Research in Developmental Disabilities 33 (2012) 1928–1936

Contents lists available at SciVerse ScienceDirect

Research in Developmental Disabilities

# Cognitive biases in individuals with mild to borderline intellectual disability and alcohol use-related problems

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ARTICLE INFO

*Article history:*
Received 13 April 2012
Received in revised form 24 May 2012
Accepted 24 May 2012
Available online 21 June 2012

*Keywords:*
Addiction
Mild intellectual disability
Cognitive biases
Eye tracking
Alcohol

ABSTRACT

The primary aim of the present pilot study was to examine cognitive biases in individuals with mild to borderline ID and alcohol use-related problems. Participants ($N = 57$) performed the approach avoidance task, picture rating task and visual dot probe task, which was combined with eye-tracking methodology. They were admitted to a forensic setting and were all abstinent and undergoing treatment at the time of testing. Three groups were formed based on the severity of alcohol use-related problems as measured by the AUDIT. In line with the expectations, no differences were found between participants based on the severity of their alcohol use-related problems. In addition, three groups were formed based on IQ to assess the relationship between IQ and the strength of the cognitive biases. There were also no differences between individuals with mild or borderline ID and individuals with (below) average IQ on any of the variables. It is concluded that computer tasks such as these can be used in individuals with mild to borderline ID. As the results suggest no influence of IQ on the strength of cognitive biases, this study opens up new opportunities for future research on the application of measuring cognitive biases in screening, diagnosing and treating individuals with mild to borderline ID and alcohol use-related problems.



## 1. Introduction

Individuals with mild to borderline intellectual disability (ID) often use alcohol (Didden, Embregts, Van der Toorn, & Laarhoven, 2009). With a prevalence of 0.5–2% of the ID population (Sturmey, Reyer, Lee, & Robek, 2003), these individuals use alcohol at a lower rate than individuals without ID (Emerson & Turnball, 2005). However, alcohol use in individuals with ID is associated with a relatively high risk of alcohol abuse and dependency (Degenhardt, 2000) and more severe adverse consequences (Slayter, 2008) than among individuals without ID. For example, alcohol use is related to problems with work, housing and the social network. Moreover, research indicates that alcohol use in individuals with ID is a risk factor for aggressive and antisocial behavior and delinquency (Didden et al., 2009). Individuals with ID are therefore at risk for developing alcohol use-related problems after initial alcohol use.

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0891-4222/$ – see front matter 
http://dx.doi.org/10.1016/j.ridd.2012.05.026

Although several suggestions have been made on how to improve diagnosis and treatment, screening tools and treatment programs developed for individuals without ID are often not useful in the case of ID. In fact, ID is often a contra-indication for treatment in regular addiction treatment facilities. Validated screening tools and effective treatment programs are lacking and the effectiveness of treatment programs has not been systematically evaluated yet. The relatively high prevalence of alcohol use-related problems and subsequent physical, social and psychological problems suggests, however, that developing and validating screening tools and effective therapies in this target group may be useful and, in fact, necessary.

Studying cognitive biases in automatic processes such as attention, stimulus evaluation and action tendencies might solve the existing issues in screening and treatment of alcohol use-related problems in individuals with mild to borderline ID. According to the incentive sensitization theory (Robinson & Berridge, 1993, 2003, 2008), repeated alcohol use is associated with adaptations within the reward centers of the brain. As a result of these adaptations, alcohol becomes a powerful incentive and related stimuli become associated with the incentive properties of alcohol through a process of classical conditioning. These stimuli acquire 'incentive salience', meaning that they seem attractive, 'grab attention' and elicit approach behaviors. The salience that is attributed to alcohol-related stimuli is at the expense of other available rewarding stimuli in the environment (Goldstein & Volkow, 2002), resulting in cognitive biases in attention, evaluation and approach tendencies that occur outside of awareness. Franken (2003) and Wiers and Stacy (2006) expanded upon this theory, suggesting that cognitive biases play a role both in the *development* of alcohol use-related problems and in the *maintenance* of these problems.

