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The Usefulness of Implicit Measures for the Screening, Assessment and Treatment of Problematic Alcohol Use in Individuals with Mild to Borderline Intellectual Disability

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Abstract Although the neuropsychological underpinnings of problematic alcohol use have been studied extensively, this research has not yet been generalised to individuals with mild to borderline intellectual disability (MBID). In this paper, we present the main findings of a research project aimed at studying the deficiencies in information processing associated with problematic alcohol use in problematic drinkers with and without MBID. The objectives were to develop and test indirect measures of cognitive biases and executive dysfunctioning of problematic drinkers with MBID and studying the extent and nature of the influence of IQ and executive control on these deficiencies. In addition to extending the fundamental knowledge about problematic alcohol use, the research findings provide practical implications that can be translated into the screening, assessment and treatment of problematic drinkers—both with and without MBID. Based on our results, we discourage the use of indirect, reaction time-based measures for cognitive biases for clinical purposes. The word association task, on the other hand, provides better opportunities, for example as a way to identify high-risk situations for alcohol use. With regard to

cognitive and executive functioning, we advise practitioners to conduct a thorough assessment in an early phase of the treatment but withhold from incorporating neurocognitive treatment protocols in the treatment of problematic alcohol use.

Keywords Problematic alcohol use · Implicit measures · Intellectual disability · Practical implications

Introduction

There is a growing body of research on (problematic) substance use among individuals with mild to borderline intellectual disability (MBID; IQ 50–85, American Psychiatric Association [APA] 2013). In fact, they have been identified as a risk group for more severe negative consequences of substance use (Slayter 2008) and for developing problematic substance use or substance use disorder (Burgard et al. 2000; McGillicuddy 2006). Despite this increasing attention, however, the current knowledge on problematic substance use in individuals with MBID is still scarce, and screening, assessment and treatment tools adapted to this population are lacking. In addition, professionals in both intellectual disability services (ID services) and addiction medicine often report having insufficient knowledge and skills to adequately care for individuals with MBID who (ab)use substances. As a result, individuals with MBID often do not receive the required specialised care and do not always profit from treatment (e.g. Burgard et al. 2000; Degenhardt 2000). Thus, there is a need for more research to improve the care and treatment of individuals with MBID who have problematic substance use (Carroll Chapman and Wu 2012; Van Duijvenbode et al. 2015; Kerr et al. 2013).

We have addressed this need by studying the neuropsychological underpinnings of problematic substance use.

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Problematic substance use has been associated with disruptions in the motivational, reward and inhibitory control processes and subsequent deficiencies in information processing (Koob 2013; Hyman et al. 2006; Nestler 2005). For example, as a result of adaptations in the motivational and reward systems, the rewarding effects of substances and related stimuli acquire ‘incentive salience’. This means that these stimuli seem attractive, ‘grab attention’ and elicit approach behaviour (Robinson and Berridge 2008). These disruptions have been called cognitive biases. Several cognitive biases have been identified, including biases in attention, action tendencies and memory associations. Problematic substance use has also been related to a disrupted inhibitory control system, which is reflected in executive dysfunctioning (i.e. a smaller working memory capacity, difficulty in delaying gratification and less behavioural control; Hyman et al. 2006). Together, these disruptions indicate a growing loss of control over substance use in the development of problematic substance use and substance use disorder (Koob 2013).

Studying the neuropsychological underpinnings of problematic substance use may have important practical implications for screening, assessment and treatment (Stacy and Wiers 2010; Yücel and Lubman 2007). First, measures of cognitive biases are thought to be useful for screening and assessment purposes. For example, as cognitive biases appear to reduce as a consequence of treatment, the strength of the biases at the start of the treatment may serve as a predictor of treatment outcome while the reduction in strength at post-treatment may have utility as an assessment tool for treatment outcome. Second, recent research also suggests that directly influencing the strength of the cognitive biases in so-called cognitive bias modification procedures may provide an additional aspect of the treatment of problematic substance use. Third, the diagnostic and treatment process could also target the motivation and ability to control the implicit processes, for example by training executive control. Research has suggested that working memory training is feasible and effective for use in individuals with MBID (e.g. Van der Molen et al. 2010). As measures of both cognitive biases as well as executive control often do not rely on verbal capacity, are less susceptible to social desirability and are generally easy to complete, they might be especially useful in the care for problematic drinkers with MBID.

