**In people who drink more, facets of theory of mind may be impaired by alcohol stimuli**

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Conflict of Interest

The authors declare no conflicts of interest.

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**Background:** Theory of mind (ToM) – the ability to understand others’ beliefs, mental states, and knowledge – is an important part of successful social interaction. There is a growing (albeit mixed) evidence base suggesting that individuals with substance use disorder or who are intoxicated (relative to sober controls) perform worse on a number of ToM tasks. The aim of this study was to explore the hitherto little explored notion that ToM-related capabilities such as the ability to see the world from another person’s perspective (termed Visual Perspective Taking; VPT), may be impacted by alcohol-related stimuli. **Method**: In this pre-registered study, 108 participants (M age = 25.75, SD age = 5.67) completed a revised version of the director task where they followed the instructions of an avatar to move both alcohol beverages and soft drinks that were mutually visible (target objects) while avoiding those only visible to the participant (distractor items). **Results**: Contrary to predictions, accuracy was lower when the target drink was alcohol and the distractor was a soft drink, although higher AUDIT scores were associated with significantly lower accuracy when alcohol drinks were the distractor items. **Conclusions**: There may be some contexts when being able to see alcohol beverages makes it harder to take another person’s perspective. It also appears that poorer VPT and perhaps ToM capacity may be evident in individuals who consume more alcohol. Future research is warranted to examine how alcohol beverages, alcohol consumption behaviours, and intoxication interact to impact VPT capacity.

The ability to understand others’ beliefs, mental states and knowledge is referred to as theory of mind (ToM) and is commonly conceptualised within the wider psychological literature as crucial to the success, or failure, of social interactions (Premack & Woodruff, 1978; McDonald et al, 2013). There is also evidence that ToM is associated with alcohol use in clinical populations. Notwithstanding some mixed findings (e.g., Kornreich et al., 2011), it has been documented that ToM impairments evident in people who drink at clinical levels may persist following detoxification (e.g., Bosco et al., 2014; Maurage et al., 2016) and that individuals with alcohol use disorder display difficulties in accurately inferring/reporting others’ mental states and emotions (see Onuoha et al., 2016 for a meta-analytic synthesis). Furthermore, when assessing social decision making across a variety of paradigms (economic games, moral dilemmas and interpersonal problem-solving tasks), performance has been found to vary consistently between people with alcohol use disorder and those without (Gautier et al., 2021). There is therefore growing evidence of ToM limitations being associated with alcohol consumption that is heavy, or at clinical levels, and research is needed to examine the extent to which potential impairments in understanding others’ beliefs may already manifest in non-clinical populations and using tasks to assess other ToM abilities.

Beginning to address this question, researchers to date have tended to employ cognitive psychological tasks from the ToM literature to explore how intoxication impacts people’s ability to interpret social stimuli and respond to everyday situations. For example, studies using the Faux Pas Task (Stone et al., 1998)[[1]](#footnote-2) and the Reading the Mind in the Eyes Test[[2]](#footnote-3) (Baron-Cohen et al., 2001) tasks suggest that participants who have consumed 6-8 units of alcohol are impaired in their identification of social faux pas and in their emotion recognition abilities (Mitchell et al., 2011). However, findings have been inconsistent; Dolder et al. (2016), found that alcohol was associated with better decoding of positive emotions (using a face emotion recognition task), suggesting that intoxication may improve the recognition of others’ emotions (a facet of ToM). While research by Johnson et al. (2018) suggests that alcohol may elevate social ToM capabilities. Here, in a novel version of the Faux Pas Task (termed the social disinhibition task[[3]](#footnote-4)), intoxicated participants used significantly more negative words to describe social faux pas scenarios than placebo participants in both control (where there were no task instructions) and inhibition conditions (where participants were only permitted to supply positive comments about the actor in the scenario), pointing to elevated ToM capabilities in those who had consumed alcohol. As such, there is a an emerging (albeit varied) evidence base indicating that intoxication may impact ToM ability, particularly with respect to the processing of social and emotional information.

However, while the tests used in this domain have, to date, examined cognitive and affective ToM (e.g., the Yoni task - used by Lannoy et al., 2020), subtle social reasoning (Faux pas task - used by Johnson et al., 2018) and more implicit social analysis (Reading the Mind in the Eyes Test- used by Mitchell et al, 2011), there has been little research on regular ToM-related capabilities such as the ability to see the world from another person’s perspective - termed Visual Perspective Taking. Tests of this capability assess accuracy when seeking to judge what another person can and cannot see (also known as level 1 VPT). One noted exception to this is work by Cox and colleagues (2016; 2018) who utilised a visuo-spatial perspective taking (VSPT) task to explore differences between those with and without alcohol dependence disorder with regards to their ability to make spatial judgments from their own perspective, which were either congruent or incongruent with the perspective of another agent whose face displayed a happy or neutral facial expression. Here, there were slower VSPT reaction times in response to incongruent happy (Cox et al., 2018) and fearful (Cox et al., 2016) faces in both those with and without alcohol dependence, although only those with dependence showed impairments to neutral faces also (Cox et al., 2016;2018). This suggests that there may be facets of ToM performance that are consistent between individuals with and without alcohol use disorder, while they may differ in response to other stimuli. Yet, and as noted by the authors, while Cox et al’s (2018) work can point to performance VSPT differences between population groups, it was not designed to assess whether VPT varies in real-world contexts where success may depend on effectively determining what another person can see.

