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Augmenting outpatient alcohol treatment as usual with online approach bias modification training: A double-blind randomized controlled trial

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ABSTRACT

Previous research shows that automatic tendency to approach alcohol plays a causal role in problematic alcohol use and can be retrained by Approach Bias Modification (ApBM). ApBM has been shown to be effective for patients diagnosed with alcohol use disorder (AUD) in inpatient treatment. This study aimed to investigate the effectiveness of adding an online ApBM to treatment as usual (TAU) in an outpatient setting compared to receiving TAU with an online placebo training.

139 AUD patients receiving face-to-face or online treatment as usual (TAU) participated in the study. The patients were randomized to an active or placebo version of 8 sessions of online ApBM over a 5-week period. The weekly consumed standard units of alcohol (primary outcome) was measured at pre-and post-training, 3 and 6 months follow-up. Approach tendency was measured pre-and-post ApBM training.

No additional effect of ApBM was found on alcohol intake, nor other outcomes such as craving, depression, anxiety, or stress. A significant reduction of the alcohol approach bias was found. This research showed that approach bias retraining in AUD patients in an outpatient treatment setting reduces the tendency to approach alcohol, but this training effect does not translate into a significant difference in alcohol reduction between groups. Explanations for the lack of effects of ApBM on alcohol consumption are treatment goal and severity of AUD. Future ApBM research should target outpatients with an abstinence goal and offer alternative, more user-friendly modes of delivering ApBM training.

1. Introduction

Psychological treatment guidelines (GGZ-standaarden, 2020) propose interventions like Cognitive Behavioral Therapy (CBT) and Motivational Interviewing (MI) as outpatient care for patients with alcohol use disorder (AUD). Both CBT and MI focus on the slower, reflective processes by strengthening patients' cognitive control over their alcohol use (Magill & Ray, 2009) and exploring and resolving the patients' ambivalence, focusing on strengthening their motivation to change their harmful behavior (Miller & Rollnick, 2013). Research in the past years has also explored the more impulsive aspects of addiction. Problem drinkers and patients with an AUD have an approach bias (Wiers et al., 2009, 2011) for alcohol-related stimuli. It takes them less time to approach alcohol-related stimuli than to avoid such stimuli. Various computerized tasks have been constructed to influence these automatically activated biases, referred to as Cognitive Bias Modification (CBM). Influencing the tendency to approach alcohol, also known as Approach Bias Modification (ApBM) (Wiers & Kordts, 2010) seems to be one of the most promising strategies (Gladwin et al., 2017). One form of retraining automatic approach tendencies is an adjusted version of the Approach Avoidance Task (AAT) (Eberl et al., 2013; Wiers et al., 2011). In this training task, participants are asked to react to pictures of alcoholic and non-alcoholic drinks on their computer screen, using a joystick.

In an initial proof-of-principal study of ApBM with students, a change

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in bias and short-term drinking behavior were demonstrated (Wiers & Kordts, 2010). Subsequently, several studies aiming to gain insight into the clinical effectiveness of ApBM were carried out with inpatients of addiction care clinics, either during their detoxification period (Manning et al., 2016, 2021) or during the subsequent treatment phase (Eberl et al., 2013; Rinck et al., 2018; Salemink et al., 2021; Wiers et al., 2011). Findings demonstrated a range of 8.4 %-13 % less relapse at 1-year follow-up in the TAU group and higher abstinence rates when offering training during the detoxification period compared to sham training (54–69 % vs 43–47 %).

To make it possible to deliver the ApBM training to the most convenient time and place for participants, an online version was developed. Researchers were therefore able to conduct experiments with problem drinking participants from the general public. A first online randomized controlled trial with self-selected problem drinkers receiving four sessions of different varieties of cognitive bias modification (including ApBM), showed a reduction in drinking, but not significantly larger than in the control group (Wiers et al., 2015). Possible explanations for the absence of significant differences were the small statistical power compared to the larger clinical studies and the training goal: abstinence for patients in the clinical trials versus reduced drinking for problem drinking participants. Also, the clinical trials all added the ApBM to TAU, while the problem drinking participants completed the ApBM as stand-alone.

Recent research tried to tackle some of these issues by setting up a larger online trial (427 participants) with a 2x2x2 factorial design and adding two modules of an online cognitive-behavioral intervention (Drinkingless), consisting of personalized feedback and goal setting. This research was not able to prove the added value of online CBM for problem drinkers (van Deursen et al., 2020). Participants in all conditions reduced their drinking, including the TAU-only condition.