Method

The overall aim of our research project was to study the deficiencies in information processing associated with problematic alcohol use in problematic drinkers with and without MBID. We thereby focused on (problematic) alcohol use, because alcohol has been found to be the main substance used and misused by individuals with MBID (To et al. 2014). The objectives of our research project were to (1) develop and test indirect measures of

cognitive biases and executive dysfunction for problematic drinkers and (2) study the extent and nature of the influence of IQ and executive control on these deficiencies by comparing individuals with and without MBID.

To meet the aims and objectives, ten cross-sectional studies were conducted. In all our studies, participants were divided into four groups based on full-scale IQ (as measured with the Wechsler Adults Intelligence Scale third edition [WAIS-III], Uterwijk 2000) and severity of alcohol use-related problems (as measured with the Alcohol Use Disorder Identification Test [AUDIT], Babor et al. 2001; Dutch translation: Schippers and Broekman 2010): light and problematic drinkers with and without MBID. Participants were recruited from organisations within ID care and addiction medicine and via advertisements on social media, the Radboud University and word of mouth. The characteristics of the studies included in this project are summarised in Table 1.

The first part of the research project consisted of four studies focussing on the existence of cognitive biases in attention and approach tendencies in problematic drinkers. We have studied the cognitive biases with implicit measures, which provide indirect measures of attention and approach tendencies derived from reaction times (RT). Such measures are thought to tap into automatic cognitive processes (Wilson et al. 2000) and are thought to reduce self-representation influences or social desirability (Greenwald et al. 2002; Stacy and Wiers 2010). The second part of the research project consisted of two studies on the interpretation bias or the tendency for problematic drinkers to interpret ambiguous, alcohol-relevant words, phrases and scenarios in an alcohol-related way. The interpretation bias is often studied using word association tasks, in which participants are asked to generate their first, spontaneous response when hearing an ambiguous, alcohol-relevant word, sentence or scenario (such as ‘draft’ or ‘pitcher’). Although participants are asked about automatic associations and interpretations, they can assert control over their responses (Ranganath et al. 2008). The third part of the research project consisted of four studies focussing on the executive and cognitive functioning of problematic drinkers. Executive functioning was studied using computerised versions of executive functioning tests, which have become increasingly popular over the past decade (Josman et al. 2008). Cognitive functioning was studied with a standardised intelligence test.

Results

Cognitive Biases

To study cognitive biases in problematic drinkers, we first created a large database of pictures of alcoholic and non-alcoholic beverages that are sufficiently familiar and simple to study automatic processing (study 1; Van

