JIDR Journal of Intellectual Disability Research
Published on behalf of mencap and in association with IASSID

Journal of Intellectual Disability Research doi: 10.1111/jir.12244
VOLUME 60 PART 3 pp 242–253 MARCH 2016

The addicted brain: cognitive biases in problematic drinkers with mild to borderline intellectual disability

N. Van Duijvenbode,[1] R. Didden,[1,2] H. P. L. M. Korzilius[3] & R. C. M. E. Engels[1,4]

1 *Radboud University Nijmegen, Behavioural Science Institute, Nijmegen, The Netherlands*
2 *Trajectum, Zwolle, The Netherlands*
3 *Radboud University Nijmegen, Institute for Management Research, Nijmegen, The Netherlands*
4 *Trimbos Institute, Utrecht, The Netherlands*

Abstract

Background Substance use disorders (SUD) are associated with several neurobiological disruptions, including biases in attention and approach/avoidance behaviour. The aims of this study were to compare the strength of cognitive biases between light and problematic drinkers, to explore the role of IQ on the cognitive biases and to study the psychometric qualities of the measures.
Method Participants ($N = 130$) were divided into four groups based on IQ and severity of alcohol use-related problems: light ($n = 28$) and problematic drinkers ($n = 25$) with (sub)average IQ and light ($n = 33$) and problematic drinkers ($n = 44$) with mild to borderline intellectual disability (MBID). All participants performed the visual dot probe task and the approach avoidance task to measure the strength of cognitive biases.
Results In contrast with the hypothesis, no cognitive biases were found in problematic drinkers. Full scale IQ nor level of craving influenced the strength of the cognitive biases in light and problematic drinkers, although IQ did influence task performance (i.e. large intra-individual, trial-to-trial variation in reaction time). The internal consistency of the visual dot probe task was good, whereas the internal consistency of the approach avoidance task was poor.
Conclusion Cognitive biases seem to vary within the group of problematic drinkers as a whole. The psychometric qualities of the measures are problematic, especially in relation to the intra-individual variability in reaction time found in participants with MBID. Until the implications of this variability on the validity of implicit measures and establishing bias scores are more clear, the use of these measures in individuals with MBID calls for scrutiny.

Keywords addiction, alcohol, cognitive biases, mild intellectual disability, psychometric qualities

Introduction

One of the central tenets of substance use disorder (SUD) is a loss of control over the alcohol or drug use. In the DSM-V criteria for SUD this is reflected as continued substance use (SU) despite awareness of the negative physical, psychological and interpersonal consequences that are caused or exacerbated by SU (American Psychiatric Association [APA], 2013). As Wiers & Stacy (2013, p. 292) note '… the typical problem in addiction is not that drug abusers do not realise that the disadvantages of continued drug use outweigh the advantages. The central paradox in

Correspondence: Neomi van Duijvenbode, Radboud University Nijmegen, Behavioural Science Institute, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands (e-mail: n.vanduijvenbode@pwo.ru.nl).

addictive behaviours is that people continue to use substances even though they know the harm'. Throughout the years this 'paradox of addiction' has been explained as a sign of moral weakness, a symptom of an underlying neurosis or personality disorder or a distinct disease caused by premorbid biological and psychological characteristics of the addicted individual. Around 1990 there was (another) paradigm shift, as researchers began to explore the neurobiological consequences of chronic and/or excessive SU (Leshner, 1997).

According to these researchers, the 'paradox of addiction' could be explained by neurobiological disruptions or cognitive biases in brain regions important to the motivational, reward and inhibitory control processes (Koob, 2013; Volkow *et al.*, 2013). For example, as a result of chronic and/or excessive SU, the rewarding effects of a substance and related stimuli (e.g. persons, places, thoughts or feelings associated with SU, drug paraphernalia) become overvalued at the expense of other rewards (Nestler, 2005; Hyman *et al.*, 2005). Robinson & Berridge (2008) have called this 'incentive salience' or cognitive biases, meaning they seem attractive, 'grab attention' and elicit approach behaviour. These biases increase in strength with a high level of craving (Field *et al.*, 2008). Chronic and/or excessive SU also leads to a disrupted inhibitory control system and reduced top-down control over behaviour (Dackis & O'Brien, 2014; Hyman *et al.*, 2005). For example, SUD is associated with a smaller working memory capacity, a larger delay of gratification and less behavioural control (Hyman *et al.*, 2005). Taken together, these disruptions contribute significantly to the loss of control over SU as alcohol consumption is increasingly influenced by automatic processes that cannot easily be controlled and sometimes even occur outside of conscious awareness.

In addition to providing a theoretical framework for understanding SUD, measuring cognitive biases also has important practical implications (Stacy & Wiers, 2008). For example, as stronger cognitive biases are usually seen in individuals with more severe SUD (Bearre *et al.*, 2007; Fadardi & Cox, 2012), measures of cognitive biases could potentially be used as screening or assessment instruments for the severity of SUD. A number of studies have also suggested that these measures can be used to predict treatment outcome (e.g. Carpenter *et al.*, 2012; Marissen *et al.*, 2006). More recently, studies have focused on directly manipulating the cognitive biases by way of training. Results have shown that repeated training reduces the cognitive biases and leads to behavioural changes such as reductions in drinking and a reduced risk of relapse (Wiers *et al.*, 1999).

However, research on cognitive biases has not yet generalised to problematic drinkers with mild to borderline intellectual disability (ID) (MBID; IQ 50–85, APA, 2013). Thus, little is known about the nature and extent of cognitive biases in this target group as well as the possible influence of IQ on the manifestations of these biases (Van Duijvenbode *et al.*, 2015a; Van Duijvenbode *et al.*, 2012). This research could fill an important niche, because (1) individuals with MBID have been identified as a risk group for more negative consequences of SU (Slayter, 2008) and for developing SUD (Burgard *et al.*, 2000; McGillicuddy, 2006), (2) adequate screening and assessment instruments and effective treatment interventions for SUD in individuals with MBID are lacking and (3) measures for cognitive biases do not rely on verbal capacity or insight of clients into the severity of their SUD, are generally easy to conduct and are less susceptible to social desirability (Van Duijvenbode *et al.*, 2015b). Indeed, results of a pilot study suggest that computerised measures of cognitive biases – such as the visual dot probe task (VDP) (MacLeod *et al.*, 1986) and the approach avoidance task (AAT) (Rinck & Becker, 2007) – are applicable and feasible in individuals with MBID. In addition, the results of this study indicated no influence of IQ on the strength and manifestation of cognitive biases when comparing participants with and without MBID (Van Duijvenbode *et al.*, 2015a), but limitations of this pilot study (e.g. limited power, use of long-term abstinent problematic drinkers) warrant further testing. In the present study we want to expand the findings from this pilot study by including currently drinking participants as opposed to abstinent participants with a history of problematic drinking.

