arise in the perceptual properties of the words. In addition to attempting to control for the physical properties of each pair of words, the word frequency was also considered.

To test whether there was any significant difference between the word frequency of the group of alcohol-related words as whole ($n = 9$) and that of the group of neutral words ($n = 9$) a t-test was performed. This showed there to be no significant difference between the group of alcohol-related words and the group of neutral words ($t(16) = 1.672, p > .05$). It would, therefore appear that there is no significant difference between the frequency of the group of alcohol-related words

and the group of neutral words. It may be, however, that the t-test does not provide a fair test of the means for several reasons—first due to the small number of words in each group, the lack of power may be concealing any real difference and second, the standard deviations of the two means are large, suggesting that the data is not normally distributed. For these reasons a Mann-Whitney test was also conducted. In line with the above t-test, the Mann-Whitney revealed no significant difference ($u(9, 9) = 27, p > .05$) in word frequency of the alcohol group and neutral group of words suggesting that there is in fact, no significant difference between the two groups of words.

As with pictorial stimuli, the lexical stimuli were chosen in pairs so that each alcohol-related word had a corresponding neutral word. The nine pairs of stimuli were as follows (see Figure 2.A.2): Pair 1, PUB and CUP; Pair 2, CORK and FORK; Pair 3, SHOT and BOWL; Pair 4, GIN and BIN; Pair 5, LAGER and TABLE; Pair 6, PINT and PLATE; Pair 7, CIDER and CHAIR; Pair 8, BAR and BED; Pair 9, WINE and VASE.

Constructing the two Original Stimuli, OS.

The 6x3 landscape matrix used in Experiment A was created in an identical way to that of Experiment 1 in which a matrix of 3x3 alcohol-related words (the A matrix) was positioned to one side of the centre of an 3x6 landscape matrix and a matrix of 3x3 neutral words to the other (the N matrix). Within this 3x6 matrix the words were carefully positioned in their pairs so that, for example, Pair 1 was located at the top extreme left and extreme right, and so on—see Figure 2.A.2 for an example of this. Two versions of the OS were created—OS-ALNR in which the 3x3 A matrix was positioned to the left and the 3x3 N matrix to the right and OS-NLAR in which the 3x3 N matrix was to the left and the 3x3 A matrix to the right.

Constructing the two Changed Stimuli, CS.

The two CS used in Experiment A were created by taking each of the OS and exchanging the centre (target) word of the 3x3 A matrix with the centre (target) word of the 3x3 N matrix. This was similar to the replacement method used in

Experiment 2 but with one main difference—new objects were not introduced to the matrix, rather the two target objects changed position. This meant that no differential information was available from the target objects themselves. This method of change implementation was used with both OS-ALNR and OS-NLAR so that two CS were created. These are displayed in Figure 2.A.2.

The Mask (M) was identical to that used in previous Experiments and comprised a matrix of 48x36 capital Xs presented in 14 point Times New Roman font.

Apparatus and Proforma

Psyscope v1.2.5 (Cohen et al., 1993) was used to create and run the flicker ICB paradigm on an Apple G3 PowerBook (OS 9.1) and the alcohol timeline followback (based on Sobell & Sobell, 1992), which was used in Experiments 1 and 2, was used to collect alcohol consumption and basic demographic details. Full details of the Apparatus and Proforma are located in the Apparatus and Proforma section of Experiment 1 and an example of the timeline followback is provided in Figure 2.1.6.

Procedure

The procedure of Experiment A was identical to that of Experiment 1. Participants were approached across the university campus and asked to take part in a short experiment claiming to investigate the differences between performance on a short task depending on whether that task was completed on a laptop or desktop computer. A brief explanation of the task was provided and if the individual agreed to take part they were taken to quiet testing areas which were outwith the Psychology Department and told that they would be part of the laptop group. Participants were asked to sit facing the PowerBook and then to read the instructions on it. They were then asked if they understood the task and if they were still happy to participate. It was emphasized that should they wish to leave the experiment at any point that they would be free to do. If still willing to take part, participants were asked to press the space bar to start the change detection task. On completion of the

task participants were asked to provide both basic demographic details and complete the alcohol timeline followback sheet. A full explanation of the procedure of Experiment A is provided in the Procedure section of Experiment 1 and all procedures employed in Experiment A were agreed by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committee).

Results

In common with Experiment 1 not all participants ($n = 15$) provided suitable data and therefore could not be included in the analyses of Experiment A. As a result, of the 100 participants who were tested only 85 provided data which were suitable for inclusion in the analyses of Experiment A. Information on the exclusion criteria is available in the Participants section of Experiment 1 and the exact numerical details are provided in the Method section of Experiment A.

Of the 85 who were included, 36 detected the alcohol-related change (the two Groups ACD, M Consumption = 17.18 units of alcohol per week, $SD = 16.80$). Of the two Groups ACD, 17 detected the alcohol-related change when that change was located on the left of the stimulus matrix (Group ACD-L, $M = 15.68$, $SD = 12.46$) and 19 detected the alcohol-related change when it was located on the right of the stimulus matrix (Group ACD-R, $M = 18.53$, $SD = 20.17$). The remaining 49 detected the neutral change (the two Groups NCD, M Consumption = 11.12 units of alcohol per week, $SD = 8.57$). Of the two Groups NCD, 25 detected the neutral change when it was located on the left of the stimulus matrix (Group NCD-L, $M = 10.18$, $SD = 7.98$) and 24 detected the neutral change when it was located on the right of the stimulus matrix (Group NCD-R, $M = 12.10$, $SD = 9.21$). It would appear that weekly alcohol Consumption was greater in participants who detected the alcohol-related change than the neutral change (see Figure 2.A.3). To formally test this observation a 2x2 ANOVA was conducted.

Analysis of Variance

A 2x2 totally between participants ANOVA was conducted to formally investigate the casual predictions made above. The usual square root ($x + 0.5$) transformation was carried out prior to analyses—which changed the coefficients of skew (1.947) and kurtosis (4.927) to more acceptable values of 0.405 and 0.404 respectively which were within the recommended distribution (-1 to +1). Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was carried out to test for equal variance between the groups. This revealed there to be no significant difference ($p > .05$).

The first factor represented the Location Change Detected and had two levels—left, L, and right, R. The second factor, Change Detected again had two levels—alcohol-related change detected, ACD and neutral change detected, NCD. The independent variable, Consumption, represented the self-reported weekly number of UK alcohol units as measured using the alcohol timeline followback. The Analysis of Variance Summary table is provided in Table 2.A.1.

It was predicted by the main hypothesis (Hypothesis 2.A.1) that self-reported weekly alcohol Consumption would be higher in participants who detected the alcohol-related change (the two Groups ACD) than in participants who detected the neutral change (the two Groups NCD). This is a one-tailed prediction and can be made for reasons outlined in the Results section of Experiment 4. Hypothesis 2.A.1 was supported for a one-tailed test—the main effect of Change Detected was significant ($F(1, 81) = 3.460$, $p = 0.0665$, two-tailed, but $p = 0.03$ one-tailed)—mean weekly alcohol Consumption of participants who detected the alcohol-related change (the two Groups ACD, transformed 3.78, raw 17.18 units) was significantly greater than the mean alcohol Consumption for those who detected the neutral change (the two Groups NCD, transformed 3.10, raw 11.12 units).

The main effect of Location of Changes failed to reach significance ($F(1, 81) = 0.191$, $p > .05$) as did the interaction between Location of Changes and Change Detected ($F(1, 81) = 0.178$, $p > .05$).

Effect Sizes

Hypothesis 2.A.2 predicted a significant effect size would be present for the 6.06 unit mean difference in Consumption between the participants who detected the alcohol-related change (the two Groups ACD, transformed $M = 3.78$, $SD = 1.87$; raw $M = 17.18$, $SD = 16.80$) and those who detected the neutral change (the two Groups NCD, transformed $M = 3.10$, $SD = 1.43$; raw $M = 11.12$, $SD = 8.57$). The hypothesis was supported—a “small” effect size (Cohen’s, 1992, $d = 0.41$) was obtained with 95% confidence limits of -0.02 and 0.85 , which include zero, suggesting the measure not to be reliable at the .05 level of significance for a 2-tailed prediction, but for a one-tailed prediction the confidence limits do not include zero (0.05 and 0.78), indicating the reliability of the d .

Summary of Results

The changes referred to below are changes implemented as object replacement.

Hypothesis 2.A.1 The mean weekly Consumption of participants who detected the alcohol-related change would be higher than that of participants who detected the neutral change—this was supported.

Hypothesis 2.A.2 There would be a reliable effect size for the mean difference in consumption between participants who detected the alcohol-related change and those who detected the neutral change—this was supported.

Preliminary Discussion

The overall results of Experiment A are in line with those of Experiment 1—a significant difference was shown in self-reported weekly alcohol Consumption between participants who detected the alcohol-related change and those who detected the neutral change. This is an important finding it not only extends the AAB found in Experiments 1-4 providing further evidence of the generalisability of the flicker ICB paradigm but also suggests that the AAB found in Experiments 1-4 using the flicker ICB paradigm is not exclusive to the pictorial stimuli employed,

furthermore suggesting that the attentional bias found in Experiments 1-4 extends to lexical stimuli and is not a unique property of pictorial stimuli.

Although previous pairs of Experiments (i.e., 1 and 2, 3 and 4) have included experiments in which the changes were implemented through object rotation (Experiments 1 and 3) and identical experiments in which the changes were implemented through object replacement (Experiments 2 and 4), it was only possible when using lexical stimuli to implement the changes through object replacement. This is because if the rotation method of change implementation was employed with lexical stimuli then the sense would be lost from the objects carrying the changes, as while when a picture is rotated by 90° on its vertical axes all sense is retained, when this is done with a word all sense is lost. For example, such a transformation might result in a pop-out effect as the rotated transformation would be quite different from the group of words within which it is contained. For this reason only one experiment was conducted with lexical stimuli—one in which the changes were implemented through object replacement, Experiment A.

Discussion

The purpose of Experiments 1 and 2 was to replicate B.C. Jones, B. T. Jones Blundell and Bruce's (2002) study in which attentional bias in social drinkers was investigated using their novel version of the flicker ICB paradigm containing two simultaneous competing changes. In their study they claimed that their finding that social drinking participants who detected the alcohol-related change had higher usual Consumption levels than social drinking participants who detected the neutral change, showed a differential attentional bias in social drinkers. Although this might not be the traditional measure of attentional bias, it nevertheless is an equally valid way to represent and explore it. Indeed, for reasons outlined in Chapter 1, it might be the only safe way of exploring attentional bias when group assignment can be ambiguous. This study was replicated in Experiments 1 and 2 for several reasons which were reviewed earlier and will be briefly summarised below.

First, Experiments 1 and 2 replicated B. C. Jones et al.'s (2002) study with a new stimulus set to test whether the attentional bias found by Jones et al. was specific to their stimulus set or whether it would generalise to a new stimulus set. Replication of their findings would provide important generalisation information

Second, the alcohol-related and neutral objects used by B. C. Jones et al. (2002) were informally chosen. Consequently, it is possible that individual objects out of the alcohol set or out of the neutral set may have had more influence on driving change detection than others. To avoid this possibility, Experiments 1 and 2 used stimuli which were not only different from the ones used by B. C. Jones et al. but carefully chosen so that each alcohol-related object was somewhat equivalent to each neutral object in terms of shape, size and colour (see Figures 2.1.4 and 2.2.4).

Third, B. C. Jones et al. (2002) only loosely controlled the presentation or layout of their stimuli. They used a table-top scene (see Figure 2.0.1) in which the positions of the alcohol-related and neutral objects were only roughly matched. It is possible, therefore, that the position of some objects may have had a greater influence on change detection than others due to the casual arrangement. To avoid this possibility a rectilinear matrix framework was used in Experiments 1 and 2 in which the matched alcohol-related-neutral pairs of objects were carefully positioned within the constraints of this framework.

The same stimulus set was used in both Experiments 1 and 2 and the only difference between the two experiments was the nature of the change that was implemented within the set. In Experiment 1 the objects carrying the changes were *rotated* on their vertical axes (as did B. C. Jones et al., 2002), while in Experiment 2 the objects carrying the changes were *replaced* by new objects which were similar in shape, size and colour to the objects they were replacing. It was postulated both in Experiments 1 and 2 that reported weekly alcohol Consumption would be higher for participants who detected the alcohol-related change than for participants who detected the neutral change.

In Experiment 1 (change through object rotation) the hypothesis was supported—participants who detected the alcohol-related change reported

significantly higher weekly alcohol consumption than participants who detected the neutral change. The hypothesis was also supported in Experiment 2 (change through object replacement)—participants who detected the alcohol-related change reported significantly higher weekly alcohol Consumption than participants who detected the neutral change. Using Cohen’s (1992) measure of effect size (d), the attentional bias was greater in Experiment 2 (“large”) than in Experiment 1 (“medium”)—i.e., change by replacement was a more sensitive route to measuring attentional bias than change by rotation within the confines of these experiments. It is, of course possible, that the difference in the effect size between the two experiments may have been an artefact created by differences in overall consumption of Experiments 1 and 2 (see Preliminary Discussion of Experiment 2 for full details of this possibility). To test this possibility, differences between the mean consumption of Experiments 1 and 2 were tested. No difference was found in the mean consumption between the two experiments suggesting that any differences in mean consumption was not responsible for the difference in the effect sizes of the two experiments.

Accordingly, it was concluded that within the confines of Experiments 1 and 2 the “replacement” method used in Experiment 2 was a more sensitive test of attentional bias than the “rotational” method used in Experiment 1. Differences notwithstanding, both experiments show that B. C. Jones et al.’s (2002) original finding of an attentional bias in social drinkers using the flicker ICB paradigm is supported. Moreover, Experiments 1 and 2 show that it is possible to demonstrate such an attentional bias with formally constructed (and therefore better controlled) stimuli not just with natural visual scenes.

Experiments 3 and 4 extended the effort to test the generalisability of B. C. Jones et al.’s (2002) original finding by manipulating the stimulus set further. In Experiments 1 and 2 new alcohol-related and neutral target stimuli were used to carry the change-to-be-detected that were different to the ones used by B. C. Jones et al. In Experiments 3 and 4, the two target stimuli—each at the centre of the alcohol and neutral 3x3 matrices—were changed from those used in Experiments 1 and 2. In

other words, the OS stimuli used in Experiments 3 and 4 were identical to the OS stimuli used in Experiments 1 and 2 except that the target alcohol-related and neutral objects were substituted by the new alcohol-related and neutral target objects.

Although there is a consistency between the results of B. C. Jones et al. and Experiments 1 and 2, the three experiments all use a “one-shot” design in which a single data point is collected from a single participant. Consequently, further replications of these three experiments using additional changes-to-be-detected has important generalisation information. As in Experiment 1, the change in Experiment 3 was implemented by *rotating* the target objects by 90 degrees, while in Experiment 4, like Experiment 2, the changes were implemented by *replacing* the target objects with new objects. It was hypothesized, that a higher level of self-reported weekly alcohol Consumption would be found in participants who detected the alcohol-related change than in those who detected the neutral change. This predicted attentional bias was confirmed—the independent ANOVAs of Experiment 3 and 4 both revealed a significant difference in the predicted direction. The effect sizes for the attentional bias tested for with object rotation (Experiment 3) were superior to the bias tested for with object replacement (Experiment 4).

To date an alcohol-related attentional bias has been shown using the flicker ICB paradigm with 2 simultaneous changes in B. C. Jones et al’s original table-top study (2002), and then in Experiments 1, 2, 3 and 4 using matrix presentation and reported in this chapter. It would therefore appear the flicker ICB paradigm delivers a robust method of eliciting an alcohol-related attentional bias in social drinkers. Although all of these studies have shown a significant difference in the level of Consumption of participants who detected the neutral change and participants who detected the alcohol-related change, the actual source behind change detection remains unclear—it is possible that the target objects (i.e., those actually carrying the changes) are responsible for change detection, or that it is driven by the context within which the target objects are set. To investigate this, a series of experiments was designed and these are reported in Chapter 3.

There are at least at least two grounds for postulating that change detection is driven by the context within which the target object is set rather than the target object, itself. First, both the context and the target object embedded in it are of the same “type”—i.e., they are both either neutral objects or alcohol-related objects. Consequently, if it is thought that the semantic properties of the target object were driving the change detection, the context would be providing nine times as much “drive” because there are nine such stimuli. Under these circumstances, it is difficult not to predict that the context is driving the change detection.

Second, and in support of this view, research with the dot-probe paradigm (Field, Mogg, & Bradley, 2004) has shown that when the left-right, substance–neutral stimulus set-up is viewed (that is equivalent to the current use of the flicker ICB paradigm) the eyes of heavier users orient towards the substance-related stimuli more than towards the neutral stimuli and this is not seen in lighter users. In addition the dependent variable of the dot probe paradigm showed that the attentional bias corresponds to these eye movements. In the same vein, there should be similar eye movements in the heavier drinking participants of B. C. Jones et al.’s (2002) flicker ICB paradigm study and of Experiments 1-4 and Experiment A reported here and there should be corresponding differences in change detection responses representing a differential attentional bias. Turatto, Bettella, Umilta and Bridgeman (2003) have shown that within the flicker ICB paradigm, changes are not normally detected unless attention is sent to the object carrying the change and they use foveal capture as their measure of attention. Turatto et al.’s work coupled with the eye-movement study of Field et al. suggest that the alcohol context might be capturing the attention of the heavier drinking participants in Experiments 1-4 and that while attention is captured by the context, there is an increased opportunity for attention to be captured by the target which is at the centre of the context.

If, as Turatto et al. (2003) claim, change is only detected when attention is sent to the object carrying the change, the change-detection profile seen in Experiments 1-4 might have a context-driven component and a target-driven component—but a target-driven component relying heavily on the context. The

series of experiments in Chapter 3 are designed to establish the extent to which change-detection is driven by target and context.

The initial experiments in Chapter 3 are designed around an “opposite context” principle in which the alcohol-related target is embedded in a neutral context and, simultaneously, the neutral target is embedded in an alcohol-related context. If the context principally drives change-detection, then the attentional bias found in Experiments 1-4 should be “reversed”. In other words under these circumstances, weekly alcohol Consumption should be higher in participants who detect changes made to neutral targets than to alcohol-related targets. Corresponding to the way changes were implemented in Experiments 1 and 2, the experiments reported in Chapter 3 implemented changes through object rotation and object replacement respectively.

Figure 2.0.1. Original and Changed Stimuli

Figure 2.0.1. Original and Changed Stimuli used by Jones, Jones, Blundell and Bruce (2002) in which a table-top scene was used in an identical design to Experiment 1.

Original Stimulus



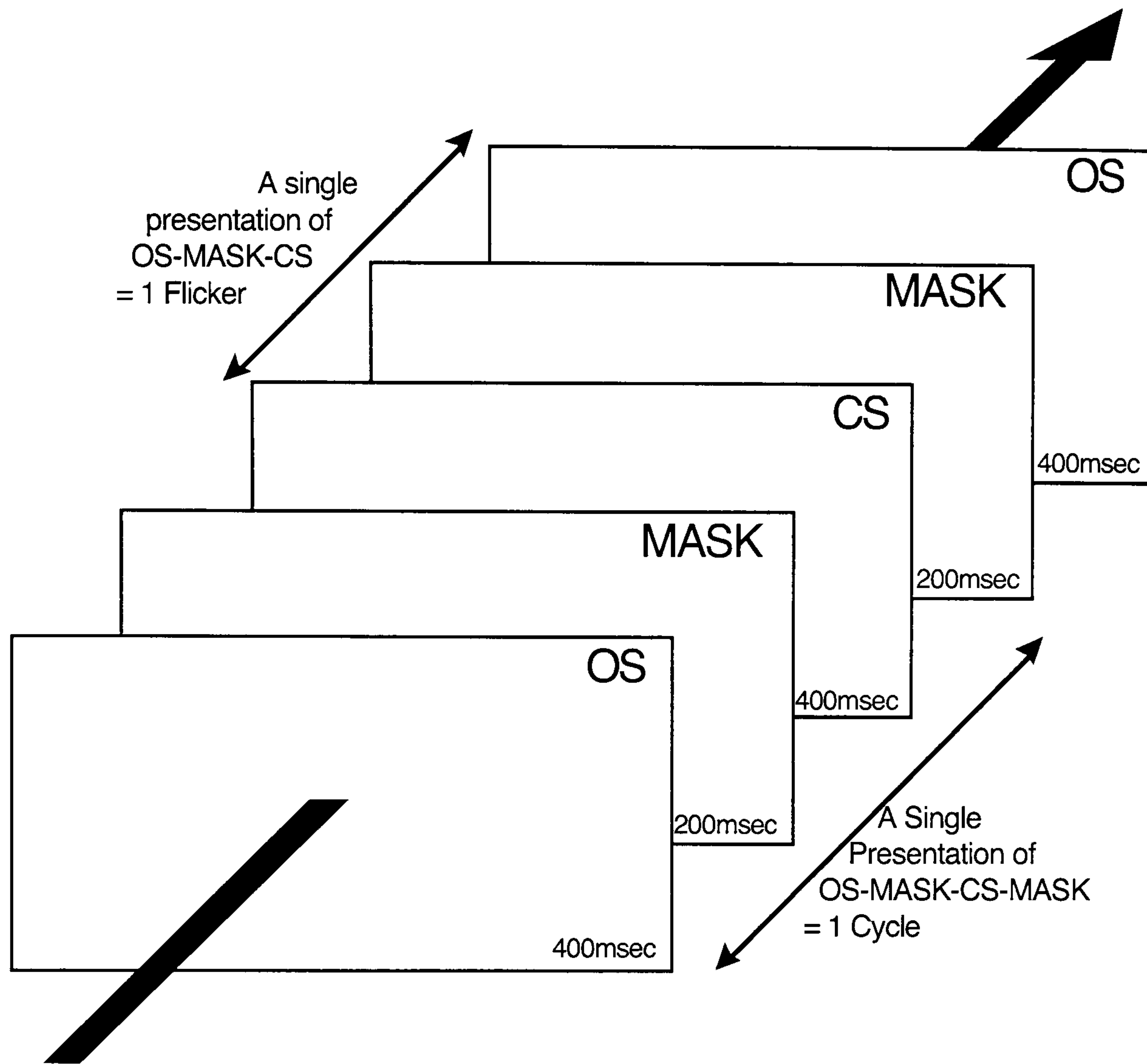
Both the label on the vodka bottle and the video cassette face the front

Changed Stimulus



Both the label on the vodka bottle and the video cassette face the back

Figure 2.1.1. Diagram of a Flicker ICB Paradigm.



OS = The Original Stimulus used in Experiment 1 (e.g., see figure 2.1.4)

CS = The Changed Stimulus used in Experiment 1 (e.g., see figure 2.1.5)

Figure 2.1.2. Design of Experiment 1.

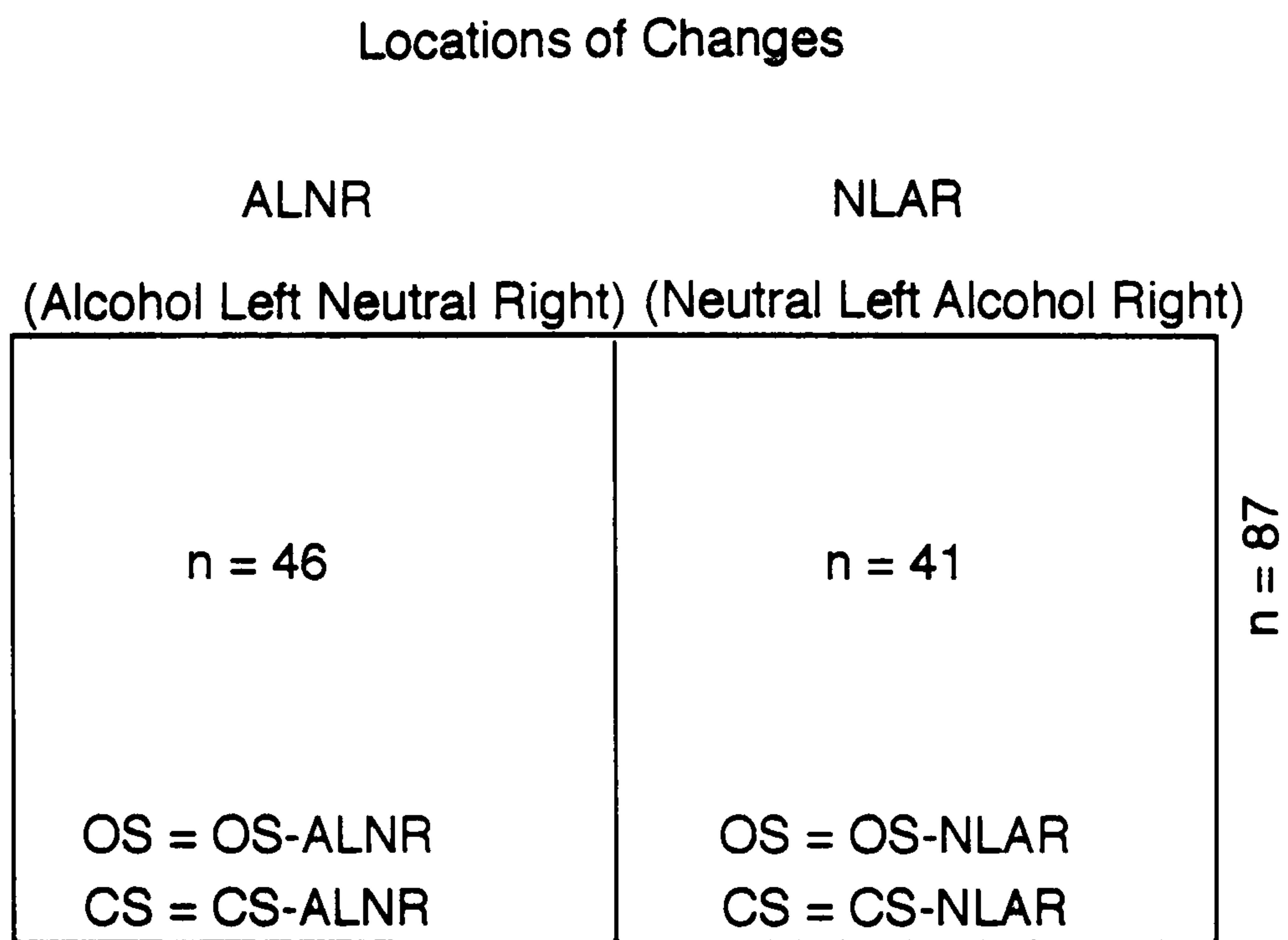


Figure 2.1.3. Pairs of Stimuli used to create the Original and Changed Stimuli in Experiment 1.



Yellow lager Can

Pair 1



Yellow Bleach Bottle



Red Corkscrew

Pair 2



Red Swiss Army Knife



Brown Beer Bottle

Pair 3



Brown Sauce Bottle



4-Pack of Red Beer Cans

Pair 4



4-Pack of Red Tomato Tins

Figure 2.1.3 Contd.



Full Half Bottle of Whisky

Pair 5



Cafetiere Full of Coffee



White Bottle of Alcopop

Pair 6



White Bottle Hair Conditioner



Pint of Guinness

Pair 7



Pint of Milk



Empty Pint Glass

Pair 8



Empty Glass Cafetiere



Green Beer Bottle

Pair 9



Green Bubble Bath Bottle

Figure 2.1.4. Original Stimuli used in Experiment 1 showing the two levels of the factor Locations of Changes.

Alcohol Left Neutral Right (ALNR)



Neutral Left Alcohol Right (NLAR)



Figure 2.1.5. The Original and Changed Stimulus of levels alcohol left neutral right (ALNR) and neutral left alcohol right (NLAR) of the factor Locations of Changes used in Experiment 1.

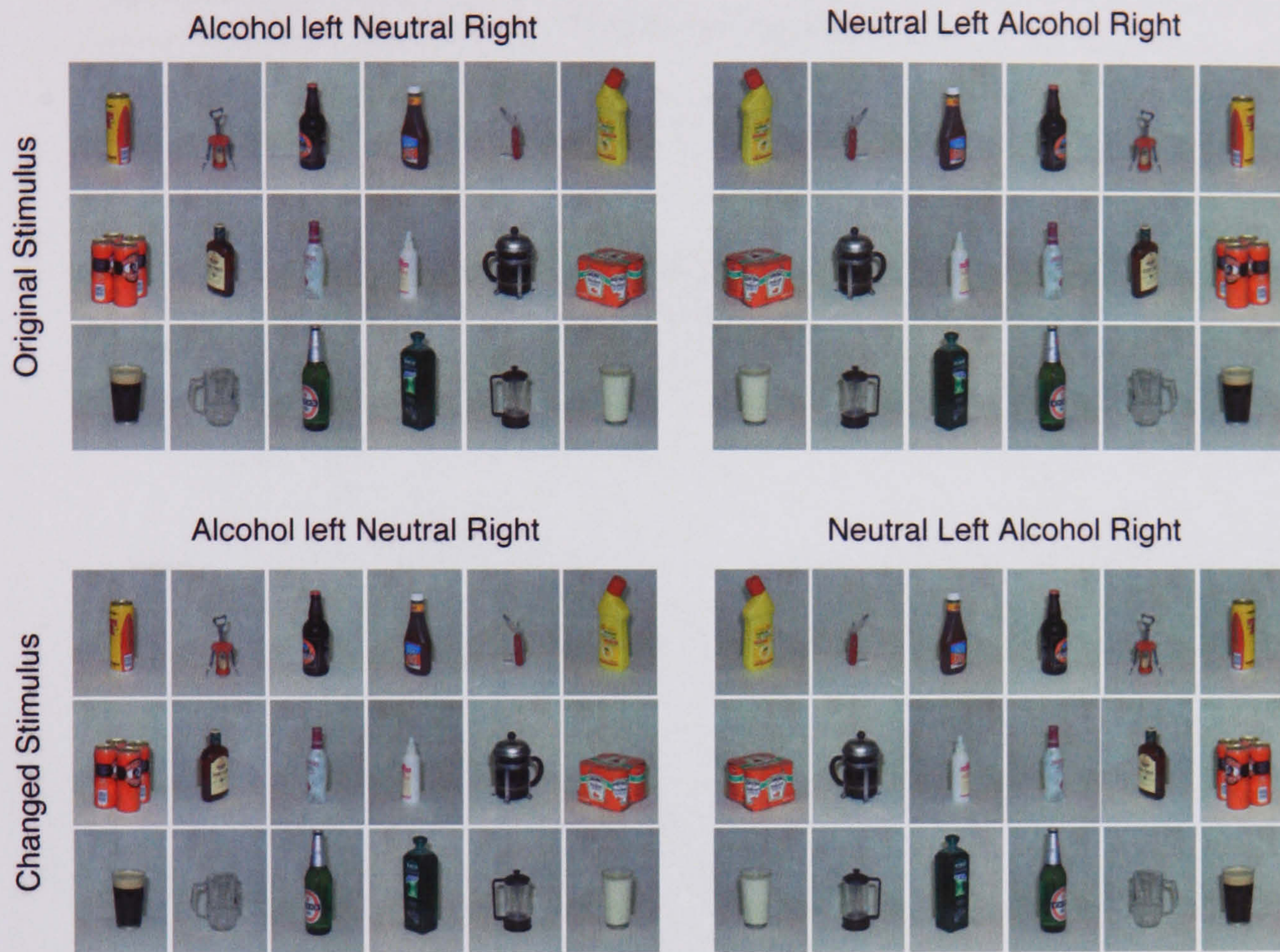


Figure 2.1.6. Alcohol timeline followback (based on Sobell & Sobell, 1992) used to record daily alcohol consumption and other personal details.

PARTICIPANT DETAILS																
SECTION 1 PERSONAL DETAILS																
sex	female <input type="checkbox"/>	male <input type="checkbox"/>	age			have you ever sought help for an alcohol-related problem?	yes <input type="checkbox"/>	no <input type="checkbox"/>								
SECTION 2																
WHAT ALCOHOLIC DRINKS HAVE YOU CONSUMED DURING THE LAST WEEK? PLEASE FILL IN EACH DAY'S DETAILS BELOW.																
today	how many drinks? write number in the box	where?	what were the drinks?			4 days ago	how many drinks? write number in the box	where?	what were the drinks?							
	<input type="text"/>	<input style="height: 40px;" type="text"/>	type	number	brand name	size	<input type="text"/>	<input style="height: 40px;" type="text"/>	type	number	brand name	size				
yesterday	how many drinks? write number in the box	where?	what were the drinks?			5 days ago	how many drinks? write number in the box	where?	what were the drinks?							
	<input type="text"/>	<input style="height: 40px;" type="text"/>	type	number	brand name	size	<input type="text"/>	<input style="height: 40px;" type="text"/>	type	number	brand name	size				
2 days ago	how many drinks? write number in the box	where?	what were the drinks?			6 days ago	how many drinks? write number in the box	where?	what were the drinks?							
	<input type="text"/>	<input style="height: 40px;" type="text"/>	type	number	brand name	size	<input type="text"/>	<input style="height: 40px;" type="text"/>	type	number	brand name	size				
3 days ago	how many drinks? write number in the box	where?	what were the drinks?			7 days ago	how many drinks? write number in the box	where?	what were the drinks?							
	<input type="text"/>	<input style="height: 40px;" type="text"/>	type	number	brand name	size	<input type="text"/>	<input style="height: 40px;" type="text"/>	type	number	brand name	size				
WAS THIS A TYPICAL WEEK'S CONSUMPTION? yes <input type="checkbox"/> no <input type="checkbox"/>																
SECTION 3 ADDITIONAL INFORMATION																
Does any of the following (i) have (or have had) a drink problem (ii) for which help was sought?					Have you ever worked in any of the following places and if so for how long?											
parent	<input type="checkbox"/>	(i)	<input type="checkbox"/>	(ii)	bar	<input type="checkbox"/>	a week	<input type="checkbox"/>	a month	<input type="checkbox"/>	3 months	<input type="checkbox"/>	a year	<input type="checkbox"/>	more	<input type="checkbox"/>
brother or sister	<input type="checkbox"/>		<input type="checkbox"/>		licenced restaurant	<input type="checkbox"/>	a week	<input type="checkbox"/>	a month	<input type="checkbox"/>	3 months	<input type="checkbox"/>	a year	<input type="checkbox"/>	more	<input type="checkbox"/>
aunt or uncle	<input type="checkbox"/>		<input type="checkbox"/>		off-licence	<input type="checkbox"/>	a week	<input type="checkbox"/>	a month	<input type="checkbox"/>	3 months	<input type="checkbox"/>	a year	<input type="checkbox"/>	more	<input type="checkbox"/>
cousin	<input type="checkbox"/>		<input type="checkbox"/>		How often do you go into bars or pubs?											
never <input type="checkbox"/> less than once a month <input type="checkbox"/> once a month <input type="checkbox"/> once a week <input type="checkbox"/> twice a week <input type="checkbox"/> more <input type="checkbox"/> daily <input type="checkbox"/>																
please do not write below this line please do not write below this line please do not write below this line please do not write below this line please do not write below this line please do not write below this line																
Pno		notes					date									
Exp							time									
Cond							place									

Figure 2.1.7. Mean Consumption and Standard Deviations for Groups used in the Analyses of Experiment 1.

		Location of Change Detected	
		Left	Right
Change Detected	ACD	<p>Group ACD-L</p> <p>n = 36</p> <p>Mean = 24.5 units</p> <p>S.D. = 20.5</p>	<p>Group ACD-R</p> <p>n = 26</p> <p>Mean = 17.7 units</p> <p>S.D. = 13.69</p>
	NCD	<p>Group NCD-L</p> <p>n = 15</p> <p>Mean = 12 units</p> <p>S.D. = 12.63</p>	<p>Group NCD-R</p> <p>n = 10</p> <p>Mean = 7.25 units</p> <p>S.D. = 7.76</p>

(Neutral Change Detected) (Alcohol Change Detected)

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. They are untransformed means.

L represents that the Change Detected occurred on the left of the stimulus matrix.

R represents that the Change Detected occurred on the right of the stimulus matrix.

Figure 2.2.1. Design of Experiment 2.

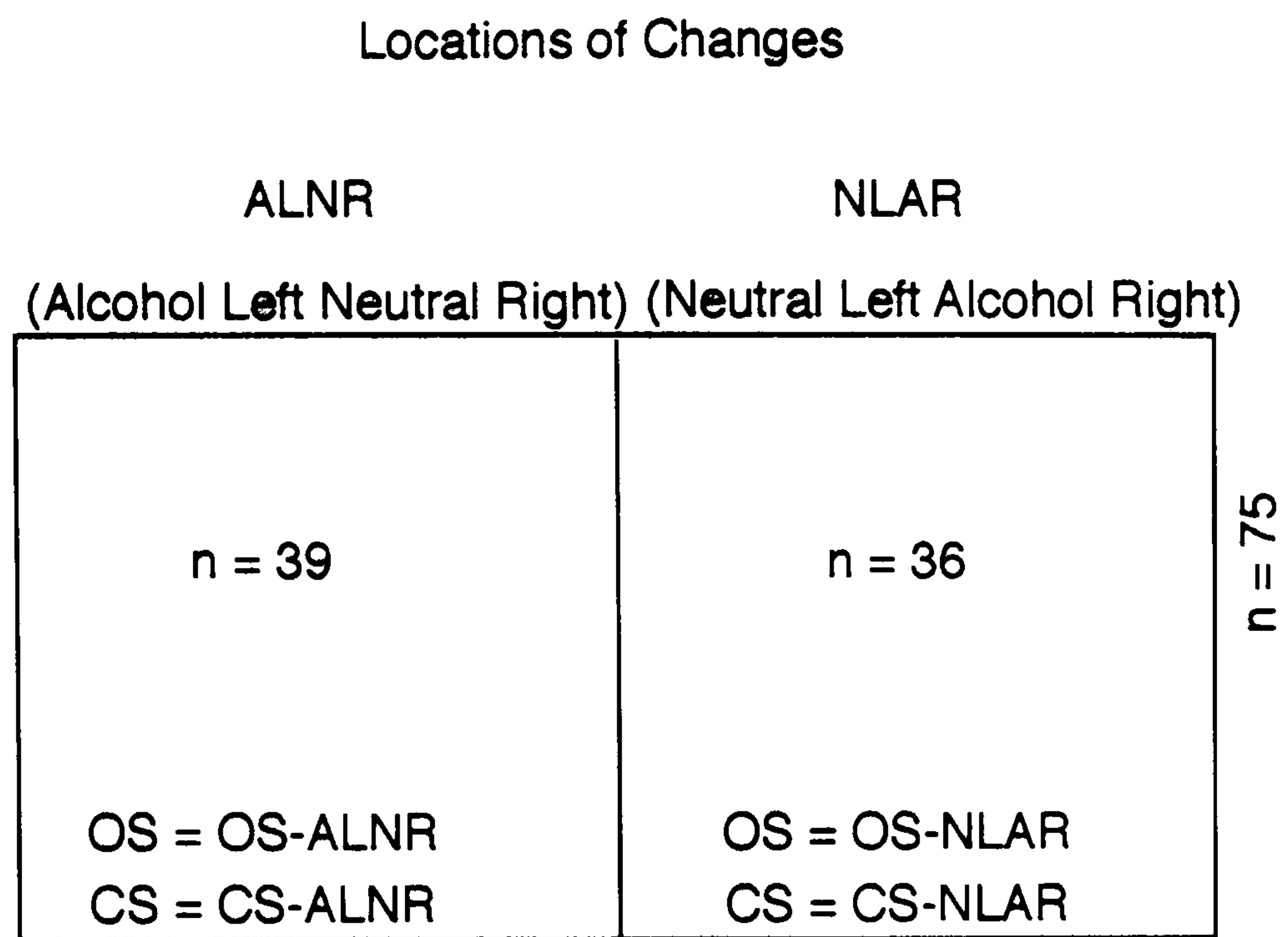


Figure 2.2.2. The pair of Pictures, in addition to those in figure 2.1.3, used in Experiment 2 to replace the target object to create the Changed Stimuli.

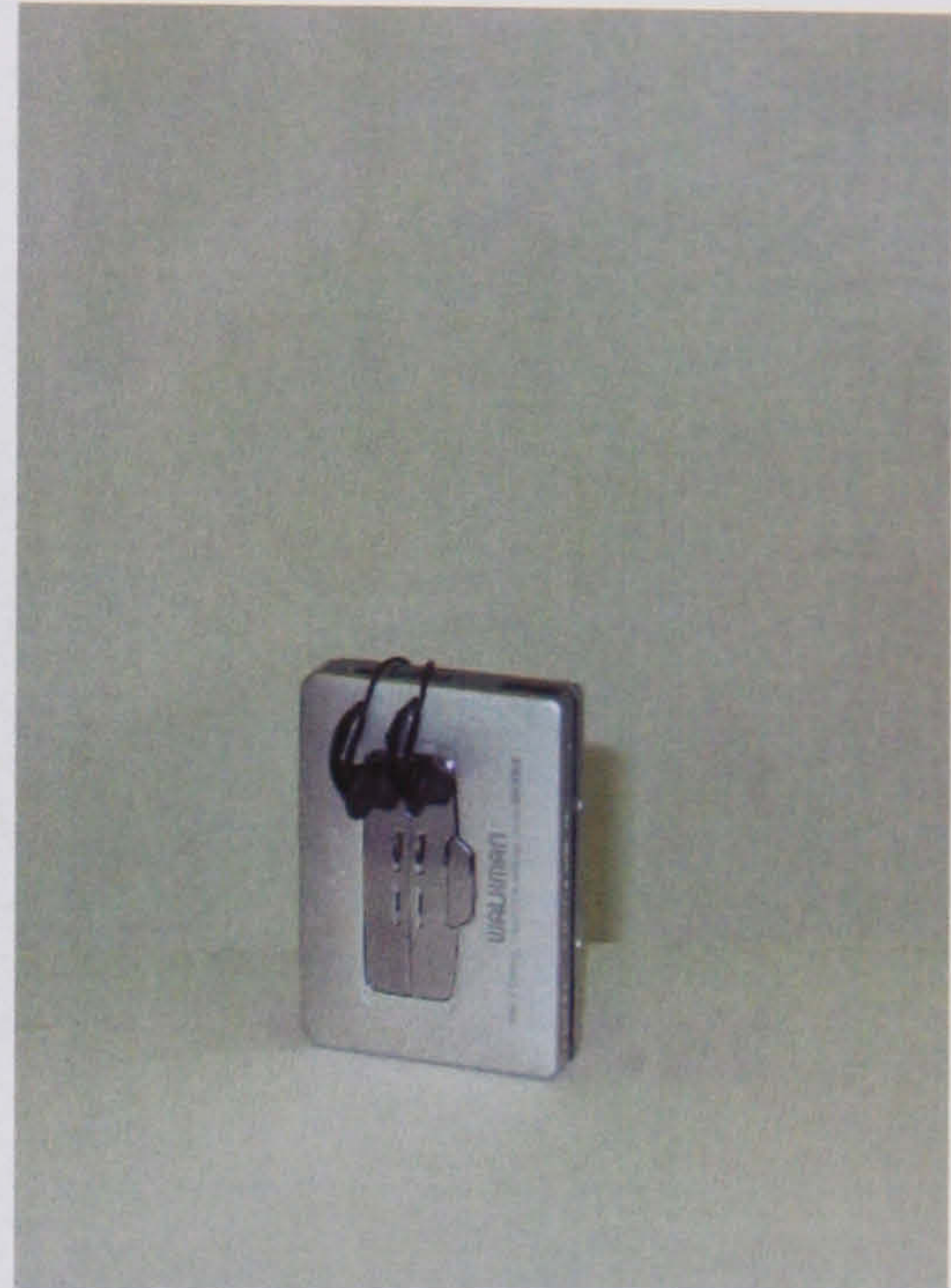


Figure 2.2.3. The Original and Changed Stimuli of both levels of Locations of Changes in Experiment 2.



Figure 2.2.4. Mean Consumption and Standard Deviations for the four Groups used in the Analyses of Experiment 2.

		Location of Change Detected	
		Left	Right
Change Detected	ACD	Group ACD-L n = 22 Mean = 34.5 units S.D. = 30	Group ACD-R n = 20 Mean = 25.8 units S.D. = 13.2
	NCD	Group NCD-L n = 17 Mean = 9.47 units S.D. = 8.64	Group NCD-R n = 16 Mean = 11.44 units S.D. = 15.8

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. The means are untransformed.

L represents that the Change Detected occurred on the left of the stimulus matrix.

R represents that the Change Detected occurred on the right of the stimulus matrix.

Figure 2.3.1. Design of Experiment 3.