Table 1 Characteristics of the studies included in this research project

Study	Sample	Age (years)	Setting	Main method	Main results
1. Van Duijvenbode et al. 2012a	40 long-term abstinent light and problematic drinkers with and without MBID	22–59	Forensic psychiatric centre	Pilot study; survey	- Database of 255 pictures of alcoholic and non-alcoholic beverages - No differences between light and problematic drinkers on attractiveness, complexity, familiarity and valence of pictures (p s .08–.77) - Measures are feasible for individuals with MBID - No attentional bias (p s .21–.87), approach bias ($p = .43$) or evaluation bias ($p = .95$) in problematic drinkers - IQ was not related to the strength of the cognitive biases - No attentional bias ($p = .26$) or approach bias ($p = .64$) in problematic drinkers ($p = .26$) - IQ was not related to the strength of the cognitive biases - All results maintained after controlling for craving - No attentional bias in problematic drinkers based on eye tracking data (p s .08–.80) or reaction time data ($p = .56$) - IQ was not related to the strength of the attentional bias - All results maintained after controlling for craving - Stronger interpretation bias in problematic drinkers compared to light drinkers ($p < .001$) - Particularly strong bias for negative scenarios compared to positive scenarios - IQ predicted total bias score ($\beta = -.02$; $p = .02$) and bias score for negative scenarios ($\beta = -.02$; $p < .001$), but not for positive scenarios ($\beta = .00$; $p = .925$)
2. Van Duijvenbode et al. 2012b	57 long-term abstinent light and problematic drinkers with and without MBID	22–62	Forensic psychiatric centre	Pilot study; implicit measures	- Measures are feasible for individuals with MBID - Working memory was smaller in individuals with MBID compared to individuals without MBID ($p = .003$), but not inhibitory control (p s .47–.76) and delay discounting (p s .03–.65) - Light and problematic drinkers did not differ on any of the parameters (p s .24–.99)
3. Van Duijvenbode et al. 2016a	130 current light and problematic drinkers with and without MBID	18–61	ID care; addiction medicine; control	Implicit measures	- No attentional bias ($p = .70$) or executive dysfunctioning (p s $> .05$) - Individuals with MBID showed a smaller working memory capacity ($p < .001$) and inhibitory control ($p = .01$) compared to individuals without MBID
4. Van Duijvenbode et al. 2016c	133 current light and problematic drinkers with and without MBID	18–65	ID care; addiction medicine; control	Implicit measures	- No attentional bias in problematic drinkers based on eye tracking data (p s .08–.80) or reaction time data ($p = .56$) - IQ was not related to the strength of the attentional bias - All results maintained after controlling for craving - Stronger interpretation bias in problematic drinkers compared to light drinkers ($p < .001$) - Particularly strong bias for negative scenarios compared to positive scenarios - IQ predicted total bias score ($\beta = -.02$; $p = .02$) and bias score for negative scenarios ($\beta = -.02$; $p < .001$), but not for positive scenarios ($\beta = .00$; $p = .925$)
5. Van Duijvenbode et al. 2016e	230 current light and problematic drinkers with and without MBID	18–61	ID care; addiction medicine; control	Implicit measures	- Stronger interpretation bias in problematic drinkers compared to light drinkers ($p < .001$) - Particularly strong bias for negative scenarios compared to positive scenarios - IQ predicted total bias score ($\beta = -.02$; $p = .02$) and bias score for negative scenarios ($\beta = -.02$; $p < .001$), but not for positive scenarios ($\beta = .00$; $p = .925$)
6. Van Duijvenbode, Didden et al. 2016d	178 current light and problematic drinkers with and without MBID	18–68	ID care; addiction medicine; control	Implicit measures; survey	- Stronger interpretation bias in problematic drinkers compared to light drinkers ($p < .001$) - Problematic drinkers with MBID showed a particularly strong interpretation bias - Social drinking motives predicted the bias score for positive scenarios ($\beta = .22$; $p = .002$), social motives ($\beta = .18$; $p = .03$) and coping motives ($\beta = .38$; $p < .001$) predicted the bias score for negative scenarios - Measures are feasible for individuals with MBID - Working memory was smaller in individuals with MBID compared to individuals without MBID ($p = .003$), but not inhibitory control (p s .47–.76) and delay discounting (p s .03–.65) - Light and problematic drinkers did not differ on any of the parameters (p s .24–.99)
7. Van Duijvenbode et al. 2013	40 long-term abstinent light and problematic drinkers with and without MBID	21–63	ID care; addiction medicine; control	Pilot study; executive control tasks	- No attentional bias ($p = .70$) or executive dysfunctioning (p s $> .05$) - Individuals with MBID showed a smaller working memory capacity ($p < .001$) and inhibitory control ($p = .01$) compared to individuals without MBID
8. Van Duijvenbode et al. 2016f	112 current light and problematic drinkers with and without MBID	18–60	ID care; addiction medicine; control	Implicit measures; executive control tasks	- No attentional bias in problematic drinkers based on eye tracking data (p s .08–.80) or reaction time data ($p = .56$) - IQ was not related to the strength of the attentional bias - All results maintained after controlling for craving - Stronger interpretation bias in problematic drinkers compared to light drinkers ($p < .001$) - Particularly strong bias for negative scenarios compared to positive scenarios - IQ predicted total bias score ($\beta = -.02$; $p = .02$) and bias score for negative scenarios ($\beta = -.02$; $p < .001$), but not for positive scenarios ($\beta = .00$; $p = .925$)