Summarizing, ApBM seems to work as an add-on to TAU in a clinical abstinent-oriented AUD treatment, resulting in lower relapse rates. On the other hand, online ApBM combined with or without a short CBT intervention does not seem to yield any additional results for problem drinkers. However, the added value of ApBM for AUD patients in an outpatient setting has not yet been established. As most contacts (>80 %) with clients in Dutch addiction care take place in an outpatient setting (Wisselink et al., 2016), the target audience for this possible benefit is quite large. In addition, offering ApBM training in a setting that exposes patients to cues related to alcohol may bolster training effects, as studies on anxiety suggest that emotional arousal before and during training may play a role in the effectiveness of attention bias modification (Kuckertz et al., 2014; Nuijs et al., 2020).

This research aims to investigate the effectiveness of online ApBM, combined with CBT treatment as usual for AUD patients in an outpatient treatment setting. We expect patients in the ApBM intervention condition to show a larger decrease in alcohol consumption and alcohol-approach bias compared to patients in the placebo condition.

2. Methods

2.1. Design

This study consisted of a double-blind randomized placebo-controlled trial. All patients included in this study received web-based or face-to-face treatment (TAU). Patients in the intervention condition received additional ApBM (Eberl et al., 2013; Wiers et al., 2011); patients in the control condition received an additional placebo training. Randomization to condition was computer-generated without the involvement of a therapist or researcher. The study was approved by the Ethics Committee of Amsterdam Academic Medical Centre in January 2015 (reference number 2014_154#C20141463) and was registered at the Netherlands Trial Register (NTR5087) and described in a study protocol (Bratti-van der Werf et al., 2018).

2.2. Participants and procedure

Participants received outpatient TAU for their primary diagnosis of AUD (with varying levels of severity) at Tactus Addiction Treatment in the Netherlands. The only criteria to participate in this study were to be > 18 years of age and to have access to the internet. Patients were given the opportunity to participate in the study, after being provided with information about the study by their therapist, during the first phase of their treatment. All patients signed informed consent and were provided with login credentials via e-mail by the researcher and were randomized after registering in the online-system. Patients started by completing baseline questionnaires and performing the first AAT-assessment, followed by their first out of 8 ApBM intervention sessions. After finishing the 8 training sessions, patients performed the post-AAT assessment and were asked to fill in post-test questionnaires. After completing both assessments and all training sessions, patients received a € 20 gift card. Follow-up questionnaires were sent via e-mail 3 and 6 months after completing TAU.

2.3. Intervention

Treatment for all participants consisted of a protocolized CBT (Hester et al., 1989) and MI (Miller & Rollnick, 2013), delivered either online or face-to-face. The ApBM and the placebo training were delivered online. The training comprised eight 15 min-sessions, over five weeks. Each session includes a sequence of 172 pictures displayed randomly to patients on the computer screen in one practice and four training blocks. The practice block consisted of grey squares for both conditions; the actual training blocks were depictions of alcoholic beverages and non-alcoholic beverages. All patients were asked to react to pictures that were tilted 3 degrees to either left/right, by pressing either the 'N' (pulling) or 'U' (pushing) key on their keyboard. For patients in the training condition, 90 % of the pictures of alcoholic beverages were presented in the 'push format' and 10 % in the pull format. The patients in the control condition received a placebo version of the same intervention, but with an 50/50 % divide between pushing and pulling alcoholic and non-alcoholic beverages, essentially functioning as a continuation of the assessment task. For a detailed description of the interventions, see (Bratti-van der Werf et al., 2018).

2.4. Measures

2.4.1. Demographic characteristics

Gender, age, education, and employment were extracted from the patient electronic health record database of Tactus at the baseline assessment.

2.4.2. Alcohol consumption

Patients filled in the Dutch version of the Timeline Follow Back (TLFB) questionnaire (Sobell & Sobell, 1992), providing self-reported estimates of the total of consumed standard units of alcohol for every day of the week preceding filling out the questionnaire at the different time points. In the current study, alcohol use was measured as a continuous variable, and also used for the assessment of safe drinking limits (<22 standard units/week for men and < 15 units/week for women, one standard unit representing 10 g of pure alcohol) as stated in the research protocol (Bratti-van der Werf et al., 2018).

2.4.3. Approach avoidance tendencies

Using the AAT (Wiers et al., 2009) the approach and avoidance tendencies were assessed. Patients responded to a total of 172 trials, consisting of 12 practice trials (grey squares) and 160 assessment trials, subdivided into four blocks of 40 pictures. The blocks of 40 pictures depicted 20 alcoholic beverages and 20 non-alcoholic beverages. Each picture was presented randomly in two formats (tilted to the left or right) twice. To assess the approach bias, the D-score was calculated,

derived from the D-score used in the Implicit Associations Test (Greenwald et al., 2003), known to perform well in earlier studies (Eberl et al., 2013; Wiers et al., 2011).

2.4.4. Alcohol dependence

The Substance Abuse Module (SAM) from the Composite International Diagnostic Interview (CIDI) (Compton et al., 1996) was used to determine whether patients fulfilled criteria for alcohol abuse and/or alcohol dependence, serving the diagnostic criteria of DSM IV.

