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**THE EFFECT OF ALCOHOL DEPENDENCE ON AUTOMATIC VISUO-  
SPATIAL PERSPECTIVE TAKING**

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**Highlights**

- Alcoholism is associated with cognitive deficits which may affect social processing
- We tested whether alcoholism affects visuo-spatial perspective taking (VSPT)
- Alcohol dependent (AD) participants show no VSPT deficits in this task
- Non-AD participants show an automatic VSPT effect to fearful faces *only*
- However ADs show an automatic VSPT effect to *both* neutral and fearful faces

**ABSTRACT**

*Background:* Alcoholism is associated with cognitive deficits that affect social functioning. Previous research has shown that alcoholism is associated with deficits in conscious, deliberate social processing. However, little is known about whether alcoholism also affects rapid, spontaneous processing. We therefore investigated the extent to which alcoholism affects the ability to spontaneously adopt the viewpoint of another in a visuo-spatial perspective taking (VSPT) task. *Methods:* VSPT was measured in participants responding to a dot probe presented for 35ms alongside neutral faces, fearful faces and baseline stimuli (rectangles). *Results:* Alcohol dependent (AD) participants showed the standard reaction time cost to fearful faces, but not neutral faces relative to baseline. However, AD participants showed a reaction time cost to both fearful and neutral faces. *Conclusions:* AD participants are not impaired in their ability to automatically adopt the perspective of another. However, unlike non-AD participants, they show automatic perspective taking to both neutral and fearful faces.

**KEYWORDS:** Alcohol dependence, social processing, perspective taking, emotion

## 1. INTRODUCTION

To interact successfully with others requires the processing of a complex array of social information. Social cognition can be slow and intentional, e.g., the deliberation of a jury in a court of law, but it is also important for successful communication that we are able to process social information quickly and economically in real time social interactions (Apperly, 2012). Increasing evidence shows that social cognition is compromised in those who are alcohol dependent (AD) including the recognition and evaluation of emotional stimuli (Clark et al., 2007; Kornreich et al., 2013; Maurage et al., 2007, 2008; Philippot et al., 1999; Townshend and Duka, 2003); humour processing (Uekermann et al., 2007), understanding how others might feel (Bosco et al., 2014) and tracking the beliefs of others (Maurage et al., 2015).

For example, Uekermann et al. (2007) investigated humour processing in adults with AD and reasoned that one needs to understand another's mind in order to 'get' the joke. In a joke completion task, they found that humour processing was impaired in AD participants. They selected fewer 'correct' funny joke endings, opting instead for more slapstick and logical endings compared to controls. Similarly, Amenta et al. (2012) showed that male AD participants were less able to detect irony within a set of ironic and non-ironic statements at the end of a story. Interestingly, recognition of irony has been significantly related to empathy as measured through the Empathy Quotient (Baron-Cohen and Wheelwright, 2004).

In an interview questionnaire study, Bosco et al. (2014) investigated social cognition in adults with Alcohol Use Disorder (AUD). Using the Theory of Mind Assessment Scale (Bosco et al., 2009) they found that adults with AUD were impaired,

relative to controls, in their understanding of others when answering a range of questions such as ‘Do you notice when others feel good? When does that happen? Can you give an example?’

In a more recent study by Maurage et al. (2015) just over half the AD participants’ performed significantly worse than controls across both a simple and more complex belief-tracking task. They found that disease-related factors (years of illness, units of alcohol consumed) was negatively related to AD participants’ ability to track another’s false belief regarding the location of an object, and also the ability to inhibit self-knowledge about the location of an object.