This limitation is in need of addressing as alcohol-related stimuli have been found to exert an attentional pull on people whose drinking is at clinical and non clinical levels (e.g., Field & Cox, 2008). This attentional bias towards alcohol stimuli has been shown to impact performance on a wide range of cognitive tasks (e.g., dot-probe tasks: Duka & Townshend, 2004; Weafer & Fillmore, 2013) and may be predicted to similarly impact VPT. Specifically, in real-life environments, there may be contextual factors such as the visual presence of alcohol cues which divert attention and therefore impact VPT ability, though this possibility has not been examined to date. The purpose of this research was therefore to examine the impact of including alcohol and soft drinks into a revised version of a VPT task. Using a version of the director task (Keysar et al., 2003), participants were required to follow the instructions of an avatar (the director) who is positioned in a spatially opposite perspective to observers, and move objects that are mutually visible in the visual array (target objects) while avoiding objects that are only visible to the participant since they are located in one of the covered slots (competitor objects; Apperly et al., 2010). In order to choose the target object, participants therefore need to consider the director’s perspective, ignoring their own. Planned and exploratory analyses (and associated predictions) were pre-registered (See Study 1: <https://osf.io/dz3gs> N.B Study 2 not reported here). The hypotheses were as follows:

1. The director task requires participants to resolve interference between self and other perspectives. Here, egocentric bias - the tendency to rely too heavily on one's own perspective impacts performance (the difficulty arising, not from taking the director’s perspective, but with integrating this perspective with the director’s message; Barr, 2008). As such, errors and response times are expected to be higher for experimental trials (where there is a competitor object present along with the target object) than in control trials (trials with only the target present).
2. In this revised version of the director task, alcohol (e.g., a bottle of beer) and non-alcohol beverages (e.g., a bottle of coke) were incorporated into the task (e.g., move the bottle up one space). Given that attentional bias is greater for alcohol-related than non-alcohol stimuli, it was expected that participant performance would be worse (e.g., Field & Cox, 2008), when the target is non-alcohol, and the competitor target is alcohol.
3. (Registered as an exploratory hypothesis) Given that attentional bias to alcohol-related stimuli has been found to be higher in people with substance use disorder[[4]](#footnote-5)\* (e.g., Field & Cox, 2008), and in light of previous research pointing to differences in ToM capabilities between individuals with and without alcohol use disorder [[5]](#footnote-6)\* (e.g., Onuoha et al., 2016), exploratory analyses were also planned to assess whether AUDIT may moderate any research findings. Higher AUDIT scores were (speculatively) expected to be associated with more errors when the target is non-alcohol and competitor is alcohol (versus when the target is alcohol and the competitor is non-alcohol).

**Method**

*Participants*

A total of 114 participants took part in the study (*M* age = 25.75, *SD* age = 5.63; range 18 – 45years ), comprising of 57 women and 57 men. Six were excluded due to high error rates in the control conditions[[6]](#footnote-7), leaving a total of 108[[7]](#footnote-8) (54 women, 54 men; *M* age = 25.75, *SD* age = 5.67). The study took around 45 minutes to complete, and participants were recompensed with £7 for their time. The study received ethical approval from the relevant Research Ethics Committee.

Participants completed the study remotely and were recruited from Prolific ([www.prolific.co](https://prolific.co/)). They were required to use a desktop computer (there was no restriction on the operating system) that had audio capability (to hear the instructions from the director) and be fluent in English. There were no geographical constraints on the participant pool: The majority of participants were from Europe (78; 68%) or Africa (32; 28%) with the remainder from Central or South America (4; 4%). They were predominantly in or about to start employment (full or part-time; 96%; 84%), with 17 (15%) being unemployed but job-seeking. One participant was not in paid work.

Participants were required to drink socially to take part in the research but could not take part if they were currently undergoing any alcohol-related therapy or had received such in the past. There were no exclusion criteria based on participants’ (high) AUDIT scores and we did not stratify the sample for alcohol use heaviness based on Prolific data. Participants’ mean AUDIT score was 6.99 (SD = 4.26; Median 6, IQR = 4 – 9), placing them below the clinical cut-off of 8 and in the lowest AUDIT risk category (Babor et al., 2001). AUDIT scores were largely normally distributed and we did not screen out any high scores in light of the fact that these can be considered natural outliers (Leys et al., 2019) - in that one would expect some people to score more highly on the AUDIT in a sample of people who drink (Garnett et al., 2015). Further, assessments of data fidelity indicated that there was a reliable association between AUDIT score listed on Prolific and scores on the AUDIT that were taken during the current study, given us reasonable assurance that these scores were reliable reflection of participant’s drinking[[8]](#footnote-9). Finally, we ran the analyses with and without high AUDIT scores and found no difference in the pattern of results.

