

The relationship between anxious-depressive symptoms and harmful cannabis use: Multiple mediation models via rumination, negative urgency, protective behavioral strategies and refusal self-efficacy

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ABSTRACT

Background: Distressful and negative affective states can be associated with limited self-regulation capacities, while emotion regulation processes (e.g., rumination, negative urgency) might contribute to further depletion of self-control capacities which in turn can lead to diminished control over cannabis use.

Aims: The mediating functions of rumination (i.e., brooding and reflection), negative urgency (NU) and constructs of cannabis use regulation (i.e., cannabis protective behavioral strategies [CPBS] and cannabis refusal self-efficacy [CRSE]) were examined on the associations between anxious-depressive symptoms and cannabis use outcomes (i.e., frequency, harmful use).

Methods: The cross-sectional study used a sample of cannabis users showing signs of harmful consumption ($N = 750$; Males: 70.13% [$N = 526$]; Age: $M = 29.11$ [$SD = 7.45$]). Standardized questionnaires measured anxious-depressive symptoms, rumination, NU, CRSE, CPBS, frequency of cannabis use and harmful cannabis use. A linear regression-based, double-mediation model was performed.

Results: Five significant indirect effects were demonstrated in the mediation model. Single-mediation effects were shown between anxious-depressive symptoms and harmful cannabis use via CRSE and via CPBS. Double-mediation effects were presented between anxious-depressive symptoms and harmful cannabis use via reflection and CPBS, via reflection and CRSE, and via NU and CRSE.

Conclusions: Emotion and cannabis use regulation pathways explained the associations between anxious-depressive symptoms and harmful cannabis use. The mediation model provided new details on how anxious-depressive symptoms, rumination and NU might lead to harmful cannabis use via regulation of cannabis use. Limited self-regulation capacities and similarities between emotion and cannabis use regulation processes might explain the identified indirect effects.

1. Introduction

Existing empirical findings showed that cannabis use disorder (CUD) is positively associated with major depressive disorder (MDD) and generalized anxiety disorder (GAD) [1,2]. Causal pathways were suggested to account for these co-occurrences, such as the self-medication (i.e., cannabis is used to cope with anxious-depressive symptoms) or the cannabis-induced models (i.e., CUD can lead to subsequent emergence of MDD or GAD) [1,3,4]. Other exploratory models, such as the

allostatic hypothesis, highlight the dominant function of anxious-depressive symptoms in the psychopathology of more severe forms of substance use disorders via negative reinforcement motivational processes [5].

Emotion regulation (ER) strategies – which can be defined as “processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions” [6] – as transdiagnostic constructs can explain the associations between anxious-depressive symptoms and problematic substance use [7,8].

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Depressive rumination – as a form of maladaptive ER strategies – can be defined as repetitive concentration on signs, antecedents and outcomes of negative affectivity, distress [7,8]. Meta-analytic findings showed positive associations between rumination and maladaptive psychopathological outcomes, such as MDD, anxiety disorders, eating disorders and substance use disorders [7]. Moreover, within depressive ruminative thinking it is possible to differentiate the more maladaptive brooding (i.e., passive, repetitive concentration on signs of negative affectivity, distress) and the less maladaptive reflection (i.e., more active focus on the background of the problems) subtypes [9]. These rumination subtypes can show differential relationships with CUD. For example, it was reported that brooding had positive, whereas reflection had negative effects on CUD [10].

The emotional cascade model (ECM) can provide a theoretical explanation on how rumination might contribute to externalizing behaviors, such as cannabis use [11,12]. According to the assumptions of the ECM, there is a bidirectional association between depressive symptoms and rumination. Higher levels of depressive symptoms can lead to increased rates of rumination, which in turn can conserve and increase the levels of depressive symptoms. As a result of this bidirectional mechanism, one might experience exacerbating negative affective symptoms. To cope with these distressful affective states and thoughts, reckless and impulsive behavior tendencies can emerge, such as self-harm, substance use or binge eating [11,12]. In accordance with the ECM, previous findings suggested mediational mechanisms between depressive symptoms, rumination and cannabis use: higher levels of depressive symptoms can lead to elevated rates of ruminative thinking which positively influence more adverse outcomes of cannabis use (e.g., quantity of use, negative consequences) via increased rates of coping motives [13].

However, in addition to cannabis motives, it might be warranted to explore the function of other proximal cannabis use-related constructs on the relationship between anxious-depressive symptoms, rumination and outcomes of cannabis use. Distressful and negative affective states can be associated with limited self-regulation capacities, but attempts to regulate these affective experiences might further reduce self-control capacities which in turn can lead to dysregulation of the substance use behavior [14]. Moreover, high levels of negative urgency (NU) (i.e., impulsive behavior preference during distressful and negative affective experiences) can also account for the link between negative affectivity and diminished self-control over substance use [14,15]. Therefore, cognitive-behavioral constructs which are related to the ability to control or regulate cannabis use – such as cannabis use-related protective behavioral strategies (CPBS) and refusal self-efficacy (CRSE) – might have an important function on how anxious-depressive symptoms and rumination contribute to cannabis use outcomes. CPBS are techniques which can be used to ensure moderate and safer consumption patterns and to avoid negative consequences due to cannabis use [16]. CRSE represents one's perceived ability to resist to cannabis use in different situations, such as when there is an opportunity to use, or when someone is experiencing negative or distressful emotions [17]. That is, the use of CPBS aims to reach moderate and non-risky cannabis consumption, whereas CRSE is rather an abstinence-focused construct. Existing research showed that cannabis use outcomes (i.e., levels of consumption, problems) are negatively associated with CPBS and CRSE [16,17]. Moreover, additive effects were also presented between CPBS and CRSE on cannabis use-related outcomes, for example, high levels on both CPBS and CRSE were associated with less harmful cannabis use [18].