Indeed, research has shown that repeated alcohol use is associated with several biases in cognitive processing, including biases in attention (Loeber et al., 2009), evaluation (Pulido, Mok, Brown, & Tapert, 2009) and approach tendencies (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011). Heavy drinkers have been shown to respond faster to targets replacing alcohol-related stimuli than to targets replacing neutral pictures on the visual dot probe task (MacLeod, Mathews, & Tata, 1986), are faster to approach alcohol-related stimuli and slower to avoid these stimuli than neutral stimuli on the approach avoidance task (Rinck & Becker, 2007) and rate alcohol-related pictures more positively than neutral pictures on the picture rating task. A recent advance in the study of cognitive biases is the use of eye-tracking methodology. Because eye movements and pupillary responses are direct behavioral manifestations of the allocation of attention (Henderson, 2003), eye tracking is a more sensitive method for studying cognitive biases than computer tasks (Field, Mogg, & Bradley, 2004). Moreover, this method does not rely on the verbal skills of participants and provides continuous and non-invasive indices of attention to visual stimuli. Research using eye tracking has revealed that heavy alcohol users have been shown to maintain their gaze on alcohol-related pictorial cues longer than non-users (Friese, Bargas-Avila, Hofmann, & Wiers, 2010). It remains unclear whether or not heavy alcohol users also show biases in the initial allocation of attention (Leventhal et al., 2008).

Studying these cognitive biases has several clinical implications for screening and treating alcohol use-related problems. For example, measuring the strength of cognitive biases can be used for screening purposes as the biases have been shown to be reliable and valid indexes of the severity of alcohol use-related problems (Field, Christiansen, Cole, & Goudie, 2007). The strength of cognitive biases prior to treatment may also serve as a predictor of treatment outcome. Individuals with more pronounced biases prior to treatment might be less likely to achieve abstinence and/or more likely to relapse following treatment (Cox, Hogan, Kristian, & Race, 2002). Moreover, the measurement of cognitive biases may also have utility as an assessment of treatment success as successful treatment of alcohol use-related problems is thought to reduce the strength of cognitive biases (Cox, Pothos, & Hosier, 2007). Abstinent alcoholics undergoing treatment may actually *avoid* alcohol-related stimuli due to newly learned coping strategies and a motivation to stay abstinent following treatment (Vollstädt-Klein, Loeber, Von der Goltz, Mann, & Kiefer, 2009). Lastly, a training directly aimed at reducing cognitive biases has recently been developed which is effective in reducing not only cognitive biases (Field et al., 2007), but also craving (Field & Eastwood, 2005), drinking behavior (Fadardi & Cox, 2009) and relapse following treatment (Wiers et al., 2011).

Although the existence of cognitive biases for alcohol-related cues has been established in individuals without ID, no study has yet assessed whether such biases also exist in individuals with ID and alcohol use-related problems. Considering the clinical implications of measuring cognitive biases, studying individuals with ID provides an opportunity for the development of new methods for assessing the severity of alcohol use-related problems, evaluating treatment success and actually treating individuals with mild to borderline ID and alcohol use-related problems. The primary aim of the present study was therefore to examine cognitive biases in individuals with mild to borderline ID and alcohol use-related problems using three computer tasks.

In line with previous research using abstinent participants who are undergoing treatment at the time of testing (Noel et al., 2006; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009), we expected no significant differences between participants based on the severity of alcohol use-related problems in the past in attention, approach behavior and evaluation of alcohol and control pictures. We also assessed the similarities and differences between individuals with and without ID on the three computer tasks. In line with previous research (Merrill, 2005), we hypothesized reaction times would differ significantly between individuals with and without ID, whereas we did not expect to find any differences in the manifestation or strength of the cognitive biases. Lastly, the relationship between cognitive biases and craving was examined. As theorized by Robinson and Berridge (2003), higher levels of subjective craving were predicted to be associated with stronger cognitive biases.

## 2. Methods

### 2.1. Participants

This pilot study was conducted at Forensic Psychiatric Centre (FPC) Oldenkotte. Participants ($N = 57$; 47 men) were involuntary admitted to a forensic psychiatric hospital on behalf of the state. As they were all admitted to a closed treatment facility where alcohol is not available they were abstinent at the time of the experiment. Groups were created based on two criteria: severity of alcohol use-related problems, as measured by the Alcohol Use Disorder Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Dutch translation: Schippers & Broekman, 2010) and intelligence quotient (IQ). Group characteristics are shown in Table 1. All participants had normal or corrected to normal vision and spoke fluent Dutch. Groups did not differ on gender ratio (severity of alcohol use-related problems: $\chi^2(2, n = 57) = 1.19$, $p = .553$; IQ: $\chi^2(2, n = 57) = 0.31$, $p = .858$), age (severity of alcohol use-related problems: $F(2, 35) = 0.45$, $p = .640$; IQ: $F(2, 54) = 0.90$, $p = .413$) and number of months abstinent (severity of alcohol use-related problems $F(2, 54) = 1.37$, $p = .263$; IQ: $F(2, 54) = 1.99$, $p = .146$). IQ and severity of alcohol use-related problems did differ between groups (Total IQ: $F(2, 35) = 69.23$, $p < .001$; Verbal IQ: $F(2, 33) = 35.22$, $p < .001$; Performance IQ: $F(2, 33) = 49.41$, $p < .001$; AUDIT: $F(2, 54) = 69.36$, $p < .001$). A post hoc analysis of planned comparisons revealed that all groups differed significantly from each other. The study was approved by the Ethics Committee of the Faculty of Social Sciences, Radboud University Nijmegen, the Netherlands.

