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ORIGINAL ARTICLE



Cognitive Distortions Associated with Alcohol and Marijuana Use in Uruguayan Citizens

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ABSTRACT

Background: Psychological distress (i.e., incipient symptoms of anxiety, stress, and depression) may promote substance use through increased emission of cognitive distortions. These are automatic irrational thoughts that can promote distress, which in turn increases substance use. **Aim:** This study analyzed, in a sample of Uruguayan citizens, the unique contribution of cognitive distortions on the frequency and quantity of alcohol or marijuana use, over and above the contribution of psychological distress or the use of emotion regulation strategies. We also assessed whether these variables were associated with having initiated or resumed the use of a substance. **Methods:** A survey asked about alcohol and marijuana use, psychological distress, emotion regulation strategies, and cognitive distortions. The study comprised a convenience sample of 1132 participants (Mean age = 29.07 ± 8.19 years, 72.26% women). Separate hierarchical linear regression analyses were conducted on the frequency and quantity of alcohol or marijuana use, whereas a logistic regression was applied on having initiated or resumed the use of a substance. **Results:** Several cognitive distortions were significant predictors of frequency and quantity of alcohol consumption or frequency of marijuana use, over and above psychological distress. Differential emission of automatic thoughts was also associated, along with higher scores of psychological distress, with a significantly higher probability of having initiated the use of a new substance or having resumed the use of a substance. **Conclusions:** Cognitive distortions may promote alcohol and marijuana use. Interventions aimed at modifying these distortions should be considered to reduce the emission of these behaviors.

KEYWORDS

Cognitive distortions; marijuana use; alcohol use; regression analyses

Introduction

Substantial effort has been invested in identifying individuals at risk for substance misuse. A factor commonly reported to promote engagement in substance use is psychological distress (Geisner et al., 2004; Jordan et al., 2018; Rodriguez et al., 2020). The latter facilitates the effects of other vulnerability factors and promotes reinstatement into drug use (Dawson et al., 2007; Mantsch et al., 2016).

It has been shown, for instance, that those with a lower ability to withstand negative emotional states are more likely to be affected by psychological distress (Rahman et al., 2022). Psychological distress could also interact with cognitive distortions. These, also referred to as automatic thoughts, encompass flawed or inaccurate cognitive processes involving perception and beliefs (American Psychological Association, 2015). These distortions, which are inherent psychological phenomena that can appear with varying intensity in all individuals, were first introduced to describe irrational thoughts that prompt negative affect and eventually depression. Specifically, the description of these cognitive patterns traces their roots to a foundational roster of six distortions put forward by Beck's early cognitive theory

(Beck, 1979) [see Helmond et al. (2015) for a review and references].

Cognitive distortions can be measured by the Automatic Thoughts Inventory (IPA, following its Spanish original name; Ruiz & Lujan, 1991), which includes 15 distortions: selective abstraction (considering a single detail of a complex situation while disregarding everything else), polarized thinking [extreme thought patterns without taking into account all the available facts, (Hughes & Neimeyer, 1993)], overgeneralization, mind reading [making unfounded assumptions about someone else's thinking, (Raj et al., 2020)], catastrophizing [extreme forecasts involving one's actions or situations (Moritz et al., 2011)], personalization, emotional reasoning, global labeling (explaining someone's personality by a single feature), culpability, "should" or "always being right" statements, and control/fairness/change/heaven's reward fallacies. The latter is a series of interconnected distortions involving the belief that hard work or sacrifice must be always counted and rewarded, or that outcomes (e.g., a promotion) must be always based on fairness or equality.

Cognitive distortions have been involved in the development of depression, the externalization of problem behaviors

(Helmond et al., 2015), and gambling disorder. For instance, Barnhofer & Chittka (2010) showed associations between negative thinking, neuroticism, and depression; others have shown that the illusion of control and other cognitive distortions are correlated with problem gambling (Ledgerwood et al., 2020; Mallorquí-Bagué et al., 2019). Similarly, several influential theoretical models posit that cognitive distortions are key components in the etiology of antisocial and criminal behaviors (Navathe et al., 2008; Ward et al., 1997). Much less is known about the role of cognitive distortions in substance use behaviors (Miller et al., 2017; Wu et al., 2022). An intriguing study (Kirisci et al., 2004) has shown that cognitive distortions in early adolescence significantly mediated the link between disinhibition during the ages of 10 to 12 and subsequent marijuana usage at 16, which in sequence, forecasted the development of substance use disorder by the age of 19. It is important to mention that this study only measured four cognitive distortions (catastrophizing, overgeneralizing, personalizing, and selective abstraction) in the context of the interpretation of social interactions, and refrained from specifying the predominant distortions influencing consumption. More recent proposals indicate that a distorted ability to interpret others' thoughts and intentions, which neurobiologically depends on the integrity of prefrontal networks that mature in adolescence and early adulthood, may increase future substance use (Winters et al., 2021). These prefrontal networks, as well as other key areas for cognitive function like the hippocampus, have the potential to be damaged by marijuana or alcohol use (Fernández et al., 2019), thus prompting further development of aberrant cognitive processes.