Previous studies showed that higher levels of CPBS are correlated with lower rates of NU and difficulties in ER, and with higher levels of adaptive ER strategies [19–21]. Moreover, the mediating effect of CPBS was also shown between emotional instability and cannabis use consequences [19]. On the other hand, the mediating function of CPBS was not supported on the link between NU and cannabis use outcomes [21]. To the best of the Authors' knowledge, existing studies did not examine the associations between CRSE and ER processes. However, more

empirical findings are available on the relationships of anxious-depressive symptoms and ER strategies with alcohol use-related protective behavior strategies (APBS) and drinking refusal self-efficacy (DRSE). Previous studies reported that anxious-depressive symptoms and NU are negatively correlated with APBS and DRSE, difficulties in ER are inversely related to DRSE, and adaptive ER strategies are positively associated with APBS [20,22–28]. Moreover, significant indirect pathways were demonstrated via APBS between anxious-depressive symptoms and alcohol use outcomes and between adaptive ER strategies (e.g., mindfulness, problem-focused coping) and alcohol use outcomes [22,23,25,28]. The significant mediating function of DRSE (but not APBS) was showed between NU and alcohol use outcomes [22,27].

Overall, existing studies mostly tested mediation models related to APBS and DRSE, and less empirical findings are available regarding the mediating function of CPBS and CRSE. Moreover, to the best of the Authors' knowledge, no literature data are available on the complex relationship between anxious-depressive symptoms, rumination, CPBS, CRSE and cannabis use outcomes. Specifically, existing studies did not test double-mediation models on the relationship between anxious-depressive symptoms and cannabis use outcomes via rumination and constructs of cannabis use regulation, such as CPBS and CRSE. Testing indirect effects in such, more comprehensive mediation models might contribute to gain a better understanding of joint pathways of rumination and reduced self-control over cannabis use on the relationships between anxious-depressive symptoms and outcomes of cannabis use (e.g., frequency and harmful patterns of use). Namely, based on previous literature findings, it might be possible that anxious-depressive symptoms and maladaptive responses to these symptoms (i.e., brooding, NU) can contribute to depletion of self-regulation capacities over cannabis use (i.e., resulting in lower levels of CPBS and CRSE) which in turn can increase the levels of cannabis use frequency and harmful cannabis use [14,19,24–27].

The present study aimed to test a double-mediation model with the mediating effects of brooding, reflection, NU, CPBS and CRSE on the relationships between anxious-depressive symptoms and frequency of cannabis use and harmful cannabis use (Fig. 1). It was assumed that higher levels of anxious-depressive symptoms would be associated with higher rates of brooding and NU which in turn contribute to lower rates of CRSE and CPBS which subsequently lead to more frequent and harmful cannabis use. Alternatively, it was also hypothesized that anxious-depressive symptoms would show a positive relationship with reflection which in turn lead to higher levels of CRSE and CPBS which in turn contribute to less frequent and harmful cannabis use. To the Authors' best knowledge, this is the first time that a comprehensive mediation model was tested which simultaneously covers anxious-depressive symptoms, rumination, NU, multiple constructs of cannabis use regulation (i.e., CRSE and CPBS) and outcomes of cannabis use (i.e., frequency of cannabis use and harmful cannabis use). However, it is important to emphasize that this proposed mediation model was built only on theoretical considerations and the suggested mediated links can be deceptive as the cross-sectional design of this study did not allow to specifically examine the temporal directions between the variables.

2. Material and methods

2.1. Participants and procedures

The present sample was based on a study using cross-sectional design, non-representative, convenience sampling and online questionnaires. Participants were recruited on the social media site of Facebook. The online recruitment was performed in thematic, illicit drug use-related Facebook pages and groups. These thematic pages and groups had content on the psychological, medical, social and political aspects of illicit drug use (e.g., sharing articles with the followers on these topics) as well as on personal experiences of using cannabis and/or other illicit drugs (e.g., members of a particular group shared experiences on

