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Examining fast and slow effect for alcohol and negative emotion in problem and social drinkers

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Abstract

Attentional bias (AB) for alcohol-related stimuli has been consistently demonstrated in social and problem drinkers. The aims of the present study was to: investigate whether AB for alcohol-related stimuli could be described as a slow effect as well as a fast effect; how these effects related to drinking behaviour; and the influence of priming effects on the experimental procedure. Two experiments were designed. In experiment 1, problem drinkers in treatment (PDT) at a community alcohol service (N = 62) and a group of social drinking controls (N = 60) were assessed using the modified Stroop task with alcohol, negative emotion and neutral words. Drinking patterns were also recorded on the Khavari Alcohol Test.. In experiment 2, social drinking controls (N = 40) completed the same procedure but were blinded to the study's aims. In experiment 1, both groups demonstrated slower response times (RTs) to alcohol-related than neutral stimuli in both fast and slow processes. Difference scores for alcohol compared to neutral words in the slow process were positively correlated with increases in drinking levels for both groups. In experiment 2, AB to alcohol-related stimuli disappeared when participants were unprimed. The findings highlight the importance of investigating the role of fast and slow processes in continued and problem drinking, alongside priming effects on the experimental procedure.

Keywords: alcohol; Stroop; emotion; bias; attention

Introduction

People who are addicted to alcohol show an attentional bias (AB) for alcohol-related cues in the environment (Albery, Sharma, Niyazi, & Moss, 2006). This bias can be non-conscious (Stormark, Laberg, Nordby, & Hugdahl, 2000) and triggered by salient cues in the environment that are semantically related to the addictive substance (Cox, Yeates, & Regan, 1999). Once triggered, this bias can produce emotional reactions such as anxiety, depression and anger (Forestell, Dickter, & Young, 2012). Alcohol-related biases can also impact the individual's decision to engage in addictive behaviour (Cox, Hogan, Kristian, & Race, 2002).

The Addiction Stroop Task

Alongside the dot-probe task, the emotional-Stroop task is one of the most widely used measures of alcohol-related AB (Field & Cox, 2008). The emotional Stroop is an adaptation of the classic Stroop paradigm (Stroop, 1935) whereby participants have to name the colour of the neutral or emotion-related word, whilst ignoring its meaning. Typically, people with concerns related to the emotionally relevant stimuli have slower response times (RTs) in naming the colour of these words compared to the neutral stimuli (Williams, Mathews, & MacLeod, 1996). Within the field of addiction research, this effect has been demonstrated with a number of addictive behaviours, including smoking (Cane, Sharma, & Albery, 2009; Waters, et al., 2003), gambling (Boyer & Dickerson, 2003; McCusker & Gettings, 1997) and alcohol misuse (Lusher, Chandler, & Ball, 2004; Sharma, Albery, & Cook, 2001), as well as illicit drugs such as marijuana (Cane et al., 2009; Sharma & Money, 2009) cocaine (Carpenter, Schreiber, Church, & McDowell, 2006; Sharma & Money, 2009) and heroin (Carpenter et al., 2006; Waters, Sayette, Franken, & Schwartz, 2005). This present study is concerned with AB and alcohol addiction on an alcohol Stroop test.

AB and Alcohol Use

The link between AB and alcohol misuse is a fairly robust finding (Field & Cox, 2008). Alcohol abusers typically show a greater AB for alcohol-related stimuli than non-abusers (e.g. Fadardi & Cox, 2006; Johnsen, Laberg, Cox, Vaksdal, & Hugdahl, 1994; Jones, Bruce, Livingstone, & Reed, 2006; Lusher, et al., 2004; Sharma, et al., 2001), although some studies have observed no between-group differences with alcoholics and low-drinking controls in their RTs to alcohol-related stimuli (Bauer & Cox, 1998; Duka, Townshend, Collier, & Stephens, 2002; Ryan, 2002; Stetter, Chaluppa, Ackerman, & Straube, 1994). Quantity and frequency of alcohol use has also been found to correlate highly with the degree of alcohol AB observed in the alcohol Stroop task (Bruce & Jones, 2004; Cox et al., 1999; Ryan, 2002) and alcohol AB has also been found to predict relapse with alcoholics at three-month follow-up (Cox et al., 2002).

Fast and Slow Processes

Research using the addiction Stroop task has generally focussed on the time-delay in naming colour words at the time of stimulus presentation (Cox, Fadardi, & Pothos, 2006). Evidence now accumulating from addiction and emotional Stroop studies suggests that the interference observed from addiction and emotional stimuli occurs not only on the stimulus presentation itself, but can carry-over onto subsequent neutral trials that follow the target stimulus (Cane et al., 2009; McKenna & Sharma, 2004; Phaf & Kan, 2007; Waters et al., 2005). As an example, McKenna and Sharma (2004) presented negative emotion and neutral words in a blocked format that allowed them to track the course of the interference. Contrary to what was previously thought, the interference was not observed on the target stimulus (either neutral or negative emotional stimuli) but on succeeding, neutral, words. McKenna and Sharma (2004) thus distinguished between fast cognitive processes from slow cognitive processes. Waters, Sayette, and Wertz (2003) demonstrated the existence of the slow process for addiction related stimuli in both smokers and heroin addicts, whilst Cane et al. (2009) found that slow effects to addiction related stimuli were present in smokers attempting to quit and marijuana smokers. So far no study has examined both the fast and slow processes with alcohol users.

AB and Negative Emotion

Participants are consistently slower to process negative emotion-related words compared with neutral words on a modified emotional Stroop task (see Phaf & Kan, 2007). This result, named the emotional Stroop effect, is more pronounced in participants suffering with emotional disorders such as depression, generalised anxiety, phobia and Post Traumatic Stress Disorder (Williams et al., 1996). Negative emotion-related stimuli have often been used alongside alcohol stimuli with studies using the modified Stroop, with mixed results. Stormark et al. (2000) found that alcoholics were slower to respond to negative words compared with social drinking controls, but both Duka et al. (2002) and Bauer and Cox (1998) found no differences between alcoholic and control participants' RTs to both positive and negative words. Based on these results, the exact relationship between AB and negative emotion remain ambiguous. For example, it is not clear whether substance-addicted participants are slower to process all emotionally related stimuli (including stimuli related to their addiction), in which case they would be equally slow to process addiction-related and negative emotion stimuli compared with non-addicted participants, or whether there are significant differences in how they process negative emotion stimuli compared to addiction-related stimuli. One explanation of these differences is that different semantic networks relating to alcohol and negative emotion are activated at different times in the course of the interference. In one unpublished study cited in Albery et al. (2006) for example, researchers tested fast/slow alcohol processes using the Stroop test with 45 drinkers. Following completion of the test, participants were asked to rate the words used in the test for their relatedness to alcohol and negative emotion. Regression analysis was then used to determine whether the interference in fast/slow processes was determined by alcohol or negative emotion. They found that alcohol ratings predicted interference in the fast process, whereas negative emotion predicted interference in the slow process. These results indicate that a semantic network related to alcohol is activated in the fast process, whilst a semantic network relating to negative emotion is also activated in the slow process. However, fast/slow processes relating to negative emotion have yet to be tested with problem drinkers.