Other exclusion criteria were that participants could not take part if they had mild cognitive impairments or dementia, had a diagnosis of autism spectrum disorder and/or any hearing difficulties. They were also required to have normal or corrected to normal vision.

*Design*

The study had a 2 x 2 within-participants design, with factors of condition (control x experimental) and type (non-alcohol target x alcohol target). In the control condition only the mutually visible target stimulus was present, whereas in the experimental condition there was a contrasting distractor – where the target was non-alcohol, the distractor in privileged ground was alcohol; where the target was alcohol, the distractor was non-alcohol. The dependent variable was the number of accurate responses to critical trials and response time to accurate trials. Regression analyses were conducted with a predictor of alcohol consumption (AUDIT) and dependent variables of *n* correct target trials (alcohol and non-alcohol separately).

*Materials*

*Questionnaires*

AUDIT (Alcohol Uses Disorders Identification Test) is a 10-item self-report questionnaire that assesses alcohol -consumption behaviours, with higher total scores indicating more consumption that is at more clinical levels (Saunders et al., 1993). The IRI (Interpersonal Reactivity Index; Davis, 1980; 1983) is a self-report measure of empathy, consisting of four sub-scales tapping a separate construct of empathy: the perspective taking scale measures the tendency to adopt the viewpoint of others, the empathic concern scale assesses the tendency to experience feelings of sympathy for others in difficult situations, the personal distress scale measures the tendency to experience discomfort in response to extreme distress in others, and the fantasy scale taps the tendency to place oneself into fictional situations. Descriptive statistics and internal consistency scores for these and key Director Task measures are shown in Table 1. While the internal consistency of response times was lower than ideal (though see Dietrich et al., 2016), those for accuracy were excellent. Comparisons on gender and relationships with age are also shown in Table 1, with no unexpected differences found.

**Table 1.**

*Descriptive statistics and internal reliability for AUDIT, IRI (sub-scales) and key Director Task performance measures.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *M* (*SD*) | Range  | Reliability (Omega) | Male | Female | Age |
| (Median; Interquartile range; IQR) | *M (SD)* | *M (SD)* | Beta (sig.) |
| AUDIT | 6.99 (4.26) | 0 – 25 | 0.709 | 6.48 (3.85) | 7.50 (4.61) | ***-.246 (p = .010)*** |
| (6; 4 - 9) |
|   |   |   |   |  |  |  |
| Interpersonal Reactivity Index (IRI) |   |   |   |   |   |   |
| Perspective taking | 16.33 (3.16) | 6 – 24 | 0.624 | 16.00 (2.92) | 16.67 (3.38) | -.082 (*p* = .401) |
| Fantasy | 17.39 (4.11) | 6 – 26 | 0.667 | ***16.59 (3.94)*** | ***18.24 (4.16)*** | -.108 (*p* = .266) |
| Empathic Concern | 17.95 (4.00) | 7 – 25 | 0.532 | ***16.30 (3.88)*** | ***19.63 (3.38)*** | ***.199 (p = .039)*** |
| Personal Distress  | 13.29 (3.36) | 3 – 20 | 0.646 | ***11.93 (2.81)*** | ***14.72 (3.30)*** | .011 (*p* = .908) |
|   |   |   |   |  |  |  |
| Director Task Condition | Target | Measure |   |   |   |   |
| Experimental | Alcohol | Response time | 0.334 | 3.48 (.92) | 3.51 (1.08) | .016 (*p* = .050) |
| Accuracy | 0.769 | 4.70 (2.55) | 4.17 (2.17) | ***-.235 (p = .015)*** |
| Non-Alcohol | Response time | 0.615 | 3.40 (.88) | 3.47 (1.03) | .006 (p = .423) |
| Accuracy | 0.682 | 7.56 (.930) | 7.17 (1.42) | ***-.200 (p = .038)*** |

*Note.* Values reported are from the sample (not model-predicted). Significant differences are italicised in bold.

*Director Task*

The stimuli were modified from the version used by Monk et al. (2021) which was, in turn, based on those used in Apperly et al. (2010). Participants were presented with a centrally positioned 4 x 4 grid of 720 x 540 pixels, with a director (male figure and male voice) facing the participant and standing to the right and behind the grid (from the point of view of the participant). Five of the 16 slots were occluded from the point of view of the director, with the remaining 11 slots visible to both the participant and the director. There were four patterns of occluded slots, and eight static objects present in each grid. These were sized and placed individually and generated for each grid. Prior to the main study, participants were shown an example grid array from both their view and that of the director, making it clear that objects in the occluded slots were not mutually visible.