Table 1 (continued)

Study	Sample	Age (years)	Setting	Main method	Main results
9. Van Duijvenbode et al. 2016g	117 participants with MBID	20–68	Forensic psychiatric centre ; ID care	IQ test	<ul style="list-style-type: none"> - Executive control and readiness to change did not moderate the relationship between severity of alcohol use-related problems and the strength of the attentional bias - The short form correlated strongly with the full WAIS-III ($r = .92$), and its reliability was excellent ($r = .96$) - The short form correctly identified ID in 97.4% of the cases and the predictive power was high ($>.80$) - The short form overestimated full scale IQ by 2 points in comparison to the full WAIS-III
10. Van Duijvenbode et al. 2016b	474 light and problematic drinkers with MBID	18–68	ID care; addiction medicine; control	IQ test	<ul style="list-style-type: none"> - Severity of alcohol use-related problems correlated weakly with performance IQ ($r = -.14, p = .003$), but not with verbal IQ ($r = -.01, p = .93$) - Problematic drinkers without MBID had a lower performance IQ than light drinkers without MBID, while there were no differences between light and problematic drinkers with MBID

MBID mild to borderline intellectual disability

Duijvenbode et al. 2012a). We then adapted two widely used computer tasks (the visual dot probe task [VDP], MacLeod et al. 1986; approach avoidance task [AAT], Rinck and Becker 2007) to the needs of individuals with MBID by increasing the number of practice trials, minimising the number of critical trials and building in frequent breaks in between the different blocks of the tasks (study 2; Van Duijvenbode et al. 2012b). Figure 1 shows a schematic overview of both tasks. In this pilot study, it was concluded that—with the adaptations in the task characteristics—the VDP and AAT are feasible in individuals with MBID.

Using these tasks, we then conducted two studies in current drinkers to study the existence of cognitive biases. Unexpectedly, we found no evidence for an attentional or approach bias in problematic drinkers. Problematic drinkers neither responded faster than light drinkers to pictures of alcoholic beverages nor were they more likely than light drinkers to direct their attention towards pictures of alcoholic beverages or look at these pictures longer than do light drinkers (also see Hobson et al. 2013; Vollstädt-Klein et al. 2009). Noteworthy is the large variation in bias scores in problematic drinkers we found in our study, of whom some showed biases towards alcohol and others biases away from alcohol (studies 3 and 4; Van Duijvenbode et al. 2016a; Van Duijvenbode et al. 2016c). Estimated full-scale IQ was not associated with the strength of the attentional or approach bias, suggesting that the automatic, implicit processing of visual stimuli is similar between individuals with and without MBID.

Interpretation Bias

We did find evidence for an interpretation bias in the same sample of problematic drinkers (study 5; Van Duijvenbode et al. 2016e). We studied the interpretation bias using a word association task in which participants were asked to finish ambiguous scenarios with their first, spontaneous response (see Table 2 for an example of the scenarios we used; Woud et al. 2012). Problematic drinkers were more likely to interpret these scenarios in an alcohol-related way. This is in line with a large body of research, which has consistently found an interpretation bias in problematic drinkers (e.g. Ames et al. 2005; Krank et al. 2010; Woud et al. 2012, 2014). Estimated full-scale IQ was related to the strength of the interpretation bias, with a relatively strong bias in individuals with MBID. These results remained when controlling for (estimated) verbal IQ, suggesting that verbal capacity did not play a role in the assessment of the interpretation bias.