The studies above provide evidence that conscious, effortful and deliberate social cognition is impaired in AD participants. They do not however, provide evidence that AD populations are impaired in their ability to spontaneously process social information in real time; that is, computations that are relevant to successful ‘online’ social interaction. Understanding the cognitive processes relevant to successful social interaction is not only important scientifically, but is also relevant to alcohol treatment settings, which often rely on the construction of a therapeutic relationship. Thus, the aim of the present study was to investigate whether alcohol dependence is related to a deficit in automatic social processing. To this end, we investigated spontaneous visuo-spatial perspective taking (VSPT). Being able to adopt the perspective of another, either intentionally or spontaneously, is widely assumed to play a key role in social cognition and successful communication (see Schwarzkopf et al., 2014, for more on the intentional/spontaneous distinction). In the research reported here, we used a task widely reported as a test of spontaneous VSPT (Zwicker and Müller, 2010). This task, and variants of it, has since

been widely used to study VSPT in both children, adults and people with autism (e.g., Böckler and Zwickel, 2013; Pearson et al., 2013). Zwickel and Müller (2010) reasoned that a key feature of understanding other peoples' perceptions lies in the ability to represent the world from their (the other person's) viewpoint. In their task, participants had to respond to a dot probe, which was shown for 35ms to either side of a fearful or neutral face (incongruent perspective trials), or above or below the neutral or fearful face (congruent perspective trials). Participants judged whether the dot was on the left or right of the screen, as *they* saw it. The authors argued that a slower reaction time (RT) to make the left/right judgement in the incongruent trials, compared to the congruent trials was indicative of automatic VSPT. To put it another way, if participants automatically compute the perspective of the other (the face on the screen) and if this perspective differs from the participant's own, then a reaction time cost to resolve the conflict will be incurred.

They found that there was indeed an RT cost when the other's perspective differed from their own, but that this cost was only evident when the face conveyed a fearful expression rather than a neutral expression. They concluded that the presence of a fearful face elicits automatic taking of the 'other' in a perspective taking task.

To date, no published research has investigated the impact of alcohol dependence on VSPT, even though AD participants show deficits in visuo-spatial abilities, such as spatial working memory, visual spatial construction and copying complex stimuli (Beatty et al., 1996; Pfefferbaum et al., 2001; Sullivan et al., 1992), as well as deficits when processing complex facial stimuli such as the detection of positive and negative emotions (Maurage et al., 2008). Given the findings reported above, and the large number of

studies reporting problems processing emotionally charged stimuli, we investigated whether AD participants would also be impaired in their ability to spontaneously take the perspective of another. Using the same methodology as Zwickel and Müller (2010) we investigated the effect that alcoholism has on VSPT. VSPT was measured by RT responses to spatial stimuli – neutral and fearful faces – as well as a black rectangle which acted as a baseline control measure.

## 2. MATERIALS AND METHODS

### 2.1 *Participants*

Twenty two non-AD and 22 AD participants were recruited to take part. AD participants were recruited from an outpatient treatment service centre in Kent, UK. Non-clinical staff from the same service centre, with no self-reported history of substance or alcohol misuse, acted as control participants. All participants were British. The groups did not differ significantly in age (AD mean =  $43 \pm 12$  years; non-AD mean =  $42 \pm 9$  years,  $t(42) = .18, p > .05$ ) or gender as both groups consisted of 11 men and 11 women. Level of educational achievement did not differ between the groups  $t(42) = 1.25, p > .05$ , nor did employment history, with both groups reporting a range of manual and professional work.

AD participants were all assessed according to the Diagnostic and Statistics Manual - IV-R (American Psychiatric Association, 2000) criteria for alcohol dependence by their keyworker at the time of entering treatment. All AD participants had self-reported 3+ weeks of abstinence from alcohol, and were alcohol free at the time of testing as assessed by their key-worker using a breathalyser test.



Psychiatric assessment at the time of entering treatment showed that no AD participants self-reported current poly-drug use, historical dependence on other substances, and their medical history showed no psychiatric or neurological disease. None self-reported being in withdrawal at the time of taking part, nor currently taking any medication relevant to aiding withdrawal symptoms. Nine AD participants had received prescribed benzodiazepine assisted detoxification 3+ weeks earlier. The groups differed on the Fast Alcohol Screening Test (FAST), a simple four question audit to detect problem drinking (Hodgson et al., 2002): AD,  $M = 9.95$ , ( $SD = 4.13$ ); non-AD,  $M = 1.19$ , ( $SD = 2.10$ ). This difference was significant,  $t(42) = 8.16$ ,  $p < .001$ .

