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Randomized Controlled Trial on Imaginal Retraining for Problematic Alcohol Use: A Dismantling Study

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ABSTRACT

Imaginal retraining (IR) is an approach-avoidance procedure that has shown promising results in previous studies. The aim of the present study was to dismantle the efficacy of IR's components in a randomized controlled trial (RCT). We conducted a RCT with nine conditions comprising eight intervention groups and a waitlist control group (WLC). Alcohol craving (primary outcome), consumption, depressive symptoms, quality of life, subjective appraisal, and side effects were assessed online at baseline, post intervention (6 weeks), and follow-up (12 weeks). The sample consisted of 426 participants (age: $M = 47.22$, $SD = 11.82$, women: 50.5%). The intervention groups received instructions for four different components of IR (mood induction, mental avoidance of unhealthy stimuli, motor avoidance of unhealthy stimuli, approach to healthy stimuli) that were each conveyed with or without prior psychoeducation (PE). The intervention was delivered online. At total of 163 individuals (42.9%) used the intervention at least once. No group differences were found for any primary or secondary outcome after Šidák correction. Uncorrected statistics showed effects of significantly decreased alcohol consumption for the approach + PE group in the intention-to-treat and the merged motor avoidance group in the per-protocol analyses at post assessment compared with the WLC. Exploratory moderation analyses revealed that individuals with high visualization skills benefited most. The authors conclude that visualization training and motivational components may increase the efficacy and adherence of IR.

1 | Introduction

Although alcohol consumption is among the leading risk factors for annual disability-adjusted life years (DALYs) and deaths (GBD 2016 Alcohol Collaborators 2018; Shield et al. 2020), it remains highly prevalent, especially in Europe but also in regions of Africa as well as countries with a low human development index (Shield et al. 2020). Its high medical burden reflects the need for earlier and more sustained interventions to reduce alcohol consumption (Rehm and Shield 2019). Self-help techniques may be a promising approach to achieving this goal as they are cost-effective, directly accessible, and easy to disseminate (Chan et al. 2019). Self-help techniques for problematic alcohol use include internet-based interventions (for a review see for example Livingston et al. 2019) and self-help groups (for a review, see, e.g., Borkman, Munn-Giddings, and Boyce 2020).

Summary

- Imaginal retraining (IR) is an approach-avoidance procedure that has shown promising results in previous studies.

- No significant differences between the control group and all intervention groups were found after 6 weeks when correcting for multiple testing.

- Uncorrected statistics suggest that the motor avoidance components may be especially important for the effectiveness of the self-help technique.

- Individuals with high visualization skills benefit the most from imaginal retraining.

- Visualization training and motivational components may increase the efficacy and adherence of IR.

Imaginal retraining (IR) is a self-help technique derived from the computerized approach bias modification (ABM), which is a variant of cognitive bias modification (CBM) (Jones and Sharpe 2017). In ABM, participants are shown stimuli they crave (e.g., an alcoholic beverage) and neutral stimuli (e.g., a non-alcoholic beverage) on a computer screen. The intervention aims at retraining biased approach tendencies toward alcohol or other substances by instructing participants to push away craved stimuli and pull toward themselves neutral stimuli with a joystick (R. W. Wiers et al. 2009, 2010). ABM is designed to reduce the tendency to approach (i.e., pulling them toward ourselves) things we like (e.g., alcoholic beverages) and avoid (i.e., push away) things we do not like, do not like much, or perceive as neutral. There is emerging evidence that ABM reduces this tendency (i.e., the approach bias), drinking behaviour, and relapse rates (Batschelet et al. 2020; Boffo et al. 2019; Loijen et al. 2020). However, results of online and laboratory studies are mixed (Ferentzi et al. 2018), and patients' motivation to use the technique is often low (Zhang et al. 2018). IR adapts this approach to the imagination, eliminating the need for a computer. Craving-associated stimuli are to be pushed away in the imagination whereas neutral stimuli are to be pulled toward oneself in the imagination, which offers the advantage that the (imagined) images of the substances can be individually adapted (e.g., variety/brand of an alcoholic beverage). Moreover, it is easy to implement in everyday life (i.e., no need for a computer device). To date, IR has been investigated in three RCTs that were carried out online; IR have led to reduced craving for and consumption of alcohol (Moritz et al. 2019), cigarettes (Moritz et al. 2020), and high-calorie foods (Moritz et al. 2019b) compared with waitlist control groups with small to large effect sizes (both groups were allowed to use other treatment options). However, it remains unclear which of its multiple components significantly contribute to its effectiveness and which are dispensable.

In the first exercise of the intervention (avoidance exercise), participants are instructed to imagine a substance they crave in a context in which they often consume it and then engage in a negative mood induction by actively contemplating aversive thoughts and feelings. Subsequently, they are asked to push away the object (e.g., a cigarette and a glass of wine) in their imagination as well as with an actual arm movement while imagining the object becoming smaller (zooming out). The

second exercise of the self-help technique involves imagining a neutral object followed by a positive mood induction and an imagined as well as actual 'pull' movement that initiates consumption of a healthy object (e.g., an apple, a glass of water) in the imagination (approach exercise; see Methods section for a more detailed description of the intervention).

In two recent dismantling studies (Moritz et al. 2021; Wirtz et al. 2021), the effectiveness of a single dose of different variants of the IR procedure was evaluated. In both studies, participants were randomly assigned to one out of six conditions in which short texts instructed them to perform a specific intervention while looking at a picture of a stimulus they craved. Four of these conditions administered single components of IR (zooming out, avoidance exercise without actual movement, avoidance exercise with actual movement, and approach exercise), and two served as control conditions (observation and thought suppression). In a sample of individuals who regularly smoked cigarettes, the avoidance exercise without actual movement (mental avoidance only) led to a significant decline in craving compared with the control groups (Moritz et al. 2021). Other training components yielded inconsistent effects. Similar results were found in a sample of women with strong craving for high-calorie foods (Wirtz et al. 2021), implying that some components of the IR technique, such as the actual movement and the approach exercise, may be dispensable. However, neither study investigated all components and combinations of components of the self-help technique (e.g., negative mood induction), and results were limited to a single application of each investigated component. The aim of the present study was to investigate the effectiveness of different components of IR in an RCT over a longer period of time with repeated applications. The latter is important as previous studies have shown dose effects of the intervention in the sense that higher frequency of performance of the IR technique correlated with the symptom improvement (Gehlenborg et al. 2022, 2023; Moritz et al. 2019a, 2020). To date, there is only one dismantling study examining the effects of different IR components after repeated application (Wirtz et al. 2022), which supported the efficacy and feasibility of a simplified version of the IR technique. The authors suggested that components such as psychoeducation and emotion induction may be dispensable as they found that a simplified motor in-sensu AAT instruction (motor avoidance component of IR) combined with psychoeducation yielded the best effects in reducing craving at 4 weeks and 8 weeks after baseline. Effects on alcohol consumption (g ethanol) were inconsistent. The authors conclude that the core element of IR (i.e., pushing away alcohol-containing stimuli with an actual movement) may be the most effective component. However, the study only investigated three different training versions (psychoeducation, a simplified motor in-sensu AAT instruction, and the original IR technique).