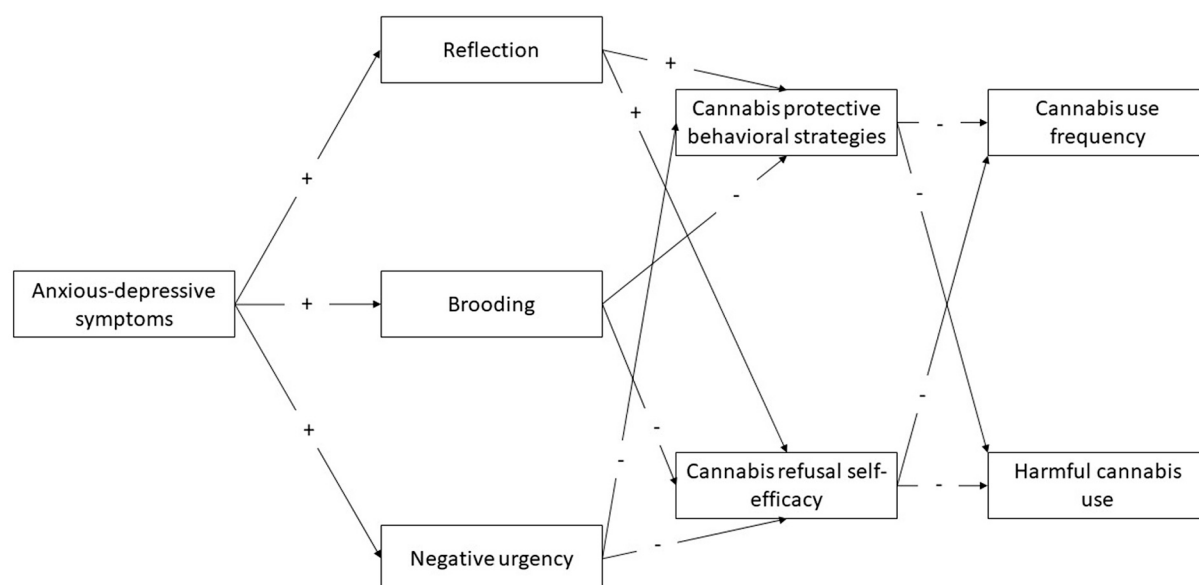


Fig. 1. Proposed mediation model. Positive and negative signs represent the hypothesized direction of the associations between the variables. The effects of age and gender was also controlled in the analyses, but to ease the interpretation of the figure, these covariate effects are not shown.

negative and positive psychological and physical effects of a given illicit drug). That is, it was assumed that the self-selection of those individuals was presented in the study who show interest in illicit drug use-related topics and who have high motivation for using cannabis and other illicit drugs. Moreover, it might be possible that some individuals were followers of multiple thematic groups and pages. Thus, individuals who used more frequently Facebook might had higher chance to be reached by the announcement of the study. The invitation to participate in the study was shared with the followers in a post in each thematic group and page. The invitation posts provided the names of the principal investigators, brief descriptions about the study aims (e.g., examining the psychological aspects of cannabis use) and about the conditions of the participation (e.g., anonymous and voluntary participation, approximate time to complete the questionnaire) and the link of the online questionnaire. The research protocol was approved by the Research Ethics Committee at the Faculty of Education and Psychology of ELTE Eötvös Loránd University, Budapest, Hungary (approval number: 2020/407). Participation was anonymous and voluntary, and informed consent regarding the study aims and terms of participation was also required from the participants.

In total 1359 individuals were included in the sample. The final sample was derived by using multiple inclusion and exclusion criteria to ensure higher levels of within-sample homogeneity. Data from male and female adult participants (18 years of age or older) were considered in the analyses if they consumed cannabis and showed at least one sign of harmful cannabis use in the past 12 months and had valid responses on all questionnaires which were included in the analyses. The six-item Cannabis Abuse Screening Test (CAST) was used to assess the presence of signs of harmful cannabis use [29,30]. Only those individuals were included in the final sample who had at least 1 point on the total scale score of the CAST based on its dichotomized items (i.e., showing at least one harmful consumption symptom at least 'Rarely' or at least 'From time to time' in the past 12 months) (see further in the Measures section) [31]. Consequently, the final sample size was 750. Table 1 presents the main sample characteristics. High proportions of the sample were males, had secondary educational attainment, worked in full-time, and did not study currently.

The Hungarian translation of some of the applied questionnaires (see below) was created in the present study in a step-by-step procedure based on the guidelines of Beaton et al.: (i) forward translation to

Hungarian language, (ii) back translation of the Hungarian version to English, (iii) comparing the original and the back translated English versions and revising the Hungarian version based on the mismatches between the two English versions, (iv) pre-testing the clarity of the instructions and items and asking for written feedback, (v) finalizing the Hungarian version [32].

2.2. Measures

The level of cannabis use was measured by two separate items. Frequency of cannabis use was rated during the past 12 months (1 = Monthly or less, 4 = 4 or more times a week) and during the past 30 days (1 = Did not use in the past 30 days, 6 = Every day). Principal component analysis was used to create a composite score of cannabis use frequency (explained variance = 90.65%; component weights = 0.95).

Harmful cannabis use was measured by the 6-item Cannabis Abuse Screening Test (CAST) [29–31]. Originally, a five-point scale is used to assess the frequency of cannabis-related negative consequences and harmful consumption patterns in the past 12 months (0 = Never, 4 = Very often). However, in the present study the dichotomized items of the scale were considered. Different thresholds indicated the presence of the given harmful consumption pattern (coding: 0 = absence of a given harmful consumption pattern, 1 = presence of a given harmful consumption pattern). In the cases of the items assessing cannabis use before midday and when being alone at least 'From time to time' frequency indicated the presence of harmful consumption (and 'Never' or 'Rarely' responses on these items indicated the absence of harmful consumption). For the other items (cannabis use-related memory problems, being encouraged to stop/reduce cannabis use, unsuccessful attempts to quit, problems related to cannabis use) at least 'Rarely' frequency indicated the presence of harmful consumption patterns (and 'Never' response on these items showed the absence of harmful consumption) [31]. To describe the sample, a dichotomous variable measured the presence (vs. absence) of the risk for harmful cannabis consumption based on the total CAST score. Scores between 2 and 6 points on the CAST indicated the risk for harmful cannabis use [31]. However, in the mediation analysis, a continuous variable measured the severity level of harmful cannabis. The Cronbach- α reliability index indicated low internal consistency for the total CAST score ($\alpha = 0.51$). Therefore, a continuous factor score was computed to assess the severity

Table 1
Sample characteristics (N = 750).

