Imaginal retraining reduces alcohol craving in problem drinkers: A randomized controlled trial

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ABSTRACT

Background and objectives: Retraining, a psychological intervention derived from the approach-avoidance paradigm, has yielded mixed results for the treatment of alcohol use disorder as well as other forms of addiction. The present study investigated the efficacy of an imaginal variant of retraining that allowed greater personalization of the content.
Methods: Within the framework of a randomized controlled trial (RCT), 84 individuals with self-reported alcohol-related problems were recruited over the Internet and allocated to either imaginal retraining (treatment manual dispatched as a pdf-file via email) or a wait-list control group (with care-as-usual). The intervention period was four weeks. Alcohol craving, as measured with a visual analogue scale (VAS), served as the primary outcome. Other emotional (e.g. self-esteem) and drinking-related variables served as secondary outcomes.
Results: Both per-protocol (PP) and intention-to-treat (ITT) analyses showed that imaginal retraining led to a significant reduction in alcohol craving compared to the control group at a large effect size. Self-esteem improved in the retraining condition relative to controls in the PP and one of the ITT analyses; 75% of the individuals in the treatment group reported less alcohol consumption in the treatment period, whereas drinking behavior remained essentially unchanged in the control group ($p < .001$) (the trial was registered at the German Clinical Trials Register, DRKS00015319).
Limitations: Whether the effects of imaginal retraining are sustained over time needs to be established. Attrition was significantly higher in the retraining group (40.5%) than in the control group (16.7%). Designs with an active control condition are needed as well as dismantling studies to explore which of the treatment's multiple components best predicts improvement. Future studies should verify participants' alcohol consumption levels using objective measures.
Conclusion: Imaginal retraining led to significant effects on the reduction of alcohol craving.

1. Introduction

Alcohol use disorder (AUD) is a severe and persistent disorder with increased rates of all-cause and cause-specific mortality compared to the general population (Abdul-Rahman, Card, Grainge, & Fleming, 2018, pp. 1–34). Apart from the hardship AUD inflicts on the affected individuals and their social environment, AUD results in very high direct costs (e.g., treatment in acute hospitals, ambulatory care, and rehabilitation units) as well as indirect costs (e.g., inability to work, early retirement, and premature mortality) (Laramee et al., 2013). Effective psychological and pharmacological therapies are available for the treatment of AUD (Reus et al., 2018; Zhang et al., 2017) and even brief

interventions have shown to reduce hazardous and harmful drinking (O'Donnell et al., 2014) including online treatment (Gonzalez & Dulin, 2015). However, evidence-based treatment is often not applied (Knight, Littlejohns, Poole, Leng, & Drummond, 2017).

Relapse rates remain high even when evidence-based treatment is applied, reflecting the need for new therapeutic approaches and delivery mechanisms for this difficult-to-treat population (DeMartini, Fucito, & O'Malley, 2015), particularly in view of some evidence indicating a slightly increasing prevalence of harmful alcohol use and binge drinking in recent years (Grucza et al., 2018).

A more recent development in treatment for AUD has focused on changing implicit cognitions (Wiers et al., 2006). In one of these

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retraining/cognitive bias modification (CBM) procedures, called approach-bias modification, individuals are asked to respond to two kinds of stimuli (Wiers, Rinck, Kordts, Houben, & Strack, 2010). Participants have to use a joystick to push away pictures presented on a computer screen showing addiction-related stimuli and to pull towards themselves addiction-unrelated, pleasant stimuli. The instructions may be implicit or explicit (Wiers et al., 2015; Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011).[1] Corresponding to the joystick movement, the pictures gradually become smaller (push) or larger (pull). Approach-bias modification builds upon broad evidence from experimental psychology demonstrating that humans are faster in pushing away unpleasant stimuli (e.g., spiders) than in pulling them towards themselves, which is moderated by the level of fear they have of the depicted object (Rinck & Becker, 2007). For pleasant stimuli, the effect is reversed. Adapted to AUD, it is expected that when people with problematic alcohol use are asked a. to *pull* a joystick for pictures that are presented in landscape format and b. to *push* it for pictures that are presented in portrait format, the pull movement is executed faster than the push movement in cases where an alcoholic beverage is shown, even though the content is irrelevant for the task instructed to the participant.

In one treatment study, 214 patients with alcohol disorder were allocated to a retraining condition or to one of two control conditions. As hypothesized, retraining changed the approach bias into an avoidance bias. This effect generalized to untrained pictures and resulted in better outcomes one year later (Wiers et al., 2011). This effect, which occurred after only four sessions, was replicated and again lasted for one year (Eberl et al., 2013). In the largest study to date on 1405 patients with alcohol dependence (Rinck, Wiers, Becker, & Lindenmeyer, 2018), variants of the technique reduced relapse one year later by 8.4% (similar to Eberl et al., 2013, but smaller than in Wiers et al., 2011) when combined with standard treatment. Yet, the effects on the alcohol-approach bias were rather small.

Approach-bias modification has been successfully applied to a number of conditions marked by pathological approach behavior, such as cigarette smoking (e.g., Wittekind, Feist, Schneider, Moritz, & Fritzsche, 2015), obesity (e.g., Ferentzi et al., 2018; Mehl, Mueller-Wieland, Mathar, & Horstmann, 2018), and online gaming (Rabinovitz & Nagar, 2015).