Aims of Study

The present study investigated whether problem drinkers in treatment (PDT) demonstrated an alcohol-related AB towards alcohol stimuli in the fast and slow processes. The relationship between AB in the fast/slow process to alcohol stimuli, negative emotion stimuli and drinking behaviour was also examined. The central prediction was that PDT would have slower RTs to alcohol-related words than neutral words compared with a low-drinking control group in both fast and slow processes. This would indicate an AB to alcohol-related stimuli (the alcohol Stroop effect) in the PDT group. Following other research (Cane et al., 2009; Sharma & Money, 2009; Waters, Shiffman, et al., 2003) it was anticipated that this effect would be greater on subsequent, neutral trials (i.e. the slow effect). From previous research, it was also expected that the size of the alcohol Stroop effect would be positively correlated with self-reported drinking levels (i.e. the effect increases according to average amount of alcohol consumed). Finally, following the study cited in Albery et al. (2006) it was also predicted that a bias towards negative emotion would be evident in the slow process for PDT participants, but this effect would be absent in control participants.

Experiment 1

Method

Participants

A sample of 62 problem drinkers receiving treatment (PDT) for their alcohol misuse was recruited from a community NHS alcohol service. All participants in the service had an ICD-10 diagnosis of alcohol dependence. The service was not abstinence-based and offered a range of psychological, pharmaceutical and social treatments. The inclusion criterion was that the service users were currently attending treatment at the service for their alcohol misuse. A control group sample of 60 was also recruited from staff at a local NHS hospital, students from a large university and from other sources. Exclusion criteria for all participants included colour-blindness, illiteracy, brain-injury or learning disability. Clinicians in the service first evaluated whether participants met the inclusion criteria before referring them into the study. All participants were paid £10 for taking part.

[Table 1 goes here]

Participant demographic details for the clinical and control group are presented in Table 1. Differences between PDT and control participants were analysed using an independent samples t-test for age, and a Pearson Chi-Square for gender, ethnicity and highest educational level completed. There were no significant differences between the two groups in terms of age (p=0.276), gender (p=0.365) or ethnicity (p=0.701). However, the differences between the two groups in terms of educational level was significant (p=<.0001). Inspecting the table indicates that the control group attained higher educational attainment at A-Level, undergraduate and postgraduate levels than the PDT group.

The Khavari Alcohol Test (KAT) was used to record participants' drinking patterns at time of testing. The KAT is a quantity-frequency alcohol use questionnaire that measures both usual and maximum frequency and volume intake alcohol in terms of alcohol intake for beer, wine and spirits to obtain an annual absolute alcohol intake (AAAI) summary index. The KAT has demonstrated reliability and validity (Khavari & Farber, 1978; Loethen & Khavari, 1990). So that participants' average drinking levels could be analysed, the AAAI index from the KAT was converted to mean weekly units of alcohol (WUA) for each participant. The participants' drinking levels are also recorded in Table 1. The clinical group on average consumed more alcohol (M = 66.5) than the control group (M = 12.62) and an independent samples t-test indicated this difference was significant (p = 0.000). Standard deviations for both clinical (SD = 103.59) and control groups (SD = 18.70) indicated a wide range of drinking levels between participants for both groups, but particularly for clinical participants.

Design

A 2 x 3 x 7 mixed factorial design was used, with group (PDT, controls) as the between-participant factor and word type (alcohol-related, negative emotion, neutral) and position of word (1-7) as the within-participant factors. The dependent variable was response latencies to identify the colour of alcohol-related, negative emotion and neutral words.

The addiction Stroop task was administered on a laptop. The Stroop program was written, run and reaction times (RT) logged using E-prime version 1.1 (Psychology Software Tools, Inc.; Pittsburgh, Pennslyvania). The Z, X, N and M keys on the keyboard were labeled with one of four colours: RED, GREEN, BLUE or YELLOW. The alcohol words (hangover, alcohol, drunk, booze, pub) were selected on the basis of their relatedness to alcohol and were adapted from a previous study (Sharma et al., 2001). Negative emotion words (rejected, failure, cancer, abuse, sad) were selected on the basis of high negative valence ratings and if they matched the word frequency and word length of the alcohol words. The negative ratings were taken from the Affective Norms for English Words (ANEW) project (Bradley & Lang, 1999). Neutral words at position 1 (airplane, station, coach, ferry, bus) were chosen on the basis that they were transport-related, matched the word frequency and word length of the alcohol words, and had no clear association with alcohol or negative emotion. All other neutral words at positions 2-7 were chosen if they matched the word frequency and length of the category words at position 1 and had no clear association with alcohol or negative emotion. Words were matched for length and word frequency using the English Lexicon Project website (Balota et al., 2007). The stimuli were 0.6 cm high, 2 cm wide and were presented in one of four colours (red, green, blue or yellow) on a black background.

For the Stroop task, stimuli were arranged in three category blocks: an alcohol-related block, a negative emotion block and a neutral block. The order of the blocks was counterbalanced across participants using a Latin-square design. Each block contained five sequences with each sequence containing a category specific word at position 1 (an alcohol word, a negative emotion word or a neutral word) followed by six neutral words (positions 2–7). The words in each sequence at position 1 remained at position 1 whenever the sequence was presented; however, words in positions 2–7 were counterbalanced using a Latin Square design. Each of the five sequences of seven trials was presented six times making 30 sets of sequences and 210 trials for each category block. All sequences were displayed randomly within each block. Each of the category blocks were counterbalanced across the participants using a Latin Square design.