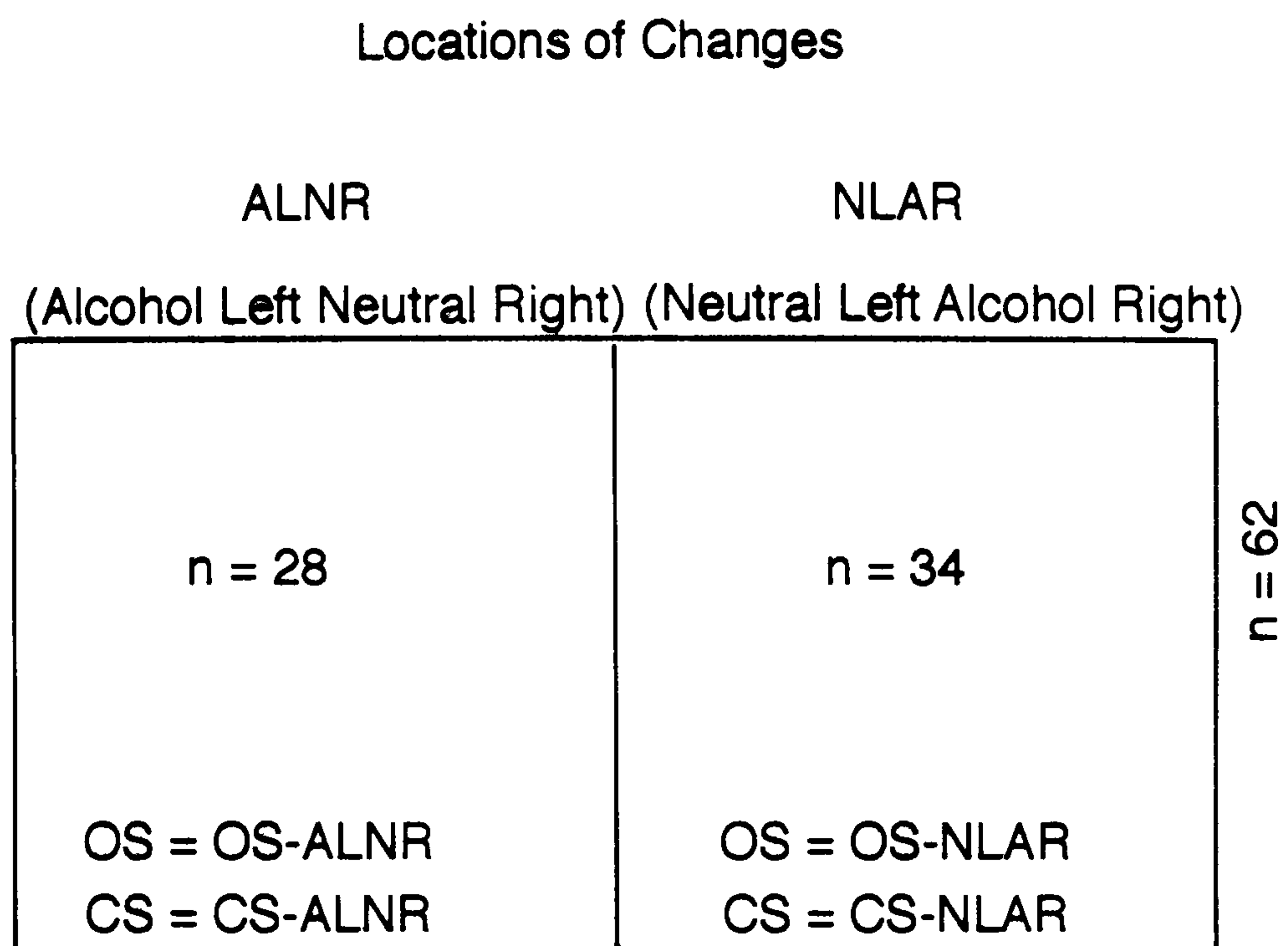


Figure 2.3.2. The pair of Pictures, used in Experiment 3 to carry the changes.

Figure 2.3.2. The pair of Pictures, used in Experiment 3 to carry the changes.



Figure 2.3.3. The Original and Changed Stimuli of both levels of Locations of Changes in Experiment 3.

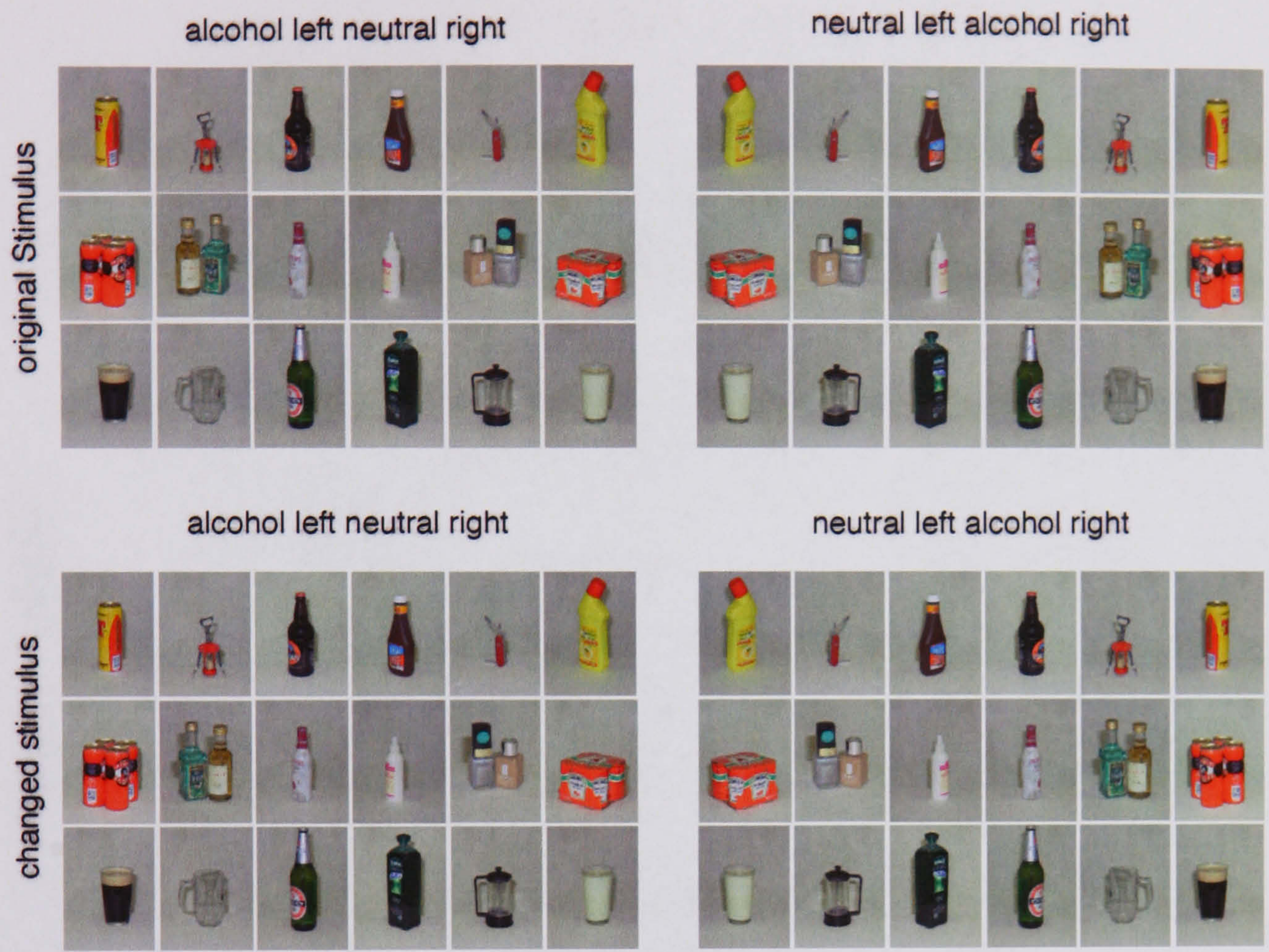


Figure 2.3.4. Mean Consumption and Standard Deviations for Groups used in the Analyses of Experiment 3.

		Location of Changes Detected	
		Left	Right
Change Detected	ACD	Group ACD-L n = 12 Mean = 23.21 units S.D. = 19.94	Group ACD-R n = 15 Mean = 23.47 units S.D. = 12.43
	NCD	Group NCD-L n = 19 Mean = 13.26 units S.D. = 13.36	Group NCD-R n = 16 Mean = 11.09 units S.D. = 18.37

(Neutral Change Detected) (Alcohol Change Detected)

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. The means are untransformed.

L represents that the Change Detected occurred on the left of the stimulus matrix.

R represents that the Change Detected occurred on the right of the stimulus matrix.

Figure 2.4.1. Design of Experiment 4.

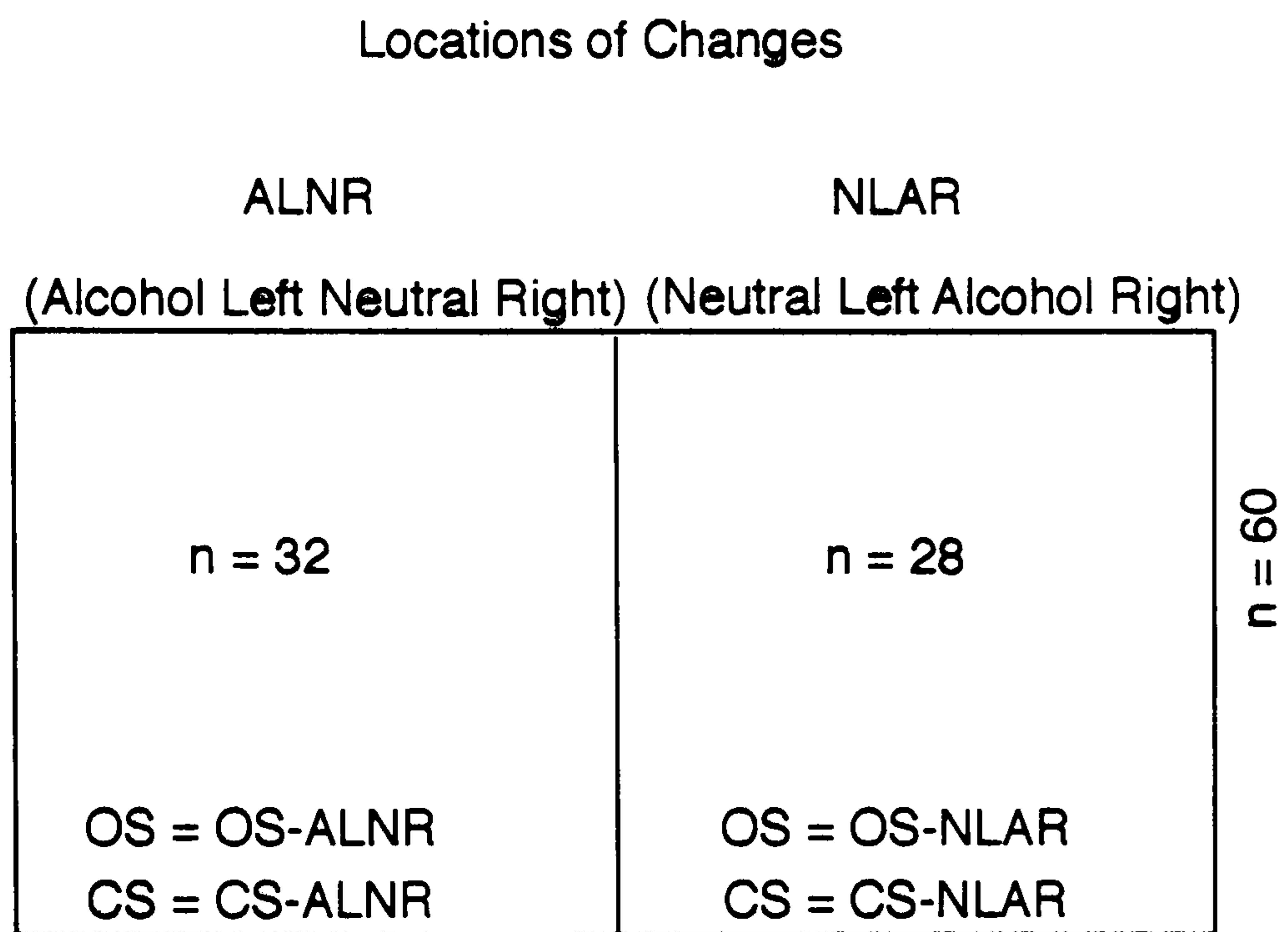


Figure 2.4.2. The pair of Pictures, used in Experiment 4, used to replace the target objects to create the Changed Stimuli.

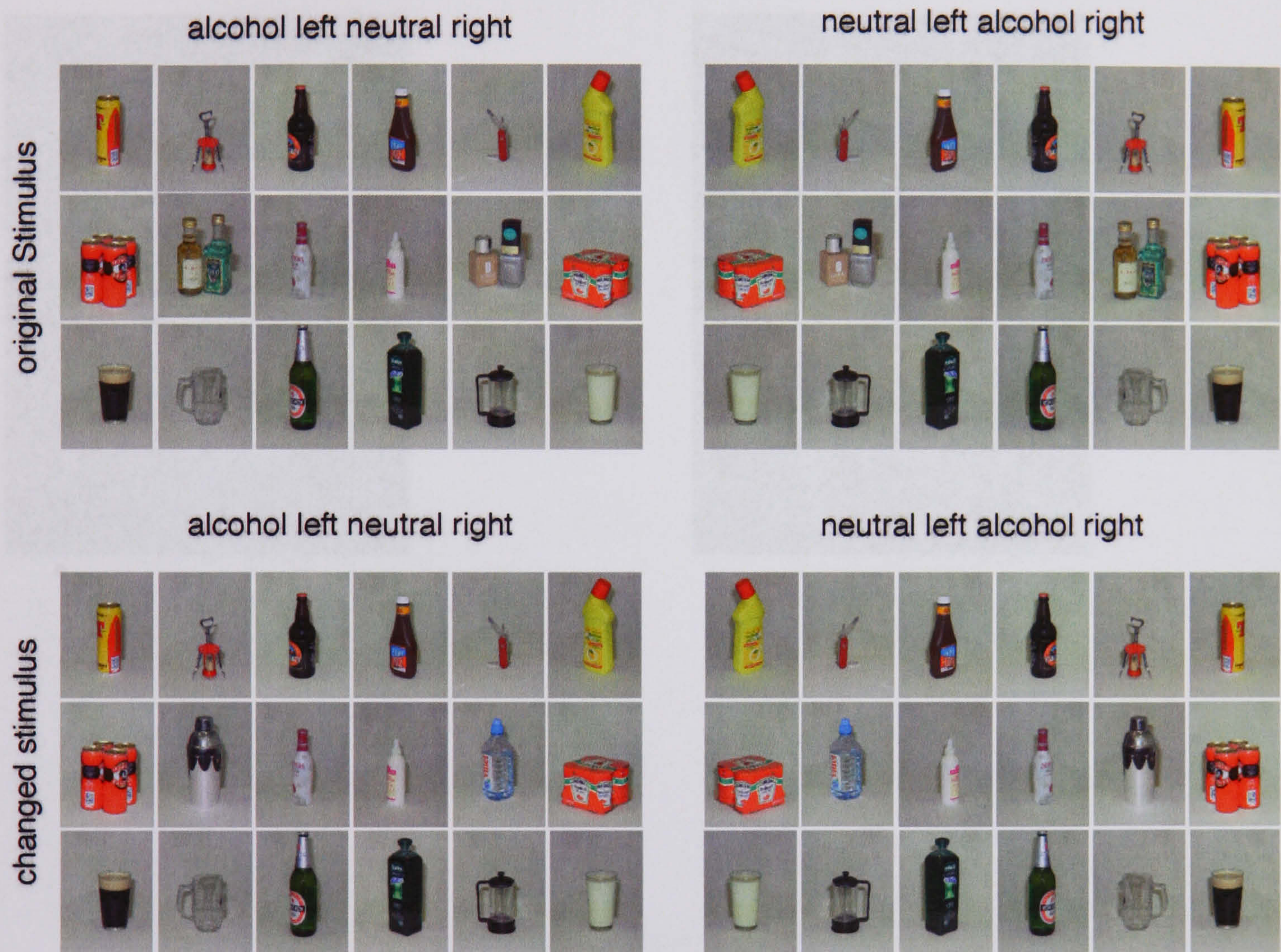


Figure 2.4.3. The pair of Pictures, used in Experiment 4 to carry the changes.



Figure 2.4.4. Mean Consumption and Standard Deviations for Groups used in the Analyses of Experiment 4.

		Location of Changes Detected	
		Left	Right
Change Detected	ACD	<p>Group ACD-L</p> <p>n = 16</p> <p>Mean = 21.75 units</p> <p>S.D. = 19.94</p>	<p>Group ACD-R</p> <p>n = 15</p> <p>Mean = 17.77 units</p> <p>S.D. = 10.44</p>
	NCD	<p>Group NCD-L</p> <p>n = 13</p> <p>Mean = 9.35 units</p> <p>S.D. = 10.24</p>	<p>Group NCD-R</p> <p>n = 16</p> <p>Mean = 12.25 units</p> <p>S.D. = 10.42</p>

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. The means are untransformed.

L represents that the Change Detected occurred on the left of the stimulus matrix.

R represents that the Change Detected occurred on the right of the stimulus matrix.

Figure 2.A.1. Design of Experiment A.

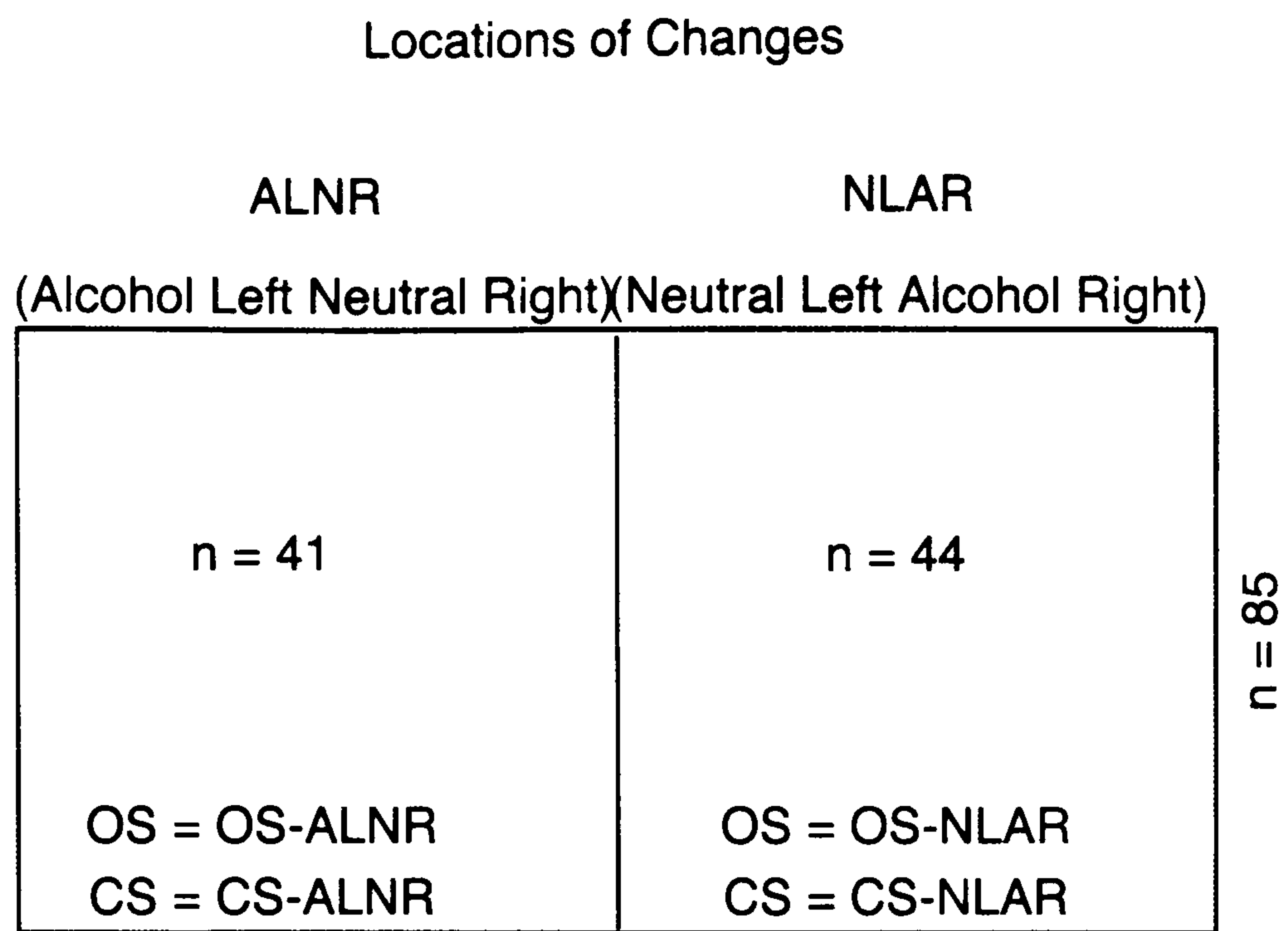


Figure 2.A.2. The Original and Changed Stimuli of both levels of Locations of Changes in Experiment A.

	Alcohol Left Neutral Right	Neutral Left Alcohol Right
Original Stimulus	PUB CORK SHOT BOWL FORK CUP	CUP FORK BOWL SHOT CORK PUB
	GIN LAGER PINT PLATE TABLE BIN	BIN TABLE PLATE PINT LAGER GIN
	CIDER BAR WINE VASE BED CHAIR	CHAIR BED VASE WINE BAR CIDER
Changed Stimulus	PUB CORK SHOT BOWL FORK CUP	CUP FORK BOWL SHOT CORK PUB
	GIN TABLE PINT PLATE LAGER BIN	BIN LAGER PLATE PINT TABLE GIN
	CIDER BAR WINE VASE BED CHAIR	CHAIR BED VASE WINE BAR CIDER

Figure 2.A.3. Mean Consumption and Standard Deviations for Groups used in the Analyses of Experiment A.

		Location of Change Detected	
		Left	Right
Change Detected	ACD	<p>Group ACD-L</p> <p>n = 17</p> <p>Mean = 15.86 units</p> <p>S.D. = 12.46</p>	<p>Group ACD-R</p> <p>n = 19</p> <p>Mean = 18.53 units</p> <p>S.D. = 20.17</p>
	NCD	<p>Group NCD-L</p> <p>n = 25</p> <p>Mean = 10.18 units</p> <p>S.D. = 7.98</p>	<p>Group NCD-R</p> <p>n = 24</p> <p>Mean = 12.1 units</p> <p>S.D. = 9.21</p>

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. The means are untransformed.

L represents that the Change Detected occurred on the left of the stimulus matrix.

R represents that the Change Detected occurred on the right of the stimulus matrix

Table 2.1.1. Analysis of Variance Summary Table and Simple Main Effects Table for Experiment 1 showing differences in Consumption (following transformation) for the two factors Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION OF CHANGE DETECTED)	7.031	1	7.031	1.999	0.1612
B (CHANGE DETECTED)	37.650	1	37.650	10.702	0.0016
AB	0.084	1	0.084	0.024	0.8774
Error	292.000	83	3.518		

Simple Main Effects Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
LOCATION OF CHANGE DETECTED at					
ACD	4.902	1	4.902	1.393	0.2412
NCD	3.023	1	3.023	0.859	0.3566
Error Term	292.000	83	3.518		
CHANGE DETECTED at					
left	21.068	1	21.068	5.989	0.0165
right	17.366	1	17.366	4.936	0.0290
Error Term	292.000	83	3.518		

Table 2.2.1. Analysis of Variance Summary Table and Simple Main Effects Table for Experiment 1 showing differences in Consumption (following transformation) for the two factors Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION) CHANGE DETECTED)	0.178	1	0.178	0.051	0.8214
B (CHANGE DETECTED)	95.195	1	95.195	27.523	0.0000
AB	2.147	1	2.147	0.621	0.4333
Error	245.568	71	3.459		

Simple Main Effects Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
LOCATION OF CHANGE DETECTED at					
ACD	2.021	1	2.021	0.584	0.4471
NCD	0.487	1	0.487	0.141	0.7086
Error Term	245.568	71	3.459		
CHANGE DETECTED at					
left	65.451	1	65.451	18.924	0.0000
right	33.117	1	33.117	9.575	0.0028
Error Term	245.568	71	3.459		

Table 2.2.2. Analysis of Variance Summary Table showing differences in Consumption (following transformation) for Experiment (Experiment 1 or Experiment 2), Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (EXPERIMENT)	10.607	1	10.607	3.039	0.0833
B (LOCATION OF	4.844	1	4.844	1.388	0.2406
C (CHANGE DETECTED)	125.220	1	125.220	35.872	0.0000
AB	2.611	1	2.611	0.748	0.3885
AC	5.562	1	5.562	1.593	0.2088
BC	0.654	1	0.654	0.187	0.6658
ABC	1.504	1	1.504	0.431	0.5126
Error	537.568	154	3.491		

Table 2.3.1. Analysis of Variance Summary Table and Simple Main Effects Table for Experiment 3 showing differences in Consumption (following transformation) s for the two factors Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION)	0.562	1	0.562	0.180	0.6729
B (CHANGE DETECTED)	29.515	1	29.515	9.449	0.0032
AB	0.912	1	0.912	0.292	0.5910
Error	181.176	58	3.		

Simple Main Effects Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
LOCATION OF CHANGE DETECTED at					
ACD	0.000	1	0.000	0.000	0.9921
NCD	1.184	1	1.184	0.436	0.5107
Error Term	219.692	81	2.712		
CHANGE DETECTED at					
left	6.901	1	6.901	2.544	0.1146
right	2.872	1	2.872	1.059	0.3065
Error Term	219.692	81	2.712		

Table 2.4.1. Analysis of Variance Summary Table and Simple Main Effects Table for Experiment 4 showing differences in Consumption (following transformation) for the two factors Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION OF CHANGE DETECTED	0.031	1	0.031	0.008	0.9301
B (CHANGE DETECTED	15.165	1	15.165	3.858	0.0545
AB	4.572	1	4.572	1.163	0.2855
Error	220.132	56	3.		

Simple Main Effects Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
LOCATION OF CHANGE DETECTED at alcohol	2.781	1	2.781	0.707	0.4039
neutral	1.857	1	1.857	0.472	0.4948
Error Term	220.132	56	3.931		
CHANGE DETECTED at left	17.526	1	17.526	4.458	0.0392
right	1.603	1	1.603	0.408	0.5257
Error Term	220.132	56	3.931		

Table 2.4.2. Analysis of Variance Summary Table showing differences in Consumption (following transformation) for Experiment (Experiment 3 or Experiment 4), Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (EXPERIMENT)	4.928	1	4.928	1.400	0.2392
B (LOCATION OF	0.164	1	0.164	0.047	0.8297
C (CHANGE DETECTED)	43.450	1	43.450	12.343	0.0006
AB	0.426	1	0.426	0.121	0.7287
AC	1.137	1	1.137	0.323	0.5709
BC	0.712	1	0.712	0.202	0.6538
ABC	4.796	1	4.796	1.362	0.2456
Error	401.308	114	3.520		

Table 2.4.3. Analysis of Variance Summary Table showing differences in Consumption (following transformation) for Experiment (Experiment 1, Experiment2, Experiment 3 or Experiment 4), Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (EXPERIMENT)	16.159	3	5.386	1.538	0.2051
B (LOCATION OF CHANGE DETECTED)	1.417	1	1.417	0.404	0.5254
C (CHANGE DETECTED)	154.333	1	154.333	44.054	0.0000
AB	6.041	3	2.014	0.575	0.6321
AC	13.670	3	4.557	1.301	0.2746
BC	1.365	1	1.365	0.390	0.5330
ABC	6.587	3	2.196	0.627	0.5983

Table 2.A.1. Analysis of Variance Summary Table for Experiment A showing differences in Consumption (following transformation) for the two factors Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION OF CHANGE DETECTED)	0.518	1	0.518	0.191	0.6632
B (CHANGE DETECTED)	9.385	1	9.385	3.460	0.0665
AB	0.483	1	0.483	0.178	0.6741

Chapter 3

SOCIAL DRINKERS' DETECTION OF COMPETING ALCOHOL-RELATED AND NEUTRAL CHANGES SIMULTANEOUSLY IMPLEMENTED THROUGH A FLICKER ICB PARADIGM—THE EFFECT OF CONTEXT ON CHANGE DETECTION.

Abstract

Textual Experiment A in Chapter 2 suggested that alcohol-related attentional bias (AAB) might not be driven by the changes made to the target stimuli, themselves, because in Experiment A the nature of the change (i.e., between alcohol-related and neutral word stimuli) was effectively the same in each of the two simultaneously-presented changes. In pictorial Experiments 1-4, each of which revealed an AAB, the nature of the context was confounded with the nature of the changing targets—alcohol-alcohol-related changes were always set in an alcohol context and neutral-neutral changes were always set in a neutral context.

In pictorial Experiments 5 and 6, opposite-context versions of Experiments 1 and 2 were carried out—in which alcohol-alcohol-related changes were embedded in a neutral context and neutral-neutral changes embedded in an alcohol context. No AAB was found in Experiment 5 (rotational changes) but in Experiment 6 (replacement changes) an AAB which was driven by the context not the target through which the change was implemented was revealed. Pictorial Experiments 7 (rotational changes) and 8 (replacement changes) returned to the logic of textual Experiment A. The two simultaneously-presented changes were identical so that if an AAB were to be found, it must be driven by the contexts. AABs were revealed in Experiments 7 and 8 which is consistent with the AABs being driven by context information because like in textual Experiment A, there was no differential target information. Experiments 9 (rotational changes) and 10 (replacement changes) were designed to retain the differential target information contained in Experiments 1, 2, 3, and 4 from Chapter 2 and Experiments 5 and 6 from Chapter 3 but to remove the

differential information provided by the contexts. No AAB was revealed which is consistent with AABs being driven by the contexts in earlier experiments and not by the targets.

Introduction

In both pictorial Experiments 1 and 2 of Chapter 2 the flicker ICB paradigm was used to investigate AAB. In these experiments pictorial objects were presented in a 3x6 rectilinear matrix framework with 3x3 pictorial alcohol-related objects to one side of the centre of the 3x6 matrix and 3x3 pictorial neutral objects to the other. The object at the centre of the 3x3 alcohol-related group and the object at the centre of the 3x3 neutral group (the two target objects) carried the changes. In Experiment 1, these two changes were implemented by simultaneously *rotating* the two target objects carrying the changes on their vertical axes. In Experiment 2, the changes were made by *replacing* the objects carrying the change with new objects. In both Experiment 1 and 2 an AAB was found, thus both replicating and extending the AAB finding with a 2-change flicker ICB paradigm first demonstrated by B. C. Jones, B. T. Jones Blundell and Bruce (2002).

Pictorial Experiments 3 and 4 of Chapter 2 were designed to examine whether the effects obtained in Experiments 1 and 2 could be replicated when new target objects were introduced or whether the effect was specific to the target objects used in Experiments 1 and 2. Reasons for doing this were explained in Chapter 2. Experiments 3 and 4 employed an identical overall layout and identical stimulus pairs as in Experiments 1 and 2 except for a new pair of target objects that were used to carry the changes. As the main findings of Experiments 1 and 2 were replicated in Experiments 3 and 4, it was concluded that change in Experiments 1 and 2 was not driven by idiosyncratic properties of the target stimulus.

Although, Experiments 3 and 4 employed different target objects to Experiments 1 and 2—together suggesting that no idiosyncratic properties of the target objects used were responsible for change detection but that it was due the alcohol-related nature of the target objects, themselves—there is another possible explanation for the four experiments generating consistent results. Whilst it is, indeed, possible that heavier drinking participants detect changes driven by the alcohol-relatedness of the actual objects that are changing (the target objects) and that attention is primarily attracted by the changing objects, an alternative

explanation might be that change detection is primarily driven by the overall context within which a target object is, itself, set. In other words, it is possible that while being attracted towards the group of objects comprising the *context* within which a target is set, participants detect whatever change occurs because they are already looking there (at the context). Of course, primarily responding to the context not the target would still represent a differential AAB in heavier over lighter drinkers.

Experiment A adds weight to this possibility. In Experiment A, in which text rather than pictures were used, to implement the change (between the OS and CS) the alcohol-related target word was changed to the neutral target word and the neutral target word was changed to the alcohol-related target word. If it was the detail of the change that attracted attention, then an AAB would not be found because both changing targets were equivalent in the sequence of changes they displayed. An AAB was found, however, which suggests that it was not the details of the target objects themselves that attracted attention but the details contained in the overall context.

Pictorial Experiments 5 and 6 were designed in an attempt to examine whether the target object or the context within which the target object is set drives change detection. These two experiments used the same basic stimuli and overall layout as Experiments 1 and 2 and Experiments 3 and 4—i.e., a 3x3 alcohol matrix to one side of the display and 3x3 neutral matrix on the other. There was however an important difference. While in Experiments 1 and 2 (and Experiments 3 and 4) all alcohol-related objects were positioned to one side of the centre and all neutral objects to the other so that the central object within the matrix of alcohol-related objects was, itself, an alcohol-related object and the object at the centre of the neutral matrix was a neutral object, in Experiments 5 and 6 the central object of the alcohol-related matrix was exchanged with the central object of the neutral object. This created an ‘opposite context’ stimulus display having a matrix of alcohol-related objects with a central neutral target and a matrix of neutral objects with a central alcohol-related target. Note that this design is quite unlike the design of Experiment A in which the targets were changing from alcohol to neutral because the targets

were changing from an alcohol-related stimulus to another alcohol-related stimulus and from a neutral stimulus to another neutral one.

Under ‘opposite context’ conditions of test, if the target objects were primarily responsible for driving change detection, then an effect the same as the effect found in Experiments 1 to 4 should be found—in which weekly alcohol consumption was significantly higher in participants who detected the alcohol-related change than in participants who detected the neutral change. If, on the other hand, change detection were driven by the context within which the target object carrying the change is set, then an effect *opposite* to the effect found in Experiments 1 to 4 should be obtained—i.e., participants detecting the neutral change (set in the alcohol-related context) should report higher weekly alcohol consumption than participants who detect the alcohol-related change (set within the neutral context). Experiments 5 and 6 are designed for an opposite context test using alcohol-related and neutral changes implemented by object rotation and object replacement, respectively. The first of these two ‘opposite context’ experiments are described below.

Experiment 5: Social drinkers’ detection of alcohol-related and neutral changes manifest as object rotations: testing for context effects with dissimilar targets and target-opposite contexts.

Pictorial Experiment 5 was designed to investigate whether the AAB found in Experiment 1 was as a result of change detection being primarily driven by the target objects (the objects carrying the changes) or primarily by the context within which these objects were set. A stimulus set and layout identical to the one used in Experiment 1 was used, with the only difference being that while in Experiment 1 the alcohol-related target object was positioned at the centre of the alcohol matrix and the neutral target object at the centre of the neutral object, in Experiment 5 the alcohol-related target object was positioned at the centre of the neutral matrix and the neutral target object at the centre of the alcohol-related matrix. As in Experiment

1, the changes in Experiment 5 were implemented by rotating the target objects. In Experiment 6, the changes will be implemented through target object replacement.

In Experiment 5 it was hypothesized that if the context was responsible for change detection, then weekly consumption will be higher in participants who detect the *neutral* change (set in the alcohol-related context) than for participants who detect the *alcohol-related change* (set in the neutral context).

Method

Participants

One hundred people (32 males, 68 females; *Mdn* age = 20 years, quartile range = 3.0, range = 18-39) were opportunistically recruited from intra-campus traffic. In common with the procedures adopted for the five experiments in Chapter 2 and for the same reasons, they were then taken to quiet testing places away from the Psychology Department and Alcohol Laboratory, kept naïve to the purpose of the experiment and allocated to one of two testing groups to be described later in this section. Of these 100 people, 73 (19 males, 54 females; *Mdn* age = 20 years, quartile range = 3.0, range = 18-38) provided information suitable for inclusion in analyses. The details of excluded participants are included in the results section.

Paradigm

A flicker ICB paradigm (Rensink, O'Regan & Clark, 1997) with parameters identical to those used in the four experiments in Chapter 2 was used in Experiment 5 (see Figure 2.1.1). An original Stimulus, OS, was presented for 400 msec, followed by a mask, M, comprising a matrix of Xs for 200 msec, followed by a changed stimulus, CS presented for 400 msec followed by the same mask for 200 msec. The OS and CS, and how they deviate from the stimuli for Experiments 1 and 2, will be described below. As in the experiments of Chapter 2, the OS-M-CS-M cycle was repeated continuously until a change was detected by the participant. Further details on the flicker ICB paradigm are contained in the Paradigm section of Experiment 1 in Chapter 2.

Design

The design of Experiment 5 was identical to the design used in Experiment 1. Factor 1 represented the Location of the Changes to be detected and had two levels: alcohol-related change on the left, neutral change on the right, ALNR; and neutral change on the left, alcohol-related change on the right, NLAR. This factor was used for group allocation at testing time to ensure proper experimentation. In common with the analyses in Chapter 2, this factor was not a factor used in analysis. Factor 2 represented the Change Detected, and had two levels: alcohol-related change detected, ACD, and neutral change detected, NCD. Factor 3 represented the Location of Change Detected, and also had two levels: change detected on the left, L, and change detected on the right, R. On recruitment participants were randomly allocated to one of the two levels of Location of Changes (i.e., either to ALNR or to NLAR). They were retrospectively allocated to the levels of Factors 2 and 3 based respectively on the change that they detected, and its location within the stimulus matrix. In common with the four experiments in Chapter 2, this meant that although there was control over the number of participants in each level of Location of Changes (group assignment for counterbalancing at testing time), there was no control over the number of participants in each level of Factors 2 and 3 (for use in analysis). The features of the design of Experiment 5 are shown in Figure 3.5.1.

As in Experiments 1 to 4, the dependent variable used in the analysis was self-reported typical total weekly alcohol consumption measured in U.K. units of alcohol.

Opposite context note.

It is an important point to note that although the two levels of Location Of Changes in Experiment 5 share the same name as the two levels of Location of Changes in Experiments 1 to 4 (i.e., ALNR and NLAR) there is an important difference between what these levels' names represent in Experiments 1 to 4 and what they represent in Experiment 5. In Experiment 1 to 4, ALNR, for example, represented a display in which a 3x3 A matrix was on the left of the display with an

alcohol-related target carrying the alcohol-related change positioned centrally in the 3x3 A matrix; and a 3x3 N matrix on the right of the display with a centrally positioned neutral target carrying the neutral change. In Experiment 5, however, there is an opposite context switch. In Experiment 5, ALNR represents a 3x3 matrix to the left of the display comprising one centrally positioned alcohol-related object (the target, carrying the change) which was surrounded by eight neutral objects (the context). In other words, the AL part of ALNR refers to the *target* (alcohol-related) and NOT to the *context*. In the previous four experiments, the nomenclature for the target and the context coincided. In Experiment 5 they do not. In the same vein, NLAR in Experiment 5 differed from NLAR in Experiments 1 to 4 in a corresponding way. In other words the design of Experiment 5 was equal to the design of Experiments 1 to 4 except that the targets were embedded in opposite contexts. This difference is described more fully in the Stimulus section below.

Stimuli

The pool of stimulus pairs used to create the Original Stimuli was identical to the pool of stimulus pairs used in Experiment 1 (see Figure 2.1.3).

Constructing the two Original Stimuli, OS.

These pairs were used to create a landscape 6x3 rectilinear matrix, almost identical to that used in Experiment 1 (see Figure 3.5.2). Thus, in the current experiment, OS-ALNR refers to the OS where the alcohol-related target carrying the change is on the left of the screen and the neutral object carrying the change is on the right. This is just as it was in the OS for Experiment 1. In Experiment 5, however, the alcohol-related object carrying the change (the target) was embedded within the matrix of *neutral* objects and the neutral object carrying the change (the other target) was embedded within the matrix of *alcohol-related* objects. These are the ‘opposite context’ original stimuli, OS.

Constructing the two Changed Stimuli, CS.

The two CS were constructed in an identical way to the CS of Experiment 1, by making concurrent changes to the two target objects referred to above. In other

words, a change was made to the neutral object positioned in the centre of the 3x3 A matrix and also to the alcohol-related object positioned in the centre of the 3x3 N matrix (see Figure 3.5.3). These two changes were implemented using Adobe Illustrator to rotate each of the objects by 90 degrees on its vertical axis—so that the label on the whisky bottle and the handle on the cafetière both changed from pointing leftwards to pointing rightwards. These were the ‘opposite context’ changed stimuli, CS.

Apparatus and Proforma

These were identical to the Apparatus and Proforma used in Experiments 1 to 4. Psyscope v1.2.5 (Cohen, MacWhinney, Flatt & Provost, 1993), run on an Apple G3 PowerBook, was used to implement a flicker ICB paradigm. The alcohol consumption timeline followback form (TLFB, based on Sobell & Sobell, 1992) was also used.

Procedure

An identical procedure to the procedure used in Experiments 1 to 4 was employed in Experiment 5. Participants were taken to quiet testing places, asked to complete the flicker ICB task and then fill out the alcohol TLFB, including demographic details. All procedures were approved by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committees).

Results

Prior to analyses the same exclusion criteria as were used in Experiments 1 to 4 were applied to remove unsuitable participants. Twenty-seven participants did not fulfil the requirements of the study and were removed—3 incorrectly detected the change, 21 reported atypical drinking in the previous week, 1 had previously taken part in a similar study and 2 had consumed alcohol on the day of testing. The remaining 73 provided suitable data and were included in the analyses.

The main hypothesis under test (Hypothesis 3.5.1) was that Consumption would be higher in participants who detected the neutral change (the two Groups NCD) than in participants who detected the alcohol-related change (the two Groups ACD). This prediction was made based on the assumption that the context within which a target object is embedded is responsible for driving the particular change detected. This in turn is based on the fact that the alcohol context (8 alcohol-related stimuli) provides more information than the alcohol-related target (1 alcohol-related stimulus). As compared with Experiments 1 to 4, this postulated reversal might be called an 'opposite context' effect.

Of the 73 participants included in the analyses, the alcohol-related change was detected by 48 (the two groups ACD, M Consumption = 14.41 units of alcohol per week, SD = 11.58) and the neutral change by 25 (the two groups NCD, M Consumption = 14.26 units of alcohol per week, SD = 16.46). Within these opposite context conditions, therefore, it does not appear that there is any difference in consumption between those detecting the alcohol-related change (in a neutral context) and those detecting the neutral change (in an alcohol context). The same appears to be true when a by-sides breakdown of the data is carried out, below

Of the 48 participants in the two groups ACD, 20 detected the alcohol-related change when it occurred on the left of the stimulus matrix (Group ACD-L, M Consumption = 14.5 units of alcohol per week, SD = 13.64), and 28 when the alcohol-related change occurred on the right of the stimulus matrix (Group ACD-R, M Consumption = 14.34 units of alcohol per week, SD = 10.3). Of the 25 participants who detected the neutral change (the two groups NCD), 11 detected the neutral change when it was positioned on the left of the stimulus matrix (Group NCD-L, M Consumption = 16.64 units of alcohol per week, SD = 17.21) and the remaining 14 when the neutral change was positioned on the right of the stimulus matrix, (Group NCD-R, M Consumption = 12.39 units of alcohol per week, SD = 16.25). This information is displayed in Figure 3.5.4. The reliability of the differences described above is examined below.

Prior to analyses, however, and in common with the experiments of Chapter 2 and for identical reasons, square root ($x + 0.5$) transformations of the data were carried out because of evidence of coefficients of skew (1.299) and kurtosis (1.225) outside of the recommended -1 to $+1$ limits. Following transformation, the coefficients of skew (0.334) and kurtosis (-0.374) were satisfactory. Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was then carried out. This revealed there to be no significant difference between the variances of the groups ($p > .05$).

Note that in common with the means reported in the figures and discussions of Chapter 2, then means in Chapter 3's figures and discussions are the untransformed means as recommended by Keppel and Wickens (2004).

Analysis of Variance

A 2x2 between participants ANOVA was used in Experiment 5. Factor 1, Location of Change Detected had two levels, left, L, and right, R. Factor 2, Change Detected also had two levels, alcohol-related change detected, ACD, and neutral change detected, NCD. The dependent variable, Consumption, represented the self-reported number of alcohol units consumed in the previous week is typical.

It was predicted that the mean number of alcohol units consumed in the previous week would be higher for participants detecting the *neutral* change, the two Groups NCD, than for participants detecting the *alcohol-related change*, the two Groups ACD (Hypothesis 3.5.1). This is because it was predicted that the particular change detected would be driven by the nature of the surrounding context of 8 objects rather than the nature of the single target object. Therefore exactly the opposite predictions would be made here to the predictions made in Experiments 1 to 4, in which it was both predicted and found that the alcohol-related change, not the neutral change, would be detected by the heavier drinkers.

As the Analysis of Variance Summary table shows (Table 3.5.1) Hypothesis 3.5.1 was not supported—the main effect of Changed Detected ($F(1, 69) = 0.435, p > .05$) failed to reach significance showing there to be no difference in mean

Consumption between participants who detected the alcohol-related change (the two Groups ACD transformed $M = 3.57$; raw = 14.41 units) and those who detected the neutral change (the two Groups NCD, transformed $M = 3.25$; raw $M = 14.26$ units). Furthermore, neither the main effect of Location of Change Detected ($F(1, 69) = 0.204, p > .05$) nor the interaction between Location of Change Detected and Change Detected ($F(1, 69) = 0.337, p > .05$) revealed a significant result.

Effect Sizes

An effect size calculation was carried out to investigate the size of the difference between the mean weekly Consumption of participants who detected the alcohol-related change (the two Groups ACD, $n = 48$, transformed $M = 3.57$ units, $SD = 1.5$; raw $M = 14.41$ units, $SD = 11.58$) and of those who detected the neutral change (the two Groups NCD, $n = 25$, transformed $M = 3.25$ units, $SD = 2.09$; raw $M = 14.26$ units, $SD = 16.47$). This revealed an effect size, d , of 0.18, which is smaller than Cohen's (1992) "small" effect size (which requires d to be greater than 0.2). The 95% confidence limits of d were -0.3 and 0.67 which included the null value, showing the measure not to be reliable.

Summary of Results

The changes referred to below are changes implemented as object rotation.

Hypothesis 3.5.1 Mean Consumption will be higher in participants who detect the neutral change than in participants who detect the alcohol-related change. This was not supported.

Hypothesis 3.5.2 There would be a significant effect size in the mean difference in Consumption between participants who detect the neutral change and participants who detect the alcohol-related change. This was not supported.

Preliminary Discussion

No evidence was found for a differential AAB towards alcohol-related objects in Experiment 5 when the changes implemented were through rotation and when the target objects were embedded in opposite contexts. This failure to find a

differential AAB was somewhat surprising since it was not expected that the AAB effect would disappear when the opposite context version of Experiment 1 was run, but that the effect would either be present or reversed. In Experiments 1 and 2, however, a more reliable effect and a larger effect size representing a differential AAB was found when the changes were implemented using the replacement method (Experiment 2) than when changes were implemented using the rotational method (Experiment 1). Consequently, if object replacement rather than rotation provides a better method of eliciting an AAB within the constraints of the stimulus set used here, then it might be predicted that a stronger effect would be found using replacement than using rotation in opposite context experiments. This possibility is explored in Experiment 6.

This reasoning might be limited, however, by the fact that the increase in effect size found in Experiment 2 (target object replacement) over the effect size found in Experiment 1 (rotation) was not sustained in the comparison between Experiments 3 and 4. Nonetheless, the directional difference in effect sizes found between Experiments 1 and 2 might be of more significance than those found in Experiments 3 and 4 in explaining the lack of opposite context effect in Experiment 5 because exactly the same target objects carrying the change were used in Experiment 5 as were used in Experiment 1.