A recent meta-analysis has tempered enthusiasm for CBM for substance addictions (Cristea, Kok, & Cuijpers, 2016) because the effects of approach-bias modification and other bias modification programs have been rather small in comparison to control conditions. In their reply, Wiers, Boffo, and Field (2018) suggests important moderators; effects are small but robust in RCTs with alcohol-dependent patients in clinical settings. Results obtained in online as well as laboratory studies with students are not fully reliable (for another meta-analysis, see Boffo et al., 2019). For the present study, we examined an imaginal variant of retraining that actively addresses shortcomings of the traditional technique. First, studies show that changes are most lasting if a new routine or program is easy to implement and fun (Duckworth, 2016). Retraining in its traditional approach is rather boring (Boendermaker, Boffo, & Wiers, 2015) and requires a computer device, which is likely detrimental to adherence. Attempts to increase motivation using gamification elements have not yet been successful (Boendermaker, Sanchez Maceiras, Boffo, & Wiers, 2016). Second, people with AUD differ greatly in their preferred drink and their predominant way of

drinking (can, bottle, glass, etc.) as well as their habitual drinking environment burdening a personalization of the computerized approach. Finally, a simple push movement with a joystick may not be sufficiently aversive to override the embodied urge to drink.

Building upon these considerations, we prepared a self-help manual that transfers the perceptual elements of the approach-bias modification procedure (i.e., stimuli, "zooming") into imagery but at the same time retains (and amplifies) the motor component of the original procedure (see the methods section for a more detailed description). The participants are instructed to imagine hurling their favorite alcoholic beverage(s) away from themselves at their favorite place of drinking following a simple mood induction. The movement is actually performed, but the beverage and the situation are only imagined. Our approach thus seeks greater emotional immersion than conventional approach-bias modification by coupling the preferred drink with a more aversive behavioral and affective response (i.e., the imagined alcoholic drink has to be thrown away with a feeling of disgust vs. a picture of a drink that has to be simply pushed away). The approach-avoidance instruction is in line with emerging evidence that explicit instructions are somewhat more effective than implicit ones (Phaf, Mohr, Rotteveel, & Wicherts, 2014).

We set up a randomized controlled trial and hypothesized that imaginal retraining would attenuate alcohol craving to a larger extent than a wait-list control condition (with care-as-usual). Due to ethical concerns, we rejected the implementation of a sham condition (e.g., Wiers et al., 2011) as this would have meant imagining drinking an alcoholic beverage in 50% of the trials, which could potentially have triggered subsequent substance abuse.

2. Methods

The study was directed at individuals between 18 and 75 years of age. No formal diagnosis of alcohol dependence nor fulfillment of any threshold criteria was required except for the presence of problematic drinking behavior (self-reported). One exclusion criterion was acute suicidality (score of 2 or 3 on the BDI-II rating for suicidal ideation). Disclosure of psychosis also led to immediate exclusion by means of a "trap door" in the online survey. Concurrent treatments (e.g., medication, psychotherapy) were allowed (care-as-usual; see Table 1). Severity of alcohol-related problems was assessed with the Alcohol Use Disorders Identification Test (AUDIT; see below).

Participants were recruited online between June and July 2018, mainly via Google AdWords. Furthermore, the database of a medical care center for people with mental disorders was searched for people with diagnosed AUD who had given their explicit consent to be contacted for scientific studies. The study was advertised as a treatment study. We explicitly stated that adverse effects could not be excluded.

We set up an Internet-based randomized wait-list-controlled trial (randomization plan). Study participation was anonymous, and we encouraged participants to create email addresses that did not disclose their names. Participants in the intervention condition received the imaginal retraining manual immediately after randomization, whereas participants in the wait-list condition received the manual upon completion of the post-assessment. The study was set up as an unguided treatment.

The final sample consisted of 84 participants. As the CONSORT flow chart (Fig. 1) shows, 139 persons accessed the first page and 26 cancelled immediately afterwards; one participant did not meet the inclusion criteria in terms of age (> 75); and 18 participants cancelled at a later point in the survey. Participants were evenly distributed into the two conditions (i.e., each $n = 42$). Completion of the assessment after four weeks was 71.4% and was higher in the wait-list ($n = 35$, 83.3%) than in the treatment group ($n = 25$, 59.5%; $\chi^2(1) = 5.83$, $p = .016$).

The trial was registered at the German Clinical Trials Register (DRKS00015319).

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[1] In the explicit condition, participants are asked to perform the movement based on the content of the picture presented (alcoholic beverage = push; nonalcoholic beverage = pull). In the implicit (concealed) condition, participants are asked to perform the movement based on, for example, the frame color or the format (e.g., portrait = push; landscape = pull), which, unbeknownst to the participant, is strongly coupled with the content of the picture presented (e.g., the portrait format (push) is always or most of the time an alcoholic beverage).

Table 1

Frequencies, means, and standard deviations (in brackets) of demographic, treatment-related, and psychopathological variables (N = 84).

	Wait-list control (n = 42)	Retraining (n = 42)	Statistics
Demographic variables			
sex (male/female)	15/27	15/27	χ^2 (1) = 0.00, $p > .99$
age (in years)	37.40 (12.23)	48.36 (11.69)	$t(82) = 4.19, p < .001$
Formal school education (9th grade/10th grade/13th grade/other)	3/12/24/3	7/15/19/1	χ^2 (3) = 3.51, $p = .319$
Treatment			
Current psychotropic medication (yes/no)	5/37	6/36	χ^2 (1) = 0.10, $p = .746$
Number of self-help materials read	0.57 (1.17)	0.76 (1.39)	$t(82) = 0.68, p = .500$
Treatment status (currently in treatment/no treatment)	6/36	12/30	χ^2 (1) = 2.54, $p = .111$
Questionnaires			
VAS total	41.98 (21.56)	54.21 (25.17)	$t(82) = 2.39, p = .019$
VAS craving	40.48 (20.83)	50.95 (27.21)	$t(82) = 1.98, p = .051$
VAS strength	46.67 (24.36)	61.19 (26.89)	$t(82) = 2.59, p = .011$
VAS frequency	38.81 (23.71)	50.48 (29.21)	$t(82) = 2.01, p = .048$
AUDIT	17.48 (6.20)	18.88 (5.04)	$t(82) = 1.14, p = .258$
BDI-II	15.36 (12.52)	21.12 (11.84)	$t(82) = 2.17, p = .033$
PHQ-9	6.76 (5.20)	9.62 (5.60)	$t(82) = 2.42, p = .018$
GAD-7	5.07 (4.45)	7.12 (4.21)	t 82) = 2.17, $p = .033$
Rosenberg-Scale	28.71 (5.19)	28.83 (5.69)	$t(82) = 0.10, p = .920$
WHOQOL-BREF global score	3.29 (0.92)	3.38 (0.99)	$t(82) = 0.46, p = .648$