2.4.5. Craving

Using the 5-items scale (de Wildt et al., 2005) of the original 14-items Obsessive Compulsive Drinking Scale (OCDS) (Anton et al., 1995), patients' compulsiveness related to craving was measured.

2.4.6. Health status

Physical health status was evaluated using the 10-item Health Symptom Scale questionnaire from the Maudsley Addiction Profile (MAP-HSS) (Marsden et al., 1998).

2.4.7. Depression, anxiety and stress

The 21-item Depression Anxiety Stress Scale (DASS-21) (Antony et al., 1998) was assessed to measure depression, anxiety and stress.

2.4.8. Drinking motives

Patients filled in the 28 items online Drinking Motives Questionnaire-Revised (mDMQ-R) (Grant et al., 2007) to assess motives for drinking.

2.4.9. Self-efficacy

8 items from the Drinking Refusal Self Efficacy Questionnaire (DRSEQ) (Oei et al., 2005) were used to assess the three dimensions of self-efficacy concerning refusal of alcohol: social pressure, emotional relief and opportunistic drinking (Young et al., 1991).

2.4.10. Credibility and satisfaction

Credibility of the CBM training was assessed using a Dutch translation (Smeets et al., 2008) of the 6-item Credibility and Expectancy Questionnaire (CEQ) (Devilly & Borkovec, 2000). Satisfaction was measured with the 8-item Client Satisfaction Questionnaire (CSQ) (De Brey, 1983).

2.4.11. Statistical analysis

A sample size of 304 patients was calculated a priori as mentioned in the study protocol (Bratti-van der Werf et al., 2018). The recruitment period was extended due to a lower amount of interest in participation; taking budget limits into account, inclusion was halted at 140 patients.

Descriptive statistics were used to describe the baseline characteristics. Means and standard deviations (SDs) or medians and interquartile ranges (IQRs) are provided for continuous variables, depending on the normality of the distribution. Categorical variables are presented as numbers with corresponding percentages. Independent samples t-tests or Wilcoxon rank-sum tests (continuous variables) and chi-square tests or Fisher exact tests (categorical variables) were used to compare baseline characteristics between the intervention group and the placebo group.

To measure the efficacy of the TAU + ApBM on safe drinking over time, Generalized Estimating Equations (GEE) were used. To measure the efficacy of TAU + ApBM on the absolute intake over time, first, missing values were imputed using the multiple imputation method in SPSS. For all 20 imputed datasets and a pooled dataset, a generalized linear model (GLM) was performed. For both the GEE and the GLM for repeated measures, the intervention*time interaction effect was used to measure whether the change over time was different for the TAU + ApBM training versus TAU + placebo. All tests were performed using SPSS version 24.0 (IBM Corp, Armonk, New York).

3. Results

A total of 172 patients signed up for the study and were provided with login credentials. 32 patients did not create an account. The remaining 140 patients were randomized to one of the two conditions. One patient was excluded due to a duplicate record. Fig. 1 shows the flow of patients in the study.

3.1. Baseline characteristics

Baseline characteristics of the training and placebo group are shown in Table 1. The mean age was 47.8 years (SD = 11.5) and a little over half were male (58 %). On average, patients drank 34.3 units of alcohol in the past 7 days. Baseline characteristics were mainly similar between both groups but differed in the D score on alcohol and non-alcohol at baseline. The baseline *avoidance* bias for alcohol and non-alcohol was stronger in the training condition compared to the placebo condition. Next to that, the percentage of patients met the criteria for alcohol dependence (indicating the severity of their AUD) was significantly higher in the training group compared to the placebo group (97.6 % vs 81.3 %, p = .02).

3.2. Adherence to training sessions

Of the 139 patients who were included for analysis, 65 % (43 training, 47 placebo) completed 6 sessions or more, described as the mean number of sessions to reach the strongest training effect in earlier research (Eberl et al., 2014). A significantly larger portion of patients in that received TAU online completed 6 sessions or more (85.5 % of the online group vs 51.2 % of the F2F group, p < .001). A total of 84 (40 training, 44 placebo) patients completed all sessions. Fig. 2 shows the dropout curve for the sessions. The groups did not differ significantly in percentage completing all sessions ($t(137) = -1{,}22, p = .23$). During the first two training sessions, dropout was highest, in both conditions.

3.3. Alcohol use

Generalized Estimating Equations (GEE) showed that both groups improved significantly (Wald $X^2 = 32.6$, df = 3, $p < 0.01$) on the binary outcome measure of attaining a safe drinking level (see Table 2). There was no difference between groups (Wald $X^2 = 0.087$, df = 1, p = .77), neither were the reductions significantly different between groups over time (Wald X2 = 2.66, df = 3, p = .45).