The aim of our study was threefold. First, we aimed to compare the strength of cognitive biases between light and problematic drinkers. In line with previous research on cognitive biases in problematic drinkers, we hypothesised that problematic drinkers would show attentional and approach biases and that these biases would be significantly stronger in problematic drinkers compared to light drinkers. Second, we wanted to explore the role of IQ by including participants with and without MBID. Based on the results of our pilot study with abstaining participants we hypothesised no influence of IQ on the strength or manifestation of cognitive biases (Van Duijvenbode *et al.*, 2015a). Third and last, we wanted to explore the psychometric qualities of the measures and task performance of the participants. In line with earlier critique of Ataya *et al.* (2012a, 2012b) and Field & Christiansen (2011), we hypothesised the measures to have poor internal consistency. In addition to the internal consistency, we also wanted to study task performance, especially of individuals with MBID as they have been shown to have a slower overall reaction time (RT) and greater variability in their RT (Deary *et al.*, 2005; Hunt, 2006; Jensen, 2010). We therefore also studied intra-individual, trial-to-trial variability in RT – especially in relation to IQ.

Method

Participants

Participants ($N = 130$; 88 men) had a mean age of 33.9 years (SD = 12.3). The majority of participants had completed some form of education, most often primary school (22.3%, $n = 29$), special education (23.1%, $n = 30$) or secondary school (18.5%, $n = 24$). Nine participants (6.9%) had not finished primary school, and 20 participants (15.4%) still attended vocational school or university (college). All participants had normal or corrected to normal vision and spoke Dutch fluently. All participants had the Dutch nationality and the majority (91.5%, $n = 119$) originated from the Netherlands. The other participants originated from Surinam/The Antilles (3.8%, $n = 5$), Morocco/Turkey (1.6%, $n = 2$), or other Western and non-Western countries (3.1%, $n = 4$).

The majority of the participants (90.0%, $n = 91$) received outpatient or residential care from organisations within ID care ($n = 64$) or addiction medicine ($n = 27$) at the time of the study. All participants had access to alcohol. Seventy-four participants were diagnosed by the treatment team with one or more psychiatric disorders. SUD (30.8%, $n = 40$), autism spectrum disorder (10.8%, $n = 14$) and attention deficit hyperactivity disorder (8.5%, $n = 11$) were diagnosed most often. Nineteen participants were also diagnosed with one or more personality disorders, most often a cluster B personality disorder (i.e. antisocial, borderline or narcissistic personality disorder, 9.2%, $n = 12$) or a personality disorder not otherwise specified (7.7%, $n = 10$).

Material

Cognitive biases

Cognitive biases were measured by two computerised measures: the VDP and the AAT (for a detailed description of the tasks, see Van Duijvenbode *et al.*, 2015a). Both tasks were presented on a 17-inch thin film transistor (TFT) flat screen monitor.

The VDP (MacLeod *et al.*, 1986) was used to measure the attentional bias. In each trial, two pictures of one alcoholic and one non-alcoholic beverage were presented on the left and the right side of the screen. Both pictures were matched for structural content, such as size and colour. After the pictures disappeared, a dot probe (white dot) appeared on either the left or the right side of the screen (see Fig. 1A). Participants were instructed to indicate the position of the probe as quickly as possible by pressing a button on the response box. The RT in ms to respond to the dot probe was recorded as the dependent variable. An attentional bias score was then calculated by subtracting the RT of trials in which the dot probe replaced the alcoholic beverage from the RT of trials in which the dot probe replaced the non-alcoholic beverage ($RT_{sod} - RT_{alc}$). A positive score is indicative of an attentional bias towards alcohol, while a negative score indicates a bias away from alcohol (Loeber *et al.*, 2009).

The AAT (Rinck & Becker, 2007) was used to measure automatic approach/avoidance tendencies. In this task, pictures of alcoholic and non-alcoholic beverages with a yellow or blue frame were presented in the centre of the screen (see Fig. 1B). Participants were instructed to respond to the colour 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. Depending on the movement of the joystick, the picture size increased or decreased, thereby adding to the sensation of approach/avoidance (Neumann & Strack, 2000) and increasing the ecological validity of the task (Rinck & Becker, 2007). An

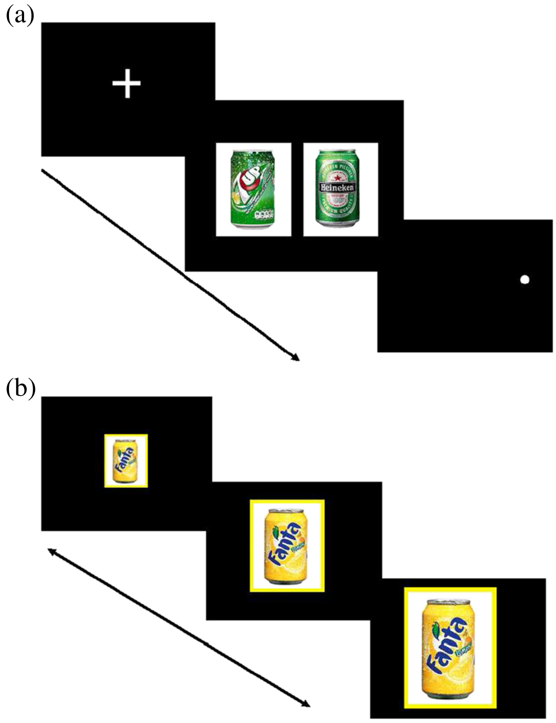

Figure 1 Schematic overview of (a) the visual dot probe task (VDP; MacLeod *et al.*, 1986) and (b) the approach avoidance task (AAT; Rinck & Becker, 2007).

approach bias score for both alcoholic as well as non-alcoholic beverages was calculated by subtracting the approach RT from the avoid RT ($RT_{avoid} - RT_{approach}$). A positive score indicates an approach bias towards alcohol, while a negative score indicates a bias away from alcohol (Cousijn *et al.*, 1992).