### 2.2. Material

The stimuli for the tasks (see Fig. 1) were derived from our previous study (Van Duijvenbode, Didden, Bloemsaat, & Engels, 2012). In this study, pictorial stimuli of both alcoholic and non-alcoholic beverages were standardized for individuals with mild to borderline ID. An additional 38 neutral pictures were used as practice and buffer trials in the visual dot probe and approach avoidance task. A different set of pictures was used for every task.

Using independent-samples *t*-tests, differences were assessed between alcohol ($N = 48$) and non-alcohol control pictures ($N = 52$) on attractiveness, complexity, familiarity, valence, brightness, and color (blue, green, and red). Between the three tasks, alcohol and control pictures differed significantly on attractiveness (AAT: $t(48) = 8.93$, $p < .001$; PRT: $t(48) = 12.15$, $p < .001$; VDP: $t(48) = 9.69$, $p < .001$) and valence (AAT: $t(48) = 4.33$, $p < .001$; PRT: $t(48) = 5.26$, $p < .001$; VDP: $t(48) = 3.80$, $p < .001$). The non-alcohol control pictures were rated as more attractive and positively valenced compared to the alcohol pictures. There were no significant differences on complexity, familiarity, brightness or color between the alcohol and control pictures. Moreover, there were no significant differences between the three computer tasks on any of the parameters (see Table 2).

**Table 1**
Group characteristics ($N = 57$).

| | Severity of alcohol use-related problems | | | Intelligence quotient | | |
|---|---|---|---|---|---|---|
| | Light drinkers | Moderate drinkers | Heavy drinkers | Average IQ | Borderline ID | Mild ID |
| | *M* (SD) | *M* (SD) | *M* (SD) | *M* (SD) | *M* (SD) | *M* (SD) |
| Age | 41.25 (11.15) | 38.07 (9.27) | 39.23 (9.75) | 40.22 (10.37) | 37.00 (8.88) | 42.22 (10.93) |
| Total IQ | 86.77 (16.46) | 82.90 (11.80) | 82.67 (11.70) | 96.35 (7.96) | 78.14 (4.19) | 66.43 (3.69) |
| Verbal IQ | 85.77 (17.37) | 85.60 (15.38) | 86.85 (10.97) | 97.88 (10.64) | 81.14 (5.53) | 66.33 (6.38) |
| Performance IQ | 84.85 (16.58) | 83.10 (11.14) | 83.23 (12.74) | 96.38 (8.26) | 75.86 (5.91) | 68.67 (4.93) |
| AUDIT score | 2.65 (2.18) | 10.67 (2.80) | 22.50 (8.26) | 12.78 (10.30) | 11.25 (8.79) | 13.22 (12.95) |
| Number of months abstinent | 42.20 (29.50) | 49.93 (33.12) | 59.05 (35.86) | 43.16 (30.27) | 59.25 (34.66) | 62.56 (37.41) |

*Note*: AUDIT, Alcohol Use Disorder Identification Test (Babor et al., 2001).


**Fig. 1.** Sample of the pictorial stimuli.
Derived from Van Duijvenbode et al. (2012).

**Table 2**
Mean parameter ratings of pictures of alcoholic ($n = 48$) and non-alcoholic beverages ($n = 52$) by task.

| | AAT | | PRT | | VDP | | $F(2, 149)$ | $p$ |
|---|---|---|---|---|---|---|---|---|
| | *M* | SD | *M* | SD | *M* | SD | | |
| Attractiveness | 3.77 | 2.73 | 3.82 | 2.83 | 3.66 | 2.58 | 0.05 | .952 |
| Complexity | 1.45 | 0.25 | 1.49 | 0.29 | 1.53 | 0.26 | 0.98 | .378 |
| Familiarity | 2.76 | 0.22 | 2.78 | 0.22 | 2.77 | 0.22 | 0.10 | .901 |
| Valence | 0.59 | 0.79 | 0.51 | 0.86 | 0.34 | 0.76 | 1.25 | .291 |
| Brightness | 228.79 | 13.72 | 227.96 | 16.75 | 228.88 | 17.17 | 0.05 | .951 |
| Blue | 216.33 | 18.33 | 218.90 | 15.52 | 217.55 | 16.98 | 0.29 | .752 |
| Green | 223.32 | 15.12 | 223.81 | 16.60 | 223.47 | 15.77 | 0.01 | .988 |
| Red | 223.84 | 10.70 | 223.79 | 11.49 | 223.38 | 12.65 | 0.02 | .977 |

*Note*: AAT, approach avoidance task (Rinck & Becker, 2007); PRT, picture rating task; VDP, visual dot probe task (MacLeod et al., 1986).

