Cannabis-Related Perceptions as Mediators of the Association Between Trait Impulsivity and Cannabis Outcomes

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ABSTRACT. Objective: Normative perceptions have been shown to mediate the effect of personality traits on cannabis outcomes. We examined descriptive norms, injunctive norms, and the role of cannabis in college life as possible mediators of the association between impulsivity-related traits (i.e., negative urgency, positive urgency, sensation seeking, perseverance, and premeditation) and cannabis outcomes (i.e., frequency of cannabis use and negative consequences) among college students from five countries. **Method:** A total of 1,175 college students (United States, *n* = 698; Argentina, *n* = 153; Spain, *n* = 178; Uruguay, *n* = 79; and Netherlands, *n* = 67) who were also cannabis users (i.e., reported cannabis use at least once within the previous month) completed an online survey. We used path analysis to test whether the proposed double-mediated paths (impulsivity-like traits→perceived cannabis norms→cannabis use frequency→negative cannabis-related consequences) were invariant across countries/cultures. **Results:** Cannabis-related perceptions, particularly college cannabis beliefs and injunctive norms, significantly mediated the association between impulsivity and cannabis outcomes. Two significant double-mediated paths, which were invariant across sex and countries, were found: (a) higher positive urgency→higher endorsement of internalized norms→higher cannabis use frequency→more negative cannabis-related consequences and (b) higher sensation seeking→higher endorsement of injunctive norms→higher cannabis use frequency→more negative cannabis-related consequences. **Conclusions:** The study corroborates previous findings on normative perceptions mediating the effects of impulsivity-like traits on cannabis outcomes and suggests that these processes may operate similarly among college student cannabis users in different legal and cultural contexts. The findings highlight the need to address internalized norms and suggest these normative perceptions may be a good intervention candidate to reduce cannabis use/consequences. (*J. Stud. Alcohol Drugs, 82,* 522–535, 2021)

EXCLUDING ALCOHOL AND TOBACCO, cannabis is the most used drug around the globe (World Health Organization, 2016), particularly among young people (United Nations Office on Drugs and Crime, 2018). Approximately 182 million people between ages 15 and 64 reported nonmedical cannabis use in 2013 (United Nations Office on Drugs and Crime, 2015), and about 9% (13.1 million people) were cannabis dependent (Degenhardt et al., 2010). The rates of dependence, among lifetime cannabis users, increase from 9% to 17% if cannabis onset occurred during adolescence (Hall & Degenhardt, 2009; National Institute on Drug Abuse, 2019) and between 25% and 50% among those with daily use (Volkow et al., 2014). For most countries and for most drugs, rates of drug use peak during

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emerging adulthood (i.e., ages 18–25; United Nations Office on Drugs and Crime, 2018).

In fact, cannabis use is more frequent among emerging adults than in any other age group (Farmer et al., 2015; National Plan of Drugs, 2018; Patrick et al., 2016; Schulenberg et al., 2017; Secretariat of Integral Policies on Drugs of the Argentine Nation, 2017), and, compared with their noncollege peers, college students exhibit increased risk for cannabis use and problems (Center for Behavioral Health Statistics and Quality, 2018; Miech et al., 2017). Emerging adulthood, and the college years for students in particular (Arnett, 2005; Cho et al., 2015; Derefinko et al., 2016; Skidmore et al., 2016), is indeed a high-risk developmental stage for the initiation and escalation of substance use. Moreover, although cannabis use before age 18 is less prevalent among those who attend college compared with those who do not, the prevalence of cannabis use increases at a faster rate among 18- to 21-year-old college students than for same-age emerging adults who do not attend college (White et al., 2005).

Cannabis use, particularly when frequent, increases the risk for experiencing a wide spectrum of negative consequences (Arria et al., 2015; Suerken et al., 2014) ranging from relatively mild (e.g., sluggishness) to more severe consequences (e.g., trouble sleeping after stopping or cutting down on cannabis use; Simons et al., 2012), including cannabis dependence (Guttmannova et al., 2017; Volkow et al., 2014). It is important, therefore, to understand the factors that increase the likelihood that college students will use cannabis and that differentiate between problematic and nonproblematic use. Factors associated with cannabis use are diverse and include distal variables (e.g., personality traits) that influence a broad set of behaviors and proximal variables (e.g., cannabis-related perceptions) that explicitly influence cannabis outcomes. Two key factors strongly associated with substance use are impulsivity (Mitchell & Potenza, 2014; Verdejo-García et al., 2008) and social norms (Neighbors et al., 2007).