These results were replicated in our second study on this topic, in which we studied the relationship between the interpretation bias and drinking motives (Study 6; Van Duijvenbode et al. 2016d). The activation of the interpretation bias seemed to depend on individual differences in

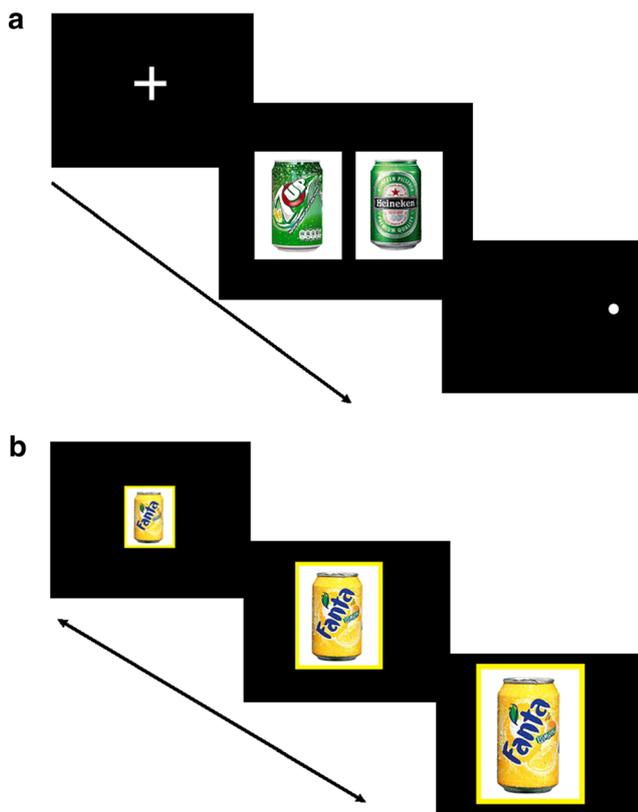


Fig. 1 Schematic overview of **a** the visual dot probe task (VDP; MacLeod et al. 1986) and **b** the approach avoidance task (AAT; Rinck and Becker 2007)

individuals' motivational schema, as we found that drinking motives could predict the strength of the interpretation bias (also see Saleminck and Wiers 2014; Woud et al. 2015a). More specifically, individuals who drink alcohol to facilitate or improve social relationships or enhance enjoyment in social situations (social drinking motives) tended to interpret positive scenarios such as a fun evening with friends or a party with alcohol use. Both individuals who drink alcohol for social motives as well as those who drink for coping reasons, on the other hand, tended to interpret negative scenarios (having a bad day, feeling stressed) with alcohol use. This implies that

the interpretation bias is not *always* present but instead may be triggered by certain internal and external contextual cues.

Executive and Cognitive Dysfunctioning

To study executive and cognitive functioning in problematic drinkers, we first piloted several measures for executive functioning (i.e. Corsi block tapping task, Self-ordered pointing task, Go/No-go task, Stop signal task; Study 7; Van Duijvenbode et al. 2013). Only the Go/No-go task (Newman and Kosson 1986) and Corsi block tapping task (Corsi 1972) remained in our later study to measure executive functioning (inhibitory control and working memory capacity) due to difficulties participants with MBID experienced in conducting the other two tasks. Figure 2 shows a schematic overview of the two tasks. Cognitive functioning was measured using the WAIS-III (Uterwijk 2000). If IQ scores were unknown, cognitive functioning was estimated with a short form of the WAIS-III, which seemed to provide a reliable and valid estimate of IQ in individuals with MBID (study 9; Van Duijvenbode et al. 2016g).

Using these tasks, we explored executive and cognitive functioning in current drinkers. Overall, we found that individuals with MBID had a smaller working memory capacity and also show a weaker inhibitory control compared to individuals without MBID. This means they have more difficulty controlling their behaviour and are more likely to act on impulses (Diamond 2013). More surprisingly, however, is that we found no executive dysfunctioning in problematic drinkers. Problematic drinkers did not have a smaller working memory capacity and did not show less inhibitory control than light drinkers (study 8; Van Duijvenbode et al. 2016f). Although this contradicts previous research, some other studies have also failed to find evidence for executive dysfunctioning in problematic drinkers (e.g. Ellingson et al. 2014; Fernie et al. 2010). With regard to cognitive functioning, we also found no differences between light and problematic drinkers in (estimated) verbal IQ, suggesting that verbal reasoning and vocabulary are relatively intact (also see Bijl et al. 2005). Problematic