Several interactions among psychological distress, cognitive distortions and substance use could be proposed. The illusion of control [i.e., an unrealistic perception of control in a context where such control is not objectively feasible, Fenton-O'Creevy et al. (2010)] is greater under stress (Friedland et al., 1992). Subjects who are under stress and exhibit high levels of illusion of control may be less likely to implement protective behavioral strategies. The latter are behaviors (executed before, during, or after drug use) aimed at reducing the harmful effects of drug use (Tabernero et al., 2019). Alternatively, the perpetuation of cognitive distortions has been long recognized to promote distress, anxiety (Helmond et al., 2015), and even dysphoria (Rnic et al., 2016), which increase substance use. Selective abstraction may shape more positive, and less negative, expectations of the effects of drugs, which in turn favor initiation and maintenance of drug use (Patel & Fromme, 2010). Other factors, in turn, such as the use of emotion regulation (ER) strategies, may help disengage the relationship between psychological distress, cognitive distortions, and substance use.

ER involves the implementation of antecedent- or response-focused cognitive strategies (Gross, 1998), to regulate current or expected emotions (Cabello et al., 2013). The cognitive reappraisal strategy acts before the actual emotion, to change the cognitive framing of the stimuli associated with the emotion (Yeung & Wong, 2020). The emotion suppression strategy ameliorates negative effects associated with the expression of the emotion, albeit it is usually considered

a less effective strategy (Lopez et al., 2020). These strategies, which can be measured using the Emotion Regulation Questionnaire (ERQ) (Gross & John, 2003), can help deter from engagement in drug use behaviors. As an example, an intriguing study observed a significant association between posttraumatic stress disorder symptoms and alcohol use. This association, however, was not present in those with high levels of cognitive reappraisal (Aase et al., 2018).

In the present study, we analyzed -in a sample of Uruguayan citizens, a population largely neglected in the analysis of psychological underpinnings of substance use behaviors- the unique predictive contribution of cognitive distortions on the frequency and volume of alcohol or marijuana use, over and above the contribution of psychological distress, the use of ER strategies and sociodemographic variables such as sex or age. We also assessed whether psychological distress, cognitive distortions, ER, and substance use variables (i.e., frequency and volume of alcohol or marijuana use), differed by age or sex.

This study was conducted during an outbreak of COVID-19, the disease caused by the SARS-CoV-2 that spread worldwide by April 2020. It had been reported, in a sample from Uruguay, that approximately one-third of the participants increased the use of their drug of choice (i.e., their "preferred" substance) during the COVID-19 pandemic, and 17% had increased the frequency of use, with psychological distress being a predictor of this pattern (Ruiz et al., 2022). The latter study was conducted at the beginning of the pandemic when nationwide daily cases in Uruguay were below 50 per day. Another aim of the present study, conducted in April-May 2021 when Uruguay had $\approx$ 2500 COVID-19 cases per day, was to assess if psychological distress, cognitive distortions, and ER were associated with the onset of use of new psychoactive substances or the reinstatement in the use of these substances.

Design, participants, and procedures

A cross-sectional design was employed. Data were collected using convenience sampling, a non-probabilistic sample selection method, between April 15 to May 25, 2021. More in detail, an invitation was distributed *via* social networks (i.e., Twitter, Facebook, and Instagram) and email listings. The latter was composed of participants from previous research who had agreed to be sent invitations for future research. Snowball sampling was not used.

The invitation had a disclaimer that emphasized the anonymity of the study, described the eligibility criteria (i.e., being a Uruguayan citizen and at least 18 years old), and contained a link at the bottom. When the participant clicked the link, a consent form was presented, and upon completion of this consent, a survey -which compiled different questionnaires- began. Participants receive no compensation, monetary or otherwise, for their participation. The study procedures conformed to the ethical guidelines for research involving human subjects of the Declaration of Helsinki. In Uruguay, no specific approval from an ethics committee is required for the type of survey employed.

Measures

Socio-demographic data

Participants were asked about biological sex, age, province of residence, and compliance with the suggestion to stay at home (total, partial, none). They were also asked on the level of self-reported worrying and distress, and on their level of hope that the current situation would improve. These three questions were answered on an ordinal scale with four levels, from “No or None” to “A lot.”

Emotion regulation

We used the Spanish version (Cabello et al., 2013) of the Emotion Regulation Questionnaire (ERQ) (Gross & John, 2003), which consists of 10 items, representative of two dimensions, that are answered *via* a 7-point scale (from 1 = *strongly disagree* to 7 = *strongly agree*). Four items addressed expressive suppression of emotions, whereas six addressed cognitive reappraisal. Responses were added up within each dimension, and greater scores indicate a higher use of that strategy. The original Spanish adaptation of this scale features adequate internal consistency ($\alpha = 0.79$ for reappraisal and $\alpha = 0.75$ for suppression). Similar reliability was found in the present work ($\alpha = 0.79$ for both subscales).