Experiment 6: Social drinkers' detection of alcohol-related and neutral changes manifest as object replacements: testing for context effects with dissimilar targets and target-opposite contexts.

Pictorial Experiment 6 was designed to carry out an opposite context version of Experiment 2 (just as Experiment 5 was derived from Experiment 1) in which the opposite context change was object replacement not rotation. Experiment 6 was designed, therefore, to investigate whether the differential AAB found in Experiment 2 was driven by the target objects carrying the replacement changes or by the context within in which these target objects carrying replacement changes were set. This was done by using the stimuli from Experiment 2 (not Experiment 4) and by

exchanging the two target stimuli so that the alcohol-related target object was at the centre of the neutral matrix and the neutral target object was at the centre of the alcohol matrix. In accord with the hypothesizing of Experiment 5, it was hypothesized that if the context was responsible for driving change detection, the weekly alcohol consumption would be higher in participants who detect the neutral change (in the alcohol context) than in participants who detect the alcohol-related change (in the neutral context). Experiment 6 is described below.

Method

Participants

In common with earlier experiments, individuals were approached on public pathways and asked to participate in a short experiment. Precautions were taken at recruitment to protect the purpose of the experiment from the participants and these have been described in earlier experiments. Of those approached, 100 (41 males, 59 females; *Mdn* age = 20 years, quartile range = 2.0, range = 17-37) agreed to take part and were taken to quiet testing areas. Seventy-six (28 males, 48 females; *Mdn* age = 20 years, quartile range = 2.0, range = 17-37) provided suitable data for inclusion in the study.

Paradigm

The flicker ICB paradigm (Rensink et al., 1997) parameters and details were identical to those described earlier—an Original Stimulus, OS (400 msec), was presented followed by a Mask, M (200 msec,) followed by a Changed Stimulus, CS (400 msec), and finally by the same Mask, M (200 msec). This cycle was repeated endlessly until the participant had detected the change.

Design

In the same vein as earlier experiments, Factor 1 was Location of Changes, (two levels: alcohol left neutral right, ALNR, and neutral left alcohol right, NLAR). As was the case in Experiment 5, symbols in the level names of Factor 1 refer to the locations of the target stimuli not the contexts in which they were embedded. Factor

1 was used for group assignments for proper experimentation, not for analysis. Factor 2 was Change Detected (two levels: alcohol-related change detected, ACD, and neutral change detected, NCD). Factor 3 was Location of Change Detected (two levels: change detected on the left, L, and change detected on the right, R). This design is shown in Figure 3.6.1). Factor 2 and 3 were used for analysis, as in earlier experiments. The dependent variable for use in all analyses of Experiment 5 was Consumption, which represented the self-reported total number of U.K. alcohol units consumed in the previous week.

As in earlier experiments, participants were randomly allocated to the two levels of the factor Location of Changes, meaning that participants could be distributed equally across the two levels of this factor at recruitment. The levels to which participants were assigned for Factor 2, Changed Detected, and also for Factor 3, Location of Change Detected was, however, dependent on the participants' responses. Participants were, therefore, retrospectively assigned to the 2x2 levels of these factors for analysis and as a result it was impossible to ensure that the number of participants in each level of Factors 2 and 3 were equal.

Stimuli

The Original Stimulus, OS, and Changed Stimulus were created using the pool of Stimulus pairs used in the earlier experiments, particularly Experiment 2 (see Figures 2.1.3 and 2.2.4).

Constructing the two Original Stimuli, OS.

The two opposite context Original Stimuli (OS) were identical to those used in Experiment 5 (see Figure 3.5.2), in which OS-ALNR represents a 6 x 3 rectilinear matrix with a 3x3 matrix on the left where an alcohol-related object is surrounded by 8 neutral objects, and a 3x3 matrix on the right, where a neutral object is surrounded by 8 alcohol-related objects. OS-NLAR represents a mirror image of this arrangement. The two OS employed in Experiment 6 are graphically represented in Figure 3.6.2.

Constructing the two Changed Stimuli, CS.

While in Experiment 5 the changes were made to the target objects by rotating them on their vertical axes, in Experiment 6 the same procedure was used as in Experiments 2 and 4—the two target objects were simultaneously replaced with new objects. The objects used to replace the two target objects in the OS were those used in Experiment 2 (see Figure 2.1.3). The two opposite context CS are represented in Figure 3.6.2.

Apparatus and Proforma

The same Apple G3 PowerBook as used in previous experiments was used to run the flicker ICB paradigm—implemented using Psyscope v1.2.5 (Cohen, et al., 1993). Alcohol Consumption and other demographic information were collected using the same alcohol consumption timeline followback form (TLFB, based on Sobell & Sobell, 1992) which was used in previous experiments. Further details of these are available in the Apparatus and Proforma section of Experiment 1.

Procedure

The procedure for Experiment 6 was identical to the procedure for previous experiments and Experiment 5—participants were recruited and taken to quiet testing places where they were given instructions, asked to complete the task on the PowerBook and then fill in the TLFB. The Procedure section of earlier experiments contains full details and all procedures were approved by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committees).

Results

Of the 100 participants who were recruited into Experiment 6, 24 were rejected as they did not fulfil the requirements for inclusion in the analyses—21 reported atypical drinking the previous week, 2 had consumed alcohol on the day of testing and 1 had incorrectly detected the change. The data from the remaining 76 participants was used in the subsequent analyses.

The main hypothesis (Hypothesis 3.6.1) was that if change detection is context driven then mean consumption would be higher in participants who detected the neutral change, (the two Groups NCD), than in participants who detected the alcohol-related change (the two Groups ACD).

Of the 76 participants who provided suitable data, 26 detected the alcohol-related change (the two Groups ACD, M Consumption = 8.85 units of alcohol per week, SD = 6.93) and 50 detected the neutral change (the two Groups NCD, M Consumption = 15.20 units of alcohol per week, SD = 12.79). Of the 26 who detected the alcohol-related change 13 did so when it was located on the left of the stimulus matrix (Group ACD-L, M Consumption = 9.12 units, SD = 6.74) and 13 when it was on right of the stimulus matrix (Group ACD-R, M Consumption = 8.58 units, SD = 7.39). Of the 50 participants who detected the neutral change 27 did so when it was located on the left of the stimulus matrix (Group NCD-L, M = 16.5 units, SD = 14.42) and 23 did so when it was on the right of the stimulus matrix (Group NCD-R, M = 13.67 units, SD = 12.12)—see Figure 3.6.3 for a graphical representation of this information. These differences were formally analysed below.

In common with the previous experiment, square root ($x + 0.5$) transformations of the data was carried out because of evidence of coefficients of skew (1.343) and kurtosis (3.011) outside of the recommended -1 to $+1$ limits. Following transformation, the coefficients of skew (-0.016) and kurtosis (-0.446) were within the limits appropriate for parametric analyses. Bartlett's test for homogeneity of variances (Snedecor & Cochran, 1989) was then carried out. This revealed there to be no significant difference between the variance of the groups ($p > 0.05$).

Analysis of Variance

A 2x2 ANOVA was performed. The first factor represented Location of Change Detected and had two levels: left, L, and right, R. The second factor represented Change Detected and also had 2 levels: alcohol, ACD and neutral, NCD.

The dependent variable, Consumption, represented the self-reported total number of alcohol units consumed in the previous week.

It was hypothesized (Hypothesis 3.6.1) that mean Consumption would be higher for participants who detected the neutral change than for participants who detected the alcohol-related change. Hypothesis 3.6.1 was supported—a significant one-tailed main effect was shown for Change Detected ($F(1, 72) = 3.95, p > .05$ two-tailed—but $p = .051/2 = .0255$ for a one-tail test, see the Results section of Experiment 4 in Chapter 2 for a full explanation). In other words, as predicted, a reliable difference in Consumption was shown between participants who detected the neutral change (the two Groups NCD, M transformed = 3.56; raw = 15.2 units) and those who detected the alcohol-related change (the two Groups ACD, M transformed = 2.74; raw = 8.85 units). Neither the main effect of Location of Change Detected ($F(1, 72) = 0.536, p > .05$) nor the interaction between Location of Change Detected and Change Detected ($F(1, 72) = 0.051, p > .05$) reached significance. This information is contained in Table 3.6.1.

Effect Sizes

In addition to the above ANOVA an effect size calculation was carried out to investigate the difference between the mean Consumption of participants who detected the neutral change (the two Groups NCD, transformed $M = 3.56$ units, $SD = 1.76$; raw $M = 15.2$ units, $SD = 12.79$) and those who detected the alcohol-related change, (the two Groups ACD, transformed $M = 2.74$ units, $SD = 1.37$; raw $M = 8.85$ units, $SD = 6.93$). Using Cohen's (1992) scheme a "medium" effect size where $d = 0.49$ was shown. The 95% confidence limits of d did not include zero (0.01 and 0.97), indicating the measure to be reliable.

Summary of Results

Hypothesis 3.6.1 Mean Consumption would be higher for participants who detected the neutral change than for participants who detected the alcohol-related change. This was supported.

Hypothesis 3.6.2 A significant effect size would be present in the mean difference in Consumption of those who chose the neutral and alcohol-related change. This was supported.

Preliminary Discussion

As compared with Experiments 1 to 4, a reversed differential AAB effect was found when the target stimuli were embedded in opposite contexts carried changes implemented by replacement (Experiment 6) but not when the changes were implemented by rotation (Experiment 5).

Experiments 5 and 6 used the same stimulus pairs and were identical to each other except for the nature of the change implemented in the target objects (i.e., the objects that carried the change). In Experiment 5, the same procedure was used to create the changed stimuli, CS, as was used in Experiment 1—namely changes were implemented by *rotating* the target objects on their vertical axes. In Experiment 6, the same procedure was used to implement the changes as was used in Experiment 2—namely, the target objects were *replaced* by new objects. The same objects as were used in Experiment 2 were also used in Experiment 6 to make this replacement. One possible explanation for the failure to find the predicted reversed AAB when target stimuli embedded in opposite contexts carried rotational rather than replacement changes, is that the superiority of replacement changes over rotational changes found between Experiments 1 (rotational) and 2 (replacement) is also present in Experiments 5 (rotational) and 6 (replacement). Except that the differential AAB is reduced in opposite context conditions of test to the extent that it disappears in the experiment in which it would be predicted to be the smallest—Experiment 5. There is another possible reason for the unexpected result found in Experiment 5 and this is explained below.

In Experiments 1 and 2, a larger effect size (i.e., measure of AAB) was found in Experiment 2 (replacement) than in Experiment 1 (rotation). This would appear to suggest that replacing the target stimuli with new objects is a more effective

method of revealing an AAB in social drinkers than reversing them. It is possible, however, that this is not the case, and that the difference between Experiment 1 and 2 in terms of eliciting an AAB was not the result of the *type* of change implemented—rotational or replacement—but may have been an artefact caused by differences in overall mean *Consumption* between the participants of Experiments 1 and 2. As explained in Chapter 2, an effect size has as its numerator the mean difference in Consumption between two Groups of participants (i.e., those detecting the alcohol-related change and those detecting the neutral change). As a result, if the overall Consumption of the participants of one experiment differs from the overall Consumption of the participants in the other, then it is possible that the mean difference between the two groups within each experiment—in this case the means difference between participants who chose the alcohol-related change and participants who chose the neutral change—will also differ in each experiment.

Such a difference would result in a difference in effect size driven by unequal Consumption across experiments rather than the differences between experiments that were part of the manipulation. Furthermore, if, as Hypotheses 3.5.1 and 3.6.1 suggest, heavier drinkers will detect the neutral change, then if one Experiment has captured a higher number “heavier drinkers” than the other, it might reasonably follow that these participants would detect the neutral change, causing the mean of this group to be inflated. This would artificially create a greater mean difference between the participants who detected the alcohol-related change, and those who detected the neutral change and would result in an increased effect size. Of course, random sampling for each experiment should avoid this possibility, but it is nevertheless a possibility. To explore this possibility, a 2x2x2 ANOVA, was performed in which Factor 1 represented Experiment (Experiment 1, Experiment 2), Factor 2 represented the Location of Change Detected (left, right) and Factor 3 represented Change Detected (alcohol, neutral). This rationale is fully reported in the Preliminary Discussion of Experiment 2 in Chapter 2 (also see Analysis of Variance Summary Table, Table 2.2.2). No significant difference between the mean Consumption of Experiments 1 and 2 was found and for this reason the possible

artefactual explanation of the fact that the AAB in Experiment 2 was bigger than Experiment 1 was rejected. Rather it was considered that the replacement change was more effective at eliciting the AAB than the rotational change. In the same vein and for the same reasons, an identical 2x2x2 ANOVA was performed to examine the differences in Consumption between Experiments 3 and 4 in Chapter 2 with the same results and conclusions as above.

Consequently, a corresponding, third, consumption check is carried out between Experiments 5 and 6 to check whether the failure to find a differential AAB in Experiment 5 while finding it in Experiment 6 might be due to differences in consumption between participants of the different experiments. This analysis is reported below.

Subsidiary combined analyses of Experiments 5 and 6

A 2x2x2 between participants ANOVA was used to investigate any differences in consumption between Experiments 3 and 4. Factor 1 represented Experiment and had two levels (Experiment 5 and Experiment 6). Factor 2 represented Location of Change Detected and had two levels (left, L, and right, R). Factor 3 represented Change Detected and also had two levels (alcohol-related change detected, ACD, and neutral change detected, NCD). The dependent variable used in the analysis was Consumption, as measured by the total weekly number of U.K. alcohol units consumed in the previous week. Table 3.6.2 contains the Analysis of Variance Summary Table.

The comparison of interest was main effect of Experiment. Participants in Experiment 5 reported mean Consumption of 14.36 units (transformed 3.46) while participants in Experiment 6 reported mean Consumption of 13.03 units (transformed 3.28). This difference was not significant ($F(1, 141) = 2.510, p > .05$) showing there to be no difference in mean weekly Consumption between the participants of Experiment 5 and the participants of Experiment 6. This suggests that the differences between Experiment 5 and 6 occurred as a result of something other than differences in Consumption between the participants in Experiment 5 and

Experiment 6. Neither the main effect of Location of Change Detected ($F(1, 141) = 1.987, p > .05$) nor Change Detected ($F(1, 141) = 2.163, p > .05$) were significant and none of the interactions were significant.

Preliminary Conclusion

In employing the opposite context method of stimuli presentation in the flicker ICB paradigm a differential AAB is reliably shown when the change is implemented through object *replacement* (Experiment 6) but not when the change is implemented through object *rotation* (Experiment 5). It seems defensible to conclude that because weekly alcohol consumption was equivalent in Experiments 5 and 6, the difference in outcome of these two experiments was not consumption-driven but that object replacement might provide a more sensitive method of revealing an AAB to alcohol-related objects than object rotation. This would be consistent with what was found in and concluded from Experiments 1 and 2. The fact that this was not consistent with the outcome of Experiment 3 has been explained above.

Experiment 7: Social drinkers' detection of alcohol-related and neutral changes manifest as object rotations: testing for context effects with identical targets and different contexts.

In the previous six pictorial experiments, an alcohol-related and a neutral change were simultaneously presented to compete for the attention of social drinkers.

First, there were four pictorial experiments (Chapter 2) in which an alcohol-related and neutral change competed for attention when these two target objects were embedded in contexts of the *same* type—i.e., the alcohol-related change was embedded in an alcohol-related context; the neutral change was embedded in a neutral context. A differential AAB was consistently found across these four experiments. Under these conditions of test, however, it was not possible to determine whether the differential AAB was driven by the target object carrying the

change or the context in which the target was embedded. This difficulty was because the location of both the target and the same-type context in which it was embedded was the same. Experiment A with text (not pictures) suggested that the effective stimulus might be the context.

Second, and to resolve this uncertainty, two additional experiments were carried out (Chapter 3) in which an alcohol-related and a neutral target were embedded in contexts of the opposite type rather than the same type—e.g., the alcohol-related change was embedded in the neutral context. Under these conditions of test it was expected that it would be possible to determine whether change detection was driven primarily by the changing target or primarily by the (opposite) context in which it was embedded. Accordingly, in one of the two opposite context experiments, a differential alcohol-related bias was detected and it was shown to be driven by information contained in the context rather than in the target. In the other experiment, however, no such bias was detected. Consequently, the possibility that the differential AAB that has been measured in pictorial Experiments 1 to 4 might be context-driven is further explored in pictorial Experiments 7 and—using a variation of the opposite-context philosophy.

Whereas in each of the six experiments reported earlier an alcohol-related and neutral change simultaneously competed for attention, in Experiment 7 the two simultaneously-presented changes were identical rather than different. In other words, two identical alcohol-related changes (one embedded in an alcohol-related matrix and the other in a neutral matrix) OR two identical neutral changes (one embedded in an alcohol-related matrix and the other in a neutral matrix) were simultaneously presented to individuals as levels of a between-participant factor. If an AAB was found under these conditions of test, it could not have been driven by target information (because there would have been no difference between the two simultaneously-presented targets). It could only have been driven by the context. Thus Experiments 7 and 8 reflect the same approach as used in Experiment A—the two target stimuli were the same and if there appears an AAB, it must be driven by the context.

Pictorial Experiment 7 explored the role of context using changes implemented by target rotation and is described below—Experiment 8 will use target replacement.

Method

Participants

One hundred and forty four people were opportunistically recruited from intra-campus traffic to participate in Experiment 7 (77 males, 67 females; *Mdn* age = 21 years, quartile range = 3.0, range = 17-51). Of these, 87 (42 males, 43 females; *Mdn* age = 21 years, quartile range = 3.0, range = 17-51) provided information suitable for inclusion in analyses. In common with earlier experiments, exclusion criteria were applied. Details of how many participants were excluded and why are included in the Results section.

Paradigm

A flicker ICB paradigm (Rensink et al., 1997) with the same parameters as in all the earlier pictorial experiments was used in Experiment 7. This involved an original stimulus, OS, being presented for 400 msec, followed by a matrix of Xs (the mask, M,) for 200 msec, followed by a changed stimulus, CS, for 400 msec, followed by the same mask, M, again for 200 msec. This cycle was repeated continuously until a change was detected by the participant (see Figure 2.1.1 and the Paradigm section of Experiment 1 for details). The four OS and CS used in Experiment 7 are described below.

Design

Four between-participant factors (not three as in earlier experiments) describe the logical structure of Experiment 7.

In common with all earlier experiments and to accommodate the possibility of a left hemispace bias described in Chapter 2, participants were assigned to two different groups prior to testing to control this possibility. Factor 1, Location of Contexts, achieved this having two levels: ALNR, in which the alcohol context was

displayed on the left and the neutral context on the right of the display, and NLAR, in which the neutral context was on the left and alcohol context was on the right. This factor was equivalent to the factor, Location of Changes, in earlier experiments. A point to note is that in Experiment 7, the symbols in the designations of the two different levels relate to the location of *contexts* not the location of targets (which is the reason for the change of name). In the four experiments reported in Chapter 2 in which the nature of the target and the context in which it was embed were the same, the nomenclature was unimportant. In the first two opposite context experiments of Chapter 3, however, the nomenclature was important and was related to the nature of the *target*. In Experiment 7, because both targets were identical (either both alcohol-related or both neutral), the nomenclature had to relate to the nature of the *contexts*. In common with earlier experiment, Factor 1 did not feature in the analysis. The second factor was a newly-introduced factor, Type of Identical Targets and participants were randomly assigned to the two different levels of this factor before testing. Type of Identical Targets had 2 levels: AA, in which both target objects were identical alcohol-related objects; and NN, in which both targets were identical neutral objects. Consequently, Experiment 7 was the first experiment in the series reported in this thesis in which a 2x2 completely between participants design was used for group assignment prior to testing. Although Factor 1, Location of Contexts, was not used in analysis, Factor 2 was used.

Factors 3 and 4 were used along with Factor 2 in analysis. Assignment to the two different levels of Factors 3 and 4 were carried out retrospectively in common with the earlier experiments. Factor 3 was the Context within which the change was Detected and had 2 levels—Detected within the Alcohol Context, DAC, in which the change detected was located within a context of alcohol-related objects and Detected within the Neutral Context Detected, DNC, in which the change detected was located within a context of neutral objects. The third factor was the Location of Change Detected with 2 levels: change detected on the left, L, and change detected on the right, R.

As in previous experiments participants were retrospectively allocated to the appropriate levels of Factors 3 and 4, and as a result it was impossible to ensure that group sizes within the 2x2x2 analysis (Type of Identical Target x Context within which the Change was Detected x Location of Change Detected) would be the same. The design of Experiment 7 is shown in Figure 3.7.1.

The dependent variable used in the analysis was self-reported typical total weekly alcohol consumption measured in U.K. units of alcohol.

Stimuli

The same set of stimulus pairs, as was used in Experiment 1 was also used to construct the Original Stimuli and Changed Stimuli in Experiment 7 (see Figure 2.1.3).

Constructing the four Original Stimuli, OS.

These were used to create a 6x3 landscape rectilinear matrix which, target objects aside, was identical to that used in Experiment 1 (see Figure 3.3.2). In Experiments 1 to 4 the rectilinear matrix comprised a 3x3 matrix of alcohol (A) objects on the left, with the central alcohol-related object carrying the change (the alcohol-related target) and 3x3 matrix of neutral (N) objects on the right with the central neutral object carrying the change (the neutral target). In Experiments 5 and 6, the stimuli were constructed in the same way except the alcohol-related and neutral targets were switched into the ‘opposite’ contexts. In Experiment 7 the same overall layout was employed as previously except that the target object and the centre of the 3x3 A matrix (or context) was identical to the target object at the centre of the 3x3 N matrix (or context) creating original stimuli described as ‘same target’ stimuli. Furthermore, to ensure that no differential information could be provided by targets, OS were constructed with two A targets or with the two N targets (representing the between participants factor, Type of Identical Targets, AA or NN). This meant that whereas in previous experiments there were two OS, in Experiment 7 there were four—two in which both target objects were alcohol-related (the two OS-AA) and two in which the both target objects were neutral (the two OS-NN).

Accordingly OS-ALNR-AA refers to the OS in which the A context is on the left of the matrix and the N context is on the right of the matrix and both target objects are alcohol-related. Correspondingly, OS-ALNR-NN was identical to the above, but both target objects were neutral. As in previous experiments the reflection function for Adobe Illustrator was used to create a mirror image reversal of the OS so that the N context was located to the right of the centre and the A context to the left, creating the two OS-NLAR. Thus OS-NLAR-AA represented a 6x3 matrix in which the N context was presented to the left of the overall matrix and the A context to the right and in which both the target objects were alcohol-related, and OS-NLAR-NN comprised an identical matrix, except that the two target objects were neutral. These are the four 'same target' original stimuli, OS.

Constructing the four Changed Stimuli, CS.

The four CS were constructed in an identical way to those of Experiment 1 in which, for each of the four OS described above, the two target objects were simultaneously rotated on their vertical axes using the reflection function of Adobe Illustrator so that in the two CS-AA the labels of the whisky bottles changed from facing the outside of the matrix to facing the centre and in the two CS-NN the two cafetières changed from facing the outside of the matrix to the centre. These were the four 'same target' changed stimuli, CS.

Apparatus and Proforma

The Apparatus and Proforma used in Experiment 7 was identical to that used in earlier experiments—the flicker ICB paradigm was constructed using Psyscope v1.2.5 (Cohen et al. 1993), and was run on an Apple G3 PowerBook (OS 9.1). The alcohol consumption timeline followback form (TLFB, based on Sobell & Sobell, 1992) was also used.

Procedure

The procedure employed in Experiment 7 was identical to that of earlier experiments—participants were approached throughout the campus of Glasgow University and were asked to take part in a short experiment purporting to examine

the differences between performance on a short task on desktop and laptop computers; and that they would be part of the group “laptop group”. They were then taken to quiet testing places, provided with full instructions and told that they were free to leave the Experiment at any point. They were then given the flicker ICB task. On completion of this task, participants were asked to provide drinking and demographic information through the TLFB. All procedures were approved by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committees).

Results

Using the previously used criteria (See Experiment 1 for full details) participants who were unsuitable for inclusion in the analyses were removed. As a result 57 were excluded, as they did not fulfil the requirements of the study. Of those removed, 52 reported atypical drinking in the previous week, the change was incorrectly detected by 2, 1 had previously taken part in a similar study and 2 had consumed alcohol on the day of testing. The remaining 87 provided suitable data and were included in the analyses.

The principle hypothesis under test (Hypothesis 3.7.1) was that weekly alcohol consumption would be higher in participants who detected the change located within a context of alcohol-related objects (the four Groups DAC, Detected in the Alcohol Context) than one located within a context of neutral objects (the four Groups DNC).

Of the 87 participants who provided suitable data for analyses, 44 detected the change located within the alcohol context (the four groups DAC, M Consumption = 19.57 units of alcohol per week, $SD = 11.97$). The remaining 43 participants detected the change located within the neutral context (the four groups DNC, M Consumption = 10.22 units of alcohol per week, $SD = 11.97$). It would therefore appear that when no differential information regarding the nature of the change is provided by the objects carrying the changes (i.e., when both the target objects are

alcohol-related or both are neutral), that the Consumption of participants who detected the change located within an alcohol context was greater than the Consumption of participants who detected the change located within a neutral context. Furthermore, it would appear that this difference is present, regardless of whether the two targets are alcohol-related, or are neutral.

When the two targets were alcohol-related then participants who detected the change within the alcohol context (the two groups DAC-AA, M Consumption = 19.72 units of alcohol per week, SD = 12.67) reported higher weekly alcohol consumption than those who detected the change within the neutral context (the two groups DNC-AA, M Consumption = 10.40 units of alcohol per week, SD = 8.60). Similarly when the two target objects were neutral, higher alcohol consumption was reported by participants who detected the change located within the context of alcohol-related objects (the two groups DAC-NN, M Consumption = 19.40 units of alcohol per week, SD = 11.46) than those who detected the change located within the context of neutral objects (the two groups ANC-NN, M Consumption = 10.05 units of alcohol per week, SD = 8.88)—see Figure 3.7.4 for a graphical representation of this information.

The following ANOVA formally tests the reliability of the above observations—after the usual square root ($x + 0.5$) transformations were applied. Coefficients of skew (0.574) and kurtosis (-0.495) were appropriately modified to -0.206 and -0.790, respectively, and were within the limits for parametric test use. Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was carried out. This revealed there to be no significant difference between the variances of the groups ($p > .05$).

Analysis of Variance

A 2x2x2 between participants ANOVA was used in which Factor 1 represented Location of Context within which the change was detected and had two levels, left, L, and right, R. Factor 2 represented the Context within which the change was detected and had two levels, alcohol context, AC, and neutral context,

NC. Factor 3 represented the Type of Targets and had two levels, two alcohol-related target objects, AA, and two target neutral objects, NN. The dependent variable, Consumption, was the self-reported number of U.K. alcohol units consumed in the week prior to testing.

The main hypothesis (Hypothesis 3.7.1) predicted that mean number of alcohol units consumed in the previous week would be higher in participants who detected the change located in the context of alcohol-related objects (the four Groups AC, transformed $M = 4.21$; raw $M = 19.57$) than in the participants who detected the change located within the neutral context (the four Groups NC, transformed $M = 2.95$; raw $M = 10.22$).

Hypothesis 3.7.1 was supported—there was a main effect for Context within which the change was Detected ($F(1, 79) = 15.512, p < .05$). Neither the main effect of Location of Context ($F(1,79) = 0.621, p > .05$) nor the main effect of Type of Targets ($F(1,79) = 0.027, p > .05$) reached significance. Similarly, none of the 2 way interactions and the 3 way interaction did not reach significance. Full details of the ANOVA are provided in the summary table (Table 3.7.1).

Effect Sizes

An effect size was calculated to examine the mean difference in weekly Consumption between participants who detected change located within the context of alcohol-related objects (the four groups AC, $n = 44$, transformed $M = 4.21, SD = 1.56$; raw $M = 19.57, SD = 11.97$) and those who detected the change located within the context of neutral objects (the four groups NC, $n = 43$, transformed $M = 2.95, SD = 1.43$; raw $M = 10.22, SD = 11.97$). According to Cohen's (1992) scheme this produced a "large" effect size, ($d = 0.84$). Furthermore, neither the 95% confidence limits (0.39 and 1.27) nor the 99% confidence limits (0.25 and 1.41) of d include zero, showing the measure to be reliable at both levels.

Although in the ANOVA the main effect of Type of Targets and all interactions involving this factor failed to reach significance, showing there to be no difference in effect whether the targets were both alcohol-related (AA) or neutral

(NN) independent effect size calculations were nonetheless carried out to examine the mean difference in Consumption between those who detected the change located in the alcohol context, when the two targets were alcohol-related (i.e., the two Groups DAC-AA, $n = 23$, transformed $M = 4.22$, $SD = 1.6$; raw $M = 19.72$, $SD = 12.67$) and those who detected the change located in the neutral context and the two target objects were alcohol-related (i.e., the two Groups DNC-AA, $n = 21$, transformed $M = 3.05$, $SD = 1.29$; raw $M = 10.40$, $SD = 8.60$). This revealed a “large” effect size, $d = 0.80$. The 95% confidence limits (0.17 and 1.40) did not include zero, showing the reliability of the measure. Similarly, a “large” effect size ($d = 0.85$) shown for the mean difference in Consumption between participants who detected the change set in the alcohol context when the two target objects were neutral (the two Groups DAC-NN, $n = 21$, transformed $M = 4.2$, $SD = 1.55$; raw $M = 19.40$, $SD = 11.46$) and that of participants who detected the change when it was located within the alcohol context and the two target objects were neutral (the two Groups DNC-NN, $n = 22$, transformed $M = 2.86$, $SD = 1.58$; raw $M = 10.05$, $SD = 8.88$). Neither the 95% confidence limits (0.21 and 1.46) nor the 99% confidence limits (0.02 and 1.66) include zero, showing the reliability of measure at both levels.

Summary of Results

The changes referred to below are changes implemented as object rotation.

Hypothesis 3.7.1 Mean Consumption will be higher in participants who detect the change located within a context of alcohol-related objects than in participants who detect the change within a context of neutral objects. This was supported. Furthermore, it was supported regardless of whether the two target objects were both alcohol-related or both neutral.

Hypothesis 3.7.2 The effect size of the mean difference in weekly Consumption between those who detected the change located in the context of alcohol-related objects and those who detected the change located within the context of neutral objects will be significant—in favour of the former group of participants. This was supported—a “large” and reliable effect size was found. The effect size

was also found to be “large” and reliable when examining the same difference when the two target objects were both alcohol-related, and independently, when the two target object were both neutral.

Experiment 8 Social drinkers’ detection of alcohol-related and neutral changes manifest as object replacement: testing for context effects with identical targets and different contexts.

Pictorial Experiment 8 was designed to further test the hypothesis that when two identical target objects were employed that the context within which these were set would be responsible for change detection and that this would result in the mean alcohol consumption of individuals who detect the change within a context of alcohol-related objects being higher than that of individuals who detect the change within a neutral context.

In common with previous sets of experiments, Experiments 7 and 8 were identical to each other except that while the changes were made to the target objects by rotating them in Experiment 7, in Experiment 8 the changes were implemented by replacing the target objects with new objects. This is described below.

Method

Participants

Participants were recruited by approaching people across the university campus and asking them to take part in a short experiment. One hundred and ten agreed (51 males, 59 females; *Mdn* age = 20 years, quartile range = 4.0, range = 18-22). The same exclusion criteria as previously employed, were used to in this experiment. A full explanation of the exclusion criteria is found in Experiment 1. After the exclusion criteria were applied, there remained 67 (31 males, 36 females; *Mdn* age = 21 years, quartile range = 4.0, range =17-34) were included in the analyses of Experiment 8.

Paradigm

An identical flicker ICB paradigm (Rensink et al., 1997) as was used in earlier experiments was employed in Experiment 8. This involved the presentation of an Original Stimulus, OS, for 400 msec, followed immediately by a Mask, M, comprising a matrix of Xs, for 200 msec. The Changed Stimulus, CS, was then displayed for 400 msec, followed by the same mask, M, again for 200 msec. This cycle was repeated until the participant detected a change. Full details of the paradigm are provided in the Paradigm section of Experiment 1 and the paradigm is presented graphically in Figure 2.1.1. The OS and CS used in Experiment 8 are described below.

Design

A 2x2x2x2 between participants design was employed in Experiment 8—equivalent to Experiment 7. Factor 1 represented Location of Context and had two levels, one in which the alcohol context was located on the left of the display and the neutral context on the right, ALNR, and the other in which the neutral context was located on the left of the display and the alcohol context on the right, NLAR. Note that the nomenclature in relation to the levels of this factor is the same as for Experiment 7 but different from earlier experiments (this was described in Experiment 7). The second factor was the Type of Identical Targets with levels alcohol-related and alcohol-related (AA) and neutral and neutral (NN). Factors 1 and 2 were used to assign participants to groups prior to testing to achieve full counterbalancing. Factor 2 was used in the analysis but Factor 1 was not used in the analysis. Factor 3 was the Context within which the Change was Detected and had two levels—change detected in the alcohol context, DAC, and change detected in the neutral context, DNC. Factor 4 represented the Location of Change Detected and had two levels, left, L and right, R. This design is shown graphically in Figure 3.4.1. The dependent variable used in analyses was Consumption, which represented the self-reported total number of U.K. alcohol units consumed in the previous week.

Similar to earlier experiments, and identical to Experiment 7, participants were allocated to one of the two levels of each of the factors, Location of Context and Type of Targets, on entry to the experiment, thus allowing equal participant numbers in each of these groups. Because of the retrospective allocation to one of the two levels of each of the two factors, Context within which the Change was Detected and Location of Change Detected, for analysis, the numbers in each level of these two factors could not be controlled. The design of Experiment 8 is shown graphically in Figure 3.8.1.

Stimuli

The Original Stimulus, OS, and Changed Stimulus, CS, were created using the pool of Stimulus pairs used in Experiment 2 (see Figures 2.1.3 and 2.2.4).

Constructing the four Original Stimuli, OS.

The four Original Stimuli, OS, were identical to those used in Experiment 7 (see Figure 3.7.3) and are described in Figure 3.8.2. A 3x3 A matrix was positioned to one side of the centre and 3x3 N matrix to the other, but instead of having an alcohol-related target object at the centre of the 3x3 A matrix (the alcohol context) and likewise, a neutral “target” object at the centre of the 3x3 n matrix (the neutral context) as in most earlier experiments the same target object was placed in the centre of both the alcohol and neutral contexts so that either both target objects were alcohol-related, or both target objects were neutral. This meant that unlike Experiments 1 to 6, but as in Experiment 7, no differential information could be obtained from the actual target objects themselves. The four CS are described below.

Constructing the four Changed Stimuli, CS.

The Changed Stimuli (CS) of Experiment 8 were constructed in an identical way to the CS of Experiment 2—namely by replacing the target object of the four OS with other objects.

Apparatus and Proforma

The paradigm was run using Psyscope v1.2.5 (Cohen et al., 1993) on an Apple G3 PowerBook (OS 9.1). Consumption and demographic information was obtained via the same alcohol timeline followback (TLFB), based on Sobell and Sobell (1992) as used in previous experiments. This is shown in Figure 2.1.6. and full details of the apparatus and proforma are available in the Apparatus and Proforma section of Experiment 1.

Procedure

An identical procedure to that of previous experiments was employed in Experiment 8. In brief, participants were recruited and taken to quiet testing places throughout the campus, where they were provided with instructions and following their agreement to participate, were given instructions. They were then given the flicker ICB task and when it was completed they were asked to provide consumption and demographic information using the TLFB (full details of which are provided in the Procedure section of Experiment 1). All procedures were approved by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committees).

Results

Sixty-seven of the 110 participants who were tested provided suitable data for inclusion in the analyses of Experiment 8. Of those rejected, 38 reported that their previous week's drinking was atypical, 1 had consumed alcohol on the day of testing, 1 had previously participated in a similar study and 3 incorrectly detected the change.

It was predicted by the principle hypothesis (Hypothesis 3.8.1) that mean weekly alcohol Consumption would be higher for participants who detected the change when it was located within a context of alcohol-related objects (the four Groups DAC) than for participants who detected the change when it was located within a context of neutral objects (the four Groups DNC). This prediction was

based on the mixed findings of Experiments 5 and 6 which suggest that the context may be important for driving change detection and on the results of Experiment 7, which supported the hypothesis that in the absence of any differential information being available from the target objects themselves, that change detection would be context driven.

Of the 67 participants who provided suitable data, 38 detected the change when it was located in the context of alcohol-related objects (the four Groups DAC, M Consumption = 15.97 units of alcohol per week, SD = 13.1). Of these, 23 detected the change when the two target objects were alcohol-related (the two Groups DAC-AA, M Consumption = 16.93 units of alcohol per week, SD = 13.41) and 15 detected the change when both the targets were neutral (the two Groups DAC-NN, M Consumption = 14.5 units of alcohol per week, SD = 13.13). The remaining 29 participants detected the change when it was located within the context of neutral objects (the four Groups ACD, M Consumption = 9.33 units of alcohol per week, SD = 8.53). Of these 13 detected the change when both target objects were neutral (the two Groups DNC-NN, M Consumption = 7.42 units of alcohol per week, SD = 6.7) and 16 detected it when the two target objects were neutral (the two Groups DNC-NN, M Consumption = 10.88 units of alcohol per week, SD = 9.7). This information is presented graphically in Figure 3.8.3. It would therefore appear that as predicted by Hypothesis 3.8.1 participants who detected the change when it was located within a context of alcohol-related objects reported higher Consumption than those who detected the change when it was located in a context of neutral objects. Furthermore, it would appear that this pattern is present regardless of whether both the target objects are alcohol-related or are neutral. These observations are formally assessed below. Prior to these analyses, the usual square root ($x + 0.5$) transformations were applied for the identical reasons described in earlier experiments. Coefficients of skew (1.45) and kurtosis (2.014) were appropriately modified to 0.329 and -0.097 respectively, and were within the -1 to $+1$ limits for parametric test use. Bartlett's test for homogeneity of variance (Snedecor &

Cochran, 1989) was then carried out. This revealed there to be no significant difference between the variances of the groups ($p > .05$).

Analysis of Variance

A 2x2x2 between participants ANOVA was carried out. Factor 1 was Location of Contexts (2 levels, alcohol context on the left and neutral context on the right, ALNR, and neutral context on the left and alcohol context on the right, NLAR). Factor 2 was the Context within which the Change was Detected (2 levels, change detected in the alcohol context, DAC, and change detected in the neutral context, CDN). Factor 3 was Type of Targets (2 levels, two alcohol-related targets, AA, and two neutral targets, NN).

The main hypothesis (Hypothesis 3.8.1) was that mean weekly self reported alcohol Consumption would be higher in participants who detected the change when it was located in the alcohol-related context than in participants who detected the change when it was located in a neutral context.

The main hypothesis was supported—there was a significant main effect for Context ($F(1, 59) = 6.210, p < .05$) showing the mean weekly alcohol Consumption of participants who detected a change when it was located within a context of alcohol-related objects (the four Groups DAC, transformed $M = 3.74$; raw $M = 15.97$ units) to be reliably higher than that of participants who detected the a change when it was located within a context of neutral objects (the four Groups DNC, transformed $M = 2.82$; raw $M = 9.32$ units). Neither the main effect of Location of Change Detected ($F(1, 59) = 0.102, p > .5$) nor the main effect of Type of Targets ($F(1, 59) = 0.003, p > .05$) reached significance and none of the 2-way interactions including Context within which the Change was Detected were significant and neither was the 3-way interaction. The Analysis of Variance Summary table is provided in Table 3.8.1.

Effect Sizes

An effect size was calculated to investigate the size of the mean difference between participants who detected the change when it was located within a context

of alcohol-related objects (the four Groups DAC, $n = 38$, transformed M Consumption = 3.74 units, $SD = 1.6$; raw M Consumption = 15.97 units, $SD = 13.1$) and participants who detected the change when it was located with a context of neutral objects (the four Groups DNC, $n = 29$, M transformed Consumption = 2.82 units, $SD = 1.44$; M raw Consumption = 9.32 units, $SD = 8.53$). According to the Cohen's (1992) scheme a "medium" effect size, $d = 0.61$, was obtained. The 95% confidence limits of d (0.10 and 1.10) did not include zero, indicating its reliability at this level of significance.

Individual effect sizes were also calculated to investigate the mean difference between participants who detected the change when it was located within the context of alcohol-related objects and those who detected the change when it was located within the context of neutral objects when both target objects were alcohol-related (i.e., between two Groups DAC-AA, $n = 23$, transformed M Consumption = 3.87 units, $SD = 1.59$; raw M Consumption = 16.93 units, $SD = 13.41$ and the two Groups DNC-AA, $n = 13$, transformed M Consumption = 2.57 units, $SD = 1.24$; raw M Consumption = 7.42 units, $SD = 6.7$) and also, independently, for the mean difference when both target objects were neutral (i.e., between the two Groups DAC-NN, $n = 15$, transformed M Consumption = 3.53 units, $SD = 1.65$; raw M Consumption = 14.5 units, $SD = 13.13$ and the two Groups DNC-NN, $n = 16$, transformed M Consumption = 3.01 units, $SD = 1.57$; raw M Consumption = 10.88 units, $SD = 9.7$).

When the two target objects were alcohol-related, the effect size for the difference in weekly Consumption between participants who detected the change when it was located within an alcohol context (the two Groups DAC-AA) and those who detected the change when it was located with a neutral context (the two Groups DNC-AA) was "large", $d = 0.88$. The 95% confidence limits of d (0.14 and 1.59) did not include zero, indicating the measure to be reliable. When both the target objects were neutral however, the effect size for the difference in Consumption between participants who detected the change in the alcohol context (the two Groups DAC-NN) and those who detected the change in when the context was neutral (the

two Groups DNC-NN) was “small” $d = 0.32$, and not reliable (95% Confidence Limits of d were -0.39 and 1.02).

Summary of Results

The changes referred to below are changes implemented as object replacement.

Hypothesis 3.8.1 Participants who detected the change in when it was located within a context of alcohol-related objects would report higher weekly alcohol Consumption than those who detected the change in a neutral context. This was supported.

Hypothesis 3.8.2 There would be a significant effect size for the mean difference in the weekly number of alcohol units consumed between participants who detected the change when it was located in a context of alcohol-related objects and those who detected the change when it was located within a context of neutral objects. This was supported. It was also supported when investigating the same difference when both targets were alcohol-related and, independently, when both target objects were neutral.

Preliminary Discussion

Experiments 7 and 8 were identical to each other, except that while in Experiment 7 the changes were implemented by rotating the target objects on their vertical axes (i.e., by using the same method as used in Experiment 1), in Experiment 8 the changes were implemented by replacing the target objects with new objects which were similar in shape size and colour (i.e., by using the same method, and indeed the same actual objects, as used in Experiment 2). Both Experiments 7 and 8 provide consistent evidence from the analysis of variance and effect size calculations that when differential information is not contained in the targeted, information from the context drives the differential AAB. This does suggest that the (implicit or explicit) process that underpins the behaviour from which differential AAB is inferred involves, first, the orientation towards the context

(not the target) and, subsequently, the detection of the target change while oriented towards that target's area. Heavier drinkers appear to orient towards the alcohol-related context and then detect whatever change is embedded therein, whilst lighter drinkers do not orient in this way.

To recapitulate: In Chapter 2's pictorial Experiments 1 to 4, heavier drinking participants appear to be biased towards alcohol-related objects while lighter drinkers do not. It is unclear, however, whether it is the context that drives the bias or the changing object constituting the target. Textual Experiment A suggests that it might be the context—at least with words as stimuli. In Chapter 3's pictorial Experiments 5 and 6, it was expected that it would become clear which of these two potential sources of information drive AAB. These were opposite context experiments in which the sources of information were put in opposition. In one experiment it was shown that the context was doing the driving but in the other experiment it did not. In the latter experiment, however, not only was the outcome inconsistent with the first experiment which showed that the context was important, there was a complete failure to find any AAB. Consequently, some limited evidence from Experiments 5 and 6 suggests that the context might be important in driving the AAB.

Experiments 7 and 8 also seek to explore whether the targets or the context drive the differential alcohol-related attentional but in circumstances different from Experiments 5 and 6. Whereas in Experiments 5 and 6, target and context information were put in opposition and the test was to determine which source was predominant when both were present (but opposing), in Experiments 7 and 8 the differential target information was simply removed and the test was to see whether changes would be detected only through context information and if they were whether AAB remained. Both Experiments 7 and 8 generated differential AAB behaviour which was in the presence of only context information.

In Experiments 1 to 4, target and context information were congruent with respect to type and location and a differential AAB was consistently found with respect to heavier over lighter drinkers. In Experiments 5 and 6 the finding was

inconsistent when the target and context information was in opposition—one experiment produced results consistent with the context driving the differential AAB while the other showed no bias at all. In other words, some very limited evidence was in favour of context. In Experiments 7 and 8, it was consistently found that the differential AAB was driven by the context. This was, however, in the absence of differential target information. Experiment 9 was designed to see whether in the absence of differential context information, differential target information could be used to elicit a differential AAB. This experiment is described below—after the following consumption check.

Subsidiary combined analysis of Experiments 7 and 8

Similar to each of the pairs of Experiments 1 and 2, 3 and 4, and 5 and 6 a combined analysis of Experiments 7 and 8 was performed to investigate any difference in total weekly Consumption between the two Experiments. Although the overall purpose of the combined analysis of Experiments 7 and 8 was identical to that of previous combined analyses—i.e., to test for any difference in overall Consumption between the two Experiments—the method of doing so was slightly different. While in each of the previous six experiments the main ANOVA comprised a 2x2 design (i.e., had two factors), the main ANOVA in Experiments 7 and 8 had 3. This meant that in previous when a combined analysis was performed in which Experiment was included as a factor, e.g., for Experiments 1 and 2, the design of this combined analysis was a 2x2x2. For experiments 7 and 8, however, if the same procedure is adopted to test for any difference in Consumption between Experiment 7 and Experiment 8, this would result in a four factor ANOVA (2x2x2x2). Due to the difficulties in interpreting 4 way interactions it was decided to remove a factor from the combined analysis. The factor that was chosen was Location of Contexts within which the change was detected. This was chosen for two reasons—first, in both individual ANOVAs of Experiments 7 and 8 this factor failed to reach significance and second throughout the entire series of experiments this was also the case.