2.1. Invitation and baseline survey

The assessments were set up using the online software Questback/Unipark®; no IP addresses were stored. Ethical approval was obtained from the ethics committee of the Medical School Hamburg (Germany) prior to the start of the trial. The Google AdWords campaign connected participants to the baseline survey. All participants were promised another self-help manual on imagery rescripting upon completion of the post survey. We offered no financial compensation. Subsequent electronic informed consent was mandatory. Then, questions on the participants' demographic backgrounds were posed as well as questions on their medical history (e.g., prior experience with psychotherapy; current treatment status; prior psychiatric diagnoses, if any). Next, psychopathological and other scales were administered (see below). Finally, we asked participants whether they had answered the questions truthfully and requested an email address and a personal code word. Participants were randomized to one of the two conditions (allocation was done based on the date of participation as displayed in the so-called "trigger email"). Due to the online setup of the study, concealed allocation is different from standard clinical trials with personal assessments in which team members perform the enrollment. Our procedure is best described as centralized assignment. There was no risk of bias with this procedure as the person allocating individuals to conditions had no information about the participants other than the date they signed up for the study.

2.2. Allocation to treatment groups

Participants in the treatment condition were sent the imaginal retraining manual via email. Participants in the control group were informed that they would receive the manual after the post-assessment. Four weeks after enrollment, all participants received a personal email invitation to take part in the post-assessment. Up to three reminders were dispatched. Participants were first requested to re-enter their email address as well as their personal code word (in order to match pre and post data). The same set of questionnaires was administered as in the baseline survey. For those who had received the manual and had at least started to read it, we posed further questions related to subjective quality, satisfaction, and subjective efficacy.

2.3. Imaginal retraining

Imaginal retraining is a manualized, stepped intervention (9.5 pages, including five photos and figures) that can be downloaded at no

cost via www.clinical-neuropsychology.de.

After a short introduction that highlights the purpose of the manual a psychoeducational section follows to increase participants' insight and stabilize their motivation to change. A number of health consequences of harmful drinking are presented, and reports of the alleged positive medical properties of alcohol are challenged. This section is not meant to induce fear in individuals but to keep their motivation high. In subsequent chapters, we familiarize participants with the classical approach-avoidance procedure and how this is utilized in retraining. We then explain the psychological mechanisms that seem to underlie retraining in order to enhance participants' understanding of the procedure.

Imaginal retraining is then explained. At the beginning, exposure in vivo and in sensu are briefly described, as the latter is a core element of our procedure. The participant is then asked to imagine his or her favorite alcoholic drink(s) followed by the nonalcoholic drink(s) they like as much or at least do not find unpleasant. Individuals are also informed about the connection between body posture and emotions. We explain that when we are depressed, we often walk slumped over and the corners of our mouths droop, whereas when we feel proud and are in a good mood, we have a more upright position. Importantly, posture and emotion influence each other in both directions. Gestures and posture are so strongly rooted in our emotions that straightening the body will automatically lead to a slight improvement in mood, but standing slumped over darkens our thoughts. We then provide specific instructions for the exercises. The individual is asked to perform two types of sequences. For the aversive sequence, the person should first exhale and literally sink down. They should round their shoulders, and this posture should be reinforced as vividly as possible with negative thoughts. Following this, they should think of their favorite alcoholic drink(s). They should then imagine pushing the drink away in their imagination in a place where they often consume alcohol (e.g., pushing it away from themselves on the counter of their favorite bar). This sequence is illustrated in the manual (see Fig. 2). We also recommend that they imagine throwing the drink onto the ground because pushing and downward movements are associated with disgust and rejection.

For the pleasant phase, the opposite is recommended. The participant should first imagine a nonalcoholic drink that they enjoy. Afterwards, they should take a deep breath and stand up straight as if someone is pulling them up by an imaginary thread attached to their head. The posture should be relaxed. Now they should move the drink towards their mouth in an exaggerated way, as in many advertisements, so that they are looking slightly upwards (this is introduced as a means to improve their mood). At the same time, they should contemplate

Table 2

Group differences across time (intention-to-treat and per-protocol analyses). Pre-post paired comparisons are presented in square brackets.