2 | Materials and Methods

2.1 | Study Design

We conducted a randomized controlled dismantling trial with nine conditions [eight intervention groups and a waitlist control group (WLC)] and parallel assignment. During the 6-week intervention period, each of the eight intervention conditions

received access to a video tutorial instructing them to conduct combinations of different components of the IR self-help technique. At baseline, post intervention, and 12 weeks after baseline (follow-up), questionnaires on sociodemographics (only at baseline), symptomatology, and subjective appraisal of the intervention (only for intervention groups at post and follow-up) were assessed via the online software Qualtrics. The study was preregistered with the German Clinical Trials registry (DRKS00023071) and approved by the local psychological ethics committee of the Center for Psychosocial Medicine of the University Medical Center Hamburg-Eppendorf (Germany; LPEK-0139), and it was conducted in accordance with the Declaration of Helsinki. No personal information such as name, address, and telephone number were obtained. Participants were merely asked to leave an e-mail address at baseline through which they were invited to participate in the post and follow-up surveys. We recommended they use a pseudonymous e-mail address to prevent any conclusions being drawn from their clear name e-mail address. Instructions on how to create a pseudonymous e-mail address were given. Moreover, participants were informed that e-mail addresses would be deleted at the end of the study and that they could request the deletion of their data at any time without giving a reason by sending us the e-mail address. E-mail addresses were requested at the start of all three assessments and were used to match participant data at each time of measurement. All data were stored electronically on password-protected computers. Participants were rewarded with a manual on relaxation techniques after completion of the post assessment and a €10 Amazon voucher at follow-up. Moreover, all participants received access to the full version of the video tutorial and the written IR manual after completion of the follow-up survey (the manual as well as the video tutorial can be assessed at www.uke.de/sucht). The study centre was the University Medical Center Hamburg-Eppendorf in Germany (UKE).

2.2 | Participants

Participants were recruited using the online participant database WiSoPanel (https://www.wisopanel.net/) of more than 13,000 German-speaking individuals who have signed up to participate in web-based noncommercial studies (Göritz, Borchert, and Hirth 2021). In addition, study advertisements were posted in self-help groups, health groups, and survey groups on the online platforms Facebook and XING as well as on the UKE Instagram account. Lastly, Facebook advertisements were used (target criteria: age: 27–75 years; gender: female and male; location: Austria and Germany). The study advertisement contained a short description of the aim and procedure of the study and information on incentives after each assessment as well as the link to the baseline survey.

Inclusion criteria were (a) problematic alcohol use (operationalized as the subjective desire to reduce alcohol consumption), (b) age 18–75 years, (c) sufficient command of the German language, (c) informed consent, (d) no acute suicidal tendencies (PHQ-9 suicidality item < 2). Excluded participants were forwarded to a page informing them about the reasons for exclusion and providing them with contact numbers and web pages for support in

case of psychological distress. Participants who were excluded because of suicidality were also told to call an ambulance in the event of an acute suicidal crisis. Ongoing treatments (e.g., psychotherapy and pharmacotherapy) during the study period did not preclude participation.

2.3 | Sample Size Calculation

Sample size calculation for analysis of covariances (ANCOVA) was conducted using the software G*Power (Faul et al. 2007). Based on the results of the RCT by Moritz and colleagues (Moritz et al. 2019) as well as other findings on the efficacy of IR (Moritz et al. 2019b, 2020), we expected a moderate effect size ($d = 0.25$), an alpha of 0.05, and a power of 0.95 in favour of IR, resulting in a required sample size of $N = 372$.

2.4 | Randomization

Participants were randomly allocated to one of the nine conditions with parallel assignment (allocation ratio 1:1:1:1:1:1:1:1:1) using a randomizer in the survey software Qualtrics. At the end of the baseline survey, participants were randomly forwarded to one of eight online pages or to a text block in Qualtrics. The online pages each presented one of the eight video tutorials and the download link as well as short instructions to conduct the exercises twice a day. Participants allocated to the WLC were informed that they would receive access to the intervention in 12 weeks. Because of the web-based and self-report design of the study, the randomization process differed from that used in face-to-face clinical trials (e.g., no need for rater blindness). None of the staff members could influence the randomization of the participants.

2.5 | Intervention

The eight intervention groups each received a version of IR that included different components of the technique. In previous studies, a 14-page manual was used to instruct participants how to conduct the exercises. In the present study, the manual was converted into a video tutorial, and eight versions of the video of different lengths were developed. The videos provided instructions for four different versions of IR. For each of these versions, two videos were created, one of which had additional psychoeducational elements (PE; information on health consequences of alcohol consumption, approach bias, and embodiment), resulting in a total of eight video tutorials. In the first version (*mood induction*; 3:06 min/5:14 min), participants were instructed to imagine their favourite alcoholic drink in a context where they often consumed it followed by a negative mood induction ('Exhale and slump forward. Round your shoulders, and reinforce this as consciously as possible with negative thoughts'). In the second version (*mental avoidance*; 3:49 min/7:44 min), participants were additionally instructed to mentally take the drink in their hand and push it away with an imaginary arm movement (e.g., along a bar top). The third version (*motor avoidance*; 4:02 min/7:58 min) additionally included an actual physical arm movement; the drink, however, was just imagined. The fourth version (*approach*;

6:40 min/10:36 min) included all described components (the complete avoidance exercise) and also instructed individuals to conduct an approach exercise by imagining a nonalcoholic drink followed by a positive mood induction ('Make yourself tall and stand up as if someone were pulling you up by an imaginary thread attached to the top of your head. Your posture is upright and relaxed, your eyes are looking straight ahead'); afterward, the individual consumed a nonalcoholic drink in the imagination with an actual physical movement of the arm.

All the tutorials explained how to perform the self-help technique using images and animations, audio recordings, and an avatar performing the technique. At the end of each video, suggestions for the application of the exercise in everyday life were given, such as setting a timer for regular application. A cautionary statement (that the self-help technique does not replace withdrawal and cessation therapy) and the contact address of the principal investigator followed. The intervention manual can be downloaded at https://clinical-neuropsychology.de/.

2.6 | Outcomes

2.6.1 | Primary Outcome

Visual Analog Scale (*VAS*). A VAS assessing craving for alcohol served as the primary outcome. The VAS refers to the previous week and includes three items assessing overall strength of craving, strongest craving, and frequency of craving. Items were answered with a slider on a scale from 0 ('not at all' or 'never') to 100 ('very strongly' or 'always'). The mean value of the three items was defined as the composite score of the VAS. Internal consistency of the VAS at follow-up was high (Cronbach's $\alpha = 0.88$).

2.6.2 | Secondary Outcomes

Alcohol Use Disorder Identification Test (*AUDIT*; Saunders et al. 1993). The AUDIT is a screening questionnaire for detecting levels of alcohol use disorder (Babor et al. 2001). The AUDIT has 10 items that are answered on a 4-point scale. The total score can range from 0 to 40, with recommended cutoffs at 8 points indicating hazardous alcohol use, at 16 points indicating harmful alcohol use and at 20 points indicating possible alcohol dependence. The AUDIT has shown good internal consistency (Cronbach's $\alpha = 0.75$–0.97) in various samples and settings (Reinert and Allen 2007). For analysing symptom change over time, the abbreviated version of the AUDIT, the AUDIT-C (Bush et al. 1998), which includes the three consumption items of the AUDIT, was used. Internal consistency of the AUDIT-C at follow-up was acceptable (Cronbach's $\alpha = 0.67$).

Patient Health Questionnaire 9 (*PHQ-9*; Kroenke, Spitzer, and Williams 2001). The PHQ-9 contains nine items assessing depressive symptoms that can be answered on a 4-point scale ranging from 0 ('not at all') to 3 ('almost every day'). The PHQ-9 has shown good internal consistency (Cronbach's $\alpha = 0.89$) and test–retest reliability ($r = 0.84$; Kroenke, Spitzer, and Williams 2001).

The total score ranges from zero to 27 points (0–4 = no/minimal, 5–9 = mild, 10–14 = moderate, 15–19 = strong, and 20–27 = severe depression). Internal consistency of the PHQ-9 at follow-up was high (Cronbach's $\alpha = 0.88$).

World Health Organization Quality of Life (*WHOQOL-BREF*; The WHOQOL Group 1998). The global item of the WHOQOL-BREF ('How would you rate your quality of life?') was used to measure quality of life in the previous 14 days on a 5-point scale ranging from 1 ('very poor') to 5 ('very good').

