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Reducing alcohol-related interpretive bias in negative affect situations: Using a scenario-based Cognitive Bias Modification training paradigm

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HIGHLIGHTS

- A novel computerized training was designed to reduce alcohol-related interpretations bias in negative affective situations.
- Training, compared to a sham condition, resulted in weaker alcohol-related interpretive bias in negative affect situations.
- These effects were not moderated by the strength of coping motives and no effects on drinking behavior were observed.

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ABSTRACT

Problematic alcohol use is associated with drinking alcohol to reduce negative mood states (negative reinforcement motive). Further, heavy drinking individuals tend to interpret ambiguous situations as alcohol-related (interpretive bias). The current experimental study aimed to examine the role of alcohol-related interpretive biases in negative-affect drinking. It was hypothesized that a single-session Cognitive Bias Modification of Interpretation (CBM-I) training condition (compared to a sham condition) would lead to less alcohol-related interpretations of negative affect situations, and less alcohol consumption while being in a negative mood state. The most pronounced effects were expected in individuals who drink alcohol to cope with anxiety. Moderate to heavy drinking university students ($N = 134$) were randomly assigned to a CBM-I or a sham condition. Interpretations were assessed during and after the training session. Drinking was assessed in a lab-based drink test and one week later using a self-report measure. With respect to alcohol-related interpretative bias, this bias was weaker in the CBM-I compared to the sham condition during the training session. This effect was not moderated by coping-anxiety motives, and did not generalize to another interpretation measure. No training effects were found on drinking behavior in the lab or on self-reported daily-level use. In sum, the CBM-I training condition was associated with lower alcohol-related interpretive bias scores during training. Generalization to another interpretation measure or to drinking behavior was not observed. Future research could explore providing multiple training sessions in order to strengthen the effects of the CBM-I training.

1. Introduction

Problematic alcohol use, as compared to occasional alcohol use, is associated with specific motives for drinking, especially negative reinforcement drinking (drinking alcohol to reduce a negative mood state) (Koob & Volkow, 2010). The literature on drinking motives postulates that individuals drink alcohol in order to attain certain affective changes (Cox & Klinger, 1988). Four types of drinking motives have been identified, i.e., social, enhancement, conformity, and coping motives (Cooper, 1994). Various studies showed that these motives are related to levels of alcohol consumption, in samples of adolescents (Kuntsche, Knibbe, Gmel, & Engels, 2006) and a large sample of undergraduates from 10 different countries ($n = 8468$; Couture et al., 2017; Mackinnon, Couture, Cooper, Kuntsche, O'Connor, Stewart, & DRINC team, 2017). Further, drinking motives have been shown to be proximal mechanisms mediating the effects of expectancies on various alcohol outcomes (Kuntsche, Wiers, Janssen, & Gmel, 2010) and the effects of personality on problematic drinking (Adams, Kaiser, Lynam, Charnigo, & Milich, 2012). Adolescents and young adults mainly report to drink for positive reinforcement motives (i.e., social and

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enhancement, Kuntsche, Knibbe, Gmel, & Engels, 2005; Mackinnon et al., 2017). But note that while coping motives are endorsed less frequently as key reasons for drinking in college students, they are the only drinking motive that predicts unique variance in alcohol-related problems after controlling for alcohol consumption (Cooper, 1994; Kuntsche et al., 2005). For example, using a longitudinal design, Merrill, Wardell, and Read (2014) found that coping motives predicted a wide range of negative consequences including poor self-care, academic/occupational problems, and physiological dependence in college students.

Cognitive models argue that a second factor that is important in understanding problematic drinking is automatically activated (or implicit) biases in information processing (Wiers et al., 2007). Indeed, meta-analyses revealed that implicit processes are reliably related to alcohol use and add unique predictive power to the prediction of drinking, above and beyond measures of explicit processes (e.g., self-report questionnaires assessing alcohol outcome expectancies or self-generation; Reich, Below, & Goldman, 2010; Rooke, Hine, & Thorsteinsson, 2008). Alcohol-related interpretive biases belong to the group of alcohol-related implicit processes and reflect the tendency to interpret ambiguous, potentially alcohol-relevant information in an alcohol-related (rather than neutral) way. Association paradigms are commonly used to assess alcohol-related interpretations. Using this paradigm, an ambiguous word (e.g., 'draft') would be presented, and participants are asked to write down the first word that comes into their mind. Studies have consistently shown that drinking is associated with generating more alcohol-related (e.g., 'beer') than neutral (e.g., 'baseball') words, and that word association tasks are better predictors of future alcohol use than self-report questionnaires (i.e., self-generated alcohol expectancies) (Stacy, 1997; Stacy, Ames, & Grenard, 2006). Other studies have presented outcomes of drinking as ambiguous words or short phrases (e.g., 'celebrating house mate's birthday') and participants rate how well an alcohol-related and an alcohol unrelated interpretation fit with the original ambiguous sentence (Woud, Becker, Rinck, & Salemink, 2015). Using this approach with positive and negative drinking outcomes presented in short phrases, recent studies showed that interpretive biases in negative affect situations are specifically related to coping (and not enhancement) motives (Salemink & Wiers, 2014), and predict drinking prospectively (Woud, Becker et al., 2015).