Consequently a 3 way ANOVA was performed in which factor 1 represented Experiment and had two levels, Experiment 7 and Experiment 8, factor 2 represented Context within which the change was detected and had two levels alcohol context, DAC and neutral context, DNC. The third factor was Type of targets, AA, and also had two levels, two alcohol-related target objects and two neutral target objects, NN. It was predicted that, similar to each of the individual ANOVAs of Experiment 7 and Experiment 8 in which there was a main effect of Context within which the change was detected that this would still be present in the combined analysis. As predicted, the main effect of Context within which the change was detected reached significance ($F(1, 146) = 18.675, p < .05$). Similarly as in both individual ANOVAs there was no effect of Type of targets, AA, or NN, it was predicted that the main effect of Type of targets in the combined analysis would be consistent with this. This was shown ($F(1, 146) = 0.013, p > .05$).

The main purpose of the analysis was, however, to investigate any difference in Consumption between Experiment 7 (raw M Consumption = 14.95 units; transformed M Consumption = 3.59 units) and Experiment 8 (raw M Consumption = 13.10; transformed M = 3.34 units). Neither the main effect of Experiment ($F(1, 146) = 1.767, p > .05$) nor any of the interactions reached significance showing there to be no difference in overall Consumption between the two Experiments and suggesting that any differences between Experiment 7 and 8 were as a result of something other than a difference in overall Consumption between the two Experiments. The Analysis of Variance Summary table for this analysis is provided in Table 3.8.2.

Experiment 9 Social drinkers' detection of alcohol-related and neutral changes manifest as object rotations: testing for target effects with different targets and the same contexts.

Pictorial Experiment 9 was designed to examine whether, when all differential information was removed from the context (i.e., the overall 6x3 matrix) the information provided from the target objects would be sufficient to elicit an

AAB. To test this three homogenous contexts were created—one comprising entirely alcohol-related objects, one entirely neutral, and one which contained an equal number alcohol-related and neutral objects to each side of the centre (these are fully explained in the Stimulus section of Experiment 9). The same target objects as used in Experiment 1 were then positioned within these homogenous contexts and, identical to Experiment 1, the changes to these targets were implemented by simultaneously rotating them. It was hypothesized that in the absence of any differential information from the context that change detection would be driven by the target objects and this would result in higher reported weekly alcohol consumption in participants who detected the alcohol-related change than in participants who detected the neutral change.

Method

Participants

One hundred and fifty people were recruited from public places throughout the campus and taken to quiet testing places. They were then allocated to one of the six testing groups to be described below. Of the 150 people who were tested (78 males, 62 females; *Mdn* age = 20 years, quartile range = 2, range = 18-48) 54 were excluded from analyses as they did not fulfill the requirements of the study. Participants were excluded if they had, for example, consumed alcohol on the day of testing, had previously participated in a similar study, had previously been treated for alcohol problems, reported that their previous week's alcohol consumption was not typical, or incorrectly detected the change. The remaining 96 were included in the analyses of Experiment 9 (51 males, 46 females; *Mdn* age = 20 years, quartile range = 2, range = 18-36). Full details of the participants excluded from the analyses of Experiment 9 are located in the Results section.

Paradigm

The same flicker ICB paradigm (Rensink et al., 1997) as used in previous experiments was employed in Experiment 9—an original stimulus, OS, was

presented for 400 msec, followed by a mask, M, comprising a matrix of Xs for 200 msec, followed by a changed stimulus, CS, for 400 msec, followed by a representation of the mask, M, again for 200 msec. This OS-M-CS-M cycle was repeated until a change was detected. The OS and CS are described in the Stimulus section below, and the full details of the paradigm are provided in the Paradigm section of Experiment 1, and graphically in Figure 2.1.1.

Design

Experiment 9 comprised a 2x2x2x3 between participants factorial design in which factor 1 represented Location of Changes to be detected and had 2 levels—one in which the alcohol-related change was located on the left and the neutral change on the right, ALNR, and the other in which the neutral change was located on the left and the alcohol-related change on the right, NLAR. As in previous experiments this factor was included to control for any possible effect of a leftwards bias. Factor 2 represented the Type of Context and had three levels- Alcohol Context, AC, in which all objects in the context were alcohol-related, Neutral Context, NC, in which all objects in the context were neutral and Mixed Context, MC, in which the context comprised a mix of alcohol-related and neutral objects (full details of the three different contexts and their construction are located in the stimulus section). Factor 3 represented the Change Detected, and had two levels—Alcohol-related change Detected, ACD, and Neutral Change Detected, NCD. Factor 4 represented the Location of Change Detected and had 2 levels, change detected on the left, L, and change detected on the right, R. As with previous experiments because each participant's response determined which level of certain factors they belonged to it was impossible to allocate participants to the appropriate level of certain factors until they had completed the task. In the current experiment this meant that participants were assigned to one of the two levels of factor 1 and one of the three levels of factor 4 on entry to the study and then retrospectively assigned to one of the two levels of each of the factors 2 and 3 based on the change that they detected and its location within the stimulus matrix. As a result, while the numbers

in each of the levels of factors 1 and 4 could be controlled, there was no such control over the numbers in each of the levels of factors 2 and 3. The design of Experiment 9 is shown in Figure 3.9.1.

Although factor 1, Location of changes was included in the design to allow any effect of whether the change was located on the left or the right of the stimulus display (see Chapter 2 for a full discussion of this) it was not included in the analyses as once the participant had been assigned to the appropriate levels of the factors Location of Change Detected and Change Detected, the information provided in Location of changes became redundant. Accordingly the main analysis of Experiment 9 comprised a 2x2x3 between factors design, which included factors 2, 3 and 4.

The dependent variable used in the analysis of Experiment 9 was the self-reported total number of U.K. alcohol units consumed weekly (Consumption).

Stimuli

The same pool of stimuli as used in Experiment 1 (see Figure 2.1.3) was used to create the Original Stimulus and Changed Stimulus in Experiment 9. The layout of these is described below.

Constructing the six Original Stimuli, OS.

Although Experiment 9 used the same stimulus set as previous experiments and the same overall 6x3 landscape matrix layout was employed, the presentation of objects with the 6x3 matrix was quite different—while in previous experiments, (although there were several slight variations—i.e., the opposite context and same target experiments) the overall layout of the OS comprised 3x3 alcohol-related objects to one side of the centre and 3x3 neutral objects to the other, in Experiment 9 an homogenous context was employed in which either all objects in the context were alcohol-related (the Alcohol Context), all were neutral (the Neutral Context) or lastly, a mixture of alcohol-related and neutral objects on both sides of the overall matrix (the Mixed Context). This meant that unlike all previous experiments in which the contexts within which the targets were set provided differential alcohol-

related and neutral information (i.e., one side was alcohol-related and one was one was neutral), by employing an homogenous context in Experiment 9 this differential information was removed making it possible to test whether under these circumstances the information provided from the target objects themselves would be sufficient to elicit an AAB. In removing the differential information 3 different Contexts were created—their OS are described below.

The first OS (which is referred to as the Alcohol Context, AC) comprised a 6x3 landscape matrix which was constructed by taking the 3x3 matrix of alcohol-related objects which was used in the OS of Experiment 1 and using Adobe Illustrator to make a mirror image reflection of this so that a 6x3 landscape matrix was created in which all objects were alcohol-related and in which the 3x3 object to the right were a direct reflection of the 3x3 on the left. This resulted in the objects at the top left and top right of the overall 6x3 matrix, for example, being identical to (but a reflection of) each other and similarly the objects at the bottom left and bottom right were also identical and so on. This provided a 6x3 homogenous matrix in which all objects were alcohol-related and in which the left 3x3 and right 3x3 matrices were an identical reflection of each other, so that no differential information (alcohol, or otherwise could be obtained). The two target objects used in Experiment 1 were employed and were positioned so that the alcohol-related target object—half bottle of whisky—was at the centre of 3x3 matrix on the left and the neutral target object—the cafetière— in the 3x3 matrix to the right. (OS-ALNR-AC). As in previous experiments in case of any leftwards bias, a mirror image reversal of the entire matrix was created do that the neutral target was located a the centre of the 3x3 matrix to the left and the alcohol-related target object at the centre of the 3x3 matrix to the right (OS-NLAR-AC).

The second type of OS (which is referred to as the Neutral Context, NC) was constructed in an identical way to the Alcohol Context OS described above, except that rather than using the 3x3 alcohol matrix from the OS in Experiment 1, the 3x3 neutral matrix was used. Again Adobe Illustrator was used to make mirror image reflection of this 3x3 neutral matrix so that a 6x3 homogenous landscape matrix of

neutral objects was constructed. Again the object at the top left of the 6x3 matrix was identical to that at the top right, the object at the bottom left identical to that at the bottom right, etc. The two target objects from Experiment 1 were again used to carry the changes and the alcohol-related target object was positioned at the centre of the 3x3 neutral matrix to the left of the centre and the neutral target object at the centre of the 3x3 neutral matrix to the right of the centre to create OS-ALNR-NC. A mirror image reversal of this was then created so that the neutral target object was located at the centre of the 3x3 neutral objects to the left of the overall matrix and the alcohol-related target object was located at the centre of the 3x3 matrix of neutral objects to the right, thus creating OS-NLAR-NC.

The third type of OS used in Experiment 9 comprised both alcohol-related and neutral objects and is referred to as the Mixed Context, MC. Although as in both the Alcohol and Neutral Contexts described above the Mixed Context provides an homogenous Context—i.e., no differential information is contained in the context—the actual construction of it was quite different to both the Alcohol and Neutral contexts. Unlike both the Alcohol and Neutral Contexts in which the 3x3 context to the right of the overall matrix was a reflection of that on the left, the Mixed Context was created by mixing the alcohol-related and neutral objects so that, target objects aside, there were an equal number of alcohol-related and neutral objects in the 3x3 matrix to the left of the stimulus matrix and an equal number of alcohol-related and neutral objects in the 3x3 matrix to the right. To minimise any differential information from the physical properties of the objects the stimulus pairs used in previous experiments were employed so that (for example) the alcohol-related object at the top right of the overall 6x3 matrix was paired with its corresponding neutral object which was positioned at the top left of the overall matrix.

This meant that like the Alcohol and Neutral Contexts there was no difference in terms of the overall alcohol-related and neutral properties of the 3x3 matrix to the left of the centre and the 3x3 matrix to the right of the centre of the overall 6x3 matrix. Unlike the Alcohol and Neural Contexts, however, the left and

right sides of the overall 6x3 matrix were not a direct reflection of each other. This meant that within the overall 6x3 matrix there were both alcohol-related and neutral objects, but unlike in previous experiments in which the context comprised both alcohol-related and neutral objects and in which the layout was usually 3x3 predominantly alcohol-related objects located to one side of the centre and 3x3 predominantly neutral objects located to the other, in this Mixed Context, there was an equal number of alcohol-related and neutral objects on each side of the overall 6x3 matrix. Consequently although the context contained both types of stimuli it can still be described as homogenous as no differential information was provided from one side of the matrix as compared with the other. The same target objects as used above (i.e., those used in Experiment 1) were then positioned at the centre of the two 3x3 mixed matrices so that the 3x3 matrix on the left contained the alcohol-related target object and the 3x3 matrix on the right contained the neutral target object to create OS-ALNR-MC. A mirror image reversal of this 6x3 matrix was produced which so that the neutral target object was located at the centre of the mixed 3x3 matrix on the left and the alcohol-related target at the centre of the mixed 3x3 matrix on the right to create OS-NLAR -MC. That meant that both OS-ALNR -MC and OS-NLAR-MC comprised a 6x3 landscape matrix which contained both alcohol-related and neutral objects, but unlike previous experiments in which the matrices comprised one side of alcohol-related objects and one side of neutral objects, in these contexts, target objects aside, and equal number of alcohol-related objects were contained on the left and on the right of the matrix and accordingly the only differential information within the matrix was provided by the target objects themselves.

These were the six homogenous context OS that were used in Experiment 9 – two in which the context comprised alcohol-related objects, two in which the context was made up of neutral objects, two in which the context was mixed. Although, in each of the above pairs of OS are made up of quite different objects they all share the property that target objects aside, none of them provide any alcohol-related/neutral differential information from the context—in both the alcohol-related and neutral

contexts the right side of the matrix is a direct reflection of the left and in the mixed context there are an equal number of alcohol-related and neutral objects on each side of the centre. The OS used in Experiment 9 are presented in Figure 3.9.2.

Constructing the six Changed Stimuli, CS.

As in Experiment 1, the CS were constructed by taking each of the OS and rotating the target objects (the objects at the centre of each of the 3x3 matrices) by 90 degrees on their vertical axes so that in the alcohol-related change the label on the whisky label was changed from facing one side to the other and in the neutral change, the cafetière was also changed from facing one side of the matrix to the other. For each of six OS this meant that in the alcohol-related change the label changed from facing to the left to the right and in the neutral change the cafetière changed from facing the left to the right. These changes were implemented using Adobe Illustrator to create the six homogenous context CS used in Experiment 9. The six CS employed in Experiment 9 are graphically represented in Figure 3.9.3.

Apparatus and Proforma

Identical to previous experiments, the flicker ICB paradigm was implemented using Psyscope v1.2.5 (Cohen et al., 1993) and run on an Apple G3 PowerBook (OS 9.1). Consumption and demographic information was again collected using a modified version of Sobell and Sobell's (1992) timeline followback (TBLF)—a copy of which is provided in Figure 2.1.6. Further information on the Apparatus and Proforma are contained in the Apparatus and Proforma section of Experiment 1.

Procedure

The same procedure as in previous experiments (full details of which are contained in the Procedure section of Experiment 1) was employed in Experiment 9. This involved approaching individuals on the campus of the University of Glasgow and asking them to take part in a short task to investigate any difference in task performance depending whether the task was completed on laptop or desktop computers. Those agreeing to participate were taken to quiet testing places and

given full instructions. Those still willing to take part were given the flicker ICB task and then asked to provide information on their previous week's alcohol consumption and also basic demographic details. They were then fully debriefed and invited to contact the Alcohol Laboratory for results of the study. All procedures were approved by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committees).

Results

The criteria used to exclude participants who did not provide data suitable for analyses in previous experiments was adopted in Experiment 9 (full details are provided in the Results section of Experiment 1). In doing so, 54 of the 150 tested in Experiment 9 were removed. Of these 54, 4 were removed as they had previously taken part in a similar experiment, 3 because they had consumed alcohol on the day of testing, 6 because they incorrectly detected a change and 41 as they reported that their alcohol consumption in the week prior to testing was not typical. The remaining 138 were included in the analyses of Experiment 9.

Of the 96 who provided suitable data for inclusion in the analyses of Experiment 9, 97 detected the alcohol-related change (the six Groups ACD, $M = 21.17$ units per week) and 33 detected the neutral change (the six Groups NCD, $M = 15.53$ units per week).

The main hypothesis under test (Hypothesis 3.9.1) was that self-reported weekly alcohol Consumption would be higher in participants who detect the alcohol-related change than in participants who detected the neutral change. This prediction was made in spite of the findings of Experiments 7 and 8, (both of which suggest that the context was responsible for change detection), as it was hypothesized that in the absence of any differential alcohol or neutral cues (as was the case for each of the homogenous contexts employed in Experiment 9) that the target objects would drive change detection and as a result Consumption would be higher in participants who detected the alcohol-related change than those who detected the neutral change.

It would appear that as predicted the mean weekly Consumption of all participants who detected the alcohol-related change (the six Groups ACD, M Consumption = 21.17 units, SD = 18.44) was greater than that of all participants who detected the neutral change (the six Groups NCD, M Consumption = 15.53 units, SD = 12.25).

Although on recruitment to the study every attempt was made to randomly allocate participants to each of the 3 levels of Type of Context (Alcohol, Neutral and Mixed), and therefore it was predicted that there would be no difference in Consumption between the three different contexts, they were nonetheless examined, first, to investigate whether there was any difference in overall Consumption, between the three types of context and second whether was any interaction between Type of Context and Change Detected.

Of the 96 people providing suitable data, 32 did so when the context was entirely alcohol-related, 36 when the context was entirely neutral and 28 when the context was mixed. When the context was alcohol-related 20 detected the alcohol-related change (the two Groups ACD-AC, M = 15.65, SD = 12.74) and 12 detected the neutral change (the two Groups NCD-AC, M = 19.96, SD = 13.22). When the context neutral 24 detected the alcohol-related change (the two Groups ACD-NC, M = 22.29, SD = 17.58) and 12 detected the neutral change (the two Groups NCD-NC, M = 14, SD = 10.21). Finally, when the Context was mixed the alcohol-related change was detected by 19 (the two Groups ACD-MC, M = 25.55, SD = 23.44) and the neutral change by 9 (the two Groups NCD-MC, M = 11.67, SD = 12.9). It would therefore appear that as predicted, participants who detected the alcohol-related change reported higher levels of Consumption than those who detected the neutral change, but only when the context was Neutral or Mixed. It would appear that when the Context was alcohol-related, however, that Consumption was higher in participants who detected the neutral change than for those who detected the alcohol-related change. This information is provided in Figure 3.9.4.

A three factor Analysis of Variance was run to formally test these observations. In common with earlier experiments, a square root ($x + 0.5$)

transformation was applied prior to analyses through which the unsatisfactory coefficients of skew and kurtosis (1.262 and -1.990 , respectively) became satisfactorily (0.019 and -0.390 respectively) within the -1 to $+1$ limits recommended for parametric analysis. Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was then carried out. This revealed there to be no significant difference between the variances of the groups ($p > .05$).

Analysis of Variance

A $2 \times 2 \times 3$ totally between participants ANOVA was used in which factor 1 was Location of Change Detected and had two levels (one in change detected was located on the left or the stimulus display, L, and the other in which the change detected was located on the right, R). The second factor, Change Detected also had two levels (Alcohol-related change Detected, ACD, and Neutral Change Detected, NCD). The third factor, Type of Context, had three levels (Alcohol Context, AC, Neutral Context, NC, and Mixed Context, MC). A full explanation of each of these Contexts is provided in the Stimulus section and graphical representations can be found in Figures 3.9.2. The dependent variable, Consumption was the self-reported number of U.K. alcohol units consumed in the week prior to testing (as measured by the TLFB).

The main hypothesis (Hypothesis 3.9.1) predicted that the self reported mean number of alcohol units consumed in the previous week to be higher in participants who detected the alcohol-related change than in participants who detected the neutral change. Hypothesis 3.9.1 was not supported—although as predicted mean Consumption for participants who detected the alcohol-related change (the three groups ACD, transformed $M = 4.17$ units; raw $M = 21.17$ units) was directionally larger than the mean consumption of those who detected the neutral change (the 3 groups NCD, transformed $M = 3.57$ units; raw $M = 15.53$ units) it failed to reach significance ($F(1, 84) = 2.197, p > .05$).

As expected neither the main effect of Location of Change ($F(1, 84) = 0.034$, $p > .05$) nor the main effect of Type of Context ($F(2, 84) = 0.294$, $p > .05$) reached significance and neither did any of the 2 way, or the 3 way interactions.

The full Analysis of Variance Summary table is provided in table 3.9.1

Effect Sizes

An effect size calculation was carried out to investigate the mean difference in Consumption between all participants who detected the alcohol-related change and all who detected the neutral change in Experiment 9. It was predicted (Hypothesis 3.9.2) that the effect size for the mean difference between those who detected the alcohol-related change the six Groups ACD, $n = 63$, transformed M Consumption = 4.16 units, $SD = 2.09$; raw M Consumption = 21.17 units, $SD = 18.44$) and those who detected the neutral change (the six Groups NCD, $n = 33$, transformed M Consumption = 3.57 units, $SD = 1.84$; raw M Consumption = 15.53 units, $SD = 12.25$) would be reliable. Hypothesis 3.9.2 was not supported—a “small” effect size ($d = 0.30$) according to Cohen’s 1992 scheme was shown. It was, however, not found to be reliable as the 95% confidence limits of d included zero (-0.13 and 0.72).

Although the overall effect size was not found to be reliable, individual effect sizes were calculated for the mean difference in Consumption between participants who detected the alcohol-related change and those who detected the neutral change in each of the three different Contexts (Alcohol, Neutral and Mixed). Again it was predicted that the effect size for the mean difference in Consumption between participants who detected the alcohol-related change and those who detected the neutral change for each of the different contexts would be reliable. When the context was alcohol-related, the effect size for the mean difference in Consumption between participants who detected the alcohol-related change, (the two Groups ACD-AC, $n = 20$, transformed M Consumption = 3.62 units, $SD = 1.79$; raw M Consumption 15.65 = units, $SD = 12.74$) and those who detected the neutral change (the two Groups NCD-AC, $n = 12$, transformed M Consumption = 4.23 units, $SD =$

1.67; raw M Consumption = 19.96 units, $SD = 13.22$) was in the opposite direction than the overall effect size (i.e., Consumption was higher for participants who detected the neutral change than those who detected the alcohol-related change). Furthermore it was found to be “small” ($d = -0.35$) and unreliable (the 95% confidence limits of d were -1.06 and 0.38)

When the context was Neutral, the effect size for the mean difference in Consumption between participants who detected the alcohol-related change (the two Groups ACD-NC, $n = 24$, transformed M Consumption = 4.34 units, $SD = 2.02$; raw M Consumption = 22.29 units, $SD = 17.58$) and those who detected the neutral change (the two Groups NCD-NC, $n = 12$, transformed M Consumption = 3.42 units, $SD = 1.76$; raw M Consumption = 14 units, $SD = 10.22$) was “small” ($d = 0.48$) but the 95% confidence limits of d (-0.23 and 1.17) showed the measure to be unreliable.

Finally the effect size for the mean difference in Consumption between participants who detected the alcohol-related change when the context was Mixed (the two Groups ACD-MC, $n = 19$, transformed M Consumption = 4.52 units, $SD = 2.44$; raw M Consumption = 25.55 units, $SD = 23.44$) and those who detected the neutral change when the context was mixed (the two Groups NCD-MC, $n = 9$, transformed M Consumption = 2.9 units, $SD = 2.06$; raw M Consumption = 11.67 units, $SD = 12.90$) was found to be “medium” ($d = 0.7$ but again the 95% confidence limits of d (-0.14 and 1.49) showed that this was not a reliable measure.

Summary of Results

The changes referred to below are changes implemented as object rotation.

Hypothesis 3.9.1 Mean Consumption will be higher in participants who detect the neutral change than in participants who detect the alcohol-related change. This was not supported

Hypothesis 3.9.2 The effect size for the mean difference between the Consumption of participants who detected the alcohol and the Consumption of those who detected the neutral change would be significant. This was not supported.

Neither was it supported when examining the same mean difference for each of the three different contexts (Alcohol, Neutral and Mixed) independently.

Preliminary Discussion

It would therefore appear that when an alcohol-related and a neutral change are simultaneously made within an homogenous context (in other words a context which provides no differential information) there is no evidence of an AAB. In other words, there is insufficient differential information in the target stimuli to drive an AAB when there is no differential information available elsewhere (i.e., the context).

It should be noted, however, that in Experiments 5 and 6 (the opposite context experiments) the hypothesis was not supported when the changes were implemented through object rotation—i.e., in Experiment 5—but was supported when the changes were implemented through object replacement—i.e., Experiment 6—which might suggest that object replacement to be a more suitable method of eliciting an AAB in heavier over lighter social drinkers. This is investigated in Experiment 10 and is reported below.

Experiment 10 Social drinkers' detection of alcohol-related and neutral changes manifest as object replacements: testing for target effects with different targets and the same contexts.

Pictorial Experiment 10 was designed to further examine the failure to find an AAB between lighter and heavier drinkers in Experiment 9. This was done by employing the same overall design—i.e., an homogenous context containing a simultaneously alcohol-related and neutral change. The only difference between Experiments 9 and 10 was that while in Experiment 9 these change were made by rotating the target objects (as in Experiment 1), in Experiment 10 the changes were implemented by simultaneously replacing the target objects (as in Experiment 2). As in Experiment 9, it was hypothesized that when all differential alcohol-related

and neutral information was removed from the context within which the changes occurred, that the target objects would be responsible for change detection. There might be stronger grounds for predicting that an AAB might be found in Experiment 10 than in 9, because there is some evidence from earlier experiments that a change implemented by replacement is more sensitive to the alcohol effects than a change implemented by rotation.

Method

Participants

One hundred and fifty people (62 males, 88 females; *Mdn* age = 20 years, quartile range = 1, range = 17-52) were recruited from public places throughout the university campus to take part in Experiment 10. Of the 150 who were tested, 87, (37 males, 56 females; *Mdn* age = 20 years, quartile range = 1, range = 17-52) provided data which was suitable for inclusion in the analyses. Details of the number of participants excluded and the reasons for their exclusion are included in the Results section.

Paradigm

An identical flicker ICB paradigm (Rensink et al., 1997) to that of previous experiments was used in Experiment 10 in which an Original Stimulus, OS, was presented for 400 msec, followed by a mask, M, for 200 msec, followed by a changed stimulus, CS, for 400 msec and finally by the same mask, M, again for 200 msec. This cycle was repeated until the participant detected a change. Full paradigm details are contained in the Paradigm section of Experiment 1 and in Figure 2.1.1 and the six OS and CS are described below.

Design

The design of Experiment 10 was identical to that of Experiment 9 in which there were 4 between participants factors. Factor 1 represented the Location of Changes and had 2 levels—alcohol-related change located on the right and neutral change on the left, ALNR, and neutral change located on the right and alcohol-

related change on the left, NLAR. Factor 2 represented the Type of Change Detected and also had two levels—alcohol-related change detected, ACD, and neutral change detected, NCD. The third factor, Type of Context, had three levels—alcohol context, AC, neutral context, NC, and mixed context, MC. Finally, the fourth factor represented the Location of Change Detected and two levels, change detected on the left, L and change detected on the right, R.

As in previous Experiments it was only possible to assign participants to specific levels of certain factors (namely Location of changes, and Type of Context) prior to testing. Assignment to the appropriate levels of the remaining two factors (Location of Change Detected and Change Detected) was based on the response provided by the participant and therefore could not be determined until the task had been completed. This meant that while the numbers in each of the levels of location of Changes and Type of contexts could be equalised, the number in each of the levels of Change Detected and Location of Change Detected could not. The design of Experiment 10 is graphically presented in Figure 3.10.1.

Stimuli

The set of stimulus pairs employed in Experiment 1 was used to create the six Original and six Changed stimuli in Experiment 10. These are shown in Figure 2.1.3.

Constructing the six Original Stimuli, OS.

The six Original Stimuli, OS, were identical to those used in Experiment 9 and are described fully in the Stimuli section of Experiment 9. OS-ALNR-AC represented the Alcohol Context OS in which the context was entirely alcohol-related and the alcohol-related change was located to the left of the stimulus matrix and the neutral change to the right. OS-NLAR -AC was the mirror image reversal of this, in which the context was alcohol-related and the neutral target was located on the left and the neutral target on the right. Similarly OS-ALNR -NC describes the Neutral Context OS in which the context was entirely neutral and the alcohol-related change was located to the left and the neutral change to the right of

the stimulus matrix and OS-NLAR-NC was the mirror image reversal of that in which the context was neutral and the neutral change was located to the left of the stimulus matrix and the neutral change to the right. Finally for the Mixed Context, OS-ALNR-MC was the OS in which the context was mixed and the alcohol-related change was located on the left of the stimulus matrix and the neutral change to the right and OS-NLAR -MC was the mirror image reversal of that in which the neutral change was located on the left of the stimulus matrix and the alcohol-related change on the right. These are presented graphically in figure 3.10.2.

Constructing the six Changed Stimuli, CS.

The six Changed Stimuli, CS, in Experiment 10 were created in the same way as those of Experiment 2, in which Adobe Illustrator was used to simultaneously replace both the alcohol-related and neutral target objects of the OS. The objects used in Experiment 2 to carry the changes were employed in Experiment 10 so that the whisky bottle (the alcohol-related change) was replaced with a hip flask, and the cafetière (the neutral change) was replaced with a personal stereo. These are both shown in Figure 2.1.3 of Chapter 2. These changes were implemented to each of the six OS to create the six ‘same context’ changed stimuli, CS. (CS-ALNR -AC, CS-NLAR -AC, CS -ALNR -NC, CS-NLAR -NC, CS-ALNR -MC, CS-NLAR -MC). A graphical representation of these is available in Figure 3.10.3.

Apparatus and Proforma

As in previous experiments the flicker ICB paradigm was constructed using Psyscope v1.2.5 (Cohen et al., 1993) and an Apple G3 PowerBook (OS 9.1) was used to run it. Consumption information was again collected using the alcohol timeline followback (TLFB, based on Sobell & Sobell, 1992)—full details of the apparatus and proforma are available in the Apparatus and Proforma section of Experiment 1 and a copy of the TLFB is provided in Figure 2.1.1.

Procedure

The procedure of Experiment 10 was identical to that of Experiment 1. Individuals were approached in public places throughout the University of Glasgow campus and asked to participate in a short experiment investigating the difference in performance on a set task on laptop and desktop computers and told that they would be part of the laptop condition. Those who agreed to take part were then taken to quiet testing places and given full instructions and told that they were free to leave the experiment at any point. They were then given the flicker ICB task and on completion of that, asked to provide drinking and demographic information via the timeline followback. Finally participants were debriefed and invited to contact the alcohol laboratory at a later date for results of the study.

All procedures were approved by the Psychology Department and Faculty Ethics Committees (sub-committees of the University of Glasgow Ethics Committees).

Results

Using the criteria established in Experiment 1 (full details of which are contained in the Results section of Experiment 1), participants who did not provide data suitable for inclusion in Experiment 10 were removed. Sixty-three participants were removed prior to analyses. Of these 2 had consumed alcohol on the day of testing, 3 had previously been involved in a similar study, 7 incorrectly detected the change and 51 reported their previous drinking week to be atypical. The remaining 87 provided suitable data to be included in the analyses of Experiment 10.

Of the 87 participants who provided data suitable for inclusion in the analyses of Experiment 10, 38 detected the alcohol-related change (the six Groups ACD, M Consumption = 12.61 units of alcohol per week, SD = 13.52) and the remaining 49 detected the neutral change (the six Groups NCD, M = 15.70, SD = 19.21). Of the 38 who detected the alcohol-related change, 11 did so when the overall context was Alcohol (the two Groups ACD-AC, M Consumption = 18.14

units, $SD = 15.38$), 13 when the overall context was Neutral (the two Groups ACD-NC, M Consumption = 9.85 units, $SD = 11.18$) and 14 when the overall context was Mixed (the two Groups ACD-MC, M Consumption = 10.82 units, $SD = 13.63$). Of the 49 who detected the neutral change, 23 did so when the overall context was Alcohol (the two Groups NCD-AC, M Consumption = 13.76 units, $SD = 19.21$), 17 when it was Neutral (the two Groups NCD-NC, M Consumption = 18.24 units, $SD = 27.32$) and 11 when it was Mixed (the two Groups NCD-M, M Consumption = 15.5 units, $SD = 15.89$). This information is provided in Figure 3.10.3.

The main hypothesis under test (Hypothesis 3.10.1) was that participants who detected the alcohol-related change (the six Groups ACD, $M = 12.61$, $SD = 13.52$) would report higher weekly alcohol consumption than participants who detected the neutral change (the six Groups NCD, $M = 15.7$, $SD = 19.21$)

Although it would appear that the main hypothesis has not been supported as mean Consumption was higher in participants who detected the neutral change than the alcohol-related change a 3 way ANOVA was conducted to formally examine the difference in consumption between participants who detected the alcohol-related change and those who detected the neutral change and also to investigate any interactions between Change Detected and Location of changes and/or Type of Context. This is reported below after the usually required square root ($x + 0.5$) transformation was applied, changing the coefficients of skew and kurtosis from an unsatisfactory 2.207 and 6.718, respectively, to a satisfactory 0.554 and 0.065, respectively—within the advised limits of -1 to $+1$ for parametric analyses. Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was carried out. This revealed there to be a significant difference between the variances of the groups ($p > .05$). As the *main* factor of interest was Change Detected (described below) Bartlett's test was carried out to investigate any difference in between the variances of all participants who detected the alcohol-related change and those who detected the neutral change regardless (i.e., level ACD and level NCD described in the ANOVA below). When this was done it revealed there to be no difference between the variances of the groups ($p < .05$). This revealed no significant difference

($t(1,85) = 0.817, p > .05$). The ANOVA was, nonetheless carried out and is described below—defensible, perhaps, because ANOVA is fairly robust to this particular violation of its assumptions.

Analysis of Variance

As with Experiment 9, although it was necessary to include the factor, Location of Changes, in the design of Experiment 10, this factor was dropped prior to analyses as it did not provide any information that could not be retrieved from factors 3 and 4 (i.e., Changed Detected and Location of Change Detected). Consequently a 2x2x3 entirely between participants ANOVA was performed in which Factor 1, Location of Change Detected had two levels—change detected on the left of the stimulus matrix, L, change detected on the right, NLAR. Factor 2, Change Detected also had two levels—Alcohol-related change Detected, ACD and Neutral Change Detected, NCD. The third factor, Type of Context, had three levels—Alcohol Context, AC, Neutral Context, NC and Mixed Context, MC. The dependent variable used in the analysis, Consumption represented the self-reported number of U.K. alcohol units consumed in the week prior to testing.

The main hypothesis under test (Hypothesis 10.3.1) was that weekly Consumption would be higher in participants who detected the alcohol-related change (the six Groups ACD, $n = 38$, transformed $M = 3.04$; raw $M = 12.61$ units) than in participants who detected the neutral change (the six Groups NCD, $n = 49$, transformed $M = 3.41$; raw $M = 15.7$ units).

The main hypothesis was not supported—the difference in Consumption between participants who detected the alcohol-related change and those who detected the neutral change was in the opposite direction than predicted (i.e., weekly Consumption was greater in participants who detected the neutral change, than in those who detected the alcohol-related change) but this difference was not significant ($F(1, 75) = 0.055, p > .05$).

As expected, neither the main effect for Location of Change Detected ($F(1, 75) = 0.466, p > .05$), nor the main effect of Context ($F(2, 75) = 0.1053, p > .05$) reached significance and neither did any of the 2 involving the factor Change Detected or 3 way interaction.

Full details of the ANOVA are provided in the Analysis of Variance Summary table (Table 3.10.1).

Effect Sizes

Although the difference in Consumption between participants who detected the alcohol-related change and those who detected the neutral change was in opposite direction than predicted and the above ANOVA showed there to be no significance difference between the two groups the effect size was calculated to examine the mean difference in Consumption between participants who detected the alcohol-related change (the six Groups ACD, $n = 38$, raw M Consumption = 3.04 units, $SD = 1.99$; raw M Consumption = 12.61 units, $SD = 13.52$) and those who detected the neutral change (the six Groups NCD, $n = 49$, raw M Consumption = 3.41 units, $SD = 2.16$; raw M Consumption = 15.7 units, $SD = 19.21$). This revealed an effect size ($d = -0.18$) which did not reach the level ($d = 0.3$) required by Cohen's 1992 scheme, to be described as "small" and was found to be unreliable (95% Confidence Limits of $d = -0.6$ and 0.25).

Although there was no reliable difference in Consumption between participants who detected the alcohol-related change and those who detected the neutral change individual effect sizes were calculated for the same difference in each of the three different contexts (Alcohol, Neutral and Mixed).

When the Context was Alcohol the difference between participants who detected the alcohol-related change (the 2 Groups ACD-AC, $n = 11$, transformed M Consumption = 3.9 units, $SD = 1.94$; raw M Consumption = 18.14 units, $SD = 15.38$) and those who detected the neutral change (the 2 Groups NCD-AC, $n = 21$, transformed M Consumption = 3.37 units, $SD = 1.76$; raw M Consumption = 13.76

units, $SD = 15.38$). The effect size for this mean difference was “small” ($d = 0.29$), but failed to reach significance (95% Confidence Limits of $d = -0.45$ and 1.02).

When the context was entirely neutral the effect size for the mean difference in Consumption between participants who detected the alcohol-related change (the two Groups ACD-NC, $n = 13$, transformed M Consumption = 2.72 units, $SD = 1.78$; raw M Consumption = 9.85 units, $SD = 11.18$) and those who detected the neutral change (the two Groups NCD-NC, $n = 17$, transformed M Consumption = 3.5 units, $SD = 2.63$; raw M Consumption = 18.24 units, $SD = 27.32$) was “small” ($d = -0.34$) but failed to reach significance (95% Confidence Limits of $d = -1.05$ and 0.40).

Finally when the context was Mixed the effect size for the mean difference in Consumption between participants who chose the alcohol-related change (the two Groups ACD-MC, $n = 14$, transformed M Consumption = 2.66 units, $SD = 2.14$; raw M Consumption = 10.82 units, $SD = 13.63$) and those who detected the neutral change (the two Groups NCD-MC, $n = 11$, transformed M Consumption = 3.36 units, $SD = 2.27$; raw M Consumption = 15.5 units, $SD = 15.89$) was “small”, ($d = -0.32$) was in the opposite direction predicted and was not found to be reliable (95% Confidence Limits of $d = -1.1$ and 0.49).

Summary of Results

The changes referred to below are changes implemented as object replacement.

Hypothesis 3.10.1 Mean weekly consumption would be higher in participants who detected the alcohol-related change than in participants who detected the neutral change. This was not supported. Nor was it supported when the context was Alcohol, Neutral or Mixed independently.

Hypothesis 3.10.2 The effect size for the mean difference in weekly alcohol units between participants who detected the alcohol-related change and those who detected the neutral change would be reliable. This was not supported, nor was it supported when investigating the same relationship for the Alcohol, Neutral and Mixed Contexts individually.

Preliminary Discussion

Experiment 10 was designed to further investigate the failure to find an AAB driven by the target objects in an homogenous context in Experiment 9. As in Experiment 9, 10 was set up to investigate whether, in the absence of any differential alcohol or neutral cues from the contexts within which the targets were set, the target objects themselves would be responsible for change detection. Unlike experiment 9, in which these target object were simultaneously rotated to implement the “change”, in Experiment 10, these were both replaced with new objects. It was expected that because there was some limited evidence from earlier experiments that replacement changes were more successful at eliciting AAB than rotation changes, the failure to find a bias in Experiment 9 (rotation) might be overturned in Experiment 10 (replacement). This expectation was not observed—no AAB was found.

Although no AAB was found in Experiments 9 or 10 and the issue of ensuring that participants in Experiments 9 and 10 were not significantly different in Consumption does not arise, a comparison was nevertheless made to make the treatment of the Experiment 9 and 10 data consistent with earlier pairs of experiments. This is done below.

Subsidiary Combined Analysis of Experiments 9 and 10

Prior to analyses, the square root ($x + 0.5$) transformation was applied—this took the coefficients of skew (1.661) and kurtosis (3.838) within the -1 to $+1$ limits recommended for parametric analyses (i.e., to 0.239 and -0.346, respectively). Bartlett’s test for homogeneity of variance was then carried out. This revealed there to be no significant difference between the variances of the groups ($p > .05$).

A 2x2x3 entirely between subjects ANOVA constructed in which factor 1 represented the Experiment and had two levels (Experiment 9, Experiment 10). Factor 2 represented the, Change Detected and had two levels (alcohol-related change detected, ACD, neutral change detected, NCD) and factor 3 Type of Context, also had three levels (alcohol context, AC, neutral context, NC and mixed context, MC). Although the individual analyses of the two experiments included the factor

Location of change detected, as with the combined analyses of Experiments 7 and 8 this was omitted from the combined analysis of Experiments 7 and 8 as to date there has been no consistent evidence of any effect of this factor and to avoid any 4 way interaction.

As with previous pairs of Experiments a combined analysis was done primarily to investigate any difference in mean weekly Consumption between the participants of the two experiments involved (in this case Experiment 9 and Experiment 10). The reasoning behind this is that it would not be wise make comparisons between the two experiments in terms of effect sizes, etc., if the overall Consumption was different from one Experiment to the other. Consequently the main effect of interest in this analysis was that of Experiment. This was found not to be significant ($F(1,171) = 2.647, p > .05$). Furthermore, none of the interactions involving this factor reached significance. This would suggest that as there is no difference in Consumption between Experiment 9 and Experiment 10 that it is reasonable to compare them.

None of the other main effects or interactions of the ANOVA reached significance and were therefore not interpreted. The ANOVA summary table is provided in Table 3.10.2.

Preliminary Conclusion of Experiments 9 and 10

Earlier experiments have shown a reliable AAB when the changes were carried by targets embedded in contexts of the same type (Experiments 1-4). The nature of the change carried by the target and the nature of the contexts were confounded in these experiments. When targets carried changes and were embedded within contexts of the opposite type, there was an AAB revealed but it was predicted by the nature of the context not the nature of the change carried by the target. From this it was concluded that the (larger) context was more “attention getting” than the (smaller target). Experiments 7 and 8 pursued this issue further using targets that were identical. In other words, there was no differential information in the targets that could conceivably drive and AAB, so that if one was to emerge, it could only

emerge from the contexts. That is what happened. Experiments 9 and 10 were designed to test whether, when there was no differential information provided by the context but only by the targets, an AAB would be revealed. It was not.

Conclusions from Experiments 1 to 10

Pictorial Experiments 1 to 4 in Chapter 2 extended the findings of B. T. Jones, B. C. Jones, Smith and Copley (2003) with the 1-change flicker ICB paradigm and, particularly B. C. Jones et al. (2002) with the 2-change flicker ICB paradigm from the use of a single set of alcohol-related and neutral objects to another completely different set. Thereby, the possibility that the AAB found in the B. C. Jones et al. and the B. T. Jones, et al. studies was the function of the stimulus set used in those studies rather than stimuli in general was tested. In the two Jones et al. studies, the changes to be detected were implemented by rotating the stimulus or stimuli in question. In Experiments 1 to 4, rotational changes were implemented as in the Jones et al. studies but, in addition, object replacement changes were made to test whether the results from the B. C. Jones et al. and the B. T. Jones, et al. studies relied on object rotation only.

Finally in Experiments 3 and 4, the identity of the target objects were changed (the objects carrying the change) to test whether whatever effect might generalize from the B. C. Jones et al. (2002) and the B. T. Jones, et al. (2003) studies to Experiments 1 and 2 would generalize when the identity of the target objects carrying the change was different. The same sort of AAB shown by heavier drinkers as compared with lighter drinkers that was found in the Jones et al. studies was found throughout Experiments 1 to 4. Tests such as these were regarded as important since the flicker ICB paradigm as implemented in the two Jones et al. studies generated only one data point per participant, increasing the reliance on a single data set.

Textual Experiment A, in Chapter 2, extended the finding of an AAB in heavier as opposed to lighter social drinkers to textual from pictorial stimuli—

thereby increasing the generalisability of the original Jones et al. findings and the findings in Experiments 1 to 4. Experiment A also raised the possibility that participants' AAB was driven by the context in which the target stimuli were set rather than the target stimuli themselves. This issue had not arisen in Experiments 1 to 4 because the nature (alcohol-related or neutral) of the target stimulus was always the same as the nature of the contextual stimuli in which each target was set. That is, alcohol-related stimuli were always set in an alcohol-related context and neutral stimuli in a neutral context. To tease out whether it was the target stimulus or the contextual stimuli that was/were driving the change detection (and therefore the AAB), the nature of the target stimulus and the context in which it had been hitherto embedded were dislocated. Experiments 5 to 10 of the current chapter (Chapter 3) implemented this dislocation in a number of different ways.

In Experiments 5 and 6 of the current chapter (Chapter 3), target stimuli were embedded in the 'opposite' context. They were called 'opposite context' experiments because they put the target information and the context information in opposition. Only when there was a replacement change (Experiment 6)—not a rotational change (Experiment 5)—was there found an AAB when these 'opposite context' experiments were carried out. The AAB data from Experiment 6 was consistent with the context rather than the target driving the measure of AAB. In other words, Experiment 6's participants detecting the change in the (neutral) target when it was embedded in the alcohol-related context were heavier consumers than those who detected the (alcohol) target when it was embedded in the neutral context. Because comparisons between Experiments 1 and 2 suggested that replacement changes were better at eliciting AABs than were rotational changes, it might have been expected that Experiment 6 (replacement) was more effective at eliciting an AAB than Experiment 5 (rotational)—and this was found. However, whereas in Experiments 1 and 2 both a rotational and a replacement effect was found, only a replacement effect was found in Experiments 5 and 6. No reason for this has been identified. A holding action is to conclude that, taken together, there is some limited evidence from Experiment 5 (no evidence) and Experiment 6 (evidence) that change

detection (i.e., AAB) is driven by the context in which the target stimuli are embedded rather than the target stimuli, themselves.

In Experiment 7 (rotational) and Experiment 8 (replacement), the two simultaneously-presented changing targets were either *both* alcohol-related or *both* neutral. In other words, no differential information was provided through the targets carrying the change and they should not be able to drive an AAB. If an AAB did emerge, however, it would demonstrate that the contexts were driving the AAB because it could only be through the contexts that differential information manifest as a potential AAB would be obtainable. Whether the two simultaneously-presented changes were alcohol-related or whether they were neutral and whether they were implemented as rotations or replacement, an AAB was found that was driven by the contexts. In other words, participants who detected changes to targets embedded in alcohol-related contexts drank more than those detecting changes in neutral contexts, no matter how the change was implemented.

Experiments 7 and 8, therefore, provide more consistent evidence than do Experiments 5 and 6 that contexts drive changes in these flicker ICB experiments than do the targets, themselves. Taken together, however, Experiment 6 and Experiments 7 and 8 suggest that the contexts are influential in driving the AAB, not the targets, themselves. Rather than provide contradictory evidence on what portion of the stimulus display drives the AAB, Experiment 5 simply fails to reveal an AAB.