Impulsivity—defined as the tendency to act without thinking, the difficulty to evaluate the consequences of a behavior, the inability to inhibit an ongoing response, or even the preference for immediate and small rewards over larger but delayed rewards (Potenza & de Wit, 2010)—is a crucial multidimensional construct in addictive behaviors (Bravo et al., 2018; LaBrie et al., 2014; Pearson et al., 2018; VanderVeen et al., 2016). The UPPS-P model (Lynam et al., 2006) of trait-like impulsivity features this multifaceted nature by measuring five distinct, yet related, factors: negative urgency (NU), positive urgency (PU), perseverance, premeditation, and sensation seeking (SS). Alcohol studies have suggested that SS is mostly related to alcohol use, whereas PU and NU are mostly associated with negative consequences (Bravo et al., 2018; LaBrie et al., 2014). Concerning cannabis, a meta-analysis showed that all impulsivity facets, except for perseverance, were associated with cannabis use, whereas SS, premeditation, and PU were associated with cannabis-related problems (VanderVeen et al., 2016).

Theories of normative social behavior (e.g., Cialdini et al., 1991) when applied to cannabis use encompass descriptive (i.e., perceived guidelines about normative prevalence, frequency, or quantity of cannabis use) and injunctive (i.e., perceived values of the level of approval/disapproval of cannabis use) perceptions. College students tend to overestimate the level of cannabis use by their peers (descriptive norms) and, also, how much their peers approve of the use of cannabis (injunctive norms; Pearson et al., 2017b). These biases are associated with greater cannabis use (Buckner, 2013). Another normative perception, extrapolated from the alcohol use literature (Osberg et al., 2010), is the internalization of the college cannabis use culture, as measured by the Perceived Importance of Marijuana to the College Experience Scale (PIMCES; Pearson et al., 2017a). This reflects the perception of the college years as a time to engage in cannabis use, and the overall belief that cannabis is an integral feature of college life. This internalized norm exhibits significant positive associations with cannabis outcomes, including negative cannabis-related consequences (Bravo et al., 2019c; Wilson et al., 2018).

Normative perceptions are plastic and amenable to interventions aimed at reducing substance use during high school (Stock et al., 2016) or college (Cronce et al., 2014). Different theoretical models posit that distal factors influence substance use via proximal factors. The Acquired Preparedness Model of alcohol risk (Smith & Anderson, 2001) states that more disinhibited individuals are biased to learn the positive, over the negative, effects of alcohol. This selective attentional bias leads to the development of more positive alcohol expectancies that, in turn, influences greater alcohol use. This and other models, such as the Theory of Planned Behavior (Ajzen, 2011), posit perceptions—such as social norms—as key mediators of the association between distal factors and substance outcomes.

Consistent with these notions, several studies indicated that normative perceptions, such as the internalization of the college drinking/cannabis use culture, mediate the effect of personality traits—mostly impulsivity and SS—on alcohol outcomes (Hustad et al., 2014; Pearson & Hustad, 2014) or cannabis outcomes (Pearson et al., 2018). For instance, Stevens et al. (2018) found that each of the five facets of impulsivity affected cannabis use via approval of cannabis, as well as descriptive or injunctive norms in a sample of college students from the United States.

The findings reviewed strengthen the importance of simultaneously examining relevant normative perceptions to unveil the intricate associations between distal and proximal factors on cannabis outcomes. However, prior

studies have largely been conducted in samples from the United States, which limits the generalizability of the findings and highlights the need to examine these associations in less studied populations (D'Amico et al., 2014; Henrich et al., 2010). It is unknown whether normative perceptions on cannabis use will significantly mediate the effects of impulsivity-related traits in cultures in which college life differs significantly from that of the United States.

Bravo et al. (2018) made progress toward this aim, albeit focused only on alcohol use. Among college student drinkers from the United States, Spain, and Argentina, they found college alcohol beliefs mediated the effects of NU, PU, SS, and perseverance similarly across countries. Cultural orientation patterns, such as individualism (i.e., which emphasizes independence and autonomy) or collectivism (i.e., which emphasizes the group and the interdependence of its members), are differentially associated with substance use (Foster et al., 2014).