The tasks were presented on a 17-in. thin film transistor (TFT) flat screen monitor, attached to a three-button response box. Eye movements were recorded during the visual dot probe task using a corneal reflection eye tracker (Tobii T120 Eye Tracker, Tobii Technology, Danderyd, Sweden). The Tobii eye-tracking system records movements of both eyes at 60 Hz with an average accuracy of 0.5° visual angle.

## 2.3. Procedure

As there were no pre-defined inclusion criteria, all patients residing in FPC Oldenkotte could participate unless the treatment team decided against it (for example because of the current psychological condition of the patient). Of the 108 patients, 100 were approached by the researcher and 63 agreed to participate. Six participants dropped out prior to testing, leaving a total *N* of 57. After obtaining their written informed consent, appointments were made. The experiment lasted approximately 2 h and 30 min and was spread out across three sessions of 1 h each.

During the first session, participants provided general demographic information. History of alcohol use was assessed using the Substance Use and Misuse in Intellectual Disability Questionnaire (SumID-Q; Van der Nagel, Kiewik, Dijk, Jong, & Didden, 2011). The AUDIT (Babor et al., 2001) was used to provide an index for the severity of alcohol use-related problems. Based on the AUDIT score, participants were classified as either light ($n = 19$), moderate ($n = 16$) or heavy drinkers ($n = 22$). A second classification was made according to the IQ of the participants. IQ was assessed using the most recent scores on the WAIS-III-NL (Uterwijk, 2000) in the participants file. Based on this information, three groups were made: participants with mild ID (IQ: 50–69; $n = 9$), borderline ID (IQ: 70–85; $n = 16$) or below average/average IQ (IQ $\geq$ 86; $n = 32$) (American Psychiatric Association, 2000).

The second session consisted of two computer tasks – the visual dot probe (VDP; MacLeod et al., 1986) and the approach avoidance task (AAT; Rinck & Becker, 2007) – and an assessment of craving. Upon arrival in the test environment, participants were seated 60 cm from the computer monitor and the researcher explained the procedure. Participants first practiced with the eye-tracker by completing a standard visual search task. Then, the gaze of each participant was calibrated using a 5-point calibration procedure. Participants were asked to accurately fixate on an expanding–contracting white circle that appeared on a black background. Calibration was repeated until all calibration points were successfully calibrated.

The VDP started after successful calibration. Each trial started with a central fixation cross, which was presented for 500 ms on a black background. This was immediately followed by the display of two pictures, one on the left and one on the right side of the screen, for a duration of 2000 ms. On each trial, the pictures portrayed one alcoholic and one non-alcoholic beverage matched for structural content (e.g., size and color of the object). The pictures were positioned in such a way that their inner edges were 30 mm apart. After picture offset, a dot probe (white dot) appeared on either the left or the right side of the screen until the participants response. Participants were instructed to indicate the position of the probe as quickly as possible by pressing a button on the response box. There was a 1000 ms inter-trial interval before the next trial started. The task consisted of 30 practice trials followed by four blocks of two buffer trials and 25 critical trials. Neutral pictures were used for the practice and buffer trials. The critical trials consisted of the alcohol pictures and their matched non-alcohol control pictures. Each picture appeared twice on the left and twice on the right side of the computer screen, thus appearing four times throughout the task. Trials were randomly presented to each participant. The probe location (left or right) and type of picture replaced by the probe (alcohol or control) were fully counterbalanced.