Gender N (%)	
Females	224 (29.87%)
Males	526 (70.13%)
Age M (SD)	29.11 (7.45)
Educational attainment N (%)	
Absence of secondary educational attainment	150 (20.00%)
Secondary educational attainment	395 (52.67%)
At least college or university degree	205 (27.33%)
Working status N (%)	
Not working currently	100 (13.33%)
Working occasionally or in part-time	141 (18.80%)
Working in full-time	509 (67.87%)
Current studies N (%)	
Not studying currently	525 (70.00%)
Currently studying	225 (30.00%)
Frequency of cannabis use in the past 12 months N (%)	
Monthly or less	70 (9.33%)
Two-four times a month	121 (16.13%)
Two-three times a week	142 (18.93%)
Four or more times a week	417 (55.60%)
Frequency of cannabis use in the past 30 days N (%)	
0 times	54 (7.20%)
1–3 times	111 (14.80%)
4–9 times	85 (11.33%)
10–19 times	102 (13.60%)
Not every day, but at least 20 times	171 (22.80%)
Every day	227 (30.27%)
Cannabis Abuse Screening Test (CAST) total score M (SD)	3.32 (1.52)
Harmful cannabis use N (%)	
Low risk for harmful substance use (1 point on the CAST)	104 (13.87%)
Risk for harmful substance use (2–6 points on the CAST)	646 (86.13%)
Risk for major depressive disorder (MDD) and generalized anxiety disorder (GAD) N (%)	
Mild risk for MDD and GAD (0–5 points on the PHQ-4)	623 (83.07%)
Moderate risk MDD and GAD (6–8 points on the PHQ-4)	74 (9.87%)
Severe risk for MDD and GAD (9–12 points on the PHQ-4)	53 (7.07%)

level of harmful cannabis use based on dichotomous categorical items. Close-to-adequate level of internal consistency was presented for the factor score ($\alpha = 0.67$).

The overall level of the use of cannabis use-related protective behavioral strategies (CPBS) was measured by the total score of the shortened, 17-item version of the Protective Behavioral Strategies for Marijuana (PBSM) Scale [16,33]. The Hungarian translation of the PBSM Scale was created in the present study by following the step-by-step guidelines of Beaton et al. [32]. The items of the questionnaire describe different cannabis use-related protective behavioral strategies, such as reducing the frequency and quantity of cannabis use, using cannabis in safer contexts [34]. A five-point scale was used to provide the frequency of use of protective behavioral strategies (1 = Never, 5 = Always). Adequate internal consistency was presented for the total scale ($\alpha = 0.80$).

The overall level of cannabis refusal self-efficacy (CRSE) was measured by the total score of the 14-item Cannabis Refusal Self-Efficacy Questionnaire (CRSEQ) [17]. The Hungarian translation of the CRSEQ was created in the present study by following the step-by-step guidelines of Beaton et al. [32]. The CRSEQ assesses the respondents' perceived ability to resist cannabis use in different situations – such as when one has an opportunity to use, when cannabis use can contribute to emotional relief, when cannabis use can contribute to social facilitation – on a six-point scale (1 = I am very sure I could not resist smoking cannabis; 6 = I am very sure I could resist smoking cannabis). High level of internal consistency was demonstrated for the total scale ($\alpha = 0.93$).

Ruminative thinking was measured by the 10-item Ruminative Response Scale – 10 (RRS-10) [9,35]. The questionnaire measures two main forms of ruminative thinking: brooding and reflection, therefore the corresponding subscale scores were calculated. Participants are instructed to rate each item of the scale on a four-point frequency scale when they are feeling sad or depressed (1 = Never, 4 = Always). Adequate levels of internal consistency were shown for the brooding ($\alpha = 0.73$) and the reflection ($\alpha = 0.75$) subscales.

Negative urgency (NU) was measured by the corresponding, 4-item subscale of the Impulsive Behavior Scale – Short Form (SUPPS-P) [36,37]. Responses are provided on a four-point scale (1 = Agree strongly, 4 = Disagree Strongly). All negative urgency items are reversely scored. Adequate internal consistency was shown for the NU subscale ($\alpha = 0.78$).

The level of anxious-depressive symptoms was measured by the 4-item Patient Health Questionnaire – 4 (PHQ-4) [38–41]. By using a four-point scale (0 = Not at all, 3 = Nearly every day), 2–2 items of the scale assess the frequency of core symptoms of MDD and GAD in the past two weeks. To describe the sample, a categorical variable measured the increasing risk for MDD and GAD. Scores between 0 and 5 points, between 6 and 8 points and between 9 and 12 points indicated mild, moderate and severe risk levels, respectively [39]. However, in the mediation analysis, the total scale score of the PHQ-4 was used. Adequate level of internal consistency was presented for the total scale ($\alpha = 0.85$).