Training procedures have been developed that aim to change implicit processing biases (Cognitive Bias Modification or CBM, MacLeod, 2012), including interpretation biases. While training paradigms have developed and tested for some alcohol-related biases (e.g., alcohol-approach and alcohol attentional biases; for an overview, see Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013), alcohol-related interpretive bias training, however, has received less attention. This is surprising as interpretive bias training has a long tradition with other forms of psychopathology (e.g., anxiety, see Mathews & Mackintosh, 2000; Salemink, Van den Hout, & Kindt, 2009, 2010), and meta-analyses revealed higher effect sizes for CBM targeting interpretive bias than attentional bias (Cristea, Kok, & Cuijpers, 2015; Hallion & Ruscio, 2011).

Two recent studies sought to modify alcohol-related interpretive bias (CBM-I training) and test its role in drinking (Hutschemaekers, Woud, Becker, & Rinck, 2016; Woud, Hutschemaekers, Rinck, & Becker, 2015). Both studies applied a single-session CBM-I training where participants received brief scenarios describing typical student life situations with a clear positive social context (e.g., being with friends, joining a party). Participants were trained to interpret the situation as non-alcohol related. Results are mixed. In Hutschemaekers et al., the CBM-I training did not result in a reduction of alcohol-related interpretations, while in Woud, Hutschemaekers et al., only the condition to increase alcohol-interpretations was successful. Regarding effects on drinking behavior, Woud, Hutschemaekers et al. observed no training effects on actual drinking in a beer drink test in the lab, and both studies observed no effects on self-reported drinking in daily life.

Several reasons may account for the mixed findings. First, in both studies, the training contained exclusively positive social situations and positive affect, which is consistent with the general aim of understanding the role of interpretation biases in drinking. However, if we want to increase our understanding of more problematic drinking, then limiting training to positive social situations and affect may be sub-optimal, as problematic drinking is more directly associated with coping drinking motives (Cooper, 1994), and thus with negative affect situations. Second, while Woud, Hutschemaekers et al. (2015) training concerned positive contexts, actual drinking behavior was assessed in the lab at the university, ostensibly a more neutral context. Thus, there was likely a mismatch in valence between the training and the lab-based drinking outcome measure, which could have hampered transfer of the training (Foa & Kozak, 1986). Third, self-reported daily-level alcohol use was not linked to participants' emotional state prior to drinking. As a result, it is unclear whether the drinking outcome reflects drinking in positive or negative emotional contexts (or some mixture), and whether there was a match between the emotional valence in the training and real-life drinking situations. Matching the emotional state prior to and during actual drinking with the emotional state described in the CBM-I scenarios should, therefore, facilitate the impact of the newly trained bias on emotional drinking. As such, in order to increase our understanding of problematic drinking and the role of alcohol-related interpretations, crucial next steps are to (1) train individual to make non-alcohol-related interpretations in negative affect situations, and (2) test the effects of that training on negative affect drinking.

The central aims of the current study are training *and* testing the effects of CBM-I on drinking behavior in negative affective situations. Therefore, a novel scenario-based CBM-I training was developed that specifically targets alcohol-related interpretation bias in negative affect situations. The scenario paradigm was used (Mathews & Mackintosh, 2000), as it is a well-established method with high ecological validity and realism (Menne-Lothmann et al., 2014). Further, it provides the possibility to capture the complex relationship between affect and drinking (i.e., association tasks that rely on single words are sub-optimal, Wiers, Houben, Smulders, Conrod, & Jones, 2006).

It was hypothesized that a single-session of CBM-I training, compared to a sham training, would lead to less alcohol-related interpretative bias, especially in coping-motived individuals. It was also hypothesized that the CBM-I (compared to the sham) training would result in less negative affect drinking, especially in coping-drinkers. Negative affect drinking was assessed in the lab where a negative mood induction was combined with a taste test (Field & Eastwood, 2005), and self-reported daily-level alcohol use and mood state was assessed online one week after the lab session.