Participants then completed the AAT. In this task, pictures of both alcoholic and non-alcoholic beverages with a blue or yellow frame were presented in the center of the screen. Participants were instructed to respond to the color of the frame as quickly and accurately as possible by moving a joystick either towards or away from themselves. The instructions were counterbalanced across participants; half of the participants pulled pictures with a yellow frame towards them and the other half pulled the pictures with a blue frame towards them. The joystick was positioned on and secured to the table in such a way that movement of the joystick would represent moving the object towards or away from the body. To add to the sensation of approach and avoidance (Neumann & Strack, 2000) and to increase the ecological validity (Rinck & Becker, 2007), the task had a zooming feature, where the stimulus size increased or decreased depending on the movement of the

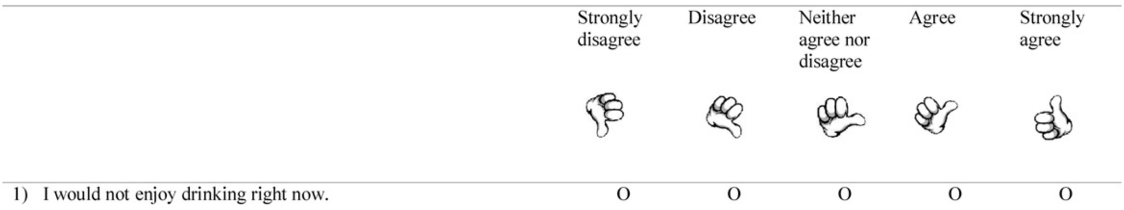


**Fig. 2.** Example of a question and the response options on the Alcohol Craving Questionnaire Short Form Revised (ACQ-SF-R; Singleton et al., 1994).

participant. As in Rinck and Becker (2007), seven different sizes (76 × 95, 152 × 190, 228 × 285, 304 × 380, 380 × 475, 456 × 570 and 532 × 665 pixels) of each picture were created to allow for this zooming effect. The size of the picture presented on the screen depended on the position of the joystick. At the start of the trial, the picture size was 304 × 380 pixels. Pushing or pulling the joystick approximately 7°, 15° or 22° resulted in a decrease or increase of the picture size. Finally, the picture disappeared when the joystick had reached an angle of approximately 30°. The picture only disappeared when the joystick was moved in the correct direction. If the participant moved the joystick in the wrong direction, the picture remained on the screen in the smallest or biggest size, depending on the movement. After the picture disappeared from the screen, a new trial started as soon as the joystick was positioned in the central position and the participant pressed the "trigger" button. The task consisted of four blocks of two buffer and 25 critical trials preceded by an extensive practice block of 30 trials. As in the VDP, neutral pictures were used in the practice and buffer trials. The critical trials consisted of 25 alcohol pictures and 25 non-alcohol control pictures. Each picture was presented twice – once with a yellow frame and once with a blue frame – resulting in a total of 100 trials. They were presented in a random order for each participant with the restriction that no more than three pictures of the same type (alcohol or control) or same required response (push or pull) were presented successively.

After completion of the computer tasks, participants were asked to rate their current level of alcohol craving. Two paper and pencil measures were used, the order of which was counterbalanced across participants. Craving was measured using an anchored visual analogue scale (VAS) ranging from 0 (*not at all*) to 10 (*extremely*). In addition, an adapted version of the Alcohol Craving Questionnaire Short Form Revised (ACQ-SF-R; Singleton, Tiffany, & Henningfield, 1994) was used. The ACQ-SF-R contains 12 items that are derived from and correlate strongly with the 47-item Alcohol Craving Questionnaire (ACQ-NOW; Singleton et al., 1994). In the current study, the Cronbach alpha coefficient was .89. The adaptations included changing the layout of the questionnaire using small, separate boxes that could be ticked by the participants. Moreover, based on previous research (Bailey, Willner, & Dymond, 2011), a visual aid was included to help decision making (see Fig. 2).

The third and final session consisted of the picture rating task (PRT) and an adapted version of the alcohol Stroop task.[1] In the PRT, a fixation cross appeared for 500 ms after which 50 pictures of both alcoholic ($N = 25$) and non-alcoholic ($N = 25$) beverages were shown on a white background. The pictures were presented one at a time and in a random order for each participant. Participants were instructed to view the pictures carefully and to rate the pleasantness of each picture on a 6-point rating scale ranging from 0 (*very unpleasant*) to 5 (*very pleasant*). Participants then rated their current level of alcohol craving using both a VAS and the ACQ-SF-R. For this point of measurement, the Cronbach alpha coefficient of the ACQ-SF-R was .92. Finally, participants were told they would receive a full debriefing after completion of the entire study. They were thanked for their time and received €5 for their participation.