The mean of number of alcoholic units taken per day prior to treatment within the AD group was 14.21 ( $SD=4.23$ ) and mean number of years of problematic drinking was 16.10 ( $SD=8.74$ ). The average number of attempts at detoxification was 1.50 ( $SD=0.50$ ).

The Trait Anxiety Inventory for adults (STAI) was administered to control for the effects of anxiety (Spielberger et al., 1983). Anxiety scores were higher in the AD group,  $M = 41.23$ , ( $SD = 8.37$ ) as compared to the non-AD group,  $M = 36.91$ , ( $SD = 11.28$ ), but this difference was not significant  $t(42) = -1.44$ ,  $p > .05$ . AD and non-AD groups also differed on their scores for depression (Beck Depression Inventory; BDI; Beck and Steer, 1990). BDI scores were higher for AD,  $M = 12.34$  ( $SD = 8.12$ ) than for the non-AD group,  $M = 9.87$  ( $SD = 6.54$ ) and this difference was significant  $t(42) = -2.56$ ,  $p < .001$ . Although scores on the BDI do indicate differences between the groups (AD group scores show a greater range) it is worth noting that neither groups' average scores reached what is considered to be the clinical level of depression.

## *2.2 Apparatus and Stimuli*

Stimuli was presented on a Toshiba laptop with a 19" computer screen (85-Hz refresh rate) positioned 50cm in front of the participants. Figure 1 provides an example of the facial stimuli that were used from the Karolinska database (Lundqvist et al., 1998). These were 12 male and 12 female grey-scaled faces with hair removed and presented within a rectangle. The remainder of the screen was white. Twelve of the faces conveyed a fearful expression and 12 a neutral expression. A black rectangle which was the same in size as the facial stimuli acted as a baseline stimulus.

### *2.3 Design and Procedure*

Half of participants completed the FAST, BDI and STAI before the trials and half after. Participants were instructed to complete a set of 10 practice trials before starting the recorded experiment. Test trials were pre-randomised into blocks of 12, consisting of faces incongruent; faces congruent; baseline (rectangles) incongruent; baseline congruent. Within each block of 12 – with the exception of the baseline trials – 6 faces conveyed fearful and 6 neutral expressions. Instructions were given before each block of trials to remind participants to respond to the location of the dot. There were a total of 144 trials.

Trials started with presentation of the stimuli, and was followed 500ms later by a dot probe, 5° in diameter, that appeared for 35ms. Reaction time was recorded from the onset of the dot probe. For the incongruent trials the dot appeared 1° to the left or right of the face/rectangle, and for the congruent trials 1° above or below the face/rectangle. During the baseline trials the dot also appeared for the same duration and in the same locations but the stimulus was a black rectangle. Participants were asked to respond as quickly and as accurately as possible, pressing 's' to indicate left, and 'k' for dots on the right, 't' for those at the top, and 'b' for the bottom.

### 3. RESULTS

Between groups differences in anxiety and depression (as measured by the STAI and BDI) were unlikely to have affected any potential group differences to the experimental measure (RTs). This was because there were no significant correlations ( $p > .05$  for all comparisons) between participants' STAI and BDI scores with their RTs in the experimental conditions. Preliminary analyses were carried out on the raw reaction times (Figure 2). ANOVA main effects revealed that AD participants responded slower than non-AD participants ( $F(1,42)=23.11, p<.001, R^2=.355$ ), that incongruent condition responses were slower than congruent ones ( $F(1,42) =73.64, p<.001, R^2=.637$ ), and that responses to faces were slower than responses to the baseline conditions ( $F(2,84) =79.91, p<.001, R^2=.655$ ).

