Back on track: Feasibility and efficacy randomized trial of a two-week online self-guided intervention for cannabis use reduction

Kroon, E.; Elsey, J.W.B.; Kuhns, L.N.; Rietveld, P.; De Vries, O.; Larsen, H.; Wiers, R.W.H.J.; Cousijn, J.

DOI
10.1016/j.drugalcdep.2025.112943

Publication date
2025

Document Version
Final published version

Published in
Drug and Alcohol Dependence

Citation for published version (APA):
Kroon, E., Elsey, J. W. B., Kuhns, L. N., Rietveld, P., De Vries, O., Larsen, H., Wiers, R. W. H. J., & Cousijn, J. (2025). Back on track: Feasibility and efficacy randomized trial of a two-week online self-guided intervention for cannabis use reduction. *Drug and Alcohol Dependence*, *277*, Article 112943. https://doi.org/10.1016/j.drugalcdep.2025.112943

Drug and Alcohol Dependence 277 (2025) 112943

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Back on track: Feasibility and efficacy randomized trial of a two-week online self-guided intervention for cannabis use reduction

E. Kroon [a,b,*], J.W.B. Elsey [a], L.N. Kuhns [a], P. Rietveld [a], O. De Vries [a], H. Larsen [a], R.W.H.J. Wiers [a], J. Cousijn [a,b]

[a] Department of Psychology, University of Amsterdam, the Netherlands
[b] Neuroscience of Addiction (NofA) Lab, Center for Substance Use and Addiction Research (CESAR), Department of Psychology, Education & Child Studies, Erasmus University Rotterdam, the Netherlands

ARTICLE INFO

Keywords:
Cannabis
Online intervention
Implementation intentions
Mental contrasting
Cue

ABSTRACT

Background and aims: Many individuals aiming to reduce or quit cannabis use prefer self-guided interventions over formal treatment. In this pilot and feasibility randomized trial, we tested a two-week self-guided online intervention combining multiple evidence-based behavior change approaches.
Participants: A total of 168 adults who used cannabis weekly, experienced severe cannabis use disorder on average, and reported being motivated to reduce or quit use participated in the baseline assessment and two-week follow-up of this international online intervention study. An additional three-month follow-up was included.
Interventions: Participants were randomized into three conditions: SMART goals alone (minimal intervention control), SMART + mental contrasting with implementation intentions (MCII), or SMART + MCII + Cue-control.
Measurements: Participants set personal reduction or quit goals. We measured subjective goal achievement, objective goal achievement, and cannabis use reduction in grams per week.
Findings: Both intervention conditions outperformed the (minimal intervention) control condition in achieving subjective and objective reduction goals, with 69 % (MCII) and 60 % (MCII + Cue-control) meeting their objective targets compared to 49 % in the control condition. Adding Cue-control to MCII did not enhance outcomes compared to MCII alone. All conditions, including the control, reported similar reductions in cannabis use (grams per week) and these reductions were largely maintained at three-month follow-up. Two-week retention was high in the active intervention groups, especially in the MCII condition, highlighting the accessibility and appeal of the intervention.
Conclusions: This pilot and feasibility randomized trial showed promise of this intervention as an accessible and effective self-guided online cannabis reduction program.

1. Introduction

Cannabis is one of the most used drugs worldwide (UNODC, 2022). Although many individuals remain in control of their use, close to 10 % escalate to daily cannabis use (World Health Organization, 2016). Of this group, about 1 in 3 will develop a cannabis use disorder (CUD; Leung et al., 2020). In addition, regular cannabis use is associated with comorbid mental health concerns, cognitive impairments, and physical harms (Kroon et al., 2020). Nevertheless, in line with changes towards more permissive legislation, attitudes towards cannabis use are increasingly positive (UNODC, 2022). Many individuals who use cannabis view their use as an integral part of their lifestyle and aims, but there are others who perceive their use as problematic and who want to cut down or stop using cannabis. This group appears to be increasing, with the demand for CUD treatment rising over the last decade (UNODC, 2022). However, many of those willing to cut down or stop decide not to seek formal treatment, trying to be self-reliant and expressing a preference for more informal interventions (Helle et al., 2021; UNODC, 2022; Van der Pol et al., 2013). Hence, there is a need for easily accessible, self-guided, and effective interventions that can help this group reach

* Correspondence to: PO Box 1738, Rotterdam 3000 DR, the Netherlands.
E-mail address: kroon@essb.eur.nl (E. Kroon).

https://doi.org/10.1016/j.drugalcdep.2025.112943
Received 17 June 2025; Received in revised form 17 October 2025; Accepted 17 October 2025
Available online 29 October 2025

their goals to reduce use or stop using cannabis all together.

Currently, psychosocial interventions such as cognitive behavioral therapy (CBT) or Motivational Interviewing (MI) remain the most common treatment for CUD in Europe (Connor et al., 2021). These approaches have shown only moderate effectiveness in those aiming to stop using cannabis (Connor et al., 2021; Davis et al., 2015). Still, even a reduction of cannabis use can reduce harms and risk for escalation to CUD substantially (Fischer et al., 2017; Sherman et al., 2022). The past decade has seen a rise in studies trying to develop easily accessible alternative interventions to reduce or quit cannabis use. Often this has been attempted by using social media (Bonar et al., 2022), smartphone apps (Prince et al., 2020), or other web interfaces (Olthof et al., 2023) to deliver classic interventions such as CBT. Nevertheless, other approaches more common in the field of health promotion and behavior change (e.g., Adriaanse et al., 2010) – for example using SMART goal setting, and mental contrasting with implementation intentions (MCII) – are underexplored in the context of cannabis use. Several studies (Hagerman et al., 2021; Malaguti et al., 2020; Mutter et al., 2020) have shown promising results in the reduction of alcohol and tobacco use with these techniques.

In this pilot and feasibility randomized trial, we combined several empirically guided techniques into a two-week online self-guided intervention for individuals who use cannabis and experience CUD symptoms who want to cut down their use. First, we included SMART goal setting in which individuals created personalized Specific, Measurable, Appealing, Realistic, and Time-bound goals to reduce use. This is a method that has been found to be effective in helping people achieve a variety of goals in different health interventions (e.g., Locke and Latham, 2002; Pearson, 2012). Second, we included mental contrasting with implementation intentions (MCII condition, Adriaanse et al., 2010; Wang et al., 2021). Mental contrasting is the process of imagining goal achievement (e.g., not using) and reflecting on the obstacles in the way to reach this goal (e.g., Adriaanse et al., 2010). Implementation intentions refer to the creation of 'if…then…' plans, in which an individualized potential trigger for cannabis use is identified along with an alternative behavior to perform when encountering this trigger, which should ideally be enacted. The combination of mental contrasting with implementation intentions has been shown to help people achieve their goals (Wang et al., 2021), for example to reduce unhealthy snacking (Adriaanse et al., 2010), to stimulate physical activity and weight loss (Marquardt et al., 2017), as well as to reduce cigarette use (Oettingen et al., 2010). Third, we included cue control, which is an approach based on research related to habitual behavior and cue reactivity (e.g., Field, 2005; Filbey et al., 2016), and is similar to stimulus control as used during CBT (Schippers et al., 2014). Cue-control focuses on the idea that cannabis-related cues may trigger cravings or an automatic intent to use cannabis. Since habitual behaviors, like cannabis use, often occur with little reflection, this method aims to help individuals regulate their response to these cues in alignment with their long-term goals. This involves controlling one's environment to reduce the likelihood of cue-induced craving and creating barriers between craving and cannabis use, thereby increasing the chance of acting on more reflective intentions. Both approaches can also be employed to facilitate more adaptive, alternative behaviors, focusing on increasing cues for these activities and removing barriers to engage in them.