### *2.4. Preparation of data*

The eye-tracking data were analyzed using a one-way ANOVA. Three dependent variables were used: number of fixations, latency of initial fixations and total amount of time fixating on alcohol and control pictures during critical trials of the visual dot probe task ("dwell time"). Fixations on either the alcohol or control picture were identified if the participant fixated on the fixation cross before picture onset and shifted his gaze to one of the pictures at least 100 ms after picture onset and before picture offset. If the gaze was directed at the position of one of the pictures before picture onset, this was only scored as a fixation if the participant focused on this spot for longer than 150 ms (Field & Cox, 2008). A direction bias score – the percentage of trials in which the initial fixation was on an alcohol picture – was then calculated for each participant. Scores higher than 50% reflected a tendency to direct attention towards alcohol pictures relative to control pictures (Mogg, Bradley, Field, & De Houwer, 2003). "Dwell time" reflected the total amount of time a participant looked at each picture at each trial and was calculated by summing the duration of fixations on the picture. Trials with missing data at least 3 SDs above the sample mean were excluded from analyses (Field et al., 2004). Missing data included saccadic shift, eye blinks and failures of the equipment to record data.

[1] Results of the adapted version of the alcohol Stroop task will not be discussed due to a high mean error rate (19.3%) and missing data of six participants due to technical problems. Details of the task and the results are available upon request from the authors.

## 3. Results

### 3.1. Eye-tracking data

The eye-tracking data were analyzed using one-way ANOVAs with number of fixations, latency of initial fixations and total fixation time on alcohol and control pictures as the dependent variables. Due to technical problems of the Tobii, data of only 30 participants could be used for analysis. Therefore, we created two groups based on the severity of alcohol use-related problems by using median split. An independent-samples *t*-test indicated a significant difference in AUDIT scores for the heavy drinking ($N = 15$, $M = 22.2$, SD = 8.09) and the light drinking group ($N = 15$, $M = 3.53$, SD = 3.52); $t(28) = -8.19$, $p < .001$. Likewise, two groups were compared based on IQ (average IQ; $N = 16$ vs. mild to borderline ID; $N = 14$). IQ did not differ significantly between the two groups. However, verbal IQ and performance IQ did approach statistical significance; $t(28) = -1.85$, $p = .075$ and $t(28) = -1.86$, $p = .073$.

As shown in Table 3, there were no significant differences on any of the dependent eye tracking variables. Participants did not fixate on or spend more time looking at one picture more often than the other, nor did they fixate on one picture faster than the other.

### 3.2. Approach avoidance task

Reaction time (RT) data from buffer trials and outliers (RTs below 200 ms, above 2000 ms and more than 3 SDs above the mean) were excluded from analyses (4% of the data). Data were analyzed using a 3 × 2 × 2 × 2 mixed design ANOVA with

**Table 3**
ANOVA results per participant group.

| | Severity of alcohol use-related problems | | Intelligence quotient | |
|---|---|---|---|---|
| | $F(1, 50)$ | $p$ | $F(1, 50)$ | $p$ |
| Number of fixations | | | | |
| Picture type | 0.36 | .556 | 0.26 | .614 |
| Picture type × group | 1.68 | .205 | 3.35 | .945 |
| Latency of initial fixation | | | | |
| Picture type | 0.87 | .358 | 0.13 | .720 |
| Picture type × group | 1.07 | .311 | 1.91 | .179 |
| Fixation duration | | | | |
| Picture type | | | 0.00 | .954 |
| Picture type× group | | | 2.72 | .111 |
| AAT | | | | |
| Picture type | 199.93 | <.001 | 0.00 | .965 |
| Response direction | 3.32 | .074 | 1.20 | .279 |
| Picture type × response direction × group | 0.16 | .434 | 1.53 | .227 |
| PRT | | | | |
| Picture type | 54.07 | <.001 | 25.10 | <.001 |
| Picture type× group | 0.05 | .949 | 0.07 | .934 |
| VDP | | | | |
| Probe position | 1.94 | .169 | 0.17 | .682 |
| Probe position × group | 0.14 | .866 | 2.06 | .138 |

*Note*: AAT, approach avoidance task (Rinck & Becker, 2007); PRT, picture rating task; VDP, visual dot probe task (MacLeod et al., 1986).