Variable	Wait-list control (n = 42)		Intervention (n = 42)		per-protocol	Intention-to-treat analyses: last observation carried forward/multiple imputation
	pre	post	pre	post	ANCOVA with baseline as covariate; ANOVA results are inside square brackets (see text)	
VAS total	39.62 (20.14)	57.90 (17.02) [****]	52.80 (26.40)	38.40 (25.04) [****]	$F_{(1,54)} = 24.33$, $p < .001$, $\eta_p^2 = .311$ [$F_{(1,55)} = 26.35$, $p < .001$, $\eta_p^2 = .324$]	$F_{(1,81)} = 22.37$, $p < .001$, $\eta_p^2 = .216$ [$F_{(1,82)} = 29.88$, $p < .001$, $\eta_p^2 = .267$] $B = 7.318$, $t = 4.49$, $p < .001$ [$B = 9.177$, $t = 5.20$, $p < .001$]
VAS craving	38.86 (19.97)	53.14 (18.27) [****]	50.00 (28.86)	38.00 (25.33) [*]	$F_{(1,54)} = 14.08$, $p < .001$, $\eta_p^2 = .207$ [$F_{(1,55)} = 15.81$, $p < .001$, $\eta_p^2 = .223$]	$F_{(1,81)} = 13.89$, $p < .001$, $\eta_p^2 = .146$ [$F_{(1,82)} = 18.65$, $p < .001$, $\eta_p^2 = .185$] $B = 1.995$, $t = 3.49$, $p = .001$ [$B = 2.524$, $t = 4.05$, $p < .001$]
VAS strength	43.14 (22.20)	65.71 (36.86) [****]	60.00 (28.28)	46.40 (31.61) [*]	$F_{(1,54)} = 16.54$, $p < .001$, $\eta_p^2 = .235$ [$F_{(1,55)} = 22.29$, $p < .001$, $\eta_p^2 = .288$]	$F_{(1,81)} = 16.56$, $p < .001$, $\eta_p^2 = .170$ [$F_{(1,82)} = 20.95$, $p < .001$, $\eta_p^2 = .204$] $B = 2.942$, $t = 3.59$, $p < .001$ [$B = 3.158$, $t = 3.67$, $p < .001$]
VAS frequency	36.86 (22.33)	54.86 (17.55) [****]	48.40 (30.80)	30.80 (23.44) [****]	$F_{(1,54)} = 27.40$, $p < .001$, $\eta_p^2 = .337$ [$F_{(1,55)} = 21.23$, $p < .001$, $\eta_p^2 = .279$]	$F_{(1,81)} = 20.63$, $p < .001$, $\eta_p^2 = .203$ [$F_{(1,82)} = 25.15$, $p < .001$, $\eta_p^2 = .235$] $B = 2.901$, $t = 4.36$, $p < .001$ [$B = 3.559$, $t = 5.21$, $p < .001$]
AUDIT	16.82 (5.91)	17.74 (5.35) [ns]	17.60 (5.09)	14.52 (5.96) [**]	$F_{(1,54)} = 8.28$, $p = .006$, $\eta_p^2 = .133$ [$F_{(1,55)} = 6.91$, $p = .011$, $\eta_p^2 = .112$]	$F_{(1,81)} = 3.35$, $p = .071$, $\eta_p^2 = .040$ [$F_{(1,82)} = 4.69$, $p = .033$, $\eta_p^2 = .054$] $B = 3.729$, $t = 2.09$, $p = .039$ [$B = 4.625$, $t = 2.33$, $p = .021$]
BDI-II	14.09 (11.69)	13.00 (9.05) [ns]	20.12 (11.72)	15.28 (11.40) [*]	$F_{(1,54)} = 0.41$, $p = .526$, $\eta_p^2 = .007$ [$F_{(1,55)} = 2.10$, $p = .153$, $\eta_p^2 = .037$]	$F_{(1,81)} = 0.12$, $p = .729$, $\eta_p^2 = .001$ [$F_{(1,82)} = 1.45$, $p = .231$, $\eta_p^2 = .017$] $B = 1.377$, $t = 0.66$, $p = .512$ [$B = 3.756$, $t = 1.60$, $p = .110$]
PHQ-9	6.00 (4.22)	7.43 (3.94) [ns]	8.88 (1.21)	7.56 (5.05) [ns]	$F_{(1,54)} = 2.70$, $p = .106$, $\eta_p^2 = .048$ [$F_{(1,55)} = 6.20$, $p = .016$, $\eta_p^2 = .101$]	$F_{(1,81)} = 2.90$, $p = .092$, $\eta_p^2 = .035$ [$F_{(1,82)} = 6.96$, $p = .010$, $\eta_p^2 = .078$] $B = 1.638$, $t = 1.75$, $p = .080$ [$B = 2.852$, $t = 2.75$, $p = .006$]
WHOQOL-BREF	3.37 (0.88)	3.57 (0.66) [ns]	3.44 (1.08)	3.60 (0.87) [ns]	$F_{(1,54)} = 0.87$, $p = .869$, $\eta_p^2 = .001$ [$F_{(1,55)} = 0.30$, $p = .586$, $\eta_p^2 = .005$]	$F_{(1,81)} = 0.11$, $p = .738$, $\eta_p^2 = .001$ [$F_{(1,82)} = 0.28$, $p = .599$, $\eta_p^2 = .003$] $B = 0.051$, $t = 0.29$, $p = .768$ [$B = 0.099$, $t = 0.49$, $p = .624$]
Rosenberg Scale	29.03 (4.55)	28.49 (3.94) [ns]	29.36 (5.38)	31.08 (5.99) [+]	$F_{(1,54)} = 7.17$, $p = .010$, $\eta_p^2 = .117$ [$F_{(1,55)} = 4.51$, $p = .038$, $\eta_p^2 = .076$]	$F_{(1,81)} = 4.25$, $p = .042$, $\eta_p^2 = .050$ [$F_{(1,82)} = 3.79$, $p = .055$, $\eta_p^2 = .044$] $B = -2.183$, $t = 1.92$, $p = .057$ [$B = -2.141$, $t = 1.76$, $p = .079$]
GAD-7	4.63 (4.10)	5.71 (3.78) [*]	6.32 (4.27)	5.72 (4.68) [ns]	$F_{(1,54)} = 2.89$, $p = .095$, $\eta_p^2 = .051$ [$F_{(1,55)} = 4.35$, $p = .042$, $\eta_p^2 = .073$]	$F_{(1,81)} = 2.60$, $p = .111$, $\eta_p^2 = .031$ [$F_{(1,82)} = 5.01$, $p = .028$, $\eta_p^2 = .058$] $B = 1.642$, $t = 1.80$, $p = .074$ [$B = 2.31$, $t = 2.41$, $p = .017$]