Substance use

The general pattern of alcohol use was assessed using the *Substance Use and Misuse in Intellectual Disability Questionnaire* (SumID-Q; VanDerNagel *et al.*, 2000; VanDerNagel *et al.*, 2011), a Dutch-language instrument to assess SU, risk factors for SUD and consequences of SU(D) in individuals with MBID. All participants reported their general frequency and quantity of alcohol use. The data provided by the participants were then converted into standard units of 10 g of alcohol (International Center for Alcohol Policies, 2006).

The severity of alcohol use-related problems was measured by the *Alcohol Use Disorder Identification Test* (AUDIT; Babor *et al.*, 2001; Dutch translation: Schippers & Broekman, 2010), which is integrated in the SumID-Q. The AUDIT is a standardised questionnaire of 10 questions about the amount, frequency and consequences of drinking alcohol. Scores range between 0 and 40, with higher scores reflecting more severe alcohol use-related problems. A score of 8 or more indicates hazardous alcohol use (Babor *et al.*, 2001) and was used in this study to classify participants as either light drinkers (score < 8) or problematic drinkers (score ≥ 8).

Craving

Craving was measured by an anchored visual analogue scale (VAS) ranging from 0 (*not at all*) to 10 (*extremely*). This measures was identical to the one used in Van Duijvenbode *et al.* (2015a) and provides a simple and minimally intrusive measure of craving for alcohol. As suggested in the literature, the VAS included a visual representation of the level of craving by a gradual change of colour from green to red (Hartley & MacLean, 2011). It has been concluded that this type of measurement can be used in individuals with MBID (Prosser & Bromley, 2012).

IQ

IQ was measured using the most recent scores on the Dutch version of the *Wechsler Adults Intelligence Scale* third edition (WAIS-III-NL; Uterwijk, 2007) in the participants' files. If IQ was unknown, a short version of the WAIS-III was used ($n = 53$) (Van Duijvenbode *et al.*, 2003). It was not possible to have all participants take the full-length WAIS-III because of time-related issues and potential participant fatigue. The short form is based on the *Wechsler Abbreviated Scale of Intelligence* (WASI; Wechsler, 2009) and consists of four subtests: Vocabulary, Similarities, Block design and Matrix reasoning. It can be administered in approximately 30 min and provides a good estimate of full scale IQ in individuals with MBID (Van Duijvenbode *et al.*, 2003). Full scale IQ was used to classify participants as having MBID (IQ < 85) or (sub) average intellectual functioning (IQ ≥ 85).

Procedure

No systematic sampling method was used to select and recruit participants. Clients receiving care from organisations within ID care or addiction medicine were selected by the treatment team and could participate if they (1) were 18 years or older, (2) had an IQ of minimally 50 and (3) were functioning stably (for example, free from withdrawal symptoms and no active psychotic or manic state as assessed by the treatment team). Abstaining clients with a history of problematic alcohol use were excluded from participating. Participants were also recruited by the first author (NvD) and trained students via advertisements on social media, the university and word of mouth. A preliminary check was conducted to see if these participants matched the inclusion criteria.

All participants were provided with a folder with general information about the study. They were told they could withdraw at any time during the study without any complications for their treatment and that their information would be analysed anonymously. They were also provided with contact information of the researcher. After obtaining written informed consent of both the clients and their treatment team, appointments were made. The experiment lasted approximately 2 h and was spread out across two sessions of 1 h each with an average time of 1 week between sessions.

During the first session, participants provided general demographic information, followed by an assessment of alcohol and drug use. If necessary, the WAIS-III short form (Van Duijvenbode *et al.*, 2003) was used to estimate full scale IQ. The second session consisted of the two computer tasks – the VDP and the AAT – and an assessment of craving. In between tasks, participants were allowed to take a break whenever necessary. Finally, participants were told they would receive a full debriefing after completion of the entire study. They were thanked for their time and received a gift worth €5 (US $6.50) for their participation.

The study was approved by the Committee of Ethics of the Faculty of Social Sciences, Radboud University Nijmegen, the Netherlands (ECG2012-1301-003).

Preparation of the data and statistical analysis

As in previous research (e.g. Bradley *et al.*, 2008; Cousijn *et al.*, 1992), RT data from buffer trials and trials with errors on the VDP and the AAT were discarded. To minimise the influence of outliers, the median RTs were used instead of the mean RTs, making it unnecessary to define cut-off points for outliers (Rinck & Becker, 2007; Peeters *et al.*, 2012). Data on the VDP of five participants were missing because of a disproportionally high rate of errors (clicking the wrong button on the response box to indicate the position of the probe). Similarly, data on the AAT of five other participants were also missing because of technical problems.

IBM SPSS Statistics (Version 20) was used to conduct the statistical analyses. Data of the VDP were analysed using a 2 × 2 mixed design ANOVA, with group (light vs. problematic drinkers) and probe position (probe replacing picture of alcoholic beverage vs. probe replacing picture of non-alcoholic beverage) as independent variables. Data of the AAT were analysed using a 2 × 2 × 2 × 2 mixed design ANOVA, with group (light vs. problematic drinkers) and version (pull yellow frame vs. pull blue frame) as between-subjects factors and picture type (alcoholic beverage vs. non-alcoholic beverage) and response direction (approach vs. avoid) as within-subjects factors. A power analysis (with G*Power Version 3.1.92) showed that with the number of participants in the sample ($N = 130$) and the statistical tests used (the most complex ANOVA in the study) a power of .81 was achieved at a medium effect size ($f = .25$) and α of .05. This is above the convention of .80 (Cohen, 2007); therefore the four groups can be expected to be large enough to sufficiently prevent a type II error. The relationship between bias scores, AUDIT score, weekly alcohol consumption, full scale IQ and craving was further investigated using *t*-tests, multiple regression analyses and Pearson product–moment correlation coefficient.

In addition, the psychometric qualities of the VDP and AAT were investigated. Cronbach's alpha was calculated as an index of the internal consistency of RT and bias scores on both tasks as a whole and for each participant group (light and problematic drinkers with and without MBID) and trial category (alcohol and soda trials, push and pull trials) separately. Following Lövdén *et al.* (2007), we studied intra-individual variability in RT by (1) calculating the intra-individual coefficient of variation (CoV;

individual SD/individual *M*), and (2) using the intra-individual SD based on all (correct) responses within each task as a whole.