2. Method

2.1. Participants

Students from the University of Amsterdam completed the Alcohol Use Disorders Identification Test (AUDIT, Saunders, Aasland, Babor, De La Fuente, & Grant, 1993) during a mass screening; individuals with an AUDIT score of 6 or higher (Reinert & Allen, 2007) were invited to participate. Participants were informed at the time of recruitment that the experiment involved the tasting of an alcoholic beverage (i.e., beer). In total 164 students participated, however 30 students scored below our AUDIT cut-off during the lab session and one participant failed to provide follow-up data on time, resulting in a final sample of N = 133 (28 males, mean age = 22.3, SD = 4.8, Table 2). All participants provided written informed consent, and the study was approved by the Ethics Review Board of the University of Amsterdam. Participants received course credit or 10 euros for participation.

Table 1
Examples and number of trials per stimulus category for the CBM-I training and sham condition.

	Example		CBM-I training condition	Sham condition
Negative affect scenario (n = 80)	I am worrying about the presentation I gave. To relax, I'll take a ___	Non-alcohol word fragment (n-p; nap)	n = 72 (90%)	n = 40 (50%)
		Alcohol word fragment (b-er; beer)	n = 8 (10%)	n = 40 (50%)
Control scenario (n = 40)	A shoe is hanging in the blue tree and that is why we drink ___	Non-alcohol word fragment (col-; cola)	n = 4 (10%)	n = 36 (90%)
		Alcohol word fragment; (be-r; beer)	n = 36 (90%)	n = 4 (10%)

2.2. Cognitive Bias Modification of alcohol-related interpretations

The modification of alcohol-related interpretations was based on the well-established, anxiety-related scenario-based CBM-I training (Mathews & Mackintosh, 2000; Salemink et al., 2009; Salemink, van den Hout, & Kindt, 2007). Participants were presented with 120 brief ambiguous scenarios in Dutch; 80 negative affect scenarios and 40 control scenarios (see Table 1). Each scenario consisted of two lines that were ambiguous regarding the role of alcohol. A word was missing in the final sentence. After pressing the space bar, this word was presented as a word fragment to create active involvement (Mathews & Mackintosh, 2000). Participants were instructed to complete the fragments as quickly as possible by pressing the spacebar and then typing the missing letter. The program only advanced when a correct letter was typed and only then the completed word was shown with feedback ('*correct answer*').

In the CBM-I training condition, 90% of the negative affect scenarios ended with a non-alcohol word fragment (n = 72 trials), and 10% with an alcohol word fragment (n = 8 trials, to assess interpretive bias, see 2.3.1. Probes). Thus, 90% of the resolutions result in a non-alcohol-related interpretation of the scenario in the CBM-I training condition. As a result, those participants in CBM-I condition are trained to interpret ambiguous, negative affective situations in a non-alcohol related way. In the sham training condition, 50% of the negative affect scenarios ended with a non-alcohol word fragment (n = 40 trials), and 50% with an alcohol word fragment (n = 40 trials). Thus, negative affect scenarios in the sham condition ended equally often with an alcohol-related or non-alcohol-related interpretation. As a result, no interpretive bias was trained in the sham condition. To ensure that both conditions were, in total, exposed to the same number of alcohol-related, and non-alcohol-related words, control scenarios consisting of nonsense sentences were created with number of alcohol-related and non-alcohol related word fragments depending on the assigned condition. In the CBM-I condition, 90% of these control scenarios ended with an alcohol-related word fragment (n = 36 trials) and 10% with a non-alcohol-related word fragment (n = 4 trials), while in the sham condition 10% ended with an alcohol-related word fragment (n = 4 trials) and 90% with a non-alcohol-related word fragment (n = 36 trials). Thus, across all scenarios (n = 120), each participant was exposed to 44 alcohol-related and 76 non-alcohol related word fragments. Scenarios were presented in a randomized order.

2.3. Interpretive bias assessment

2.3.1. Probes

To assess interpretations during training, it is common practice in this type of training to record reaction times to complete alcohol-related and non-alcohol-related word fragments in probe scenarios (Mathews & Mackintosh, 2000; Salemink et al., 2007, 2009). Probe scenarios are a pre-defined subset (n = 24) of the 120 training scenarios, randomly dispersed throughout the training. Those probe scenarios and the included word fragments are exactly the same across the two conditions. That is, there were 16 negative affect probe scenarios (eight with an alcohol-related and eight with a non-alcohol-related word fragment) and eight nonsense scenarios (four with an alcohol-related and four with a non-alcohol-related word fragment) are embedded within the training. Latencies were excluded if they were < 200 ms (0.1%) or > 10.000 ms (0.2%). An interpretive bias index was calculated separately for the negative affect and the nonsense scenarios by subtracting mean reaction times of alcohol-related word fragments from non-alcohol-related word fragments. A higher positive index reflects quickly solving the alcohol-related probes (shorter response time; easier) and slowly solving the non-alcohol-related probes (longer response time; more difficult), and represents a stronger alcohol-related interpretive bias. A negative index represents a non-alcohol-related interpretive bias.