In Uruguay, the federal government regulates the production, distribution, and selling of cannabis for recreational use. In Argentina, as in different U.S. states, there is a legal framework regulating cannabis access to patients and researchers; however, in the United States, there is currently a patchwork of cannabis-related policies. Some states treat cannabis as an illicit substance whose possession is followed by severe legal consequences, some allow medical use of cannabis with varying degrees of regulation, and some allow legal recreational use. Moreover, even those U.S. states with similar policies exhibit heterogeneity in their implementation. In Spain, cannabis consumption, cultivation, possession, and purchase are illegal, unless these occur privately and not-for-profit. Across the globe, the legal status of cannabis use influences the preferred route of administration (Borodovsky et al., 2017), with the nonsmoking routes (e.g., edibles) being more frequent where recreational or medical use of cannabis is legal (Borodovsky et al., 2018; Johnson et al., 2016). In this context, cross-cultural studies are useful not only to understand and serve different populations but also, perhaps more important, to help develop culturally sensitive treatments and interventions (Prashad et al., 2017).

Built on previous cross-cultural substance-related research (Bravo et al., 2018), the present study sought to replicate and extend previous cannabis-related findings (Pearson et al., 2018). Specifically, we examined (a) whether the mediational role of cannabis-related normative perceptions found in previous research (Pearson et al., 2018) remains when examining impulsivity as a multidimensional construct; and (b) whether the double mediation model (i.e., impulsivity-related facets→cannabis-related norms→cannabis use→negative consequences) is invariant across distinct cultural contexts (i.e., across different countries [United States, Spain, Argentina, Uruguay, and Netherlands]) and sex.

Of note, these countries exhibit differences in cultural orientation (Chiou, 2001), in college life (Bravo et al., 2017), and in the legal regulation of cannabis use that may influence the associations between distal and proximal factors and cannabis outcomes (Prashad et al., 2017). The objective was to disentangle the complex combinations by which cannabis-related perceptions mediate the influence of distinct impulsivity facets, while acknowledging the potential modulation of cultural backgrounds (i.e., social behavior, norms, beliefs, laws, customs, habits, and other idiosyncratic elements that characterize a given society/culture).

We examined if three cannabis-related normative perceptions (i.e., descriptive norms, injunctive norms, and the role of cannabis in college life) mediate the association between five distinct dimensions of trait impulsivity (NU, PU, SS, perseverance, and premeditation) and cannabis outcomes (i.e., cannabis involvement). Based on previous findings from the alcohol (Bravo et al., 2018; Hustad et al., 2014; Pearson & Hustad, 2014) and cannabis literature (Pearson et al., 2018), we expected that all normative cannabis-related perceptions would mediate the association between all the impulsivity-related facets and cannabis outcomes (e.g., SS influencing college cannabis beliefs that, in turn, influence cannabis use). Given the predominantly exploratory nature of the present study, a priori hypotheses were not proffered for specific differences across countries or sex.

Method

Participants and procedures

College students (N = 3,482; 68.1% female; M_{age} = 21.07, SD = 4.5) from five countries (United States [n = 1,918; recruited from Colorado, New Mexico, New York, and Virginia], Argentina [n = 375], Uruguay [n = 133], Spain [n = 754], and the Netherlands [n = 302]) completed an online survey as part of a broader study focused on mental health, personality traits, and cannabis use behaviors (see Bravo et al., 2019a). To focus on regular/current use of cannabis, only data from students that reported past-30-day cannabis use (n = 1,175; 62.9% female) were included in the final analysis from each country (United States: n = 698, 64.5% female; Argentina: n = 153, 60.1% female; Spain: n = 178, 54.5% female; Uruguay: n = 79, 81.0% female; and Netherlands: n = 67, 60.6% female). The study was approved by institutional review boards (or their international equivalent) at each participating university and conducted in accordance with the Declaration of Helsinki.