In Experiment 9 (rotation) and Experiment 10 (replacement) opportunities were designed to test whether, when differential information was removed from contexts but retained within targets, an AAB could still be found. Simultaneously-presented alcohol-related and neutral targets were embedded in a context that was either wholly, alcohol-related or wholly neutral or an homogeneous mixture of alcohol-related and neutral objects (not bilaterally arranged). Under the same conditions of tests as Experiments 1 to 8, no evidence of an AAB was found in either Experiment 9 or 10. From this we conclude that under these conditions of test, there is insufficient information in target stimuli (as compared with the contexts) to drive an AAB. It remains to be seen, however, whether under different conditions of

test—such as longer or shorter exposure times for the changing stimuli or the mask—generate the same failure to reveal an AAB and the same conclusions that the targets are uninformative.

What is not in doubt, however, is that the flicker ICB paradigm (whether the 1-change or the 2-change variety) is capable of revealing a differential attentional bias in heavier as compared with lighter social drinkers.

What might be going on?

Earlier ‘what might be going on’ was typified as the large bilaterally-positioned, alcohol-related context (comprising 8 alcohol-related objects set in a 3x3 matrix) might attract the attention of the heavier drinkers than the large bilaterally-opposite-positioned neutral context (comprising 8 neutral objects set in a 3x3 matrix). Once the attention had been attracted to this particular region, there was a high likelihood of heavier drinkers spotting the change carried by the target stimulus at the centre of the alcohol-related 3x3 matrix, no matter what was the nature of this stimulus. In other words, according to this view, it would not matter whether the target at the centre of the 3x3 alcohol-related was alcohol-related or neutral, heavier drinkers would detect the change carried by the target because they were attending to the alcohol-related *context*. Such a state of affairs would not be expected in lighter drinkers because there would be no grounds for believing their attention would be attracted to the alcohol-related over the neutral context (or vice versa).

Speculation such as this might be tested by measuring ‘gaze’ through continuous eye-movement monitoring—for as Henderson (2003), for example, observes when talking about scene perception “... eye-movements provide an unobtrusive, real-time behavioural index of ongoing visual and cognitive processing”. After all, if AAB is to have any explanatory power in understanding drinking decisions, it will operate in a real world which is comprised of scenes—so Henderson’s observation is a pertinent one. In Chapter 4, continuous eye-movement monitoring over an extended period to stimuli of the sort used thus far in this thesis will be carried out (in fact, using the OS used in Experiment 1 of Chapter 2).

Limitations of the eye-movement monitoring apparatus has meant that gaze cannot be monitored superimposed upon the implementation of the flicker ICB paradigm but could only be carried out as an independent exercise. This necessity, however, becomes a virtue because it means that a perfectly legitimate third way of representing and measuring AAB can be explored. This is fully explained in Chapter 4 prior to Experiment B that is designed to measure gaze in heavier and lighter social drinkers when viewing a composite alcohol-related and neutral stimulus over 30 seconds.

Figure 3.5.1. Design of Experiment 5.

Locations of Changes

ALNR (Alcohol Left Neutral Right)	NLAR (Neutral Left Alcohol Right)
n = 34	n = 39
OS = OS-ALNR CS = CS-ALNR	OS = OS-NLAR CS = CS-NLAR

n = 73

Figure 3.5.2. Original Stimuli used in Experiment 5 showing the two levels of the factor Location of Changes.

Alcohol Left Neutral Right (ALNR)



Neutral Left Alcohol Right (ALNR)



Figure 3.5.3. The Original and Changed Stimulus of levels alcohol left neutral right (ALNR) and neutral left alcohol right (NLAR) of the factor Locations of Changes used in Experiment 5.

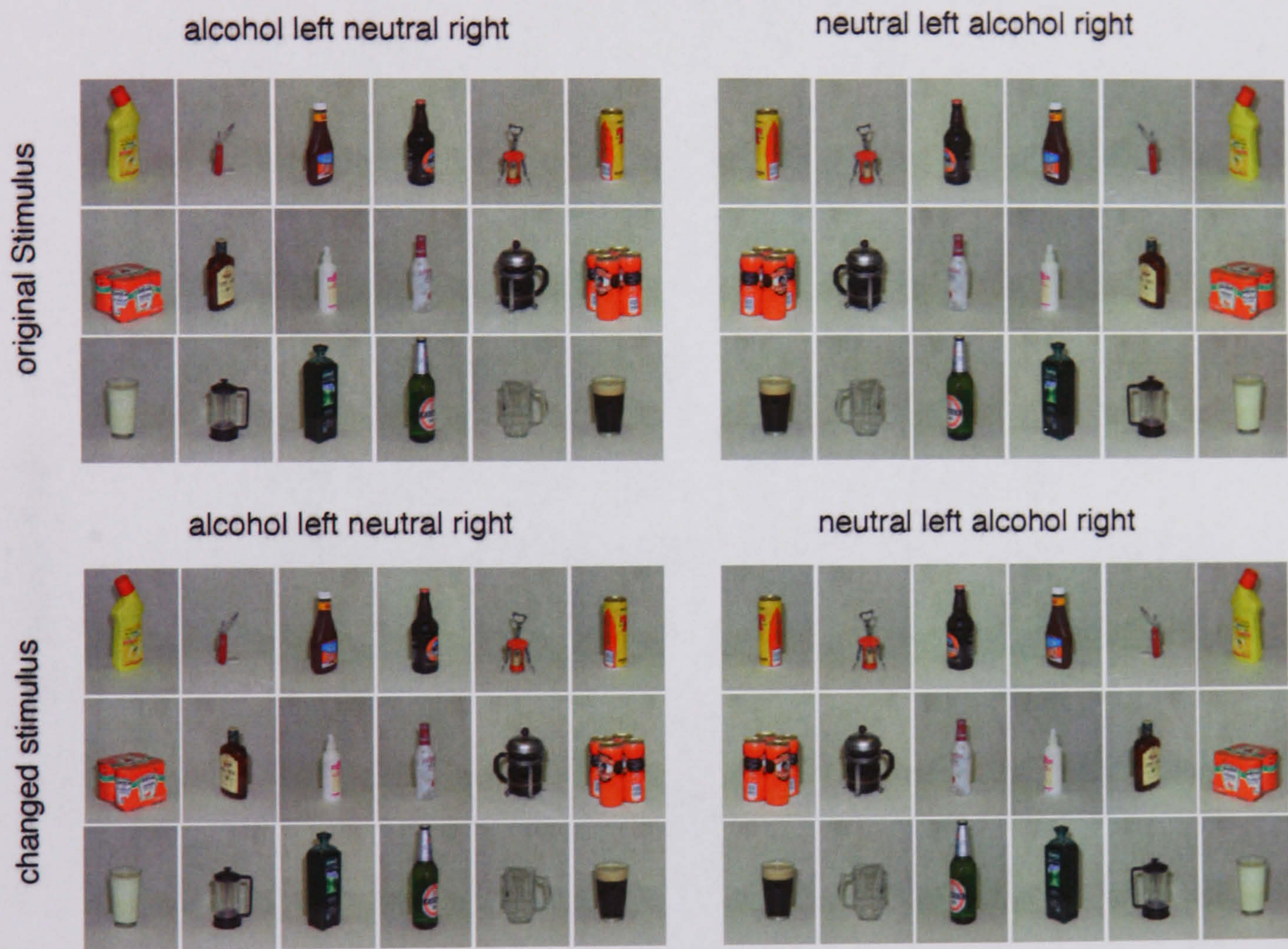


Figure 3.5.4. Mean Consumption and Standard Deviations for the four Groups used in the Analyses of Experiment 5.

		Location of Changes Detected	
		Left	Right
Change Detected	ACD	Group ACD-L n = 20 Mean = 14.5 units S.D. = 13.64	Group ACD-R n = 28 Mean = 14.34 units S.D. = 10.3
	NCD	Group NCD-L n = 11 Mean = 16.64 units S.D. = 17.21	Group NCD-R n = 14 Mean = 12.39 units S.D. = 16.25

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. They are untransformed means.

L represents that the Change Detected occurred on the left of the stimulus matrix.

R represents that the Change Detected occurred on the right of the stimulus matrix.

Figure 3.6.1. Design of Experiment 6.

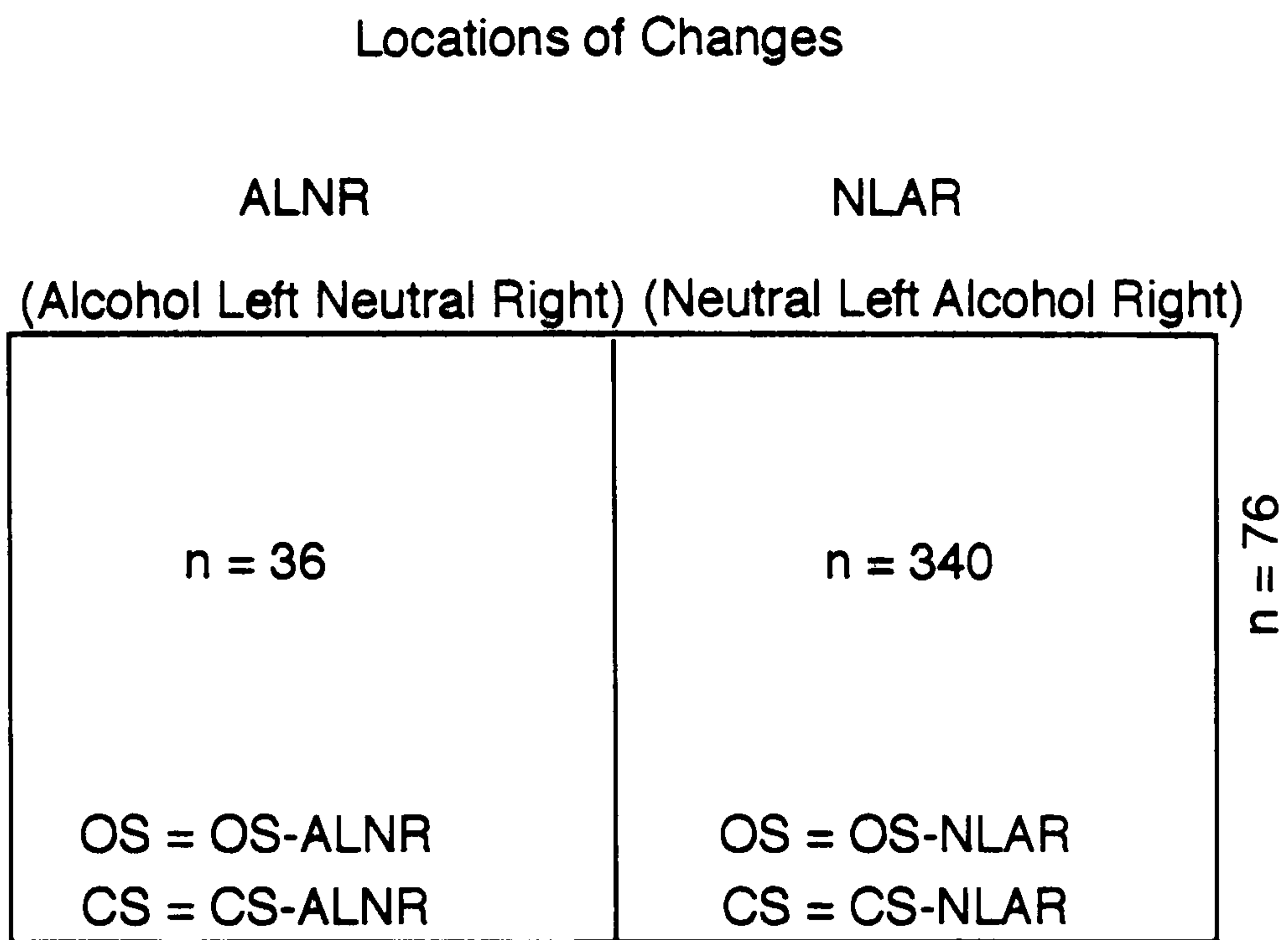


Figure 3.6.2. The Original and Changed Stimulus of levels alcohol left neutral right (ALNR) and neutral left alcohol right (NLAR) of the factor Locations of Changes used in Experiment 6.

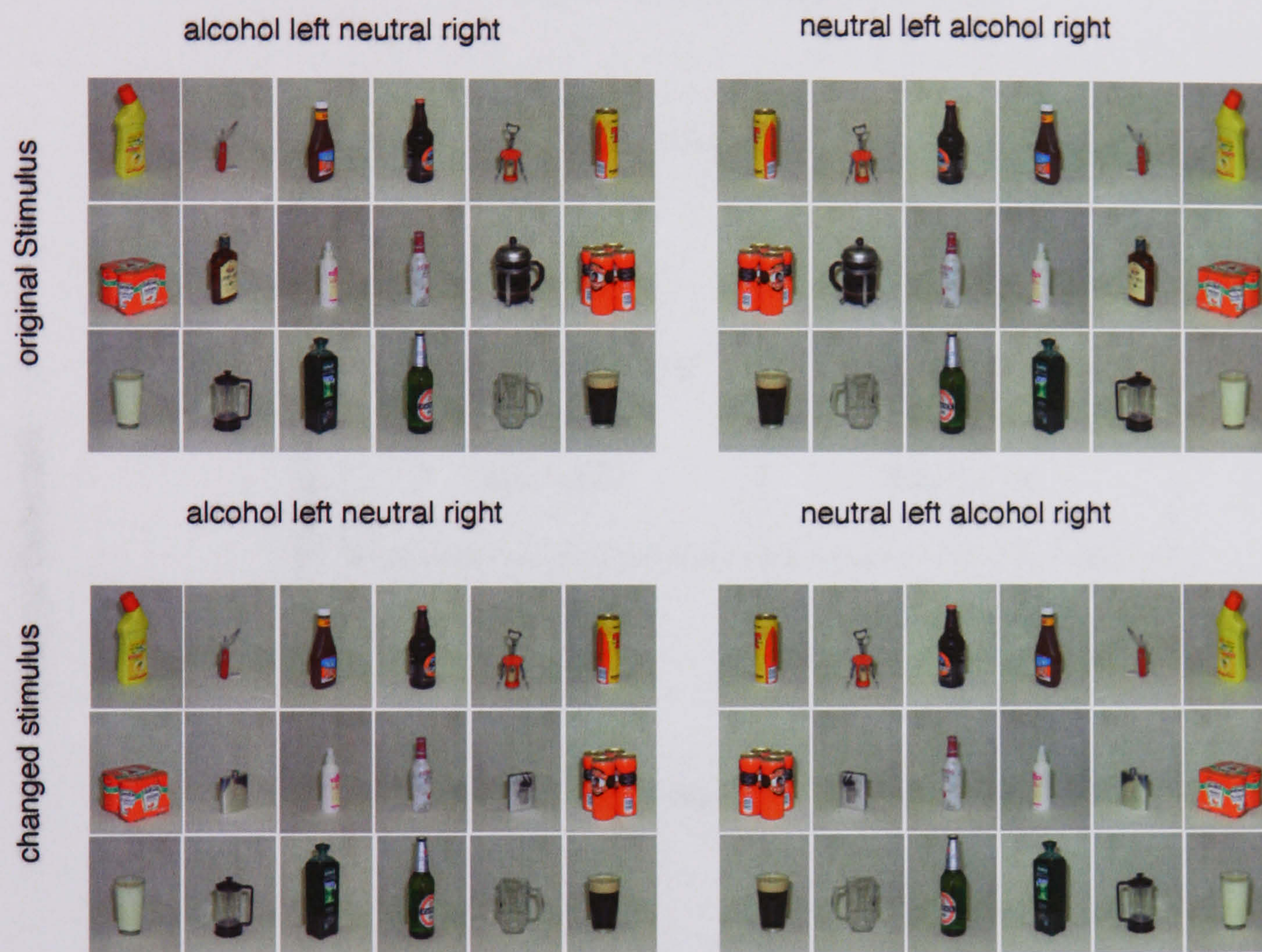


Figure 3.6.3. Mean Consumption and Standard Deviations for the four Groups used in the Analyses of Experiment 6.

		Location of Changes Detected	
		Left	Right
Change Detected	ACD	<p>Group ACD-L</p> <p>n = 13</p> <p>Mean = 9.12 units</p> <p>S.D. = 6.74</p>	<p>Group ACD-R</p> <p>n = 13</p> <p>Mean = 8.58 units</p> <p>S.D. = 7.39</p>
	NCD	<p>Group NCD-L</p> <p>n = 27</p> <p>Mean = 16.5 units</p> <p>S.D. = 13.42</p>	<p>Group NCD-R</p> <p>n = 23</p> <p>Mean = 13.67 units</p> <p>S.D. = 12.12</p>

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. They are untransformed means.

L represents that the Change Detected occurred on the left of the stimulus matrix.

R represents that the Change Detected occurred on the right of the stimulus matrix.

Figure 3.7.1. Design of Experiment 7.

		Locations of Contexts	
		ALNR	NLAR
		(Alcohol Left Neutral Right)	(Neutral Left Alcohol Right)
Type of Identical Targets	NN (Two Neutral Targets)	<p>n = 21</p> <p>OS = OS-ALNR CS = CS-ALNR</p>	<p>n = 22</p> <p>OS = OS-NLAR CS = CS-NLAR</p>
	AA (Two Alcohol Targets)	<p>n = 23</p> <p>OS = OS-ALNR CS = CS-ALNR</p>	<p>n = 21</p> <p>OS = OS-NLAR CS = CS-NLAR</p>
		n = 44	n = 43
			n = 43
			n = 44

Figure 3.7.2. Two of the Original Stimuli used in Experiment 7 showing the two levels of the factor Type of Targets.

Alcohol Left Neutral Right (ALNR)



Neutral Left Alcohol Right (ALNR)



Figure 3.7.3. The Original and Changed Stimulus of levels alcohol left neutral right (ALNR) and neutral left alcohol right (NLAR) of the factor Locations of Contexts and Type of Targets used in Experiment 7.

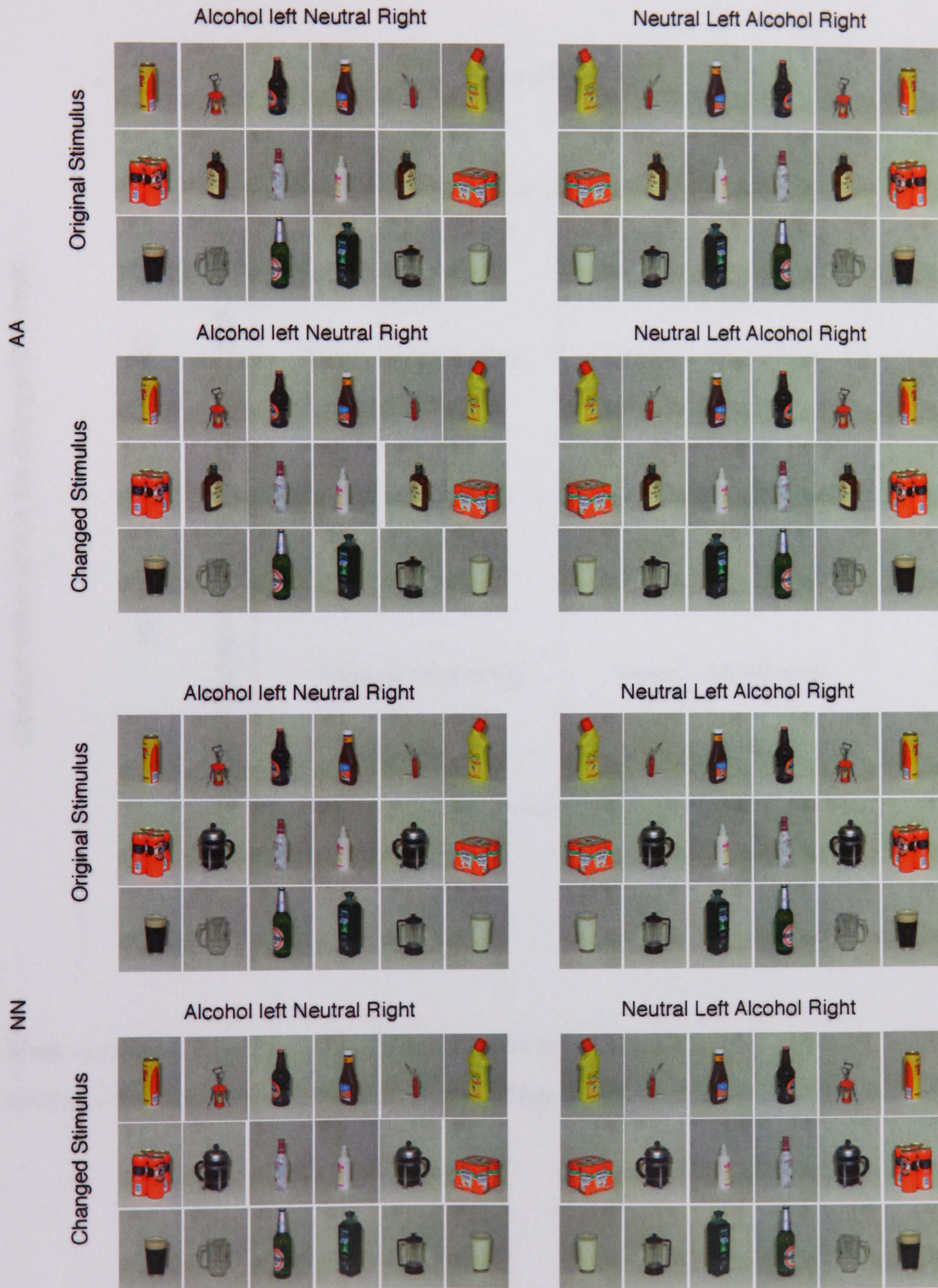


Figure 3.7.4. Mean Consumption and Standard Deviations for the four Groups obtained by crossing the two factors Context with which the change was detected and Type of Targets used in the Analyses of Experiment 7.

		Type of Targets	
		AA	NN
Context within which the change Detected	AC	Groups DAC-AA n = 23 Mean = 19.72 units S.D. = 12.67	Groups DAC-NN n = 21 Mean = 19.4 units S.D. = 11.46
	NC	Group DNC-AA n = 21 Mean = 10.4 units S.D. = 8.6	Group DNC-NN n = 22 Mean = 10.05 units S.D. = 8.88

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. They are untransformed means.

Figure 3.8.1. Design of Experiment 8.

		Locations of Contexts	
		ALNR (Alcohol Left Neutral Right)	NLAR (Neutral Left Alcohol Right)
Type of Identical Targets	NN (Two Neutral Targets)	n = 18 OS = OS-ALNR CS = CS-ALNR	n = 18 OS = OS-NLAR CS = CS-NLAR
	AA (Two Alcohol Targets)	n = 16 OS = OS-ALNR CS = CS-ALNR	n = 15 OS = OS-NLAR CS = CS-NLAR
		n = 34	n = 33
			n = 36
			n = 31

Figure 3.8.2. The Original and Changed Stimulus of levels alcohol left neutral right (ALNR) and neutral left alcohol right (NLAR) of the Factors Locations of Contexts and Type of Targets.

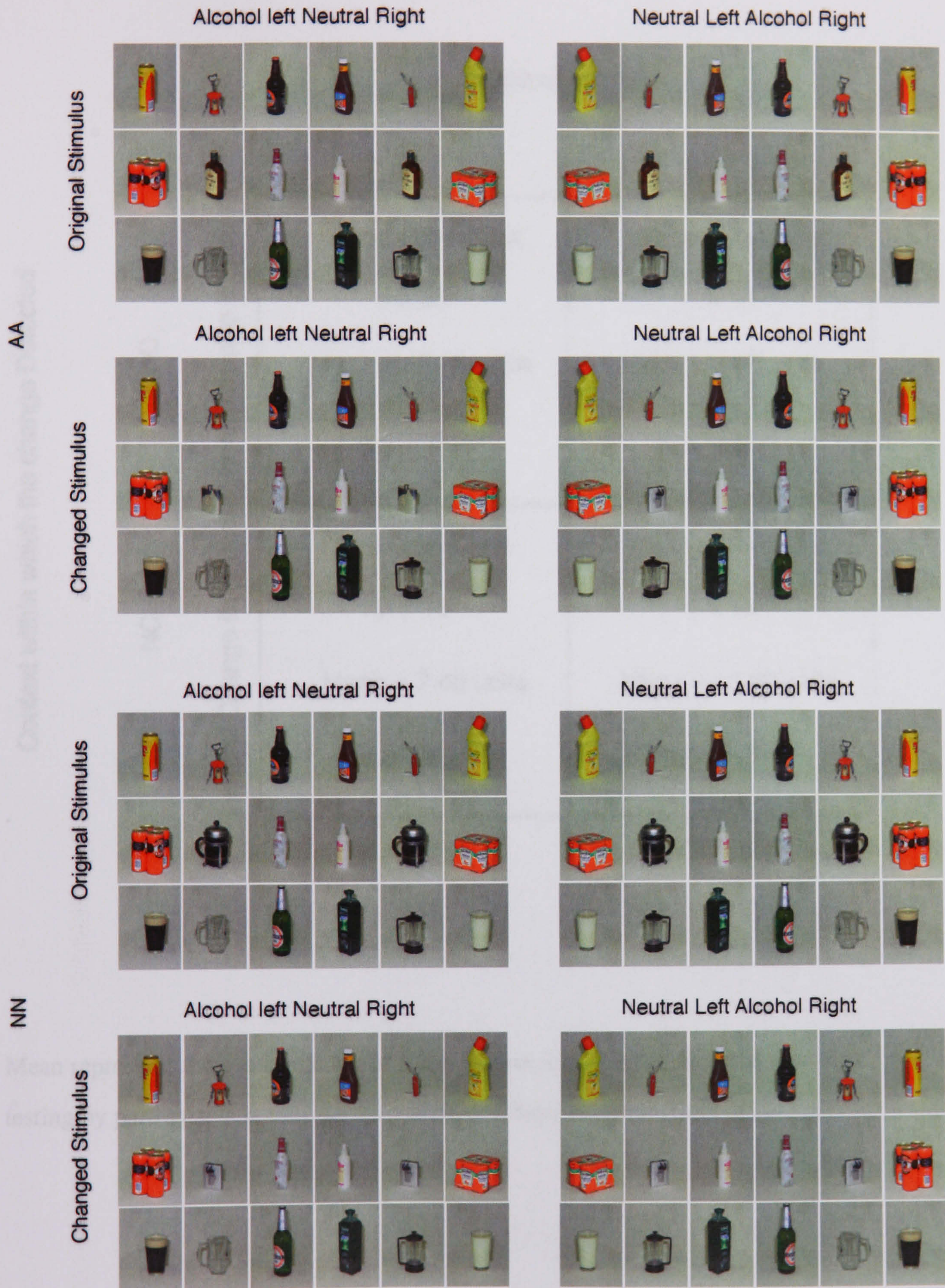


Figure 3.8.3. Mean Consumption and Standard Deviations for the four Groups obtained by crossing the two factors Context with which the change was detected and Type of Targets used in the Analyses of Experiment 8.

		Type of Targets	
		AA	NN
Context within which the change Detected	AC (Alcohol Change Detected)	<p>Groups DAC-AA</p> <p>n = 23</p> <p>Mean = 16.93 units</p> <p>S.D. = 13.41</p>	<p>Groups DAC-NN</p> <p>n = 15</p> <p>Mean = 14.5 units</p> <p>S.D. = 13.13</p>
	NC (Neutral Change Detected)	<p>Group DNC-AA</p> <p>n = 13</p> <p>Mean = 7.42 units</p> <p>S.D. = 6.7</p>	<p>Group DNC-NN</p> <p>n = 16</p> <p>Mean = 10.88 units</p> <p>S.D. = 9.7</p>

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 4 groups. They are untransformed means.

Figure 3.9.1. Design of Experiment 9.

		Type of Context			
		Alcohol	Neutral	Mixed	
Change detected	ACD	Group ACD-AC n = 20	Group ACD-NC n = 24	Group ACD-MC n = 19	n = 63
		OS = OS-ALNR-AC	OS = OS-ALNR-NC	OS = OS-ALNR-MC	
		OS = OS-NLAR-AC	OS = OS-NLAR-NC	OS = OS-NLAR-MC	
		CS = CS-ALNR-AC	CS = CS-ALNR-NC	CS = CS-ALNR-MC	
		OS = OS-NLAR-AC	OS = OS-NLAR-NC	OS = OS-NLAR-MC	
		CS = CS-NLAR-AC	CS = CS-NLAR-NC	CS = CS-NLAR-MC	
	NCD	Group NCD-AC n = 12	Group NCD-NC n = 12	Group NCD-MC n = 9	n = 33
		OS = OS-ALNR-AC	OS = OS-ALNR-NC	OS = OS-ALNR-MC	
OS = OS-NLAR-AC		OS = OS-NLAR-NC	OS = OS-NLAR-MC		
CS = CS-ALNR-AC		CS = CS-ALNR-NC	CS = CS-ALNR-MC		
	OS = OS-NLAR-AC	OS = OS-NLAR-NC	OS = OS-NLAR-MC		
	CS = CS-NLAR-AC	CS = CS-NLAR-NC	CS = CS-NLAR-MC		
		n = 32	n = 36	n = 28	

Figure 3.9.2. Three of the Original Stimuli used in Experiment 9 showing the three levels of the factor Type of Context.



Figure 3.9.3. The Original and Changed Stimulus of levels alcohol left neutral right (ALNR) and neutral left alcohol right (NLAR) of the Factors Locations of Changes and Type of Context.

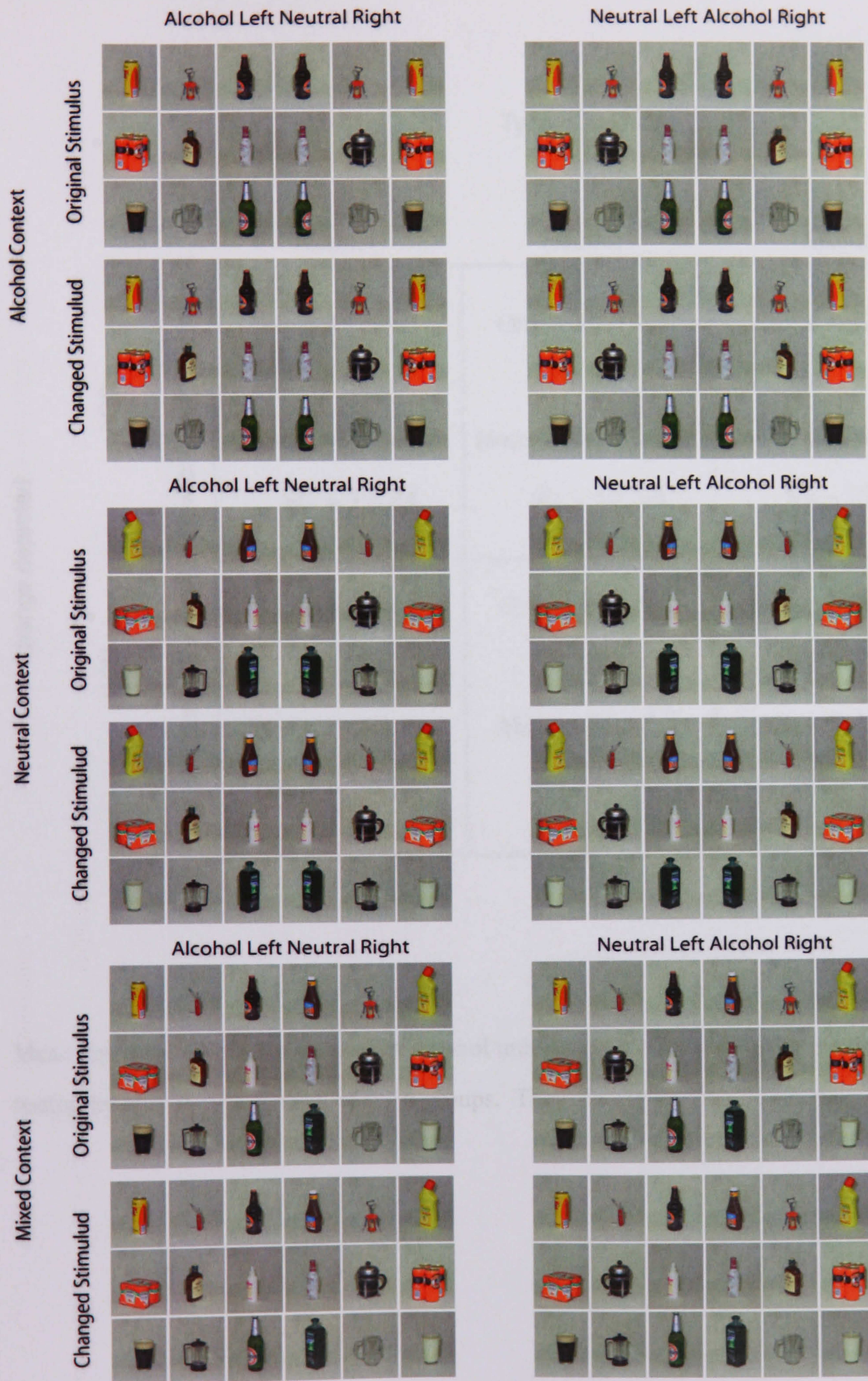


Figure 3.9.4. Mean Consumption and Standard Deviations for the six Groups obtained by crossing the two Factors Change Detected and Type of Context used in the analyses of Experiment 9.

		Type of Context		
		Alcohol	Neutral	Mixed
Change detected	ACD	Group ACD-AC n = 20 Mean = 15.65 units SD = 12.74	Group ACD-NC n = 24 Mean = 22.29 units SD = 17.58	Group ACD-MC n = 19 Mean = 25.55 units SD = 23.44
	NCD	Group NCD-AC n = 12 Mean = 19.96 units SD = 13.21	Group NCD-NC n = 12 Mean = 14 units SD = 10.22	Group NCD-MC n = 9 Mean = 11.67 units SD = 12.9

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 6 groups. They are untransformed means.

Figure 3.10.1. Design of Experiment 10.

		Type of Context			
		Alcohol	Neutral	Mixed	
Change detected	ACD	Group ACD-AC n = 11	Group ACD-NC n = 13	Group ACD-MC n = 14	n = 38
		OS = OS-ALNR-AC	OS = OS-ALNR-NC	OS = OS-ALNR-MC	
		OS = OS-NLAR-AC	OS = OS-NLAR-NC	OS = OS-NLAR-MC	
		CS = CS-ALNR-AC	CS = CS-ALNR-NC	CS = CS-ALNR-MC	
		CS = CS-NLAR-AC	CS = CS-NLAR-NC	CS = CS-NLAR-MC	
	NCD	Group NCD-AC n = 21	Group NCD-NC n = 17	Group NCD-MC n = 11	n = 49
		OS = OS-ALNR-AC	OS = OS-ALNR-NC	OS = OS-ALNR-MC	
		OS = OS-NLAR-AC	OS = OS-NLAR-NC	OS = OS-NLAR-MC	
CS = CS-ALNR-AC		CS = CS-ALNR-NC	CS = CS-ALNR-MC		
	CS = CS-NLAR-AC	CS = CS-NLAR-NC	CS = CS-NLAR-MC		
		n = 34	n = 30	n = 25	

Figure 3.10.2. The Original and Changed Stimulus of levels alcohol left neutral right (ALNR) and neutral left alcohol right (NLAR) of the Factors Locations of Changes and Type of Context.



Figure 3.10.3. Mean Consumption and Standard Deviations for the six Groups obtained by crossing the two Factors Change Detected and Type of Context used in the analyses of Experiment 10.

		Type of Context		
		Alcohol	Neutral	Mixed
Change detected	ACD	Group ACD-AC n = 11 Mean = 18.14 units SD = 15.38	Group ACD-NC n = 13 Mean = 9.85 units SD = 11.18	Group ACD-MC n = 14 Mean = 10.82 units SD = 13.63
	NCD	Group NCD-AC n = 21 Mean = 13.76 units SD = 12.38	Group NCD-NC n = 17 Mean = 18.24 units SD = 27.32	Group NCD-MC n = 11 Mean = 15.5 units SD = 15.89

Mean represents the mean number of alcohol units consumed in the week prior to testing by participants in each of the 6 groups. They are untransformed means.

Table 3.5.1. Analysis of Variance Summary Table for Experiment 5 showing differences in Consumption (following transformation) for the two factors Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION OF CHANGE DETECTED)	0.618	1	0.618	0.204	0.6530
B (CHANGE DETECTED)	1.321	1	1.321	0.435	0.5115
AB	1.020	1	1.020	0.337	0.5637
Error	209.232	69	3.032		

Table 3.6.1. Analysis of Variance Summary Table for Experiment 6 showing differences in Consumption (following transformation) for the two factors Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION CHANGE DETECTED)	1.472	1	1.472	0.536	0.4664
B (CHANGE DETECTED)	10.840	1	10.840	3.950	0.0507
AB	0.139	1	0.139	0.051	0.8223
Error	197.584	72	2.744		

Table 3.6.2. Analysis of Variance Summary Table showing differences in Consumption (following transformation) for Experiment (experiment 5 or experiment 6), Location of Change Detected (left or right) and Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (EXPERIMENT)	2.510	1	2.510	0.870	0.3526
B (LOCATION OF CHANGE DETECTED)	1.987	1	1.987	0.689	0.4081
C (CHANGE DETECTED)	2.163	1	2.163	0.750	0.3880
AB	0.079	1	0.079	0.027	0.8685
AC	9.727	1	9.727	3.371	0.0684
BC	0.970	1	0.970	0.336	0.5630
ABC	0.215	1	0.215	0.075	0.7851
Error	406.816	141	2.885		

Table 3.7.1. Analysis of Variance Summary Table for Experiment 7 showing differences in Consumption (following transformation) for the three factors Location of Change Detected (left or right) and Context within which the change detected was located (alcohol context detected, ACD, or neutral context detected, NCD) and Type of Target (two alcohol-related targets or two neutral targets).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION OF CONTEXT)	1.431	1	1.431	0.621	0.4330
B (CONTEXT WITHIN WHICH THE CHANGE WAS DETECTED)	35.735	1	35.735	15.512	0.0002
C (TYPE OF TARGET)	0.063	1	0.063	0.027	0.8695
AB	1.828	1	1.828	0.794	0.3757
AC	4.721	1	4.721	2.049	0.1562
BC	0.818	1	0.818	0.355	0.5528
ABC	1.035	1	1.035	0.449	0.5045
Error	181.998	79	2.304		

Table 3.8.1. Analysis of Variance Summary Table for Experiment 8 showing differences in Consumption (following transformation) for the three factors Location of Change Detected (left or right) and Context within which the change detected was located (alcohol context detected, ACD, or neutral context detected, NCD) and Type of Target (two alcohol-related targets or two neutral targets).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION OF CONTEXT)	0.235	1	0.235	0.102	0.7512
B (CONTEXT WITHIN WHICH THE CHANGE WAS DETECTED)	14.371	1	14.371	6.210	0.0155 *
C (TYPE OF TARGETS)	0.007	1	0.007	0.003	0.9565
AB	1.217	1	1.217	0.526	0.4712
AC	0.119	1	0.119	0.051	0.8215
BC	1.707	1	1.707	0.738	0.3939
ABC	8.958	1	8.958	3.871	0.0538
Error	136.545	59	2.314		

Table 3.8.2. Analysis of Variance Summary Table showing differences in Consumption (following transformation) for Experiment (Experiment 7 or Experiment 8), Context within which the change was detected (alcohol context or neutral context) and Type of targets (two alcohol-related target objects or two neutral targets).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (EXPERIMENT)	4.083	1	4.083	1.767	0.1858
B (CONTEXT WITHIN WHICH THE CHANGE WAS DETECTED)	43.140	1	43.140	18.675	0.0000
C (TYPE OF TARGETS)	0.031	1	0.031	0.013	0.9078
AB	1.057	1	1.057	0.458	0.4997
AC	0.223	1	0.223	0.097	0.7565
BC	0.870	1	0.870	0.377	0.5404
ABC	2.128	1	2.128	0.921	0.3388
Error	337.273	146	2.310		

Table 3.9.1 Analysis of Variance Summary Table for Experiment 9 showing differences in Consumption (following transformation) for the three factors Location of Change Detected (left or right), Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD) and Type of Context (alcohol, neutral, mixed).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION OF CHANGE DETECTED)	0.135	1	0.135	0.034	0.8545
B (CHANGE DETECTED)	8.792	1	8.792	2.197	0.1420
C (TYPE OF CONTEXT)	0.588	2	0.294	0.073	0.9293
AB	5.505	1	5.505	1.376	0.2441
AC	4.376	2	2.188	0.547	0.5808
BC	17.847	2	8.924	2.230	0.1138
ABC	11.023	2	5.511	1.378	0.2578
Error	336.077	84	4.001		

Table 3.10.1. Analysis of Variance Summary Table for Experiment 10 showing differences in Consumption (following transformation) for the three factors Location of Change Detected (left or right), Change Detected (alcohol-related change detected, ACD, or neutral change detected, NCD) and Type of Context (alcohol, neutral, mixed).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (LOCATION OF CHANGE DETECTED)	1.924	1	1.924	0.466	0.4969
B (CHANGE DETECTED)	0.228	1	0.228	0.055	0.8149
C (TYPE OF CONTEXT)	8.693	2	4.347	1.053	0.3540
AB	5.169	1	5.169	1.252	0.2667
AC	38.513	2	19.256	4.665	0.0123
BC	4.890	2	2.445	0.592	0.5556
ABC	11.292	2	5.646	1.368	0.2609
Error	309.566	75	4.128		

Table 3.10.2. Analysis of Variance Summary Table showing differences in Consumption (following transformation) for Experiment (Experiment 9 or Experiment 10), Change Detected (alcohol-related change detected or neutral change detected) and Type of Contexts (Alcohol, Neutral or Mixed).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (EXPERIMENT)	606.353	1	606.353	2.147	0.1447
B (CHANGE DETECTED)	98.056	1	98.056	0.347	0.5565
C (TYPE OF CONTEXT)	30.558	2	15.279	0.054	0.9474
AB	821.682	1	821.682	2.909	0.0899
AC	92.163	2	46.082	0.163	0.8496
BC	198.174	2	99.087	0.351	0.7046
ABC	1617.906	2	808.953	2.864	0.0598
Error	48297.095	171		282.439	

Chapter 4

CONTINUOUS EYE-MOVEMENT MONITORING IS USED TO DELIVER A REPRESENTATION OF ALCOHOL-RELATED ATTENTIONAL BIAS IN SOCIAL DRINKERS.

Abstract

In the previous chapters, the flicker ICB paradigm has been employed to measure AAB. Experiment B, reported in this chapter extends the method of measuring AAB beyond that of the flicker ICB paradigm, to measure continuous eye-movements to a stationery scene (the Original Stimulus of Experiment 1 was employed).

When eye-movements were measured over a 30 second period an AAB was shown in heavier over lighter social drinkers, both in the proportion of fixations and the proportion of dwell time to alcohol-related stimuli. When data were examined for the first fixation and first two seconds of the stimulus presentation, however, no differences were revealed in either the first fixation or in the proportion of fixations or dwell time in first two seconds between the heavier and lighter social drinkers.

Introduction

Research from a range of different domains (some of which was discussed in Chapter 1) shows that there is a very close relationship between the attentional and the oculomotor systems. Although this same research has shown that *covert* attention (no overt behavioural manifestation such as eye-movements) might be shifted to a particular object of interest before an eye-movement is made (Kowler, 1995), it is important to note that an eye-movement typically will come after this and *land on the object at which this (covert) attention is first directed* (e.g., Bryden, 1961; Crovitz & Daves, 1962; Deubel & Schneider, 1996; Shepherd, Findlay, & Hockey, 1986). This behaviour is usually described as representing *overt* attention. In other words, although eye-movements are not necessarily attention *per se*, they are an excellent proxy for it—a proxy that might be used to explore for a better understanding of AAB.

With respect to scene perception (which, after all, might be regarded as the natural domain for AAB, not brief exposure paradigms such as the Stroop, dot-probe or other derivative paradigms), “... eye-movements provide an unobtrusive, sensitive, real-time behavioural index of ongoing visual and cognitive processing” (Henderson, 2003, p 498). Consequently, there might be some value in using continuous eye-movement monitoring (CEMM) to measure responses to scenes with alcohol-related and neutral content of the sorts used by B. C. Jones, B. T. Jones, Blundell and Bruce (2002) and B. T. Jones, B. C. Jones, Copley and Smith (2003) and of the sort used in Experiments 1 to 10 of this thesis. All conceptions of AAB used in research to date has conceptualised AAB as either a perceptual or a cognitive phenomenon just like the “ongoing visual or cognitive processing” of Henderson (2003) and for this reason CEMM might be expected to capture aspects of these conceptions. Indeed, in this same vein, eye-movements have already facilitated a better understanding of perceptual and cognitive processes underpinning text reading and comprehension (Ashby, Clifton, & Rayner, 2005; Rayner, 1998).

Brief exposure and extended exposure paradigms

Fifteen years of AAB research has relied almost entirely on *brief exposure* paradigms (Stroop, dot probe and variations of these), evaluating attention over timescales of less than 2 seconds. Much has been learned about AAB using this approach, yet the significance of AAB in explaining chronic excessive drinking (see Chapter 1) and variability in social drinking (see Chapter 1) is set within a timeframe of many minutes, hours or more. In other words, whatever triggers the “popping into mind” of going for a drink might be visible in brief exposure paradigms but the perceptions and cognitions that follow this trigger—filling the gaps between “popping into mind”, the generation of a subsequent decision and its implementation—will not necessarily be visible because they occur outside the timeframe of a brief exposure paradigm trial. This is not to say the triggering of attentional processes during the timeframe of brief exposure paradigms is unimportant. Indeed, the trigger might be the most important feature of AAB. But what happens between the trigger and the ultimate behaviour that is triggered also warrants investigation.

The use of the flicker ICB paradigm in Experiments 1 to 10 and the use of CEMM in Experiment B goes beyond the brief exposure paradigm time frame. It should be noted, however, that there is some research that suggests that information or effects from earlier brief exposure trials impacts on the performance and the perceptual and cognitive processes of later trials and this has been reviewed by Cox, Fadardi and Pothos (2006) and to this extent it might not be strictly defensible to refer to brief exposure paradigms as having a time frame of less than 2 seconds. In principle, however, it is difficult to see how knowledge derived from trials in brief exposure paradigms can be extended into the time gap that separates the first impact of AAB when exposed to an AAB stimulus to a drinking decision (to drink or otherwise).