Procedure

PDT participants were recruited from a provincial NHS Trust alcohol service. Testing took place in a variety of sites within the Trust. Control participants were recruited through staff at a local NHS hospital, with students at a large local university through the psychology department's online university-wide research participation scheme and from other sources. Testing took place at a variety of locations including participant's homes, NHS clinical sites and in psychology laboratories at the university. All participants were informed that participation was voluntary and they were free to withdraw at any time; clinical participants were also informed that deciding not to participate would not affect their treatment.

Willing participants were then given instructions to the Stroop task. They were told they would have to respond to the colour of words shown on the screen whilst ignoring the words themselves. Participants were told to respond as quickly and as accurately as possible and not to correct errors. No feedback was given when an error was made. The task was completed in a darkened room in the absence of the experimenter.

Participants began with a practice session in order to be familiarised with the task. In total, 150 practice trials were administered using random letter strings of four letters (e.g. FXHP, HTGX) presented one after another in the centre of the computer screen. After this, participants completed the experimental session. In total, 210 trials were presented in each of the three category blocks consecutively, with a short break after each category block. On each trial, a word was presented at the centre of a computer screen and remained visible until a response was made. After a response was recorded, the next word was immediately displayed. This process was continued until all 210 trials for each category block were completed. Following the Stroop task, participants completed the KAT.

Results

Data were analysed from 121 participants in total (62 PDT, 59 control), as the data from one control participant had become corrupted and was unusable. Analysis of error rates indicated that these were generally low (less than 4%). Mean error rates were entered into a three-way ANOVA with Group (clinical, control) as the between-participants factor and Word Type (alcohol, negative emotion, neutral) and Position (1-7) as within-participants factors. The only significant effect was a main effect of Group ($F(1,119) = 1.37$, $p = .002$); control participants made significantly more errors ($M = 0.025$, $SD = 0.002$) than clinical participants ($M = 0.015$, SD

= 0.002). The smaller number of errors for the clinical participants may implicate a more cautious strategy and may be due to the group differences in educational attainment (see Table 1). The overall response times for the PDT group seem higher than for the control group; however, this difference in response times was not significant and thus precludes a trade-off between speed and accuracy.

Fast/Slow Alcohol and Emotional Stroop Effects by Group

As in previous AB studies (Adams, Ataya, Attwood, & Munafò, 2012; Cane et al., 2009) in order to control for outliers, median correct RTs to naming the colour of alcohol, negative emotion and neutral words were entered into a 2 x 3 x 7 ANOVA with Group (PDT, control) as the between-participants factor and Word Type (alcohol, negative emotion, neutral) and Position (1-7) as within-participants factors. The analysis showed significant main effects of Word ($F(2,119) = 17.92$, $p < .001$) and Position ($F(6,119) = 13.22$, $p < .001$) There was no main effect of group ($F(1,97) = .182$, $p = .670$). As expected, post-hoc t-tests with Bonferroni correction indicated that overall participants were significantly slower ($p < .001$) to respond to alcohol words (*M* = 968.88ms, *SD* = 18.42) compared with neutral words (*M* = 938.28ms, *SD* = 17.70) and negative emotion words (*M* = 940.73ms, *SD* = 16.56). There were no significant differences between participants' responses to negative emotion and neutral words. This shows that overall there was an alcohol Stroop effect but not an emotional Stroop effect for negative emotion.

[Figure 1 goes here]

[Figure 2 goes here]

The main effects of Position and Word Type were qualified by a significant two-way interaction between Word Type x Position ($F(12,119) = 4.25$, $p < .001$). Further analysis of this interaction showed that there were significant simple main effects of Word Type at positions 1, 2, 3, 4 and 6 (all *F's* > 4, p<.01). As expected, post-hoc t-tests with Bonferroni correction indicated that participants were significantly slower to respond to alcohol words compared to neutral and negative emotion words at positions 1, 2, 3, 4 and 6. The same analysis also indicated that participants were significantly slower to respond to negative emotion words compared to neutral words only at position 2 (see Figure 1). These results show a fast effect for alcohol words and a slow effect for alcohol words that extends beyond position 2 onto the following positions. There was also a slow effect for negative emotion words at position 2. There was no significant three-way interaction between Group x Word type x Position ($F(12,119) = 1.27$, $p = 0.23$) and no significant two-way interaction between Group x Word type ($F(2,119) = 1.15$, $p = 0.32$).

Relationship Between Alcohol Stroop Effect, Emotional Stroop Effect and Alcohol Consumption

Correlation analyses were conducted to identify any relationship between alcohol Stroop effect (RTs to alcohol words – RTs to neutral words), emotional Stroop effect (RTs to negative emotion – RTs to neutral words) and self-reported drinking levels as reported on the KAT. Also included in the analysis was participants' age, as research with the classic Stroop task often shows age effects for Stroop scores (MacLeod, 1992). The difference scores for the alcohol and emotional Stroop effect were calculated across each position so that there were seven difference scores for alcohol and seven for negative emotion words.

So that participants' average drinking levels could be analysed, the AAAI index from the KAT was converted to mean weekly units of alcohol (WUA) for each participant. The clinical group on average consumed more alcohol (M = 66.5) than the control group (M = 12.62). Standard deviations for both clinical (SD = 13.59) and control groups (SD = 18.70) indicated a wide range of drinking levels between participants for both groups, but particularly for clinical participants.

[Table 2 goes here]

As the ANOVA of median RT data revealed no differences according to group, correlations were calculated across the two groups for all participants (see Table 2). There was a significant positive correlation between mean WUA and RTs to alcohol words at position 2 ($r(119) = 0.26$, $p < .005$), demonstrating that participants' consumption of alcohol increased with their interference score for alcohol words at Position 2. This suggests that AB for alcohol words (the alcohol Stroop effect) in the slow process increased with alcohol consumption across the two groups.

Discussion of Experiment 1

This study investigated alcohol and negative emotional attentional bias across the fast/slow processes in a group of 62 alcoholics receiving treatment at a community alcohol service and a group of 59 social drinking controls. The relationship of these factors to alcohol consumption was also explored. Contrary to expectations, an alcohol Stroop effect in the fast and slow processes was found in both clinical and control groups.