After the two-week intervention period, effectiveness of all conditions – SMART goal setting, MCII, or MCII with Cue-control - was assessed on three measures: subjective self-reported goal achievement (whether people report having met their goal), objective goal achievement (whether the reported amount of cannabis use matched the intended level of cannabis use), and reduction in cannabis use (reduction in grams per week). We hypothesized that both MCII and MCII + Cue-control would be more effective than the minimal intervention control condition on all outcomes.

2. Methods

2.1. Sample

Recruitment took place between May 2022 and October 2022 using online (i.e., social media advertisement, faculty lab system, researcher database) and offline (i.e., flyers in the Netherlands) methods. Participants had to be 18 years or older, fluent in Dutch or English, use cannabis weekly, and intend to reduce or quit their cannabis use. No constraints on country of residence were in place. The study lasted for a predefined six months, including as many participants as possible during this period. The study screener and all assessments were completed using Qualtrics survey software (Qualtrics, 2022). A total of 872 participants initiated the online screener, of which 466 individuals completed it. Of these 466 individuals, 230 were deemed eligible. All 230 were allocated to an intervention condition and completed the baseline assessment (Fig. 1). Of these participants, 152 met the additional inclusion criteria to be included in analyses: 1) completed at least the 2-week follow-up assessment to be able to assess efficacy, 2) sufficient motivation at baseline (>mid-point of 7-point Likert scale indicating motivation to change), 3) having a goal to reduce at least 0.32 g per week (approximately the amount of cannabis in an average joint, Ridgeway and Kilmer, 2016), and 4) indicating binary gender (men or women). Non-binary respondents could still participate in the intervention to create equal opportunity but were not included in the analyses owing to insufficient sample size and how gender was coded in the models. Participants did not receive a monetary compensation for their participation but did have the option to 1) receive research credit from the University of Amsterdam for each study component that was completed, 2) enter a raffle for one of ten 40 euro (or local equivalent) gift cards/bank transfers after completing the two-week follow-up assessment, and 3) enter a raffle for one of ten 20 euro (or local equivalent) gift cards/bank transfers after completing the three-month follow-up assessment.

2.2. Intervention and procedures

After online informed consent procedures, and successful online screening - using a parallel trial design - participants were randomly assigned to the SMART (minimal intervention control condition; referred to as Control), the SMART + MCII (referred to as MCII), or the SMART + MCII + Cue-control condition (referred to as Cue-control; Fig. 1). Randomization was immediately performed using the Qualtrics Survey Flow Randomizer, which distributes respondents roughly evenly over conditions by using an equal probability for each individual participant to be assigned to each condition. All information and detailed instructions for the two-week intervention was provided to the participants via the Back on Track study website to which they could refer throughout the study (this website is no longer online, see Appendix A-E for the full instructions and supplemental Video 1 for an impression). Before and during the study, participants were not explicitly made aware of their assigned condition and how this condition compared to the other study conditions.

Supplementary material related to this article can be found online at doi:10.1016/j.drugalcdep.2025.112943.

On day 0, all individuals completed the baseline assessment before starting their intervention by completing the intervention initiation questionnaire (Fig. 2). Individuals in all intervention conditions started with setting SMART goals to reduce cannabis use (Appendix A-B).

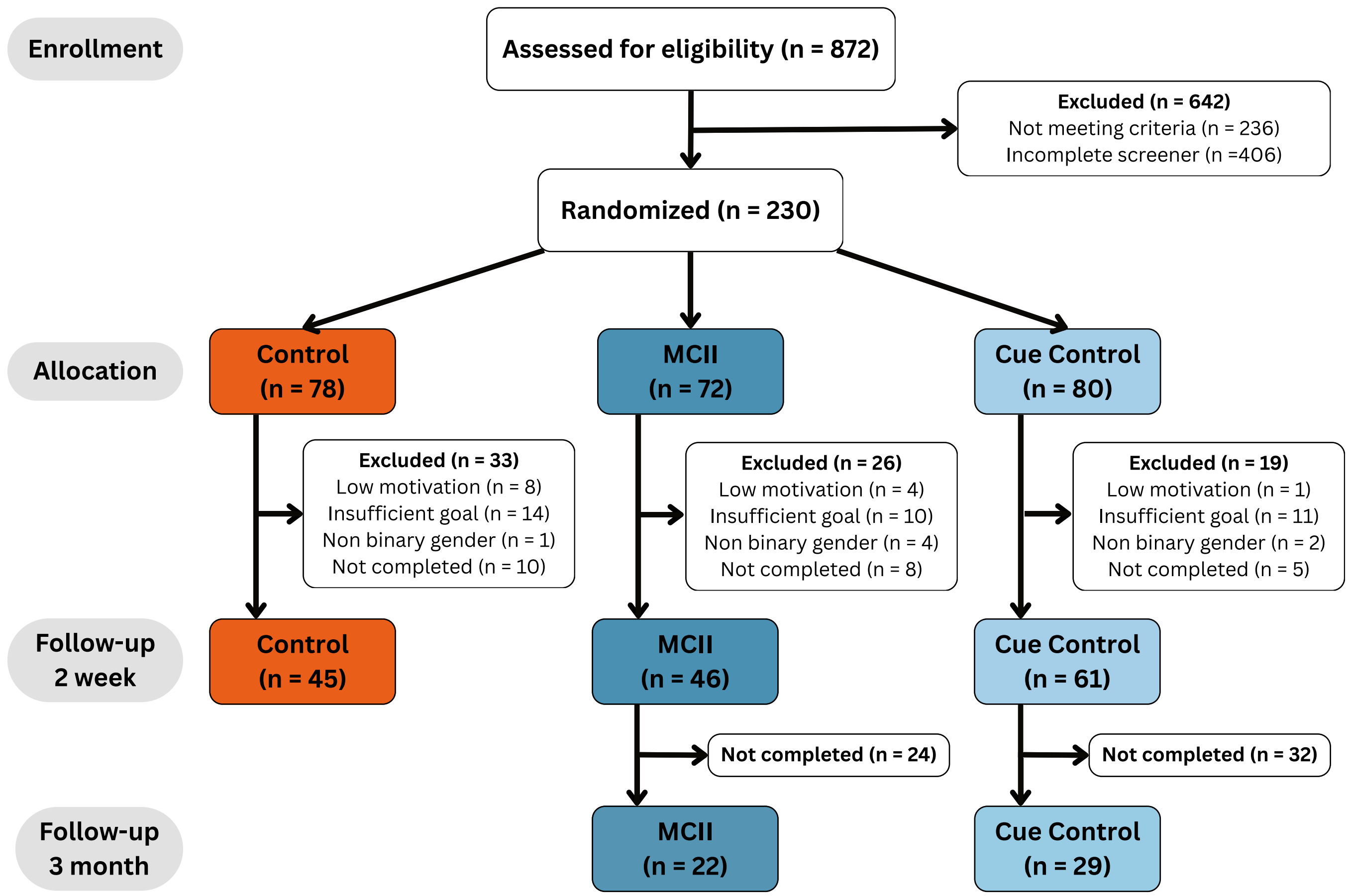

Fig. 1. CONSORT flow diagram of exclusion and retention.