Note. Means and standard deviations were calculated for study completers (pairwise data) and thus deviate from the descriptive statistics presented in Table 1 ns = nonsignificant; * = $p \leq .05$; ** = $p \leq .01$; *** = $p \leq .005$; **** = $p \leq .001$.
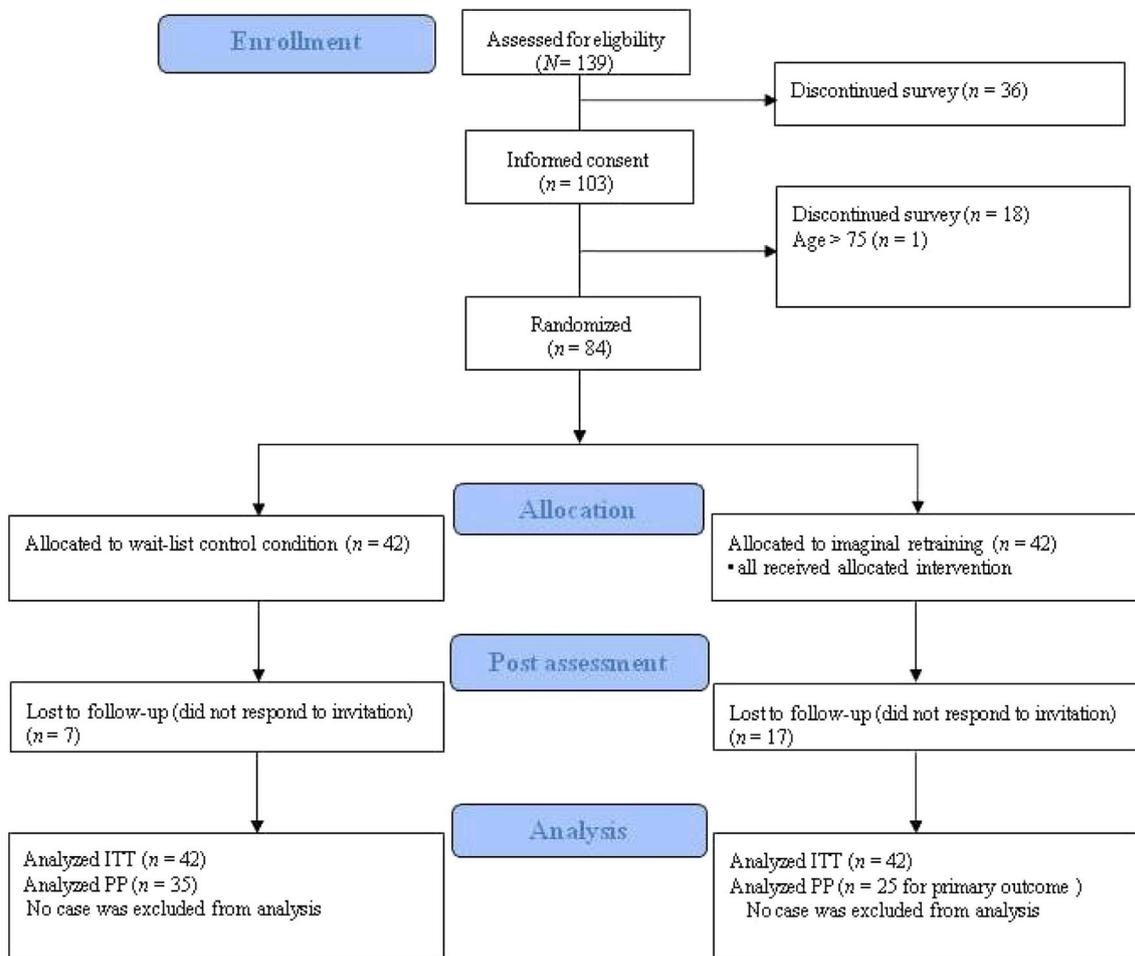
Fig. 1. CONSORT flow chart.

Fig. 2. The two sequences of training. Aversion movement (upper panel): Imagine grabbing an alcoholic beverage – bend your body forward and contemplate negative thoughts – imagine throwing the drink down and away from yourself. Approach movement (lower panel): Imagine grabbing a nonalcoholic beverage – stretch your body up – imagine lifting the drink high and, if possible, couple this with other positive feelings (e.g., stroking a pet).

pleasant thoughts and images (e.g., drinking while stroking a pet lying against their chest). Again, a drawing illustrates this procedure (see Fig. 2). This second exercise should be performed regularly as well, but the manual does not impose a strict "recipe" or order.

The final part of the manual consists of a few tips, including the suggestion to **s**et a timer so that participants are reminded at least twice a day to perform the exercises. Practicing about 10 min a day is encouraged. We also advise drinking from smaller bottles than before (e.g., 0.3 L instead of 0.5 L) and "interval" drinking, that is, following each alcoholic drink with a nonalcoholic drink of a similar size.

2.4. Questionnaires

2.4.1. Primary outcome

Visual Analogue Scale (VAS). The total score of the VAS served as the primary outcome and measured alcohol craving during the last week using three items. For scoring, the individual moves a bar between 0 and 100 (strength of alcohol craving in nondrink phases [not at all (= 0) to very strong (= 100); strongest alcohol craving (not at all (= 0) to very strong (= 100); frequency of alcohol craving (never (= 0) to always (= 100)].

2.4.2. Secondary outcomes

Alcohol Use Disorders Identification Test (AUDIT) (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). The AUDIT consists of 10 items. It was issued by the World Health Organization to measure the severity of alcohol-related problems. At post, we also asked whether participants had drunk much less, less, the same or more alcohol in the last weeks.

Beck Depression Inventory II (BDI-II) (Beck, Steer, & Brown, 1996). The BDI-II contains 21 items that tap into common symptoms of depression. The psychometric properties of the German version are good (Kühner, Bürger, Keller, & Hautzinger, 2007).

Patient Health Questionnaire (PHQ-9) (Kroenke, Spitzer, & Williams, 2001). The PHQ-9 is derived from the Primary Care Evaluation of Mental Disorders (PRIME-MD) and captures the nine depression criteria of the *DSM-IV*. The PHQ-9 is a valid instrument to assess depression (Kroenke et al., 2001).