We used an alpha level of .05 in all statistical analyses except for the hypothesis assuming no influence of IQ on the strength or manifestation of cognitive biases. In testing this hypothesis we used another alpha level in order to avoid making a type II error – not rejecting H_0 when it is false. Type II error (beta level) is conventionally set at .20, and the chances of making this type of error can be decreased by increasing type I error (alpha level) because there is a trade off between the two error types: if alpha increases, beta decreases and vice versa (Field, 2006). Therefore, in line with Kirk (1982) an alpha level .25 was adopted to test this hypothesis.

Results

Group characteristics

Participants were divided into four groups based on AUDIT score and IQ: light drinking participants with (sub)average IQ ($n = 28$), problematic drinking participants with (sub)average IQ ($n = 25$), light drinking participants with MBID ($n = 33$) and problematic drinking participants with MBID ($n = 44$). Group characteristics are shown in Table 1. As expected, a one-way between groups analysis of variance showed that (est.) full scale IQ ($F_{3,126} = 111.95$, $P < .001$, $\eta_p^2 = .73$), AUDIT score ($F_{3,126} = 68.82$, $P < .001$, $\eta_p^2 = .62$), and weekly alcohol consumption ($F_{3,126} = 9.80$, $P < .001$, $\eta_p^2 = .19$) differed significantly between the groups. A *post-hoc* Tukey HSD test revealed that problematic drinkers in both IQ groups had a higher AUDIT score and consumed more alcohol per week than light drinkers. Similarly, participants with MBID had a significantly lower IQ compared to non-ID participants, irrespective of severity of alcohol use-related problems. Although groups also differed on gender ratio ($\chi^2(3, n = 130) = 17.96$, $P < .001$) – with larger proportions of light drinking compared to problematic drinking women – this was to be expected considering the gender differences in the prevalence of SU(D) (Lev-Ran *et al.*, 2013; Seedat *et al.*, 2009). Groups did not differ on cultural background and age ($P > .05$).

Cognitive biases

Our first hypothesis was that problematic drinkers would show attentional and approach biases and that these biases would be significantly stronger in problematic drinkers compared to light drinkers. A 2 × 2 mixed design ANOVA carried out on the VDP data revealed no significant main effect for probe position ($F_{1,124} = 2.79$, $P = .10$), meaning participants did not respond faster to probes replacing pictures of alcoholic beverages than pictures of non-alcoholic beverages. The probe position × group interaction did not reach statistical significance either ($F_{1,124} = 1.27$, $P = .26$). Data of the AAT were analysed using a 2 × 2 × 2 × 2 mixed design ANOVA, which showed a significant main effect for picture type ($F_{1,120} = 4.62$,

Table 1 Participant Characteristics per Group (N = 130); Light Drinkers with (Sub)Average IQ (n = 28), Problematic Drinkers with (Sub)Average IQ (n = 25), Light Drinkers with Mild to Borderline Intellectual Disability (MBID; n = 33), and Problematic Drinkers with MBID (n = 44).

	(Sub)Average IQ		MBID	
	Light drinkers ***M (SD)***	**Problematic drinkers** ***M (SD)***	**Light drinkers** ***M (SD)***	**Problematic drinkers** ***M (SD)***
Age	31.96 (12.78)	33.25 (11.63)	34.67 (12.64)	34.45 (12.51)
Est. full scale IQ	107.29 (12.79)	105.88 (12.72)	71.63 (9.22)	69.31 (9.24)
Est. verbal IQ	103.00 (13.22)	106.17 (15.42)	72.50 (11.80)	69.43 (10.92)
Est. performance IQ	108.93 (13.81)	104.75 (12.53)	70.43 (10.05)	70.43 (10.05)
AUDIT score	3.89 (2.28)	16.79 (7.45)	2.60 (2.19)	17.14 (7.15)
Weekly alcohol consumption	4.30 (5.36)	57.42 (73.50)	1.10 (2.75)	30.47 (48.56)

Note: AUDIT = Alcohol Use Disorders Identification Test (Babor et al., 2001).

$P = .03$, $\eta_p^2 = .04$). Overall, participants responded faster to alcoholic beverages ($M = 777$, SD = 239) than to non-alcoholic beverages ($M = 790$, SD = 222). All other main effects and the group × version × picture type × response direction interaction did not reach statistical significance ($F_{1,120} = 0.22$, $P = .64$). These results maintained after controlling for craving and gender ($F_{VDP}(1, 121) = 0.03$, $P = .85$; $F_{AAT}(1, 117) = 0.11$, $P = .74$) in a one-way between-groups analysis of covariance.

Furthermore, bias scores were investigated using a one-sample *t*-test to compare the mean bias scores to zero, meaning no bias. Neither the attentional and approach bias score for light drinkers (VDP: M = 2.57, SD = 25.26, t(57)=0.78, P = .44; AAT: M = 1.09, SD = 131.64, t(57)=0.06, P = .95) nor for problematic drinkers (VDP: M = 12.75, SD = 67.94, t(67)=1.55, P = .13; AAT: M = 29.44, SD = 134.80, t(65)=1.77, P = .08) differed significantly from zero. There was also no significant difference in bias scores between the two groups (tVDP(124)= -1.08, P = .28; tAAT(122)= -1.18, P = .24). The magnitude of the difference in the means for the attentional bias score (mean difference = -10.18, 95% CI -28.86 to 8.50) and the approach bias score for alcoholic beverages (mean difference = -28.35, 95% CI -75.86 to 19.15) were very small (η_p^2 = .009; η_p^2 = .011 respectively).