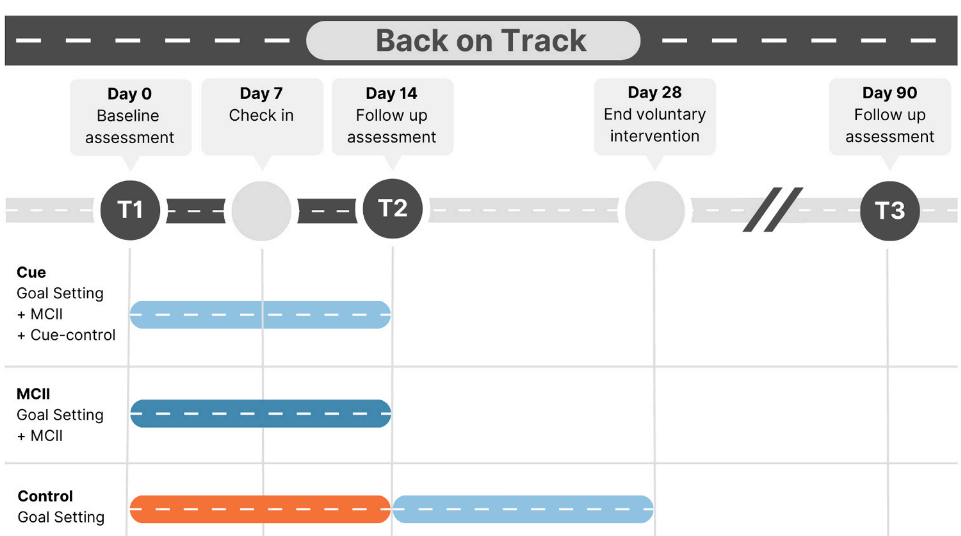

Fig. 2. Overview of study design.

Participants in the MCII condition received instructions on implementation intentions and mental contrasting before creating if-then statements (Appendices A and C), while those in the Cue-control condition were additionally instructed to remove cannabis-related cues, enhance cues for alternative behaviors, and adjust environmental barriers accordingly (Appendix A and D). A summary of the SMART goals, MCII, and Cue-control plans was provided at the end of the intervention initiation questionnaire and participants were again pointed to the website with instructions on how to apply the intervention, provided for future reference.

On day 7, participants received an email check-in that served as a motivational reminder before continuing with the second half of the intervention. On day 14, participants completed the final day of intervention and the two-week follow-up assessment. On day 14, participants that were assigned to the SMART Control condition were offered to participate in the Cue-control condition from day 15–28. On day 90, participants were contacted to complete the three-month follow-up assessment. During work hours, participants could reach out to the researchers with concerns, adverse events, and questions throughout the research period, but the researchers did not contact the participants aside from the scheduled template-based contact on day 0, 7, 14, and 90. All procedures were approved by the ethical committee of the department of psychology of the University of Amsterdam (2020-DP-12264).

2.3. Assessments

2.3.1. Baseline

First, participants completed an online version of the DSM-5 Mini International Neuropsychiatric Interview for CUD (American Psychiatric Association, 2014; Sheehan et al., 1997) to assess symptoms of CUD. Then, they reported their gender and years of education. Cannabis use and related concerns during the last 6 months were assessed using the Cannabis Use Disorder Identification Test – Revised (CUDIT-R; Adamson et al., 2010). Participants reported on the presence of any psychiatric diagnoses, and the Generalized Anxiety Disorder 7 (Spitzer et al., 2006) and Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) were used to assess symptoms of anxiety and depression, respectively. Using single item questions, participants reported on several cannabis use characteristics including preferred method of administration, duration of weekly use, past cannabis use, number of previous treatment attempts, average number of use days per week during the past 6 months, and average grams of cannabis used per week during the past 6 months. Then, participants completed a timeline follow-back (TLFB) calendar to assess cannabis, alcohol, and cigarette use during the last 14 days (Sobell and Sobell, 1992). These assessments were followed by the group-appropriate intervention initiation procedure, including setting a cannabis-use-reduction goal.

2.3.2. Two-week follow-up

At two-week follow-up, participants reported on their cannabis use during the last week in grams per week as well as days per week, and last use of cannabis. They also reported on subjective goal achievement (4-point Likert scale) and indicated their motivation and to what extent they implemented the intervention during the last week. The Control group was then provided the option to continue with the Cue-control intervention for the next two weeks.

2.3.3. Three-month follow-up

At three-month follow-up, participants again reported on their cannabis use during the last week in grams per week to assess maintenance of cannabis reduction.

2.4. Outcome measures

Subjective goal achievement was assessed using a 4-point Likert scale item included in the two-week follow-up (Ordinal: 1–4). Objective goal achievement was calculated based on the goal in grams per week and self-reported grams per week at two-week follow-up, with a minimum of 95 % of the intended reduction (their goal) being considered an achieved goal (Binary: yes/no). Reduction in grams per week was calculated based on self-reported grams per week at baseline and two-week follow-up (Continuous: grams, z-scored).

2.5. Data analysis

2.5.1. Group differences in sample characteristics

Multiple Bayesian three-way ANOVAs (continuous variables) and chi-square tests (categorical variables) were used to assess intervention group differences on all assessments, using default priors in JASP (JASP Team, 2025) and using common evaluation criteria for Bayes factors ($<$ 1 evidence for the null hypothesis, and 1–3 weak evidence, 3–10 moderate evidence, $>$ 10 strong evidence, $>$ 100 overwhelming evidence against the null hypothesis, Wagenmakers et al., 2018).

2.5.2. Goal achievement

A Bayesian cumulative ordinal logistic regression (probit link) analysis was used to assess the effect of intervention condition on subjective goal achievement. A Bayesian binary logistic regression (logit link) analysis was used to assess the effect of intervention condition on objective goal achievement. Baseline cannabis use, MINI CUD symptom count, depression scores, anxiety scores, and gender were added to these models to control for potential confounding effects. Gender was set to -0.5 and 0.5 before being added to the model. All other control variables were Z-scored before being added to the model. The following weakly informative priors were included: intercept = normal(0,2), main effect = normal(0,1).

One intervention condition was considered more effective than the other condition if $>$ 99 % of the posterior distribution was indicative of higher effectiveness for that condition relative to what it was compared to. A 95 % cut-off was used as an indicator of a likely difference in effectiveness. Analyses were conducted in RStudio (2023.9.0.463) using R (version 4.3.1).

2.5.3. Reduction in cannabis use

A Bayesian multilevel linear regression analysis (identity link) was used to assess the effect of intervention condition, timepoint (baseline vs. follow-up), and their interaction on cannabis use (grams per week). Intercepts were allowed to vary over participants to incorporate the repeated measures structure into the model. Cannabis use outcomes were square root transformed to correct for non-normality and then z-scored for analyses. Gender was set to -0.5 and 0.5 before being added to the model. Scores on all other control variables were z-scored before being added to the model. The following minimal informative priors were included: intercept = normal(1,2), main effect = normal(0,1), interaction effect = normal(0,.5), standard deviation of the subject intercept = exp(5).

One intervention condition was considered more effective than the other condition if $>$ 99 % of the posterior distribution for the interaction between condition and time was indicative of higher effectiveness for that condition relative to what it was compared to. A 95 % cut-off was used as an indicator of a likely difference in effectiveness. Analyses were conducted in RStudio (2023.9.0.463) using R (version 4.3.1).