Rosenberg Self-Esteem Scale (RSES) (Rosenberg, 1965). This unidimensional self-report scale assesses self-esteem and has good psychometric properties (Roth, Decker, Herzberg, & Brähler, 2008).

WHO Quality of Life (WHOQOL-BREF) (Skevington, Lotfy, & O'Connell, 2004). Quality of life was estimated with the global item of the WHOQOL-BREF.

Generalized Anxiety Disorders 7 (GAD-7) (Spitzer, Kroenke, Williams, & Lo, 2006). The GAD-7 screens for general anxiety symptoms. Its seven items are assessed for the past two weeks. Reliability is very good (Spitzer et al., 2006).

2.5. Moderator variables

Willingness to change was assessed at baseline with a subset of items from the University of Rhode Island Change Assessment (URICA) (Greenstein, Franklin, & McGuffin, 1999) that were aggregated to the following subscales: precontemplation (e.g., "I guess I have faults, but there's nothing that I really need to change"), contemplation (e.g., "It might be worthwhile to work on my problems") and action (e.g., "I have started working on my problems but I would like to have help"). The questionnaire has satisfactory reliability (Chan, Chan, Siu, & Poon, 2007; Dozois, Westra, Collins, Fung, & Garry, 2004). Participants' expectations regarding the success of the intervention were measured with a single item (1 = not successful at all; 9 = very successful).

2.6. Subjective appraisal and benefit

Participants who read the manual were presented with the Patient Satisfaction Questionnaire (German acronym ZUF-8) (Schmidt,

Lamprecht, & Wittmann, 1989), adapted for online interventions (see Table 3). The ZUF-8 assesses subjective appraisal of the technique (e.g., quality, satisfaction, effectiveness, and intention to use the application in the future). We posed additional questions on treatment satisfaction that are displayed in Table 4.

2.7. Statistical analyses

The main analyses were performed using ANCOVAs to correct for possible regression to the mean; this procedure usually leads to an increase in power (Borm, Fransen, & Lemmens, 2007; Vickers & Altman, 2001).

We performed intention-to-treat (ITT) and per-protocol (PP) analyses. The ITT analysis considered all participants with available baseline data. We used both multiple imputation as well as last observation carried forward (LOCF) as no gold standard currently exists as to how to handle missing data. The latter procedure is particularly conservative as it assumes that non-completers of the endpoints show unchanged values over time. The PP analysis considered participants with endpoint data who had at least started to read the manual. In view of the ongoing debate (Van Breukelen, 2006) over whether ANOVA or ANCOVA should be performed under certain circumstances (e.g., baseline differences), we also provide ANOVA results for the PP and ITT analyses.

Sample size calculation was performed with G*Power (Erdfelder, Faul, & Buchner, 1996) based on the assumption of a medium to large effect size in favor of imaginal retraining (alpha = .05; ß = 0.8). This indicated that 80 participants were needed to detect significant effects. We also explored whether completers differed from non-completers of the post-assessment. Potential moderators of treatment outcome were examined using the PROCESS macro by Hayes (model 1); the parameters were set to default mode.

3. Results

Table 1 shows that the two groups did not differ on sex, education, medication, or current therapeutic status. However, the treatment group was older and was more depressed and anxious. VAS but not AUDIT scores of the treatment group were elevated. The effect of the baseline difference was compensated by ANCOVA models that attempted to adjust for baseline scores. As discussed below, age did not exert any effect on the data.

The mean level of depression was at the upper limit of mild depression ($M = 18.24$), with 20.2% of the individuals meeting the criteria for severe depression (29 or higher). Mean AUDIT scores ($M = 18.18$) were in a range (16–19) that, according to the authors of the test (Babor et al., 2001), is suggestive of "brief counseling and continued monitoring" (p. 20), and 38.9% had a score that "clearly warrant[ed] further diagnostic evaluation for alcohol dependence" (p. 20; score of 20 or higher). Eighteen participants (21%) were currently in treatment (see Table 1).

According to self-report, 75% in the imaginal retraining group had drunk less in the preceding four weeks (i.e., during the intervention) than before the intervention, and none reported having drunk more (the same amount: 25%). In the control group, 14.7% reported having consumed more or less alcohol (the same amount: 70.4%). The difference was significant, $\chi^2(2) = 22.08$, $p < .001$.

Table 2 presents the results from the PP and the two ITT analyses (both ANCOVAs and ANOVAs are reported; see above). For the primary outcome (i.e., the VAS total score), the treatment group was superior to the wait-list control group at a large effect size, which was corroborated by significant pre-post effects (paired *t*-test) in the treatment group (Cohen's $d = .74$ for the total score). For the AUDIT, the PP analysis (medium to large effect size) and the ITT analysis with multiple imputation were significant as well, whereas the more conservative ITT analysis with LOCF bordered significance using the ANCOVA (and reached significance using the ANOVA); similar results emerged for

Table 3

Subjective appraisal of imaginal retraining (adapted from the Patient Satisfaction Questionnaire [ZUF-8]) with means and standard deviations (in brackets).

Item	Imaginal retraining	Positive appraisal in %
How do you rate the quality of the manual? (excellent, good vs. okay, not good)*	2.05 (0.58)	81.8%
Did you receive the type of treatment you expected to receive? (absolutely, a lot vs. a little, not at all)	2.86 (0.77)	72.7%
To what extent did the manual meet your needs? (absolutely, a lot vs. a little, not at all)*	2.55 (0.91)	59.1%
Would you recommend the manual to a friend with similar symptoms? (yes, probably yes vs. probably not, no)	3.14 (0.99)	77.3%
How happy are you with the extent of the help you have received through using the manual? (very satisfied, mostly satisfied vs. somewhat dissatisfied, dissatisfied)	2.91 (0.87)	68.2%
Did the manual help you to cope with your problems more successfully? (absolutely, a lot vs. a little, not at all)*	1.91 (0.87)	86.4%
How satisfied are you with the manual in general? (very satisfied, mostly satisfied vs. somewhat unsatisfied, unsatisfied)*	2.09 (0.87)	77.3%
Would you use the manual again? (yes, probably yes vs. probably not, no)	3.09 (1.15)	77.3%

Note. * Lower scores indicate more positive values (inverted scores).