Numerous types of priming effects prior to testing have been observed to influence alcohol AB in research participants (Cox et al., 1999; Jones & Schulze, 2000; Rose & Duka, 2008; Stewart, Hall, Wilkie, & Birch, 2002) and these effects can be sensitive to context (Cox, Brown, & Rowlands, 2003). Also, alcohol-based expectancies (i.e. the degree to which participants are expecting to be presented with alcohol cues) has been associated with alcohol Stroop interference (Field et al., 2007; Rofey, Corcoran, & Kavanagh, 2006). In Experiment 1, as part of the NHS ethics panel requirements, participants were specifically told that they would be presented with alcohol words. This would have raised expectancy salience and may have inadvertently primed participants to respond to alcohol cues. This could be responsible for the similar pattern of responses for both PDT and control groups. This hypothesis required further investigation, so another experiment was designed in order to test this prediction.

Experiment 2

Hypothesising that the lack of between group differences may be due to unintentional priming effects from the experimental procedure, a second study was conducted with a second, and unprimed, control group. Another clinical group was not included due to ethical concerns around blinding problem drinkers to the study intention (and thereby potentially triggering alcohol-related representations). Based on the results from Experiment 1, the main hypothesis for Experiment 2 was that priming gives rise to the AB effect in the fast process, which can then be tested for via the interaction and post-hoc analysis.

Method

An identical design and procedure to Experiment 1 was employed using exactly the same instructions and materials. However, the only difference was that the main study intention was masked and participants were not told to expect alcohol stimuli; instead they were told that the researchers' were investigating attention and distraction.

Participants

Sixty participants for the unprimed control group were recruited through students at a large local university through the psychology department's online university-wide research participation scheme and from other sources. However, only data from 40 participants were eventually used in the analysis. This additional data was compared with the primed control group from Experiment 1. Demographic characteristics from both the unprimed control group from Experiment 2 and the primed control group from Experiment are presented in Table 3.

[Table 3 goes here]

The drinking levels of this unprimed group, as measured by WUA, were slightly higher ($M = 16.11$, $SD = 15.77$) than the control group from Experiment 1 ($M = 12.62$, $SD = 18.70$). An independent samples t-test indicated that this difference was not significant ($p = .551$). The mean age of the primed control group were older ($M = 43.20$, $SD = 14.05$) than the unprimed control group ($M = 32.93$, $SD = 16.19$) but an independent samples t-test indicated this difference was not significant ($p = 0.111$). The ethnicity and educational background of the unprimed control group varied somewhat from the primed control group; a Pearson's Chi-Square test indicated this difference was not significant for ethnicity ($p = 0.015$) but significant for education ($p = 0.001$).

Finally, although there were a slightly higher proportion of male participants in the primed group compared with the unprimed group (53.3% compared to 45%), a Pearson's Chi-Square test indicated this difference was not significant ($p = 0.414$)

Results

Data were analysed from 40 participants in the unprimed group, as 20 participants' data was corrupted due to computer failure. As before, median correct RTs to naming the colour of alcohol, negative emotion and neutral words were used to control for outliers and were entered into a 2 x 3 x 7 ANOVA with Group (primed control, unprimed control) as the between-participants factor and Word type (alcohol, negative emotion, neutral) and Position (1-7) as within-participants factors. The analysis showed a main effect of Word type ($F(2,194)=3.016$, $p=.05$) and an interaction between Word type and Group ($F(2,194)=3.022$, $p=.05$).

[Figure 3 goes here]

Post hoc analysis showed a simple main effect of word type (that is, an alcohol AB) for the primed group ($F(2,116)=7.751$, $p<.01$) but not the unprimed group ($F(2, 78)=.018$, $p=.982$). This suggests that the alcohol Stroop effect was not present when priming was removed. The 3-way interaction between Group, Word type and Position was not significant ($F(12,1164)=.695$, $p=.757$).

[Figure 4 goes here]

Summary statistics (Median RTs, Standard Error) for all three groups are presented in Table 4.

[Table 4 goes here]

Discussion of Experiment 2

As expected, social drinking participants who were given exactly the same experimental instructions and procedure as participants in Experiment 1 (except they were not told to expect alcohol words) did not demonstrate slower RTs to alcohol, compared with neutral, words (i.e. alcohol AB). This finding was in contrast to the social drinking control participants from Experiment 1 who were told to expect alcohol words and demonstrated an alcohol AB. The implications of this result, including all the results from both experiments, are discussed in more detail in the General Discussion, below.

General Discussion

This article reports two experiments that investigated alcohol and negative emotional attentional bias across the fast/slow processes in a group of problem drinkers in treatment at a community alcohol service, along with primed and unprimed control participants. The relationship of these factors to drinking behaviour was also explored.

Alcohol AB in the Fast Process and Priming Effects

In Experiment 1, both groups showed significantly longer RTs to alcohol-related words compared to neutral words at position 1. An alcohol AB was thus observed for all participants in the fast process irrespective of drinking status, with alcohol-related stimuli in the form of alcohol words appearing to 'grab' the participants' attention immediately at time of stimulus presentation. Considering this further, it was hypothesised that the fast effect for alcohol words observed in Experiment 1 may have been reflecting unintentional priming effects from the experimental procedure. In other words, participants were told to expect alcohol words and so were primed to respond quicker to alcohol-related words, based on their expectancy of seeing this type of word meaning in the stimulus set. The results from Experiment 2 supported this hypothesis, as the alcohol Stroop effect was not present in the unprimed control group and represents an interesting finding regarding AB research in general.

If this result is genuinely the result of priming, it supports other studies that evaluated the influence of priming, expectancies and context on alcohol AB (Cox et al., 1999; Cox et al., 2003; Jones & Schulze, 2000; Rofey et al., 2006; Rose & Duka, 2008; Stewart et al., 2002). As well as these studies on contextual priming in experimental research, a systematic review of 80 articles conducted by Monk and Heim (2008) found evidence that broader contextual influences, including demographic factors such age and gender, may also influence variations in research studies on alcohol use. Whilst it is very difficult to eliminate all environmental influences in experimental psychological research, the results from this study provide further evidence for the need for future studies to ensure that such factors are adequately controlled for, both in the design and the experimental procedure. Additionally, further research is needed to establish the frequency of these effects in AB research, as the finding suggests that some AB effects may be the product of a methodological artefact. Future studies will need to consider the presence of these effects and ensure that they are not induced unintentionally through the experimental procedure.

Alcohol AB in the Slow Process

In addition to fast effects, participants showed significantly longer RTs to neutral words that immediately followed the alcohol words. This result suggests that an alcohol AB was observed for both groups in the slow process, with the interference effect appearing at the position immediately following the target stimulus and continuing across subsequent positions. These carry-over effects have been observed with smokers (Cane et al., 2009; Waters, Shiffman, et al., 2003), marijuana users (Cane et al., 2009; Sharma & Money, 2010) and cocaine users (Sharma & Money, 2010) but according to the author's knowledge this is the first time such effects have been observed with alcohol users. This thus represents a novel finding in alcohol AB research.