2.5.4. Maintenance of cannabis use levels

To assess long-term maintenance of cannabis use levels following intervention, we used a Bayesian repeated measures ANOVA to assess the effect of timepoint (within person: baseline, two-week follow-up, and three-month follow-up) and condition (between person: MCII, Cue-control) on grams of cannabis per week, using default priors in JASP (JASP Team, 2025). The control condition was excluded from this analysis due to the interference of additional Cue-control interventions between the two-week and three-month follow-up assessments that were offered to participants (Fig. 2).

2.6. Preregistration

All analyses were preregistered (https://osf.io/hfdxa). We deviated from the pre-registration in the outcome measure used for reduction in cannabis use: we used a single item grams per week, rather than the TLFB procedure described in the pre-registration. In the current study, the TLFB was completed online without the supervision of an experimenter, which resulted in many questionable values (i.e., likely missing a comma or very high values) and missing data (only N = 135 of N = 152 having complete and most likely accurate data, unevenly distributed across groups). Although the TLFB is often considered a superior way of assessing cannabis use (Lorenzetti et al., 2022), previous research has shown very high correlations between single item and TLFB measures of cannabis use in grams per week (Kroon et al., 2024) and a high correlation between single item and TLFB was observed in the likely accurate subset of our data (N = 135, r = .81, p < .001).

3. Results

3.1. Retention and adverse events

Of the 230 participants that completed the baseline assessment and were allocated to an intervention condition, 152 (66.1 % of the baseline sample) were included in the analyses. Of the 78 participants that were excluded across conditions, 55 did not meet the criteria to be included in the analyses, while 23 did not complete the two-week follow-up assessment (Fig. 1). Of those that met all inclusion criteria (N = 175), retention was highest in the Cue-Control group (61 of 66; 92.4 %), followed by the MCII group (46 of 54; 85.2 %), and the Control group (45 of 55; 81.8 %). Retention at three-month follow-up was relatively low with only 22 participants in the MCII condition (47.8 % of the MCII group included in analysis) and 29 participants in the cue-control condition (47.5.0 % of the MCII group included in analysis) completing the assessment. No adverse events were reported throughout the study.

3.2. Sample characteristics

Groups were matched on all variables included at baseline (Table 1). Across groups, participants were on average 21.78 (SD = 3.75) years old, with women being slightly overrepresented (44.1 % men). Participants indicated moderate levels of anxiety and depression, and about 1 in 3 participants reported a psychiatric diagnosis. On average, participants used cannabis on 4 days per week during the last year, using around one gram on each use day. CUDIT-R scores (M > 17 in all groups) and CUD symptoms (Mean > 6) indicated high risk use and severe CUD in the majority of participants and CUD symptoms being present in all individuals. On average, participants reported weekly use for 3 years. In terms of recency of cannabis use, and its potential acute or subacute effects, 22.5 % of participants reported using cannabis on the day of the baseline assessment, which was similar to the reported same day use at 2-week follow-up (24.3 %).

3.3. Subjective goal achievement

Subjective goal achievement in both the MCII and Cue-control conditions was higher than subjective goal achievement in the Control condition, using the 99 % cut-off criterion (Table 2, Fig. 3, Table S1, MCII: Estimate = −0.90, 99.98 % of the posterior indicating higher subjective goal achievement, 95 %HDI: [-1.40, −0.40]; Cue-control: Estimate = −0.66, 99.8 % of the posterior indicating higher subjective goal achievement, 95 %HDI: [-1.13, −0.20]). Subjective goal achievement was not reliably different between the MCII and Cue-control conditions (Estimate = 0.24, 95 %HDI: [-0.14, 0.62]). The model explained a moderate amount of variance (R^2 = 0.21, 95 %HDI: [0.13, 0.28]), showed good convergence (Rhat = 1) and a high effective sample size (ESS; lowest > 25000). Looking at the posterior distributions, Fig. 3 shows the estimated percentage of individuals indicating each level of subjective goal achievement within each condition controlling for all covariates (at the average level of all covariates). These posterior estimates suggest that an average respondent going through each of the conditions would be expected to achieve or surpass their goal 58.8 % of the time for Cue-control, 67.4 % of the time for MCII, and 34.1 % for the Control condition.

3.4. Objective goal achievement

Over 60 % of the individuals in the Cue-control (69.0 %, 95 %HDI: [55.0, 83.7]) and MCII (60.3 %, 95 %HDI: [46.6, 73.8]) conditions achieved their use-reduction goal - defined as reaching at least 95 % of their goal - while less than half of the individuals in the Control group did (49.5 %, 95 %HDI: [35.5, 65.3], Table 2, Fig. 4). Results indicated a likely higher effectiveness (.95 cut-off) of the MCII condition compared to the Control condition with 96.7 % of the posterior indicating higher goal achievement (Estimate = 0.82, 95 %HDI: [-0.05, 1.72], Table S2). This was not the case for the Cue-control condition (85.5 % of the posterior indicating higher objective goal achievement, Estimate = −0.38, 95 %HDI: [-0.37, 1.27]), which did not differ from the Control condition. However, direct comparisons showed similar objective goal achievement in the Cue-control condition and MCII condition (Estimate = −0.38, 95 %HDI: [-1.14, 0.38]). The model explained a moderate amount of variance (R^2 =.16, 95 %HDI: [0.10, 0.22]), showed good convergence (Rhat = 1) and a high ESS (lowest > 28000). Looking at the posterior distributions, Fig. 4 shows the estimated percentage of individuals that achieved their goal within each condition controlling for all covariates (at the average level of all covariates). These posterior estimates suggest that an average respondent going through each of the conditions would be expected to achieve or surpass their goal 69.0 % of the time for Cue-control, 60.3 % of the time for MCII, and 49.5 % for the Control condition.

3.5. Change in cannabis use

A reduction in cannabis use – measured in grams per week – during the two-week intervention was observed in all groups (Estimate = −0.86, 95 %HDI: [-1.10, −0.62], Table S3). Looking at the interaction between time (baseline, two-week follow-up) and condition, the MCII (Estimate = −0.00, 95 %HDI: [-0.34, 0.34], 51.4 % of posterior indicating a larger reduction in use) and Cue-control condition (Estimate = −0.08, 95 %HDI: [-0.39, 0.23], 69.4 % of posterior indicating a larger reduction in use) did not outperform the Control condition. Removal of potential outliers did not affect the results. The model explained a substantial amount of variance (R^2 =.37, 95 %HDI: [0.31, 0.43]), showed good convergence (Rhat = 1), and had a sufficient effective sample size (ESS; lowest > 4600). Looking at the posterior distributions, Fig. 5 shows the estimated grams used (z-scored) at baseline and at two-week follow-up within each condition controlling for all covariates (at the average level of all covariates).

3.6. Maintenance of cannabis use at three-month follow-up

Results showed that the model including Time - but not condition or their interaction - outperformed other models (BF_m = 10.578). Post hoc

Table 1
Sample characteristics at baseline.