The grid was presented for 5000ms, prior to the initial instruction. Instructions were then given at 5000ms intervals. Verbal instructions lasting approximately 800ms were pre-recorded as .wav files by a member of the research team. These were given by the director and asked participants to “Move the [bottle/drink] left/right/up/down one slot”. Each grid array had between three and five instructions, with a total of 128 instructions across 32 grid arrays (16 experimental and 16 control). In the 16 experimental grids, the critical instruction could refer to both a mutually visible drink (either alcohol or non-alcohol) and a competitor drink (non-alcohol or alcohol) that was only visible to the participant. In the 16 matched control grids, this competitor drink was replaced by a non-consumable filler item. The referent in the instruction was “bottle” or “drink” so included both the target and distracter objects but not the filler object. All other instructions were filler trials that referred to mutually visible objects.

Alcohol drink images were taken from a standardised image set (the Amsterdam Beverage Picture Set (ABPS; Pronk et al., 2015), in accordance with guidance from Pennington et al. (2021). A total of 32 images were used, comprising of 16 alcohol drinks and 16 non-alcohol drinks. Eight alcohol drinks and eight non-alcohol drinks were used as targets in the 16 experimental grids, with eight non-alcohol and eight alcohol drinks used as distracters (so that an alcohol target had a non-alcohol distracter, with a non-alcohol distracter paired with an alcohol distracter). These target-distractor pairs were matched as closely as possible on measures of valence and arousal. The matched control grids had only the target drinks present, with the distractor drink replaced by a non-consumable filler object that the critical instruction could not refer to. There were between three and five instructions per grid, with the critical instruction one of these (there were no restrictions on which position this was). Conditions were balanced across the grids and the presentation order was randomised. The target, competitor and filler items and their accompanying referent are shown in Table 2 and an example experimental trial image is shown in Figure 1.

**Table 2.**

*Target, competitor and filler stimuli*

|  |  |  |  |
| --- | --- | --- | --- |
| Target | Competitor | Filler | Referent |
| Bacardi Breezer | Water | Lipstick | Bottle |
| Tequila | Sprite | Cards | Bottle |
| Rum | Water | Can opener | Bottle |
| Beer | Fanta | Screwdriver | Bottle |
| Water | Amaretto | Car | Drink |
| Apple juice | Smirnoff Ice | Nail varnish | Bottle |
| Orange juice | Wine | Duck | Drink |
| Water | Prosecco | Tie | Drink |
| Whiskey | Pepsi | Egg | Bottle |
| Vodka | Fanta | Candle | Bottle |
| Champagne | 7up | Bear | Drink |
| Wine | Coca-Cola | Stapler | Drink |
| Water | Grolsch | Christmas card | Drink |
| Fanta | Wine | Pen | Bottle |
| Iced Tea | Amstel | Truck | Drink |
| Evian | Heineken | Apple | Drink |

**Figure 1.**

*Example experimental and control trial schematic (non-alcohol target, alcohol distracter)*



*Procedure*

Participants were recruited via Prolific (prolific.co) [February – April 2022] and were briefed fully before filling out an informed consent form on Qualtrics. After this they completed the AUDIT (Saunders et al., 1993) and IRI scales (Davis, 1980). They were then shown an example grid array from both their own and the director’s perspective to make it clear that there was a perspective difference between them, and that the director did not know what was present in the occluded slots. They were instructed to respond as quickly and accurately as possible by clicking on the object to be moved using the mouse cursor on-screen (this did not move the object on the screen, and they were reminded they did not need to recall where objects had been moved to, but to always move the object from where it was present on the screen). They were then redirected to the main experiment which was created on PsychoPy and hosted on Pavlovia (Peirce et al., 2019). The experiment started with two practice grids (with no explicit feedback), followed by 32 grids for the main experiment. Once the experiment was complete, they were debriefed and received payment once their data was validated. Attention checks were placed in eight of the grids, where participants were instructed to click on the face of the director rather than any object in the grid. Participants who did not pass these checks were excluded from analyses.

*Statistical analyses*

Analyses were conducted using STATA 11.2. Factors of condition (control x experimental) and type of target (alcohol x non-alcohol) were entered into a logistic regression for accuracy (0, 1) and in a mixed linear regression for response times (accurate trials only), using xtmelogit and xtmixed commands respectively. In order to control for variation in performance across items[[9]](#footnote-10) and participant, both were included as (crossed independent) random factors in both analyses, reducing the possibility of an inflation of the rate of false positives that could occur if they were treated as fixed (raw, trial-level data are available in Supplementary materials). Target type and condition were also included as random slopes within the subject random factor (Barr, 2013; Barr et al., 2013). All continuous variables were grand mean centered to allow interpretation of model parameters.

**Results**

An initial correlation matrix between the AUDIT, IRI sub-scales and the dependent variables (response times and accuracy) was run to assess any potential covariates. This is shown in Table 3.