Generalized linear model (Table 2), showed that both groups reduced their weekly alcohol consumption over time ($P < .001$). Similar to the dichotomous outcome, there were no significant differences between groups (condition effects ranged from p=.32 to p = .98) and between groups over time (time * condition effects ranged from p = .14 to p = .89).

3.4. Approach avoidance tendencies

After completing the initial AAT-test (T0) and the 8 training sessions, 83 patients (40 training, 43 placebo) completed the second AAT-test (T1). D scores were calculated from these AAT-tests; Table 2 shows the D scores for alcohol at T0 (at baseline) and T1 (after 8 training sessions) for both training and placebo group. Fig. 3 is a visual representation of these data. Patients that completed both AAT-assessments and all 8 ApBM sessions (n = 83), showed no main effect over time for the D-score on alcohol (F (1,81) = 0.88, p = .351) and non-alcohol (F (1,81) = 0.1.6, p = .209). An interaction effect was found for time * condition for the D-score on alcohol (F(1,81) = 5.1, p = .026, indicating that D-scores for patients in the training group reduced significantly more than for patients in the placebo group (see Fig. 3). Generalized linear model, using multiple imputations (n = 139), showed no main effect of time, but time * condition effects ranged from p = .001 to p =

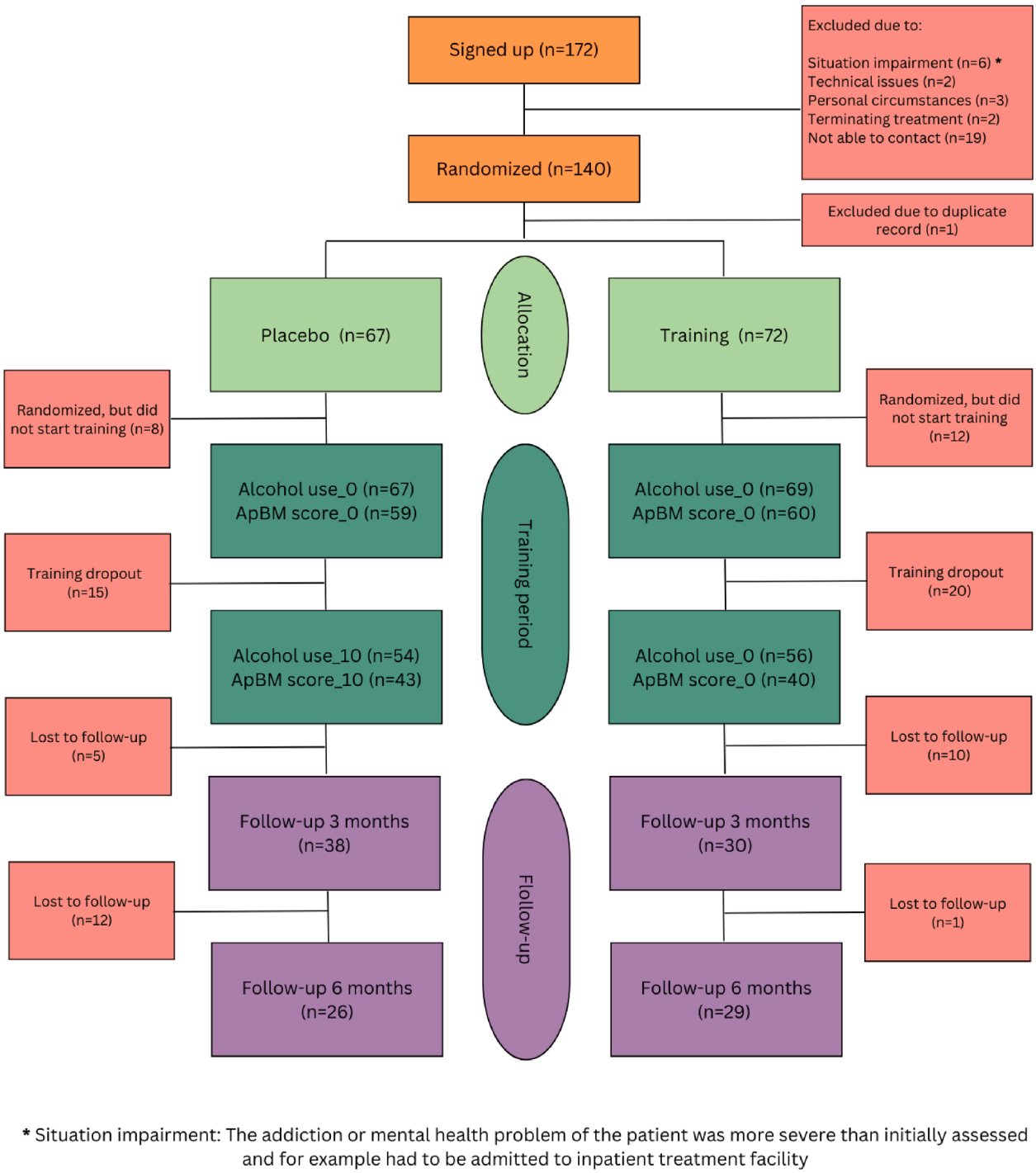

Fig. 1. Flow RCT.