2.6.3 | Moderator Variables

Moderator variables were assessed at baseline. The Vividness of Visual Imagery Questionnaire (VVIQ; Marks 1973) was used to assess participants' ability to use their imagination using 16 items. Participants were instructed to mentally imagine specific scenes and rate the vividness of their imagination on a 5-point scale ranging from 1 (You see no image at all. You only know you are thinking about the object) to 5 (You see the image very clearly and vividly as if it were real). Internal consistency of the VVIQ in the present study was excellent (Cronbach's $\alpha = 0.96$).

Participants' motivation to change was assessed using a subset of nine items from the German Version of the University of Rhode Island Change Assessment (German acronym: FEVER; Hasler, Klaghofer, and Buddeberg 2003). Items are answered on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The FEVER showed good psychometric properties (Hasler, Klaghofer, and Buddeberg 2003). Participants' treatment expectation was assessed using a single item ('At this point, how successful do you think the self-help technique will be in relieving your symptoms?'; response range: 1 = not successful at all to 9 = very successful). Internal consistency of all URICA subscales in the present study was high (precontemplation: Cronbach's $\alpha = 0.85$; contemplation: Cronbach's $\alpha = 0.83$; action: Cronbach's $\alpha = 0.81$).

2.6.4 | Subjective Evaluation

For the post and follow-up assessments, patients in the intervention group who conducted the self-help exercises at least once during the study period were asked for their subjective evaluation of the technique. To assess satisfaction with the intervention, the patient satisfaction questionnaire (German acronym:ZUF-8; Schmidt and Wittmann 2002) was administered. The ZUF-8 comprises eight items (e.g., quality, subjective effectiveness, fulfilment of expectations, and intentions for future use) that are answered on a 4-point scale (response categories differ per item). Moreover, we administered five additional questions in each assessment on subjective appraisal of the self-help technique and the video tutorial (see Table 4). Potential side effects of the intervention were assessed along seven items on a 5-point scale (1 = agree to 5 = disagree). The items included side effects of positive effects (taking responsibility for oneself; pride; increased performance capability) and negative effects (increased thoughts about alcohol; increased alcohol consumption; incorrect therapeutic techniques; distress caused by imagination of alcoholic drink) and are displayed in Table 5.

2.7 | Statistical Analyses

IBM SPSS Statistics 26 was used for data analyses. Originally, we planned to calculate analyses of covariance (ANCOVAs) and estimate missing values by means of multiple imputations. However, as the imputation of missing data is not recommended if its proportion exceeds 40% (Jakobsen et al. 2017), which was the case in the present study (see Results section), we chose to calculate linear mixed-effects models (LMM). To increase the statistical power of analyses, LMM allows all participants to be included in the analyses regardless of whether they participated in all assessments. Models were computed using a two-level structure, with within-subject changes in outcomes over time at level 1 and group allocation (between-subject) at level 2. We chose restricted maximum likelihood (REML) as the method for parameter estimation. Models with random intercept and time and group, as well as their interaction as fixed predictors, were computed for all outcomes. Likelihood ratio tests were used to examine whether adding a random slope improved model fit. For each model, all covariance structures for repeated measures and random effects available in SPSS were tested. If covariance structures did not differ significantly regarding model fit, the Akaike information criterion (AIC) was used for model selection. For the final model of each outcome, pairwise comparisons of estimated marginal means of each intervention group compared with the control group were calculated using the SPSS function EMMEANS. Mean differences (MD), standard errors (SE), and t-statistics were reported for all significant comparisons at post and follow-up. As this is the first study of its kind, we chose to report uncorrected as well as corrected (Šidák) p-values. Analyses were conducted for the intention-to-treat sample (ITT), which included all participants who completed the baseline assessment, as well as for the per-protocol sample (PP), which only included participants who took part in the post or follow-up assessment and reported having conducted the exercises at least once during the study period.

We also conducted exploratory moderation analyses using the SPSS macro PROCESS (developed by Andrew F. Hayes) to evaluate whether any subgroups particularly benefited from the intervention. Lastly, subjective appraisal, satisfaction with the treatment, and positive and negative side effects were compared between intervention groups using the Kruskal-Wallis test.

3 | Results

3.1 | Baseline Characteristics

A total of 426 participants were recruited from September to October 2020. Follow-up data collection was completed in January 2021. Baseline characteristics of the total sample ($N = 426$) as well as the nine conditions are given in Table 1. No significant baseline group differences were found except for the VVIQ ($F(8, 417) = 3.58$, $p < 0.001$). Post-hoc t-tests with Bonferroni correction accounting for alpha inflation indicated significantly lower imagination skills in the mood + PE group compared with the approach + PE, mental + PE, and motor + PE groups ($p = 0.003–0.009$).

3.2 | Completion and Usage

The CONSORT flow chart is in Figure 1. Of the 426 individuals who completed the baseline survey, 216 (50.7%) took part in the post assessment and of which 191 (44.8%) completed the whole survey; 265 (62.2%) took part in the follow-up assessment of which 261 (61.3%) completed the whole survey. Completion rate of the post ($\chi^2(8) = 4.45$, $p = 0.814$) and follow-up ($\chi^2(8) = 7.86$, $p = 0.447$) assessments did not vary among conditions.

Participants in the intervention groups were instructed to conduct the exercises twice a day during the 6-week intervention period. However, at post assessment, 41.1% reported not having used the self-help technique at all and 20.8% conducted the exercises once, 22.6% once a week, 10.7% multiple times a week, 1.8% on a daily basis, and 3.0% multiple times a day. At follow-up, participants in the intervention group were again asked how often they had conducted the exercises in the past 6 weeks (since the post assessment). No specific instructions on usage after the post assessment were given. Approximately half of the participants (58.2%) reported not having used the intervention at all, 19.8% conducted the exercises once, 15.6% once a week, 3.8% multiple times a week, 1.3% on a daily basis, and 1.3% multiple times a day. The ratio of users versus nonusers of the intervention at the post ($\chi^2(7) = 4.99$, $p = 0.661$) and follow-up ($\chi^2(7) = 9.31$, $p = 0.231$) assessments did not vary significantly across intervention groups, nor did the frequency of use (post: $\chi^2(7) = 4.15$, $p = 0.762$; follow-up: $\chi^2(7) = 4.89$, $p = 0.674$).

3.3 | Symptom Changes Over Time

3.3.1 | Primary Outcome

As participants, despite randomization, differed significantly in VVIQ total scores at baseline, we included this variable as a fixed covariate in the model calculation for all outcomes. Pairwise comparisons of estimated marginal means of LMM analyses did not show any group differences in the VAS at baseline, post, or follow-up assessment, neither for the ITT sample ($p = 0.288–0.970$) that included all participants nor for the PP sample ($p = 0.120–0.985$) that included participants who reported having conducted the self-help technique at least once during the study period. To improve the statistical power of the analyses, we merged groups that received the same version of the self-help technique and differed only in whether they had received psychoeducation or not. Still, intervention groups did not differ in alcohol craving compared with the WLC at any time of measurement (ITT: $p = 0.435–0.882$; PP: $p = 0.373–0.963$).

3.3.2 | Secondary Outcomes

On the AUDIT-C, the approach + PE group showed significantly lower scores at post assessment compared with the WLC in the ITT analyses ($MD = -1.58$, $SE = 0.66$; $t(721.52) = 2.40$, $p = 0.017$). However, in the PP analyses, this effect did not emerge ($MD = -0.78$, $SE = 0.95$; $t(221.98) = 0.82$, $p = 0.416$). Moreover, pairwise group comparison of the motor avoidance group (without psychoeducation) and the WLC narrowly missed statistical significance in the ITT analyses ($MD = -1.25$,

TABLE 1 | Baseline characteristics of intervention groups and waitlist control group. Means and standard deviations (in brackets) or percentages.