2.3. Data analysis

A linear regression-based, double-mediation model was performed to test the aim of the study. In the model the distal predictor variable was anxious-depressive symptoms, and the outcome variables were cannabis use frequency and harmful cannabis use. The direct effects of the distal predictor variable on the outcome variables were mediated by variables measuring emotion regulation capacities (i.e., NU, brooding and reflection) and cannabis use regulation capacities (i.e., CPBS and CRSE). The variables measuring the regulation of cannabis use were more proximal predictors than emotion regulation-related variables. The effects of gender and age were controlled. Variables in the mediation model were modelled as observed variables. The maximum likelihood robust to non-normality (MLR) method was used to estimate the parameters of the mediation model. Listwise missing data handling was applied. However, no missing cases were presented in any of the variables as responses were mandatory on all questions in the online questionnaire and due to the inclusion criterion to have valid responses on all the relevant study variables. All analyses were performed by Mplus 8.0 statistical software [42]. The dataset and the codes for the analyses are available at <https://osf.io/gzpmc/>.

3. Results

3.1. Descriptive statistics

Table 1 presents the main descriptive statistics of the sample. More than half of the participants reported to use cannabis more than 4 times

a week in the past 12 months and at least 20 times in the past 30 days. Very high proportion of the participants showed a risk for harmful cannabis use based on the CAST total score. More than 15% of the participants showed moderate or severe risk for MDD and GAD.

3.2. Mediation analysis

Bivariate correlations between the variables are presented in Table 2. Table 3 and Fig. 2 show the results of the mediation model.

Female gender was significantly associated with elevated rates of brooding and reflection, and with lower levels of harmful cannabis use. Higher age was significantly linked to lower brooding and higher frequency of cannabis use. Anxious-depressive symptoms had significant positive predictive effects on NU, reflection, brooding in addition to the significant and positive direct effect of anxious-depressive symptoms on harmful cannabis use. Anxious-depressive symptoms were also significantly and negatively linked to CRSE and CPBS. A significant and negative relationship was presented between brooding and cannabis use frequency. Reflection had positive predictive effects on CPBS and CRSE. NU was significantly and negatively related to CRSE and cannabis use frequency. Higher levels of CRSE and CPBS were significantly associated with less frequent and less harmful cannabis use.

Total, direct and indirect effects are summarized in Table 4. In the case of cannabis use frequency, indirect effects were not estimated as the total effect of anxious-depressive symptoms on cannabis use frequency was non-significant. Overall, five significant indirect effects were identified on harmful cannabis use. First, anxious-depressive symptoms had a negative effect on CPBS which in turn was negatively linked to harmful cannabis use. Second, higher levels of anxious-depressive symptoms were associated with lower levels of CRSE which subsequently had a negative effect on harmful cannabis use. Third, a double-mediation pathway indicated that anxious-depressive symptoms had a positive effect on reflection which in turn was positively associated with CPBS which subsequently contributed to lower levels of harmful cannabis use. Fourth, in a double-mediation pathway, higher levels of anxious-depressive symptoms were associated with increased rates of reflection which subsequently had a positive effect on CRSE which in turn was negatively associated with harmful cannabis use. Fifth, in a double-mediation pathway anxious-depressive symptoms were positively associated with NU which had a negative link with CRSE and higher levels of CRSE were associated with lower rates of harmful cannabis use.

4. Discussion

The present study aimed to examine the mediating functions of rumination, negative urgency (NU), and constructs of cannabis use regulation (i.e., cannabis use-related protective behavioral strategies

[CPBS] and refusal self-efficacy [CRSE]) on the associations of anxious-depressive symptoms with cannabis use frequency and harmful cannabis use. To the Authors' best knowledge, this is the first time that a comprehensive mediation model was tested which simultaneously covers anxious-depressive symptoms, constructs of ER and cannabis use regulation and outcomes of cannabis use. It is important to highlight that the present sample was consisted of cannabis users showing signs of harmful cannabis use. Moreover, due to the recruitment procedure of the study, it might be possible that the self-selection of those individuals was presented who show high interest and motivation in cannabis- and illicit drug use. These characteristics can indicate that regular and problematic cannabis users might be overrepresented in the sample which might influenced the levels of other constructs as well. For example, it might be possible that the associations with CPBS and CRSE would have been different by having more recreational users in the sample with less frequent and less harmful consumption patterns (e.g., they might show more favorable patterns on CPBS and CRSE).

In the mediation model a non-significant total-effect was demonstrated between anxious-depressive symptoms and cannabis use frequency. Therefore, indirect effects were not estimated on this relationship. Existing findings reported significant, positive and weak associations between anxious-depressive symptoms and cannabis use [43–45]. However, the studies in the literature largely vary how they measure cannabis use and which confounding variables they control for. These can influence the association between cannabis use and anxious-depressive symptoms [43].