**Table 4**
Mean (M) and standard deviation (SD) of the rating of alcohol and soda pictures on the picture rating task and reaction time on the approach avoidance task and visual dot probe task per participant group.

| | N | AAT | | | | PRT | | | | VDP | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alcohol | | Soda | | Alcohol | | Soda | | Alcohol | | Soda | |
| | | *M* | SD | *M* | SD | *M* | SD | *M* | SD | *M* | SD | *M* | SD |
| AUDIT scores | | | | | | | | | | | | | |
| Light drinkers | 19 | 876.34 | 267.66 | 858.60 | 267.45 | 2.46 | 1.02 | 3.97 | 0.58 | 474.10 | 118.10 | 463.04 | 135.25 |
| Moderate drinkers | 16 | 857.37 | 220.01 | 834.26 | 204.40 | 2.69 | 1.10 | 4.30 | 0.60 | 549.01 | 205.59 | 541.22 | 202.96 |
| Heavy drinkers | 22 | 798.31 | 188.33 | 803.03 | 188.59 | 2.54 | 1.15 | 3.99 | 0.68 | 514.43 | 100.83 | 510.24 | 100.00 |
| Total | 57 | 841.60 | 224.82 | 830.25 | 219.55 | 2.55 | 1.08 | 4.06 | 0.63 | 510.66 | 142.00 | 503.24 | 145.90 |
| IQ | | | | | | | | | | | | | |
| Average IQ | 32 | 814.63 | 210.94 | 801.68 | 212.98 | 2.46 | 0.89 | 3.99 | 0.61 | 475.10 | 108.15 | 458.46 | 103.22 |
| Borderline ID | 16 | 867.06 | 202.34 | 859.18 | 194.58 | 2.77 | 1.24 | 4.19 | 0.59 | 572.90 | 202.83 | 578.84 | 211.02 |
| Mild ID | 9 | 885.58 | 303.20 | 876.17 | 278.40 | 2.52 | 1.37 | 4.10 | 0.77 | 542.75 | 78.69 | 545.48 | 67.50 |
| Total | 57 | 840.55 | 222.80 | 829.58 | 217.64 | 2.56 | 1.07 | 4.06 | 0.63 | 512.17 | 141.15 | 504.69 | 144.97 |

*Note*: AAT, approach avoidance task (Rinck & Becker, 2007); PRT, picture rating task; VDP, visual dot probe task (MacLeod et al., 1986).

group (light vs. moderate vs. heavy drinkers respectively average IQ vs. borderline ID vs. mild ID) and version (pull yellow frame vs. push yellow frame) as the between-subjects factors and stimulus type (alcohol vs. control pictures) and response type (approach vs. avoidance) as the within-subjects factors.

When comparing participants based on the severity of alcohol use-related problems, there was a main effect for picture type ($F(1, 50) = 199.93$, $p < .001$, $\eta_p^2 = .80$). Overall, participants responded faster to control pictures ($M = 829.58$, SD = 217.64; see also Table 4) than to alcoholic ones ($M = 840.55$, SD = 222.80). When classifying participants according to their IQ, this result disappeared ($F < 1$). The main effect of response type and the picture type × response direction × group interaction did not reach statistical significance in either group.

### 3.3. Picture rating task

A 3 × 2 ANOVA with group (light vs. moderate vs. heavy drinkers respectively average IQ vs. borderline ID vs. mild ID) and picture type (alcohol vs. control pictures) as the independent variables revealed that, overall, non-alcohol control pictures were rated as significantly more pleasant than alcohol pictures ($F(1, 51) = 54.07$, $p < .001$, $\eta_p^2 = .52$ respectively $F(1, 51) = 25.10$, $p < .001$, $\eta_p^2 = .33$). Non-alcoholic beverages were rated as positive ($M = 4.06$; SD = 0.63), while alcoholic beverages were rated as neutral ($M = 2.55$; SD = 1.08). However, there were no significant differences between the groups on mean pleasantness ratings of alcohol or control pictures.

### 3.4. Visual dot probe

Consistent with previous research (e.g., Bradley, Field, Healy, & Mogg, 2008; Mogg, Field, & Bradley, 2005) RT data from buffer trials and trials with errors (<1% of the data) were discarded. RTs below 200 ms, above 2000 ms or more than 3 SDs above each participant's mean were excluded (2% of the data). Data of one participant were removed from analyses due to a disproportionally high rate of errors (75%).

A 3 × 2 mixed design ANOVA was carried out on the remaining data with group (light vs. moderate vs. heavy drinkers respectively average IQ vs. borderline ID vs. mild ID) and probe position (probe replacing alcohol picture vs. probe replacing control picture) as independent variables. The groups did not differ on number of errors ($F < 1$) or outliers ($F(2, 52) = 2.063$, $p = .137$ respectively $F < 1$). Although heavy, moderate and light drinkers did not differ significantly on overall mean RT ($F(2, 52) = 1.215$, $p = .305$), there was a significant difference based on IQ ($F(2, 53) = 3.70$, $p = .031$). Post hoc comparisons using the Tukey HSD test indicated that the mean RT for individuals with average IQ ($M = 466.78$, SD = 103.28) was significantly lower than the mean RT for individuals with borderline ID ($M = 575.87$, SD = 206.52). Individuals with mild ID ($M = 544.11$, SD = 72.08) did not differ significantly from either individuals with average IQ or borderline ID. There was no significant main effect for probe position, indicating that participants did not respond faster to probes replacing alcohol pictures than control pictures. The probe position × group interaction did not reach statistical significance either.