Measure	Unit	Total N = 152	Groups Control N = 45	MCII N = 46	Cue-Control N = 61	BF_{10}
Sample characteristics						
Language	%Dutch	27	9	10	8	0.111
Age	M(SD)	21.78(3.75)	22.27(3.65)	21.17(3.67)	21.87(3.87)	0.152
Gender	%male	44.08	40.00	47.83	44.26	0.080
Education years	M(SD)	14.63(2.81)	14.89(2.94)	14.63(3.51)	14.43(2.06)	0.089
Psychiatric Diagnosis	%yes	30.26	28.89	34.78	27.87	0.053
Anxiety	M(SD)	8.67(4.85)	9.24(5.04)	9.02(4.89)	7.98(4.67)	0.162
Depression	M(SD)	10.27(5.09)	10.07(4.85)	9.74(5.18)	5.09(3.50)	0.167
Alcohol use 14-day[1]	M(SD)	13.78(13.41)	15.74(17.29)	13.86(11.68)	12.28(11.22)	0.138
Cigarette use 14-day[2]	M(SD)	33.56(65.23)	34.37(67.09)	33.34(67.08)	33.12(63.52)	0.066
Cannabis use						
MINI CUD	M(SD)	6.62(2.28)	6.58(2.30)	6.98(2.18)	6.38(2.35)	0.144
Single symptom (1)	N(%)	2(1.32)	0(0.00)	0(0.00)	2(3.28)	-
Mild (2–3)	N(%)	8(5.26)	3(6.67)	2(4.35)	3(4.92)	-
Moderate (4–5)	N(%)	44(28.95)	14(31.11)	12(26.09)	18(29.51)	-
Severe (6 +)	N(%)	98(64.47)	28(62.22)	32(69.56)	38(62.30)	-
CUDIT-R	M(SD)	17.81(4.86)	17.80(5.61)	18.11(4.70)	17.59(4.45)	0.075
Cannabis use 14-day[3]	M(SD)	6.69(6.65)	6.73(6.66)	6.35(5.58)	6.90(6.99)	0.072
Years weekly use	M(SD)	3.03(2.83)	3.16(2.66)	2.90(2.95)	3.02(2.90)	0.072
Self-reported Days/week	M(SD)	4.36(2.08)	4.56(2.16)	4.20(2.06)	4.34(2.06)	0.088
Self-reported Gram/Week	M(SD)	3.72(3.79)	4.36(4.45)	3.10(2.83)	3.72(3.87)	0.192
Treatment attempts	M(SD)	0.27(1.12)	0.34(1.11)	0.21(0.76)	0.28(1.49)	0.077
Last use	%Today/ %Yesterday/ %LongerAgo	22.37/ 42.11/ 35.53	20.00/51.11/ 24.89	23.91/36.96/ 39.13	22.95/39.34/ 37.71	0.019
Administration method	%SmokeTob/ %SmokeNoTob/ %SmokeConc/ %Vaping/Other	62.5/26.97/ 1.32/3.29/ 5.92	62.22/28.89/0.00/2.22/ 6.67	60.87/23.91/0.00/6.52/ 8.70	63.93/27.87/3.28/1.64/ 3.28	0.031
Gram/Week goal	M(SD)	1.20(1.35)	1.41(1.50)	0.92(0.98)	1.25(1.45)	0.246
Motivation to change	Med(MAD)	2(1)	2(1)	2(0)	2(1)	0.223

Note. [1]Missing: Control: N = 2, MCII: N = 1, Cue-Control: N = 2; [2] Missing: Control: N = 2, MCII: N = 2, Cue-control: N = 2;. [3] Missing: MCII: N = 2; M = mean, SD = standard deviation; Med: median, MAD = median absolute deviation; CUDIT-R: cannabis use disorder identification test – revised; MINI: mini international neuropsychiatric interview, CUD: cannabis use disorder; BF = bayes factor; Tob = tobacco.

Table 2
Follow-up outcomes.

Measure	Unit	Total	Groups		
			Control	MCII	Cue-Control
Subjective Goal Achievement	Med(MAD)	2(1)	3(1)	2(1)	2(1)
Objective Goal Achievement	%Yes	58.55	46.67	65.22	62.30
Gram/Week Change BL-2W	M(SD)	−2.22(3.24)	−2.47(3.89)	−1.76(2.42)	−2.38(3.26)
Gram/Week Change BL-3M	M(SD)	-	-	−1.33(2.23)	−1.23(2.92)
Gram/Week Change 2W-3M	M(SD)	-	-	0.59(2.35)	0.48(1.62)

Note. BL = baseline, 2 W = two-week follow-up, 3 M = three-month follow-up, Med = median, MAD = median absolute deviation, M = mean, SD = standard deviation.

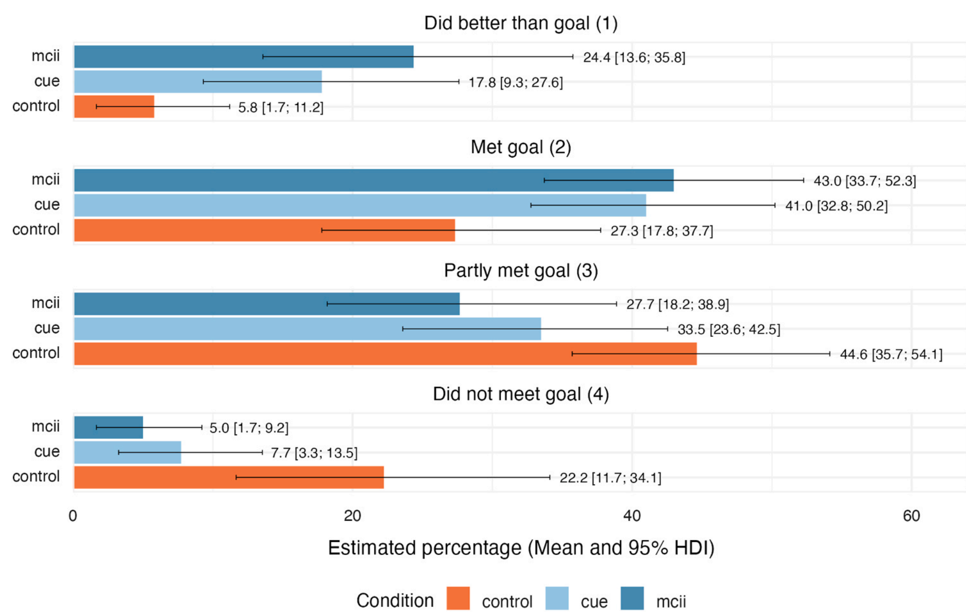

Fig. 3. Subjective goal achievement. Results of the Bayesian cumulative ordinal logistic regression (probit link) analysis assessing intervention group difference in subjective goal achievement, controlling for sex, depression, anxiety, cannabis use disorder symptoms and baseline cannabis use. The figure represents the estimated percentage of people that self-reported each level of subjective goal achievement (at average levels of the control variables).