Measures

We conducted multi-group confirmatory factor analyses using a diagonally weighted least squares estimator in Mplus

7.4 (Muthén & Muthén, 1998–2018) to determine the factorial invariance of the questionnaires assessing constructs in our model before running our hypothesized model. Specifically, we tested three levels of measurement invariance: configural (test whether all items load on the proposed factor), metric (test whether item-factor loadings are similar across groups), and scalar (test whether the unstandardized item thresholds are similar across groups). Given that the chi-square test statistic is sensitive to sample size (Brown, 2015), we used model comparison criteria of Δcomparative fit index/ΔTucker–Lewis index of .01 or greater (Cheung & Rensvold, 2002) and Δroot mean square error of approximation of .015 or greater (Chen, 2007) to indicate significant decrement in fit when testing for measurement invariance. Invariance testing of all measures supported at least metric invariance (i.e., item-factor loadings similar across groups; Putnick & Bornstein, 2016) across countries and sex. This is a necessary step when examining associations between a set of constructs across different groups (analyses available on request). Table 1 includes internal consistencies for each measure.

Negative cannabis-related consequences

Consequences were measured using the Brief Marijuana Consequences Questionnaire (Simons et al., 2012), or its Spanish and Dutch versions (Bravo et al., 2019a). Participants indicated whether they had experienced (yes/no) each of the 21 consequences in the last month. The total score reflects the total number of cannabis-related consequences an individual experienced in the past month.

Cannabis use

Typical cannabis use frequency was assessed using the Marijuana Use Grid (Pearson et al., 2021). Participants reported their cannabis use in each 4-hour period of each day of a typical week (e.g., 12 noon–4 P.M. Monday, 4 P.M.–8 P.M. Monday). By adding up all nonzero values, we obtained the number of periods of cannabis use during a typical week (possible range: 0–42), reflecting typical frequency of cannabis use. We focused on frequency of cannabis use as the outcome variable because it is the most measured cannabis behavior (Buckner, 2013; LaBrie et al., 2010; Pearson et al., 2018; VanderVeen et al., 2016), probably related to the difficulty of accurately estimating cannabis quantity (Prince et al., 2018).

Cannabis perceived norms

The Marijuana Norms Grid (Montes et al., 2021) was used to assess cannabis descriptive and injunctive norms in reference to one's "close friends." Specifically, the typical week grid was filled out to reflect the perceived frequency of cannabis use among close friends (descriptive norms), as well as the frequency of cannabis use that close friends would approve of (injunctive norms). Internalized norms of the college cannabis use culture were measured using the eight-item PIMCES (Pearson et al., 2017a), or its Spanish and Dutch versions (Pearson et al., 2019). Prior psychometric work (Pearson et al., 2019) revealed that there were sparse cell counts for four items in the Uruguay sample. To keep the eight-item version in the present analyses, we combined the Uruguay and Argentina samples into a South America sample (n = 232). It is important to highlight that the Uruguay and Argentina samples did not statistically differ on any of the study variables (except SS; d = 0.47), and these two neighboring countries share a highly similar cultural/historical heritage (Rocha et al., 2017).

Impulsivity-like traits

Five impulsivity-like traits were measured using the 20-item Short UPPS-P Impulsive Behavior Scale (Cyders et al., 2014) at the U.S. sites, or its Spanish (Pilatti et al., 2015; Verdejo-García et al., 2010) and Dutch versions (Supplemental Table 1): PU (tendency to act rashly when experiencing positive affect); NU (tendency to act impulsively when experiencing negative affect), premeditation (tendency to reflect about the consequences of an action), perseverance (tendency to persist in an activity that can be boring or difficult), and SS (tendency to seek new and exciting experiences and sensations). (Supplemental material appears as an online-only addendum to this article on the journal's website.) Items were averaged for each trait, such that higher scores indicate greater endorsement of that specific trait.

Statistical analysis

Fully saturated path models were conducted using Mplus 7.4 (Muthén & Muthén, 1998–2018), such that double-mediated paths were examined for each impulsivity-related trait and perceived norm (e.g., SS→injunctive norms→cannabis use frequency→consequences) within the same model. We examined the total/indirect/direct effects of each predictor variable on cannabis outcomes using bias-corrected, bootstrapped estimates (Efron & Tibshirani, 1993), based on 10,000 bootstrapped samples, with statistical significance by 95% bias-corrected, bootstrapped confidence intervals not containing zero. We conducted five simple models (where each UPPS-P facet was tested separately) and one complex model (where all UPPS-P facets were tested simultaneously). Further, in a recent methodological article examining indirect effects in sequential mediation models, Tofighi and Kelley (2020) recommend using semi-partial R^2 values of the endogenous variables (mediators and outcome variables) as metrics of effect size in sequential mediation models. In addition, MacKinnon