IQ

Our second hypothesis was that there would be no influence of IQ on the strength or manifestation of cognitive biases. Pearson r correlations showed that AUDIT score correlated significantly with the attentional bias score ($r = .19$, $P = .03$) and the approach bias score for alcoholic beverages ($r = .23$, $P = 0.1$), whereas full scale IQ ($r_{VDP} = -.07$, $P = .41$; $r_{AAT} = .01$, $P = .92$), craving ($r_{VDP} = .17$, $P = .06$; $r_{AAT} = .04$, $P = .68$) and weekly alcohol consumption did not ($r_{VDP} = -.03$, $P = .77$; $r_{AAT} = .00$, $P = .99$). These results remained after controlling for gender in a partial correlation analysis. These results were confirmed by multiple regression analyses to assess the ability of AUDIT score, weekly alcohol consumption, full scale IQ and craving to predict the bias scores on the VDP and AAT. When attentional bias score was predicted, it was found that the full model was statistically significant ($F_{4,118} = 2.75$, $P = .03$) and explained 29.2% of the variance. AUDIT score ($\beta = .24$, $P = .03$) and weekly alcohol consumption ($\beta = -.24$, $P = .03$) were both significant predictors, while full scale IQ ($\beta = -.04$, $P = .67$) and craving ($\beta = .17$, $P = .10$) were not. The full model for approach bias for alcoholic beverages on the AAT was also statistically significant ($F_{4,116} = 2.51$, $P = .05$) and explained 28.2% of the variance in AAT bias score for alcoholic beverages. AUDIT score ($\beta = .36$, $P = .01$) was the only significant predictor. Full scale IQ ($\beta = .05$, $P = .55$), weekly alcohol consumption ($\beta = -.18$, $P = .11$) and craving ($\beta = -0.4$, $P = .89$) did not make unique contributions to the model. The full model for the AAT bias score for non-alcoholic beverages did not reach statistical significance ($F_{4,116} = 1.39$, $P = .24$).

Psychometric qualities

Our third and final hypothesis was that the measures would have poor internal consistency. Internal consistency of the VDP and AAT was assessed by Cronbach's alpha. The internal consistency of the RTs was excellent, reflected by a mean inter-item correlation of .87 and a Cronbach's alpha of .99 for the VDP and a mean inter-item correlation of .34 and a Cronbach's alpha of .97 for the AAT. The internal consistency of the attentional bias scores was good (Cronbach's alpha = .71, mean inter-item correlation = .07). The internal consistency of the approach bias score, on the other hand, was poor (Cronbach's alpha = .58, mean inter-item correlation = .03). These results maintained when exploring each participant group (light and problematic drinkers with and without MBID) and trial category (alcohol and soda trials, push and pull trials) separately.

Last, we explored task performance by studying intra-individual, trial-to-trial variability in RT in relation to IQ. An independent samples *t*-test with equal variances not assumed showed that participants with MBID had a significantly larger overall RT, overall SD in RT and intra-individual CoV in RT (individual SD/individual *M*) compared to non-ID participants (see Table 2). Pearson correlations showed that full scale IQ correlated negatively with all these parameters, on both the AAT and the VDP (correlations ranging between $-.27$ and $-.57$, $P < .001$). These results

Table 2 Descriptives and Independent Samples T-Test with Equal Variance not assumed of Reaction Time (RT) and Intra-Individual Variability per Participant Group.

	Participants with MBID		**Participants with (sub)average IQ**				
	M	***SD***	***M***	***SD***	***t* (122)**	***p***	η_p^2
AAT							
Overall M RT	874	231	669	138	6.17	<.001	238
Overall SD of RT	217	109	136	52	5.56	<.001	202
CoV	0.24	0.07	0.20	0.05	3.65	<.001	098
VDP							
Overall M RT	572	201	462	132	3.71	<.001	098
Overall SD of RT	115	60	82	57	3.13	002	072
CoV	0.20	0.07	0.17	0.06	2.60	011	051

Note: MBID = Mild to Borderline Intellectual Disability; AAT = Approach Avoidance Task (Rinck & Becker, 2007); VDP = Visual Dot Probe Task (MacLeod et al., 1986); CoV = Coefficient of variation in RT.

maintained after controlling for age in a partial correlation analysis.

Discussion

This is the first study of cognitive biases in problematic drinkers with MBID. The goals of this study were to compare the strength of cognitive biases between light and problematic drinkers, to explore the influence of IQ on the strength and manifestation of cognitive biases and to study the psychometric qualities of the VDP (MacLeod *et al.*, 1986) and AAT (Rinck & Becker, 2007).

Our first hypothesis was that problematic drinkers would show attentional and approach biases and that these biases would be significantly stronger in problematic drinkers compared to light drinkers. In line with previous research (e.g. Field & Cox, 2012), light drinkers showed no attentional or approach bias towards alcohol. In contrast with previous research (e.g. Field *et al.*, 2013; Sharbanee *et al.*, 2013), however, problematic drinkers in this convenience sample showed no attentional or approach bias towards alcohol either, although severity of alcohol use-related problems did make a unique contribution to the prediction of and was significantly correlated with the strength of the cognitive biases. Noteworthy is the large variation in bias scores in problematic drinkers, with some showing an attentional bias *towards* alcohol and others an attentional bias *away from* alcohol. This large variation suggests that problematic drinkers are a heterogeneous group, perhaps as a factor of executive functioning (e.g. working memory, inhibitory control and processing speed), level of craving or motivation to become or remain abstinent (see for example Grenard *et al.*, 2012; Field *et al.*, 2008; Burton *et al.*, 2000). Another explanation lies in the characteristics of the participant group with the majority of the participants receiving outpatient or residential care from organisations within ID care or addiction medicine at the time of the study, as attentional avoidance of alcohol cues has been found in problematic drinkers (without MBID) receiving treatment (e.g. Noel *et al.*, 2006; Townshend & Duka, 2010; Vollstädt-Klein *et al.*, 2013; Van Duijvenbode *et al.*, 2015a).

Our second hypothesis was that there would be no influence of IQ on the strength of manifestation of the cognitive biases. As in our previous pilot study (Van Duijvenbode *et al.*, 2015a), full scale IQ was not associated with the strength or manifestation of the cognitive biases. Yet, IQ does appear to influence task performance. Individuals with MBID showed a slower overall RT and a greater trial-to-trial variability in their RT (see also Deary *et al.*, 2005; Hunt, 2006; Jensen, 2010). Baumeister & Kellas (1968) have associated this variability in RT with a greater difficulty of individuals with MBID to maintain an optimal level of performance, for example because of momentary fluctuations in attention or deficiencies in executive functioning such as working memory or information processing speed (Schmiedek *et al.*, 2007;

Haishi *et al.*, 2008). One could argue that RT measures therefore cannot be used when studying individuals with MBID, as RT is inconsistent and therefore relatively meaningless – especially in comparison with other groups. One could also argue that intra-individual variability in RT is a stable characteristic of the individual and should therefore be explored in itself when studying individuals with MBID, for example in relation to concentration span and executive functioning. The implications of intra-individual variability in RT on the validity of RT measures in individuals with MBID thus remain unclear.