Kessler psychological distress scale

Participants answered ten questions addressing anxiety or depression symptoms experienced during the last 30 days, using a Likert-type format of five points, from 1 to 5. Thus, the range of possible scores went from 10 to 50, where greater values represent greater psychological distress. The reliability (Cronbach's Alpha) of the scores obtained in the present study was optimal ($\alpha = 0.90$).

Inventory of automatic thoughts (IPA)

This instrument evaluates 15 cognitive distortions through 45 items. These items are scored from 0 to 3; the lowest score corresponds to the affirmation “I never think about that” and the highest, “I often think about it.” As an example, an item corresponding to the heaven's reward fallacy is “Even if I suffer now, someday I will have my reward,” whereas responses to the item “If I feel sad it is because I am mentally ill” evaluate emotional reasoning. The sum of the items is a measure of the level of cognitive distortions. The reliability (Cronbach's Alpha) of the scores obtained in the present study was optimal ($\alpha = 0.93$).

Alcohol use

A visual guide, with different alcohol beverages, oriented participants about the standard drink unit (SDU) concept. One SDU was defined as containing 14 g of alcohol [i.e., one SDU = 14 grams of alcohol]. We first asked (question 1) frequency of (any alcohol) consumption in the last two months; using an 8-point scale from “Never” to “Everyday.”

Participants then indicated (question 2) how many SDUs they had consumed every day of a typical week of the last two months. Those who had never drunk alcohol or who abstained from drinking within the previous two months had the option to indicate so. We also asked (question 3) about binge drinking, using the following question “How often did you take 5 or more measurements, if you are a man, or 4 or more measurements, if you are a woman, on one occasion?” The reliability of these scores was optimal ($\alpha = 0.80$). The answers to questions 1 and 2 were used to calculate the total number of days in which alcohol was consumed (in the last two months) and the total amount of alcohol (grams) consumed in a typical week of the last two months.

Marijuana use

Participants were given a visual guide reference that exemplified different marijuana-containing products and informed the grams contained in each product. Similar to alcohol, we asked about the last two months' frequency of marijuana use, using an 8-point scale. Then participants reported the usual quantity of grams of marijuana consumed in each day of a typical week of the last two months. Those who had not consumed marijuana indicated this with 0. The answers to questions 1 and 2 exhibited an optimal Cronbach's alpha ($\alpha = 0.95$) and served to calculate the frequency of marijuana consumption (i.e., the total number of days in the last two months) and the total amount of marijuana (grams) consumed in a typical week of the last 2 months.

Use of other substances

The participants answered about the use of the following substances: cocaine, tobacco, heroin, designer drugs (e.g., MDMA), methamphetamines, hallucinogens, non-prescription opioids, or overuse (i.e., using more than the amount prescribed) of tranquilizers, opioid or stimulants. They were asked about the frequency of use in the last two months, using an ordinal scale from “I did not use that substance” to “Every day or almost every day.” They were also asked whether (yes/no) they had initiated the use of a new psychoactive substance (a substance they had never used before) during the COVID-19 pandemic and if (yes/no) during the pandemic they resumed the use of a psychoactive substance they had discontinued.

Data analysis

Descriptive analyses of the sociodemographic characteristics of the sample were separately reported by sex (male, female). We also describe the prevalence of psychoactive substance use, as derived from the question on frequency of use. Analysis of Variance (ANOVA), with age (under or above 30) and sex as between-group factors, were separately conducted on Kessler scores, emotional regulation strategies (one for each dimension), and the total number of cognitive distortions. Similar ANOVAs were conducted on the

frequency and quantity (g) of alcohol or marijuana consumed during a typical week of the timeframe measured. The effect size in the ANOVAs is described *via* the partial eta squared (η^2p). Following Lakens (2013), the effect size measures were described as small ($\eta^2p=0.01-0.05$), medium ($\eta^2p=0.06-0.13$), and large ($\eta^2p = \geq 0.14$).

Four separate hierarchical multiple regressions assessed whether cognitive distortions were associated with the following dependent variables: frequency of alcohol use, frequency of marijuana use, quantity (g) of alcohol consumed, and quantity (g) of marijuana consumed, during a typical week of the timeframe measured. It should be noted that the data analysis technique employed is different from Hierarchical Linear Modeling. Separate regressions were conducted for each of these dependent variables. Each regression was conducted with the subset of participants who endorsed the use of alcohol or marijuana. The regression for marijuana consumed during a typical week was conducted on the participants who reported use of that substance during the time frame measured, whereas the regression for the quantity of alcohol was conducted in alcohol users only (i.e., abstainers were excluded). In each regression, the following independent variables were used: sex, age, psychological distress, the two dimensions of ER, and the 15 automatic thoughts. The nesting of the hierarchical regression was as follows: in the first step we entered age and sex. Psychological distress scores and ER strategies were introduced in the second step, whereas automatic thoughts were entered in the third and last step. Each successive step featured the predictors introduced in that particular step, along with those introduced in preceding steps. This is, even if certain predictors were found to be statistically non-significant in a given step, they were still included in the subsequent step.