2.3.2. Open-ended scenario task

A paper and pencil open-ended scenario task (Woud et al., 2014; Woud, Fitzgerald, Wiers, Rinck, & Becker, 2012) was used as a test for generalization of alcohol-related interpretations. It consisted of 15 novel, ambiguous scenarios describing common student situations, presented in a fixed random order. Each scenario started with a title and contained three sentences. It ended abruptly with an empty line. There were 12 scenarios with six describing negative affect and six describing positive affect situations. The remaining three scenarios were neutral, filler scenarios. Participants were instructed to imagine themselves in the situation. They were asked to complete each scenario quickly by writing down the first thing that came to mind.

Two raters (the first and third author), who were blind to training condition, coded the continuations in a conservative way; only unambiguous alcohol-related continuations were coded (Woud et al., 2012). Interrater reliabilities were high; average κ = 0.99 for the negative affect scenarios, and κ = 0.94 for the positive affect scenarios. A mean consensus score of alcohol-related interpretations was obtained separately for negative and positive affect situations, with higher scores reflecting stronger alcohol-related interpretations.

2.4. Mood induction

To induce a negative mood state, a self-relevant procedure of imagining a negative memory was combined with a music-based procedure (Van der Does, 2002) and provided before the drink test (in line with previous studies, e.g., Field & Quigley, 2009). While listening to the orchestral introduction by Prokofiev, entitled "Russia Under the Mongolian Yoke" played at half speed (Segal, Gemar, & Williams, 1999), participants were asked to write down an anxious, stressful experience (see Sinha, Fuse, Aubin, & O'Malley, 2000). They were asked to write down the situation as if they were actually in that situation right now. Specific stimulus and response details were solicited by instructing participants to describe the specific context, their thoughts and interpretations, and bodily sensations. Afterwards, participants received instructions for imagining their situation: "Your task is to close your eyes and imagine yourself in the situation as if it were happening right now. Allow yourself to become completely involved in the situation and re-experience the anxious/stressful feelings." The imagery period lasted for a period of five minutes. Because mood manipulations can have transient effects, the music element of the mood manipulation continued to play during the following drink test to support the maintenance of the negative mood state.

Table 2
Demographic and baseline variables as a function of training condition.

	CBM-I condition (N = 63)	Sham condition (N = 70)	Group difference statistic	p-Value
Age, M (SD)	22.6 (6.2)	22.0 (3.0)	$t(131) = -0.77$	0.44
Females (%)	54 (85.7%)	51 (72.9%)	$\chi^2 = 3.30$	0.07
AUDIT, M (SD)	11.8 (4.4)	11.5 (5.0)	$t(131) = -0.29$	0.78
Drinking motives, M (SD)				
Enhancement	2.9 (0.81)	2.9 (0.86)	$t(131) = -0.27$	0.79
Social	3.1 (0.87)	3.0 (0.76)	$t(131) = -0.29$	0.78
Coping anxiety	2.2 (0.65)	2.1 (0.75)	$t(131) = -0.62$	0.54
Coping depression	1.6 (0.70)	1.6 (0.61)	$t(131) = -0.33$	0.74
Conformity	1.3 (0.59)	1.4 (0.57)	$t(131) = 0.47$	0.64

Notes. AUDIT means total score on the Alcohol Use Disorders Identification Test. Drinking motives were assessed with the modified Drinking Motives Questionnaire Revised.

Actual mood state was assessed with six computerized Visual Analogue Scales (VAS, three positive; relaxed, cheerful, calm and three negative; anxious, stressed, tense) to determine whether the mood induction procedure was successful. The scales consisted of a 15-cm horizontal line that was labelled at opposite ends with the words ‘not at all’ and ‘very much’. Both a positive and negative mood index was calculated by averaging the three VAS-scales, with higher scores reflecting a higher level of the mood state.

2.5. Drink test

The lab-based drink test (Field & Eastwood, 2005; Wiers, Rinck, Kordts, Houben, & Strack, 2010) was explained to participants as a taste test to increase our understanding of individual differences in ‘taste-sensitivity’. They were informed that they would receive different questions about the different beverages and that they could drink as much or as little as they wished in order to answer the questions. Participants received three glasses of (one type of) light beer (2.5% alcohol) and three glasses of (one type of) cola. Participants rated each drink on a 100-mm VAS along four different continuums (unpleasant–pleasant, tasteless–strong tasting, bitter–sweet, flat–gassy). There was no time limit. Outside of the laboratory, the experimenter weighted the glasses before and after the taste test to determine the amount of beer consumed (in grams), which was the dependent variable (Wiers et al., 2010; Woud, Hutschemaekers et al., 2015). (Analyses were repeated with the amount of beer consumed, expressed as a percentage of total fluid consumption (sum of beer and cola amount consumed) as the dependent variable, following Field & Eastwood, 2005, and the pattern of observed effects was virtually identical.)