Our third and final hypothesis was that the VDP and AAT would have poor internal consistency. As opposed to Ataya *et al.* (2012a, 2012b) and Field & Christiansen (2011), we found the internal consistency of the attentional bias score to be good as it reached the acceptable level of .70 (DeVellis, 2001). The internal consistency of the approach bias score, on the other hand, was poor. Of importance is the very low mean inter-item correlation ($r < .1$), suggesting poor item homogeneity, irrespective of IQ. Following Field & Christiansen (2011), this might be explained by differences in individual preferences to alcoholic beverages (beer, wine, alcopops and liquor), which could subsequently yield inconsistent bias scores within a task and across participants and thus poor item homogeneity and construct validity.

We note several limitations of this study. First, the majority of the participants were diagnosed with one or more psychiatric disorders and often also used cannabis and other drugs, in addition to drinking alcohol. Furthermore, most of the participants were prescribed medications. Although this co-morbidity between psychiatric disorders, subsequent use of prescribed psychotropic medication and SUD reflects the complex nature of the target group (see for example Center for Substance Abuse Treatment, 2006), a possible influence of these co-morbid disorders on the cognitive biases and the performance on (the short form of) the WAIS-III (Uterwijk, 2007; Van Duijvenbode *et al.*, 2003) cannot be ruled out. One line of future inquiry could therefore be to study the influence of co-morbidity on the strength of cognitive biases, for example by comparing problematic drinkers with poly-substance users and identifying factors that could influence the strength of cognitive biases in problematic drinkers (e.g. executive functioning, motivation to become or remain abstinent). Second, SU was assessed using the SumID-Q (VanDerNagel *et al.*, 2000), and the severity of alcohol use-related problems was measured by the AUDIT (Babor *et al.*, 2001). Because MBID is associated with memory-related problems (Lifshitz *et al.*, 2011), the psychometric qualities of the SumID-Q have not been studied yet and there are no valid cut-off scores for the AUDIT for individuals with MBID, the validity and reliability of these measures in individuals with MBID can be questioned. Research could therefore be directed at validating the SumID-Q and the AUDIT for individuals with MBID. Last, the psychometric qualities and usefulness of implicit measures such as the VDP and AAT remain unclear and need to be examined further, especially in light of the observed intra-individual, trial-to-trial variability in RT in individuals with MBID and the poor item homogeneity of the bias scores. Several suggestions have already been made to improve the validity and reliability of implicit measures, including the use of eye tracking methodology in addition to calculating bias scores, the use of individualised stimuli based on drinking preferences and the use of different ways to calculate bias scores and handling outliers in RT (Ataya *et al.*, 2012a; Field & Christiansen, 2011; Price *et al.*, 2015). Future research could also focus on ways to minimise intra-individual variability in RT, for example by studying optimal task and procedural factors to increase the stability of RT (e.g. providing within-task feedback, using fixed and long preparatory intervals between trials and using simple rather than complex tasks; Dykiert *et al.*, 2014; Garrett *et al.*, 2012)

To summarise, the nature of implicit tasks (i.e. no reliance on verbal capacity, less susceptible to social desirability and easy to complete; Van Duijvenbode *et al.*, 2015b) makes implicit measures look promising for use in individuals with MBID. However, as we found no attentional or approach biases in problematic drinkers with and without MBID, the results of our study call for caution. Cognitive biases seem to vary within the group of problematic drinkers as a whole, perhaps as a function of executive functioning, level of craving or other participant-related factors (e.g. motivation to become or remain abstinent, co-morbid psychiatric disorders and use of prescribed medication). Although full scale IQ does not influence the strength of the cognitive biases, it does appear to influence task performance in the form of a greater intra-individual variability in RT. In future studies, we will examine this variability and the implications it has on for example the validity of RT measures and establishing bias scores further, as well as the relationship between executive functioning, cognitive biases and alcohol use. Until the implications of this variability for example on the validity of RT measures and establishing bias scores are more clear, the use of these measures in individuals with MBID calls for scrutiny.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

Support from several Dutch organisations within ID care (Aveleijn, Ipse de Bruggen, Leekerweide, Pluryn and Trajectum) and addiction medicine (Tactus) in the conductance of the study is gratefully acknowledged.

References

American Psychiatric Association (2013) *Diagnostic and Statistical Manual of Mental Disorders*, 5th edn. American Psychiatric Association, Washington DC.

Ataya A. F., Adams S., Mullings E., Cooper R. M., Attwood A. S. & Munafo M. R. (2012a) Internal reliability of measures of substance-related cognitive bias. *Drug and Alcohol Dependence* **121**, 148–51.

Ataya A. F., Adams S., Mullings E., Cooper R. M., Attwood A. S. & Munafo M. R. (2012b) Methodological considerations in cognitive bias research: the next steps. *Drug and Alcohol Dependence* **121**, 191–92.

Babor T. F., Higgins-Biddle J. C., Saunders J. B. & Monteiro M. G. (2001) *AUDIT. The Alcohol use Disorders Identification Test: Guidelines for Use in Primary Care*, 2nd edn. World Health Organisation, Geneva.

Baumeister A. A. & Kellas G. (1968) Reaction time and mental retardation. *International Review of Research in Mental Retardation* **3**, 163–93.

Bearre L., Sturt P., Bruce G. & Jones B. T. (2007) Heroin-related attentional bias and monthly frequency of heroin use are positively associated in attenders of a harm reduction service. *Addictive Behaviors* **32**, 784–92.

Bradley B. P., Field M., Healy H. & Mogg K. (2008) Do the affective properties of smoking-related cues influence attentional and approach biases in cigarette smokers? *Journal of Psychopharmacology* **22**, 737–45.

Burgard J. F., Donohue B., Azrin N. H. & Teichner G. (2000) Prevalence and treatment of substance abuse in the mentally retarded population: An empirical review. *Journal of Psychoactive Drugs* **32**, 293–298.