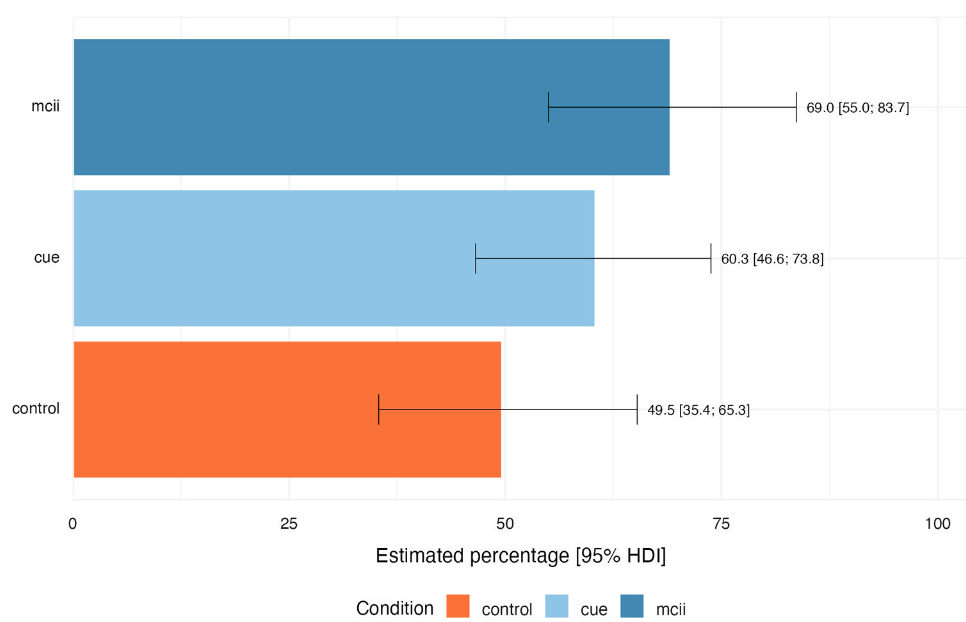

Fig. 4. Objective goal achievement. Results of the Bayesian binary logistic regression (logit link) analysis assessing intervention group difference in objective goal achievement, controlling for sex, depression, anxiety, cannabis use disorder symptoms and baseline cannabis use. The figure represents the estimated percentage of people that achieved their goal (at average levels of the control variables).

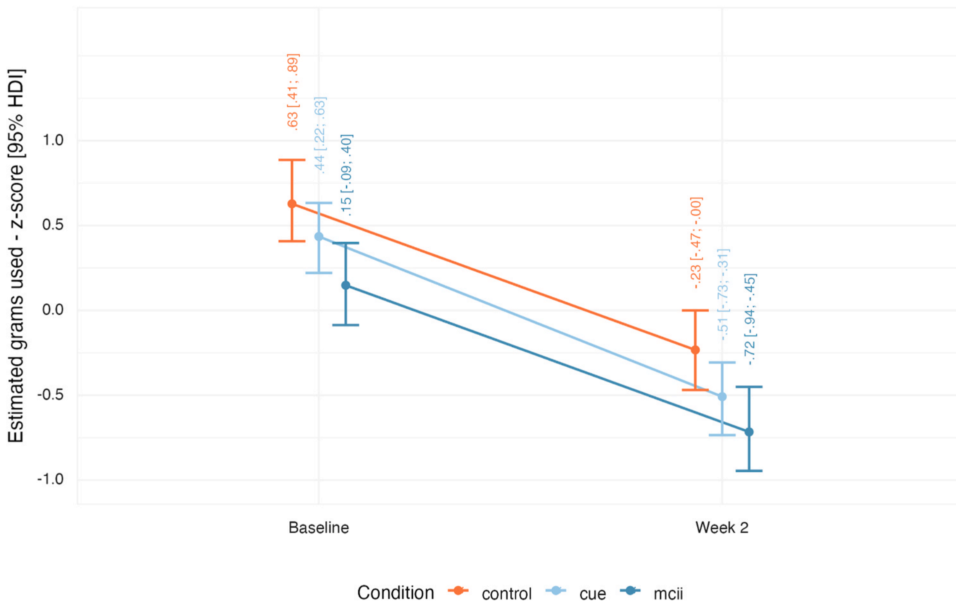

Fig. 5. Change in cannabis use. Results of the Bayesian multilevel linear regression analysis (identity link) assessing the effect of time and intervention group on cannabis use in grams per week, controlling for sex, depression, anxiety, cannabis use disorder symptoms and baseline cannabis use. The figure represents the estimated grams of use (z-scored; at average levels of the control variables).

comparisons of this model showed that, regardless of condition, participants maintained their reduction in cannabis use at three-month follow-up (Table 2; baseline-two-week: $BF_{10} = 13426.755$; baseline-three-month: $BF_{10} = 26.858$; two-week-three-month: $BF_{10} = 0.795$).

4. Discussion

This pilot study assessed the effectiveness of a two-week self-guided online intervention to help individuals reach their personal cannabis reduction goals. The *Back on Track* intervention – both MCII and MCII + additional Cue-control conditions – was more effective than the minimal intervention condition (SMART goal setting) in helping individuals with heavy cannabis use and CUD symptoms reach their reduction goals. Participants reduced their cannabis use over time regardless of the intervention, indicating a general motivation or study participation effect; however, differences between interventions emerged only when examining goal achievement. These results indicate that the type of intervention influenced whether participants met their goals – both subjectively and objectively – but not the degree of reduction in grams per week within this short intervention. However, the maintenance of this intervention-independent reduction in grams per week at three-month follow-up suggests that the initial decreases in cannabis use across groups were sustained over longer time periods. Around 69 % of participants in the MCII condition and 60 % of the participants in the Cue-control condition achieved their reduction goal. This was largely in line with the reported subjective goal achievement: 67 % in the MCII condition and 59 % in the Cue-control condition reported achieving their goal (subjective goal achievement of 'met goal' or 'did better than goal'). These results are in line with previous studies on the effectiveness of implementation intentions in tobacco and alcohol use reduction (Hagerman et al., 2021; Malaguti et al., 2020). Compared to MCII, Cue-control did not increase the likelihood of subjective or objective goal achievement. Hence, MCII might be preferred for ease of implementation and instruction. However, anecdotally, several participants reported finding cue-reduction useful and enjoyed actively implementing it. With cue-induced craving being a central factor for return to use and continued heavy use (Vafaie and Kober, 2022), it would be worth to assess whether Cue-control alone - or as part of an online CBT intervention (Schippers et al., 2014) - can be used to achieve cannabis reduction goals or whether it might be a useful tool in the maintenance of reduction after the intervention. Furthermore, individual differences in cannabis cue-induced craving and attentional bias might affect the effectiveness of Cue-control. Hence, future studies could assess baseline cue-induced craving or attentional bias to cannabis-related stimuli (Field, 2005; Vafaie and Kober, 2022) to explore individual differences in effectiveness.

The *Back on Track* intervention did not affect the objective reduction in cannabis use in grams per week over the two-week period; all participants including those in the minimal intervention Control condition reduced their use by a similar amount. As use in grams at baseline and reduction goals in grams did not differ between groups, early achievement of goals in one group over another seems unlikely. However, as the average use per week at baseline was 3.7 g per week across conditions, the mean reduction of 2.2 g across conditions (with a SD of 3.2) might have resulted in a ceiling effect in some individuals and reduced the possible range of scores reflecting successful reduction. Furthermore, the drop-out rate was higher in the Control group (12.8 % drop-out) than in the other conditions (Cue-control: 6.25 % drop-out, MCII 11.11 % drop-out), which could have biased the results in favor of the Control group as relatively more individuals that were unsuccessful in their use reduction might not have finished the study. Larger samples, including individuals who use cannabis heavily but have more room for reduction in use, are needed to assess potential differentiation of intervention methods at different levels of use. Also, although no significant differences between two-week follow-up and three-month follow-up were observed, there appears to be a trend pointing towards a slight increase in use after the end of the intervention. Larger sample sizes and longer follow-ups are needed to explore who maintains reduced levels of use, for what period they maintain this reduction, and whether this differs depending on intervention.