Table 1. Bivariate correlations among study variables in total sample

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	*M*	*SD*
1. Negative urgency	.82										2.11	0.75
2. Positive urgency	**.51**	.87									1.84	0.73
3. Perseverance	.06	-.04	.80								3.00	0.67
4. Premeditation	**-.21**	**-.17**	**.42**	.87							3.05	0.64
5. Sensation seeking	.02	**.21**	**.18**	**.15**	.74						2.80	0.71
6. Descriptive norms	.04	.00	-.03	-.03	.04	–					9.28	10.02
7. Injunctive norms	.03	-.01	-.02	.00	**.07**	**.77**	–				10.43	11.76
8. Internalized norms	**.15**	**.22**	**-.08**	**-.10**	.03	**.13**	**.10**	.85			2.32	0.78
9. Marijuana use frequency	.01	.00	**-.08**	**-.07**	.04	**.54**	**.47**	**.22**	–		6.10	7.97
10. Negative consequences	**.23**	**.13**	-.02	**-.09**	**.06**	**.22**	**.19**	**.19**	**.39**	.86	3.59	3.91

Notes: Significant correlations are in **bold** for emphasis and were determined by a 95% bias-corrected, standardized, bootstrapped confidence interval (based on 10,000 bootstrapped samples) that does not contain zero. Cronbach's alphas are underlined and shown on the diagonals.

(2008) provides three indirect effect size estimates that are based on semi-partial R^2 values.

We chose to report on the effect size presented in equation 4.5 in MacKinnon (2008). This R^2 (which we will refer to as $R^2_{4.5}$) metric localizes the amount of variance in the outcome that is explained by the mediator specific to the mediated effect. $R^2_{4.5}$ identifies the variance in the outcome explained by both the mediator and the predictor but not by the predictor or mediator alone. However, it should be noted that effect size for complex mediational chains is still an active area of research and currently there is not an agreed upon effect size to best represent effect size in double mediation models. Therefore, we will only report on effect sizes (i.e., $R^2_{4.5}$) as a post hoc analysis of significant mediation paths by examining effect sizes in parts. Specifically, we will present effect sizes for the impulsivity-related trait to the internalized norm to use, and then separately for the impulsivity-related trait to the internalized norm to consequences, to compare the magnitude of each part of the sequential pathway.

To test whether our mediation model was culturally specific or culturally universal (i.e., invariant or non-invariant across countries/cultures), we conducted chi-square difference tests comparing a freely estimated multi-group model to a constrained multi-group model (i.e., constraining the paths of the mediation model) to determine whether constraining the paths to be equivalent across countries resulted in a worse fitting model. Given the chi-square test statistics sensitivity to sample size (Brown, 2015), a more stringent alpha level was used ($\alpha = .01$). In addition, we explored whether this mediational model was invariant across sex (more information about these results is available upon request to the authors).

Results

Bivariate correlations, descriptive statistics, and internal consistency of study variables are presented in Table 1 (for country-specific statistics, see Supplemental Tables 2–6). The total, indirect, and direct effects are summarized in Table 2 for the simple mediation models and in Table 3 and Figure 1 for the full multivariate mediation model.

Simple multivariate mediation models

In the simple mediation models, total indirect effects were statistically significant for NU on cannabis use frequency and for perseverance on negative consequences (Table 2). In addition, internalized norms significantly mediated the association between impulsivity-like facets (NU, PU, and premeditation) and negative consequences. Higher scores in NU and PU and lower scores in premeditation led to higher internalized norms, which were associated with higher frequency of use, which in turn were associated with more consequences.

Full multivariate mediation model

When all the UPPS-P facets were examined simultaneously, all norms (descriptive, injunctive, and internalized) were significantly associated with more consequences via higher cannabis use frequency (Table 3). While controlling for effects of all other predictors, only internalized norms significantly predicted more consequences.