Table 2 Examples of the positive, negative and neutral scenarios used (Woud et al. 2012) and possible answers given by participants, derived from Van Duijvenbode et al. (2016e)

	Scenario	Possible answers
Positive scenario	<i>Movie night</i> Movie night at your friends house. "One more?", one of your friends asks. You cannot resist temptation and reach for a ...	New film (alcohol-unrelated) Your glass (ambiguous) Beer (alcohol-related)
Negative scenario	<i>Bad day</i> It is a horrible day and nothing works. You want to lose this bad feeling and treat yourself. You get a strong craving for ...	Chocolate (alcohol-unrelated) A drink (ambiguous) Alcohol (alcohol-related)
Neutral scenario	<i>Poker</i> You play poker with your friends every other week. Everything is ready and the cards have been dealt. This time, your cards are very ...	Good (alcohol-unrelated) Bad (alcohol-unrelated) Difficult to win with (alcohol-unrelated)

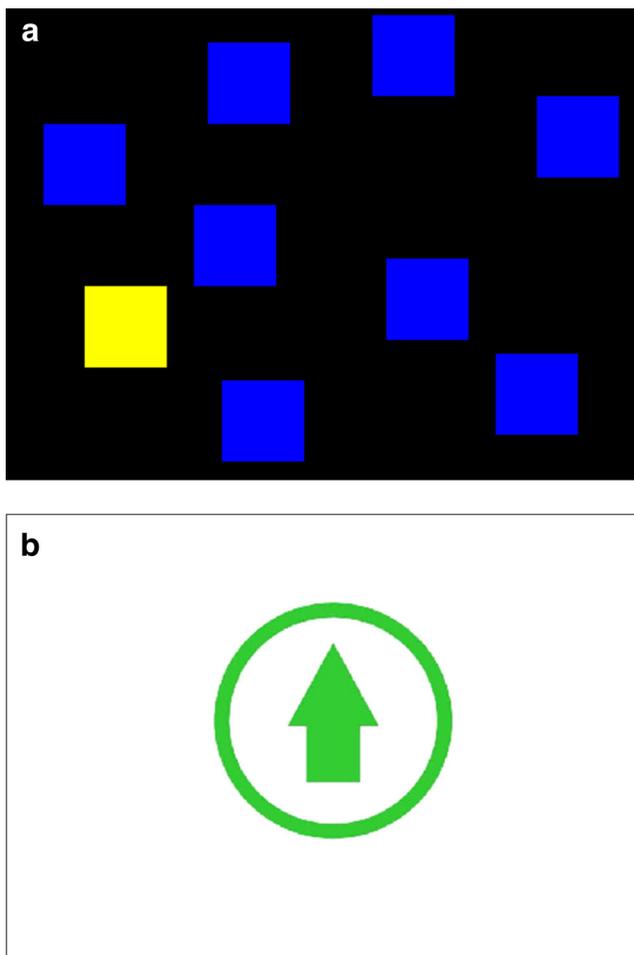


Fig. 2 An overview of the executive control tasks. **a** the Corsi block tapping task (Corsi 1972). The yellow block symbolises the current block in the sequence. An example of a go trial on the Go/No-go task (Newman and Kosson 1986) is shown in **b**. Participants were instructed to press a space bar as quickly as possible on go trials and withhold from responding on the no-go trials

drinkers without MBID, however, did show a significantly lower (estimated) performance IQ compared to light drinkers without MBID. This indicates possible impairments in processing speed, problem solving abilities and cognitive and behavioural flexibility in problematic drinkers without MBID. However, problematic drinkers with MBID were not found to have a lower (estimated) performance IQ compared to light drinkers (Study 10; Van Duijvenbode et al. 2016b). Although executive and cognitive functioning were impaired among participants with MBID, we found no additive effects of MBID and problematic alcohol use.