Core strengths of this intervention are the online accessibility and related scalability – not requiring professional help and avoiding health care related costs – and the option to opt for a reduction goal rather than an abstinence goal. Giving individuals the chance to set personal goals can increase agency and patient empowerment which could aid goal achievement (Loukanova et al., 2007; Lozano et al., 2006). Also, retention was relatively high in the MCII (85.2 %) and Cue-control (91.4 %) conditions. Reducing the number of baseline assessments –

which would also better reflect a pure treatment rather than research objective – could potentially increase retention even more.

Some limitations of this study must be noted. Although the study was pre-registered, it was not registered as a clinical trial. The three conditions were very well matched on a large range of relevant variables, but the sample size of this pilot and feasibility randomized trial was relatively limited. A replication with a larger sample could for example 1) assess the potential effect of Cue-control as a stand-alone intervention or as part of an online CBT intervention, 2) include a non-active (waitlist) control as a comparison condition, 3) evaluate the role of additional variables such as type of cannabis used, previous unsuccessful treatment attempts, attentional bias, and craving in order to identify individual differences in effectiveness, or 4) include different novel intervention groups such as ABC training which has shown promising initial results in alcohol use reduction (Pan et al., 2024; Van Dessel et al., 2023). Furthermore, the relatively large drop-out rate at three-month follow-up limits our ability to assess the long-term effects of the interventions and future studies should intend to and incentivize the participation in longer-term follow-up assessments. This could for example be done by providing a financial compensation for participation in the follow-up assessments. Currently, the limited age range – with our sample including largely older adolescents and young adults – limits our ability to generalize these results to older age groups. Follow-up studies should consider focusing on a broader age range, also assessing accessibility and evaluate ease of implementation in these groups and potentially adapt the instructions accordingly. Furthermore, we cannot exclude the possibility of intoxication effects or sub-acute effects of cannabis during the online assessments. Although this is related to the online nature of the study, researchers are encouraged to explicitly instruct participants to complete the assessments sober. Finally, our assessments of grams per week of cannabis use relied on a single item question due to low data quality from the online version of - the more extensive - TLFB procedure. Future studies could include multiple types of measurements of cannabis use to enable cross-validation or could opt for more extensive instructions – potentially including experimenter contact – on how to accurately complete the online TLFB calendar.

Based on this pilot and feasibility randomized trial, the *Back on Track* MCII intervention seems to be a promising short, online, self-guided intervention that is suitable for a broad range of cannabis reduction goals. MCII showed better results than the minimal SMART goal intervention in individuals with heavy cannabis use and CUD symptoms, but the inclusion of Cue-control did not increase the effectiveness of MCII. Replication studies in larger samples should be conducted to assess its short- and long-term effectiveness in a broader range of individuals interested in reducing or quitting cannabis use without formal intervention.

Preregistration

https://osf.io/hfdxa

CRediT authorship contribution statement

All authors reviewed and approved the final version. *Conceptualization:* JWBE, LNK, JC; *Methodology:* JWBE, LNK, OV, RWHJW, HL, JC; *Investigation:* JWBE, LNK, PR; *Formal Analysis:* JWBE, EK; *Data curation:* JWBE, EK; *Writing – Original draft:* EK; *Writing – Review & Editing:* JWBE, LNK, PR, OV, RWHJW, HL, JC; *Visualization:* JWBE, EK; *Supervision:* JC; *Funding Acquisition:* JWBE, LNK, JC.

Funding

This research was supported by Stichting Volksbond

Declaration of Competing Interest

None

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2025.112943.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

Adamson, S.J., Kay-Lambkin, F.J., Baker, A.L., Lewin, T.J., Thornton, L., Kelly, B.J., Sellman, J.D., 2010. An improved brief measure of cannabis misuse: the cannabis use disorders identification test-revised (CUDIT-R). Drug Alcohol Depend. 110, 137–143. https://doi.org/10.1016/j.drugalcdep.2010.02.017.

Adriaanse, M.A., Oettingen, G., Gollwitzer, P.M., Hennes, E.P., De Ridder, D.T.D., De Wit, J.B.F., 2010. When planning is not enough: fighting unhealthy snacking habits by mental contrasting with implementation intentions (MCII). Eur. J. Soc. Psychol. 40, 1277–1293. https://doi.org/10.1002/ejsp.730.

American Psychiatric Association, 2014. Diagnostic and statistical manual of mental disorders: DSM-5. American Psychiatric Association, DSM. https://doi.org/10.1176/appi.books.9780890425596.744053

Bonar, E.E., Goldstick, J.E., Chapman, L., Bauermeister, J.A., Young, S.D., McAfee, J., Walton, M.A., 2022. A social media intervention for cannabis use among emerging adults: randomized controlled trial. Drug Alcohol Depend. 232. https://doi.org/10.1016/j.drugalcdep.2022.109345.

Connor, J.P., Stjepanović, D., Le Foll, B., Hoch, E., Budney, A.J., Hall, W.D., 2021. Cannabis use and cannabis use disorder. Nat. Rev. Dis. Prim. https://doi.org/10.1038/s41572-021-00247-4.

Davis, M.L., Powers, M.B., Handelsman, P., Medina, J.L., Zvolensky, M., Smits, J.A.J., 2015. Behavioral therapies for treatment-seeking cannabis users: a meta-analysis of randomized controlled trials. Eval. Health Prof. 38, 94–114. https://doi.org/10.1177/0163278714529970.

Field, M., 2005. Cannabis "dependence" and attentional bias for cannabis-related words. Behav. Pharmacol. 16, 473–476. https://doi.org/10.1097/00008877-200509000-00021.

Filbey, F.M., Dunlop, J., Ketcherside, A., Baine, J., Rhinehardt, T., Kuhn, B., DeWitt, S., Alvi, T., 2016. fMRI study of neural sensitization to hedonic stimuli in long-term, daily cannabis users. Hum. Brain Mapp. 37, 3431–3443. https://doi.org/10.1002/hbm.23250.

Fischer, B., Russell, C., Sabioni, P., Van Den Brink, W., Le Foll, B., Hall, W., Rehm, J., Room, R., 2017. Lower-risk cannabis use guidelines: a comprehensive update of evidence and recommendations. Am. J. Public Health. https://doi.org/10.2105/AJPH.2017.303818.

Hagerman, C.J., Hoffman, R.K., Vaylay, S., Dodge, T., 2021. Implementation Intentions to reduce smoking: a systematic review of the literature. Nicotine Tob. Res. https://doi.org/10.1093/ntr/ntaa235.

Helle, A.C., Boness, C.L., Sher, K.J., 2021. College students receptiveness to intervention approaches for alcohol and cannabis use. Psychol. Addict. Behav. 36, 157–176. https://doi.org/10.1037/adb0000699.

JASP Team, 2025. JASP (Version 0.19.3).

Kroenke, K., Spitzer, R.L., Williams, J.B.W., 2001. The PHQ-9: validity of a brief depression severity measure. J. Gen. Intern Med 16, 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x.

Kroon, E., Cousijn, J., Filbey, F., Berchtold, C., Binz, T.M., Kuhns, L., 2024. Associations between hair-derived cannabinoid levels, self-reported use, and cannabis-related problems. Psychopharmacology 241, 1237–1244. https://doi.org/10.1007/s00213-024-06558-0.

Kroon, E., Kuhns, L., Hoch, E., Cousijn, J., 2020. Heavy cannabis use, dependence and the brain: a clinical perspective. Addiction 115, 559–572. https://doi.org/10.1111/add.14776.

Leung, J., Chan, G.C.K., Hides, L., Hall, W.D., 2020. What is the prevalence and risk of cannabis use disorders among people who use cannabis? a systematic review and meta-analysis. Addict. Behav. 109, 106479. https://doi.org/10.1016/j.addbeh.2020.106479.