**Table 3.**

*Correlation matrix between AUDIT, IRI and dependent variables*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Response time | Accuracy | AUDIT | Perspective taking | Fantasy | Empathic concern |
| Accuracy | -.025 |  |  |  |  |  |
| AUDIT | .001 | -.010 |  |  |  |  |
| Perspective taking | .012 | -.040\*\*\* | .009 |  |  |  |
| Fantasy | -.045\* | .002 | .155\*\*\* | .306\*\*\* |  |  |
| Empathic concern | .069\*\*\* | -.046\*\* | .158\*\*\* | .384\*\*\* | .426\*\*\* |  |
| Personal distress | -.003 | .023 | .240\*\*\* | .105\*\*\* | .281\*\*\* | .356\*\*\* |

\**p* < .05, *\*\*\*p* < .001

The IRI sub-scales of Fantasy and Empathic Concern were therefore included in analyses on response time, and the IRI sub-scales of Perspective Taking and Empathic Concern were included in the analyses using accuracy.

*Response time (accurate trials only)*

There was no main effect of trial condition (*p* = .408) but a main effect of trial type (b = -.258, *p* < .001), with faster response times for alcohol target trials (than for non-alcohol target trials). There was an interaction between trial condition and trial type (b = .189, *p* = .005). The overall model was also significant (Table 4).

**Table 4.**

*Multi-level mixed linear regression for response time (ms; accurate trials only) for trial condition x trial type (including Fantasy and Empathic Concern sub-scales of IRI) (Wald Χ2 (5) = 44.15, p < .001)*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Coefficient | *p* | 95% confidence interval |
| Reference: Control |  |  |  |
| Experimental | -.043 | .408 | -.145 – .059 |
|  |  |  |  |
| Reference: Non-alcohol target |  |  |  |
| Alcohol target | -.258 | < .001 | -.348 – -.167 |
|  |  |  |  |
| Trial Condition x Trial Type | .189 | *.*005 | .056 – .321 |
| Reference: Control, Non-alcohol target |  |  |  |
| Control, Alcohol target | -.258 | < .001 | -.348 – -.167 |
| Experimental, Non-alcohol target | -.043 | .408 | -.148 – .059 |
| Experimental, Alcohol target | -.112 | .047 | -.225 – -.001 |
|  |  |  |  |
| Fantasy | -.022 | .014 | -.040 – -.005 |
| Empathic Concern | .028 | .002 | .010 – .047 |
|  |  |  |  |
| Constant | 3.43 | < .001 | 3.080 – 3.785 |
|  |  |  |  |
| Random-effects parameter | Estimate (SE) | 95% confidence interval |
| SubjectStandard deviation (condition) | .127 (.071) | .043 – .379 |
| Standard deviation (type) | .227 (.050) | .147 – .350 |
| Standard deviation (constant) | .280 (.032) | .224 – .350  |
| Target |  |  |  |  |
| Standard deviation (constant) | .227 (.057) | .138 – .371  |
| Standard deviation (residual) | .791 (.019) | .754 – .830  |
| Intraclass correlation coefficient (Subject) | .177 |  |
| Intraclass correlation coefficient (Target) | .062 |  |

The likelihood ratio suggests that the random factors of subject and target object account for a significant proportion of the variance in the model (Χ2 (4) = 145.38, *p* < .001). Intraclass correlation coefficients (ICC) indicated that a small amount of variance was explained by the random factor of subject (.177) but only a very small amount by the random factor of target object (.062).

Response times for alcohol targets in control (b = -.258, *p* < .001) and experimental (b = -.112, *p* = .047) trials were significantly faster than for non-alcohol targets in control trials. However, there was no difference in response times for non-alcohol targets in control and experimental trials (*p* = .408; see Figure 2).

**Figure 2.**

*Response time (ms; accurate trials only) by trial condition and trial type (error bars = confidence intervals)*

Analyses without the random factors of target object and subject or the random slopes of target type and condition (within subject) showed the same pattern of results, as did those not including the sub-scales of Fantasy and Empathic Concern (see Appendix A for full results).

*Accuracy*

There was a main effect of trial condition (b = .462, *p* < .001), with greater accuracy in control trials than in experimental trials. There was no main effect of trial type (b = 1.12, *p* = .396). There was an interaction between trial condition and trial type (b = .654, *p* = .010). The overall model was also significant (Table 5).