The aim of these hierarchical regressions (Fein et al., 2022), and the rationale for the three-step clustering structure, was to assess the unique association of cognitive distortions with alcohol and marijuana outcomes, over and above the contribution of psychological distress and the use of ER strategies. Regular multiple correlation coefficients (R^2) and standardized regression coefficients ($\alpha = 0.05$) were calculated.

Questions concerning having initiated the use of a new substance (yes/no) or having resumed the use of a substance (yes/no) were collapsed into a dichotomic outcome, which was analyzed *via* binary logistic regression. Specifically, this analysis assessed, in the complete database, the membership into the dichotomous dependent variable (i.e., yes/no concerning the use of a new or relapse into a previously used substance) as a function of sociodemographic variables (sex and age), psychological distress, automatic thoughts, and emotional regulation (in its dimensions of emotional suppression and cognitive reappraisal). The data were analyzed using IBM SPSS Statistics (Version 23).

Results

Descriptive and group-related analyses

A total of 1252 responses were received. Of those, 10 were excluded (3 due to the participants being 17 years old and 7 due to inconsistent responses). The database employed in the present study was composed of a subset of those participants aged between 18 to 50 years (i.e., emerging adults and adults). Thus, the final sample was composed of 1132 participants (Mean age = 29.07 ± 8.19 years, 72.26% women).

Table 1 presents mean $\pm$ SEM or percentages (for continuous or categorical variables, respectively) of the

Table 1. Description of sociodemographic characteristics of the sample as a function of sex.

	Sex	
	M (<i>n</i> =314)	F (<i>n</i> =818)
Age	29.8 ± 0.4	28.7 ± 0.3
18-30 years	57.9	33.8
31-50 years	42.0	66.1
Geographic area of residence		
Montevideo	67.5	64.3
Rest of the country	32.5	35.7
Endorsement of recommended social distance measures		
Total	13.7	15.7
Partial	78.3	78.4
None	7.9	5.9
How worried do you feel about the current sanitary situation?	None: 2.2 Somewhat worried: 35.9 Fairly worried: 48.1 Very worried: 13.7	None: 0.8 Somewhat worried: 26.3 Fairly worried: 54.7 Very worried: 18.1
How distressed do you feel?	None: 14.9 Somewhat distressed: 45.8 Fairly distressed: 33.4 Very distressed: 5.7	None: 6.5 Somewhat distressed: 44.9 Fairly distressed: 36.3 Very distressed: 12.2
Feel hope about the future?	None: 10.2 A little: 40.1 Some: 34.3 A lot: 15.3	None: 12.3 A little: 55.5 Some: 26.6 A lot: 5.5

Notes. The table shows the distributions of responses to the sociodemographic questions of the survey, in male (M) and female (W). For nominal variables, data are presented as percentages of participants placed in each category. For continuous variables, data are presented as means and standard deviation of the mean. The sample involved 1132 participants.

sociodemographic characteristics of the sample: age (under 30, over 30), area of residence (Capital city of Montevideo, rest of the country), level of endorsement of the recommended social distance measures (total, partial, no endorsement) and level of self-reported worrying and distress and hope for the future]. The participants were predominantly females (72%) residing in Montevideo. The latter is consistent with the known geographical distribution of the Uruguayan population. At the time of the data collection, the Uruguayan government was recommending (albeit there was no enforcement) several social distance measures to prevent the spread of COVID-19. Most of the current sample indicated partial endorsement of these recommendations. Most reported feeling somewhat distressed, with minimal sex-related differences, and the majority reported being fairly worried about the current sanitary situation.

When asked “how often did you use (a given drug) in the last two months,” the substance with the highest prevalence of use was alcohol (81.4%), with “once a week” (16.6%) being the most common reported frequency of use. Marijuana, in turn, was consumed by 35.4% of the sample, and the most common reported frequency was every day (8.3%). Use of tobacco and non-prescribed anxiolytics were reported by 28.6% and 12.8% of the sample, respectively, with 7.9% reporting smoking tobacco 2-3 times a day. Any use of hallucinogens or cocaine was endorsed by 6.1% and 4.9% of the sample, whereas the use of designer drugs (e.g., ecstasy) or non-prescribed analgesics neared 4.6% of the sample. Use of heroin, (0.2%), methamphetamines (1.2%), and non-prescribed stimulants (e.g., Ritalin) (0.6%) was relatively low.

Participants under 30 years of age and women exhibited significantly greater psychological distress ($F_{1,1128}=51.11$, $p<0.001$, $\eta^2p=0.04$ and $F_{1,1128}=67.97$, $p<0.001$, $\eta^2p=0.06$, respectively) than those over 31 or men. The interaction between age and sex did not reach significance. Cognitive reappraisal scores were significantly higher in women than

in men ($F_{1,1128}=6.75$, $p<0.01$, $\eta^2p=0.01$); whereas men and participants aged 30 years or under showed significantly greater expressive suppression than women ($F_{1,1128}=54.78$, $p<0.01$, $\eta^2p=0.05$) or participants aged 31 or older ($F_{1,1128}=25.70$, $p<0.01$, $\eta^2p=0.02$) (see Table 2).