.391 (of which 8 of 20 imputations showed a significant result).

3.5. Secondary health measures

Using Generalized linear model, with multiple imputations (n = 139) No significant results were found on time * condition for depression, anxiety, stress (effects ranged from p = .060 to p = .993) and health status (effects ranged from p = .065 to p = .993). For craving, effects ranged from p = .0.19 to p = .917, of which 2 of 20 imputations showed a significant result. Analyses for craving and health status showed a main effect of time, indicating a decrease in craving and an increase in health status (see Table 2). Analysis for depression, anxiety and stress (total score) did not show a main effect of time.

3.6. Credibility, expectancy, satisfaction and training experience

The overall CEQ and the subscale for credibility (as shown in Table 3) differed significantly between the training and placebo group, indicating that the training group deemed the AAT training more credible and had an overall higher expectancy of positive outcomes than the placebo group.

After dropping out or completing the training, patients were asked about their satisfaction with the AAT training. Patients (n = 99) had an overall CSQ score of 20.2 (SD = 5.0) with an average score of 2.5 on a

Table 1
Descriptive statistics at baseline for training group and placebo group.

Variable	Training N = 72		Placebo N = 67		X^2 / P value	Missing (n)
Age (mean, SD)	48.8	(10.7)	46.7	(12.3)	0.28	training n = 2
						placebo n = 4
Gender (n, %)					0.93	training n = 0
Male	42	(58.3)	38	(57.6)		placebo n = 1
Female	30	(41.7)	28	(42.4)		
Education (n, %)					0.52	training n = 12
Low[b]	12	(20)	8	(15.1)		placebo n = 14
Middle[c]	21	(35)	24	(45.3)		
High[d]	27	(45)	21	(39.6)		
Occupation (n, %)					0.22	training n = 13
Employed	33	(55.9)	35	(67.3)		placebo n = 15
Unemployed	26	(44.1)	17	(32.7)		
CIDI[e] (n, %)						training n = 31
abuse	37	(90.2)	43	(89.6)	0.60	placebo n = 19
dependence	40	(97.6)	39	(81.3)	.02[a]	
Treatment form (n, %)					0.23	
Online	32	(44.4)	23	(34.3)		training n = 0
Face to face	40	(55.6)	44	(65.7)		placebo n = 0
Baseline Alcohol use						training n = 3
Mean (SD)	32.81	(26.6)	35.85	(38.3)		placebo n = 0
Median (IQR)	32.00	(38.0)	27.00	(38)	0.78	
OCDS[f] (mean, SD)	7.86	(4.7)	6.76	(4.1)	0.23	training n = 31
						placebo n = 18
DASS[g] (median, IQR)						training n = 31
Total	32.33	(22.4)	29.42	(23.84)	0.37	placebo n = 18
Depression	10.0	(15.0)	6.0	(14.0)	0.21	
Anxiety	6.0	(9.0)	6.0	(10.0)	0.64	
Stress	12.0	(10.0)	10.0	(16)	0.54	
MAP_HSS[h] (mean, SD)	11.79	(7.2)	10.92	(6.7)	0.55	training n = 31
						placebo n = 18
Drinking motives (mean, SD)						training n = 31
Social	3.00	(1.02)	2.90	(1.09)	0.56	placebo n = 18
Coping anxiety	3.08	(0.95)	2.98	(1.07)	0.58	
Coping depression	2.97	(1.11)	2.81	(1.11)	0.41	
Enhancement	2.71	(0.86)	2.55	(0.97)	0.32	
Conformity	1	(0.60)	1	(0.40)	0.68	
DRSE[i]	24.4	(7.04)	22.49	(7.35)	0.94	Training n = 5
						Placebo n = 2
Baseline alcohol D score (mean, SD)	−0.13	(0.32)	−0.004	(0.30)	.03[a]	training n = 12
						placebo n = 8
Baseline non-alcohol D score (mean, SD)	−0.09	(0.29)	0.60	(0.31)	.01[a]	training n = 12
						placebo n = 8

a: P < .05 (two tailed). b: Primary school or lower vocational education. c: Higher general secondary education or intermediate vocational education. d: University of research or university of professional education. e: CIDI = Composite International Diagnostic Interview. f: OCDS = Obsessive Compulsive Drinking Scale (min 0 – max 20). g: DASS = Depression Anxiety Stress Scale (min 0- max 126). h: MAP_HSS = Maudsley Addiction Profile (min 0 – max 40). i: DRSE = Drinking Refusal Self Efficacy.

scale from 1 to 4 (item variances: 0.3), indicating moderate satisfaction. There was no significant difference in the scores for training ($M = 20.7$, $SD = 4.8$) and placebo ($M = 19.8$, $SD = 5.2$) conditions; $t(97) = 0.93$, $p = .36$.