Although this result partly supports previous research findings in which higher levels of drinking were positively correlated with greater Stroop interference (Bruce & Jones, 2004; Ryan, 2002), the finding that the slow process is associated with increased alcohol consumption but the fast process is not, is a novel finding that demands further comment. Whilst the exact nature of the slow process is unclear, it could be that these processes reflect 'top-down' rumination-based processes that interfere with 'bottom-up' information processing (Wyble et al., 2008). Speculating further, the slow process could represent priming effects or more stable, enduring alcohol-related rumination processes. In this way, slow processes in AB research may provide a better indication of the participants' alcohol-related AB than the fast process. The latter point is further reinforced by the finding of a positive relationship between participants' interference scores for neutral words at position 2 following the alcohol words (i.e. the slow process) with WUA as recorded by the KAT.

Negative Emotion in the Fast/Slow Processes

In addition to the fast/slow effects observed with alcohol, both groups showed significantly longer RTs to negative emotion words compared with neutral words at position 2. An emotional Stroop effect for negative words was therefore present in the slow process. The effect was observed at position 2 and did not continue past position 2 onto following trials. Previous research using the emotional Stroop test has found similar results (Phaf & Kan, 2007; Sharma & McKenna, 2001). The results need to be interpreted with caution, as the effect was only observed at one serial position. However, it is worth noting that Zetteler, Stollery, Weinstein, and Lingford-Hughes (2006) found that the strength of alcohol-related interference directly correlated with self-reported anxiety levels, whilst Cane et al. (2009) demonstrated that self-reported negative emotional states in smokers correlated with emotional Stroop effects for negative words in both fast and slow processes. More research is therefore needed to investigate this link further.

Limitations of Study

The limitations of the present study need to be acknowledged. Testing took place in a variety of locations including NHS treatment clinics, university premises and participant homes and so certain contextual and environmental cues could not be eliminated from the experimental procedure. Whilst this was a pragmatic choice based on inclusion reasons, future studies may need to provide greater standardisation across testing format in order to provide greater control for contextual influences (e.g. Monk & Heim, 2008).

Ethical procedures did not allow for the testing of an unprimed clinical group in Experiment 2, which would have allowed an examination of whether between-group differences were observed in the "unprimed" experiment, as well as how this affected fast/slow processes. Of course, the overall study would have been stronger if clinical and control participants were both assessed in Experiment 2 as well as in Experiment 1. This omission remains a significant limitation of the present study. However, testing for priming effects in PDT participants may provide an important avenue for future research in alcohol AB research.

Additionally, urinalysis was not conducted at the time of testing and data regarding prescription medications or illicit drug use were not collected. Also, the period of abstinence from alcohol was not recorded. Missing data from Experiment 2 meant that numbers for both primed and unprimed groups were slightly uneven. Additionally, interpretation of the findings relating to negative emotion remains speculative as an effect for negative emotion was only found at one serial position and self-reported mood levels were not collected. Future studies in AB for addition would benefit from collecting such information (Donovan & Marlatt, 2007), as well as measuring mood levels via standardised questionnaires (Cane et al., 2009).

Finally, methods of self-report are notoriously unreliable in addictions research (Donovan & Marlatt, 2007), particularly with measures such as the KAT which asks participants to report drinking levels retrospectively. Therefore, results concerning self-reported drinking levels need to be interpreted with some caution. However, the KAT is a well-validated measurement tool in alcohol research (e.g. Khavari & Farber, 1978; Loethen & Khavari, 1990) and has been used in similar studies to record drinking levels (e.g. Cox, Blount & Rozak, 2000; Cox et al., 2003; Cox et al., 2002 etc.).

Despite these limitations however, the study provided novel findings in alcohol AB and point towards some interesting lines of inquiry for future research. These directions could include examining the role of alcohol AB in the fast and slow processes in terms of predicting treatment response and the role of priming effects in clinical and control participants. Future studies would also benefit from a greater consideration of the role of contextual factors and study methodology in terms of influencing effects.

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References

Adams, S., Ataya, A. F., Attwood, A.S., & Munafò, M. R. (2012). Effects of acute alcohol consumption on alcohol-related cognitive biases in light and heavy drinkers are task-dependent. *Journal of Psychopharmacology*, *26*(2), 245–253. doi:10.1177/0269881111405355

Albery, I.P., Sharma, D., Niyazi, A., & Moss, A.C. (2006). Theoretical perspectives and approaches. In M. Munafó & I. Albery (Eds.), *Cognition and Addiction* (pp. 1–29). Oxford: Oxford University Press.

Algom, D., Chajut, E., & Lev, S. (2004). A rational look at the emotional stroop phenomenon: a generic slowdown, not a stroop effect. *Journal of Experimental Psychology. General*, *133*(3), 323–338. doi:10.1037/0096-3445.133.3.323

Balota, D.A., Yap, M.J., Cortese, M.J., Hutchison, K.A., Kessler, B., Loftis, B., Neely, J.H., Nelson, D.L., Simpson, G.B., & Treiman, R. (2007). The English Lexicon Project. *Behavior Research Methods, 39*, 445-459.

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.

Boyer, M., & Dickerson, M. (2003). Attentional bias and addictive behaviour: automaticity in a gambling-specific modified Stroop task. *Addiction*, *98*(1), 61–70.

Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEW): Stimuli, instruction manual and affective ratings*. Technical report C-1, Gainesville, FL. The Center for Research in Psychophysiology, University of Florida.

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), 527–533. doi:10.1177/0269881104047280

Cane, J. E., Sharma, D., & Albery, I. P. (2009). The addiction Stroop task: examining the fast and slow effects of smoking and marijuana-related cues. *Journal of Psychopharmacology*, *23*(5), 510–519. doi:10.1177/0269881108091253

Carpenter, K. M., Schreiber, E., Church, S., & McDowell, D. (2006). Drug Stroop performance: relationships with primary substance of use and treatment outcome in a drug-dependent outpatient sample. *Addictive Behaviors*, *31*(1), 174–181. doi:10.1016/j.addbeh.2005.04.012

Cox, W.M., Blount, J.P., & Rozak, A.M. (2000). Alcohol abusers' and nonabusers' distraction by alcohol and concern-related stimuli. *The American Journal of Drug and Alcohol Abuse, 26*, 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. doi:10.1093/alcalc/agg010

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. doi:10.1037/0033-2909.132.3.443

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., 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.