Frequency and quantity (g) of alcohol use (see descriptive data in Figure 1A-B) was significantly greater in men than in women ($F_{1,1128}=12.43$, $p<0.001$, $\eta^2p=0.01$ and $F_{1,1128}=12.13$, $p<0.001$, $\eta^2p=0.01$, respectively), and those over 30 years old drank significantly more days than those 18 to 30 years old. Men reported close to 10 days in which marijuana was consumed, which was significantly higher than the 6 days reported by women ($F_{1,1128}=10.27$, $p<0.001$, $\eta^2p=0.01$). The total grams of marijuana consumed in a typical week was also significantly greater in men than in women ($F_{1,1128}=9.98$, $p<0.001$, $\eta^2p=0.01$). The latter results are shown in Figure 1C-D.

Hierarchical multiple regression analyses

Frequency of alcohol use

Sex and age were entered in the first step of the regression that considered the frequency of alcohol use as the dependent variable. These variables increased the explained variance by 1% (F change_{2,846}=6.59, $p<0.05$). Being male and older was associated with greater alcohol use ($b=0.08$, $t=2.32$, $p<0.05$ and $b=0.09$, $t=2.59$, $p<0.05$). The entering of psychological distress in the second step significantly increased the explained variance by an additional 2% (F change_{3,843}=4.82, $p<0.005$; $b=0.13$, $t=3.33$, $p<0.001$). The ER strategies were not significantly associated with the dependent variable. In the third and last step, the entering of automatic thoughts significantly increased the explained variance to 7% (i.e., a 4% increase in R^2 ; F change_{15,828}=1.97, $p<0.05$). Higher scores in the Shoulds subscale ($b=0.19$, $t=3.43$, $p<0.001$) and lower scores in Heaven's reward fallacy ($b=-0.11$, $t=2.48$, $p<0.05$)

Table 2. Description of psychological discomfort, Emotion regulation strategies and cognitive distortions, as a function of sex and age.

	Sex		Age (years)	
	Male	Female	18-30	31-50
Psychological discomfort	22.2±0.4	26.8±0.4	27.04±0.3	22.9±0.4
Emotion regulation strategies				
Cognitive Reappraisal facet	28.0±0.4	29.02±0.2	28.4±0.2	29.3±0.3
Expressive Suppression facet	15.8±0.3	13.2±0.2	14.5±0.2	12.9±0.3
Cognitive distortions				
Filtering	2.1±0.1	2.9±0.1	3.0±0.1	2.1±0.1
Polarization	1.3±0.1	1.5±0.1	1.7±0.1	1.0±0.1
Overgeneralization	1.6±0.1	1.9±0.1	2.2±0.1	1.8±0.1
Mind reading	1.5±0.1	1.6±0.05	1.7±0.06	1.3±0.06
Catastrophizing	2.4±0.1	3.1±0.1	3.1±0.1	2.4±0.1
Personalization	1.9±0.1	1.9±0.1	2.2±0.07	1.5±0.07
Control fallacies	1.8±0.1	1.9±0.1	2.1±0.06	1.6±0.07
Fallacy of fairness	1.4±0.1	2.3±0.1	2.3±0.1	1.6±0.1
Emotional reasoning	0.9±0.1	1.1±0.05	1.2±0.06	0.8±0.06
Fallacy of change	1.9±0.1	2.4±0.06	2.4±0.07	1.8±0.1
Global labeling	2.2±0.1	2.2±0.06	2.4±0.07	1.9±0.1
Culpability	1.5±0.1	1.5±0.05	1.6±0.05	1.3±0.07
Shoulds	2.7±0.1	2.9±0.1	3.0±0.1	2.1±0.1
Always being right	2.2±0.1	2.3±0.06	2.4±0.07	2.0±0.1
Heaven's reward	4.5±0.1	5.1±0.1	5.3±0.1	4.3±0.1

Notes. The table shows scores of psychological distress, emotion regulation strategies and cognitive distortions, as a function of sex and age. Data are presented as means and standard deviation of the mean. The sample involved 1132 participants.