Of the five impulsivity-like traits, only PU and SS had significant associations with any of the three perceived norms in the model. Specifically, higher PU was associated with higher internalized norms ($\beta = .18$), and higher SS was associated with higher injunctive norms ($\beta = .09$; Figure 1). In predicting cannabis outcomes, internalized norms uniquely mediated the associations between PU and both cannabis use frequency and consequences. Moreover, a significant double-mediated association was found such that higher PU was associated with higher endorsement of internalized norms, which in turn was associated with higher cannabis use frequency, which in turn was associated with more consequences.

To explore this double mediation further, we calculated $R^2_{4.5}$ effect sizes for the indirect effect separately for PU→internalized norms→use, $R^2_{4.5} = -.001$, and for

TABLE 2. Effects from simpler multivariate mediation models on marijuana use frequency and negative consequences

	Marijuana use frequency		Negative consequences	
Variable	β	[95% CI]	β	[95% CI]
Model: Negative urgency				
Total	.008	[-.055, .070]	**.231**	**[.175, .287]**
Total indirect[a]	**.043**	**[.006, .080]**	.015	[-.012, .041]
Descriptive norms	.017	[-.010, .043]	.000	[-.005, .005]
Injunctive norms	.004	[-.005, .013]	.000	[-.003, .004]
Internalized norms	**.023**	**[.010, .035]**	**.012**	**[.001, .022]**
Marijuana use frequency			-.013	[-.031, .006]
Descriptive norms – marijuana use frequency			.006	[-.004, .016]
Injunctive norms – marijuana use frequency			.001	[-.002, .005]
Internalized norms – marijuana use frequency			**.008**	**[.003, .013]**
Direct	-.035	[-.086, .015]	**.217**	**[.161, .272]**
Model: Positive urgency				
Total	.000	[-.060, .060]	**.128**	**[.066, .190]**
Total indirect[a]	.033	[-.005, .071]	.019	[-.009, .046]
Descriptive norms	.000	[-.026, .026]	.000	[-.003, .003]
Injunctive norms	-.001	[-.010, .007]	.000	[-.003, .003]
Internalized norms	**.034**	**[.019, .050]**	**.019**	**[.003, .035]**
Marijuana use frequency			-.012	[-.032, .008]
Descriptive norms – marijuana use frequency			.000	[-.009, .009]
Injunctive norms – marijuana use frequency			-.001	[-.004, .003]
Internalized norms – marijuana use frequency			**.012**	**[.006, .018]**
Direct	-.033	[-.088, .021]	**.109**	**[.047, .171]**
Model: Perseverance				
Total	**-.079**	**[-.144, -.013]**	-.024	[-.083, .035]
Total indirect[a]	-.025	[-.062, .012]	**-.037**	**[-.064, -.011]**
Descriptive norms	-.011	[-.038, .017]	.000	[-.004, .004]
Injunctive norms	-.003	[-.012, .006]	.000	[-.004, .003]
Internalized norms	**-.012**	**[-.023, -.001]**	-.009	[-.018. .000]
Marijuana use frequency			-.019	[-.038, .000]
Descriptive norms – marijuana use frequency			-.004	[-.013, .006]
Injunctive norms – marijuana use frequency			-.001	[-.004, .002]
Internalized norms – marijuana use frequency			-.004	[-.008, .000]
Direct	**-.054**	**[-.107, -.001]**	.013	[-.041, .068]

Table continued

PU→internalized norms→consequences, $R^2_{4.5}$ = .01. Note that the negative $R^2_{4.5}$ for the PU→internalized norms→use pathway results from not squaring the difference computed between the overall R^2 and the squared correlation between the outcome and predictor in the equation (Fairchild et al., 2009), and likely represents a suppression effect (Seibold & McPhee, 1979).

For SS, injunctive norms uniquely mediated the association between SS and cannabis use frequency; there was a significant double-mediated association such that higher SS was associated with higher injunctive norms, which in turn was associated with higher cannabis use frequency, which in turn was associated with more consequences (Table 2). Effect sizes were similar for SS→injunctive norms→use, $R^2_{4.5}$ = .002, and for SS→injunctive norms→consequences, $R^2_{4.5}$ = .002. Although there were several significant indirect effects from NU to cannabis outcomes via injunctive norms, caution should be taken given a nonsignificant direct effect between NU and injunctive norms. It is important to note that even when controlling for all other predictors, NU was still significantly positively associated with consequences (β = .22).