Burton C. M., Pedersen S. L. & McCarthy D. M. (2012) Impulsivity moderates the relationship between implicit associations about alcohol and alcohol use. *Psychology of Addictive Behaviors* **26**, 766–72.

Carpenter K. M., Schreiber E., Church S. & McDowell D. (2006) Drug Stroop performance: relationships with primary substance of use and treatment outcome in a drug-dependent outpatient sample. *Addictive Behaviors* **31**, 174–81.

Center for Substance Abuse Treatment (2007) The epidemiology of co-occurring substance use and mental disorders. COCE overview paper 8. Substance Abuse and Mental Health Services Administration and Center for Mental Health Services, Rockville, MD.

Cohen J. (1992) A power primer. *Psychological Bulletin* **122**, 155–59.

Cousijn J., Luijten M. & Wiers R. W. (2014) Mechanisms underlying alcohol-approach action tendencies: the role of emotional primes and drinking motives. *Frontiers in Psychiatry* **5**, 44 E-print.

Dackis C. & O'Brien C. (2005) Neurobiology of addiction: treatment and public policy ramifications. *Nature Neuroscience* **8**, 1431–36.

Deary I. J., Der G. & Ford G. (2001) Reaction times and intelligence differences. *A population-based cohort study. Intelligence* **29**, 389–99.

DeVellis F. R. (2003) *Scale Development: Theory and Applications*, 2nd edn. Sage, Thousand Oaks, CA.

Van Duijvenbode N., Didden R., Van den Hazel T. & Engels R. C. M. E. (2015a) Psychometric qualities of a tetrad WAIS-III short form for use in individuals with mild to borderline intellectual disability. *Developmental Neurorehabilitation* **24**, 1–5.

Van Duijvenbode N., Didden R., Voogd H., Korzilius H. P. L. M. & Engels R. C. M. E. (2012) Cognitive biases in individuals with mild to borderline intellectual disability and alcohol use-related problems. *Research in Developmental Disabilities* **33**, 1928–36.

Van Duijvenbode N., VanDerNagel J. E. L., Didden R., Engels R. C. M. E., Buitelaar J. K., Kiewik M. et al. (2015b) Substance use disorders in individuals with mild to borderline intellectual disability: current status and future directions. *Research in Developmental Disabilities* **38**, 319–28.

Van Duijvenbode N., VanDerNagel J. E. L. & Didden R. (2014) The road ahead: new developments in the field of substance use in individuals with intellectual disability. *NADD Bulletin* **17**, 118–23.

Dykierkt D., Der G., Starr J. M. & Deary I. J. (2012) Age differences in intra-individual variability in simple and choice reaction time: systematic review and meta-analysis. *Plos One* **7**, e45759.

Fadardi J. S. & Cox W. M. (2006) Alcohol attentional bias: drinking salience or cognitive impairment? *Psychopharmacology* **185**, 169–78.

Field A. (2013) *Discovering Statistics Using IBM SPSS Statistics*, 4th edn. Sage Publications, Los Angeles (CA).

Field M., Caren R., Fernie G. & De Houwer J. (2011) Alcohol approach tendencies in heavy drinkers: comparison of effects in a relevant stimulus–response compatibility task and an approach/avoidance Simon task. *Psychology of Addictive Behaviors* **25**, 697–701.

Field M. & Christiansen P. (2012Commentary on Ataya et al. (2012)) Internal reliability of measures of substance-related cognitive bias. *Drug and Alcohol Dependence* **124**, 189–90.

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

Field M., Munafo M. R. & Franken I. H. A. (2009) A meta-analytic investigation of the relationship between attentional bias and subjective craving in substance abuse. *Psychological Bulletin* **135**, 589–607.

Garrett D. D., MacDonald S. W. S. & Craik F. I. M. (2012) Intraindividual reaction time variability is malleable: feedback- and education-related reductions in variability with age. *Frontiers in Human Neuroscience* **6**, 101.

Grenard J. L., Ames S. L., Wiers R. W., Thush C., Sussman S. & Stacy A. W. (2008) Working memory capacity moderates the predictive effects of drug-related associations on substance use. *Psychology of Addictive Behaviors* **22**, 426–32.

Haishi K., Okuzumi H. & Kokubun M. (2011) Effects of age, intelligence and executive control function on saccadic reaction time in persons with intellectual disabilities. *Research in Developmental Disabilities* **32**, 2644–50.

Hartley S. L. & MacLean W. E. (2006) A review of the reliability and validity of Likert-type scales for people with intellectual disability. *Journal of Intellectual Disability Research* **50**, 813–27.

Hunt E. (2005) Information processing and intelligence: where we are and where we are going. In: *Cognition and Intelligence: Identifying Mechanisms of Mind* (eds R. J. Sternberg & J. E. Pretz), pp. 1–25. Cambridge University Press, Cambridge.

Hyman S. E., Malenka R. C. & Nestler E. J. (2006) Neural mechanisms of addiction: the role of reward-related learning and memory. *Annual Review of Neuroscience* **29**, 565–98.

International Center for Alcohol Policies. (2010). International drinking guidelines. Retrieved from http://www.icap.org/table/Internationaldrinkingguidelines.

Jensen A. R. (2006) *Clocking the Mind: Mental Chronometry and Individual Differences*. Elsevier, Oxford.

Kirk R. E. (1982) *Experimental Design Procedures for the Behavioral Sciences*, 2nd edn., Belmont (CA): Wadsworth.

Koob G. F. (2013) Addiction is a reward deficit and stress surfeit disorder. *Frontiers in Psychiatry* **4**, 1–18.

Leshner A. I. (1997) Addiction is a brain disease, and it matters. *Science* **278**, 45–47.

Lev-Ran S., Le Strat Y., Imtiaz S., Rehm J. & Le Foll B. (2013) Gender differences in prevalence of substance use disorders among individuals with lifetime exposure to substances: results from a large representative sample. *The American Journal on Addictions* **22**, 7–13.

Lifshitz H., Shtein S., Weiss I. & Vakil E. (2011) Meta-analysis of explicit memory studies in populations with intellectual disability. *European Journal of Special Needs Education* **26**, 93–111.

Loeber S., Vollstädt-Klein S., Von der Goltz C., Flor H., Mann K. & Kiefer F. (2009) Attentional bias in alcohol-dependent patients: the role of chronicity and executive functioning. *Addiction Biology* **14**, 194–203.