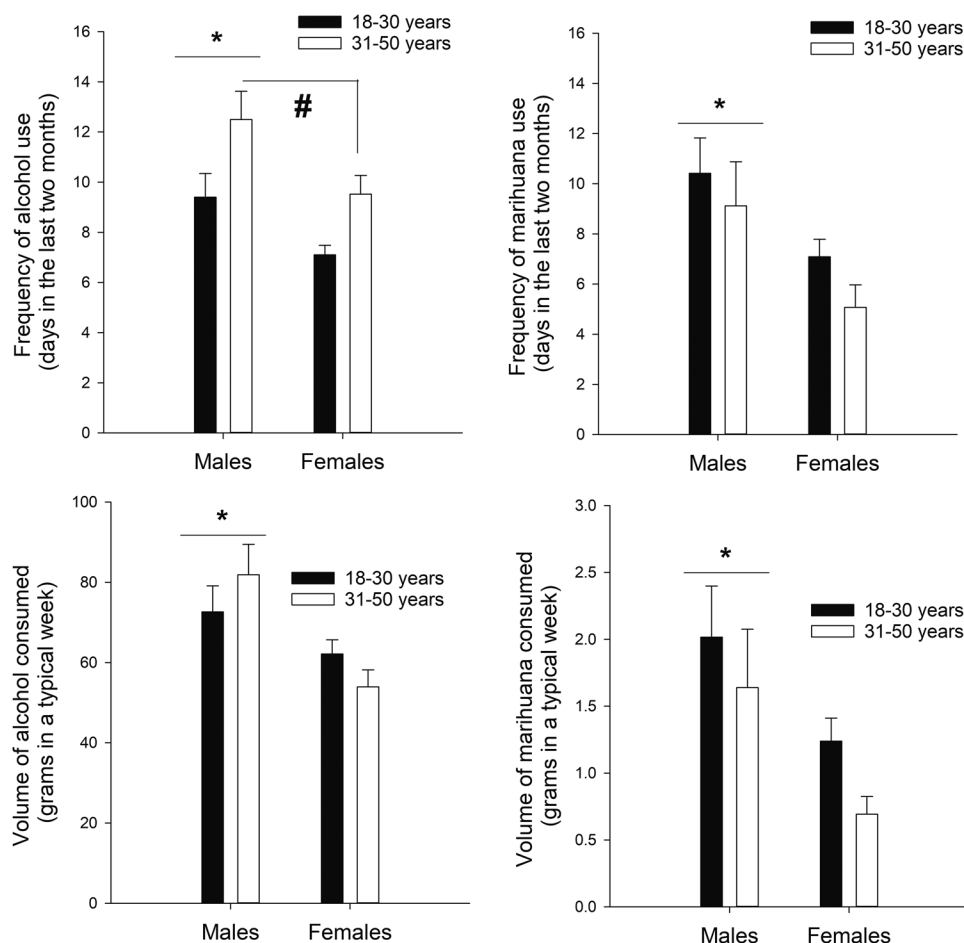


Figure 1. A-B. Frequency of alcohol or marijuana use (days in the last two months) as a function of sex and age (18-30 years old or 31-50 years old). C-D. The volume of alcohol or marijuana consumed (grams in a typical week) as a function of sex and age (18-30 years old or 31-50 years old). The statistical analysis revealed that frequency and quantity (g) of alcohol and marijuana use were significantly greater in men than in women, a result indicated with the asterisk (*) sign. The analysis also indicated that those over 30 years of age drank significantly more days than those between 18 and 30 years of age, a result indicated by the pound (#) sign. Data are expressed as mean $\pm$ SEM.

were associated with greater frequency of alcohol use. There was a trend for higher scores in the interpretation subscale to be associated with greater frequency of alcohol use ($b=0.08$, $t=1.75$, $p=0.08$).

Quantity of alcohol use

Sex and age explained 1% of the variance in the quantity of alcohol use (F change_{2,846} = 5.06, $p<0.01$). Being male and younger was associated with a greater volume of alcohol use ($b=0.08$, $t=2.31$, $p<0.05$ and $b=-0.08$, $t=2.37$, $p<0.05$). Psychological distress—but not the ER strategies—significantly increased the explained variance by an additional 1% in the second step (F change_{3,843} = 2.72, $p<0.01$; $b=0.08$, $t=2.07$, $p<0.05$). The entering of automatic thoughts in the last step significantly increased the explained variance to 6% (F change_{15,828} = 2.03, $p<0.05$). Higher Interpretation scores ($b=0.12$, $t=2.41$, $p<0.05$) and lower scores in Heaven's reward fallacy ($b=0.11$, $t=2.29$, $p<0.05$) were associated with a greater quantity of alcohol use. Psychological distress was no longer a significant predictor of the quantity of alcohol use, after entering automatic thoughts.

Frequency of marijuana use

The entering of sex and age was associated with a significant increase in the explained variance of frequency of marijuana use (F change_{2,353} = 5.57, $p<0.005$, $R^2=0.3$). Being male was associated with a greater frequency of marijuana use ($b=0.15$, $t=2.86$, $p<0.05$). Neither the entering of psychological distress nor ER strategies significantly increased the explained variance, in the second step. In the third and last step, the entering of automatic thoughts significantly increased the explained variance to 13% (F change_{15,335} = 2.37, $p<0.005$, $R^2=0.13$). Higher scores in the Interpretation subscale ($b=0.31$, $t=3.84$, $p<0.001$) and lower scores in Control Fallacy ($b=-0.24$, $t=3.03$, $p<0.005$) were associated with a greater frequency of marijuana use.

Quantity of marijuana use

The entering of sex and age, in the first step of the regression, was not associated with a significant increase in the explained variance of the quantity of marijuana use. Likewise, neither the entering of psychological distress or ER strategies (in the second step) nor the entering of automatic thoughts

Table 3. Outcomes of the logistic regression that examined factors associated with having initiated use of a new substance or having resumed use of a substance, during the timeframe measured.