When asked about their opinion on the training in open-ended questions after the CSQ, patients reported having experienced positive elements from the AAT training. The two most mentioned elements were 1. the interest for outcomes of the study and the condition patients were put in and 2. The training was helpful to them. The five most mentioned negative elements were 1. Questioning the purpose of the training, 2. No explanation of the principle of CBM, 3. Monotonous training, 4. Impossibility to use the training on other devices, and 5. Dislike of certain non-alcoholic drinks.

4. Discussion

This randomized placebo-controlled trial aimed to investigate the effectiveness of online Approach Bias Modification (ApBM) compared to placebo as an add-on to usual treatment in an outpatient setting for AUD patients. The ApBM consisted of 8 sessions of online keyboard-operated ApBM training administered on participants' home computer or laptop. The results showed that ApBM did not improve effectiveness of TAU. No additional effects were found on alcohol intake or other clinical outcomes, including craving, depressive and anxiety symptoms, and stress. Patients in both groups reduced their alcohol intake significantly, but no difference between conditions over time was found. Patients in the ApBM condition did show a significantly larger reduction in alcohol-approach tendencies post-treatment, in comparison to the placebo condition.

4.1. Alcohol consumption

The findings of this study on alcohol consumption are in contrast with earlier inpatient ApBM studies (Eberl et al., 2013; Manning et al., 2021; Rinck et al., 2018; Wiers et al., 2011) that found patients in the active training condition relapsing about 10 % less than the placebo group. Compared to our study, more similar results on main effects were found in studies that evaluated online ApBM training for problem drinkers (van Deursen et al., 2020; Wiers et al., 2015) or smokers (Kong et al., 2015; Wittekind et al., 2019) either as stand-alone training or as an addition to a short CBT intervention. In these studies, no main effects for reduction in alcohol or cigarette use were found as well. One explanation might be the difference in treatment goal (abstinence vs reduced drinking) (Wiers et al., 2018). Although research suggests that

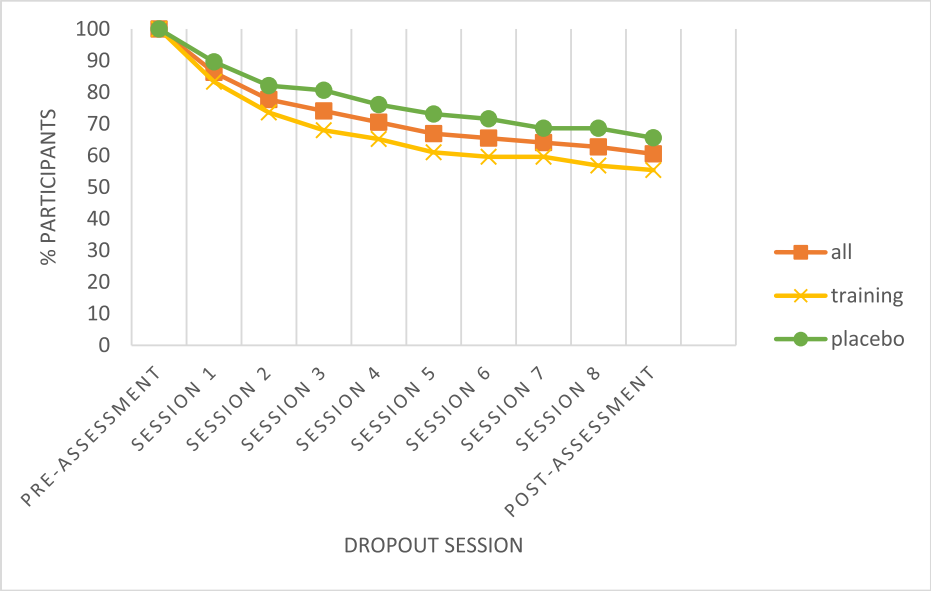

Fig. 2. Dropout curve: percentage of patients by last session in the training, placebo and complete group.

Table 2
Outcomes for primary and secondary measures at different timepoints.