To some extent, the flicker ICB paradigm extends exposure to test stimuli beyond the brief exposure paradigm time frame and is the first paradigm to do this. Although arguments might be put forward that each flick is equivalent to each trial

in a brief exposure paradigm, this is probably not defensible because information built up during each of the flicks is critical to the production of the single required spot-the-difference response. In this sense, the flicker ICB paradigms used in this thesis and used by B. C. Jones, et al. (2002), B. T. Jones, et al. (2003), Jones, Macphee, Broomfield, Jones and Espie, (2005) and Jones, Bruce, Livingstone and Reed (2006) have already begun to extend explorations of AAB beyond the timeframe of brief exposure paradigms in what might be called an *extended exposure* paradigm. Using CEMM, Chapter 4 adds to the information provided outside the timeframe of brief exposure paradigms through the use of an extended exposure paradigm.

Attention, in general

Attention (predating AAB research) has long been conceived as comprising two concatenating components—an initial orienting component and then one of attentional capture/maintenance (Allport, 1989; Jonides, 1981; Shepherd et al., 1986). Recent attention research confirms this and has shown that eye-movements are sensitive to both components. Little is known of the fate of the capture/maintenance component, however, other than it is triggered—this is because trials used in research in which the components feature are usually less than 1 second long.

In scene perception research, however—whilst the initial orienting component and the capture/maintenance component are of interest—the additional interest is how, of these two components (both probably driven by information in long term memory), *the capture/maintenance component is continuously modified by the accumulation of information (in short term memory) as a result of the continuous scanning of the scene while it is in view* (e.g., Henderson, Weeks & Hollingworth, 1999; Turano, Gerguschat & Baker, 2003). This modification of attention over time—measurable by CEMM—comprises perhaps a critically important and missing third component of AAB that can begin to fill the explanatory gap between the initial

manifestation of AAB (seen in brief exposure paradigms) and the drinking decisions and implementary behaviour that AAB is thought to influence.

Components of AAB

Some limited evidence from brief exposure paradigms that *does not involve eye-movement data* (Stormark, Field, Hugdahl & Horowitz, 1997) identifies the initial orienting component in alcoholics as compared with controls—although Field, Mogg, Zetteler and Bradley, (2004) have not found the corresponding component in heavier as compared with lighter social drinkers. Both studies find evidence for the second component, however—in Field et al.'s study, it is attentional capture; while in Stormark et al.'s study attention is directed away from the target hit by the initial orienting component (representing the approach-avoidance conflict of treated drinkers).

Although eye-movements have not yet been used in AAB research, they have been used in two brief exposure studies of attentional bias with *smokers* as compared with non-smokers (Mogg, Bradley, Field & De Houwer, 2003) and with smokers of different levels of nicotine dependence (Mogg, Field & Bradley, 2005). Using eye-movements, there is evidence for an initial orienting and a subsequent maintenance component. These eye-movements have only been measured within the timeframe of a brief exposure paradigm (< 2 seconds).

Encouraged by Mogg et al.'s (2003) and Mogg et al.'s, (2005) innovative (although limited) use of eye-movement data to explore smoking-related AB within the timeframe of brief exposure paradigms, Experiment B in Chapter 4 measures eye-movements for the first time in AAB research. Also for the first time in AAB research, it extends the measure beyond the timeframe of brief exposure paradigms.

There is expected to be seen in the CEMM data a representation of what has been called the orienting component and what has been found by Mogg and colleagues (2003; 2005) with smokers and also similarly found in a more recent study by Field, Eastwood, Bradley and Mogg (in press), which, measuring eye-movements to a visual dot probe task, showed an attentional bias in cannabis users.

It is expected that this component would be manifest in the first fixation or maybe the first and second fixations. A pilot study has shown that under the conditions of test proposed in Experiment B, some half dozen fixations will be made during the first two seconds—the timeframe of previously used brief exposure paradigms. Although there is some evidence that covert attention can provide crude information of a scene prior to the first fixation—probably while the first fixation is being programmed—there is the expectation that the first or second fixation will follow up on this early-acquired information and hit the point of interest or the area for which more information is required (e.g., Henderson, 2003). For these reasons it is expected that the orienting component of attention and AAB will be captured in the first or the first and second fixations.

It is also expected that the second component of attention—capture or repulsion—will be identified in the fixations that normally occur within the timeframe of brief exposure paradigms (< 2 seconds). There might be up to 10 fixations during this time—although there is much variation across individuals, tasks and scenes.

Finally, it is expected that the fixations during the extended timeframe of 30 seconds will represent the extent to which capture or repulsion is maintained after initiated as the second component. This additional, third, component of AAB derives its impetus from scene perception research. Scene perception research (Biederman, Mezzanotte & Rabinowitz, 1982; Intraub, 1981; Potter, 1976) shows, that the ‘gist’ of the scene is acquired by the first hundred milliseconds of exposure—i.e., whether the scene is a ‘room’, or a ‘person’, or ‘buildings’ or a ‘landscape’. It is probably instantiated by massive parallel processing and has little to do with foveal fixation. The instantiation is probably through stored knowledge in long-term memory built up during experiences with such similar stimuli. The research also shows that the acquisition of the scene *detail* is a subsequent and continuing attentional process that once triggered by *stored knowledge* (e.g., by the general ‘room’ knowledge) is elaborated through *accumulating knowledge* as the act of scene perception continues over however long the scene is present. This process

is probably driven by accumulating knowledge in short term memory that builds up as the scene is explored. The scene is explored by pointing the fovea at areas of interest or at areas about which more detail is wanted—since the fovea is the instrument that is capable of acquiring maximum detail. The exploration might be influenced by (or might be) implicit or explicit processes or both.

The task

Pilot studies in which participants were simply asked to “look at the presentation” for a period of time and then debriefed on what they recalled they did during this time (i.e., while “looking”) revealed a range of different activities—for example, “I memorised the objects, like in Kim’s game”, “I looked for the odd one out”, “I went along the rows” and “I put them into categories”. Rather than have a range of activities driving eye-movements differently in the study that is reported here, each participant was given the *same* (bogus) task to reduce this variability. This bogus task is explained in the appropriate part of the next section.

Method

Participants

Eighty participants were recruited from a university campus (37 males, 43 females, *Mdn* age = 21 years, quartile range = 3.0, range = 18-40). All participants reported normal or corrected vision (and were tested prior to CEMM). Those participants for whom the eye-tracker could not be calibrated and those who completed the experiment but did not provide suitable data for analyses were excluded prior to analyses (full details of the exclusion criteria are in the Method section of Experiment 1). Accordingly 31 were excluded, 7 for whom it was not possible to calibrate the eye-tracker to record their eye-movements, 18 who reported their previous drinking week to be atypical, 2 who had consumed alcohol on the day of testing, 1 who reported that they had participated in a similar study using the flicker paradigm and 3 who falsely reported having detected a change. Data from

the remaining 49 (23 males, 26 females, *Mdn* age = 21 years, quartile range = 3.0, range = 18-40) were retained and used to construct the groups for analyses.

The recruitment and the testing context was designed to hide that the experiment was alcohol-related. Following testing, and prior to analyses the same criteria were applied to remove participants whose data was unsuitable for inclusion in the analyses of Experiment B (see the Method section of Experiment 1 for full details).

Apparatus and proforma

An SMI EyeLink 1 System (SensoMotoric Instruments GmbH, Teltow, Germany) was used to measure online eye-movements from the right eye at a 250Hz sampling rate with an operational spatial resolution of approximately 0.3°. Saccade onset was defined as a change in eye position with a minimum velocity of 30 degrees per second or a minimum acceleration of 8000 degrees per second². Eye-movements were measured using a headband-mounted camera positioned between 4 and 7 cm from the right eye and recorded using a Compaq Prolinea 5133 PC. The camera contained two infrared LEDs which illuminated the eye so that pupil position and size could be recorded. A second headband-mounted camera was located in the centre to measure head position relative to four infrared markers located on the stimulus monitor—this meant that CEMM accuracy (using *exact* eye position) could be maintained even when small (< 15°) head movements occurred. Stimuli were presented using a Compaq Prolinea 5133 PC with a 17" Viewsource 17PS monitor (resolution 800 x 600 pixels, refresh rate 75 Hz), located 57 cm from a chin rest. The two computers (one to present stimuli and one to record eye-movements) were linked and synchronised as part of the SMI EyeLink package. An additional contingency was programmed that a centrally-located dot had to be fixated prior to the presentation of any stimulus complex and that this presentation was held up unless the dot was currently fixated.

An alcohol consumption timeline followback form was used based upon the TLFB (Sobell and Sobell 1992) to collect information on alcohol consumption from

the previous week and other personal details. As was the case in earlier experiments in this thesis, of particular importance on the form was a box to be checked if the reported week's consumption was typical throughout the year. Also in common with earlier experiments, this form was not presented until CEMM was complete to ensure that the participants were not aware the experiment was an 'alcohol' one.

Stimuli

The generic stimulus complex consisted of a landscape 3x6 rectilinear matrix of full colour photographs (5M pixels) of alcohol-related and neutral (household) objects. A 3x3 matrix of alcohol-related photographs comprised one side of the 3x6 matrix and a 3x3 matrix of neutral photographs, the other. The generic stimulus was based on the stimuli used by Jones et al. (2006) in which 9 pairs of alcohol-related and neutral stimuli were collected so that each pair's physical characteristics (colour, shape, and form—see Figure 2.1.3) were as close as practicable and each member of a pair was placed in an equivalent location in the respective 3x3 matrix (see Figure 2.1.4 in Chapter 2). In other words, the difference between each member of any alcohol-neutral pair was based only on semantic content. Each element of the 3x6 matrix was photographed on the same background and the elements were separated by a plain white margin that was 5% of each element's width. Two versions were made of the generic stimuli: one, ALNR, in which the alcohol matrix was on the left and the neutral matrix on the right and the other, NLAR, with the opposite orientation.

The two stimuli were the same as the two OS used in Experiment 1 of Chapter 2 and are shown in Figure 2.1.4.

Design

A 3-factor mixed design was used for analysis. For the initial group assignment, a between factor, Stimulus Orientation (2 levels: ALNR, NLAR, see above), was used. On entering the study, participants were randomly assigned to either ALNR or NLAR until each contained 40 participants. Following testing and on the basis of alcohol consumption data collected from the timeline followback,

participants were retrospectively assigned to one of two levels of the second between factor, Type of Drinker (2 levels: lighter, heavier). Strict exclusion criteria were applied when assigning to each of these two levels. First, participants for whom the EyeLink calibration procedures proved impossible were not tested ($n = 7$). Second, in common with earlier experiments, participants who on the timeline followback form had not checked the “typical week’s consumption” box ($n = 18$), those who had consumed alcohol on the day of testing were excluded ($n = 3$) and those who incorrectly reported from the instructed task (see below) were excluded ($n = 3$). Consequently, 49 participants remained for the analysis. Rather than employ a median split assignment to the two levels of Type of Drinker, the 20 heaviest and the 20 lightest drinkers from the 49 considered were so assigned (an extreme groups method). The consumption measure used to represent a person’s alcohol consumption was the total number of UK alcohol units per week—as in previous experiments in this thesis. The final factor for analysis was a within factor, Time Period (3 levels: 0-10, 10-20, 20-30 seconds of stimulus presentation). Eye-movement data was principally analysed with a 2x2(x3) mixed ANOVA to explore whether AAB (represented by eye-movement data) was different for lighter versus heavier drinkers over the 30-second viewing period (or for the different 10 second phases of the 30 second viewing period). Other analyses addressed the first fixation and the fixations made within the first 2 seconds (in common with earlier analyses of smoking-related attentional bias). These three different measures mapped onto the three possible components of AAB that were described earlier in this chapter.

Two types of measures were reclaimed from CEMM: the fixation-location and the dwell time. Fixations to one of the 18 stimuli were classified as such when they lasted 80 msec or more and were located within the ‘rectangle’ in which that particular stimulus was housed. Fixations of a legal duration that were located either within a margin or beyond the outer limits of the 3x6 stimulus matrix, were not classified. Fixations on any of the 4 corners or on the rectangle itself were not classified. The duration of each fixation was recorded, the dwell time.

Participants were given a bogus task during the 30-second viewing period: to detect a change that might occur to any of the 18 stimuli, remember what it was and to report it *at the end* of the 30-second viewing period—*but not before*. There was, in fact, no change implemented. It was a deception. This is an important difference between Experiment B and the previous 10 experiments in this thesis in which a change was intimated and was actually implemented to be detected. It is not unusual for bogus tasks to be given when so-called implicit measures are being examined and also when some explicit measures are being examined.

Procedure

Participants were approached in public places throughout the university campus and asked to take part in a short experiment purporting to examine differences between performance on laptop and desktop computer tasks. It was explained that their eye-movements would be measured during this task and that to do this a headband-housed-camera would be placed on their head. Careful attention was paid to ensuring that there were no alcohol-related cues in or around the eye-tracking laboratory where testing took place to ensure that participants were not primed for alcohol. Participants were paid £3 on entering the laboratory.

Participants were told that they should fixate a dot in the centre of the screen and a picture would subsequently appear for approximately a half minute. With their chin on the rest and with their head still, they were asked to look at the picture to detect a change that might occur during the half minute. When detected, they were asked to remember it but not to report it until the picture had left the screen. They were given no information of what or how to scan and their questions on this remain unanswered.

The headband was then fitted and the participant was asked to put their chin on the chin rest. The lights were dimmed and the headband and camera adjusted so that the camera was in the optimum position to record eye-movement information from the participant. Calibration procedures were carried out and when they were satisfactorily completed the testing was begun. Once the testing was finished,

participants were asked to complete the timeline followback like in previous experiments and then told of the true nature of the experiment and why it was necessary to carry out a minor deception. In common with earlier experiments, all procedures were approved by the Faculty's Ethics Committees (a sub-committee of the University of Glasgow Ethics Committee).

Results

As described earlier, data from 40 participants were analysed: 20 heavier ($M = 31.2$ units per week, $SD = 10.4$) and 20 lighter drinkers ($M = 4.9$ units, $SD = 3.2$). The following analyses were then carried out.

First fixation analyses

Binomial tests showed that there was no significant difference ($p > .05$) between the *total number of first fixations* made by the heavier group of drinker to the alcohol-related and to the neutral stimuli (10 fixations each), nor by the lighter group (6 and 14 fixations, respectively). Nor was there a significant difference between the heavier and lighter group's first fixations to the alcohol-related stimuli (10 and 6 fixations, respectively). A totally between 2x2 ANOVA (Type of Drinker x Fixation-Location, alcohol-related or neutral) showed that there were no significant main, interactive or simple main effects with first fixation-duration (dwell-time).

The expected orienting component of the AAB was not found in first fixation information from the CEMM data.

First 2 seconds analyses

Fixations were counted into this analysis if they were begun within the first 2 seconds. Unexpectedly, the proportion of fixations made by the lighter drinkers to alcohol-related stimuli was more than the proportion made by the heavier drinkers (respectively, 0.545 and 0.443); the difference was not significant, however ($F(1, 38) = 1.017, p > .05$). Fixation-durations were counted into this analysis if the fixation was begun within the first 2 seconds, as above, and the whole of the duration was included on those occasions when it exceeded the 2-second time period.

Unexpectedly, the proportion of the dwell time on alcohol-related stimuli was greater by the lighter drinkers than the heavier drinkers (0.544 and 0.472, respectively) but was not significant ($F(1, 38) = 0.499, p > 0.05$).

In addition to the above ANOVA, correlation analyses were carried out to examine the relationship between the proportion of fixations to alcohol-related stimuli in the first 2 seconds and alcohol consumption as measured by the number of weekly alcohol units consumed. Unexpectedly this revealed a negative correlation, but this did not deviate significantly from zero ($r = -0.14, n = 40, p > 0.05$).

A correlation was also carried out to examine the relationship between the proportion of dwell time on alcohol-related stimuli in the first 2 seconds and the alcohol consumption. As above a negative correlation which did not deviate significantly from zero was found ($r = -0.039, n = 40, p > 0.05$).

The attentional capture/repulsion component of the AAB was not found in the CEMM data.

Thirty seconds analyses

The total number of fixations on alcohol-related and neutral stimuli was calculated for each participant for each of the 10-second time phases of the 30-second presentation time and the proportion of fixations to alcohol-related stimuli was calculated. The average fixations per second and fixation duration varies greatly across different individuals and within individuals (e.g., Rayner, 1998) and, if absolute measures were processed in the current study, it would lead to some individuals' data being overrepresented in the analysis. Using proportions avoids this danger.

It was postulated (Hypothesis 4.B.1a) that the proportion of fixations on the alcohol-related stimuli would be greater for heavier drinkers than for lighter drinkers. When the descriptive statistics were examined the heavier drinkers showed a greater proportion of fixations on alcohol-related stimuli ($M = 0.578, SD = 0.18$) than the lighter drinkers ($M = 0.437, SD = 0.2$). To formally test this observation a 2x2(x3) ANOVA was performed (full details of the factors and levels are described

in the Design section). Prior to analysis, the coefficients of skew and kurtosis were examined. These were within the recommended -1 to +1 limits (-0.109 and -0.184 respectively). Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was then carried out. This revealed there to be no significant difference between the variance of the groups ($p > .05$).

Analysis of Variance—Fixations.

Although the mean proportion of fixations to alcohol-related stimuli was greater in heavier drinkers (0.534) than in the lighter drinkers (0.498), the ANOVA revealed that the main effect for Type of Drinker was not significant—the proportion of fixations to the alcohol-related stimuli by the heavier drinkers ($F(1, 36) = 1.76, p > .05$). Table 4.B.1a shows the ANOVA summary table. Neither were the main effects for Stimulus Orientation and Time Period ($ps > .05$). The Type of Drinker x Time Period interactive effect was, however, significant ($F(1, 2) = 4.00, p < .05$)—see Figure 4.B.1. Tests for simple main effects (also see ANOVA summary Table 4.B.1a) revealed that the difference between lighter and heavier drinker for Time Period 0-10 secs (0.486 and 0.504, respectively) and Time Period 10-20 secs (0.540 and 0.514) were not significant ($ps > .05$), but that the difference for Time Period 20-30 secs (0.469 and 0.583) was significant ($F(1, 2) = 5.99, p < .05$).

Effect Sizes—Fixations.

In addition to testing the reliability of the difference between means of interest with ANOVAs, effect sizes were also calculated—see Figure 4.B.2. Hypothesis 4.B.2a postulated that effect size for the 0.036 unit mean difference between the heavier drinkers and the lighter drinkers would be significant. Using Cohen's (1992) method a “small” effect size was shown ($d = 0.35$) The 95% confidence limits of d incorporated zero (-0.28 and 0.97) however, indicating the measure not to be reliable. Effect sizes for Time Periods 0-10 secs ($d = 0.14, 95\%$, confidence limits -0.49 and 0.75) and 10-20 secs ($d = -0.19, 95\%$ confidence limits -0.81 and 0.43) were not significant but was significant for Time Period 20-30 secs (d

= 0.65, 95% confidence limits 0.005 and 1.28). Figure 4.B.2 shows the different effect sizes and the 95% confidence limits.

Correspondingly, the *total* of the number of fixations analysed above was recorded for each participant for each of the 10 seconds time phases and the proportion of the time dwelled on alcohol-related stimuli was calculated. It was postulated (Hypothesis 4.B.1b) that the proportion of time on alcohol-related objects would be greater in heavier drinkers than in light drinkers. Similar to the proportion of fixations examined above, the mean proportion of time spent on the alcohol-related stimuli by the heavier drinkers ($M = 0.542$, $SD = 0.18$) was greater than the proportion of time spent on alcohol-related stimuli by the lighter drinkers ($M = 0.474$, $SD = 0.17$). Prior to analysis, the coefficients of skew and kurtosis were examined. These were within the recommended -1 to +1 limits (-0.316 and 0.017 respectively). Bartlett's test for homogeneity of variance (Snedecor & Cochran, 1989) was then carried out and this revealed there to be no significant difference between the variances of the groups ($p > .05$).

Analysis of variance—Time.

To formally examine this observation a 2x2(x3) ANOVA was carried out in which each factor and its respective levels were identical to the above ANOVA, but in which the dependent variable was the proportion of time spent (rather than the proportion of fixations) on alcohol-related stimuli.

For this analysis, the main effect for Type of Drinker was significant ($F(1, 36) = 5.70$, $p < .05$): heavier drinkers spent proportionally more time fixating alcohol-related stimuli than did lighter drinkers (0.542 and 0.474, respectively). Table 4.B.1b shows the ANOVA summary table. The main effects for Stimulus Orientation and Time Period were not significant ($ps > .05$) and neither were the 2-way nor the 3-way interactions—($ps > .05$) except for the Type of Drinker x Time Period interaction which—unlike the corresponding proportion of fixations interaction—was not significant ($F(1, 2) = 2.89$, $p < .05$) but whose means and tests for simple main effects has an intriguing resemblance to the fixation-location data in

Figure 4.B.1 and is reported here for this reason (see Figure 4.B.3). The corresponding tests for simple main effects (see ANOVA summary Table 4.B.1b) showed the difference between lighter and heavier drinker on the proportion of dwell-time on alcohol-related stimuli for Time Period 0-10 secs (0.469 and 0.518, respectively) and Time Period 10-20 secs (0.516 and 0.531) was not significant (p s > .05), but that the difference for Time Period 20-30 secs (0.437 and 0.578) was significant ($F(1, 2) = 5.72, p < .05$)—see Figure 4.B.3.

Effect Sizes—Time.

In addition to the above ANOVA, effect sizes were calculated. It was postulated (Hypothesis 11.4.2b) that mean difference in the proportion of time spent on alcohol-related objects between heavier drinkers and lighter drinkers would be reliable.

The Type of Drinker effect size for the 0.0627 unit mean difference in the proportion of time spent on alcohol-related stimuli between the heavier drinkers ($M = 0.547, SD = 0.104$) and lighter drinkers ($M = 0.484, SD = 0.115$) over the 30-second viewing period was “medium” ($d = 0.57$) but not significant, (95% confidence limits -0.07 and 1.19). Similarly, neither for the Time Periods 0-10 secs ($d = 0.38, 95\%$ confidence limits = -0.25 and 1.00) nor 10-20 secs ($d = 0.10, 95\%$ confidence limits = -0.52 and 0.72) but the effect size was significant for the Time Period 20-30 secs ($d = 0.73, 95\%$ confidence limits = 0.09 and 1.37). Figure 4.B.4 shows the effect sizes and confidence limits referred to above.

Summary of Results

Hypothesis 4.B.1a The proportion of fixations on alcohol-related stimuli would be greater in heavier drinkers than in lighter drinkers. This was supported

Hypothesis 4.B.1b The proportion of dwell time on alcohol-related stimuli would be greater in heavier drinkers than in lighter drinkers. This was supported.

Hypothesis 4.B.2a The effect size for the mean difference in the proportion of fixations on alcohol-related stimuli between the heavier drinkers and the lighter drinkers would be reliable. This was supported.

Hypothesis 4.B.2b The effect size for the mean difference in the proportion of dwell time on alcohol-related stimuli between the heavier drinkers and the lighter drinkers would be reliable. This was supported.

Discussion

There were three principles underpinning this departure. First, that if AAB were of any consequence to subsequent drinking decisions and behaviour, it should have a measurable impact on visual and cognitive processing extending beyond the timeframe of brief exposure paradigms. Second, that "... eye-movements provide an unobtrusive, sensitive, real-time behavioural index of [some of such] ongoing visual and cognitive processing" (Henderson 2003). Finally, the status of the AAB phenomenon should be evaluated both for the reliability (ANOVA) of the effect and the size of effect (Effect Size) as in the previous 10 experiments in this thesis.

The CEMM data show that when AAB was represented by the proportion of *fixation-locations* made to alcohol-related objects during the 30 seconds of stimulus presentation, the heavier drinkers featured a larger proportion than did the lighter drinkers but the difference was not significant. The effect size of this difference was also not significant. Equivalent analyses carried out for the first and second 10-second period also produced similar non-significant results. For the final 10-second period, however, heavier drinkers fixated alcohol-related stimuli proportionally more than did lighter drinkers: not only was this difference reliable, the effect size of the difference was reliable, too (an effect size categorised as "medium" in Cohen's scheme). As measured by fixation-location, therefore, there appears to be an AAB in the final 10-second period of the 30-second viewing period but not in the earlier two periods.

The corresponding analyses of the *fixation-durations* (dwell-time) to alcohol-related stimuli reveals something similar but with notable differences. First, in contrast to the fixation-location data, the heavier drinkers' proportion of dwell-time on alcohol-related objects during the 30 seconds of exposure was reliably more than

the lighter group's. This AAB was not supported by its effect size, however, which—in common with the fixation-location data—was unreliable. Although the interaction of Type of Drinker and Time Period failed to reach significance in the dwell-time analysis ($p > .05$, in fact $p = .062$), an inspection of Figure 4.B.3 and a comparison with Figure 4.B.1 (equivalent data from the fixation-location analysis) reveals intriguing similarities between the fixation and dwell-time data. For these reasons, simple main effects were pursued in the absence of a prior significant interaction. It was found that consistent with the fixation-location data, dwell-time data shows an unreliable AAB in first and second 10-second Time Periods but a reliable AAB in the final Time Period. Also consistent with the fixation-location data, the AAB's effect size was unreliable in the first two Time Periods but reliable in the final Time Period.

Taken together from the CEMM data, the fixation-location and the dwell time data and their respective ANOVA and effect size calculations suggest that in the 30-second period during which individuals view the stimulus complex, there might be evident an AAB represented in the eye-movement data but that it appears to be particularly evident in the final 10 seconds of viewing.

By contrast, there was no evidence within the CEMM data of any AAB within the timeframe of brief exposure paradigms. The first fixation data did not show that heavier drinkers oriented more to alcohol-related stimuli than to neutral stimuli; and neither to alcohol-related stimuli more than did lighter drinkers. Nor did it show that on those occasions when heavier drinkers oriented to alcohol-related stimuli, the dwell-time of the first fixation was longer than the dwell-time to neutral stimuli; neither was the dwell time of the first fixation on the alcohol-related stimuli longer than that of the lighter drinkers. Corresponding CEMM data for the cumulative fixation-locations and dwell-times during the first 2000 msec also failed to reveal any AAB. This failure might be interpreted as a possible power problem, rather than a failure to support the generalisation of eye-movement representations of a smoking-related attentional bias from a brief exposure paradigm (e.g., Mogg et al., 2003; Mogg et al., 2005) to an equivalent representation of an AAB within an

equivalent timeframe but from this vigilance paradigm. In brief exposure paradigms there is a substantial repeated measure component in which a series of 30 to several hundred trials are run within a single participant to seek the AAB. In the flicker studies used in this thesis and the first fixation and 2-second data of the current experiment, no such repeats are provided, reducing the power of the investigation. It is this feature that might account for the failure to find the expected orienting component of the attentional bias and the subsequent maintenance of attention (or otherwise) component.

The adoption of *continuous* eye-movement monitoring (CEMM) over extended periods reduces the need to use repeated measures to counteract the natural variation in the measures in which we are interested because the CEMM, itself, delivers what is equivalent to ‘repeated’ measures. This advantage does not extend, however, to *discrete* first fixation data (and to data collected over relatively short periods) and the vulnerability to natural variation remains unaddressed. Power problems notwithstanding, the data is consistent with Field et al.’s (2004) failure to find an initial orienting component but not with their finding a maintenance component of AAB in heavier as compared with lighter social drinkers—in a study not employing eye-movement measuring. Field et al. speculate that the initial orienting component might only be found in individuals higher up the consumption continuum.

The failure to find an AAB in higher social drinkers’ CEMM data during the early moments of stimulus exposure, should not obscure the main feature of the study: the use of CEMM data to test whether there is present an AAB in heavier as compared with lighter social drinkers within a timeframe extending far beyond the timeframe of brief exposure paradigms (hitherto the traditional tool used in attentional bias research).

For the first time, it has been shown that there appears to be an AAB represented in some eye-movement data of heavier as compared with lighter social drinkers measured over 30 seconds of stimulus presentation and also that it appears to be particularly evident in the final 10 seconds. Thus, if eye-movements can be

said to represent aspects of attention, it appears as though AAB is not simply a feature of the brief exposure paradigm in which it is traditionally measured (e.g., alcohol Stroop, dot probe). Evidence extending the presence of an AAB beyond the timeframe of brief exposure paradigms should not surprise, of course, if AABs are thought to have a general impact on future consumption decisions and behaviour. But this does not remove the onus to show that they are there.

Although, evidence extending the presence of an AAB beyond the timeframe of brief exposure paradigms does not surprise, the profile of an increasing AAB with time from initial exposure, does. One possible explanation is that the bogus task consumes much of whatever attentional resource is available but, as the participants weary of the search, the attentional resource so consumed declines, liberating more resources that in the heavier but not lighter drinkers becomes increasingly manifest as an AAB. This is defensible; but on the other hand there is no reason to believe that participants would not assign more (not less) attentional resource to the bogus task as the session nears the end because they would not yet have detected the target event which they had been led to believe would occur (but, in fact, has not). It is impossible to decide which of these two possible explanations might be the one driving behaviour. The CEMM data are consistent with the former view, however. Although the CEMM data are consistent with the former view, there is an alternative explanation that derives from scene perception frameworks that should be considered and this is explained below.

As explained earlier, in scene perception, eye-movements are thought to be controlled at first by information residing in the visual input (bottom-up control) then, subsequently, by stored knowledge (top-down control, implicit and explicit). The stimulus-based information that appears to initially control fixations is typified by high spatial frequency content and edge density (e.g., Mannan, Ruddock & Wooding, 1997; van Diepen et al., 1998), colour, contrast, intensity and edge orientation (e.g., Torralba, 2003), and temporal changes (e.g., Rensink, 2002). In Experiment B, the 9 alcohol-and-neutral pairs of photographs used in the 3x6 composite stimulus matrix have been matched as far as possible on much of this

stimulus-based information (this process was described in Chapter 2 in relation to Experiment 1, also see Figure 2.1.3). For these reasons it is, perhaps, not likely that the location of the initial fixation would be different between the lighter and the heavier drinkers—and this is what was found in Experiment B. Scene perception research has shown, however, that subsequent fixations appear to be controlled less by stimulus-based information and more by information from long-term and short-term memory (knowledge)—particularly for more complex stimuli that are less abstract and potentially more *meaningful* (e.g., Henderson et al., 1999; Oliva, Torralba, Castelhana & Henderson, 2003). In such cases, as described earlier, information from long-term memory is used first: rapidly instantiated as an appropriate ‘gist’ or ‘schema (e.g., Rousselet, Joubert & Fabre-Thorpe, 2005; Schyns & Oliva, 1994; Thorpe, Fize & Marlot, 1996) as a result of massive parallel processing taking place before or during the first fixation. Whatever control the gist/schema initially has over eye-movements is then thought to be modulated by information in short-term memory that *accumulates* as the viewing episode proceeds.

What gist or schema might be instantiated with the stimuli of Experiment B and how might the information that it carries be modulated by the 30-second viewing? As described earlier, in scene perception research, typical stimulus presentations give rise to, for example, landscape, person, animal or street schemas and although Experiment B stimuli are much less impoverished than those normally in brief exposure paradigms (see Bruce and Jones, 2004 for an exception) they are nevertheless distant from the real-world occasions in which the role for AAB is set. Informal, retrospective probing in pilot studies revealed that the most likely gist/schema instantiated by the initial exposure was ‘shelving’ (or ‘display cabinet’). Experiment B’s task demands of change-detection will have ensured that the ‘shelves’ were extensively searched, providing *detail* of the scene which, in turn, will have modulated the perception, itself. For example, as a result of the search process for the change, the heavier drinkers might have grouped the (alcohol-related) objects more readily and the grouping might have driven their eye-movements rather than individual objects. Whatever occurred is currently speculative and will need to

be the focus of future research but it appears that, as a result of something like this process, eye-movements to alcohol-related objects *eventually* increase beyond chance in the heavier but not lighter drinkers.

The use of CEMM to measure AAB needs to be extended to more realistic scenes: for example, objects naturally arranged on a table top (see B. C. Jones et al., 2002; B. T. Jones et al., 2003) rather than in a matrix; also within room or street scenes (see Bruce and Jones, 2004) and with 3D rather than 2D representations of 3D scenes (i.e., *true* rather than *ersatz* real-world scenes, Henderson and Ferreira, 2004). Real world scenes are considerably more informative than the relatively impoverished stimuli used in brief exposure paradigm research in AAB. For this reason there is the possibility that there might develop a theory of AAB, when only using brief exposure paradigms and the stimuli normally used in them, that generalizes poorly to the real world in which drinking decisions are made and AAB is thought to operate—in much the same way that the development of computer models of vision stalled when impoverished stimuli were employed in a similar effort to ‘start simple’ (Marr, 1982) and conditioning theories of learning stalled when simplified learning tasks in an impoverished environment were used (Hodos & Campbell, 1969; Seligman, 1970). The ability with contemporary kit to put a free-moving participant in a real 3D environment and carry out CEMM opens up possibilities of measuring AAB properties in the very environment that it is thought to have its effect.

Figure 4.B.1. Proportion of fixations made by heavier and lighter social drinkers to the alcohol-related components of the composite alcohol-related and neutral viewing stimulus measured over a 30 second period.

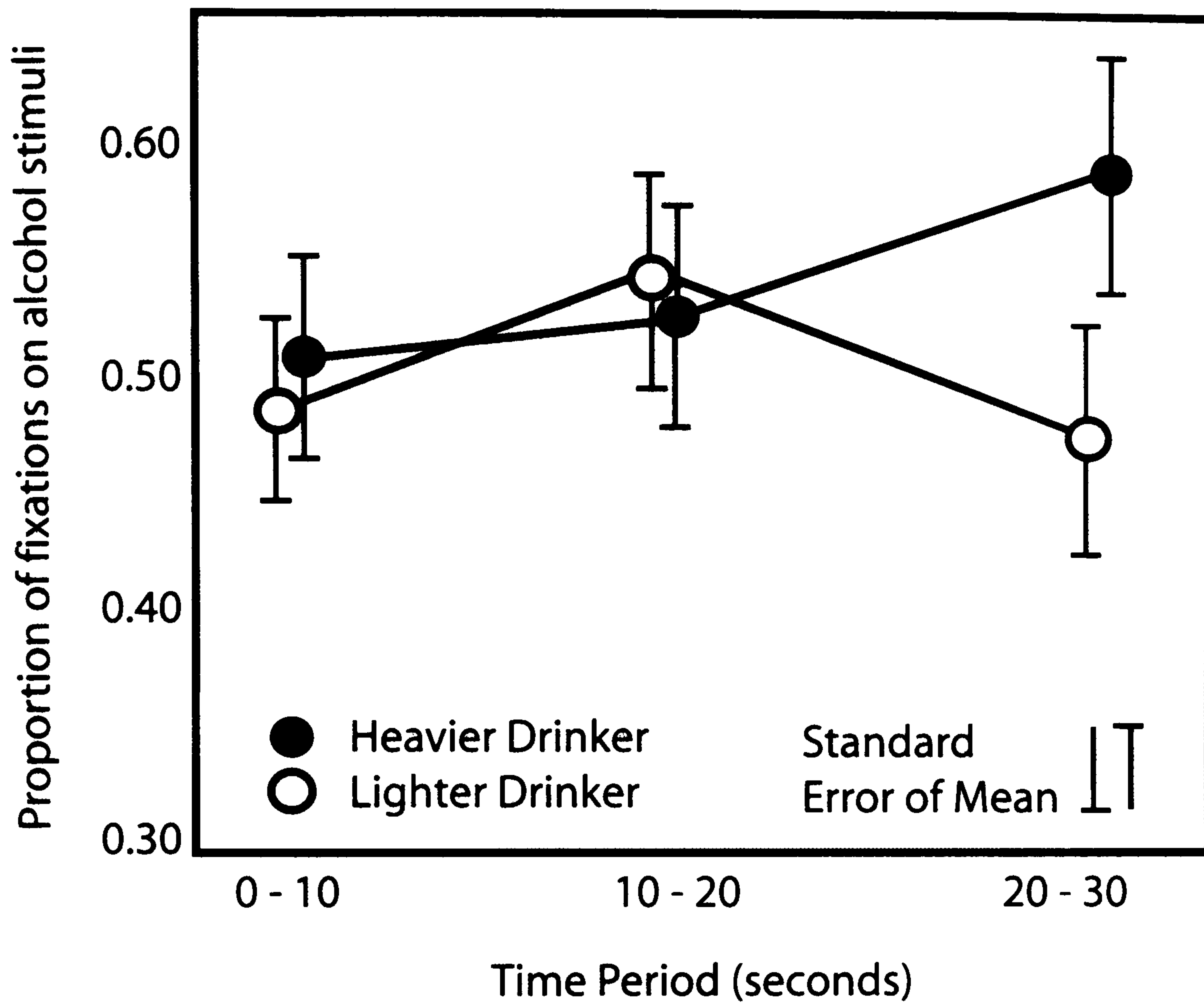


Figure 4.B.2. Effect sizes of the proportion of fixations made by heavier and lighter social drinkers to the alcohol-related components of the composite alcohol-related and neutral viewing stimulus measured over a 30 second period.

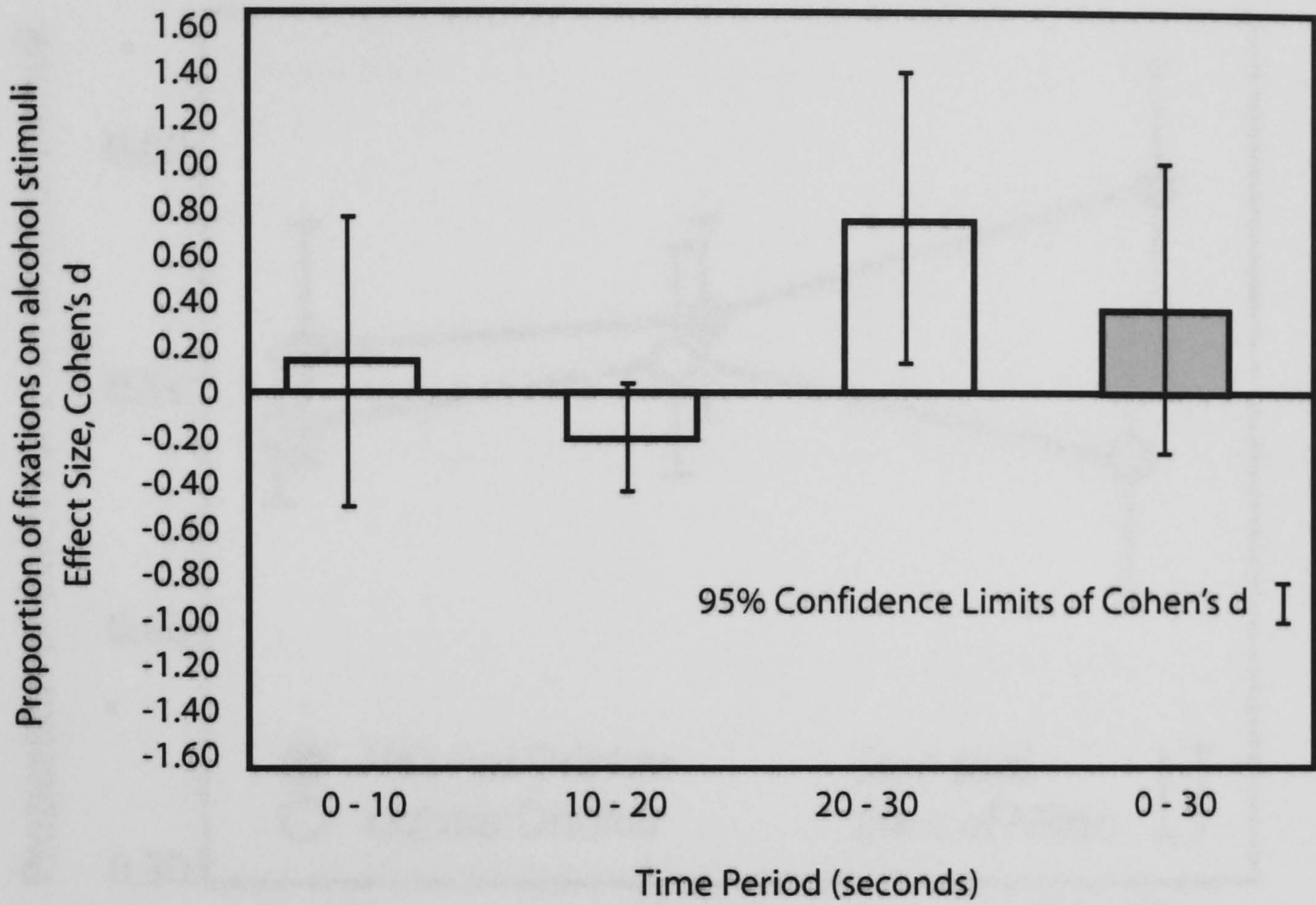


Figure 4.B.3. Proportion of dwell-times of the fixations made by heavier and lighter social drinkers to the alcohol-related components of the composite alcohol-related and neutral viewing stimulus measured over a 30 second period.

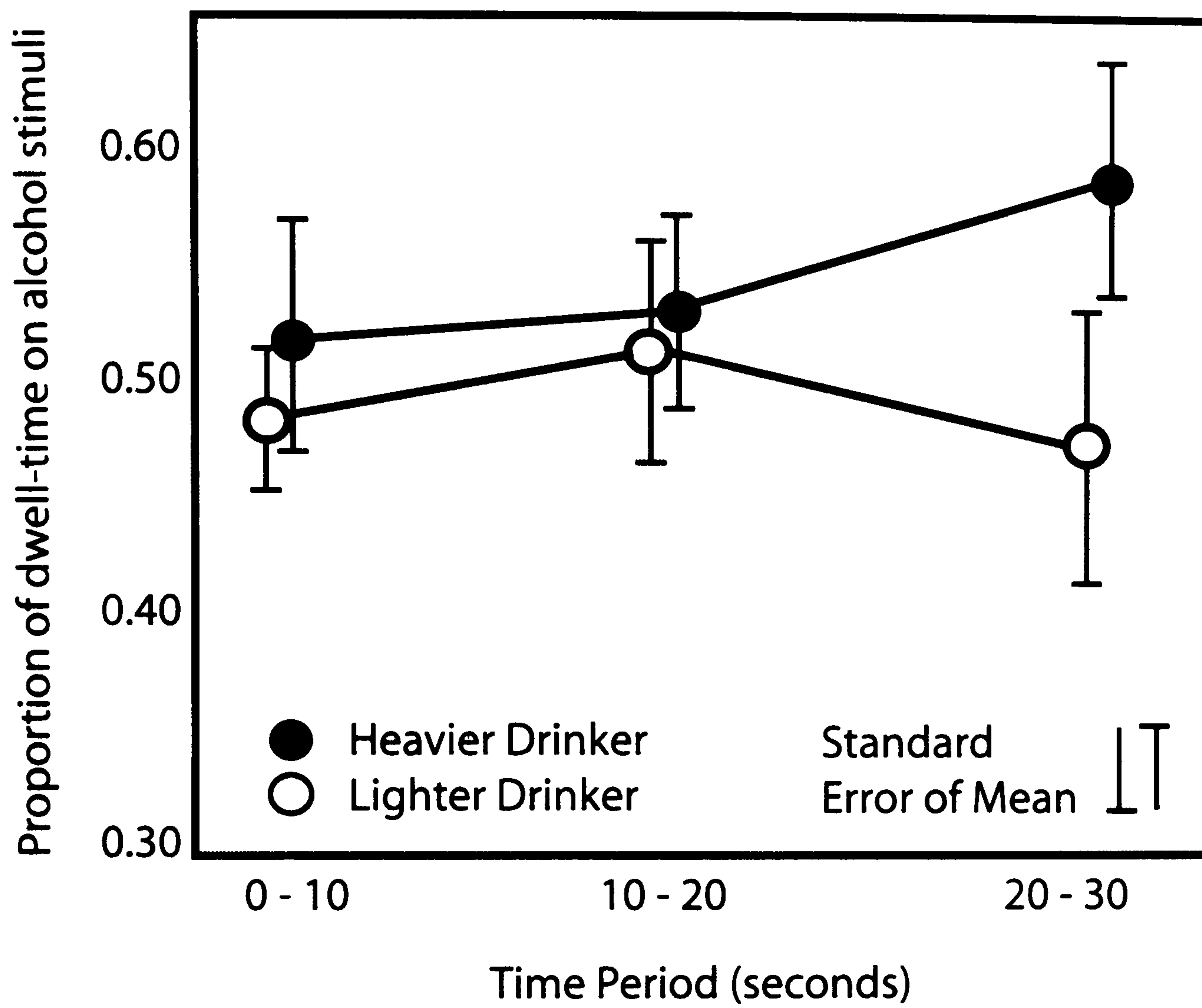


Figure 4.B.4. Effect sizes of the proportion of dwell-time of the fixations made by heavier and lighter social drinkers to the alcohol-related components of the composite alcohol-related and neutral viewing stimulus measured over a 30 second period.