Donovan, D. M., & Marlatt, G. A. (2007). *Assessment of Addictive Behaviors (2nd ed.)*. New York: Guilford Press.

Duka, T., Townshend, J. M., Collier, K., & Stephens, D. N. (2002). Kindling of withdrawal: a study of craving and anxiety after multiple detoxifications in alcoholic inpatients. *Alcoholism, Clinical and Experimental Research*, *26*(6), 785–795.

Fadardi, J., & Cox, W. (2006). Alcohol attentional bias: drinking salience or cognitive impairment? *Psychopharmacology*, *185*(2), 169–178. doi:10.1007/s00213-005-0268-0

Field, M., & Cox, W. M. (2008). Attentional bias in addictive behaviors: a review of its development, causes, and consequences. *Drug and Alcohol Dependence*, *97*(1-2), 1–20. doi:10.1016/j.drugalcdep.2008.03.030

Field, M., Duka, T., Eastwood, B., Child, R., Santarcangelo, M., & Gayton, M. (2007). Experimental manipulation of attentional biases in heavy drinkers: do the effects generalise? *Psychopharmacology*, *192*(4), 593–608. doi:10.1007/s00213-007-0760-9

Forestell, C. A., Dickter, C. L., & Young, C. M. (2012). Take me away: the relationship between escape drinking and attentional bias for alcohol-related cues. *Alcohol*, *46*(6), 543–549. doi:10.1016/j.alcohol.2012.05.001

Garland, E. L., Carter, K., Ropes, K., & Howard, M. O. (2012). Thought suppression, impaired regulation of urges, and Addiction-Stroop predict affect-modulated cue-reactivity among alcohol dependent adults. *Biological Psychology*, *89*(1), 87–93. doi:10.1016/j.biopsycho.2011.09.010

Monk, R.L., & Heim, D. (2013). A critical systematic review of alcohol-related outcome expectancies. *Substance Use & Misuse, 7*, 539-557

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*, *8*(2), 111–115. doi:10.1037/0893-164X.8.2.111

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, 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: Journal of the Society of Psychologists in Addictive Behaviors*, *20*(2), 171–177. doi:10.1037/0893-164X.20.2.171

Loethen, G. J., & Khavari, K. A. (1990). Comparison of the Self-Administered Alcoholism Screening Test (SAAST) and the Khavari Alcohol Test (KAT): results from an alcoholic population and their collaterals. *Alcoholism, Clinical and Experimental Research*, *14*(5), 756–760.

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. doi:10.1016/j.drugalcdep.2004.03.004

MacLeod, C. M. (1992). The Stroop task: The "gold standard" of attentional measures. *Journal of Experimental Psychology: General*, *121*(1), 12–14. doi:10.1037/0096-3445.121.1.12

Marlatt, G. A., & Donovan, D. M. (2007). *Relapse Prevention: Maintenance Strategies in the Treatment of Addictive Behaviors*. New York: Guilford Press.

McCusker, C. G., & Gettings, B. (1997). Automaticity of cognitive biases in addictive behaviours: further evidence with gamblers. *The British Journal of Clinical Psychology*, *36 (Pt 4)*, 543–554.

McKenna, F. P., & Sharma, D. (2004). Reversing the emotional Stroop effect reveals that it is not what it seems: the role of fast and slow components. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *30*(2), 382–392. doi:10.1037/0278-7393.30.2.382

Phaf, R. H., & Kan, K. J. (2007). The automaticity of emotional Stroop: a meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry*, *38*(2), 184–199. doi:10.1016/j.jbtep.2006.10.008

Rofey, D., Corcoran, K. J., & Kavanagh, G. (2006). Alcohol Expectancy and Sex Predict Alcohol Relevant Stroop Interference. *Addictive Disorders & Their Treatment*, *5*(4), 173–178. doi:10.1097/01.adt.0000210729.38509.74

Rose, A. K., & Duka, T. (2008). Effects of alcohol on inhibitory processes. *Behavioural Pharmacology*, *19*(4), 284–291. doi:10.1097/FBP.0b013e328308f1b2

Ryan, F. (2002). Attentional bias and alcohol dependence: a controlled study using the modified stroop paradigm. *Addictive Behaviors*, *27*(4), 471–482.

Ryan, F. (2006). Appetite lost and found: Cognitive psychology in the addiction clinic. In *Cognition and Addiction* (pp. 279–302). Oxford: Oxford University Press.

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. doi:10.1080/09652140020021026

Sharma D., & McKenna F. P. (2001). The role of time pressure in the emotional Stroop task. *British Journal of Psychology*, 92, 471-481.

Sharma, D., & Money, S. (2010). Carryover effects to addiction-associated stimuli in a group of marijuana and cocaine users. *Journal of Psychopharmacology*, *24*(9), 1309–1316. doi:10.1177/0269881109350079

Shiffman, S., & Waters, A. J. (2004). Negative affect and smoking lapses: a prospective analysis. *Journal of Consulting and Clinical Psychology*, *72*(2), 192–201. doi:10.1037/0022-006X.72.2.192

Stetter, F., Chaluppa, C., Ackerman, K., & Straube, E.R. (1994). Alcoholics' selective processing of alcohol related words and cognitive performance on a Stroop task. *European Psychiatry*, *9*(2), 71–76.

Stewart, S. H., Hall, E., Wilkie, H., & Birch, C. (2002). Affective priming of alcohol schema in coping and enhancement motivated drinkers. *Cognitive Behaviour Therapy*, *31*(2), 68–80. doi:10.1080/16506070252959508

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.

Waters, A. J., Sayette, M. A., Franken, I. H. A., & Schwartz, J. E. (2005). Generalizability of carry-over effects in the emotional Stroop task. *Behaviour Research and Therapy*, *43*(6), 715–732. doi:10.1016/j.brat.2004.06.003

Waters, A. J., Sayette, M. A., & Wertz, J. M. (2003). Carry-over effects can modulate emotional Stroop effects. *Cognition and Emotion*, *17*(3), 501–509. doi:10.1080/02699930143000716

Waters, A. J., Shiffman, S., Sayette, M. A., Paty, J. A., Gwaltney, C. J., & Balabanis, M. H. (2003). Attentional bias predicts outcome in smoking cessation. *Health Psychology*, *22*(4), 378–387.