Locke, E.A., Latham, G.P., 2002. Building a practically useful theory of goal setting and task motivation: a 35-year odyssey. Am. Psychol. 57, 705–717. https://doi.org/10.1037/0003-066X.57.9.705.

Lorenzetti, V., Hindocha, C., Petrilli, K., Griffiths, P., Brown, J., Castillo-Carniglia, Á., Caulkins, J.P., Englund, A., ElSohly, M.A., Gage, S.H., Groshkova, T., Gual, A., Hammond, D., Lawn, W., López-Pelayo, H., Manthey, J., Mokrysz, C., Pacula, R.L., van Laar, M., Vandrey, R., Wadsworth, E., Winstock, A., Hall, W., Curran, H.V., Freeman, T.P., 2022. The International Cannabis Toolkit (iCannToolkit): a multidisciplinary expert consensus on minimum standards for measuring cannabis use. Addiction 117, 1510–1517. https://doi.org/10.1111/add.15702.

Loukanova, S., Molnar, R., Bridges, J.F.P., 2007. Promoting patient empowerment in the healthcare system: highlighting the need for patient-centered drug policy. Expert Rev. Pharm. Outcomes Res. https://doi.org/10.1586/14737167.7.3.281.
Lozano, B.E., Stephens, R.S., Roffman, R.A., 2006. Abstinence and moderate use goals in the treatment of marijuana dependence. Addiction 101, 1589–1597. https://doi.org/10.1111/j.1360-0443.2006.01609.x.
Malaguti, A., Ciocanel, O., Sani, F., Dillon, J.F., Eriksen, A., Power, K., 2020. Effectiveness of the use of implementation intentions on reduction of substance use: a meta-analysis. Drug Alcohol Depend. https://doi.org/10.1016/j.drugalcdep.2020.108120.
Marquardt, M.K., Oettingen, G., Gollwitzer, P.M., Sheeran, P., Liepert, J., 2017. Mental contrasting with implementation intentions (MCII) improves physical activity and weight loss among stroke survivors over one year. Rehabil. Psychol. 62, 580–590. https://doi.org/10.1037/rep0000104.
Mutter, E.R., Oettingen, G., Gollwitzer, P.M., 2020. An online randomised controlled trial of mental contrasting with implementation intentions as a smoking behaviour change intervention. Psychol. Health 35, 318–345. https://doi.org/10.1080/08870446.2019.1634200.
Oettingen, G., Mayer, D., Thorpe, J., 2010. Self-regulation of commitment to reduce cigarette consumption: Mental contrasting of future with reality. Psychol. Health 25, 961–977. https://doi.org/10.1080/08870440903079448.
Olthof, M.I.A., Goudriaan, A.E., van Laar, M.W., Blankers, M., 2023. A guided digital intervention to reduce cannabis use: the ICan randomized controlled trial. Addiction 118, 1775–1786. https://doi.org/10.1111/add.16217.
Pan, T., Szpak, V., Laverman, J., Van Dessel, P., Bovens, R., Larsen, H., Wiers, R.W., 2024. ABC-training for alcohol use during a voluntary abstinence challenge: a randomized controlled trial. Int J. Ment. Health Addict. https://doi.org/10.1007/s11469-024-01409-7.
Pearson, E.S., 2012. Goal setting as a health behavior change strategy in overweight and obese adults: a systematic literature review examining intervention components. Patient Educ. Couns. https://doi.org/10.1016/j.pec.2011.07.018.
Prince, M.A., Collins, R.L., Wilson, S.D., Vincent, P.C., 2020. A preliminary test of a brief intervention to lessen young adults' cannabis use: episode-level smartphone data highlights the role of protective behavioral strategies and exercise. Exp. Clin. Psychopharmacol. 28, 150–156. https://doi.org/10.1037/pha0000301.
Qualtrics, 2022. Qualtrics.
Ridgeway, G., Kilmer, B., 2016. Bayesian inference for the distribution of grams of marijuana in a joint. Drug Alcohol Depend. 165, 175–180. https://doi.org/10.1016/j.drugalcdep.2016.06.004.
Schippers, G.M., Smeerdijk, M., Merkx, M.J.M., 2014. Handboek cognitieve gedragstherapie bij middelengebruik en gokken. Perspectief, Utrecht.
Sheehan, D.V., Lecrubier, Y., Sheehan, K.H., Janavs, J., Weiller, E., Keskiner, A., Schinka, J., Knapp, E., Sheehan, M.F., Dunbar, G.C., 1997. The validity of the Mini International Neuropsychiatric Interview (MINI) according to the SCID-P and its reliability. Eur. Psychiatry 12. https://doi.org/10.1016/S0924-9338(97)83297-X.
Sherman, B.J., Sofis, M.J., Borodovsky, J.T., Gray, K.M., McRae-Clark, A.L., Budney, A.J., 2022. Evaluating cannabis use risk reduction as an alternative clinical outcome for cannabis use disorder. Psychol. Addict. Behav. 36, 505–514. https://doi.org/10.1037/adb0000760.
Sobell, L.C., Sobell, M.B., 1992. Timeline follow-back. Meas. Alcohol Consum. https://doi.org/10.1007/978-1-4612-0357-5_3.
Spitzer, R.L., Kroenke, K., Williams, J.B.W., Löwe, B., 2006. A brief measure for assessing generalized anxiety disorder. Arch. Intern Med. 166, 1092. https://doi.org/10.1001/archinte.166.10.1092.
UNODC, 2022. Drug market trends: Cannabis Opioids, in: World Drug Report 2022.
Vafaie, N., Kober, H., 2022. Association of drug cues and craving with drug use and relapse: a systematic review and meta-analysis. JAMA Psychiatry. https://doi.org/10.1001/jamapsychiatry.2022.1240.
Van der Pol, P., Liebregts, N., de Graaf, R., Korf, D.J., Van den Brink, W., Van Laar, M., 2013. Predicting the transition from frequent cannabis use to cannabis dependence: a three-year prospective study. Drug Alcohol Depend. 133, 352–359. https://doi.org/10.1016/j.drugalcdep.2013.06.009.
Van Dessel, P., Cummins, J., Wiers, R.W., 2023. ABC-training as a new intervention for hazardous alcohol drinking: two proof-of-principle randomized pilot studies. Addiction 118, 2141–2155. https://doi.org/10.1111/add.16271.
Wagenmakers, E.J., Love, J., Marsman, M., Jamil, T., Ly, A., Verhagen, J., Selker, R., Gronau, Q.F., Dropmann, D., Boutin, B., Meerhoff, F., Knight, P., Raj, A., van Kesteren, E.J., van Doorn, J., Šmíra, M., Epskamp, S., Etz, A., Matzke, D., de Jong, T., van den Bergh, D., Sarafoglou, A., Steingroever, H., Derks, K., Rouder, J.N., Morey, R.D., 2018. Bayesian inference for psychology. Part II: example applications with JASP. Psychon. Bull. Rev. 25, 58–76. https://doi.org/10.3758/s13423-017-1323-7.
Wang, G., Wang, Y., Gai, X., 2021. A meta-analysis of the effects of mental contrasting with implementation intentions on goal attainment. Front. Psychol. https://doi.org/10.3389/fpsyg.2021.565202.
World Health Organization, 2016. The health and Social Effects of Nonmedical Cannabis Use. Geneva.