**Table 5.**

Mixed effects logistic regression on accuracy for trial condition x trial type (including Perspective taking and Empathic Concern sub-scales of IRI) (Wald Χ2 (5) = 81.32, p < .001))

|  |  |  |  |
| --- | --- | --- | --- |
|  | Coefficient | *p* | 95% confidence interval |
| Reference: Control |  |  |  |
| Experimental | .462 | < .001 | .351 – .608 |
|  |  |  |  |
| Reference: Non-alcohol target |  |  |  |
| Alcohol target | 1.119 | .396 | .863 – 1.45 |
|  |  |  |  |
| Trial Condition x Trial Type | .654 | .010 | .475 – .902  |
| Reference: Control, Non-alcohol target |  |  |  |
| Control, Alcohol target | 1.119 | .396 | .863 – 1.45 |
| Experimental, Non-alcohol target | .462 | .<.001 | .351 – .608 |
| Experimental, Alcohol target | .338 | < .001 | .253 – .452 |
|  |  |  |  |
| Perspective Taking | .982 | .440 | .938 – 1.028 |
| Empathic Concern | 1.002 | .933 | .965 – 1.039 |
|  |  |  |  |
| Random-effects parameter | Estimate (SE) | 95% confidence interval |
| SubjectStandard deviation (condition) | .478 (.113) | .302 – .758 |
| Standard deviation (type) | .811 (.115) | .614 – 1.072 |
| Standard deviation (constant) | .409 (.087) | .268 – .622  |
| Target |  |  |  |  |
| Standard deviation (constant) | .7.75e-10 | 0 - . |
| Intraclass correlation coefficient (Subject) | .243 |  |
| Intraclass correlation coefficient (Target) | .000 |  |

The likelihood ratio suggests that the random factors of subject and target object account for a significant proportion of the variance in the model (Χ2 (4) = 171.17, *p* < .001). ICC values indicated that a small amount of variance was explained by the random factor of subject (.243) but none by the random factor of target object (.000).

The accuracy for alcohol targets, while lower, did not differ from that for non-alcohol targets in the control condition (*p* = .396). However, accuracy for both alcohol (b = .338, *p* < .001) and non-alcohol (b = .462, *p* < .001) targets in the experimental conditions was significantly lower than that for non-alcohol targets in the control condition. Further comparisons suggest that in the experimental condition, accuracy was lower for alcohol targets compared to non-alcohol targets. This is shown in Figure 3. There was no relationship between either Perspective Taking or Empathic Concern and accuracy.

**Figure 3.**

*N accurate trials by trial condition and trial type (bars = confidence intervals)*

In line with the response time data, analyses without the random factors of target object and subject or the random slopes of target type and condition (within subject) showed the same pattern of results, as did not including the sub-scales of Perspective Taking and Empathic Concern (see Appendix A for full results). Participants found it harder to take the director’s perspective into account when the target drink was alcohol, as indicated by lower accuracy (albeit not significantly so).

*Relationship between alcohol consumption and target accuracy (influence of distracters on perspective taking)*

As an exploratory analysis, AUDIT score was used to predict the number of correct responses for alcohol targets and non-alcohol targets separately using simple linear regression. This would assess the influence of non-alcohol and alcohol distracters respectively on taking into account the director’s perspective.

Results suggests that AUDIT was not related to alcohol target accuracy (F (1, 105) = 1.394, *p* = .240; adjusted R2 = .004), with β = .115. However, higher AUDIT was associated with lower non-alcohol target accuracy and hence greater interference from alcohol distractors (F (1, 105) = 4.774, *p* = .031; adjusted R2 = .035), with β = -.209.

**Discussion**

While there is a growing, if somewhat mixed, evidence base regarding potential deficiencies in ToM capacity among individuals with alcohol use disorder (e.g. Kornreich et al., 2011), as well as on the impact of intoxication on ToM (Dolder et al. 2016; Johnson et al., 2018; Mitchell et al., 2011), there has been scant literature in this domain which has explored VPT. Building on work by Cox et al. (2016; 2018), who introduced a VPT task into their exploration of people whose drinking is (non) alcohol dependent using facial images, the current study is the first to explore the impact of including (non) alcohol-related beverages into a revised version of a VPT task that assessed people’s ability to take the perspective of others. Using a revised version of the director task (Keysar et al., 2003) the current research examined whether a VPT task, which requires that participants to resolve interference between their own perspective and that of an avatar, may be impacted by the presence of (non) alcohol distractor items.

In accordance with hypothesis one, there was evidence of an egocentric bias, whereby an individual’s tendency to rely too heavily on their own perspective negatively impacts performance (Epley et al., 2004; Royzman et al., 2003; Wang et al., 2020). This manifested in higher errors and longer response times for experimental trials (with a competitor object present along with the target object) than in control trials (trials with only the target present). This current study thereby adds to this cognitive literature by indicating that this egocentric bias in ToM-related capacities – in this case, VPT - appears regardless of the inclusion of (non) alcohol beverages within the standard director task (as originally designed by Keysar et al., 20003).