Williams, J. M., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin*, *120*(1), 3–24.

Wyble, B., Sharma, D., & Bowman, H. (2008). Strategic regulation of cognitive control by emotional salience: A neural network model. *Cognition & Emotion*, *22*(6), 1019–1051. doi:10.1080/02699930701597627

Zetteler, J. I., Stollery, B. T., Weinstein, A. M., & Lingford-Hughes, A. R. (2006). Attentional bias for alcohol-related information in adolescents with alcohol-dependent parents. *Alcohol and Alcoholism*, *41*(4), 426–430. doi:10.1093/alcalc/agl026

Tables

Table 1.
Participant demographic characteristics and alcohol consumption by group.

		PDT (N=62)	Control (N=60)	P-Value
Mean age in months (SD)		45.55 (9.04)	43.2 (14.05)	0.276[a]
Gender (% male)		54.8	53.3	0.365[b]
Ethnicity (%)	White British	87.1	90.0	0.701[b]
	White Other	9.7	6.7	
	Asian British	3.2	1.65	
	Black British	0.0	1.65	
Highest education level completed (%)	No qualifications	19.4	1.7	0.000[b]
	GCSE	32.3	16.7	
	A-Level	12.9	22.7	
	Undergraduate	6.5	20.0	
	Postgraduate	1.6	13.3	
	Other	27.4	26.7	
Alcohol consumption, Mean (SD)		66.5 (13.59)	12.62 (18.70)	0.000[a]

[a] P-value from independent samples t-test comparing PDT and control groups
[b] P-value from Pearson chi-square comparing PDT and control groups

Table 2.

Pearson's correlations (r) for mean Weekly Units of Alcohol (WUA), age, and interference scores for alcohol (A) and negative emotion (N) at positions 1-7[a]

	WUA	*Age*	*A 1*	*A 2*	*A 3*	*A 4*	*A 5*	*A 6*	*A 7*	*N 1*	*N 2*	*N 3*	*N 4*	*N 5*	*N 6*	*N 7*
WUA	—	0.04	0.02	0.26**	0.08	0.09	0.01	-0.12	-0.01	0.03	0.02	-0.16	-0.04	0.03	-0.10	0.04
Age		—	-0.03	0.08	0.01	-0.08	0.02	-0.06	-0.07	0.04	0.13	0.01	-0.05	0.12	-0.01	0.03
A 1			—	0.07	0.28**	.374**	0.32**	0.23*	0.22*	0.60**	0.12	0.24**	0.25**	0.13	0.04	0.13
A 2				—	0.32**	0.21*	-0.01	0.16	0.28**	-0.23*	0.20*	-0.33**	-0.19*	0.01	0.01	0.02
A 3					—	0.36**	0.21*	0.23*	0.45**	0.07	0.20*	0.21*	-0.08	0.29**	0.10	0.26**
A 4						—	0.31**	0.41**	0.26**	0.17	0.23*	0.13	0.45**	0.14	0.21*	0.16
A 5							—	0.28**	0.20*	0.29**	0.22*	0.15	0.14	0.58**	0.14	0.04
A 6								—	0.21*	0.07	0.10	0.07	0.22*	0.12	0.56**	0.13
A 7									—	0.01	0.18	0.06	-0.06	0.12	0.01	0.45**
N 1										—	0.24**	0.56**	0.46**	0.23*	0.29**	0.32**
N 2											—	0.30**	0.37**	0.39**	0.38**	0.42**
N 3												—	0.45**	0.26**	0.29**	0.34**
N 4													—	0.15	0.48**	0.27**
N 5														—	0.08	0.12
N 6															—	0.37**
N 7																—

[a]Interference scores were calculated by subtracting RTs of neutral trials from RTs of alcohol and negative emotion trials for each position 1-7. Greater interference scores indicate greater AB to alcohol or negative emotion words.

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table 3.
Participant demographic characteristics and alcohol consumption of control and unprimed control groups.

		Primed Control (N=60)	**Unprimed Control (N=40)**	**P-Value**
Mean age in months (SD)		43.2 (14.05)	32.93 (16.18)	0.111[a]
Gender (% male)		53.3	45.0	0.414[b]
Ethnicity (%)	White British	90.0	65.0	
	White Other	6.7	5.0	
	Asian British	1.65	5.0	
	Black British	1.65	5.0	0.015[b]
	Asian Other	0	7.5	
	Black Other	0	7.5	
	Mixed Black/White British	0	5.0	
Highest education level completed (%)	No qualifications	1.7	0	
	GCSE	16.7	12.5	
	A-Level	22.7	52.5	0.001[b]
	Undergraduate	20.0	30.0	
	Postgraduate	13.3	5.0	
	Other	26.7	0	
Alcohol consumption, Mean (SD)		12.62 (18.70)	16.12 (15.77)	0.551[a]

[a] P-value from independent samples t-test comparing primed and unprimed control groups
[b] P-value from Pearson chi-square comparing primed and unprimed control groups

Table 4.
Summary statistics (Mean, Standard Error) for all three experimental groups.

Group	Position of Word	Word Category - Means (SE)		
		Negative	Neutral	Alcohol
Primed Control	1	891.65 (24.42)	902.96 (28.95)	939.64 (25.93)
	2	914.78 (25.48)	893.43 (24.01)	936.36 (32.07)
	3	895.79 (23.61)	890.85 (27.82)	921.68 (30.43)
	4	878.42 (24.66)	895.99 (29.09)	912.98 (28.87)
	5	883.44 (25.32)	893.78 (24.84)	905.81 (22.62)
	6	883.53 (23.65)	888.18 (24.67)	904.57 (24.71)
	7	883.38 (24.38)	899.59 (24.64)	904.46 (26.71)
Unprimed Control	1	894.26 (25.70)	894.76 (26.87)	896.61 (26.42)
	2	904.08 (25.35)	899.66 (27.79)	921.01 (26.29)
	3	873.93 (23.61)	883.95 (26.74)	866.38 (25.12)
	4	898.15 (26.02)	891.41 (30.16)	896.05 (26.74)
	5	882.26 (25.31)	886.53 (29.04)	865.20 (23.92)
	6	889.04 (26.73)	885.58 (28.14)	894.41 (26.61)
	7	866.06 (23.24)	878.55 (26.77)	872.54 (26.29)
PDT	1	1000.19 (23.82)	990.68 (28.24)	1049.37 (25.30)
	2	1011.49 (24.85)	983.96 (23.42)	1069.19 (31.29)
	3	980.09 (23.03)	985.39 (27.14)	1023.89 (29.68)
	4	991.77 (24.06)	977.40 (28.38)	1016.01 (28.16)
	5	981.65 (24.70)	986.65 (24.23)	993.72 (22.07)
	6	984.78 (23.07)	970.11 (24.06)	998.88 (24.12)
	7	989.23 (23.78)	977.04 (24.03)	987.73 (26.05)

Figures

Figure 1. Median correct reaction times (in milliseconds) for each word and position for PDT group in Study 1.