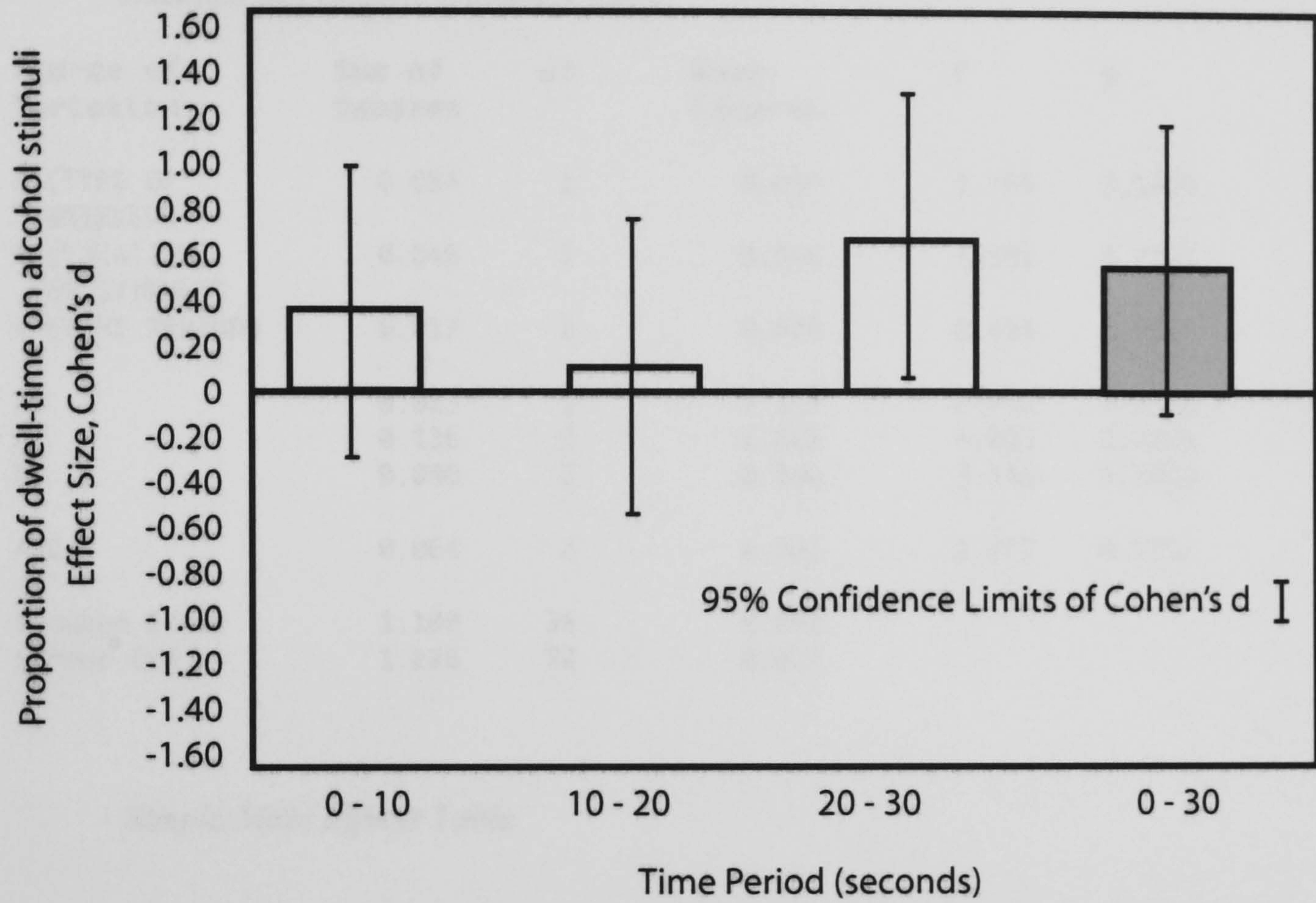


Table 4.B.1a. Analysis of Variance Summary Table and Simple Main Effects Table for Experiment B showing differences in Proportion of Fixations for the two factors Type of Drinker (Heavier or Lighter), Location of Stimuli (alcohol left neutral right, ALNR, or neutral left alcohol right, NLAR) and Time Period (0-10, 10-20, 20-30).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (TYPE OF DRINKER)	0.054	1	0.054	1.765	0.1924
B (LOCATION OF STIMULI)	0.046	1	0.046	1.501	0.2285
C (TIME PERIOD)	0.017	2	0.008	0.494	0.6121
AB	0.023	1	0.023	0.746	0.3936
AC	0.136	2	0.068	4.003	0.0225
BC	0.080	2	0.040	2.348	0.1029
ABC	0.064	2	0.032	1.872	0.1612
Between Error (Error CxS)	1.100	36	0.031		
	1.226	72	0.017		

Simple Main Effects Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
TYPEOFDRIN at					
0-10	0.003	1	0.003	0.161	0.6894
10-20	0.007	1	0.007	0.321	0.5721
20-30	0.129	1	0.129	5.992	0.0160
Error Term	2.326	108	0.022		

Table 4.B.1b. Analysis of Variance Summary Table and Simple Main Effects Table for Experiment B showing differences in Proportion of Time for the two factors Type of Drinker (Heavier or Lighter), Location of Stimuli (alcohol left neutral right, ALNR, or neutral left alcohol right, NLAR) and Time Period (0-10, 10-20, 20-30).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (DRINKER OF DRINKER)	0.167	1	0.167	5.699	0.0223
B (LOCATION OF STIMULI)	0.040	1	0.040	1.370	0.2496
C (TIME PERIOD)	0.006	2	0.003	0.154	0.8577
AB	0.049	1	0.049	1.657	0.2062
AC	0.113	2	0.056	2.890	0.0621
BC	0.077	2	0.039	1.990	0.1442
ABC	0.075	2	0.037	1.925	0.1534
Between Error (Error CxS)	1.055	36	0.029		
	1.402	72	0.019		

Simple Main Effects Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
DRINKER at					
1-10	0.024	1	0.024	1.075	0.3020
11-20	0.002	1	0.002	0.098	0.7548
21-30	0.201	1	0.201	8.818	0.0037
Error Term	2.457	108	0.023		

Chapter 5

ALCOHOL-RELATED ATTENTIONAL BIAS IN DRINKERS ON A TREATMENT PROGRAMME COMPARED WITH SOCIAL DRINKERS

Abstract

Using the flicker paradigm for induced change blindness (flicker ICB paradigm) Experiments 1-10 and Experiment A, reported in this thesis, and the two studies which were carried out prior to the inception of this thesis (B. C. Jones, B. T. Jones, Blundell and Bruce, 2002; B. T. Jones, B. C. Jones, Smith and Copley, 2003) have investigated AAB in social drinkers. No studies have, however, employed the flicker ICB paradigm to investigate AAB in alcoholics/problem drinkers.

Experiment C was designed to do this. Unlike all flicker ICB paradigm studies reported in this thesis which have employed the 2-change version of the paradigm Experiment C employed the original 1-change version. This is because when using drinkers in treatment and controls who are not, the potential problems in relation to group assignment (discussed in Chapter 6) of the 1-change flicker ICB paradigm, are avoided.

Using the 1-change flicker ICB paradigm an AAB is shown in drinkers in treatment as compared to those who are not. Furthermore, a correlation is shown between the level of problem severity and the time taken to detect the change, suggesting the flicker ICB paradigm to be a sensitive tool for measuring level of AAB at this level of drinking.

Introduction

The previous 11 experiments in this thesis and the related studies by B. C. Jones, et al. (2002) and B. T. Jones, et al. (2003) show that the flicker ICB paradigm is a useful addition to the tools for exploring attentional bias in different levels of social use. The paradigm has not yet been used to measure AAB in problem drinkers—i.e., in psychopathological drinking. A sleep-related attentional bias in individuals diagnosed with the sleep pathology, primary insomnia (Jones, Macphee, Broomfield, Jones & Espie, 2005), has been measured by the laboratory here with the flicker paradigm and the finding of a bias in insomniacs has been used to help evaluate models of this disorder. Experiment C extends the approach of this laboratory in psychopathological sleep to another psychopathology, chronic excessive alcohol consumption. This is for completeness, the earlier experiments in this thesis have compared the AAB between two relative points on the consumption continuum—lighter and heavier social drinkers. Experiment C is designed to compare problem drinkers with social drinkers. There is not yet any experiment that has used the flicker ICB paradigm to evaluate the AAB hypothesis in problem drinkers.

Using the traditional version of the flicker paradigm, in which there is only one change, (B. T. Jones et al., 2003), it is postulated that, first, excessive drinkers' change detection latencies will be shorter when the object carrying the change is alcohol-related than when it is neutral (an AAB); and, second, that social drinkers as an homogenous group will not show this, or will show a smaller difference. These two features of the predictions will be explained below.

First, the 2-change version of the flicker ICB paradigm. A two-change version of the traditional flicker ICB paradigm was used in Experiments 1 to 10—a flicker version that was published by B. C. Jones et al., (2002) following its earlier development by Bruce (2002). It has previously been argued in Chapter 1 that such a flicker ICB paradigm was advisable when the assignment of participant drinkers to

the different groups (i.e., lighter vs. heavier) might involve a lack of rigour since it is difficult to define lighter and heavier social drinkers in absolute terms—at least, it is difficult to get any degree of agreement across laboratories, cultures, etc. Group assignment is not a problem, however, when drinkers in treatment are being compared with drinkers who are not because a procedure—treatment admission—defines the groups. Consequently, in common with the sleep-related attentional bias study carried out by Jones et al. (2005) and in which group assignment was straightforward by clinical diagnosis (admission to treatment), Experiment C uses the traditional 1-change version of the flicker ICB paradigm. The AAB prediction, therefore, is made in Experiment C in terms of the change detection latency to alcohol OR to neutral changes made by two different groups of drinkers in treatment AND also by two different groups of social drinkers. This is rather than using the consumption of social drinkers detecting the alcohol-related change compared with the social drinkers detecting the neutral change as was the case with a 2-change version of the paradigm in which alcohol-related and neutral changes were simultaneously presented.

Second, an additional type of prediction can be made. Ryan (2002), with drinkers in treatment using the Stroop paradigm, has found that AAB increases with problem severity. Lusher, Chandler and Ball (2004), however, in a similar study have not (although, as discussed in Chapter 1, this might be as a result of the method use to test this—i.e., an ANOVA using a median split method to create two levels of drinker). If the data from Experiment C are to support Ryan, I would expect that the group of excessive consumers who are given the (single) alcohol-related change to detect would exhibit a negative relationship between the speed with which the change is detected and the severity of their alcohol problem. It would not be predicted that this be found in those excessive consumers given the (single) neutral change to detect. In other words, I test a *relational* AAB hypothesis (within the drinkers in treatment) in addition to the *difference* AAB hypothesis (between the social drinkers and drinkers in treatment).

If there is indeed a continuity of attentional bias along the alcohol consumption continuum (and the results of Experiments 1 to 10 and Experiment B are consistent with this), then there ought to be a continuation of this continuity into the realm of drinkers in treatment. Measuring consumption levels of drinkers in treatment is a problem, however, and in Experiment C, the lead of Lusher et al. (2004) is taken and problem severity is used as a proxy for consumption.

Method

Participants

Thirty-six patients (24 male, 12 female; *Mdn age* = 34 years, quartile range = 12, range = 23-60) treated by the Alcohol Problems Service of a Scottish hospital volunteered for the study. They met the criteria for alcohol dependence (DSM IV; APA, 1994); had completed the first five days of the program (including a reducing regime of chlordiazepoxide) and had no additional psychiatric diagnosis. Thirty-six social drinking staff and students opportunistically recruited from the campus and matched with problem drinkers for gender and approximate age (*Mdn age* = 31 years, quartile range = 11, range = 21-55) also volunteered.

Paradigm

The flicker ICB paradigm (Rensink, O'Regan & Clark, 1997) was used in Experiment C. In which the original stimulus (OS) was presented for 250 ms, followed by the mask (M) for 80 ms, then the changed stimulus (CS) for 250 ms. The OS-M-CS-M series was continuously presented until change detection—change detection latency was the total number of OS-M-CS and CS-M-OS changes to detection, completing a single flicker ICB task. A graphical representation of the paradigm is available in Figure 2.1.1 in Chapter 2. Unlike previous experiments, however, there was only one change, rather than the usual 2 simultaneous changes. This is described below.

Design

A 2x2x2 totally between participants design was adopted: Factor 1, Type of Drinker (problem, social); Factor 2, Type of Change to be detected (alcohol-related, neutral); Factor 3, Stimulus Orientation (alcohol-related stimuli on the left and neutral on the right, ALNR; neutral left and alcohol right, NLAR). The gender distribution of problem drinkers across the levels of factor 2 was designed to be equal and there was approximate matching for the number of times previously treated. Age was also randomized across these two levels; the median difference between experimental and control participants (2.3 years) was not significant. The dependent variable was change detection latency, CDL (the number of changes occurring before the change was detected). This is the dependent variable used in 1-change flicker paradigms and is different from the dependent variable used in 2-change flicker paradigms (Experiments 1 to 10 of this thesis). This difference was fully discussed in Chapter 1.

In common with the previous uses of the flicker ICB paradigm to measure attentional bias (B. C. Jones et al., 2002; B. T. Jones et al 2003; Jones et al 2005), participants were given only one single flicker ICB task (in the current case, to detect either the alcohol-related or the neutral change). Although this practice generates only one data point per participant which is less powerful than if there were many such data points, self-reports from participants who took part in pilot studies and who were given multiple flicker ICB tasks revealed that most of them quickly developed search strategies that compromised the process of measuring bias. Unconventionally, but for this good reason, Factor 2 is designed to be a between rather than within factor—and it is also the reason why practice trials have never been given in the earlier flicker studies, nor in the current one.

Apparatus and Proforma

An Apple G3 PowerBook (Mac OS 9.1) with Psyscope v1.2.5 (Cohen, MacWhinney, Flatt & Provost, 1993) was used to implement the paradigm. The

viewing distance was 60cms. Participants indicated they had detected a change by pressing the keyboard's space bar.

Stimuli

In common with Experiments 1 to 10, the OS comprised a matrix of 18 photographs of 9 alcohol-related and 9 neutral (household) objects on each side (see Figure 5.C.1a). The 9 pairs of alcohol-related and neutral objects were selected so that their physical properties (colour, height, width, shape) were generally similar (see Figure 2.1.4 in Chapter 2). Also in common with earlier experiments, the two sets of 9 photographs were each arranged in two 3x3 matrices set in a 3x6 landscape matrix—with items of each matched pair occupying corresponding positions across their respective matrices. The CS with the alcohol-related change was identical to the OS except that the object at the centre of the alcohol matrix was replaced with a new object (see Figure 5.C.1b).

There was a second CS with a corresponding neutral replacement (see Figure 5.C.1c). The 2 different CS with their common OS represented the two levels of factor 2, nature of change. Finally, bilateral reversals of each of the OS and the 2 CS were made, for the 2 levels of Factor 3, ALNR and NLAR. The single mask comprised rows of upper case, 20-point Xs in Times font.

Note that unlike the earlier 2-change experiments, each of the two CS carried only one change in this experiment.

An alcohol timeline followback (TLFB, based on Sobell & Sobell, 1992) was used to collect alcohol consumption and other demographic information.

Procedure

Participants were invited to take part in a bogus evaluation of the relative ease with which patients and students might use laptop and desktop computers in hospital waiting room and university common room settings—by playing a “spot the difference” game. They were told they were in the laptop group. This minor deception followed the practice in earlier experiments. Those who agreed were taken to a quiet area and asked to look at two almost identical pictures “flicked back

and forth” on the screen and to detect the difference between them as quickly as possible and indicate that they had detected a change by quickly pressing the space bar. To help offset the lack of practice trials, detailed instructions were presented on a number of screens and progression through them was self-paced by the participant pressing the space bar (thereby also learning the direction and weight of manual response required by the flicker ICB task). Once the change detection response had been made, participants described it to the experimenter to check whether it had been correctly detected. Social drinkers were then asked to complete a timeline followback sheet (Sobell & Sobell, 1992) for the previous seven days’ consumption. If they endorsed it as an ‘atypical week’, they not included in the analysis of Experiment C

Ethical approval for the procedure including the minor deception was given by the Ethics Board of the NHS Trust in which the treatment centre was located and the University Ethics Board.

Results

All participants made correct detections and it was not necessary to remove any participants’ data prior to analyses. The main hypothesis under test (Hypothesis 5.C.1 was that CDL for the alcohol-related change will be less than for the neutral change in the problems drinkers but not in the social drinkers. It would appear that the problem drinkers who were given the alcohol-related change detected the change ($M = 29.3$ flicks, $SD = 11.9$) more quickly than the problem drinkers who were given the neutral change ($M = 58.7$, $SD = 21.1$). The reliability of this observation is formally tested in the ANOVA reported below.

Analysis of Variance – A difference AAB

It was postulated (Hypothesis 5.C.1) that problem drinkers would detect the alcohol-related change more quickly than the neutral change but social drinkers would show no difference in CDL for the alcohol-related change than the neutral change (i.e., for problem drinkers the CDL would be less for the alcohol-related

change than for the neutral change where as with social drinkers there would be no difference).

The ANOVA revealed a main effect for Factor 1 (Type of Drinker) in which problem drinkers M CDL was and was 44.00 and social drinkers M CDL was 65.78. This was however modified by the following interaction, which as predicted supported the AAB hypothesis in problem but not in social drinkers. Table 5.C.1 shows the ANOVA source table.

An interaction between type of drinker and type of change, was found ($F(1, 64) = 4.62, p < .05$ —see Figure 5.C.1). Simple main effects (see Table 5.C.1) revealed that problem drinkers' change detection latency for the alcohol-related change ($M = 29.3, SD = 11.9$) was smaller ($F(1, 64) = 5.14, p < .05$) than for the neutral change ($M = 58.7, SD = 21.1$)—an AAB in problem drinkers, the effect size of which is significant (Cohen, 1992) $d = 1.74$ (“large”, 95% confidence limits were 2.44 and 0.92). Social drinkers' change detection latency for the alcohol-related change ($M = 70.8, SD = 37.4$) and the neutral change ($M = 60.8, SD = 41.25$), however, were not different—no AAB in problem drinkers (effect size, $d = 0.24$; “small”, 95% confidence limits were -0.41 and 0.89, enclosing the zero value and, therefore, not significant).

There were no main effects of Factor 2 (Type of Change) nor Factor 3 (Stimulus Orientation) and no other interactions were significant.

An alternative way of conceptualising the effect size is to measure it to the alcohol-related change only. It was postulated (Hypothesis 5.C.2) that there would be a reliable effect size for the difference in CDL between problem drinkers and social drinkers for the alcohol-related change. This was supported—problem drinkers detected the alcohol-related change relatively quickly ($M = 29.3, SD = 11.9$) and social drinkers relatively slowly ($M = 70.8, SD = 37.4$).

The effect size in this case was $d = 1.50$ (“large”, 95% confidence limits were 0.73 and 2.20, significant because the zero value was not enclosed). The corresponding effect size measure by the neutral change was $d = 0.0$ (“negligible”,

95% confidence limits of -0.72 and 0.5 , not significant because the zero value is enclosed).

Correlations – A relational AAB

In addition to the above ANOVA and effect sizes, correlation analyses were also carried out. It was postulated (Hypothesis 5.C.3) that for problem drinkers that there would be a significant negative correlation between CDL to detect the alcohol-related change and problem severity—i.e., the less severe the problem the longer it would take to detect the change. This was supported—a negative correlation which reached significance ($r = -0.51$, $n = 18$, $p < .05$) was shown between CDL and problem severity and (severity indexed by the number of times previously treated). The corresponding correlation in the 18 problem drinkers given the neutral change was positive but did not significantly deviate from zero ($r = 0.14$, $n = 18$, $p > .05$). The directional prediction derived from the AAB hypothesis in problem drinkers—that the former correlation would be more strongly negative than the latter—was also confirmed ($z = -1.929$, $p = .027$; Sokal & Rohlf, 1973, p 276).

Finally, although not directly comparable to the problem drinker analysis, the correlation between typical weekly consumption and change detection latency was calculated for social drinkers who were given the alcohol-related change ($r = 0.18$, $n = 18$, $p > .05$) and those given the neutral change ($r = 0.04$, $p > .05$)—they were not significantly different. The *difference* AAB found with the flicker ICB paradigm by Jones et al. (2003) between lighter and heavier social drinkers is not, therefore, manifest as a *relational* AAB in the social drinkers' data above. Jones et al., however, specifically selected for groups of lighter and heavier social drinkers to test the difference AAB whereas the current controls were opportunistically recruited (subject to certain matching criteria described earlier). A likely reason for this apparent inconsistency is that the variation in consumption of the current control group of social drinkers ($M = 10.8$, $SD = 3.1$ UK units of alcohol per week; $Mdn = 7.3$ units, semi interquartile range = 2.2) is much smaller than in the bimodal distribution of social drinkers used by Jones et al. (lighter drinkers $M = 3.6$ units, SD

= 2.9; heavier drinkers $M = 19.7$ units, $SD = 8.3$; combined $Mdn = 12.9$ units, semi interquartile range = 7.1, not published in Jones et al.), with a commensurate reduction in opportunity to detect a relationship.

Summary of Results

The changes referred to below are changes implemented as object replacement.

Hypothesis 5.C.1 In problem drinkers CDL for the alcohol-related change will be less than for the neutral change. In social drinkers, there will be no such difference. This was supported.

Hypothesis 5.C.2 There would be a reliable effect size for the difference in CDL for the alcohol-related change between problem drinkers and social drinkers. This was supported.

Hypothesis 5.C.3 There would be a negative correlation between CDL to detect the alcohol-related change and problem severity for problem drinkers. This was supported.

Discussion

An AAB in drinkers in treatment has been found with a 1-change flicker ICB paradigm which adds this paradigm to the list of paradigms that have been shown to find AAB in drinkers in treatment. This paradigm also increases the types of paradigm in which visual attention to one spatial location rather than another is measured in problem drinkers.

As, for example, Rensink et al. (1997), Scholl (2000), Simons and Rensink (2005), and Turatto, Bettella, Umiltà and Bridgeman (2003) describe, change detection within the flicker ICB paradigm entails attention being sent to the objects ‘out there’ carrying the change. They claim that in the absence of a local visual transient that would normally register the change, a change would be most quickly detected in “areas of interest”—although “interest” is poorly specified in their writings. As explained in Chapter 1, in the case of chronic excessive consumers of

alcohol, photographs of alcohol-related objects (set alongside neutral objects) should comprise such an area of interest. Such areas of interest are also defined within the context of Robinson & Berridge's (2003) Incentive-Sensitization theory. They posit that the neurophysiological processes that accompany the rise from social to excessive consumption "... transform neural representations of otherwise neutral stimuli into salient incentives, able to "grab" attention [making] them attractive and "wanted"." (Robinson & Berridge, 2003, p 42). Experiment C's data are consistent with this view. The data also provide the strongest support yet for others' speculation based on textual Stroop AAB data. Namely, that if the textual Stroop effect extrapolates from the laboratory to "real life," then it would mean that problem drinkers more than social drinkers "... would be more likely to *notice* alcohol-related stimuli in the *environment* ..." and that it could "... mediate the maintenance of their addiction by producing craving." (Lusher et al., 2004, p 229; my added italics). Less controversially but in a similar vein, Lusher et al. (p 229) also observe that such a bias would make "the drinker want to drink alcohol by [seeing] stimuli that capture attention and remind them of drinking."

Experiment C's data is consistent with this point of view. There is also the data from Experiments 1 to 11 that is also consistent with this view but extended to the region of social drinking.

In addition to this, the data show in excessive consumers that the alcohol-related (but not the neutral) change detection latency is negatively correlated with severity of alcohol problem indexed by the number of times previously treated. Using an appropriate statistical test, this correlation is significantly stronger than the corresponding correlation between neutral change detection latency and severity and this difference is in the direction predicted by the AAB hypothesis. Although Lusher et al. (2004) found no relationship between problem severity (SADQ scores) and Stroop AAB—and concluded that chronic excessive consumption *per se* rather than the *extent* of the consumption might drive AAB—their conclusion is limited by their use of a difference rather than a relational test of severity, based on a median split method of group assignment.

The finding in Experiment C is supported by Ryan (2002), however, who found a similar relationship using regressions between a clinical group's Stroop AAB and their SADQ scores. Together Experiment C and Ryan's relational data with chronic excessive consumers are consistent with Robinson and Berridge's (2003) view that there is a *progressive* increase in the ability of drug-related stimuli to grab attention as drug use or drug dependence increases.

Such a progressive increase might also be manifest across different levels of social drinking—several studies with different paradigms have found an AAB in heavier, frequent as compared with lighter, infrequent social drinkers (e.g., Bruce & Jones, 2004, Stroop; B. C. Jones et al., 2002; B. T. Jones, et al., 2003, flicker; Townshend & Duka, 2001, dot-probe—as well as the data from Experiments 1 to 10 in this thesis). The relational AAB data from chronic excessive consumers (coupled with the difference AAB data from social drinkers) has led to suggestions elsewhere (e.g., Bruce & Jones, 2006) that there might be a graded continuity of attentional bias along the consumption continuum rather than, as Lusher et al. (2004) suggest, a discontinuity.

The failure to find a relational AAB in the current control group of social drinkers speaks against this, however, but as explained in an earlier section, this was probably because of the relatively small variation in consumption as compared with, for example, B. T. Jones, et al.'s (2003) study.

The conclusion that the flicker ICB paradigm reveals a difference AAB in excessive consumers as compared with social drinkers—and the importance attached to it for drinking decisions in terms of visual capture by objects 'out there'—is limited by Experiment C's use of a single alcohol-related and a single neutral object carrying the change-to-be-detected. As a result, there remains the possibility that the finding might not generalize to other stimuli.

This possibility seems unlikely, however. First, using this paradigm, a corresponding AAB was found by B. T. Jones et al., (2003) in heavier, frequent as compared with lighter, infrequent social drinkers with a quite different *set* of alcohol-related and neutral stimuli, *configured* differently and with different single

alcohol-related and neutral stimuli within the set *carrying* the change. Second, from Experiments 1 to 10 it has been shown that the AAB found in heavier, frequent as compared with lighter, infrequent social drinkers remains when new stimuli are used to carry the change and when the sort of change used is varied.

Finally, as discussed earlier a single alcohol report using the dot probe paradigm (Stormark et al. 1997) has shown that the AAB when measured with a dot probe paradigm might comprise two components: an initial orienting component during the first few hundred milliseconds and a subsequent orientation away (in the alcoholics). Stormark et al. and subsequently Noel et al., (2006) have interpreted this as the approach/avoid behaviour that is seen in alcoholics. Similar behaviour has been found by Mogg and colleagues with smoking addicts and was discussed earlier in this thesis). Why has this approach/avoidance not been found as a feature of the study reported in this chapter?

It is difficult to know what sort of behaviour this might represent in the current flicker ICB paradigm study. The flicker ICB paradigm predicates on attention being directed towards an object before a change carried by the object can be spotted—conversely, spotting the change means that attention has been directed towards the object carrying the change. For this reason, change detection latency has been taken in this thesis as representing the extent to which attention has been directed towards the said object—a measure of AAB.

If Stormark et al and Noel et al. are correct in their explanation of the behaviour they see (approach for 2-300 msec and then avoidance), it is difficult to know why the flicker data does not show a LONGER not shorter change detection latency by alcoholics to the alcohol-related change. This would be more compatible with Stormark et al. and Noel et al. that the data this chapter records.

It is possible that the dot probe paradigm shares the difficulties described for other brief exposure paradigms elsewhere in this thesis (the previous chapter) and that the approach/avoidance behaviour Stormark et al. and Noel et al. have found is an artefact of the simple (artificial) conditions that I have described these paradigms as representing—conditions of test that are avoided with the flicker paradigm. This

remains speculation, of course, but the (prolonged) avoidance seen in Stormark et al.'s and Noel et al.'s alcoholics is not seen in the current data.

Figure 5.C.1. The Original (OS) and Changed (CS) stimuli used in the 1-change flicker ICB paradigm of Experiment C.

1a Two Original Stimulus, OS

(alcohol-left, neutral right, AN and neutral-left, alcohol-right, NA)



1b Two Changed Stimuli, CS-alcohol-related-change

(alcohol-left, neutral right, AN and neutral-left, alcohol-right, NA)



1c Two Changed Stimuli, CS-neutral-change

(alcohol-left, neutral right, AN and neutral-left, alcohol-right, NA)



Figure 5.C.2. Alcohol-related attentional bias (AAB) shown by problem drinkers but not by social drinkers using the 1-change flicker ICB paradigm of Experiment C.

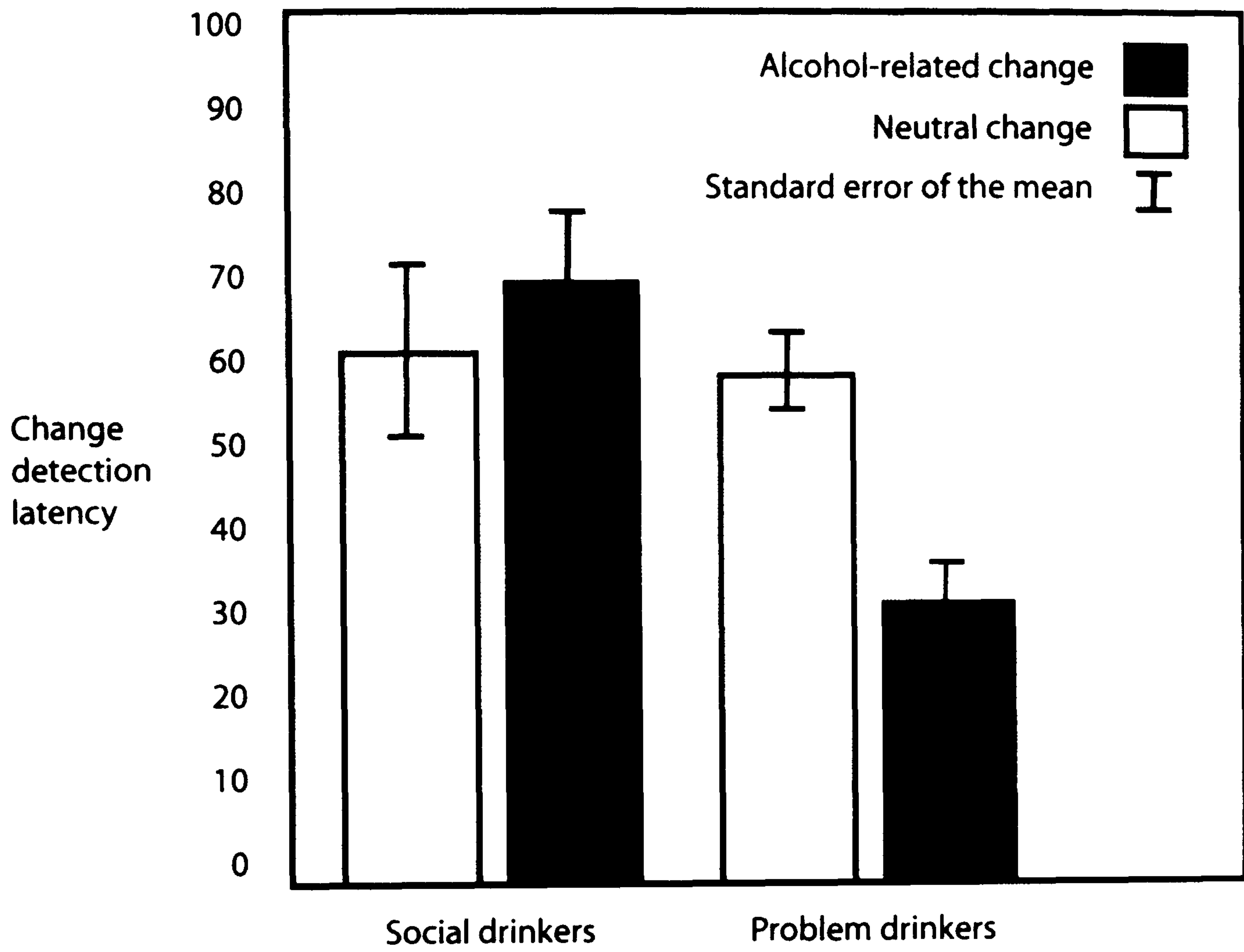


Table 5.C.1. Analysis of Variance Table showing differences in Change Detection Latency for the three factors Type of Drinker (problem or social), Type of Change to be detected (alcohol-related or neutral) and Stimulus Orientation (alcohol left neutral right, ALNR or neutral left alcohol right, NLAR).

Analysis of Variance Summary Table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
A (TYPE OF DRINKER)	8536.889	1	8536.889	5.662	0.0203
B (LOCATION OF CHANGE)	50.000	1	50.000	0.033	0.8561
C (TYPE OF CHANGE)	1682.00	1	1682.00	1.116	0.2948
AB	1760.22	1	1760.222	1.168	0.2840
AC	6962.00	1	6962.000	4.618	0.0354
BC	227.556	1	227.556	0.151	0.6989
ABC	43.556	1	43.556	0.029	0.8656
Error	96488.89	64	1507.639		

Simple main effects table

Source of Variation	Sum of Squares	df	Mean Squares	F	p
TYPE OF CHANGE at ALCOHOL	15458.778	1	15458.778	10.254	0.0021
NEUTRAL	40.111	1	40.111	0.027	0.8709
Error Term	96488.889	64	1507.639		
TYPE OF DRINKERS at PROBLEM	7744.000	1	77744.000	5.137	0.0268
SOCIAL	900.00	1	900.00	0.597	0.4426
Error Term	96488.889	64	1507.639		

Chapter 6

DISCUSSION

The first two experiments (Experiments 1 and 2) reported in Chapter 2 were designed to replicate and extend the AAB finding of my original pre-doctoral study (B. C. Jones, B. T. Jones, Blundell & Bruce, 2002). To do this the flicker paradigm for induced change blindness (flicker ICB paradigm) was again used and, like the original study, contained two simultaneous changes. In contrast to the original B. C. Jones et al. study, however, the stimuli were more carefully chosen (i.e., they were controlled) so that pairs were created in which each alcohol-related object had a corresponding neutral object which was similar in shape, colour and form. Furthermore, although the complexity introduced in the original study was maintained in terms of the number of stimuli used, a more formal layout was employed so that it could be systematically manipulated if required in subsequent experiments. Finally, the method of implementing the changes was extended from object rotation—the only method employed in the original B. C. Jones et al. study—to also include object replacement. With these new extensions, an AAB in heavier social drinkers as compared with lighter social drinkers was found in both Experiments 1 and 2, supporting the AAB found in the original study (B. C. Jones et al.).

A further replication of B. C. Jones et al. (2002) and of Experiments 1 and 2 was reported in Chapter 2 (Experiments 3 and 4). This replication was designed to ensure that the target objects used in Experiments 1 and 2 were not responsible for the AAB that was observed there. With the exception of the introduction of new target objects to carry the rotational and replacement changes, Experiments 3 and 4 were identical in all other ways to Experiments 1 and 2. In accord with the original study (Jones et al.), and with the results of Experiments 1 and 2, an equivalent AAB was found—suggesting the flicker ICB paradigm to be robust across different stimuli, different stimuli layout, different target objects and different methods of change implementation.

In Chapter 2, Experiment A was also reported, in which the finding with pictorial stimuli (B. C. Jones et al., 2002, and Experiments 1-4) was extended to the more traditionally used stimuli in AAB research—textual stimuli. Although only significant at the 1-tailed level, an AAB was found; further increasing the generalisability of the AAB finding with the 2-change flicker ICB paradigm.

Taken together, the results of the five experiments reported in Chapter 2, alongside the original study (B. C. Jones et al., 2002), suggest that the flicker ICB paradigm reliably reveals an AAB in heavier as compared with lighter social drinkers. What remains unclear, however, is what is driving change detection. For example, on the one hand attentional resources might have been primarily and initially allocated to the larger contexts (in which the targets were set) and the change of the target was detected secondarily and subsequently, because attention was already allocated to that particular region. On the other hand, attention might have been drawn to the changing target because of some attribute of the change, itself. The experiments reported in Chapter 3 sought to resolve this issue.

Two “opposite context” experiments (Experiments 5 & 6) were reported in Chapter 3 in which the alcohol-related target object was positioned within the overall neutral context and the neutral target object within the overall alcohol-related context (in contrast to Experiments 1-4 in which the alcohol-related target object was located within the overall alcohol-related context and the neutral target object was located within the overall neutral context). Experiments 5 and 6 provided only limited resolution of the issue. A 1-tailed AAB was found in one of the two experiments suggesting that the context, not the target, was driving change detection.

The four remaining experiments reported in Chapter 3 extended the testing of this still unresolved issue. First, Experiments 7 and 8 employed the same overall layout as all previous experiments (including Experiments 5 and 6) with an alcohol-related context and a neutral context. Unlike all other experiments (and particularly unlike Experiments 5 and 6), however, both target objects were identical—either both alcohol-related or both neutral. With this configuration it was shown that the

differential AAB that was found was consistent with the context rather than the changing targets. This supported the limited finding from Experiments 5 and 6

Finally, to test whether an AAB could be manifest from different targets but when no differential information was provided from the overall context, Experiments 9 and 10 were designed. Under these circumstances, although the changes were eventually detected the AAB hypothesis was not supported—consistent with the hypothesis suggested in experiments 5 and 6 and confirmed in Experiments 7 and 8.

Taken together, Experiments 1-10 and Experiment A have shown, first, the generalisability of the flicker ICB paradigm in revealing an AAB. Second, they have shown that the overall context within which an object is located, rather than the target object, itself, is responsible for driving change detection. These 11 experiments were carried out with social drinkers not with problem drinkers.

Experiment C in Chapter 5 was designed to extend this research with the flicker ICB paradigm to include drinkers in treatment.

Experiment C was carried out because it had not yet been established that the traditional AAB (in drinkers in treatment as compared to those not in treatment) could be demonstrated with the flicker ICB paradigm. Although failure to find a traditional AAB with the flicker ICB paradigm with these participants would have been surprising, it, nevertheless, remained to be seen. Unlike Experiments 1-10 and Experiment A, the 1-change version of the paradigm was appropriate for testing drinkers in treatment against drinkers not in treatment because group assignment could be unambiguously achieved. Consequently, in Experiment C, although the same stimuli and layout were employed, only a single change was implemented for each participant. Experiment C revealed an AAB in alcoholics over social drinking controls, indicating that the flicker ICB paradigm provides a feasible method of measuring AAB in drinkers in treatment.

Finally, in summary, in Chapter 4, a change in the method of measuring attentional bias was implemented—continuous eye-movements were monitored (Experiment B). The same basic stimuli were used as in *all* earlier experiments but the measurement was not change detection but eye-movements to the individual

components of the stimuli. In other words, the flicker ICB paradigm was eschewed in favour of continuous eye-movement monitoring over a period very approximately equivalent to the time taken for change detection. In line with the flicker ICB paradigm studies reported in previous chapters, simple gaze measurements revealed and AAB in a group of heavier, as compared with a group of lighter social drinkers.

The series of experiments using the both flicker ICB paradigm described above and continuous eye-movement monitoring bring two new methods of exploring AAB to the attentional bias literature. In doing so they not only increase the robustness of the finding of an AAB in social drinkers, which at the inception of this thesis was both limited (by the number of studies investigating it) and inconsistent (in the findings of these studies), but in addition provide evidence for the generalisability of the flicker ICB paradigm across a variety of stimuli, layouts, mode and level of drinker.

How do these two quite different approaches to measuring AAB add to what is currently known?

Prior to the inception of this thesis B. T. Jones, B. C. Jones, Copley and Smith (2003) carried out the first study in which the flicker ICB paradigm was used to investigate AAB in social drinkers. This study used the traditional version of the flicker ICB paradigm in which a single change was employed (see page 47 of Chapter 1 for further details)—although widely used in studies of visual perception the flicker ICB paradigm had not been used to investigate attentional bias prior to the B. T. Jones et al. study. The Stroop, visual dot probe, Posner, artificial grammar learning, and dual task paradigms had been used prior to 2003. Although each of these paradigms appear to differ from the others, they have major similarities. They all share having an instructed task and a distracter task (see Chapter 1)—and they are also similar in that they all use artificially simple stimuli presented within artificially simple contexts for artificially short periods of time. In the Stroop paradigm for example stimuli are generally single words presented on either a white or black background for less than 1 second, while in the visual dot probe paradigm pairs of

words or pairs of simple pictures are presented on a black or white background, generally for less than 1 second (some studies have employed 2 seconds). Moreover, the instructed task is usually very (artificially) simple, e.g., name the colour of ink in which the word is presented, or press a button that corresponds to the location of a dot appearing. Taken together the simplicity of the stimulus and the simplicity of the task might be problematic. For, as discussed in Chapter 1, in other areas of psychology (e.g., vision, Marr, 1982 and learning, Seligman, 1970) researchers have been misled in developing theory when simplicity of stimulus, simplicity of context and simplicity of instructed task have been adopted on the back of starting simple and then developing complexity. Where complexity refers to real world stimuli, contexts and tasks, both Seligman and Marr review how starting simple can dangerously develop principles that can be consistently replicated but are invalid representations of the real world. If this criticism can be extended to the representation of AAB in brief exposure paradigms, the AAB measured by these paradigms may not be a valid representation of cognitive processes which are active in real world situations which are more complex.

In an attempt to address this possible potential problem in AAB research, the flicker ICB paradigm was introduced to provide a new and potentially more valid method of measuring AAB (B. T. Jones et al., 2003). The advantages of the flicker ICB paradigm over the traditionally used brief exposure paradigms are discussed below in more detail.

Flicker Paradigm for Induced Change Blindness

Single change version of the paradigm

The use of the flicker ICB paradigm has involved a higher level of complexity in the stimuli themselves, their layout and by employing a time period which exceeds those of the brief exposure paradigms. In doing so it is argued that the flicker ICB paradigm brings to the AAB literature a measure which provides a closer representation of real life experiences.

Complexity of Stimuli and layout.

The criticism of using simple stimuli which might not generalise to the real world is not unique to the AAB literature. It has already been noted in relation to using textual stimuli in investigating attentional biases in the threat literature (e.g., Mansell, Clark, Ehlers & Chen, 1999) and also in investigating biases in studying snake fear, in which Constantine, McNally and Hornig, (2001) have suggested that when concerns are linked with visual cues (e.g., in snake fear) as compared with non-visual cues (in which they use the example of fear of heart-attack) then textual stimuli appear to induce less of a response. As a result, this has led to the use of pictorial stimuli in some studies using brief exposure paradigms—pictorial Stroop tasks, for example, have been employed in investigating attentional biases in areas such phobias, but these have tended to use overly simplistic pictorial stimuli such as line drawings. Marr (1982), for example, review the work on visual recognition that has used line drawings and recorded how inappropriate and misleading it is for developing theory. In an attempt to improve on such stimuli, Bruce & Jones (2004) have employed photographs of objects and more importantly scenes in their pictorial Stroop study and similarly, Field, Mogg and Zetteler and Bradley (2004) have used photographs in their visual dot probe. While these pictorial stimuli might indeed be more complex and therefore improve on stimuli comprising text or line drawings, they are still presented in an artificial context (usually on a white or black background) either individually or in pairs and for artificially short time periods.

In the flicker ICB paradigm, however, there is not only the possibility of employing more complex individual stimuli such as photographs, but also the opportunity to move away from the usual one or two stimuli per trial found in the brief exposure paradigms to presenting many competing alcohol-related and several neutral components within each trial. Accordingly, with an increase in the number of stimuli which can be presented within one trial there comes the opportunity for a range of more complex overall layouts to be adopted and compared.

In relation to smoking, Mogg, Field and Bradley (2005) have pointed to the need for more ecologically valid measures of attentional bias and although using the

type and layout of stimuli described in the preceding paragraph in the flicker ICB paradigm might go some way towards this improvement, there are opportunities when using this paradigm to take this improvement even further as it is not necessary to employ rigid experimental layouts, but stimulus arrays can be employed which are much closer to real world scenes. These could, for example, take the form of table-top scenes, room scenes or street scenes. Both B. C. Jones et al. (2002) and B. T. Jones et al. (2003) have used table-top scenes in their flicker ICB paradigm studies and Bruce and Jones (2004) used street and room scenes in their Stroop paradigm studies found an AAB.

Although this thesis recognises the need for more ecologically valid stimuli and stimulus layouts, for reasons discussed in earlier chapters a position is adopted in this thesis' experiments *between* the paucity of information contained in brief exposure paradigm stimuli and the richness of info contained in photos of real world scenes. As such, this thesis work represents a step along the path to ecological validity (rather than an arrival there).

Time.

In addition to the issue of stimulus complexity discussed above, the flicker ICB paradigm addresses another of the potential problems with the brief exposure paradigms—the duration of stimulus presentation. In the brief exposure paradigms stimuli are generally presented for less than 1 second (although there some studies which have used slightly longer presentation times). This has been criticised by Mogg et al. (2005) who suggest that such short times only provide a “‘snapshot’ view of the allocation of attention” which is unlike real world viewing. In the flicker ICB paradigm, however, this problem is avoided as although like in the brief exposure paradigms the stimulus array is only presented for a short period (less than 1 second) it is then, following a short disruption, replaced with a second stimulus array which, with the exception of a change, is identical to the first. This cycle is repeated until the change is detected and it might be said that until the participant actually detects the change that they are effectively looking at the same array time

and time again. In other words, the same scene is effectively presented for an extended period of time—consequently allowing a cumulative picture to be developed. This is not only likely to be more representative of real life experiences than in brief exposure paradigms but also, if attention is necessary to detect the change as proposed by many visual perception researchers (e.g., Simons & Ambinder, 2005), then it is likely to provide a better measure of the allocation of attention than in brief exposure paradigms. Consequently, a measure of AAB can be obtained over a longer time period using the flicker ICB paradigm. This might be potentially important as there is some evidence from brief exposure paradigm research that AAB decreases with time—Sharma, Albery and Cook (2001) suggested that similar to the habituation shown using the Stroop paradigm with emotion stimuli (e.g., McKenna & Sharma, 1995) habituation (resulting in a decrease in observed AAB) might occur over time in the alcohol Stroop. While Sharma et al. reported no “substantial statistical evidence” for this, Bruce and Jones (2004) found a decrease in their measured AAB from the first to final block of their Stroop study.

If such habituation is, in fact, a feature of brief exposure paradigms then this would suggest that there is a lessening impact of the alcohol-related stimuli with repeated presentation leading to a decreased AAB. This, however, seems to be unusual especially if, as reported in the alcohol cue-reactivity literature in which exposure to alcohol-related cues has been shown to relate to an increase in the desire to consume alcohol and suggested by, for example, Franken (2003) and Ryan (2002), attentional bias provides the link between drug-related stimuli and subsequent decisions regarding use then a such a reduction in attentional bias over time contrary to this prediction. More research on this aspect of AAB is needed and is one way in which the flicker ICB paradigm can add knowledge.

Task Difficulty.