Lövden M., Li S.-C., Shing Y. L. & Lindenberger U. (2007) Within-person trial-to-trial variability precedes and predicts cognitive decline in old and very old age: longitudinal data from the Berlin Aging Study. *Neuropsychologica* **45**, 2827–38.

MacLeod C. M., Mathews A. & Tata P. (1986) Attentional bias in emotional disorders. *Journal of Abnormal Psychology* **95**, 15–20.

Marissen M. A., Franken I. H., Waters A. J., Blanken P., Van den Brink W. & Hendriks V. M. (2006) Attentional bias predicts heroin relapse following treatment. *Addiction* **101**, 1306–12.

McGillicuddy N. B. (2006) A review of substance use research among those with mental retardation. *Mental Retardation and Developmental Disabilities Research Reviews* **12**, 41–47.

Neumann R. & Strack F. (2000) Approach and avoidance: the influence of proprioceptive and exteroceptive cues on encoding of affective information. *Journal of Personality and Social Psychology* **79**, 39–48.

Nestler E. J. (2005) Is there a common molecular pathway for addiction? *Nature Neuroscience* **8**, 1445–49.

Noel X., Colmant M., Van der Linden M., Bechara A., Bullens Q., Hanak C. *et al.* (2006) Time course of attention for alcohol cues in abstinent alcoholic patients: the role of initial orienting. *Alcoholism, Clinical and Experimental Research* **30**, 1871–77.

Peeters M., Wiers R. W., Monshouwer K., Van de Schoot R., Janssen T. & Vollebergh W. A. M. (2012) Automatic processes in at-risk adolescents: the role of alcohol-approach tendencies and response inhibition in drinking behavior. *Addiction* **107**, 1939–46.

Price R. B., Kuckertz J. M., Siegle G. J., Ladouceur C. D., Silk J. S., Ryan N. D. *et al.* (2015) Empirical recommendations for improving the stability of the dot-probe task in clinical research. *Psychological Assessment* **27**, 365–76.

Prosser H. & Bromley J. (2012) Interviewing people with intellectual disabilities. In: *Clinical Psychology and People With Intellectual Disabilities* (eds E. Emerson, C. Hatton, K. Dickson, R. Gone, A. Caine & J. Bromley), 2nd edn, pp. 107–120. John Wiley & Sons, West Sussex.

Rinck M. & Becker E. S. (2007) Approach and avoidance in fear of spiders. *Journal of Behavioral Therapy and Experimental Psychiatry* **38**, 105–20.

Robinson T. E. & Berridge K. C. (2008) The incentive sensitization theory of addiction: some current issues. *Philosophical Transaction of the Royal Society of London: Series B, Biological Sciences* **363**, 3137–46.

Schippers G.M. & Broekman T.G. (2010) De AUDIT. Nederlandse vertaling van de Alcohol Use Disorders Identification Test. [Dutch translation of the Alcohol Use Disorders Identification Test.]. Retrieved from http://www.mateinfo.nl/audit/.

Schmiedek F., Oberauer K., Wilhelm O., Süss H.-M. & Wittmann W. W. (2007) Individual differences in components of reaction time distributions and their relations to working memory and intelligence. *Journal of Experimental Psychology. General* **136**, 414–29.

Seedat S., Scott K. M., Angermeyer M. C., Berglund P., Bromet E. J., Brugha T. S. *et al.* (2009) Cross-national associations between gender and mental disorders in the World Health Organization World Mental Health Surveys. *Archives of General Psychiatry* **66**, 785–95.

Sharbanee J. M., Stritzke W. G. K., Wiers R. W. & MacLeod C. (2013) Alcohol-related biases in selective attention and action tendency make distinct contributions to dysregulated drinking behaviour. *Addiction* **108**, 1758–66.

Slayter E. M. (2008) Understanding and overcoming barriers to substance abuse treatment access for people with mental retardation. *Journal of Social Work in Disability and Rehabilitation* **7**, 63–80.

Stacy A. W. & Wiers R. W. (2010) Implicit cognition and addiction: a tool for explaining paradoxical behavior. *Annual Review of Clinical Psychology* **6**, 551–75.

Townshend J. M. & Duka T. (2007) Avoidance of alcohol-related stimuli in alcohol-dependent inpatients. *Alcoholism, Clinical and Experimental Research* **31**, 1349–57.

Uterwijk J. M. R. (2000) *WAIS-III: Nederlandstalige Bewerking: Wechsler Adult Intelligence Scale – Ed3*: Afname en scoringshandleiding (WAIS-III 2000). Swets Test Publishers, Lisse.

VanDerNagel J. E. L., Kiewik M., Van Dijk M., De Jong C. A. J. & Didden R. (2011) *Handleiding SumID-Q, Meetinstrument Voor het in Kaart Brengen van Middelengebruik bij Mensen met een Lichte Verstandelijke Beperking [Manual of the SumID-Q, An Instrument to Assess Substance Use in Individuals with a Mild Intellectual Disability*]. Tactus, Deventer.

VanDerNagel J. E. L., Kemna L. E. M. & Didden R. (2013) Substance use among persons with mild intellectual disability: approaches to screening and interviewing. *NADD Bulletin* **16**, 87–92.

Volkow N. D., Wang G.-J., Tomasi D. & Baler R. D. (2013) Unbalanced neuronal circuits in addiction. *Current Opinion in Neurobiology* **23**, 639–48.

Vollstädt-Klein S., Loeber S., Von der Goltz C., Mann K. & Kiefer F. (2009) Avoidance of alcohol-related stimuli increases during the early stage of abstinence in alcohol-dependent patients. *Alcohol & Alcoholism* **44**, 458–63.

Wechsler D. (1999) *Wechsler Abbreviated Intelligence Scale*. Psychological Corporation, San Antonio, Texas.

Wiers R. W., Gladwin T. E., Hofman W., Salemink E. & Ridderinkhof K. R. (2013) Cognitive bias modification and cognitive control training in addiction and related psychopathology: mechanisms, clinical perspectives, and ways forward. *Clinical Psychological Science* **1**, 192–212.

Wiers R. W. & Stacy A. W. (2006) Implicit cognition and addiction. *Current Directions in Psychological Science* **15**, 292–96.

Accepted 7 October 2015