Contrary to our pre-registered predictions, participant performance was not worse when the target was non-alcohol, and the competitor was alcohol. Rather than supporting the notion that attentional bias towards alcohol stimuli (e.g., Field & Cox, 2008) may worsen performance on tasks where these make up the distractor items (owing to one’s own attention being pulled towards the alcohol) participants appeared to find it harder to take the director’s perspective into account when the target drink was alcohol (and the distractor was a soft drink), as indicated by lower accuracy on these trials. This observation could be explained by the faster response times that were observed for alcohol targets, though there was no correlation between accuracy and response times, so this seems unlikely. As such, current findings may suggest that the non-alcohol nature of the competing drink diverts attention away from task performance, or that there is something about the alcohol nature of the target item itself which impairs ToM performance directly. In other words, taking the visual perspective of the director may be hindered when the target is alcohol and suggests that alcohol-related attentional bias to wider stimuli is not as apparent in this process, perhaps in line with a recent review which suggests that attentional bias may not be as ubiquitous as was previously thought (see Bollen et al., 2022). In the real world, these tentative results may therefore suggest that there may be at least some contexts when being able to see alcohol beverages may make it harder to take another person’s perspective. This may have implications for understanding behaviour such as alcohol-related aggression in the night-time economy (Levine et al., 2012) which has been linked to impaired ToM (Blair, 2004)

An alternative interpretation of this findings may lie in the stimulus onsets of the current task: While the use of 5000 ms trials in this study is not unusual within research (e.g., Apperly et al., 2010; Band et al., 2003; McNeill et al., 2021; Qureshi et al., 2019; Vistoli et al., 2016), these are longer than those used within many alcohol-related attentional bias tasks, where visual probes are typically 500ms (e.g., Jones et al., 2011; Field et al., 2004;2013). As such, while the current task was not designed to assess attentional bias, the findings from this study may be indicative of an initial attention towards alcohol beverages, followed by a diversion of attention elsewhere. As such, with longer latencies, while an individual may initially orient towards alcohol they may then have disengaged, meaning that they may be more likely to be attending to the non-alcohol drink (versus the alcohol drink) when the instruction is delivered, and it is time to act. If it is assumed that participants are more likely to select the bottle/drink that they are looking at the time of instruction, this may explain why they appeared to be more likely to select non-alcohol in both trials, leading to poorer performance in alcohol target trials and improved performance in non –alcohol trials. Attentional bias would essentially bias the response away rather than towards alcohol related stimuli. It should be emphasised, however, that this interpretation is merely speculative and future research using eye tracking technology is strongly recommended to examine the potential cause of this unexpected finding.

Beginning to unpack this unexpected finding further, pre-registered but exploratory analyses examined the extent to which respondents' consumption (measured via AUDIT) heightened or interfered with their ability to take the director's perspective. Here, given that attentional bias to alcohol-related stimuli has been found to be higher those with substance use disorder (e.g., Field & Cox, 2008; though see Bollen et al., 2022), it was speculatively predicted that higher AUDIT scores would be associated with lower accuracy when the target was non-alcohol and competitor was alcohol (versus when the target was alcohol, and the competitor was non-alcohol). To that end, we observed a significant negative correlation between accuracy on non-alcohol target trials and AUDIT score, such that higher scores were associated with lower accuracy when alcohol drinks were the distractor items. Furthermore, while AUDIT was not a predictor of accuracy where the alcohol item was the target, where the non-alcohol item was the target (and the alcohol item was the competitor) higher AUDIT scores were significantly associated with lower accuracy. This finding appears to offer some support for the assertion that there may be differences in ToM capabilities between individuals with and without alcohol use disorder (e.g., Onuoha et al., 2016), or at least suggest that they may be more prone to alcohol-related attentional bias which impacts VPT performance on specific trials.

Indeed, it may be speculated that people who drink to elevate levels may be more likely to maintain sustained attention to the alcohol distractor stimuli, while those whose drinking is at lower levels may be more likely to initially orientate then move away from the stimuli. Given the exploratory nature of these analyses, future research is clearly required to examine the extent to which alcohol stimuli may interfere ability to take the perspective of others amongst those who drink to heavier levels. Future assessments using eye tracking technology may also offer the opportunities to test this tentative hypothesis as to the cause of these AUDIT results. Nevertheless, the current study could potentially inform the development and pre-registration of future hypotheses in this regard. Future research is also needed using longitudinal designs in order to unpick the extent to which alcohol consumption may play a causal role in VPT impairments, or whether these VPT impairments may be associated with the development of alcohol use disorder to begin with.

Turning to study limitations, it should be noted that the images used in this task took the form of branded alcohol and soft drinks, in order to make the stimuli more immediately recognisable. However, given the power of branding, particularly in the alcohol industry (Casswell, 2012; Esser & Jernigan, 2018), and the established impact of branding on decision making (Simonson, 1992), it is possible that some elements of VPT performance were impacted by individual preferences for the brands being displayed. Indeed, research in the (slightly wider) domain of alcohol consumption research advocates for the use of alcohol products which match participant preferences (Jones et al., 2016) and so this may offer a fruitful avenue for future exploration. Further, while intraclass correlations indicated that target object did not account for any variance, suggesting that results were not being driven by stimulus type (e.g., type/brand of bottle), these analyses did suggest that there may be some variance being contributed by within participant discrepancies, which were not currently tested for. Future exploration of such potential factors is consequently advised.