Variable	Total (N=426)	Mood induction + PE (n=53)	Mental avoidance + E (n=49)	Motor avoidance + PE (n=48)	Approach + PE (n=45)	Mood induction (n=48)	Mental avoidance (n=47)	Motor avoidance (n=44)	Approach (n=46)	Waitlist control group (n=46)	Statistics
Sociodemographic variables											
Age in years	47.22 (11.82)	47.58 (11.11)	49.33 (10.69)	43.17 (11.59)	45.42 (12.79)	49.83 (12.16)	47.72 (11.40)	48.59 (10.82)	46.11 (12.64)	47.07 (12.61)	$F_{(8, 417)}=1.48$, $p=0.162$
Education (% not graduated)	0.9	0	2.0	0	2.2	0	0	2.3	0	2.2	$\chi^2_{(32)}=21.30$, $p=0.925$
Gender (% female)	50.5	47.2	49.0	50.0	46.7	52.1	59.6	54.5	45.7	50.0	$\chi^2_{(8)}=2.871$, $p=0.942$
Employed full-time (%)	54.0	49.1	49.0	56.3	51.1	60.4	55.3	59.1	56.5	50.0	$\chi^2_{(56)}=46.27$, $p=0.820$
Psychopathology											
VAS	45.76 (24.50)	48.21 (25.53)	47.40 (21.97)	49.53 (26.64)	42.94 (22.69)	42.54 (24.81)	47.94 (23.19)	41.20 (26.51)	44.16 (23.44)	47.06 (25.85)	$F_{(8, 417)}=0.69$, $p=0.702$
AUDIT	16.93 (7.54)	18.47 (7.80)	16.92 (7.81)	17.48 (6.44)	15.23 (6.89)	16.54 (7.82)	17.11 (8.58)	16.36 (7.79)	17.07 (6.90)	16.85 (7.77)	$F_{(8, 417)}=0.639$, $p=0.745$
PHQ-9	8.15 (5.14)	10.00 (5.83)	8.45 (5.06)	8.88 (4.77)	7.42 (5.11)	7.06 (5.23)	7.47 (4.37)	7.66 (4.77)	8.11 (5.61)	8.02 (5.00)	$F_{(8, 417)}=1.553$, $p=0.137$
WHOQOL-BREF	3.49 (0.90)	3.26 (0.99)	3.33 (0.85)	3.52 (0.90)	3.62 (0.86)	3.85 (0.88)	3.40 (0.99)	3.50 (0.70)	3.54 (0.94)	3.41 (0.83)	$F_{(8, 417)}=1.898$, $p=0.059$
Treatment-related information											
No current treatment (%)	79.8	75.5	75.5	75.0	86.7	79.2	78.7	79.5	82.6	87.0	$\chi^2_{(8)}=4.91$, $p=0.767$
Number of times in psychotherapy	1.12 (2.07)	1.23 (1.58)	1.71 (2.89)	1.40 (1.54)	0.82 (1.17)	0.87 (1.06)	1.37 (3.20)	0.90 (1.22)	1.35 (3.10)	0.67 (1.21)	$F_{(8, 407)}=1.29$, $p=0.246$
Moderators											
VVIQ	3.75 (0.86)	3.37 (0.86)	3.76 (0.73)	3.61 (0.93)	3.99 (0.82)	3.62 (0.79)	4.03 (0.78)	4.03 (0.80)	3.63 (0.97)	3.79 (0.86)	$F_{(8, 417)}=3.58$, $p<0.001$
CEQ	4.52 (1.88)	4.74 (2.20)	4.53 (1.87)	4.48 (1.69)	4.84 (1.83)	4.56 (1.89)	4.51 (1.91)	4.70 (1.71)	4.35 (1.74)	3.96 (1.94)	$F_{(8, 417)}=0.88$, $p=0.532$
URICA (precontemplation; contemplation; action	1.80 (0.90); 3.85 (0.87); 3.45 (0.83)	1.67 (0.86); 3.82 (0.80); 3.33 (0.93)	1.79 (0.93); 3.93 (0.88); 3.59 (0.72)	1.68 (0.77); 3.99 (0.79); 3.58 (0.90)	1.98 (0.93); 3.82 (0.85); 3.47 (0.88)	1.90 (0.93); 3.88 (0.78); 3.56 (0.75)	2.01 (1.00); 3.02 (0.94); 3.46 (0.80)	1.78 (0.95); 3.64 (0.95); 3.45 (0.84)	1.80 (0.85); 3.76 (0.97); 3.30 (0.79)	1.66 (0.82); 3.84 (0.90); 3.30 (0.82)	$F_{(8, 417)}=1.00$, $p=0.433$; $F_{(8, 417)}=0.64$; $p=0.744$, $F_{(8, 417)}=0.97$, $p=0.701$

Abbreviations: AUDIT = Alcohol Use Disorder Identification Test; CEQ = Credibility Expectancy Questionnaire; PHQ-9 = Patient Health Questionnaire Depression module; URICA = University of Rhode Island Change Assessment Scale; VAS = Visual Analogue Scale; VVIQ = Vividness of Visual Imagery Questionnaire; WHOQOL-BREF = global item of the World Health Organization Quality of Life questionnaire.
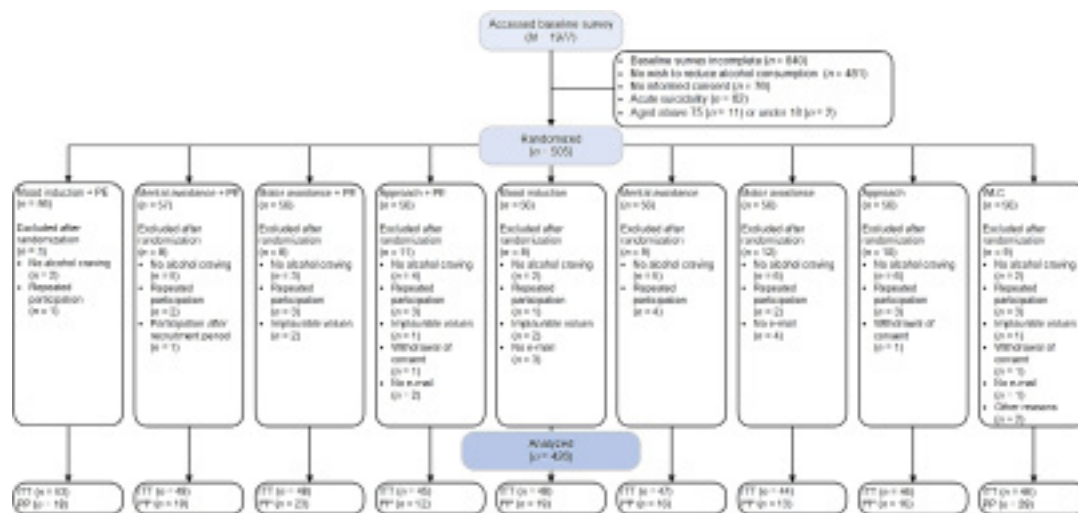
FIGURE 1 | CONSORT flowchart.

$SE = 0.64$; $t(701.00) = 1.94$, $p = 0.052$) but were not significant in the PP analyses ($MD = -1.58$, $SE = 0.93$; $t(219.00) = 1.70$, $p = 0.091$). At follow-up, no significant group differences were found (ITT: $p = 0.124$–0.932; PP: $p = 0.328$–0.855). Therefore, we reanalyzed pairwise comparisons of merged groups to increase the power of the analysis. No group differences in mean scores of the AUDIT-C were found in the ITT analyses. In the PP analyses, the merged motor avoidance group showed significantly lower AUDIT-C scores at post assessment compared with the WLC ($MD = -1.37$, $SE = 0.67$; $t(219.52) = 2.03$, $p = 0.043$).

Pairwise group comparisons of PHQ-9 scores showed a significant difference between the mood induction group and the WLC at post assessment in the ITT analyses ($MD = -2.81$, $SE = 1.25$; $t(745.67) = 2.25$, $p = 0.025$). In the PP analyses, the mood induction group ($MD = -3.41$, $SE = 1.50$; $t(254.83) = 2.27$, $p = 0.024$) and the motor avoidance + PE group ($MD = -3.14$, $SE = 1.40$; $t(243.46) = 2.25$, $p = 0.026$) differed significantly from the WLC at post assessment, with lower scores for both intervention groups. At follow-up, no significant effects for the mood induction group were found (ITT: $MD = -1.15$, $SE = 1.25$; $t(723.97) = 0.92$, $p = 0.357$; PP: $MD = -1.59$, $SE = 1.50$; $t(253.51) = 1.06$, $p = 0.290$). The effect for the motor avoidance + PE group did not achieve statistical significance ($MD = -2.74$, $SE = 1.42$; $t(253.83) = 1.93$, $p = 0.055$).