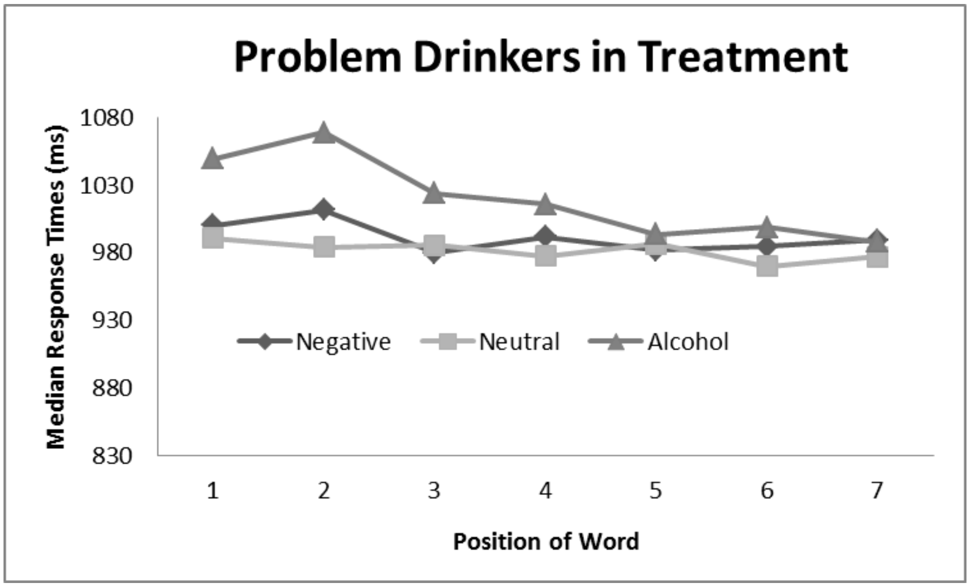

Figure 2. Median correct reaction times (in milliseconds) for each word and position for control group in Study 1.

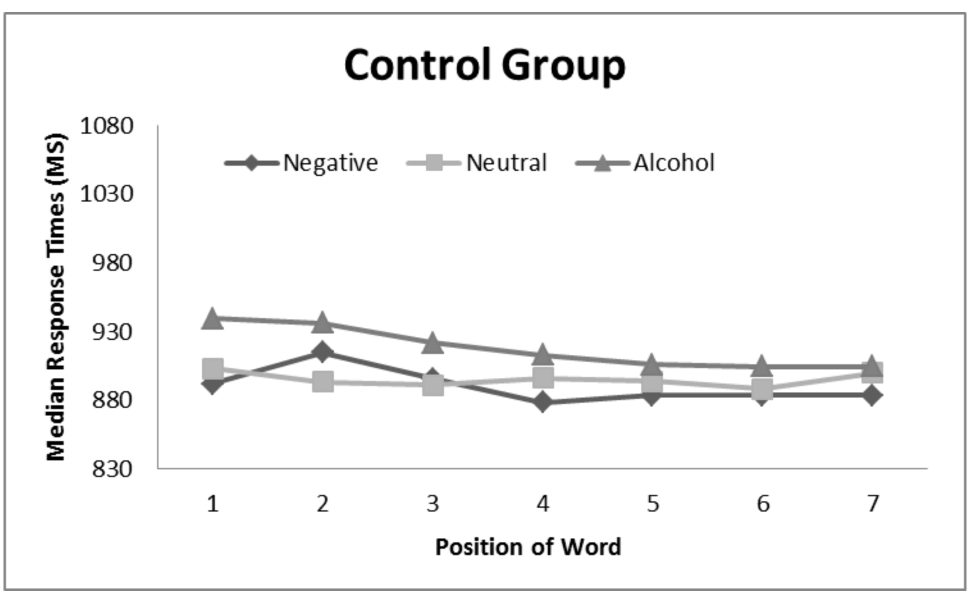

Figure 3. Median correct reaction times (in milliseconds) for each word and position for unprimed control group in Study 2.

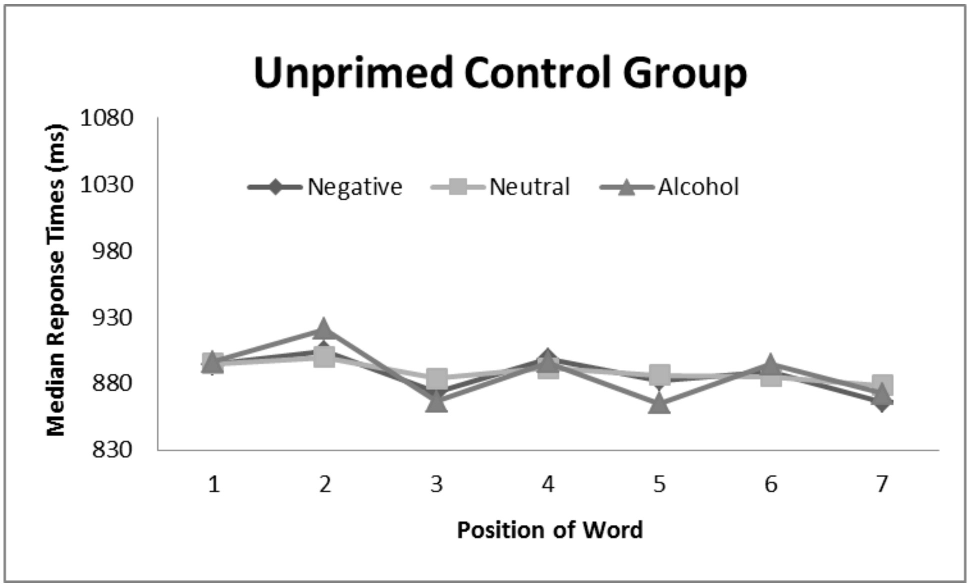

Figure 4. Median reaction times (in milliseconds) for each word type for primed and unprimed control groups.