2.6. Questionnaires

To assess drinking motives, the Modified Drinking Motives Questionnaire-Revised (modified DMQ-R, Grant, Stewart, O'Connor, Blackwell, & Conrod, 2007) was used. The 28-item self-report inventory assesses the relative frequency of drinking for each of the five different motives (i.e., enhancement; coping-anxiety; coping-depression; social; conformity). Participants indicated their relative frequency of alcohol use for each of the listed reasons on a scale ranging from 1 (*almost never/never*) to 5 (*almost always/always*). Mean scores for each motive were calculated and ranged from 1 to 5. This questionnaire has been found to be a reliable and valid measure of undergraduate's drinking motives (Grant et al., 2007). In the present study, Cronbach's alphas for the subscales were 0.80 (enhancement), 0.65 (coping-anxiety), 0.91 (coping-depression), 0.74 (social), and 0.87 (conformity). Though the coping-anxiety subscale internal consistency is below the widely accepted 0.70 cutoff, it is acceptable by Loewenthal's (1996) standard (a Cronbach's $\alpha \geq 0.60$ is adequate for short scales) and comparable to the internal consistencies reported in Grant et al. (2007).

To assess alcohol use and alcohol-related problems, the AUDIT (Saunders et al., 1993) was used. The questionnaire consists of 10 items and a total score was calculated. This is a widely used measure that has previously demonstrated high levels of reliability and validity (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). Cronbach's alpha in the present study was 0.72.

Self-reported daily-level alcohol use was measured online with a modified version (Wiers, Hoogeveen, Sergeant, & Gunning, 1997) of the time-line follow-back questionnaire (TLFB, Sobell & Sobell, 1990) one week after completing the training. Participants indicated how many glasses of alcoholic beverages they consumed during each day of the past week. Similarly, participants also indicated how they felt on each day, on a scale from 0 (very negative) to 10 (very positive). To obtain an index of self-reported daily-level negative affect drinking, the average number of alcohol beverages consumed on a negative affect day (score of 0–4 on the mood scale) was calculated.

2.7. Procedure

The experiment lasted approximately one hour and was conducted in separate lab cubicles between 1 and 8 p.m. Participants completed the AUDIT and DMQ-R, and were randomly assigned to the CBM-I or sham condition. The training procedure was double blind. Afterwards, participants received the scenario task, the DMQ-R, and the VAS-scales. Then all participants received the negative mood induction procedure, with mood state VAS-scales presented before and after the induction procedure. This was followed by the drink test with the music still playing. One week later, participants received an email with a link to complete the TLFBs for alcohol consumption and mood state online.

3. Results

3.1. Baseline group characteristics

At baseline, the mean score on the AUDIT was 11.7 (SD = 4.7, 81% had a score of ≥ 8). The two conditions did not differ significantly regarding age, sex, AUDIT total score, or drinking motives (Table 2).

3.2. Effects on alcohol-related interpretation bias

To examine whether the CBM-I (and not the sham) training was associated with less strong alcohol-related interpretative bias and especially for coping-drinkers, moderated regression analyses were conducted with condition, coping motives, and the interaction as the predictors (Tables 3 and 4). All the analyses were conducted twice; once with the coping-anxiety motive and once with coping-depression motive as a moderator. Similar patterns of findings were observed for the two motives. For conciseness, the results for the coping-anxiety motive are reported here and for the coping-depression motive in the Supplementary Information section (S1). All variables were z-standardized before inclusion in the regression analyses and these were used to create interaction terms (Aiken & West, 1991). Two regression analyses were conducted with interpretations assessed during training (probes) as the dependent variables. The regression model for the negative affect interpretive bias was significant, $R^2 = 0.06$ (adjusted $R^2 = 0.04$), $F(3,126) = 2.7$, $p < .05$. Condition was a significant predictor, indicating that, as predicted, the alcohol-related interpretive bias in negative affect situations was weaker in the CBM-I than in the sham condition (Table 3). However, the predicted interaction effect between condition and the coping-anxiety motive was not significant. Finally, as expected, the regression model for interpretive bias in the nonsense context was not significant, $R^2 = 0.03$ (adjusted $R^2 = 0.01$), $F(3,126) = 1.5$, $p = .23$.