	T0 (pre-assessment)		T1 (post-assessment)		T2 (3 months FU)		T3 (6 months FU)	
	Training	Placebo	Training	Placebo	Training	Placebo	Training	Placebo
Primary measure								
Alcohol use								
Safe drink (%)	42	41	60	56	65	77	62	75
Units/week (mean, SE)*	33.0 (3.4)	35.9 (4.6)	18.8 (2.4)	20.3 (2.7)	16.6 (2.7)	15.0 (3.4)	18.1 (3.8)	15.4 (3.5)
Secondary measures								
D-scores training completers (n = 83) (mean, SD)								
Alcohol approach bias	−0.138 (0.33)	0.007 (0.31)	−0.290 (0.40)	0.070 (0.41)				
Non-alcohol approach bias	−0.108 (0.30)	0.058 (0.31)	0.000 (0.35)	0.064 (0.37)				
MAP-HSS (mean, SE)*	11.65 (1.09)	10.83 (0.87)	7.15 (0.84)	6.24 (0.98)	7.18 (0.96)	6.35 (0.84)	7.13 (1.18)	6.54 (1.13)
DASS (mean, SE)*	30.98 (4.22)	27.80 (2.42)	15.83 (2.18)	14.18 (2.21)	14.41 (2.27)	13.99 (2.25)	17.24 (2.75)	17.19 (3.13)
Depression	11.86 (1.12)	9.67 (1.04)	5.47 (1.18)	3.95 (1.15)	4.80 (1.32)	4.46 (1.16)	6.14 (1.37)	5.15 (1.42)
Anxiety	7.67 (0.83)	7.39 (0.76)	2.16 (0.87)	3.55 (0.85)	2.93 (0.98)	3.23 (0.86)	3.36 (1.01)	4.23 (1.05)
Stress	12.81 (1.13)	12.37 (1.05)	7.21 (1.19)	7.50 (1.16)	5.67 (1.34)	6.26 (1.17)	7.71 (1.38)	7.31 (1.44)
OCDS (mean, SE)*	7.41 (0.62)	6.50 (0.52)	4.92 (0.49)	4.72 (0.47)	6.51 (0.53)	6.22 (0.64)	7.38 (0.77)	6.89 (0.62)

* Pooled imputation GLM analysis.

long term alcohol use can result in adaptations in the incentive salience circuitry that can still influence reactions to alcohol-associated cues, even after prolonged abstinence, some parts of the incentive salience circuitry seem to have a reduced threshold for activation during prolonged abstinence (Cofresí et al., 2019). This may be why sustained abstinence is the optimal outcome in addiction treatment for those with more severe alcohol use disorders (Connor et al., 2016) and could therefore raise the question of whether ApBM would have the most added value in a sample aiming for abstinence.

4.2. Approach avoidance tendencies

In contrast to earlier online ApBM studies with problem drinkers (van Deursen et al., 2020; Wiers et al., 2015), we found a significantly larger decrease in alcohol approach tendencies in the active condition compared to the placebo condition. This might be explained by the fact that although the delivery mode in these CBM studies was similar (online, in the comfort of their own home, using their laptop or computer with a keyboard), the target group of this study was somewhat different. The participants in the studies by van Deursen (van Deursen et al., 2020) and Wiers (Wiers et al., 2015) consisted of problem drinkers who were interested in reducing their alcohol intake. This study, however, targeted patients that were already diagnosed with AUD and were in treatment at an addiction care clinic. Thus, within this sample, it proved possible to use online delivery modes to attenuate AUD-patients' approach biases.

The question remains, however, why this decrease in approach bias did not translate into clinical effects. A possible explanation might be that patients in our study received their treatment online or face to face in regular sessions, but either way residing in their homes, contrary to studies mentioned before (Eberl et al., 2013; Manning et al., 2021; Rinck et al., 2018; Wiers et al., 2011) where patients resided in an addiction clinic. Adding ApBM training to inpatient TAU might therefore be a better choice, as inpatients are not constantly exposed to important "environmental determinants of relapse, such as cognitive expectancies, psychosocial high-risk situations, and giving in to social influence to resume drinking" (Owen & Marlatt, 2001), which may undo the effects realized with ApBM training. This opposes our earlier presumption that exposure to cues might bolster CBM effects as it did in CBM studies on anxiety (Kuckertz et al., 2014; Nuijs et al., 2020). A second explanation might be that the strength of the effect of an improved ApB score might be influenced by the mode of delivery. Research suggests that automatic