We caution that, despite the advantages and increasing popularity of the use of crowd sourcing platforms, there are several potential considerations to this approach, including the possibility of faithless respondents (who provide inaccurate information in order to participate), of “robots” rather the people completing tasks, and of participant fatigue (resulting from participating in multiple studies affecting attentive responses; Sheehan, 2018). The time-efficient nature of the task and the use of attention checks absolves some of these concerns, however as researchers increasingly turn to these methods, the potential implications of these will need to be investigated further. The current findings are also based on just one modified version of a level 1 VPT task (the director task) with a limited number of visual stimuli. Future research should seek to replicate these findings using other forms of assessment (e.g., the Dot Task; Samson et al., 2010). Further, the extent to which the current study replicates real-life VPT performance may be limited owing the pictographic nature of the task. Yet, stimuli could be expanded to use more realistic scenes (e.g., a real-life home environment; See Del Sette et al., 2022), real images of all items in the task (the new items were from a standardised image database while the other items from the original Keysar task are clipart style) and changes in the emotional expression of the avatar (see Monk et al., 2021). Finally, while research indicates that the director task involves representing the director’s mental states (Rubio-Fernández, 2016), others would suggest that (only) domain-general cognitive processes can be used (Santiesteban et al., 2015). We therefore suggest that while the current findings cannot be fully attributable to ToM more widely, they still relate to ToM and not solely VPT. Future research should nevertheless be expanded to include assessments of other facets of ToM to further explore this notion.

There are also a number of considerations that should be borne mind with respect to the demographics of the current sample. First, a strength of the current research is that it contains individuals from Europe, Africa and America. However, wider sampling would be beneficial so as to include participants from Asia, in view of potential differences in the ToM capabilities of those from collectivistic cultures (Sabbagh et al., 2016). Second, while we feel reasonably assured that the results were not being driven by a few influential (high) AUDIT scores and represents AUDIT levels that would be typically expected in the population, it should be noted that the current research did not contain a sample of people who do not drink alcohol. As such, there may be some bias in our results relative to those that may be observed in the general population and future research may benefit from comparative data drawn from people who do not consume alcohol. Additionally, it may be fruitful for subsequent research which stratifies participants based on their AUDIT scores and examines potential differences in performance as a function of AUDIT sub-scores (e.g., AUDIT-C and AUDIT-P). This may shed further insights into whether ToM (or at least VPT) may vary depending on the quantity of alcohol that people consume (AUDIT-C) as well as depending on “problem” (more dangerous) levels usage (AUDIT-P), and point towards any potential subpopulation differences in ability.

In conclusion, for the first time in this research area, the current study employed a VPT task to examine the extent to which alcohol-related stimuli may act as an attentional force that impairs people’s ability to infer the mental states of others. Findings indicate that, contrary to expectations, there may be at least some contexts when being in the presence of alcohol beverages may make it harder to take another person’s perspective. They also suggest that consumption that is heavier may be associated with poorer VPT capacity, particularly when alcohol-related beverages are in one’s visual array. Future research should explore further how alcohol beverages, alcohol consumption behaviours and indeed intoxication may interact to impact the ability to take another’s perspective.

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1. Participants are required to read vignettes and identify if a socially awkward faux pas has been made. For example, someone inadvertently revealed that a surprise birthday party was being organised to the person whose birthday it was. [↑](#footnote-ref-2)
2. Participants are shown a grey-scale image of the eye region of a person and given four options as to the emotion they are showing. [↑](#footnote-ref-3)
3. Rather than participants being asked if there was a faux pas made, they are asked to say the first ‘word or thing’ that comes to mind after each scenario [↑](#footnote-ref-4)
4. \*Please note phrasing changed slightly here (versus pre-registration) in light of journal specifications regarding potentially stigmatising language [↑](#footnote-ref-5)
5. \*\*please note phrasing changed here (from pre-registration) in light of journal specifications regarding potentially stigmatising language [↑](#footnote-ref-6)
6. The control conditions have no distractor items, so accuracy should be unimpaired. That these participants showed a high error rate suggests that they either not following the task instructions or were not consistently attending to the task. However, no participants were removed due to failing attention checks. [↑](#footnote-ref-7)
7. Power analyses using GPower suggested that, based on prior analyses, a sample size of at least 70 participants would be required based on a medium effect size of .25 and an observed power of .80. There was no hard stopping in place for data collection (within our pre-registration) and when more resources became available to pay for testing, the decision was made to exceed this minimum target for recruitment and increase the power of the analyses. No analyses were completed until data collection had been completed, as noted in our pre-registration. [↑](#footnote-ref-8)
8. Specifically, grouping AUDIT scores by risk group and comparing with alcohol unit consumed from Prolific showed no significant difference (X2 (4, N = 108) = .285, *p* = .583) [↑](#footnote-ref-9)
9. As there were discrete target and distracter combinations that were repeated for each participant, including only target as a random factor also accounted for the distracter paired with that target. [↑](#footnote-ref-10)