In line with the artificially simple features discussed above which are typical characteristics of brief exposure times, the instructed task in such paradigms might also be described as artificially simple. In the Stroop paradigm, for example,

participants are asked to respond to the colour of a single alcohol-related or single neutral stimulus. Whereas in the original Stroop task, in which the stimuli comprised the names of colours and resulted in a conflict between the semantic properties of the word (i.e., the word itself) and its perceptual properties (i.e., the colour in which it is presented), such a cognitively demanding conflict is absent in the alcohol Stroop. Consequently, participants are being asked to make a simple judgement on a single simple stimulus presented for a brief period of time which is quite unlike real word experiences. In the real world, for example, individuals are generally required to engage with a rich environment which involves multiple ongoing complex cognitive processes competing for dominance and (attentional) resources.

In the flicker ICB paradigm, although the task itself—change detection—might appear relatively simple, the complexity of the stimulus and the stimulus layout coupled with the length of time of view mean that the change is in practice difficult to detect. This has been shown in the general flicker ICB paradigm literature in which even large changes which would be thought to be easily detected go unnoticed for longer than would be expected (e.g., Hollingworth, Shrock and Henderson, 2001; Scholl, 2000). Moreover, with the extended viewing period (coupled with the more complex stimuli and layouts) there is more opportunity for the competing complex cognitive processes that occur in parallel in real life to occur—increasing the ecological validity of whatever AAB might be found

Conclusions on the use of the 1-change flicker ICB paradigm.

It would therefore appear, that the 1-change flicker ICB paradigm might provide a new method of measuring AAB which might have advantages over those which have traditionally been employed. This is because it provides a test which employs more complex stimuli, set in a more complex context and presented for a more realistic time period suggesting that it might provide a step towards it being more related to real life experiences. Nevertheless the 1-change flicker ICB paradigm retains some of the problems of the brief exposure paradigms. For these

reasons the 1-change flicker ICB paradigm was modified to include 2 simultaneous changes to create a 2-change version of the flicker ICB paradigm. The advantages of using the 2-change paradigm are discussed below.

Two change version of the paradigm

My development of the 2-change flicker ICB paradigm takes with it all the advantages offered by the 1-change version—traditionally used in visual cognition and scene perception research that has had a new application in alcohol, cannabis and sleep attentional bias research referred to in Chapter 1—but also adds a number of additional advantages that emerge when the research goal is to explore AAB between lower and higher drinking social drinkers. First, it helps solve a problem inherent in dividing social drinkers into lower and higher drinking groups. Second, it helps reduce the variability inherent in measuring change detection latency (whether in terms of reaction time or number of change-cycles to change detection). Finally, it might provide a more direct measure of selective attention. These possible advantages are discussed below.

Group Assignment.

In the brief exposure paradigms, AAB (usually based on some measure of reaction time) is usually compared between two different groups of drinker. When investigating the difference between a group of alcohol abusers or problem drinkers and a group of social drinkers, constructing the two groups is straightforward. In such a case the alcohol abusers/problem drinkers are defined as those engaging with treatment while the social drinkers are not. When investigating AAB between two groups at different levels of social drinking, however, group assignment is less straightforward. In such a case some strategy is employed by the experimenter to divide participants into groups based on alcohol consumption measures. Finding an appropriate method to create the groups can be difficult. Groups can, for example, be created by ranking all participants in the study based on consumption and then performing a median split to create a heavier and a lighter drinking group, or alternatively by ranking all participants based on their consumption and then

performing an extreme groups method in which a number participants from the top of the group are taken to represent the heavier drinking group and a number from the bottom to represent the lighter drinking group. There are however problems (which are discussed fully in Chapter 1) associated with such methods—for example, depending on the method employed it is possible that the size of any effect will be either inflated or deflated. Consequently, the representativeness of the AAB is indeterminate. In the 2-change flicker ICB paradigm, however, because the measure taken is the change that is detected by the participant—i.e., whether that change is alcohol-related or neutral—then two groups are automatically formed avoiding the need for group assignment. The alcohol consumption of the participants who detected the alcohol-related change and that of the participants who detected the neutral change can be used to investigate the AAB hypothesis. This avoids any problems that might arise from group assignment, and at the same time provides an AAB that is less arbitrarily determined in its representativeness than with the 1-change approach.

Variability.

In addition to avoiding the problem of group assignment the 2-change flicker ICB paradigm provides a measure of AAB which is quite different to the usual measures employed in the brief exposure paradigms and to some extent in the 1-change flicker ICB paradigm. This is because in the 2-change flicker ICB paradigm the primary dependent variable is the actual change detected (i.e., whether it is alcohol-related or neutral) rather than the more usual measures which are based on reaction times.

This difference is important because, for reasons discussed in Chapter 1 only 1 data point is obtained from each participant in these AAB flicker ICB paradigm studies. This is quite unlike the brief exposure paradigms in which a measure of AAB is calculated based on average reaction times to a large number of trials. While it is reasonable to expect that in the flicker ICB paradigm AAB should be reflected in change detection latency (a form of reaction time) it is also reasonable to expect

that that a true representation of AAB will not be found when looking at a single reaction time from a single trial. This is because factors other than AAB are influential in the determining change detection latency in the flicker ICB paradigm.

This might not be such a problem when comparing alcohol abusers/problem drinkers and social drinkers because it is likely that there is substantial difference in AAB between the two groups and consequently any noise introduced by factors such as individual differences might not be large enough to negatively impact on the observed AAB. For this reason there might be no difficulty in comparing AAB between alcohol abusers/problem drinkers and social drinkers when using the 1-change flicker ICB paradigm. When examining AAB at two different levels of social drinker, it is likely that a much smaller difference in AAB will be present between the 2 groups. As a result, when noise is added to the measure change detection latency, as a result of using single trials it is possible, or even likely, that the difference cannot be reliably measured.

This problem is avoided, however, when using the 2-change version of the paradigm as the primary dependent variable for group assignment is the change that has been detected rather than its change detection latency.

Conclusions on the use of the 2-change flicker ICB paradigm.

It would therefore appear that although the 1-change flicker ICB paradigm, generally provides a method of measuring AAB which might be an improvement on that of the brief exposure paradigms, that when investigating AAB within social drinkers that the 2-change version of the paradigm is in fact more useful. This is because it avoids the problem of finding a method artificially creating two groups of social drinker and at the same time addresses the problems associated with variability, especially when only 1 single trial is employed.

More direct measurements of visual attention might be obtained from measuring eye-movements. Within the context of brief exposure paradigms, the approach has been useful (see below)—adding yet another dimension to the different measures of attentional bias and a measure that, perhaps, more closely represents

“attention” than do others. Consequently the final experiment reported in this thesis turned to this method and lengthened the time frame of the eye-movement measurement from the time frame employed in brief exposure paradigms. This experiment is discussed below.

Continuous eye-movement monitoring

It has also been argued that in using the flicker ICB paradigm a more ‘direct’ measure of AAB might be obtained—for example, Simons and Ambinder, (2005) argue that for changes to be detected attention must have been directed to the source of the change.

In areas outwith AAB research, it has been shown that there is a close relationship between attention and eye-movements, with eye-movements generally following attention—i.e., if covert attention (i.e., with no behavioural component) is directed to an object, then overt attention (i.e., eye-movements) is highly likely to follow (e.g., Bryden 1961; Crovitz & Daves, 1962; Deubel & Schneider, 1996; Shepherd, Findlay & Hockey, 1986). In other words, eye-movements are a good proxy for attention (this was discussed in Chapter 4). Indeed, eye-movements have frequently been used to investigate cognitive processes involved in reading. (e.g., Rayner, 1998). Furthermore, in scene perception, Henderson (2003, p 498), encouraged the benefits of measuring eye movements suggesting that “... (they) provide an unobtrusive, sensitive, real-time behavioural index of ongoing visual and cognitive processing”. If this is the case then it should be possible to use eye-movements to measure attentional bias, and of particular advantage, its different components across time (Mogg et al., 2005). Eye-movement monitoring has not yet been employed to measure AAB. The method has, however, been employed in measuring biases towards smoking. Mogg et al. (2003) and Mogg et al. (2005) have, for example, sought to investigate both initial orienting towards smoking stimuli and maintenance of attention to such stimuli. While these studies provide an important step, the eye-movements have been only measured within the timeframe of brief

exposure paradigms (visual dot probe). Consequently, although the eye-movement data which is obtained is likely to provide an accurate reflection of processes which are present during brief exposure tasks, the limitations of the brief exposure paradigms are still present. For as discussed earlier in this chapter, the brief exposure paradigms might not provide a good measure of a “real world” attentional bias because of their simplicity. As a result, if there is the need for more complex measures with greater ecological validity (as suggested by Mogg et al., 2005) when measuring AAB then measuring using brief exposure paradigms might not be the most suitable approach. In an attempt to address this potential deficit, eye-movements were employed in Experiment C to measure AAB over a longer time period than in the brief exposure paradigms

A stationary scene was used (the OS used in several of the flicker ICB paradigm experiments was employed—see Figure 2.1.4). This scene was presented for 30 seconds without changing (although for reasons discussed in Chapter 4 participants were told to monitor the scene for a possible change). In monitoring eye-movements over a 30 second period it is possible to measure continuous behaviour. Thus the initial orienting and maintenance of attention can be monitored over longer time periods than in brief exposure paradigms.

If eye-movements (i.e., location of fixations and length of time of fixations) can be used as a proxy for selective attention (AAB) then both measures revealed an AAB for heavier over lighter drinkers. Moreover, within the confines of this experimental test, it appeared that in social drinkers, AAB might not be immediately manifest as exposure to scenes that are more complex than in brief exposure paradigms and more like “real life” scenes

While in Experiment C, eye-movements were measured for 30 seconds—time which much exceeds that of brief exposure paradigms—this could easily be extended to measure AAB over a longer period. Furthermore, while in Experiment C the scene which was presented to participants was the Original Stimulus (OS) from earlier experiment, there is the possibility of further increasing the complexity of the stimulus to provide a more realistic setting in which to measure AAB. For

example, it would be possible to measure eye-movements to 3D not 2D objects such as “real life” table-top scenes or bar scenes. Future studies might take advantage of such stimuli and in doing so investigate AAB at a greater level of complexity and reality than is possible with 2D images presented on a computer screen.

A final note on AAB research

The evidence is substantial supporting the existence of a (differential) AAB both in alcoholics in treatment (as compared with non-alcoholics) and in social drinkers (heavier as compared with lighter). The evidence is particularly persuasive because it comes from a wide range of quite different paradigms—from the more simplistic brief exposure paradigms such as the Stroop and visual dot probe paradigms to the more extended exposure paradigms such as the flicker ICB paradigm and also from continuous eye-movement monitoring technologies.

The explanatory significance of the AAB is clear for excessive chronic consumers, deriving principally from non alcohol-related research; namely, that drug-related attention bias is related to drug craving and subsequent consumption (e.g., Lubman, Peters, Mogg, Bradley and Deakin, 2000; Franken 2003). Observations such as these have been extended to include AAB and excessive chronic consumption (although the alcohol-related research on this is thin). Of the very few studies that have looked at AAB and alcoholism directly within a treatment framework, Cox, Hogan, Kristian and Race (2002) have found an increase in AAB from the start of treatment in those did not successfully complete treatment but no increase in those who did complete it. This provides some direct evidence that AAB might be of significance to explaining consumption at this level. Moreover, Marissen, Franken, Waters, Blanken, van den Brink and Hendriks (2006) have shown that in heroin research, attentional bias prior to treatment can predict relapse after 3 months. What remains unclear, however, is whether at this level of consumption, the AAB is an important cause of current levels or whether the current levels of consumption are caused by other factors and that the AAB detected is simply an epiphenomenon of what is going on and has little effect on anything. Certainly, it has been suggested by Franken, for example, that attentional bias has a

causal role in drug taking behaviour. Indeed, he argues that there are 3 ways in which attentional bias contributes to drug use and to relapse (which could be extended to AAB and alcohol). First, he suggests that drug-related stimuli in the environment might be detected more easily. Second, that once detected the drug-related stimuli are automatically processed and therefore may lead to craving. Third, because the attention is limited, the automatic processing of drug related stimuli occurs at the expense of other stimuli.

Taken together and extrapolated to alcohol, these postulated steps suggest that AAB contributes to excessive chronic consumption and to relapse. Moreover, more recently, Field, Mogg and Bradley (2006) and Franken, Rosso and van Honk (2003) have shown a correlation between AAB and craving. Once again, however, it is difficult to know the extent and the direction of the causal component in this correlation.

AAB and alcohol is not the only research domain in which there has been difficulty teasing out the causal/correlational component in explaining levels of consumption—and a look at this area might be instructive. In alcohol consumption outcome expectancy research, for example, predictions on levels of consumption and of treatment outcomes have been made on the number and type of expectancies held. Here, although correlations between expectancies held and consumption (and also between expectancies held and treatment outcome) can readily be made on the basis of a very large number of correlational studies, the acid test of whether there is a causal relationship between expectancies held and subsequent consumption is whether when expectancies are manipulated there is a subsequent and commensurate change in consumption (i.e., using within subject rather than across subject designs). As Jones, Corbin and Fromme (2001a) have shown in their critical review of the causal claim, in spite of the world-wide belief that there is indeed a causal connection between expectancies held subsequent consumption, the critical evidence that would support such a link has never been provided.

In the same vein, it makes sense that, rather than looking for yet another way to measure AAB (i.e., by extending the range of paradigms in which AAB might be

detected), some form of AAB manipulation in consumers might be sought and the extent to which the manipulation impacted on subsequent consumption might be measured. Wiers, de Jong, Havermans, Jelicic (2004), for example, also come to this conclusion. In other words, from Franken's model, a reduction AAB should cause subsequent reduction in consumption.

Research towards this end (and since the inception of this thesis work) has now begun. It has begun not in the area of alcoholism, but in the area of heavy social drinking (see below). Two points should be made here, initially, however. First, research on heavy social drinkers is as important as research on alcoholics in an effort to reduce a nation's alcoholic-related harm because there are more heavy drinkers than alcoholics and heavy drinkers might also be thought of alcoholics in training. Second, as Jones and McMahon (1998) discuss, in other areas of understanding consumption variability (e.g., through the alcohol cognition construct, alcohol consumption outcome expectancy) strong evidence emerges that there is a continuity of alcohol cognition underpinning the continuity of consumption and that research with social drinkers might be extrapolated to chronic excessive drinkers more readily than carrying out research with the chronic excessive consumers, themselves, whose psychological life will have been warped in many ways that get in the way of scientific enquiry.

As an acid test of the causal link between AAB and consumption, Field and Eastwood (2005) have experimentally manipulated AAB in heavy social drinkers using a visual dot probe to train participant either to attend to, or to avoid alcohol-related stimuli. They found that the AAB was increased in the group that was trained to attend to alcohol and reduced in the group trained to avoid the alcohol-related stimuli (as compared with their AABs prior to the training). This showed that AAB could be manipulated. Furthermore, when offered up to 250 ml of beer, the participants trained to attend to the alcohol-related stimuli consumed significantly more than those trained to avoid the alcohol-related stimuli. This provides critical evidence of a causal link. In a subsequent study designed to replicate this approach but directed towards simply reducing consumption (and also

designed to include a more critical test of stimulus generalization), Schoenmakers, Wiers, Jones, Bruce and Jansen (submitted), have also employed attentional retraining. Unlike Field and Eastwood (2005), however, they only trained a group of participants to avoid alcohol and did not train a group to attend to it. Furthermore, they sip primed participants with beer to increase the chances of eliciting an AAB (Duka & Townshend, 2004; Jones & Schulze, 2000; Schulze & Jones, 1999). In their pre-training test they did not find any difference in AAB between the control and experimental groups, whilst in the post-training test, there was a reduction in AAB in those who had been trained to avoid the alcohol-related stimuli. Like Field and Eastwood, they were able to manipulate AAB but they found no subsequent difference between the groups in a construct thought to promote consumption, craving. In addition, they tested whether AAB retraining would generalise to stimuli other than those used in the retraining phase. They found that while the participants who had been retrained had a decreased AAB to the retraining stimuli, it did not generalise to other stimuli.

This would suggest that AAB training might not be such a promising route to pursue alcohol consumption reduction (at, least at heavy social drinking levels). This conclusion would be premature, however. First, it is part of the scientific process that procedures and outcomes need to be replicated to come to any firm conclusions—and only two AAB studies have been reported thus far. Second, the procedures used for AAB retraining are only still being explored. For example, the method of AAB retraining has only involved a single retraining session; whilst in other areas of research that try to manipulate attentional bias (e.g., ABs related to general anxiety disorder) effects on measured outcomes, have only been shown after multiple retraining sessions (see De Jong, Kindt & Roefs, 2006; Vasey, Hazen & Schmidt, 2002). This point has also been made in relation to efforts to manipulate other alcohol cognitions (see Wiers' (2002) criticisms of Jones, Corbin & Fromme's (2001a, 2001b) critical review of expectancy manipulation research). Moreover, the AAB retraining methods which have been used might be criticised as being fairly simple—in a similar vein to earlier criticisms in this thesis of the measuring AAB,

itself— employing brief exposure paradigms. AAB might benefit from an increase in ‘ecological validity’—perhaps involving extended paradigms such as the 1-change flicker ICB paradigm in which the stimulus contained both alcohol-related and neutral stimuli and in which the changes were implemented only within the neutral stimuli. The retraining could also make use of eye-movement measuring in which, the equipment could be programmed to initiate a change to neutral stimuli only if the participant had been fixating on the neutral stimuli for a fixed period. In using such a technique, the eye-movements over successive trials and training sessions could be compared to measure any differences and perhaps allow better insight into the effects of the attentional retraining.

On a final note: the time has perhaps come for a moratorium on seeking out AAB with yet another paradigm and for more research to be directed towards developing effective means of manipulating AAB and then testing the causal link between the manipulated AAB and subsequent consumption. For it is largely through testing the purported causal link between levels of or changes in AAB and subsequent levels of or changes in alcohol consumption that developing theories of AAB might be tested.

REFERENCES

- Allport, A. (1989). Visual Attention. In M. I. Posner (Ed.), *Foundations of cognitive science* (pp. 631–682). Cambridge, MA: MIT Press.
- American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC.
- Ashby, J., Rayner, K., & Clifton, C. (2005). Eye movements of highly skilled and average readers: Differential effects of frequency and predictability. *Quarterly Journal of Experimental Psychology Section a-Human Experimental Psychology*, *58*(6), 1065-1086.
- Barrett, A. M., Kim, M., Crucian, G. P., & Heilman, K. M. (2002). Spatial bias: effects of early reading direction on Korean subjects. *Neuropsychologia*, *40*(7), 1003-1012.
- Bauer, D., & Cox, W. M. (1998). Alcohol-related words are distracting to both alcohol abusers and non-abusers in the Stroop colour-naming task. *Addiction*, *93*(10), 1539-1542.
- Biederman, I., Mezzanotte, R. J., & Rabinowitz, J. C. (1982). Scene Perception - Detecting and Judging Objects Undergoing Relational Violations. *Cognitive Psychology*, *14*(2), 143-177.
- Bowers, D., & Heilman, K. M. (1980). Pseudoneglect - Effects of Hemispace on a Tactile Line Bisection Task. *Neuropsychologia*, *18*(4-5), 491-498.
- Bradley, B. P., Mogg, K., & Millar, N. H. (2000). Covert and overt orienting of attention to emotional faces in anxiety. *Cognition & Emotion*, *14*(6), 789-808.

- Bruce, G. (2002). *Exploring Information Processing Biases in Social Cannabis and Alcohol Users through the implementation of a Flicker Paradigm for Induced Change Blindness*. Unpublished MA dissertation, University of Glasgow, Glasgow, Scotland, UK.
- Bruce, G., & Jones, B. T. (2004). A pictorial Stroop paradigm reveals an alcohol attentional bias in heavier compared to lighter social drinkers. *Journal of Psychopharmacology*, *18*(4), 527-537.
- Bruce, G., & Jones, B. T. (2006). Methods, measures and findings of attentional bias in alcohol use, abuse and dependence. In R. W. Wiers & A. W. Stacy (Eds.), *Handbook of Implicit Cognition and Addiction* (pp. 135–149). Thousand Oaks, CA: Sage.
- Bryden, M. P. (1961). The Role of Post-Exposural Eye-Movements in Tachistoscopic Perception. *Canadian Journal of Psychology*, *15*(4), 220-225.
- Chokron, S., & DeAgostini, M. (1995). Reading habits and line bisection: A developmental approach. *Cognitive Brain Research*, *3*(1), 51-58.
- Cohen, J. (1992). A Power Primer. *Psychological Bulletin*, *112*(1), 155-159.
- Cohen, J., Macwhinney, B., Flatt, M., & Provost, J. (1993). Pyscope - an Interactive Graphic System for Designing and Controlling Experiments in the Psychology Laboratory Using Macintosh Computers. *Behavior Research Methods Instruments & Computers*, *25*(2), 257-271.
- Collins, A. M., & Loftus, E. F. (1975). Spreading Activation Theory of Semantic Processing. *Psychological Review*, *82*(6), 407-428.
- Constantine, R., McNally, R. J., & Hornig, C. D. (2001). Snake fear and the pictorial

- emotional stroop paradigm. *Cognitive Therapy and Research*, 25(6), 757-764.
- Cox, W. M., Blount, J. P., & Rozak, A. M. (2000). Alcohol abusers' and nonabusers' distraction by alcohol and concern-related stimuli. *American Journal of Drug and Alcohol Abuse*, 26(3), 489-495.
- Cox, W. M., Brown, M. A., & Rowlands, L. J. (2003). The effects of alcohol cue exposure on non-dependent drinkers' attentional bias for alcohol-related stimuli. *Alcohol and Alcoholism*, 38(1), 45-49.
- Cox, W. M., Fadardi, J. S., & Pothos, E. M. (2006). The addiction-stroop test: Theoretical considerations and procedural recommendations. *Psychological Bulletin*, 132(3), 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., & Klinger, E. (1988). A Motivational Model of Alcohol-Use. *Journal of Abnormal Psychology*, 97(2), 168-180.
- Cox, W. M., Pothos, E. M., Johnsen, B. H., & Laberg, J. C. (2001). Methodological issues attached to the alcohol Stroop paradigm: comments on a paper by Sharma, Albery & Cook (2001). *Addiction*, 96(9), 1261-1265.
- 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(1-2), 85-89.
- Crovitz, H. F., & Daves, W. (1962). Tendencies to Eye-Movement and Perceptual

- Accuracy. *Journal of Experimental Psychology*, 63(5), 495-498.
- Dalgleish, T. (1995). Performance on the Emotional Stroop Task in Groups of Anxious, Expert, and Control Subjects - a Comparison of Computer and Card Presentation Formats. *Cognition & Emotion*, 9(4), 341-362.
- Dandeneau, S. P., & Baldwin, M. W. (2004). The inhibition of socially rejecting information among people with high versus low self-esteem: The role of attentional bias and the effects of bias reduction training. *Journal of Social and Clinical Psychology*, 23(4), 584-602.
- De Houwer, J. (2003). On the role of stimulus-response and stimulus-stimulus compatibility in the Stroop effect. *Memory & Cognition*, 31(3), 353-359.
- De Jong, P., Kindt, M., & Roefs, A. (2006). Changing implicit cognition: findings from experimental psychopathology. In R. W. Wiers & A. W. Stacy (Eds.), *Handbook of Implicit Cognition and Addiction* (pp. 425–437). Thousand Oaks, CA: Sage.
- Dehghani, M., Sharpe, L., & Nicholas, M. K. (2004). Modification of attentional biases in chronic pain patients: a preliminary study. *European Journal of Pain*, 8(6), 585-594.
- Deubel, H., & Schneider, W. X. (1996). Saccade target selection and object recognition: Evidence for a common attentional mechanism. *Vision Research*, 36(12), 1827-1837.
- Duka, T., & Townshend, J. M. (2004). The priming effect of alcohol pre-load on attentional bias to alcohol-related stimuli. *Psychopharmacology*, 176(3-4), 353-U356.
- 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), 421-435.

- Field, M., & Eastwood, B. (2005). Experimental manipulation of attentional bias increases the motivation to drink alcohol. *Psychopharmacology*, *183*(3), 350-357.
- Field, M., Eastwood, B., Bradley, B. P., & Mogg, K., (in press). Selective processing of cannabis cues in regular cannabis users. *Drug and Alcohol Dependence*.
- Field, M., Mogg, K., & Bradley, B. P. (2005). Craving and cognitive biases for alcohol cues in social drinkers. *Alcohol and Alcoholism*, *40*(6), 504-510.
- Field, M., Mogg, K., & Bradley, B. P. (2006). Attention to drug-related cues in drug abuse and addiction: component processes. In R. W. Wiers & A. W. Stacy (Eds.), *Handbook of Implicit Cognition and Addiction* (pp. 151-164). Thousand Oaks, CA: Sage.
- 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.
- Floyd, F. J., & Widaman, K. F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. *Psychological Assessment*, *7*(3), 286-299.
- Fox, E. (1993). Allocation of Visual-Attention and Anxiety. *Cognition & Emotion*, *7*(2), 207-215.
- Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology-General*, *130*(4), 681-700.
- Franken, I. H. A. (2003). Drug craving and addiction: integrating psychological and

- neuropsychopharmacological approaches. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 27(4), 563-579.
- Franken, I. H. A., Rosso, M., & van Honk, J. (2003). Selective memory for alcohol cues in alcoholics and its relation to craving. *Cognitive Therapy and Research*, 27(4), 481-488.
- Gadon, L., Bruce, G., McConnochie, F., & Jones, B. T. (2004). Negative alcohol consumption outcome associations in young and mature adult social drinkers: A route to drinking restraint? *Addictive Behaviors*, 29(7), 1373-1387.
- Goldman, M. S. (1999). Risk for substance abuse: Memory as a common etiological pathway. *Psychological Science*, 10(3), 196-198.
- Greeley, J. D., Swift, W., Prescott, J., & Heather, N. (1993). Reactivity to Alcohol-Related Cues in Heavy and Light Drinkers. *Journal of Studies on Alcohol*, 54(3), 359-368.
- Henderson, J. M. (2003). Human gaze control during real-world scene perception. *Trends in Cognitive Sciences*, 7(11), 498-504.
- Henderson, J. M., & Ferreira, F. (2004). Scene perception for psycholinguists. In J. M. Henderson & F. Ferreira (Eds.), *The interface of language, vision, and action: Eye movements and the visual world* (pp. 1-58). New York Psychology Press.
- Henderson, J. M., Weeks, P. A., & Hollingworth, A. (1999). The effects of semantic consistency on eye movements during complex scene viewing. *Journal of Experimental Psychology-Human Perception and Performance*, 25(1), 210-228.
- Hill, A. B., & Knowles, T. H. (1991). Depression and the Emotional Stroop Effect. *Personality and Individual Differences*, 12(5), 481-485.

- Hodos, W., & Campbell, C. B. (1969). Scala Naturae - Why There Is No Theory in Comparative Psychology. *Psychological Review*, 76(4), 337-350.
- Hollingworth, A., Schrock, G., & Henderson, J. M. (2001). Change detection in the flicker paradigm: The role of fixation position within the scene. *Memory & Cognition*, 29(2), 296-304.
- Intraub, H. (1981). Rapid Conceptual Identification of Sequentially Presented Pictures. *Journal of Experimental Psychology-Human Perception and Performance*, 7(3), 604-610.
- Johnsen, B. H., Laberg, J. C., Cox, W. M., Vaksdal, A., & Hugdahl, K. (1994). Alcoholic subjects' attentional bias in the processing of alcohol-related words. *Psychology of Addictive Behaviors*, 43, 111-115.
- Jones, B. C., Jones, B. T., Blundell, L., & Bruce, G. (2002). Social users of alcohol and cannabis who detect substance-related changes in a change blindness paradigm report higher levels of use than those detecting substance-neutral changes. *Psychopharmacology*, 165(1), 93-96.
- Jones, B. T., Bruce, G., Livingstone, S., & Reed, E. (2006). Alcohol-related attentional bias in problem drinkers with the flicker change blindness paradigm. *Psychology of Addictive Behaviors*, 20(2), 171-177.
- Jones, B. T., Corbin, W., & Fromme, K. (2001a). A review of expectancy theory and alcohol consumption. *Addiction*, 96(1), 57-72.
- Jones, B. T., Corbin, W., & Fromme, K. (2001b). Half full or half empty, the glass still does not satisfactorily quench the thirst for knowledge on alcohol expectancies as a

- mechanism of change. *Addiction*, 96(11), 1672-1674.
- Jones, B. T., Jones, B. C., Smith, H., & Copley, N. (2003). A flicker paradigm for inducing change blindness reveals alcohol and cannabis information processing biases in social users. *Addiction*, 98(2), 235-244.
- Jones, B. T., Macphee, L. M., Broomfield, N. M., Jones, B. C., & Espie, C. A. (2005). Sleep-related attentional bias in good, moderate, and poor (primary insomnia) sleepers. *Journal of Abnormal Psychology*, 114(2), 249-258.
- Jones, B. T., & McMahon, J. (1988). Alcohol motivations as outcome expectancies. In P. Miller & N. Heather (Eds.), *Treating Addictive Behaviors* (2nd ed., pp. 75-92). New York: Plenum.
- Jones, B. T., & Schulze, D. (2000). Alcohol-related words of positive affect are more accessible in social drinkers' memory than are other words when sip-primed by alcohol. *Addiction Research*, 8(3), 221-232.
- Jones-Chesters, M. H., Monsell, S., & Cooper, P. J. (1998). The disorder-salient stroop effect as a measure of psychopathology in eating disorders. *International Journal of Eating Disorders*, 24(1), 65-82.
- Jonides, J. (1981). Voluntary versus automatic control over the mind's eye's movement. In J. B. Long & A. D. Baddeley (Eds.), *Attention and Performance IX* (pp. 187-203). Hillsdale, NJ: Erlbaum.
- Keppel, G., & Wickens, T. D. (2004). *Design and analysis : a researcher's handbook* (4th ed.). Upper Saddle River, NJ: Prentice Hall.
- Kertzman, S., Lowengrub, K., Aizer, A., Ben Nahum, Z., Kotler, M., & Dannon, P. N.

- (2006). Stroop performance in pathological gamblers. *Psychiatry Research*, 142(1), 1-10.
- Kinsbourne, M. (1970). Cerebral Basis of Lateral Asymmetries in Attention. *Acta Psychologica*, 33, 193.
- Klein, G. S. (1964). Semantic Power Measured through the Interference of Words with Color-Naming. *American Journal of Psychology*, 77(4), 576-588.
- 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), 169-181.
- Klinger, E., Cox, W. M., & Blount, J. P. (1995). Motivational Structure Questionnaire (MSQ). In J. P. Allen & M. Columbus (Eds.) *Motivational Structure Questionnaire (MSQ)* (pp. 399–411). U.S. Department of Health and Human Services: Washington, DC.
- Kowler, E. (1995). Eye movements. In S. M. Kosslyn & D. M. Osherson (Eds.), *Visual Cognition*. Cambridge, MA: Harvard UP.
- Kramer, D. A., & Goldman, M. S. (2003). Using a modified stroop task to implicitly discern the cognitive organization of alcohol expectancies. *Journal of Abnormal Psychology*, 112(1), 171-175.
- Laberg, J. C. (1990). What Is Presented, and What Prevented, in Cue Exposure and Response Prevention with Alcohol Dependent Subjects. *Addictive Behaviors*, 15(4), 367-386.

- Lang, P. J., Ohman, A., & Vaitl, D. (1988). *The international affective picture system* [photographic slides]. The Center for Research in Psychophysiology. University of Florida, Gainesville, FL.
- Lubman, D. I., Peters, L. A., Mogg, K., Bradley, B. P., & Deakin, J. F. W. (2000). Attentional bias for drug cues in opiate dependence. *Psychological Medicine*, *30*(1), 169-175.
- Luh, K. E. (1995). Line Bisection and Perceptual Asymmetries in Normal Individuals - What You See Is Not What You Get. *Neuropsychology*, *9*(4), 435-448.
- Luh, K. E., Rueckert, L. M., & Levy, J. (1991). Perceptual Asymmetries for Free Viewing of Several Types of Chimeric Stimuli. *Brain and Cognition*, *16*(1), 83-103.
- Lusher, J., Chandler, C., & Ball, D. (2004). Alcohol dependence and the alcohol Stroop paradigm: evidence and issues. *Drug and Alcohol Dependence*, *75*(3), 225-231.
- MacCallum, R. C., Zhang, S. B., Preacher, K. J., & Rucker, D. D. (2002). On the practice of dichotomization of quantitative variables. *Psychological Methods*, *7*(1), 19-40.
- Macleod, C., Mathews, A., & Tata, P. (1986). Attentional Bias in Emotional Disorders. *Journal of Abnormal Psychology*, *95*(1), 15-20.
- Macleod, C. M. (1991). Half a Century of Research on the Stroop Effect - an Integrative Review. *Psychological Bulletin*, *109*(2), 163-203.
- Mannan, S. K., Ruddock, K. H., & Wooding, D. S. (1997). Fixation patterns made during brief examination of two-dimensional images. *Perception*, *26*(8), 1059-1072.
- Manning, L., Halligan, P. W., & Marshall, J. C. (1990). Individual Variation in Line

Bisection - a Study of Normal Subjects with Application to the Interpretation of Visual Neglect. *Neuropsychologia*, 28(7), 647-655.

Mansell, W., Clark, D. M., Ehlers, A., & Chen, Y. P. (1999). Social anxiety and attention away from emotional faces. *Cognition & Emotion*, 13(6), 673-690.

Marissen, M. A. E., Franken, I. H. A., Waters, A. J., Blanken, P., van den Brink, W., & Hendriks, V. M. (2006). Attentional bias predicts heroin relapse following treatment. *Addiction*, 101(9), 1306-1312.

Marr, D. (1982). *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. San Francisco: W. H. Freeman.

Mattingley, J. B., Bradshaw, J. L., Nettleton, N. C., & Bradshaw, J. A. (1994). Can Task Specific Perceptual Bias Be Distinguished from Unilateral Neglect. *Neuropsychologia*, 32(7), 805-817.

McCourt, M. E. (2001). Performance consistency of normal observers in forced-choice tachistoscopic visual line bisection. *Neuropsychologia*, 39(10), 1065-1076.

McCourt, M. E., & Jewell, G. (1999). Visuospatial attention in line bisection: stimulus modulation of pseudoneglect. *Neuropsychologia*, 37(7), 843-855.

McCourt, M. E., & Olafson, C. (1997). Cognitive and perceptual influences on visual line bisection: Psychophysical and chronometric analyses of pseudoneglect. *Neuropsychologia*, 35(3), 369-380.

McCusker, C. G. (2001). Cognitive biases and addiction: an evolution in theory and method. *Addiction*, 96(1), 47-56.

- McKenna, F. P., & Sharma, D. (1995). Intrusive Cognitions - an Investigation of the Emotional Stroop Task. *Journal of Experimental Psychology-Learning Memory and Cognition*, 21(6), 1595-1607.
- McNair, D. M., Lorr, M., Droppleman, L. F., (1981). *Manual for the profile of mood states*. Educational and Industrial Testing Service, San Diego, CA.
- Mennemeier, M., Vezey, E., Chatterjee, A., Rapcsak, S. Z., & Heilman, K. M. (1997). Contributions of the left and right cerebral hemispheres to line bisection. *Neuropsychologia*, 35(5), 703-715.
- 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., Millar, N., & White, J. (1995). A Follow-up-Study of Cognitive Bias in Generalized Anxiety Disorder. *Behaviour Research and Therapy*, 33(8), 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.
- Munafò, M., Mogg, K., Roberts, S., Bradley, B. P., & Murphy, M. (2003). Selective processing of smoking-related cues in current smokers, ex-smokers and never-smokers on the modified Stroop task. *Journal of Psychopharmacology*, 17(3), 310-316.
- Nicholls, M. E. R., Bradshaw, D. L., & Mattingley, J. B. (1999). Free-viewing perceptual asymmetries for the judgement of brightness, numerosity and size. *Neuropsychologia*, 37(3), 307-314.

- Nicholls, M. E. R., & Roberts, G. R. (2002). Can free-viewing perceptual asymmetries be explained by scanning, pre-motor or attentional biases? *Cortex*, 38(2), 113-136.
- Nisbett, R. E., & Wilson, T. D. (1977). Telling More Than We Can Know - Verbal Reports on Mental Processes. *Psychological Review*, 84(3), 231-259.
- Oliva, A., Torralba, A., Castelano, M. S., & Henderson, J. M. (2003). Top-down control of visual attention in object detection. In *2003 International Conference on Image Processing, Vol 1, Proceedings* (pp. 253-256).
- Posner, M. I. (1980). Orienting of Attention. *Quarterly Journal of Experimental Psychology*, 32(FEB), 3-25.
- Pothos, E. M., & Cox, W. M. (2002). Cognitive bias for alcohol-related information in inferential processes. *Drug and Alcohol Dependence*, 66(3), 235-241.
- Potter, M. C. (1976). Short-Term Conceptual Memory for Pictures. *Journal of Experimental Psychology-Human Learning and Memory*, 2(5), 509-522.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124(3), 372-422.
- Rensink, R. A. (2002). Change detection. *Annual Review of Psychology*, 53, 245-277.
- Rensink, R. A., Oregan, J. K., & Clark, J. J. (1997). To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science*, 8(5), 368-373.
- Reuterlorenz, P. A., & Posner, M. I. (1990). Components of Neglect from Right-Hemisphere Damage - an Analysis of Line Bisection. *Neuropsychologia*, 28(4), 327-

- Riemann, B. C., & McNally, R. J. (1995). Cognitive Processing of Personally Relevant Information. *Cognition & Emotion*, 9(4), 325-340.
- Robinson, T. E., & Berridge, K. C. (1993). The Neural Basis of Drug Craving - an Incentive-Sensitization Theory of Addiction. *Brain Research Reviews*, 18(3), 247-291.
- Rousselet, G. A., Joubert, O. R., & Fabre-Thorpe, M. (2005). How long to get to the "gist" of real-world natural scenes? *Visual Cognition*, 12(6), 852-877.
- Ryan, F. (2002). Attentional bias and alcohol dependence - A controlled study using the modified Stroop paradigm. *Addictive Behaviors*, 27(4), 471-482.
- Sampaio, E., & Chokron, S. (1992). Pseudoneglect and Reversed Pseudoneglect among Left-Handers and Right-Handers. *Neuropsychologia*, 30(9), 797-805.
- Saunders, J. B., Aasland, O. G., Babor, T. F., Delafuente, J. R., & Grant, M. (1993). Development of the Alcohol-Use Disorders Identification Test (Audit) - Who Collaborative Project on Early Detection of Persons with Harmful Alcohol-Consumption .2. *Addiction*, 88(6), 791-804.
- Scholl, B. J. (2000). Attenuated change blindness for exogenously attended items in a flicker paradigm. *Visual Cognition*, 7(1-3), 377-396.
- Schoenmakers, T., Wiers, R. W., Jones, B. T., Bruce, G. & Jansen, A. T. M. (submitted). Something else for a change: A clinically designed attentional retraining in heavy drinkers.

- Schulze, D., & Jones, B. T. (1999). The effects of alcohol cues and an alcohol priming dose on a multi-factorial measure of subjective cue reactivity in social drinkers. *Psychopharmacology, 145*(4), 452-454.
- Schyns, P. G., & Oliva, A. (1994). From Blobs to Boundary Edges - Evidence for Time-Scale-Dependent and Spatial-Scale-Dependent Scene Recognition. *Psychological Science, 5*(4), 195-200.
- Segal, Z. V., & Vella, D. D. (1990). Self-Schema in Major Depression - Replication and Extension of a Priming Methodology. *Cognitive Therapy and Research, 14*(2), 161-176.
- Seligman, M. E. (1970). On Generality of Laws of Learning. *Psychological Review, 77*(5), 406.
- Sharma, D., Albery, I. P., & Cook, C. (2001). Selective attentional bias to alcohol related stimuli in problem drinkers and non-problem drinkers. *Addiction, 96*(2), 285-295.
- Sharma, D., & McKenna, F. P. (1998). Differential components of the manual and vocal Stroop tasks. *Memory & Cognition, 26*(5), 1033-1040.
- Shepherd, M., Findlay, J. M., & Hockey, R. J. (1986). The Relationship between Eye-Movements and Spatial Attention. *Quarterly Journal of Experimental Psychology Section a-Human Experimental Psychology, 38*(3), 475-491.
- Simons, D. J., & Ambinder, M. S. (2005). Change blindness - Theory and consequences. *Current Directions in Psychological Science, 14*(1), 44-48.
- Simons, D. J., & Levin, D. T. (1997). Failure to detect changes to attended objects. *Investigative Ophthalmology & Visual Science, 38*(4), 3273-3273.

- Simons, D. J., & Rensink, R. A. (2005). Change blindness: past, present, and future. *Trends in Cognitive Sciences*, 9(1), 16-20.
- Snedecor, G. W., & Cochran, W. G. (1989). *Statistical Methods* (8th ed.). Ames, IA: Iowa State University Press.
- Sobell, L. C., & Sobell, M. B. (1992). Timeline followback: A technique for assessing self-reported alcohol consumption. In R. Z. Litten & J. P. Allen (Eds.), *Measuring Alcohol Consumption: Psychosocial and Biochemical Methods* (pp. 41-72). Totowa, NJ: Humana Press.
- Sokal, R., & Rohlf, J. (1973). *Introduction to Biostatistics*. San Francisco CA: Freeman.
- Speedie, L. J., Wertman, E., Verfaellie, M., Butter, C., Silberman, N., Liechtenstein, M., et al. (2002). Reading direction and spatial neglect. *Cortex*, 38(1), 59-67.
- Stacy, A. W. (1997). Memory activation and expectancy as prospective predictors of alcohol and marijuana use. *Journal of Abnormal Psychology*, 106(1), 61-73.
- Stacy, A. W., Leigh, B. C., & Weingardt, K. R. (1994). Memory accessibility and association of alcohol use and its positive outcomes. *Experimental and Clinical Psychopharmacology*, 2, 269-282.
- Stetter, F., Ackermann, K., Bizer, A., Straube, E. R., & Mann, K. (1995). Effects of Disease-Related Cues in Alcoholic Inpatients - Results of a Controlled Alcohol Stroop Study. *Alcoholism-Clinical and Experimental Research*, 19(3), 593-599.
- Stewart, J., de Wit, H., and Eikelboom, R. (1984). The role of conditioned and

- unconditioned drug effects in the self-administration of opiates and stimulants. *Psychological Review*, 91, 251-268.
- Stockwell, T., Hodgson, R., Edwards, G., Taylor, C., & Rankin, H. (1979). Development of a Questionnaire to Measure Severity of Alcohol Dependence. *British Journal of Addiction*, 74(1), 79-87.
- 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 Behaviors*, 22(4), 509-519.
- Stormark, K. M., Laberg, J. C., Nordby, H., & Hugdahl, K. (2000). Alcoholics' selective attention to alcohol stimuli: Automated processing? *Journal of Studies on Alcohol*, 61(1), 18-23.
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 643-662.
- Thorpe, S., Fize, D., & Marlot, C. (1996). Speed of processing in the human visual system. *Nature*, 381(6582), 520-522.
- Thorpe, S. J., & Salkovskis, P. M. (1997). Information processing in spider phobics: The stroop colour naming task may indicate strategic but not automatic attentional bias. *Behaviour Research and Therapy*, 35(2), 131-144.
- Tiffany, S. T. (1990). A Cognitive Model of Drug Urges and Drug-Use Behavior - Role of Automatic and Nonautomatic Processes. *Psychological Review*, 97(2), 147-168.
- Tomie, A. (1996). Locating reward cue at response manipulandum (CAM) induces

- symptoms of drug abuse. *Neuroscience and Biobehavioural Reviews*, 20, 505-535.
- Torralba, A. (2003). Modeling global scene factors in attention. *Journal of the Optical Society of America a-Optics Image Science and Vision*, 20(7), 1407-1418.
- Townshend, J. M., & Duka, T. (2001). Attentional bias associated with alcohol cues: differences between heavy and occasional social drinkers. *Psychopharmacology*, 157(1), 67-74.
- Turano, K. A., Gerguschat, D. R., & Baker, F. H. (2003). Oculomotor strategies for the direction of gaze tested with a real-world activity. *Vision Research*, 43(3), 333-346.
- Turatto, M., Bettella, S., Umiltà, C., & Bridgeman, B. (2003). Perceptual conditions necessary to induce change blindness. *Visual Cognition*, 10(2), 233-255.
- van Diepen, P. M. J., Wampers, M., & d'Ydewalle, G. (1998). Functional division of the visual field: moving masks and moving windows. In G. Underwood (Ed.), *Eye Guidance in Reading and Scene Perception*. Oxford, England: Elsevier.
- Vasey, M. W., Hazen, R., & Schmidt, N. B. (2002). *Attentional retraining for chronic worry and generalized anxiety disorder (GAD)*. Paper presented at the Annual Conference of the American Association of Behavior Therapy, Reno, NV.
- Waters, H., & Green, M. W. (2003). A demonstration of attentional bias, using a novel dual task paradigm, towards clinically salient material in recovering alcohol abuse patients? *Psychological Medicine*, 33(3), 491-498.
- Waters, A. J., Sayette, M. A., & Wertz, J. M. (2003). Carry-over effects can modulate

emotional Stroop effects. *Cognition & Emotion*, 17(3), 501-509.

- Werner, S., & Thies, B. (2000). Is "change blindness" attenuated by domain-specific expertise? An expert-novices comparison of change detection in football images. *Visual Cognition*, 7(1-3), 163-173.
- Wiers, R. W. (2002). Half full or half empty, what are we drinking? Some comments on the discussion of the causal role of alcohol expectancies as a mechanism of change. *Addiction*, 97(5), 599-600.
- Wiers, R. W., De Jong, P., Havermans, R., & Jelicic, M. (2004). How to Change Implicit Drug Use-Related Cognitions in Prevention: A Transdisciplinary Integration of Findings from Experimental Psychopathology, Social Cognition, Memory, and Experimental Learning Psychology. *Substance Use & Misuse*, 39(10-12), 1625-1684.
- Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional stroop task and psychopathology. *Psychological Bulletin*, 120(1), 3-24.
- Yaxley, R. H., & Zwaan, R. A. (2005). Attentional bias affects change detection. *Psychonomic Bulletin & Review*, 12(6), 1106-1111.
- Young, J. (1990). *Looking for consistency: goal-directed attention in the attitude-behavior relation*. Doctoral dissertation University of Minnesota: Minneapolis.