Outcome (i.e., dependent variable)	Predictor	β	Sig.	Odds ratio	95% confidence interval	
					Lower limit	Upper limit
Having initiated use of a new substance or having resumed use of a substance	Sex	-0.367	0.089	0.693	0.454	1.057
	Age	-0.01	0.232	0.99	0.974	1.006
	Filtering	-0.038	0.504	0.963	0.863	1.075
	Polarization	-0.032	0.665	0.969	0.84	1.118
	Overgeneralization	-0.129	0.075	0.879	0.763	1.013
	Mind reading	0.13	0.047	1.139	1.002	1.295
	Catastrophizing	0.002	0.973	1.002	0.911	1.101
	Personalization	-0.17	0.012	0.844	0.738	0.964
	Control fallacies	-0.061	0.378	0.941	0.821	1.078
	Fallacy of fairness	-0.04	0.486	0.96	0.857	1.076
	Emotional reasoning	0.054	0.427	1.055	0.924	1.206
	Fallacy of change	0.002	0.979	1.002	0.883	1.136
	Global labeling	0.092	0.119	1.096	0.977	1.23
	Culpability	0.279	0.001	1.321	1.142	1.53
	Shoulds	0.12	0.034	1.128	1.009	1.261
	Always being right	-0.016	0.754	0.984	0.888	1.09
	Heaven's reward fallacy	-0.034	0.395	0.967	0.895	1.045
	Cognitive Reappraisal	-0.015	0.251	0.985	0.961	1.011
	Expressive Suppression	-0.026	0.110	0.974	0.944	1.006
	Psychological distress	0.077	0.001	1.08	1.05	1.112

Notes. This regression examined which factors predict the dichotomous outcome having initiated use of a new substance or having resumed use of a substance (yes/no), within the timeframe measured. The predictors were cognitive distortions, emotional regulation strategies, and sociodemographic variables (sex, age). Sex is coded as follows: 0= male, 1=female.

(in the third step) significantly increased the explained variance of the quantity of marijuana use.

Binary logistic regression

This regression modeled the relationship of a set of independent variables (sociodemographic variables, psychological distress, automatic thoughts, and emotional regulation) and a dichotomous dependent variable (i.e., yes/no concerning the use of a new substance or relapse into a previously used substance). The model was statistically significant ($\chi^2 = 125.14$; $p < 0.001$) and explained (Nagelkerke's R^2) 16% of the variance. The good fit was corroborated by the Hosmer-Lemeshow test ($\chi^2 = 6.69$; $p > 0.50$). The model correctly ascertained 84.2% of the cases, and five variables achieved statistical significance (complete description of associated variables scores in Table 3). For every one-unit increase in Culpability ($\beta = 0.28$; OR = 1.32; CI: 1.14–1.53; $p < 0.001$), participants exhibited a 32% increase in the odds of having initiated the use of a new substance or having resumed the use of a substance. Higher levels of psychological distress ($\beta = 0.08$; OR = 1.08; 95% confidence interval [CI]: 1.05–1.11; $p < 0.001$), and higher scores in the Shoulds ($\beta = 0.12$; OR = 1.13; CI: 1.01–1.26; $p < 0.05$) or Mind reading ($\beta = 0.13$; OR = 1.14; CI: 1.00–1.30; $p < 0.05$) subscales were also associated with a significantly higher probability of this outcome. Moreover, for every one-unit increase in the personalization scale, the odds of reporting using a new substance were reduced by 16% ($\beta = -0.17$; OR = 0.84, CI: 0.74–0.96; $p < 0.05$).

Discussion

The main result of the present study is that a variety of automatic thoughts were associated with the frequency and quantity of alcohol use and frequency of marijuana use, over

and above the contribution of psychological distress, and sociodemographic variables like age or sex. Differential emission of automatic thoughts was also associated, along with higher scores of psychological distress, with a significantly higher probability of having initiated use of a new substance or having resumed use of a substance.

A recent study suggested that high levels of cognitive distortions could counter the efficacy of psychological treatments on drug use disorders (Wu et al., 2022). Another study revealed that the association between exposure to violence while dating and alcohol and marijuana-induced problems were greater among adolescents exhibiting high (vs. low) levels of cognitive distortions (Miller et al., 2017). Furthermore, Kirisci et al. (2004) showed that cognitive distortions in late infancy but not in early adolescence mediated the relationship between neurobehavior disinhibition and the use of marijuana at the age of 16 years. The present study extends these observations by indicating that, to our knowledge for the first time in a sample drawn from South America, cognitive distortions are associated with alcohol and marijuana outcomes, and with the onset of the use of a new substance, or with resuming the use of a substance previously consumed.