Lastly, the mood induction ($MD = 0.54$, $SE = 0.21$; $t(775.31) = 2.57$, $p = 0.010$) and the motor avoidance + PE group ($MD = 0.45$, $SE = 0.21$; $t(774.87) = 2.15$, $p = 0.032$) showed significantly higher scores on the global item of the WHOQOL-BREF compared with the WLC at post assessment in the ITT analyses. Importantly, the mood induction group and the WLC already differed at baseline in this analysis ($MD = 0.47$, $SE = 0.18$; $t(538.90) = 2.65$, $p = 0.008$). At follow-up, only the motor avoidance + PE group significantly differed from the WLC ($MD = 0.57$, $SE = 0.21$; $t(786.13) = 2.70$, $p = 0.008$) in favour of the intervention. The PP analyses showed similar results for the motor avoidance + PE group, showing higher quality of life compared with the WLC at post assessment ($MD = 0.40$, $SE = 0.18$; $t(773.11) = 2.15$, $p = 0.032$) and follow-up assessment ($MD = 0.42$, $SE = 0.18$; $t(774.53) = 2.28$, $p = 0.023$).

Significant effects are illustrated in Figure 2. It is important to note that none of the reported group differences (between different components of IR as well as comparisons with the WLC, see Figure 2) remained significant after *Šidák* correction for multiple testing.

3.4 | Moderation

We conducted exploratory moderation analyses for VAS and AUDIT-C improvement from baseline to post assessment for all intervention groups compared with the WLC. Sociodemographics, baseline psychopathology scores, and predefined moderator questionnaires (see Section 2) were entered in the analyses. No significant moderator variables were found for the VAS. Significant moderators for AUDIT-C improvement are shown in Table 2. Negative coefficients (B) indicate that a higher score on the moderator variable resulted in a greater baseline to post symptom reduction. The last three columns report the intervention effect when scores on the moderator variable are average as well as 1 SD below or above the mean. Higher vividness of imagery on four items of the VVIQ predicted better outcome in the intervention groups compared with the WLC at post assessment. Three of these items referred to imagining a close friend or relative and one to imagining a rising sun. Moreover, higher sores on the AUDIT items morning drinking and blackouts at baseline also moderated symptom reductions in AUDIT-C scores. Note that for both AUDIT items as well as one VVIQ item, the *p*-value of the total model was not significant in two-sided testing. Therefore, these results have to be interpreted with caution and are only reported for exploratory reasons.

3.5 | Subjective Appraisal and Satisfaction With Treatment

Completers' satisfaction with the treatment as measured with the ZUF-8 is shown in Table 3. Overall, participants reported high satisfaction with the treatment. For example, about 90% rated the quality of the intervention as good to excellent and
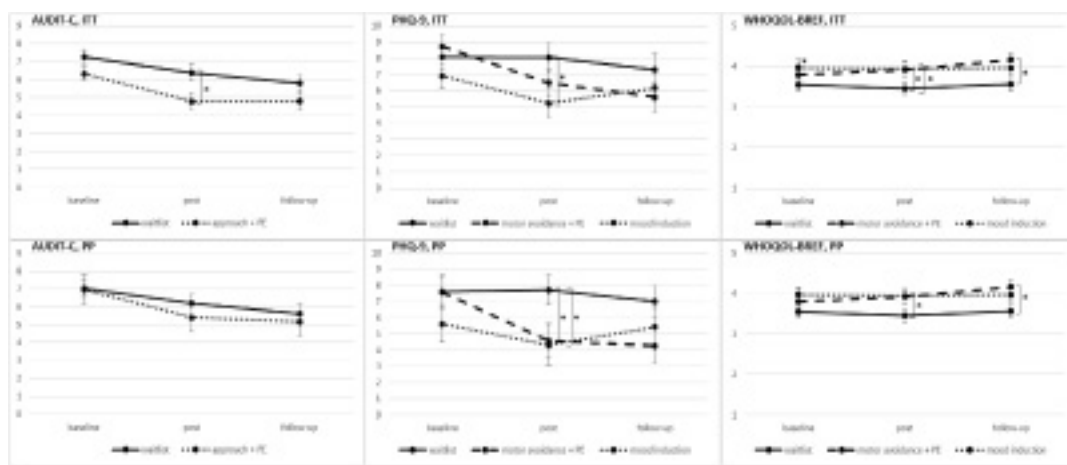
FIGURE 2 | Comparisons of each imaginal retraining group to the waitlist control group at baseline, post, and follow-up assessments. Linear mixed-effects model estimates of marginal means of the intention-to-treat (ITT) and the per-protocol (PP) samples. *Note:* Only comparisons in which an intervention group differed significantly from the waitlist control group at post or follow-up assessment are displayed; AUDIT-C = Alcohol Use Disorder Identification Test-Concise; PHQ-9 = Patient Health Questionnaire Depression module; WHOQOL-BREF = global item of the World Health Organization Quality of Life questionnaire. *$p < 0.05$.

TABLE 2 | Moderators for Alcohol Use Disorder Identification Test-Concise (AUDIT-C) improvement for intervention groups compared with waitlist control group (AUDIT-C difference scores, means are centred).

Outcome parameter	B	SE	t	p	LLCI	ULCI	−1SD	0	+1SD
VVIQ 1a	−0.759	0.359	−2.113	0.036	−1.467	−0.051	0.765	0.104	0.014
VVIQ 1b	−0.638	0.325	−1.965	0.051	−1.278	0.002	0.948	0.081	0.018
VVIQ 1d	−0.790	0.335	−2.360	0.019	−1.450	−0.130	0.236	0.041	0.009
VVIQ 2a	−0.861	0.378	−2.281	0.024	−1.605	−0.117	0.605	0.103	0.009
AUDIT morning drinking	0.030	0.017	1.723	0.086	−0.004	0.063	0.024	0.214	0.871
AUDIT blackouts	0.665	0.394	1.689	0.093	−0.111	1.441	0.041	0.104	0.955

Abbreviations: AUDIT = Alcohol Use Disorder Identification Test; VVIQ = Vividness of Visual Imagery Questionnaire; VVIQ1a = face, head, shoulders, and body of relative/friend; VVIQ 1b = characteristic poses of relative/friend; VVIQ 1d = colours of clothes of relative/friend; VVIQ 2a = rising sun in a hazy sky.