The effect of perspective taking was measured by calculating a difference score (Zwikel and Müller, 2010) between the congruent and incongruent trials (Figure 3). These difference scores were analysed in a 2-way mixed ANOVA with Stimulus type (Neutral, Fearful, Baseline) as the within-participants factors and Group (Non-AD, AD) as the between-participant factor. There was a main effect for Stimulus type,  $F(2,84)=31.10, p<.001, R^2=.425$ , and of Group,  $F(1,42)=13.10, p=.001, R^2=.238$ . There was also a significant interaction between Stimulus type and Group,  $F(2,84)=8.56, p<.001, R^2=.169$ . In the non-AD group, a perspective effect was observed with fearful faces,  $t(21) = 8.00, p<.001$ , but not with the neutral faces  $t(21) = 0.80, p = .431$ . In contrast, in the AD group, there was a perspective effect for *both* the fearful,  $t(21) = 4.85, p<.001$  and the neutral faces,  $t(21) = 6.07, p<.001$ .

### 4. DISCUSSION

The aim of the study was to investigate the effect of alcoholism on spontaneous VSPT. Specifically, we investigated whether AD and non-AD participants show a reaction time cost to a dot location decision, when simultaneously presented with a neutral or fearful face. Both AD and non-AD participants took significantly longer to respond when their perspective (a left/right decision) differed from that of the fearful face on the screen. There was therefore no *deficit* in spontaneous VSPT in our group of AD participants. With regard to non-AD participants, our findings are consistent with those of Zwickel and Müller (2010). They found that responses to fearful faces, but not neutral faces, were more delayed in the incongruent conditions. Thus, the current data add to the growing body of evidence supporting the view that VSPT is automatically triggered by salient stimuli.

However, there were differences in behaviour between our AD and non-AD groups. First, the AD group were significantly slower at responding across all conditions compared to the non-AD group (even though this was unlikely to have been due to anxiety or depression). This delay is not unusual, and has been demonstrated in many previous studies (Cox et al., 2002; Maurage et al., 2007, 2008; Sharma et al., 2001). Alcohol abuse over a significant period, may well lead to slower cognitive skill, manifested in memory, mental speed and motor responses (Clark et al., 2007; Oscar-Berman and Marinkovic, 2003). There is also a high comorbidity between alcohol dependence and anxiety and depression with both these clinical conditions reported to heighten awareness of emotional stimuli (Williams et al., 1996). While the design controlled for the effects of anxiety and depression by using the STAI and the BDI,

alcohol dependence may nonetheless increase the salience of social stimuli and this may, in turn, give rise to delayed RTs to facial stimuli.

This leads to the study's second main finding, that while for the non-AD group a perspective effect was observed for fearful faces only, this was not case with the AD group – they showed equally long perspective taking costs to both neutral and fearful faces. Thus, the salience of the emotion *fear* made no difference to VSPT in the AD group. The findings suggest that AD participants do not have a deficit in spontaneous VSPT: a key ability in rapid online social interaction. However, that their RTs were similar to neutral and fearful faces suggests that a wider range of stimuli trigger this automatic mechanism for AD participants than controls. In future work it would be interesting to see how AD participants perform on a task requiring intentional perspective taking (Schwarzkopf et al., 2014).

There are a number of potential explanations as to why AD participants might demonstrate automatic perspective taking to *both* neutral and fearful faces. One possibility is that the AD group *misinterpreted* neutral faces as fearful faces. A tendency for AD participants to over-estimate the emotional valence of faces has been reported previously. Philippot et al. (1999) observed that faces conveying neutral or mild emotional expressions (sadness, anger and disgust) were rated as more intense by AD participants than controls. Moreover, AD participants were also more likely to interpret a happy face as expressing a negative mood. Similarly, Clark et al. (2007) report that AD participants rated drawings and emotional words, across valences, as more intense than controls, and Kornreich et al. (2013) report higher emotional intensity ratings to music, faces and voices by AD participants compared with controls. Taken together, these data

suggest that a wide variety of emotional stimuli and emotional expressions are often interpreted differently by AD participants compared to controls.