Table 4

Subjective appraisal (additions to the Patient Satisfaction Questionnaire [ZUF-8]). Means and standard deviations (in brackets).

Item	Imaginal retraining	% endorsement (fully applies to applies a little)
I think the retraining manual is good for self-help and self-guidance.	2.91 (0.75)	100%
I think the content of the manual was comprehensible.	3.55 (0.60)	100%
I think the manual was helpful.	2.91 (0.97)	90.9%
I was able to use the manual on a regular basis during the past weeks.	2.73 (1.03)	86.4%
I had to force myself to use the manual.	2.00 (0.82)	68.2%
I have drunk less alcohol due to the exercises	2.41 (1.10)	72.7%
I think the manual would make more sense if it were used together with psychotherapy.	3.00 (0.82)	95.5%
The manual is not applicable to my alcohol-related symptomatology.	1.68 (0.95)	40.9%
My alcohol-related symptomatology has decreased through my use of the program	2.09 (0.81)	77.3%

self-esteem, with a slight improvement in the imaginal retraining condition and a slight worsening in the control condition. For the BDI-II and quality of life (WHOQOL-BREF), the results were nonsignificant. The ANOVA results led to somewhat more progressive results, and for the PP and ITT analyses, significant effects in favor of the experimental condition emerged for GAD-7 and the PHQ-9.

3.1. Evaluation of the intervention

At least four out of five participants endorsed the following statements: appropriate for self-help, good quality, comprehensible, helpful, helped participant cope with problems more successfully, and usage of the manual on a regular basis (see Tables 4 and 5).

Almost 80% endorsed the following items: satisfied with the manual, would use again in the future, would recommend to a friend, helped to reduce alcohol-related problems.

However, the vast majority also endorsed that the manual should be part of a psychotherapeutic program. About two out of three participants had to force themselves to perform the exercises, and two out of five did not find the manual applicable to their problems. Needs were met in 59.1% of cases. Seventy-three percent thought they had received the help they had expected and had drunk less due to the exercises.

3.2. Adherence

In the intervention group, non-completers of the post-assessment had a lower education than completers (university degree: 25% vs. 54.5%, $\chi^2(1) = 3.80$, $p = .050$) and were younger ($t(40) = 2.12$, $p = .040$; 44.50 years vs. 51.86 years). At statistical trend level, non-completers more often worked full-time (70% vs. 40.9%, $\chi^2(1) = 3.68$, $p = .059$).

3.3. Moderation

For the moderation analyses (independent variable: condition; dependent variable: change in VAS total score), we entered approximately 100 scores obtained at baseline, including the variables displayed in Table 1. Only two significant interactions emerged that would not have

survived a correction for multiple comparisons. Even so, we would like to report these results for exploratory reasons. Respondents in the wait-list condition who were currently in treatment (6 out of 18; see Table 1) as well as those reporting a prior psychiatric diagnosis showed a slight deterioration in VAS scores, whereas individuals in this condition who were not in treatment and had no psychiatric diagnosis showed an improvement. For the treatment group, a corresponding pattern was not observed, resulting in a significant moderation effect (current treatment; $B = 12.95$, $SE = 4.20$, $t = 3.08$, $p = .003$, lower level confidence interval (LLCI) = 4.53, upper level of confidence interval (ULCI) = 21.37; psychiatric diagnosis; $B = 10.27$, $SE = 3.55$, $t = 2.90$, $p = .005$, LLCI = 3.16, ULCI = 17.38). The participants' expectations regarding treatment had no differential predictive value across groups; however, the main effect became significant, indicating that a higher expectation of treatment efficacy led to general improvements in treatment outcome (B = 1.32, $SE = 0.57$, $t = 2.31$, $p = .025$, LLCI = 0.18, ULCI = 2.47). Age, which differed for the two conditions (see above), did not impact results, neither as a main effect ($B = 0.14$, $SE = 0.08$, $t = 1.65$, $p = .11$, LLCI = -0.03, ULCI = 0.31) nor as a moderator ($B = -0.12$, $SE = 0.18$, $t = -0.64$, $p = .523$, LLCI = -0.48, ULCI = 0.25).

4. Discussion

The present study employed an in sensu variant of retraining, a cognitive technique aimed at overriding the embodied urge for alcohol via an approach-avoidance procedure. Participants with problematic alcohol use were instructed to perform two kinds of imaginary action sequences. First, they were instructed to imagine hurling away their favorite beverage(s) following a negative mood induction. Importantly, the beverage was only imagined but the movement was actually executed. Second, they were instructed to imagine themselves drinking a nonalcoholic beverage following a positive mood induction. Four weeks after the baseline assessment, 75% of the completers of the post-assessment in the imaginal retraining group reported a decline in drinking due to the intervention. In the wait-list control group, the amount that participants drank stayed the same, with most participants drinking the same amount as before. This was corroborated with scores obtained

from a visual analogue scale measuring alcohol craving (primary outcome) and from the AUDIT. Results show very large effect sizes for the primary outcome for both the PP and ITT analyses in favor of imaginal retraining. Even when no change was assumed for the non-completers of the post-assessment using the LOCF method, who were more numerous in the treatment than in the control group, the results remained significant for craving (for a critical review of LOCF see Lachin, 2016). The significant interaction of Group and Time can be partly explained by an increase in craving in the control group. Still, paired t-tests showed that the amelioration of craving in the treatment group was significant at a medium to large effect size ($d = .74$).