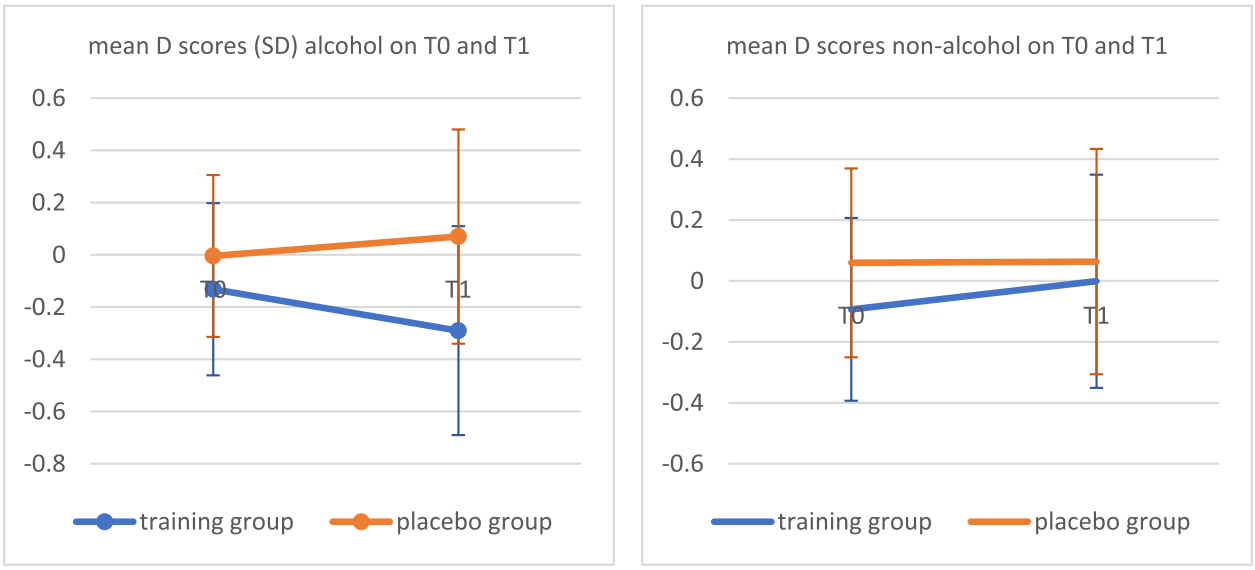

Fig. 3. Visual representation of mean (SD) D scores on alcohol approach bias at T0 and T1 and D scores on non-alcohol approach bias at T0 and T1 n = 40 training, n = 43 placebo, n = 83 total.

Table 3
Credibility Expectancy questionnaire (n = 108).

	Training		Placebo		*p*
	Mean	SD	Mean	SD	
CEQ (6–54)	33.1	11.6	28.3	12.0	0.034
Credibility (3–27)	15.6	5.5	13.3	5.4	0.028
Expectancy (3–27)	17.5	6.8	15.0	7.3	0.064

approach bias is embodied, so might translate better into real life situations when patients approach and avoid alcohol using their arms and hands for the actual movement. This would implicate that using a joystick or virtual reality training, would have a stronger clinical effect. (Solzbacher et al., 2022). A third explanation may be that the CBM effect did not last long enough to contribute to sustained reduction in alcohol use, and faded out soon after the last CBM session. As no bias measures were taken on the follow-ups, this cannot be verified within this study's data.

Development in ApBM research has recently lead to the suggestion of not simply replacing 'alcohol approach' with 'alcohol avoidance', but rather using a patients' relevant, goal-driven associations as an alternative (Wiers et al., 2020).

4.3. Limitations

A priori power analyses (Bratti-van der Werf et al., 2018) indicated a minimum of 304 patients, to have enough power to conduct all relevant analyses. As inclusion was halted at 140 patients. The study was unequivocally underpowered to generalize the results. We did conduct sensitivity analyses for treatment variant (online or F2F) and amount of sessions (<6 or ≥6). Results did not show a different pattern (analyses shown in supplemtary material). Also, a loss to follow-up influenced our research negatively; sixty percent of patients that were included completed the training, and data of just forty percent of patients were collected at the 6-month follow-up. Though the data were adequately imputed, the results of the follow-up measurements must be interpreted with great care.

4.4. Recommendations for future research

Future CBM research for AUD outpatients should clearly distinguish between patients with an abstinence goal and patients that are seeking to reduce their alcohol consumption. Future research could also include novel elements like training to automize behavioral decisions that are pertinent to a person's goals in particular situations, like ABC training (Wiers et al., 2020).

Additionally, a more user-friendly way of delivering the training would be a logical next step, as multiple patients recommended explaining the principle of CBM beforehand and offering CBM training via a mobile application, so they can have their training device close by at all times.

5. Conclusion

Adding online CBM training to regular treatment for AUD outpatients is effective in reducing the tendency to approach alcohol but not in reducing alcohol use above and beyond TAU.

CRediT authorship contribution statement

Melissa C. Laurens: Formal analysis, Investigation, Data curation, Writing – original draft, Project administration. **Marloes G. Postel:** Conceptualization, Writing – review & editing. **Marjolein Brusse-Keizer:** Formal analysis, Writing – review & editing. **Marcel E. Pieterse:** Conceptualization, Writing – review & editing. **Somaya Ben Allouch:** Conceptualization, Writing – review & editing, Supervision. **Ernst T. Bohlmeijer:** Conceptualization, Writing – review & editing, Supervision. **Elske Salemink:** Conceptualization, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2023.107630.

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