Discussion

In sum, we have reached our objective to develop and test measures of cognitive biases and executive dysfunctioning in problematic drinkers. Participants with MBID understood

the instructions and were able to conduct the tasks—although the reliability of the RT-based tasks for cognitive biases were a concern. Our results regarding the second objective—to study the extent and nature of the influence of IQ and executive control on the cognitive biases by comparing individuals with and without MBID—were mixed and remained inconclusive. Although we did not find attentional or approach biases in problematic drinkers, we did find an interpretation bias in the same sample. Similarly, though we found no executive dysfunctioning in problematic drinkers, aspects of cognitive functioning did seem impaired. While IQ was not related to the strength or manifestation of the attentional and approach bias, it seemed to relate to the strength of the interpretation bias. Although executive and cognitive functioning were impaired among both light and problematic drinkers with MBID, we found no additive effects of problematic alcohol use and MBID on executive or cognitive functioning.

We offer two explanations for our results. First, it is possible that the degree in which neuropsychological functions are affected by substance use varies across individuals. In other words, the strength of the cognitive biases and the degree of executive/cognitive dysfunctioning in problematic drinkers could be influenced by personal and contextual factors. This explanation is supported by our data on the attentional and approach biases, which suggested a large variation in the strength of the biases. Indeed, factors such as current levels of craving (Field et al. 2009), poly-substance use (Marks et al. 2015), co-morbid psychiatric disorders and the use of psychotropic medication (Sinclair et al. 2010) and being in treatment (Field et al. 2014) have been found to influence the strength of the cognitive biases as well as the effects of problematic alcohol use on the brain in individuals without MBID (Petrakis et al. 2002; Parsons 1998). Although co-morbidity between psychiatric disorders, subsequent use of prescribed psychotropic medication and problematic substance use reflects the complex nature of the target group (Center for Substance Abuse Treatment 2007), a possible influence of these co-morbid disorders on the cognitive biases and executive and cognitive functioning cannot be ruled out. The complexity and heterogeneity of our samples thus forms both a strength (representative sample, reflecting the complex and diverse nature of the target group) as well as a weakness of our studies, as the diversity of the participants in, for example combinations of used substances, type and degree of psychiatric co-morbidity, and the type of medication described made it difficult to disentangle the precise mechanisms in which these factors influenced our results.

A second explanation for our results concerns the psychometric qualities of the measures we used. In line with results of Ataya et al. (2012), Field and Christiansen (2012), Kersbergen et al. (2015) and Schmukle (2005), we found the internal consistency of the bias scores to be poor. Cronbach's alpha and the mean inter-item correlation were unacceptably low,

suggesting poor item homogeneity and construct validity. This could explain why we found an interpretation bias in problematic drinkers, but no attentional or approach biases in the same group of participants. In individuals with MBID, the use of RT-based measures was complicated further by a large trial-to-trial, intra-individual variability in RT. Individuals with MBID not only showed a slower overall RT, but their RT also fluctuated within the tasks (see also Hunt 2005; Jensen 2006). This has been associated with a difficulty of individuals with MBID to maintain an optimal level of performance (Baumeister and Kellas 1968), for example due to momentary fluctuations in attention or deficiencies in executive functioning such as working memory or information processing speed (Haishi et al. 2011; Schmiedek et al. 2007). What the implications of this intra-individual variability are on the reliability and validity of RT-based measures remains unclear and should be studied further.

Our results provide practical implications that can be translated into the screening, assessment and treatment of problematic drinkers. First, the large variability in the strength of the attentional and approach bias suggests that there are problematic drinkers (and light drinkers) who *do* show cognitive biases. We advise practitioners to be aware of the possibility of cognitive biases in the information processing of problematic drinkers in their perception and conceptualisation of problematic alcohol use and discuss the potential existence of cognitive biases with clients and/or other caregivers as a component of educating clients about problematic alcohol use (Field et al. 2014).