Five significant indirect effects of anxious-depressive symptoms were discriminated on harmful cannabis use. These indirect effects can be categorized into three groups based on the similarities in the mediational mechanisms between them. First, higher levels of anxious-depressive symptoms were associated with lower levels of CRSE and CPBS which subsequently contributed to higher levels of harmful cannabis use. In line with these single mediation pathways, previous studies also reported negative relationships between cannabis use outcomes and CRSE, and between cannabis use outcomes and CPBS [16–18]. However, to the best of the Authors' knowledge, less empirical evidence is available on the links between anxious-depressive symptoms and CRSE, and between anxious depressive symptoms and CPBS. This is the first time that the mediating effects of CRSE and CPBS were tested and supported between anxious-depressive symptoms and outcomes of cannabis use. The single mediation pathway via CRSE matches and extends previous gambling-related findings which suggested the mediating role of refusal self-efficacy on the relationship between depressive symptoms and negative gambling outcomes [46]. The single mediation pathway via CPBS shows similarities with previous studies, which demonstrated mediating effects via APBS between anxious-depressive symptoms and alcohol use outcomes [22,25]. These single mediation

Table 2
Descriptive statistics and bivariate correlations between the study variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Female gender (vs. male gender)	–									
2. Age	–0.03	–								
3. Anxious-depressive symptoms	0.12**	–0.11**	–							
4. Rumination – Brooding	0.14***	–0.16***	0.52***	–						
5. Rumination – Reflection	0.20***	–0.14***	0.35***	0.40***	–					
6. Negative urgency (NU)	0.09*	–0.07	0.22***	0.40***	0.07	–				
7. Cannabis use-related protective behavioral strategies (CPBS)	0.08*	–0.04	–0.05	0.06	0.17***	–0.04	–			
8. Cannabis use refusal self-efficacy (CRSE)	–0.07	0.09*	–0.24***	–0.21***	–0.04	–0.20***	0.41***	–		
9. Cannabis use frequency	–0.02	0.16***	–0.02	–0.15***	–0.12**	–0.08*	–0.51***	–0.26***	–	
10. Harmful cannabis use	–0.09*	–0.03	0.18***	0.13***	0.01	0.10**	–0.25***	–0.33***	0.34***	–
<i>M (SD)</i>	–	29.11 (7.45)	3.05 (2.92)	9.36 (2.99)	11.17 (3.24)	9.05 (2.86)	55.10 (10.96)	56.33 (16.31)	0.00 (1.00)	0.00 (0.22)

Note. All correlation coefficients were estimated by using the maximum likelihood robust to non-normality (MLR) estimation method. Level of significance: * $p < .050$; ** $p < .010$; *** $p < .001$.

Table 3
Predictive effects in the mediation model.

Predictor variables	Outcome variables						
	Rumination – Brooding β (S.E.)	Rumination – Reflection β (S.E.)	Negative urgency β (S.E.)	Cannabis use-related protective behavioral strategies β (S.E.)	Cannabis use refusal self-efficacy β (S.E.)	Cannabis use frequency β (S.E.)	Harmful cannabis use β (S.E.)
Female gender (vs. male gender)	0.07 (0.03)*	0.16 (0.03)***	0.07 (0.04)	0.06 (0.04)	−0.04 (0.04)	0.03 (0.03)	−0.12 (0.03)***
Age	−0.10 (0.03)**	−0.10 (0.03)	−0.04 (0.04)	−0.02 (0.04)	0.05 (0.04)	0.13 (0.03)***	0.00 (0.03)
Anxious-depressive symptoms	0.50 (0.03)***	0.32 (0.03)***	0.21 (0.04)***	−0.15 (0.04)***	−0.19 (0.04)***	0.00 (0.04)	0.10 (0.04)*
Rumination – Brooding	–	–	–	0.07 (0.05)	−0.08 (0.05)	−0.10 (0.04)**	0.05 (0.04)
Rumination – Reflection	–	–	–	0.19 (0.04)***	0.09 (0.04)*	0.02 (0.04)	0.00 (0.04)
Negative urgency	–	–	–	−0.05 (0.04)	−0.12 (0.04)**	−0.07 (0.03)*	0.01 (0.04)
Cannabis use-related protective behavioral strategies	–	–	–	–	–	−0.46 (0.03)***	−0.13 (0.04)***
Cannabis use refusal self-efficacy	–	–	–	–	–	−0.11 (0.03)**	−0.24 (0.04)***
Explained variance (R^2)	29%	16%	5%	5%	9%	30%	15%
Correlations between the variables	Brooding – Reflection: $r = 0.26$ *** Brooding – Negative urgency: $r = 0.33$ *** Reflection – Negative urgency: $r = -0.02$			Protective behavioral strategies – Refusal self-efficacy: $r = 0.42$ ***		Cannabis use frequency – Harmful cannabis use: $r = 0.28$ ***	

Note. β (S.E.): Standardized regression coefficient with the related standard error value. Level of significance: * $p < .050$; ** $p < .010$; *** $p < .001$.