For the AUDIT and self-esteem, analyses favored the experimental condition over the wait-list control group (significant difference or statistical trend). For other secondary outcomes, results were more mixed, with no clear advantage for the experimental condition.

Attrition was high (28.6%) and was significantly higher in the imaginal retraining group than in the wait-list control group (40.5% vs. 16.7%). We can only speculate about the reasons why. Interestingly, individuals in the treatment group were older than those in the wait-list control group. Although age did not impact outcome, older age was associated with low adherence. Of note, attrition does not necessarily reflect poor outcome or no improvement; it could be due to other influences such as sealing over (participants' preference not to think about his/her symptoms during abstinence/recovery) or that participants have not improved to the desired level to undergo another assessment, particularly as participants in the treatment group had less to gain from another participation than the wait-list control group who received both the treatment manual and another incentive. Non-completers of the post-assessment may have also reached a "good enough level of improvement", that is, had ended treatment after a satisfactory level of gains was achieved (Barkham et al., 2006). Still, we considered this possibility by using the LOCF method (see above). Moderation analyses did not indicate that expectancy or any of the URICA items had an effect on the results. These analyses suggest that patients in the control group showed deterioration if they were currently in treatment and if they had received a prior diagnosis, but no such effect occurred for the treatment group.

Traditional approach-bias modification and our technique share important features, particularly the motor element (alcoholic beverage = push; nonalcoholic beverage = pull). Yet, some features of our protocol are different and could offer an advantage. The traditional approach-bias modification procedure uses a computer to display screenshots of beverages. Movements are usually performed using a joystick, which either gradually increases or decreases the size of the pictures presented. This procedure cannot be implemented at any time of day (because the participant must have access to a computer or app), and it requires at least some time and preparation before implementation, whereas our technique can be performed virtually anywhere and anytime. Perhaps more importantly, people with alcohol use disorder differ in the drinks they prefer as well as their preferred drink containers (e.g., can, glass, bottle) and their habitual drinking environments. These combinations are virtually impossible to simulate by means of a computer device with constraints as to stimulus material. In addition, individuals using our technique are asked to throw away the alcoholic beverage and contemplate drinking a nonalcoholic beverage, and these acts may be accompanied by more extreme emotions than a simple joystick movement. We also encouraged a mood induction before the action sequence is initiated.

Replication is needed before solid conclusions can be drawn, and a head-to-head comparison with the traditional procedure has to be carried out before we can claim that our procedure is superior to the traditional one, which yields small effects (Rinck et al., 2018; Wiers et al., 2011); in fact, Wiers et al. (2018) suggest that online cognitive bias modification interventions yield even smaller effects. Other limitations also need to be considered. First, a follow-up is needed to

examine whether the effects of imaginal retraining are short-lived or sustained. Second, dismantling studies are needed to elucidate the driving factors of the effect, such as whether prior mood induction is an important prerequisite and whether the push sequence is more important than the pull sequence. Third, studies with formally diagnosed patients are necessary (although outcomes will rely on similar subjective measures as in our study) in which the primary outcome should be relapse rates. In addition, more fine-grained addiction scales are needed to capture the specific effects of the procedure on drinking behavior; the AUDIT and the craving scale are both considered too general for this purpose. Moderators of the effects should also be explored more thoroughly. Our results suggest that neither expectancy nor symptom severity represented a moderator. Still, it needs to be established whether people with severe and chronic alcohol use disorder will benefit from this treatment; from the approach-bias modification literature, it seems that effects are larger for problem drinkers (Wiers et al., 2015) than for patients with alcohol dependence (Wiers et al., 2011). Fourth, the technique should be tested against an active control group. We decided against a sham condition where the alcoholic beverage would be as often associated with a pull as with a push movement (and the same for the nonalcoholic beverage) since we did not find this ethically justifiable. The effect of a sham condition has not been fully established. In one study where sham and wait-list control groups were pooled to form a control group, no effect was shown (Wiers et al., 2011), whereas in another study the sham condition was as effective as retraining (Wiers et al., 2015). The psychoeducation sections of the manual and the general instructions at the end of the manual (to drink from smaller bottles, etc.) could be used as an active control, as could a manual describing relaxation and mindfulness techniques, in order to capture both the imaginal and practical features of imaginal retraining. Placebo effects cannot be ruled out, but, as mentioned, expectancy did not moderate the results differently across groups. Fifth, although we set up a randomized control trial, baseline differences occurred. We countered regression to the mean by adopting an ANCOVA analysis design. Still, replications with balanced baseline values are desirable. Sixth, the reported outcomes all relied on self-report. Testing for blood alcohol and other somatic screening procedures are clearly desirable to verify responses regarding alcohol consumption. This problem, however, also applies to expert interviews and clinician-rated instruments as they also depend on the reliability of patient responses. In our case, the bias may be lower than in expert interviews because the study was anonymous and the participants thus had nothing to gain by responding in a socially desirable manner, unlike in a face-to-face context where a relapse is perhaps more embarrassing to acknowledge (e.g., due to not meeting the therapist's expectations). Finally, in the last part of the protocol, additional advice was given (e.g., to drink from smaller bottles than before), and although these suggestions were only briefly described, their impact needs to be explored.

If the results are confirmed, the proposed technique may be easily transposed to other forms of addiction and impulsive control disorders (i.e., "behavioral addictions"), as has been done with classical computerized approach-bias modification in relation to obesity, for example (Ferentzi et al., 2018).

To conclude, a simple behavioral technique, augmented with imagery, led to a significant decrease over time in alcohol craving (primary outcome) at a very large effect size as well as in the amount of alcohol consumed. However, results are compromised by lack of a follow-up assessment and high attrition in the experimental group. Active control conditions are warranted for future studies.

Conflicts of interest

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbtep.2019.04.001.

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