Second, the large variability in the strength of the attentional and approach bias also suggests that there are problematic drinkers who *do not* show cognitive biases. Also taking into consideration the problematic psychometric qualities of the measures we have used, we discourage the use of RT-based measures for clinical purposes such as the screening, assessment and treatment of problematic alcohol. After all, establishing the strength of the cognitive biases at a group level has proven to be difficult given the reliability of the measures, let alone the strength of the cognitive biases at an individual level. We therefore discourage the use of these measures to screen for or assess the severity of alcohol use-related problems and do not recommend implementing cognitive bias modification procedures aimed at reducing the cognitive biases (also see critique on these procedures by Christiansen et al. 2015; and Field et al. 2014; and a recent meta-analysis by Cristea et al. 2016 on the ineffectiveness of cognitive bias modification procedures). The clinical relevance of the (less implicit) word association tasks, on the other hand, looks more promising. For example, these tasks could be incorporated into treatment and relapse prevention interventions as a way to identify high-risk situations for alcohol use or relapse (Woud et al. 2012). In addition, preliminary evidence in problematic drinkers without MBID shows that the interpretation bias can

be trained in interpretation retraining procedures, although the effectiveness of such a training in reducing the strength of the interpretation bias and subsequent alcohol use was limited (Woud et al. 2015b).

Third, considering the cognitive dysfunctioning in problematic drinkers without MBID, we advise practitioners to consider neurocognitive *assessment* of cognitive and executive functioning in an early phase of the diagnostic and treatment procedure (also see Bates et al. 2013; Schulte et al. 2014). Identifying executive/cognitive deficiencies improves treatment outcome and success (Copersino et al. 2009) because it allows those with executive/cognitive deficiencies to be entered into treatment interventions more tailored to their needs (McLaughlin et al. 2007). For example, it has been suggested that cognitive dysfunctioning often associated with MBID (e.g. attentional dysfunctioning, impaired organisational and planning skills and impaired self-monitoring) hamper the usefulness of treatment programmes based on cognitive and behavioural change (Allan et al. 2012). Identifying such factors in an early phase of the treatment thus guides practitioners in their choices for treatment interventions. In the assessment of executive/cognitive functioning, we would recommend to cover a broad range of executive/cognitive functions, because both our (i.e. lower performance but not verbal IQ in problematic drinkers) and other research (e.g. Parsons 1998) suggests that cognitive and executive deficits vary across participants and represent a diffuse pattern of neuropsychological alterations in the brain. Broad spectrum measures such as intelligence tests or standardised test batteries for executive functioning thus seem especially useful for the purpose of neurocognitive assessment.

Fourth and last, taking into account that we found limited and mixed results regarding executive/cognitive dysfunctioning in problematic drinkers, implementing neurocognitive *treatment protocols* aimed at improving executive/cognitive functioning might not be useful in the treatment of problematic alcohol use at this stage. However, as we did find working memory capacity and inhibitory control to be impaired among individuals with MBID—regardless of the severity of alcohol use-related problems—they could benefit from training procedures aimed at improving executive functioning (also see Van der Molen et al. 2010). In addition, deficiencies in executive/cognitive functioning should be taken into account in the planning and course of the treatment for this group (see Cunha and Novaes 2004). For example, concentrating on the long-term positive consequences of cessation might not be effective in individuals with a low working memory capacity and weak inhibitory control, as these treatment goals will be overruled easily when confronted with the positive, short-term consequences of alcohol use (Diamond 2013). Processing speed could also be taken into account in the planning and course of the treatment, for example by slowing down the pace in treatment protocols,

increasing the number of treatment sessions and repeating the same information multiple times to ensure optimal understanding by the client. Our research thus underscores previous findings suggesting that treatment interventions for individuals with MBID must be tailored to their needs (e.g. Degenhardt 2000; Kerr et al. 2013).

To conclude, our studies show that problematic alcohol use—in both individuals with and without MBID—is a complex disorder that is likely to be associated with several neuropsychological disruptions. Although we found many similarities between problematic drinkers with and without MBID, we also found some differences between the two groups (i.e. stronger interpretation bias in participants with MBID, no executive and cognitive dysfunctioning in problematic drinkers with MBID), suggesting that problematic drinkers with MBID do in fact form a specific group that should be distinguished from problematic drinkers without MBID. This indicates that problematic alcohol use requires specialised treatment from multidisciplinary teams with sufficient knowledge of both problematic alcohol use and MBID. To achieve this, a close collaboration and cross-fertilisation between addiction medicine and ID service providers is vital.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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