An alternative to the view that AD participants misinterpreted the neutral faces is the idea that the fearful faces were so salient that their presence created a carry-over effect to the neutral stimuli. Another possibility is that all faces, irrespective of their emotion, are highly salient for AD participants, and that the mere presence of *any* face was enough to create a delayed response in conditions where there was a requirement to adopt another's perspective. Future studies should control for, or investigate, carry-over effects.

In summary, the findings suggest that automatic VSPT was not impaired in this AD sample, although there were behavioural differences between the AD and non-AD participants in the stimuli that trigger this perspective taking. Further research should investigate the behaviour of AD participants in a range of social processing tasks, including intentional perspective taking, to establish the degree to which alcoholism impacts our ability to navigate our social worlds.

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**Contributors' statement:**

\*Dr. Sharon Cox led the design of the experiment, data collection and analysis and the writing of the paper.

Dr. Chris Chandler was involved in the design of the study and in the writing of the paper.

Dr. Andrew Simpson contributed to the data analysis and the writing of all drafts.

Dr. Kevin Riggs contributed to the experimental design, data analysis and writing of all drafts.

\*I can confirm that all authors have read the manuscript and approve of its submission to Drug and Alcohol Dependence.

**Conflicts of Interest:**

No conflict declared

**FIGURE LEGENDS**

Figure 1. Example of the facial stimulus used from the Karolinska database. Same female actor conveying fear (left) and a neutral expression (right).

Figure 2. Reaction times to respond to the dot probe in the three stimulus conditions for both the AD and non-AD participants. Error bars represent the 95% confidence interval.

Figure 3. Difference scores (reaction time differences between congruent and incongruent trials) in all 3 stimulus conditions for both AD and non-AD participants. Error bars represent the 95% confidence interval.



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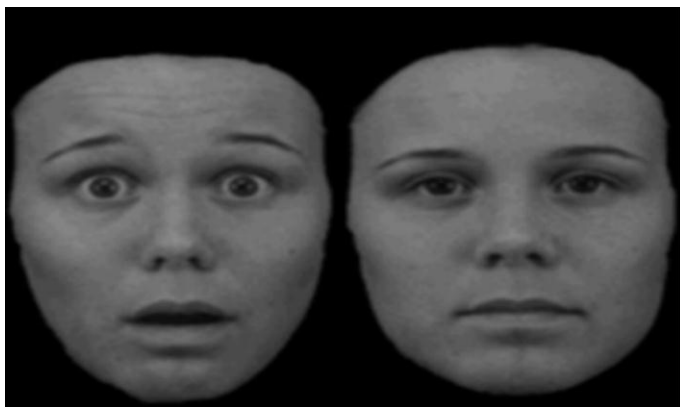
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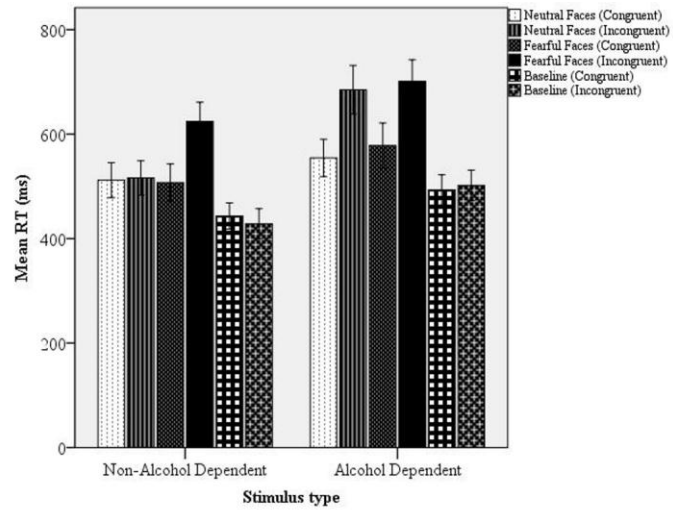
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## Alcohol dependence and perspective taking



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