Among the cognitive distortions, higher interpretation scores were ubiquitously associated with substance use in the present study, being associated with frequency and quantity of alcohol use and with the frequency of marijuana use. Interpretation biases have been associated with mental disorders such as depression, anxiety (Hirsch et al., 2016) or anorexia nervosa (Brockmeyer et al., 2018). We can only speculate as to the mechanism by which they also regulate substance use, yet it can be hypothesized that those with higher interpretation scores may consider ambiguous events as aversive or stressful information. It is also possible that higher interpretation scores are associated with the development of positive expectations toward substance use. In that

regard, Rivarola Montejano et al. (2022) have recently shown that positive marijuana expectancies mediated the effect of sensation-seeking on marijuana use frequency.

Another automatic thought that achieved significance in the present study was heaven's reward, with lower scores on this scale being associated with greater alcohol use (both frequency and quantity). It is notable that a previous study, conducted on adolescents who endorsed alcohol use, showed significant associations between this cognitive distortion and (lack of) tolerance to frustration (Ávila Fray & Guadalupe, 2016). Distress tolerance, in turn, is known to predict alcohol outcomes *via* drinking-to-cope motives (Pilatti et al., 2022). A limitation of the present results is that we observed a negative association between heaven's reward and alcohol use. Future studies should address this apparent contradictory outcome. It is worth mentioning that we did not control for religiosity, which could be positively associated with Heaven's reward and is protective of substance use (Grim & Grim, 2019).

Akin to prior research (Geisner et al., 2004; Jordan et al., 2018; Rodriguez et al., 2020) psychological distress was significantly associated with alcohol use. It had been reported, in a sample drawn from the Uruguayan population, that psychological distress predicted alcohol-related negative consequences, over and beyond the level of alcohol consumed (Ruiz et al., 2020). In the present work, psychological stress was not a significant predictor of marijuana use. This intriguing dissociation is similar to a finding of a recent study conducted on Argentinian citizens (Salguero et al., 2022), which reported that negative emotional states (measured *via* the depression, anxiety and stress scale) were associated with use of only alcohol but not with use of marijuana or with simultaneous use of both substances. Taken together, these results suggest that, at least in the samples of these studies (which share sociocultural and socioeconomic characteristics), alcohol -but not marijuana- use may be associated with the need to cope with the burden of psychological distress. It is also worth noting that, similar to other studies conducted before and during the COVID-19 pandemic (Drapeau et al., 2014; Rega et al., 2022; Varma et al., 2021), we found that younger people and women report greater psychological distress than older participants or their male counterparts.

The excitement brought by the present findings must be tempered due to the study's significant limitations. First and foremost, the amount of explained variance was low to very low across the models, suggesting that other variables are needed to adequately account for these substance use variables. The regression that considered resuming or initiating a new substance as the dependent variable captured, from the analyses executed, the greatest amount of variance explained. This likely relates to the fact that resuming/initiating a new substance is a dichotomous variable, whereas frequency and volume of use are continuous variables. Treatments or other socio-cognitive factors are known (Hedeker & Mermelstein, 2000) to exert varying effects on dichotomous vs. continuous variables (e.g., full vs. partial abstinence).

Notably, we did not measure impulsivity, a multidimensional concept that has been repeatedly associated with

engagement in substance use (Stojek & Fischer, 2013; Xiao, 2008; Yates et al., 2012). Different aspects of impulsivity predict different substance use behaviors or consequences (Tran et al., 2018). For instance, a recent study conducted on 1057 Argentinian citizens indicated that sensation seeking, one component of impulsivity, was uniquely associated with simultaneous use of alcohol and marijuana, whereas lack of premeditation, another component of impulsivity, was associated with separate but concurrent use of alcohol and marijuana (Salguero et al., 2022). We also failed to account for the role of social norms on substance use. The latter are cognitive shortcuts that shape behavior by indicating the perceived extent or social acceptance of different substance use behaviors and are significant modulators of substance use (Stock et al., 2016).

Another limitation is that we relied on an online convenience sample. This sampling strategy relies on self-selection, which could result in over-representation of certain groups. This prevents generalizing the findings to the general population, until confirmed by research that uses probability samples. In that regard, our sample was predominantly composed of females. The greater proportion of females, which was not unexpected [i.e., several studies have shown that women are more willing to self-select into health-related studies, (Glass et al., 2015)], could have influenced the findings. Consistent with prior research, in the present study males exhibited higher levels of substance use, whereas females exhibited higher levels of psychological stress. Therefore, it could be argued that the associations reported pertain more to samples with relatively low levels of substance use engagement or relatively high levels of psychological distress. It is notable, however, that the seemingly important sex-related differences in terms of alcohol and marijuana use translated into relatively mild sex effects in the context of the regression analyses. Yet, the analysis of effect sizes indicated that the differences revealed by the ANOVAs were, albeit significant, very small in size, which helps elucidate why sex did not exert a more meaningful role in the regression analyses.

Despite these limitations, the present study yields valuable information that can be used for the design of interventions to reduce the extent of substance use. Unlike other factors, such as personality factors or a family history of drug use, cognitive distortions are amenable to psychological intervention.

Declaration of interest

No potential conflict of interest was reported by the author(s).

Disclosure statement

No potential conflict of interest was reported by the authors.

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Data availability statement

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

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