Two regression analyses were conducted with the post-training

Table 3
Summary of Regression Analyses for predicting CBM-I effects and coping anxiety motives on Interpretive Bias and Drinking Behavior.

	Interpretations_Probes					
	Negative affect			Nonsense		
	β	*t*-Value	*p*-Value	β	*t*-Value	*p*-Value
Condition	−0.49	−2.85	0.005	−0.11	−0.64	0.52
Coping-anxiety motives	0.03	0.24	0.81	0.07	0.58	0.57
Condition × Coping-anxiety motives	0.02	0.09	0.93	−0.33	−1.83	0.07

	Interpretations_Open-ended task					
	Negative affect			Positive affect		
	β	*t*-Value	*p*-Value	β	*t*-Value	*p*-Value
Condition	−0.10	−0.57	0.57	−0.08	−0.47	0.64
Coping-anxiety motives	0.25	2.22	0.03	−0.07	−0.60	0.55
Condition × Coping-anxiety motives	−0.08	−0.48	0.63	0.09	0.47	0.64

	Negative affect drinking					
	Lab drink test			Self-report alcohol use		
	β	*t*-Value	*p*-Value	β	*t*-Value	*p*-Value
Sex	1.23	6.51	< 0.001	0.38	1.25	0.22
Condition	0.19	1.23	0.22	0.33	1.34	0.18
Coping-anxiety motives	−0.09	−0.87	0.39	0.12	0.73	0.47
Condition × Coping-anxiety motives	0.23	1.46	0.15	0.07	0.27	0.79

Notes: All variables other than Condition and Sex were z-standardized. Condition was coded as 0 = sham training condition and 1 = CBM-I training condition. Sex was coded as 0 = female and 1 = male.

Table 4
Means and Standard Deviations for Training Effects for the CBM-I and Sham Training Condition.

	CBM-I training condition *M (SD)*	Sham training condition *M (SD)*
Interpretations		
Bias index_Probes_Negative Affect	110.9 (242.1)	253.9 (319.3)
Bias index_Probes_Nonsense	−340.1 (516.4)	−277.6 (508.9)
Open-ended task_Negative Affect	0.23 (0.21)	0.25 (0.23)
Open-ended task_Positive Affect	0.27 (0.17)	0.28 (0.14)
Mood Induction		
Pre-assessment Negative Mood index	26.1 (19.4)	23.1 (15.7)
Post-assessment Negative Mood index	50.4 (19.9)	49.3 (18.3)
Pre-assessment Positive Mood index	61.3 (16.2)	63.5 (16.7)
Post-assessment Positive Mood index	37.6 (19.0)	40.9 (18.4)
Negative Affect Drinking		
Beer consumption (in gram) lab drink test	104 (92)	102 (85)
Self-reported alcohol use on negative affect days	0.96 (1.53)	0.53 (1.32)
Self-reported alcohol use per day	1.9 (1.8)	1.9 (1.4)

Notes. For the interpretive bias indices; higher scores represent a stronger alcohol-related interpretive bias. For the mood indices; higher scores reflect a higher level of the mood state. The observed range for beer consumption during the drink test in the lab was 0–448 g of beer, for self-reported alcohol use on negative affect days was 0–7.0 alcoholic drinks per day and for self-reported alcohol use (independent of mood state) was 0–9.3 drinks per day.

interpretations as the dependent variables to test generalization[1] (Tables 3 and 4). Contrary to our hypothesis, the regression model for interpretations in the negative affect open-ended scenarios was not significant, $R^2 = 0.05$ (adjusted $R^2 = 0.03$), $F(3,126) = 2.2$, $p = .09$. Note that the coping-anxiety motive was a significant predictor, indicating that individuals who drink alcohol to cope with their anxious emotions interpreted the negative affect scenarios as more alcohol-related. As expected, the regression model for interpretations in positive affect situations was not significant, $R^2 = 0.01$ (adjusted $R^2 = -0.02$), $F(3,126) = 0.2$, $p > .50$.

3.3. Effects on drinking behavior while in a negative mood state

As a first step, it was determined whether the negative mood induction procedure was successful. The visual analogue scales assessing negative and positive mood states before and after the mood induction procedure were analyzed with a 2 (Valence: negative mood vs. positive mood) × 2 (Time: pre vs. post mood induction procedure) repeated measures ANOVA. It revealed a significant main effect of Valence, $F(1,130) = 34.7$, $p < .001$, $\eta_p^2 = 0.21$ (stronger positive than negative emotions) and a significant Valence × Time interaction effect, $F(1,130) = 208.6$, $p < .001$, $\eta_p^2 = 0.62$. There was a significant increase in negative affect ($M_{pre} = 24.5$, $SD = 17.6$ to $M_{post} = 49.8$, $SD = 19.1$, $t(130) = -14.1$, $p < .001$), and significant decrease in positive affect ($M_{pre} = 62.5$, $SD = 16.4$ to $M_{post} = 39.3$, $SD = 18.7$, $t(130) = 12.7$, $p < .001$), indicating a successful negative mood induction (see Table 4).