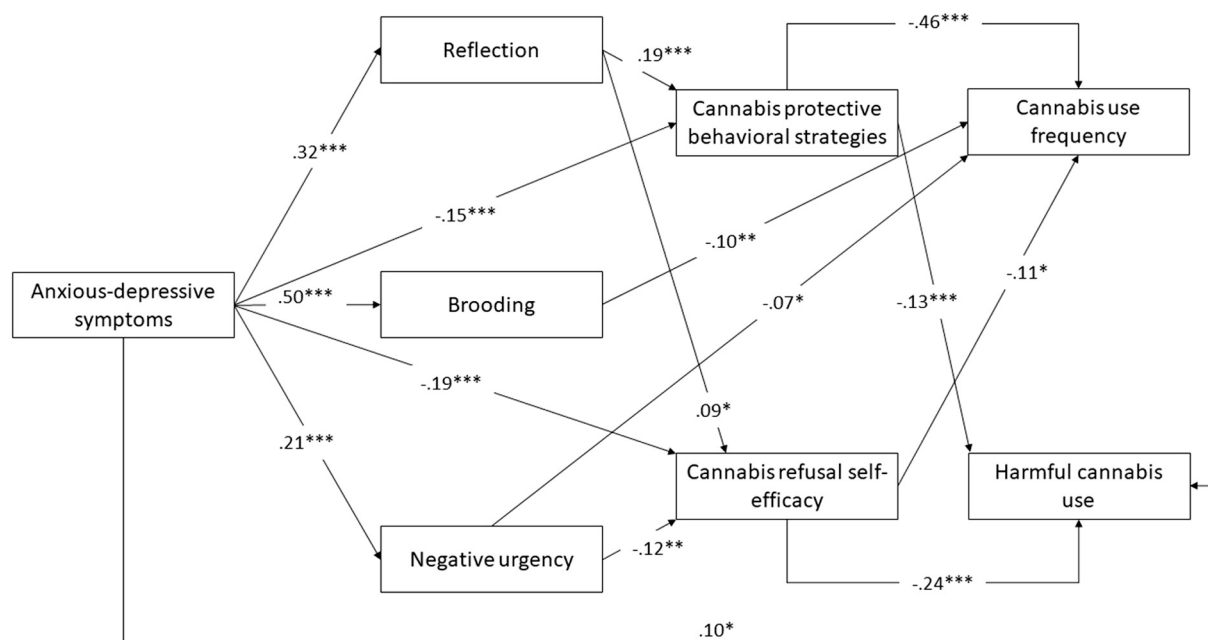


Fig. 2. Findings of the mediation model. To ease the interpretation of the figure, only significant ($p < .050$) regression coefficients are presented, whereas non-significant ($p \geq .050$) regression coefficients in addition to correlation coefficients and the covariate effects of gender and age are not shown (see: Table 3). Single-headed arrows represent regression predictive effects and values in these arrows are standardized regression coefficients. Level of significance: * $p < .050$; ** $p < .010$; *** $p < .001$.

pathways might suggest that limited self-regulation capacities that are related to distressful and negative affective states can account for the negative links of anxious-depressive symptoms with CRSE and CPBS [14]. Alternatively, it might be possible that those with more harmful cannabis use patterns have more negative self-views on their ability to successfully control and regulate their behavior when experiencing distressful and negative affective states [47]. However, these assumptions should be interpreted cautiously as the present study did not test these explanations.

Moreover, double-mediation pathways indicated that anxious-depressive symptoms had a positive effect on reflection which in turn

was positively associated with CPBS and CRSE which subsequently contributed to lower levels of harmful cannabis use. Previous studies also reported that higher levels of depressive symptoms are associated with increased levels of reflection, in addition to findings showing that CPBS are positively correlated with more adaptive ER strategies and negatively with outcomes of cannabis use [10,20,48]. Although existing literature findings also reported negative relationships between cannabis use outcomes and CRSE [17,18], they did not investigate the associations between CRSE and ER processes. To the best of the Authors' knowledge, this is the first time that the double mediating effects via reflection and CPBS as well as via reflection and CRSE were supported

Table 4

Total, direct and indirect effects.

	Outcome variables	
	Cannabis use frequency β (S.E.)	Harmful cannabis use β (S.E.)
Total effect	−0.005 (0.034)	0.193 (0.038) ***
Direct effect	0.000 (0.035)	0.101 (0.042)*
Total indirect effect	− ¹	0.092 (0.026) ***
Anxious-depressive symptoms → Brooding → Cannabis use frequency / Harmful cannabis use	–	0.025 (0.022)
Anxious-depressive symptoms → Reflection → Cannabis use frequency / Harmful cannabis use	–	−0.001 (0.012)
Anxious-depressive symptoms → Negative urgency → Cannabis use frequency / Harmful cannabis use	–	0.003 (0.008)
Anxious-depressive symptoms → Protective behavioral strategies → Cannabis use frequency / Harmful cannabis use	–	0.020 (0.008)*
Anxious-depressive symptoms → Refusal self-efficacy → Cannabis use frequency / Harmful cannabis use	–	0.047 (0.012) ***
Anxious-depressive symptoms → Brooding → Protective behavioral strategies → Cannabis use frequency / Harmful cannabis use	–	−0.005 (0.004)
Anxious-depressive symptoms → Reflection → Protective behavioral strategies → Cannabis use frequency / Harmful cannabis use	–	−0.008 (0.003)**
Anxious-depressive symptoms → Negative urgency → Protective behavioral strategies → Cannabis use frequency / Harmful cannabis use	–	0.001 (0.001)
Anxious-depressive symptoms → Brooding → Refusal self-efficacy → Cannabis use frequency / Harmful cannabis use	–	0.010 (0.006)
Anxious-depressive symptoms → Reflection → Refusal self-efficacy → Cannabis use frequency / Harmful cannabis use	–	−0.007 (0.003)*
Anxious-depressive symptoms → Negative urgency → Refusal self-efficacy → Cannabis use frequency / Harmful cannabis use	–	0.006 (0.003)*