almost 80% would recommend the video intervention. However, less than 60% stated that the self-help technique met their needs. The sum score of the ZUF-8 significantly varied between groups at post ($F(7, 90) = 2.90$, $p = 0.009$, $\eta_p^2 = 0.184$) and follow-up ($F(7, 56) = 2.43$, $p = 0.030$, $\eta_p^2 = 0.233$). Post-hoc tests indicated that at post and follow-up, the motor avoidance + PE group and the motor avoidance group had significantly higher scores on treatment satisfaction compared with the mental avoidance group. There were no statistically significant group differences in single items of the ZUF-8 except for item 6 ('Did the video help you cope with your problems more successfully?') at post and item 7 ('How satisfied are you with the video in general?') at follow-up assessment. Post hoc group comparisons showed higher satisfaction with treatment for item 6 in the motor avoidance group compared with the approach group ($|z| = 3.34$, $p = 0.001$, $p_{corr} = 0.024$) with a large effect of $r = 0.712$ (Cohen 1992). Moreover, the motor avoidance group showed superior appraisal compared with the mood induction + PE group ($|z| = 2.65$, $p = 0.008$, $p_{corr} = 0.224$, $r = 0.553$), the mood induction group ($|z| = 2.07$, $p = 0.038$, $p_{corr} > 0.999$, $r = 0.423$), and the mental avoidance group ($|z| = 2.96$, $p = 0.003$, $p_{corr} = 0.087$, $r = 0.661$), and the motor avoidance + PE group showed superior appraisal

compared with the mood + PE group ($|z| = 2.12$, $p = 0.034$, $p_{corr} = 0.957$, $r = 0.380$), the mental avoidance group ($|z| = 2.48$, $p = 0.013$, $p_{corr} = 0.369$, $r = 0.468$), and the approach group ($|z| = 2.90$, $p = 0.004$, $p_{corr} = 0.106$, $r = 0.529$). However, these comparisons were not sustained after correction for alpha inflation. For item 7 at follow-up, uncorrected group differences showed superior satisfaction with treatment for the motor avoidance + PE group compared with the approach + PE group ($|z| = 2.02$, $p = 0.043$, $p_{corr} > 0.999$, $r = 0.375$), the mood induction + PE group ($|z| = 3.05$, $p = 0.002$, $p_{corr} = 0.064$, $r = 0.557$), and the mental avoidance group ($|z| = 2.95$, $p = 0.003$, $p_{corr} = 0.088$, $r = 0.577$). No significant group differences survived Bonferroni correction.

Participants' subjective appraisal of the self-help technique and the design of the video is in Table 4. Overall, subjective appraisal of all nine video tutorials of the self-help technique was good. The majority of the participants reported that their alcohol consumption decreased because of IR. However, the majority of the participants also stated that they had to force themselves to use the technique and, depending on group and time of measurement, 14.3% to 63.6% said that the technique was difficult to

TABLE 3 | Satisfaction with treatment (adapted version of the Patient Satisfaction Questionnaire; ZUF-8) reported by the eight intervention groups.

Item	Total (n=98/ n=99)	Mood induction+PE (n=12/ n=13)	Mental avoidance+PE (n=14/ n=15)	Motor avoidance+PE (n=19/ n=17)	Approach+PE (n=9/ n=8)	Mood induction (n=13/ n=12)	Mental avoidance (n=9/ n=11)	Motor avoidance (n=11/ n=11)	Approach (n=11/ n=12)	Statistics
How do you rate the quality of the video? (excellent (1), good (2) vs. less good (3), not good (4))	89.8/ 90.9	83.8/92.3	78.6/ 86.7	100/ 94.1	88.9/ 100	92.3/ 83.3	77.8/ 81.8	100/ 100	90.9/ 91.7	$\chi^2(7)=13.10$, $p=0.070$/ $\chi^2(7)=13.14$, $p=0.069$
Did you receive the type of treatment you expected to receive? (not at all (1), not really (2) vs. in general, yes (3), yes, absolutely (4))	69.4/ 69.7	66.7/ 53.8	57.1/ 66.7	89.5/ 88.2	66.7/ 62.5	69.2/ 83.3	44.4/ 45.5	90.9/ 81.8	54.5/ 66.7	$\chi^2(7)=13.06$, $p=0.071$/ $\chi^2(7)=11.28$, $p=0.127$
To what extent did the video meet your needs? (it met nearly all my needs (1), it met most of my needs (2) vs. it met a few of my needs (3), it did not meet my needs (4))	57.1/ 59.6	50.0/ 53.8	71.4/ 53.3	63.2/ 76.5	66.7/ 50.0	61.5/ 75.0	44.4/ 36.4	63.6/ 63.6	27.3/ 58.3	$\chi^2(7)=9.37$, $p=0.228$/ $\chi^2(7)=7.77$, $p=0.353$
Would you recommend the video to a friend with similar symptoms? (definitely not (1), probably not (2) vs. probably yes (3), absolutely (4))	77.6/ 78.8	83.3/ 69.2	64.3/ 73.3	89.5/ 94.1	77.8/ 75.0	76.9/ 83.3	66.7/ 63.6	100/ 90.9	54.5/ 75.0	$\chi^2(7)=11.36$, $p=0.124$/ $\chi^2(7)=10.15$, $p=0.180$
How happy are you about the extent of help you have received through using the video? (dissatisfied (1), somewhat dissatisfied (2) vs. mostly satisfied (3), very satisfied (4))	75.5/ 75.8	75.0/ 69.2	71.4/ 80.0	84.2/ 92.4	77.8/ 75.0	76.9/ 83.3	66.7/ 63.6	100/ 72.7	45.5/ 75.0	$\chi^2(7)=12.85$, $p=0.076$/ $\chi^2(7)=4.11$, $p=0.767$
Did the video help you cope with your problems more successfully? (yes, absolutely (1), yes, a little (2) vs. no, not that much (3), no, not at all (4))	67.3/ 72.7	58.3/ 53.8	71.4/ 80.0	89.5/ 82.4	66.7/ 50.0	61.5/ 91.7	33.3/ 54.5	100/ 90.9	36.4/ 66.7	$\chi^2(7)=19.23$, $p=0.007$/ $\chi^2(7)=13.30$, $p=0.065$

(Continues)

TABLE 3 | (Continued)

Item	Total (n=98/ n=99)	Mood induction+PE (n=12/ n=13)	Mental avoidance+PE (n=14/ n=15)	Motor avoidance+PE (n=19/ n=17)	Approach +PE (n=9/ n=8)	Mood induction (n=13/ n=12)	Mental avoidance (n=9/ n=11)	Motor avoidance (n=11/ n=11)	Approach (n=11/ n=12)	Statistics
How satisfied are you with the video in general? (very satisfied (1), mostly satisfied (2) vs. somewhat unsatisfied (3), unsatisfied (4))	74.5/ 77.8	66.7/ 61.5	71.4/ 73.3	84.2/ 94.1	88.9/ 75.0	69.2/ 91.7	55.6/ 54.5	100/ 90.9	54.5/ 75.0	$\chi^2(7)=13.11$, $p=0.069$/ $\chi^2(7)=14.52$, $p=0.043$
Would you use the manual again? (definitely not (1), probably not (2) vs. probably yes (3), yes (4))	78.6/ 75.8	75.0/ 53.8	85.7/ 73.3	84.2/ 88.2	88.9/ 75.0	84.6/ 91.7	55.6/ 63.6	90.9/ 90.9	54.5/ 66.7	$\chi^2(7)=9.71$, $p=0.205$/ $\chi^2(7)=11.28$, $p=0.127$

Note: Positive appraisal in percentage as well as group comparisons by means of Kruskal–Wallis tests for post and follow-up assessments.

Abbreviation: PE=psychoeducation.

perform. Group differences only emerged for item 6 at follow-up ('I think the instructions in the video were understandable'). Uncorrected post-hoc tests showed inferior appraisal regarding understandability for the mood induction groups (with and without PE) compared with the mental avoidance group (with PE: $|z|=2.40$, $p=0.016$, $p_{corr}=0.457$, $r=0.490$; without PE: $|z|=2.04$, $p=0.042$, $p_{corr}>0.999$, $r=0.425$), the motor avoidance+PE group (with PE: $|z|=3.05$, $p=0.002$, $p_{corr}=0.064$, $r=0.557$; without PE: $|z|=2.63$, $p=0.009$, $p_{corr}=0.242$, $r=0.488$), and the approach group (with PE: $|z|=2.94$, $p=0.003$, $p_{corr}=0.097$, $r=0.588$; without PE: ($|z|=2.54$, $p=0.011$, $p_{corr}=0.312$, $r=0.518$). Again, no significant group differences were found after Bonferroni correction.