To examine whether the CBM-I (and not the sham) condition would result in reduced negative affect drinking, especially for coping-

[1] Three participants were removed from the open-ended task analysis, as they accidently completed it at a wrong time-point, resulting in $N = 130$ (CBM-I: $n = 62$, sham: $n = 68$).

drinkers, a moderated regression analysis was conducted with the amount of beer consumed during the drink test in the lab[2] as the dependent variable (Tables 3 and 4). Sex was included as an additional predictor. The regression model was significant, $R^2 = 0.27$ (adjusted $R^2 = 0.24$), $F(4,126) = 11.4$, $p < .001$. Contrary to expectations, sex was the only significant predictor, indicating that males drank more beer during the drink test.

With respect to the self-reported mood states in the week following the lab session (TLFB mood); participants reported on average approximately one negative affect day (score 0–4) during the follow-up week ($M = 1.1$; $SD = 1.3$; range = 0–6 days). The average mood state on those negative affect days was 3.2 ($SD = 0.9$, range = 0.5–4.0) and on positive affect days was 6.9 ($SD = 0.9$, range = 5.0–9.7). In total, 59 individuals did not report any negative affect days (TLFB mood scores were always five or higher). We first conducted a regression analysis, excluding these individuals to examine whether the CBM-I (and not the sham) condition would result in reduced negative affect drinking, especially for coping-drinkers. The analytical sample was $N = 74$ (CBM-I: n = 36, sham: n = 38) and the regression model was not significant, $R^2 = 0.06$ (adjusted $R^2 = 0.01$), $F(4,69) = 1.1$, $p = .35$. To include all participants, a secondary analysis was conducted with the average number of self-reported alcoholic beverages consumed per day (independent of mood state) as the dependent variable ($N = 133$). The regression model was again not significant, $R^2 = 0.06$ (adjusted $R^2 = 0.03$), $F(4,128) = 2.1$, $p = .09$. Sex was a significant predictor, $\beta = 0.59$, $t = 2.8$, $p < .01$, males reported to have drunk more alcoholic beverages per day than females in the week following the lab session.

3.4. Correlations between interpretive bias and drinking behavior

To examine the relationship between alcohol-related interpretive bias after training and drinking behavior, correlations were calculated between the negative affect interpretive bias measures (RT probe measure and open-ended task) and the drinking behavior measures. Results revealed that the reaction time probe measure of interpretive bias was not significantly correlated with the amount of beer consumed during the drink test in the lab, $r(127) = 0.09$, $p = .30$, nor with self-reported negative affect drinking, $r(70) = -0.06$, $p = .62$, or drinking in general, $r(128) = 0.02$; $p = .85$. The open-ended task measure of negative affect interpretive bias was borderline significantly correlated with beer consumption in the lab, $r(127) = 0.17$, $p = .052$, and significantly, positively correlated with both self-reported negative affect drinking, $r(70) = 0.41$; $p < .001$, and drinking in general, $r(128) = 0.32$, $p < .001$.

4. Discussion

The current study examined the effects of a computerized training designed to reduce alcohol-related interpretation bias in negative affect situations (compared to a sham condition) on interpretive bias and negative affect drinking outcomes. The findings were mixed. Consistent with predictions, participants in the CBM-I training made less alcohol-related interpretations in negative affective situations compared to the sham training, when assessed during training. However, contrary to predictions, the effects were not stronger for individuals who drink to cope with anxious (or depressed) feelings. Furthermore, the training effects did not generalize to another interpretation measure: the open-ended scenario task. The difference between the measures might be illustrative of near versus far transfer, which is defined as the degree of overlap between training and assessment tasks (Hertel & Mathews, 2011). The format of probe scenarios and participants' response are the same as in the training procedure, while they deviate much more in the open-ended task (i.e., producing an own interpretation vs. completing word fragments). As such, the observed pattern of findings regarding alcohol-related interpretations could reflect successful near transfer of the training effect and a failure to obtain far transfer effects. Given previous failures to reduce alcohol-related interpretations using a CBM-I training (Hutschemaekers et al., 2016; Woud, Hutschemaekers et al., 2015), the current near transfer effects are promising as the CBM-I training, compared to the sham condition, was associated with less alcohol-related interpretive bias.