### 3.5. Correlations

Pearson correlations were calculated between attentional and approach bias scores, pleasantness ratings of alcohol pictures, AUDIT scores and craving (VAS and ACQ-SF-R). The two measures of craving correlated significantly with each other on both points of measurement ($r = .67$, $p < .001$ respectively $r = .85$, $p < .001$). Craving was also positively associated with AUDIT scores ($ACQ_1$: $r = .26$, $p = .049$; $ACQ_2$: $r = .29$, $p = .031$; $VAS_1$: $r = .27$, $p = .044$; $VAS_2$: $r = .38$, $p = .005$). The pleasantness ratings of alcohol pictures correlated significantly with craving ($ACQ_2$: $r = .49$, $p < .001$; $VAS_2$: $r = .45$, $p < .001$) and attentional bias scores ($r = .42$, $p = .002$).

With regard to IQ, the approach bias score for control pictures was positively associated with both total IQ ($r = .40$, $p = .013$) and performance IQ ($r = .56$, $p < .001$). The approach bias score for alcohol pictures was also associated with performance IQ ($r = .34$, $p = .044$) but not with total IQ ($r = .23$, $p = .175$).

## 4. Discussion

Although studies on the role of cognitive biases in the development and maintenance of alcohol use-related problems in individuals with average IQ have been blooming, this research has not generalized to individuals with mild to borderline ID yet. Considering the clinical implications of measuring cognitive biases for screening, diagnosing and treatment evaluation, however, this research is highly needed. The primary aim of the present study was therefore to examine cognitive biases in individuals with mild to borderline ID and alcohol use-related problems.

In line with our expectations, we found no significant differences in cognitive biases between participants based on the severity of their alcohol use-related problems. There was actually a tendency for participants to show cognitive biases *away* from alcoholic beverages, meaning an *avoidance* of alcoholic cues. Similar results have been found in research using abstinent alcoholics undergoing treatment (e.g., Van Duijvenbode et al., 2012; Noel et al., 2006; Townshend & Duka, 2007; Vollstädt-Klein et al., 2009). Indeed, research on former alcoholics (Cox et al., 2002), but also smokers (Ehrman et al., 2002) and opiate users (Constantinou et al., 2010), suggests that successful treatment is associated with a reduction in the strength of cognitive biases.

A second aim was to assess the relationship between IQ and the strength of the cognitive biases. No differences were found between individuals with mild or borderline ID and individuals with (below) average IQ on any of the variables. It is therefore concluded that IQ does not appear to be associated with strength of cognitive biases, which, in turn, means that based on our results there is no reason to assume that the results of earlier studies on cognitive biases do not apply to individuals with mild to borderline IQ and alcohol use-related problems. As cognitive biases are a reliable and valid index for the severity of alcohol use-related problems (Field et al., 2007), predictive of relapse after treatment (Cox et al., 2002) and can be directly trained away (Wiers et al., 2011), this opens up new possibilities for treating alcohol use-related problems in individuals with mild to borderline ID.

This study had several limitations. The sample size of the current study was small and statistical power was limited. Moreover, there are no valid cut off scores for the AUDIT (Babor et al., 2001) for individuals with mild to borderline ID yet and as participants were all abstinent at the time of testing, it has to be established whether or not the AUDIT scores can be used for these purposes. Lastly, tasks were completed in a fixed order. Future studies may wish to present the tasks and the assessment of craving in a counterbalanced order to avoid potential order effects.

In summary, computer tasks such as the visual dot probe (MacLeod et al., 1986), the picture rating task and the approach avoidance task (Rinck & Becker, 2007) can be used in individuals with mild to borderline ID. The results of the current study suggest no influence of IQ on the strength of cognitive biases, which opens up new opportunities for future research on the application of measuring cognitive biases in screening, diagnosing and treating individuals with mild to borderline ID and alcohol use-related problems. Although we found no differences between participants based on severity of alcohol use-related problems, this can be explained by the characteristics of the population (i.e., abstinent and undergoing treatment). Taking into account the limitations of the current study, it is advised to replicate these results in future research.

## Conflict of interest statement

The authors declare no conflict of interest.

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