3.6 | Side Effects

Positive and negative effects reported by the participants in the intervention groups are in Table 5. Intervention groups differed significantly only on item six ('My performance has improved through the self-help technique') at post assessment. The motor avoidance group reported greater improvements compared with the mood induction group ($|z|=2.34$, $p=0.019$, $p_{corr}=0.545$, $r=0.478$), the mood induction+PE group ($|z|=2.50$, $p=0.012$, $p_{corr}=0.345$, $r=0.521$), the mental avoidance group ($|z|=3.01$, $p=0.003$, $p_{corr}=0.074$, $r=0.673$), the mental avoidance+PE group ($|z|=3.12$, $p=0.002$, $p_{corr}=0.051$, $r=0.624$), and the approach+PE group ($|z|=2.21$, $p=0.027$, $p_{corr}=0.767$, $r=0.494$) in the uncorrected but not the corrected test statistics.

4 | Discussion

The present study is the first to dismantle nine different combinations of components of the self-help technique IR in an RCT over multiple weeks. We investigated the four essential components of IR: (negative) mood induction, mental avoidance, motor avoidance, and the approach exercise. All components were conveyed by means of a video tutorial with or without psychoeducation, resulting in a total of eight intervention groups that were tested against a WLC.

We found no significant differences between any intervention group and the WLC in alcohol craving (VAS; primary outcome) at post or follow-up assessment. This was unexpected because in a previous RCT (Moritz et al. 2019) the full version of imaginal retraining (with psychoeducation conveyed by means of a written self-help manual) led to a significant decline in alcohol craving with large effect sizes compared with the WLC. For people smoking cigarettes (Moritz et al. 2020) as well as people identified as overweight or obese (Moritz et al. 2019b), craving was measured with the VAS and declined at small effect sizes when compared with WLCs. In the present study, alcohol consumption as measured with the AUDIT-C significantly declined for the approach+PE group compared with the WLC at post assessment, but only in the ITT analysis. Since no effects were found in the PP analysis, it is uncertain whether this effect was due to the intervention. When the PE and no-PE groups were merged to improve the power of the analyses, a significant decline in AUDIT-C scores was found for the merged

TABLE 4 | Subjective appraisal of imaginal retraining and the video tutorials reported by the eight intervention groups at post and follow-up assessments.

Item	Total (n=98/ n=99)	Mood induction+PE (n=12/ n=13)	Mental avoidance+PE (n=14/ n=15)	Motor avoidance+PE (n=19/ n=17)	Approach+PE (n=9/ n=8)	Mood induction (n=13/ n=12)	Mental avoidance (n=9/ n=11)	Motor avoidance (n=11/ n=11)	Approach (n=11/ n=12)	Statistics
I think the manual is good for self-help and self-guidance.	98.0/ 97.0	100/ 100	92.9/ 100	100/ 100	100/ 100	100/ 83.3	88.9/ 100	100/ 90.9	100/ 100	$\chi^2(7)=3.89, p=0.792$ / $\chi^2(7)=12.96, p=0.073$
I had to force myself to use the self-help technique.	81.6/ 82.8	100/ 84.6	85.7/ 80.8	89.5/ 76.5	55.6/ 100	69.2/ 83.3	88.9/ 81.8	81.8/ 72.7	72.7/ 91.7	$\chi^2(7)=5.19, p=0.637$ / $\chi^2(7)=5.36, p=0.617$
I think the self-help technique makes sense as a complement to psychotherapy.	93.9/ 93.9	100/ 100	92.9/ 93.3	100/ 94.1	88.9/ 100	92.3/ 83.3	88.9/ 90.9	100/ 90.9	81.8/ 100	$\chi^2(7)=5.49, p=0.600$ / $\chi^2(7)=6.34, p=0.500$
My alcohol consumption decreased because of the application of the self-help technique.	71.4/ 76.8	58.3/ 69.2	71.4/ 73.3	89.5/ 76.5	77.8/ 75.0	69.2/ 83.3	66.7/ 63.6	90.9/ 90.9	36.4/ 83.3	$\chi^2(7)=10.23, p=0.176$ / $\chi^2(7)=5.41, p=0.610$
I found the technique difficult to perform.	38.8/ 43.4	58.3/ 61.5	14.3/ 53.3	31.6/ 23.5	22.2/ 25.0	30.8/ 41.7	55.6/ 45.5	45.5/ 45.5	63.6/ 50	$\chi^2(7)=10.20, p=0.177$ / $\chi^2(7)=7.43, p=0.385$
I think the instructions in the video were understandable.	99.0/ 100	100/ 100	92.9/ 100	100/ 100	100/ 100	100/ 100	100/ 100	100/ 100	100/ 100	$\chi^2(7)=5.27, p=0.628$ / $\chi^2(7)=16.85, p=0.018$
The instruction by means of a video is useful.	100/ 99.0	100/ 100	100/ 100	100/ 100	100/ 100	100/ 91.7	100/ 100	100/ 100	100/ 100	$\chi^2(7)=4.23, p=0.753$ / $\chi^2(7)=9.42, p=0.224$
The images in the video are vivid.	99.0/ 99.0	100/ 100	100/ 100	100/ 100	100/ 100	100/ 91.7	88.9/ 100	100/ 100	100/ 100	$\chi^2(7)=7.57, p=0.372$ / $\chi^2(7)=10.55, p=0.160$
The sound quality of the video is good.	99.0/ 99.0	100/ 100	100/ 100	100/ 100	100/ 100	100/ 100	88.9/ 100	100/ 90.9	100/ 100	$\chi^2(7)=0.78, p=0.998$ / $\chi^2(7)=2.57, p=0.922$
The video is too long.	33.7/ 38.4	50.0/ 38.5	35.7/ 40.0	47.4/ 47.1	22.2./ 50.0	15.4/ 41.7	22.2/ 36.4	27.3/ 18.2	36.4/ 33.3	$\chi^2(7)=5.63, p=0.584$ / $\chi^2(7)=2.18, p=0.949$
The video is too short.	19.4/ 23.2	25.0/ 46.2	14.3/ 33.3	15.8/ 5.9	11.1/ 12.5	23.1/ 25.0	33.3/ 36.4	18.2/ 9.1	18.2/ 16.7	$\chi^2(7)=1.60, p=0.979$ / $\chi^2(21)=2.07, p=0.956$

Note: Endorsement of statements (totally applies, generally applies, applies a little) in percentages as well as group comparisons by means of Kruskal–Wallis tests for post and follow-up assessments.

Abbreviation: PE = psychoeducation.

TABLE 5 | Positive and negative side effects reported by the eight intervention groups at post and follow-up assessments.

Item	Total (n=98/ n=99)	Mood induction+PE (n=12/ n=13)	Mental avoidance+PE (n=14/ n=15)	Motor avoidance+PE (n=19/ n=17)	Approach+PE (n=9/ n=8)	Mood induction (n=13/ n=12)	Mental avoidance (n=9/ n=11)	Motor avoidance (n=11/ n=11)	Approach (n=11/ n=12)	Statistics
The self-help technique made my thoughts about alcohol stronger.	10.2/ 8.1	8.3/ 0	28.6/ 13.3	5.3/ 0	0/ 0	0/ 8.3	11.1/ 9.1	9.1/ 9.1	18.2/ 25.0	$\chi^2(7)=5.09, p=0.649$ / $\chi^2(7)=4.12, p=0.766$
The self-help technique has increased my alcohol consumption.	5.1/ 2.0	0/ 0	7.1/ 0	5.3/ 0	0/ 0	7.7/ 8.3	11.1/ 0	9.1/ 9.1	0/ 0	$\chi^2(7)=5.37, p=0.616$ / $\chi^2(7)=10.93, p=0.142$
From my point of view, the therapeutic techniques used were wrong.	7.1/ 7.1	8.3/ 15.4	0/ 0	5.3/ 0	0/ 0	7.7/ 16.7	22.2/ 9.1	9.1/ 9.1	9.1/ 8.3	$\chi^2(7)=9.64, p=0.210$ / $\chi^2(7)=6.38, p=0.496$
I learned to take responsibility for myself through the self-help technique.	27.6/ 37.4	25.0/ 23.1	21.4/ 13.3	42.1/ 58.8	33.3/ 25.0	23.1/ 50.0	11.1/ 36.4	36.4/ 54.5	18.2/ 33.3	$\chi^2(7)=9.37, p=0.227$ / $\chi^2(7)=9.20, p=0.239$
I am proud of myself for using the self-help technique.	31.6/ 43.4	25.0/ 23.1	42.9/ 33.3	42.1/ 58.8	44.4/ 50.0	15.4/ 58.3	11.1/ 27.3	36.4/ 63.6	27.3/ 33.3	$\chi^2(7)=9.54, p=0.216$ / $\chi^2(7)=10.75, p=0.150$
My performance has improved through the self-help technique.	14.3/ 26.3	0/ 15.4	14.3/ 13.3	15.8/ 35.3	11.1/ 37.5	23.1/ 25.0	11.1/ 18.2	27.3/ 45.5	9.1/ 25.0	$\chi^2(7)=14.99, p=0.036$ / $\chi^2(7)=5.33, p=0.620$
Imagining my favourite alcoholic drink was burdensome.	12.2/ 13.1	16.7/ 0	21.4/ 13.3	5.3/ 17.6	0/ 25.0	7.7/ 16.7	11.1/ 9.1	9.1/ 9.1	27.3/ 16.7	$\chi^2(7)=9.08, p=0.247$ / $\chi^2(7)=2.95, p=0.889$