With respect to our second hypothesis, the results did not provide any evidence of training effects on negative affect drinking. Groups did not differ significantly in the amount of beer consumed during the negative affect drink test nor in self-reported daily-level alcohol use assessed one week later, which is consistent with findings from earlier studies (Hutschemaekers et al., 2016; Woud, Hutschemaekers et al., 2015). In addition, there was no moderation by coping motives. Given that the training effects did not generalize to another interpretation measure, it might not be surprising that no effects were observed on the drinking outcome measures as they can be considered “very far transfer” (Fox, Mackintosh, & Holmes, 2014). Furthermore, it has been shown that effects on the outcome measure are observed only when the targeted process (here interpretive bias) is successfully changed (Grafton et al., 2017). This is consistent with our findings. Training did not systematically change interpretations (no effect on the open-ended task) and there was no evidence of changes in drinking, whether in the lab or in daily-life.

The question then is why the training procedure did not systematically change alcohol-related interpretations; the two conditions differed in interpretations assessed with the probe scenarios, but not with the open-ended scenario task. Note that the latter task was related to coping motives and various drinking outcomes, while the probe scenarios were not. This is an unexpected finding. It could indicate the relevance of self-generation or more details in a task (two sentences in the probes versus three in the scenario task), or could reflect chance, and it is important to see if it replicates in future studies. With respect to training effect, in the current study, participants completed only a single session of training. Although CBM-I training in the anxiety domain had success with single training sessions changing interpretations (Mathews & Mackintosh, 2000; Salemink et al., 2007; Salemink & Wiers, 2011), it appears that multiple sessions are critical in the domain of alcohol for generalization (Wiers et al., 2013). Second, the sample in the current study might play a role in explaining the results. Participants were moderate to heavy drinking undergraduate students. While it has been shown that college students drink more and more heavily than peers who do not attend college (Merrill & Carey, 2016), and that coping motives prospectively predict a range of negative consequences in college students (Merrill et al., 2014), generally, students drink for social and enhancement motives (Cooper, 1994; Kuntsche et al., 2005). Indeed, participants in the current study endorsed these motives more than the coping motives. Given that the CBM-I had a focus on negative affect drinking, this may not be the optimal fit with this student population, so replications studies with a more selected sample are needed. Furthermore, participants were not selected on a motivation to reduce drinking. On the contrary, given the strong drinking culture among (Dutch) students (18 is the legal drinking age in the Netherlands), it seems unlikely that this group was motivated to cut down drinking. As motivation to change one's behavior is important for the success of treatments (Miller, 1985; Wiers et al., 2013), our sample might have limited the potential for the training to be successful (e.g., Lindgren et al., 2015). Finally, the current study included predominantly women so whether results would generalize to men is unknown.

There are some additional limitations. The current study focused on negative affect situations, as specifically the coping motive is associated

[2] Two participants were excluded in the analyses with lab-based drinking; one due to gluten-intolerance, and one person due to completing assessments at a wrong time-point, resulting in $N = 131$ (CBM-I: $n = 63$, sham: $n = 68$).

with problem drinking (Cooper, 1994). However, the outcomes measures in the study were lab-based drinking, and self-reported number of drinks, which might not be optimal proxies for alcohol-related *problems*. In addition, while congruent mood changes in response to the negative lab-based mood induction procedure were observed within individuals, the absence of a neutral mood induction condition precludes establishing the validity of the negative mood induction procedure. Also, the lab-based drink test, like most lab-based procedures, has limitations with respect to ecological validity and as students could have participated simultaneously (though in separate cubicles), we cannot rule out the possibility that the drink test included a social element. And further, while the inclusion of mood assessments in the week following the lab session was a strength, we were only able to assess participants' average mood for each day and those assessments were retrospective. Given the focus on negative reinforcement drinking, assessing emotions directly before drinking would be stronger. Future research could include technological innovations such as ecological momentary assessments to assess mood state immediately prior to drinking.

Despite having a strong design (placebo-matched condition, random assignment) focusing on dysfunctional, negative affect drinking and matching the emotional contexts of training and drinking assessments, results only indicated that participants in the CBM-I training had lower alcohol-related interpretive bias scores, when assessed with a task quite similar to the training. Contrary to expectations, these effects were not moderated by the strength of coping-anxiety motives, nor were effects observed on another interpretive bias task, nor on drinking behavior. Nevertheless, this study is the first to show that the CBM-I training is associated with a less strong alcohol-related interpretive bias in negative affect situations in a near-transfer task.

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Contributors

All authors (Elske Salemink, Marcella Woud, Marit Roos, Reinout Wiers, Kristen Lindgren) designed the study and wrote the protocol. Elske Salemink and Marit Roos conducted the statistical analyses. Elske Salemink wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

Conflict of interest

All of the authors declare they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2018.07.023.

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