Note. β (S.E.): Standardized effect size with the related standard error value. Level of significance: * $p < .050$; ** $p < .010$; *** $p < .001$. ¹The indirect effects between anxious-depressive symptoms and cannabis use frequency were not estimated due to the non-significant total effect between the variables.

between anxious-depressive symptoms and outcomes of cannabis use. The double-mediation pathway via reflection and CPBS is in line with previous findings which suggested the mediating function of APBS on the effects of adaptive ER on alcohol use outcomes [23,28]. However, the present sequential mediating effect might contribute to broaden the existing knowledge on the link between ER and protective behavioral strategies by testing for cannabis use for the first time and by controlling for the effects of anxious-depressive symptoms and different rumination dimensions in the mediation model. In the context of refusal self-efficacy, previous studies reported that difficulties in ER are inversely related to DRSE [24]. Therefore, the double-mediating effect via reflection and refusal self-efficacy was not only tested and supported for the first time for cannabis use, but it also provides new empirical data on the associations of substance use refusal self-efficacy with more adaptive ER processes and with rumination. A possible (though not tested) explanation for these double mediating effects can be that some elements of reflection indicate a more active, problem- and goal-focused orientation which might lead to a more adaptive and pre-planned regulation of cannabis use (e.g., ability to resist to cannabis use in different situations, planning the manner of consumption before starting

to use) [23,49].

Finally, in a double mediation pathway, higher levels of anxious-depressive symptoms were associated with increased rates of NU which in turn had a negative effect on CRSE which subsequently contributed to less harmful cannabis use. In line with this double mediation pathway, previous studies also reported positive link between depressive symptoms and NU among cannabis users and negative relationships between cannabis use outcomes and CRSE [17,18,50]. However, to the best of the Authors' knowledge, this is the first time that the mediating effect of CRSE was tested and supported between anxious-depressive symptoms, NU and harmful cannabis use. Thus, this indirect effect matches and replicates for cannabis use the previously reported indirect effect between NU and harmful alcohol use via DRSE [27]. This indirect link can suggest that increased impulsive tendencies and impaired decision making due to distressful and negative affective experiences might lead to more harmful cannabis use via diminished ability to refuse consumption.

4.1. Limitations

Various methodological limitations must be considered during the interpretation of the present findings. First, the use of self-report measurements of cannabis use-related constructs, ER constructs and anxious-depressive symptoms might bias the present findings, for example, due to effects of social desirability, recall bias [51]. Second, the cross-sectional design did not allow to explore the causal relationships between the variables. Namely, findings of the statistical mediation models can deceptively suggest temporal and causal relationships between the variables. However, it is important to consider that the proposed mediation model was only built on theoretical considerations and the cross-sectional design impeded to examine the temporal order and bidirectional relationships between the variables (e.g., it might be possible that constructs of cannabis use regulation were not just predictors but also outcomes of harmful cannabis use) [52,53]. Moreover, cautious interpretation of the identified mediating effects is also warranted due to the small indirect effect sizes and weak regression predictive effects in the significant indirect effects. Third, generalizability of the findings was restricted due to the use of the present non-representative and convenience sample. Individuals with less frequent cannabis use patterns were most likely underrepresented. Fourth, several constructs were measured in a general and non-specific way (e.g., CPBS and CRSE). Thus, the use of specific subscales in some cases might contributed to more specific and precise estimation of the associations between the variables. Fifth, the tested mediation model did not control for several relevant variables which can explain cannabis use outcomes (e.g., other aspects of impulsivity and ER, cannabis motives and outcome expectancies).

5. Conclusions

The present study tested emotion and cannabis use regulation pathways explaining harmful cannabis use and frequency of cannabis use. The mediation model showed indirect effects via reflection, NU, CPBS and CRSE between anxious-depressive symptoms and harmful cannabis use. This comprehensive mediation model provided new details on how anxious-depressive symptoms, rumination and NU might lead to harmful cannabis use via regulation of cannabis use. Future studies might aim using longitudinal research design (e.g., ecological momentary assessment, EMA) to explore more specifically the direction of the effects between anxious-depressive symptoms, rumination, cannabis use regulation and outcomes. It would be also important to extend the present findings by testing similar mediation models in the context of other psychoactive substances (e.g., alcohol). Future studies might also consider investigating the function of other adaptive and maladaptive ER strategies in addition to rumination (e.g., planning, positive reappraisal, catastrophizing, blaming others).

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Ethics

Authors declare that all procedures followed the ethical standards of the Declarations of Helsinki. Informed consent was obtained from all the participants for being included in the study.

Contributions

Zsolt Horváth: Conceptualization, Methodology, Formal analysis, Data Curation, Visualization, Writing - Original Draft, Writing - Review & Editing; *Péter Sárosi*: Methodology, Investigation, Writing - Review & Editing; *Csilla Magyar*: Conceptualization, Methodology, Investigation, Provision, Writing - Review & Editing; *Letícia Boda*: Methodology, Investigation, Provision, Writing - Review & Editing; *Eszter Farkas*: Methodology, Investigation, Provision, Writing - Review & Editing; *Mónika Koós*: Methodology, Investigation, Writing - Review & Editing; *Zsolt Demetrovics*: Conceptualization, Supervision, Writing - Review & Editing; *Róbert Urbán*: Conceptualization, Supervision, Writing - Review & Editing.

Declaration of Competing Interest

none.

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