Note: Endorsement (applies, somewhat applies) in percentages as well as group comparisons by means of Kruskal–Wallis tests for post and follow-up assessments.
Abbreviation: PE = psychoeducation.

motor avoidance group compared with the WLC at post assessment. This is in line with studies on computer-based ABM that report reductions in alcohol consumption but not in craving compared with sham conditions (Manning et al. 2016, 2019). In accordance with theoretical craving models (Baker, Morse, and Sherman 1986; Tiffany 1999), it can be assumed that attempts to abstain from alcohol or reduce consumption may result in increased craving. However, evidence supporting these models is mixed (van Lier et al. 2018), and there are also studies reporting changes in alcohol craving after both computer-based (R. W. Wiers et al. 2011; C. E. Wiers, Stelzel, et al. 2015) as well as imaginal ABM (Moritz et al. 2019). Therefore, more research is needed to better understand the specific effects of IR on craving and consumption as well as their underlying mechanisms. Another possible explanation might be that IR (primarily the motor avoidance component) reduces alcohol consumption not through reducing craving but through providing individuals with a tool to handle their craving. Therefore, craving in general might not decline, but individuals might be more successful in not giving in to their urges, leading to a decline in consumption. However, in the first dismantling study on IR over multiple weeks, Wirtz and colleagues found that the motor avoidance component of IR led to a significant decline in craving for alcohol (measured with the VAS) but not in alcohol consumption (g ethanol), which contradicts our finding. In line with our findings, they also found the motor avoidance component to be the core element of IR (Wirtz et al. 2022). As exploratory moderation analyses showed that individuals in the intervention group reporting higher scores on the VVIQ significantly decreased alcohol consumption at post assessment compared with the WLC, implementing visualization training (see, e.g., Parthasarathi et al. 2017) prior to IR may be a promising way to improve the magnitude of the effect.

Moreover, we found that depressive symptoms significantly decreased in the mood induction group (ITT and PP) as well as the motor avoidance + PE group (PP) at post assessment compared with the WLC. At the same time, the motor avoidance + PE group showed significantly higher quality of life at the post and follow-up assessments compared with the WLC (IIT and PP). These results are promising as negative affect has been identified as an important predictor of relapse (Serre et al. 2015; van Lier et al. 2018). Interestingly, previous RCTs investigating the full version of IR (approach + PE) have not found any effects of the self-help technique on depressive symptoms and quality of life (Moritz et al. 2019, 2019b, 2020). However, ABM for depressive symptoms has been shown to be effective (Becker et al. 2019; Vrijsen et al. 2018). There is consistent evidence that negative mood induction results in increased negative affect and reduced positive affect in the short term (Benau and Atchley 2020; Campbell, Berezina, and Gill 2021; Hamamura and Mearns 2020; Marcusson-Clavertz et al. 2019), which is also intended in IR as alcoholic beverages are meant to be linked to negative consequences. In line with this intention, Hamamura and colleagues showed that a negative musical mood induction in individuals with problematic drinking behaviour resulted in a stronger association of negative physical and mental consequences with alcohol compared with a positive mood induction (Hamamura and Mearns 2020). On the other hand, some studies showed that negative mood inductions in substance-using individuals may

result in substance-seeking behaviour if individuals show depressive symptoms and use substances to cope with negative affect (Hogarth et al. 2018, 2019). However, long-term effects (i.e., after multiple weeks) of negative mood inductions on substance use or affect were not investigated in these studies. Unfortunately, after reviewing the literature, we cannot provide an empirically derived explanation as to why imagining an alcoholic beverage combined with negative mood induction reduces depressive symptoms after 6 weeks and why this effect did not occur when participants received psychoeducation. Further research is needed to determine if this is an incidental finding.

In summary, the two motor avoidance groups showed the best outcomes in alcohol consumption, depression, and quality of life as well as participants' subjective appraisal, suggesting that the approach exercise may not have a decisive impact on the intervention's efficacy, which is in line with findings of single-dose dismantling experiments (Moritz et al. 2021; Wirtz et al. 2021). Moreover, the mental (i.e., nonmotor) avoidance groups did not significantly improve on any outcome measure compared with the WLC, emphasizing the importance of the actual physical avoidance movement, which is in line with embodiment theories of ABM (for a review, see Fridland and Wiers 2018). Interestingly, the single-dose dismantling study by Moritz (Moritz et al. 2021) did not provide evidence for the motor avoidance component, which may be due to the single application of the component as well as the experimental design of the study, including lack of individualization (stimuli that should be avoided were presented on a computer screen). However, the study by Wirtz (Wirtz et al. 2021) that used a similar design showed superior results for the mental + motor avoidance component compared with the mental avoidance component alone.

Findings of the present study need to be interpreted with caution and should be considered in exploratory fashion as no significant differences between intervention groups and the WLC were observed when p-values were corrected for multiple testing. Moreover, most comparisons were null findings (especially at follow-up assessment), and only some groups improved on single outcomes. This may be due to the small sample size. Although the a priori calculated sample size was achieved, the high dropout rate and the large number of individuals who did not apply the intervention limit the validity of the results. A large number of individuals did not adhere to our instruction to use the technique at least twice a day. Therefore, it is unclear whether the present study enables conclusions on the effects of different IR components after repeated application. Low adherence has been a problem in previous online studies on imaginal retraining (Moritz et al. 2019b, 2020) as well as computer-based ABM (R. W. Wiers, Houben, et al. 2015; Wittekind et al. 2015; Wittekind, Lüdecke, and Cludius 2019), and this has not been resolved despite attempts to increase motivation using gamification (Boendermaker, Boffo, and Wiers 2015; Prior et al. 2020; Zhang et al. 2018). Future studies should look for measures to increase training expectations and motivation to improve the adherence and effectiveness of (imaginal) ABM. Including a motivational interviewing module at the beginning of the training has been suggested (Prior et al. 2020), and we support this. Further limitations of the present study are data collection via

self-report and lack of measurement of approach bias. As a result, no conclusions can be drawn regarding whether the symptom changes are mediated by the successful retraining of approach bias. Moreover, future studies should replicate the study in a clinical sample of individuals with alcohol use disorder and assess number of performed trials during one training session.

5 | Conclusion

The present study provides tentative results on the efficacy of repeated application of individual components of the IR technique. Findings suggest that the approach exercise with healthy objects of consumption as well as negative mood induction (at least for alcohol craving and consumption) in the avoidance exercise may be dispensable as these components did not lead to improvements in reported psychopathology compared with the WLC. However, no significant differences between any IR component and the WLC were found after statistics were corrected for multiple testing indicating no effects of the intervention when considering alpha error cumulation. The authors suggest that the administration of visualization training as well as motivational components prior to IR might increase efficacy and adherence.

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