Model invariance across sex and countries

Constrained multi-group models compared to the freely estimated model indicated model invariance across sex, $\Delta\chi^2(32) = 42.625$, $p = .099$, but not countries, $\Delta\chi^2(96) = 185.449$, $p < .001$. To identify an invariant model, we identified the paths with the greatest contribution to reducing model fit within the fully constrained model. In the final multi-group model, $\Delta\chi^2(93) = 120.919$, $p = .027$, all asso-

TABLE 2. *Continued*

	Marijuana use frequency		Negative consequences	
Variable	β	[95% CI]	β	[95% CI]
Model: Premeditation				
Total	**-.073**	**[-.141, -.006]**	**-.093**	**[-.151, -.035]**
Total indirect[a]	-.026	[-.065, .013]	-.036	[-.064, -.009]
Descriptive norms	-.011	[-.040, .017]	.000	[-.004, .004]
Injunctive norms	.000	[-.009, .009]	.000	[-.003, .003]
Internalized norms	**-.015**	**[-.026, -.003]**	**-.011**	**[-.020, -.001]**
Marijuana use frequency			-.016	[-.035, .003]
Descriptive norms – marijuana use frequency			-.004	[-.014, .006]
Injunctive norms – marijuana use frequency			.000	[-.003, .003]
Internalized norms – marijuana use frequency			**-.005**	**[-.009, -.001]**
Direct	-.047	[-.100, .006]	**-.057**	**[-.112, -.002]**
Model: Sensation seeking				
Total	.041	[-.019, .100]	**.061**	**[.004, .117]**
Total indirect[a]	.030	[-.006, .065]	.018	[-.007, .044]
Descriptive norms	.016	[-.010, .042]	.000	[-.005, .005]
Injunctive norms	.009	[-.002, .021]	.001	[-.006, .008]
Internalized norms	.004	[-.006, .014]	.003	[-.005, .011]
Marijuana use frequency			.004	[-.014, .021]
Descriptive norms – marijuana use frequency			.006	[-.004, .015]
Injunctive norms – marijuana use frequency			.003	[-.001, .007]
Internalized norms – marijuana use frequency			.001	[-.002, .005]
Direct	.011	[-.038, .060]	.042	[-.011, .096]

Notes: Significant associations are in **bold** for emphasis and were determined by a 95% bias-corrected, standardized, bootstrapped confidence interval (CI) (based on 10,000 bootstrapped samples) that does not contain zero. [a]Reflects the combined indirect associations within the model.

ciations were constrained between countries except for one path: cannabis use frequency→consequences. Although cannabis use frequency was significantly positively associated with consequences in all countries, the magnitude of the effect was greater in Spain (β = .645 [.519, .739]), Netherlands (β = .640 [.401, .817]), and South America (β = .446 [.321, .563]) compared with the United States (β = .294 [.210, .376]). Importantly, all indirect effects remained significant across all countries, including double-mediated effects: PU as distal predictor via internalized norms: United States (β = .006 [.003, .011]), Spain (β = .016 [.008, .029]), Netherlands (β = .018 [.009, .037]), and South America (β = .010 [.005, .019]); SS as distal predictor via injunctive norms: United States (β = .002 [.000, .007]), Spain (β = .007 [.001, .020]), Netherlands (β = .010 [.001, .031]), and South America (β = .005 [.001, .017]).

Discussion

Among college student cannabis users from five countries, the present study examined three types of cannabis-related normative perceptions (i.e., descriptive, injunctive, and internalized norms) as mediators of the associations between five distinct facets of impulsivity (i.e., NU, PU, SS, perseverance, and premeditation) and cannabis outcomes. We will now discuss the main findings, which should be interpreted with caution considering that the mediation effects were small and derived from relatively small samples. Despite this drawback, our findings are consistent with and extend previous work on alcohol (Bravo et al., 2018) and cannabis use (Pearson et al., 2018; Stevens et al., 2018).

First, when examining impulsivity as a multidimensional construct, the present results suggest that cannabis-related norms mediate impulsivity–cannabis outcomes associations (Pearson et al., 2018; Stevens et al., 2018). Second, consistent with previous work (Bravo et al., 2018; Stevens et al., 2018), our findings indicate that there may be unique mediated effects, via particular perceived norms, involving specific impulsivity-facets and cannabis outcomes. We further explored these mediated paths by estimating the effect sizes for the significant indirect effects in pieces (i.e., PU→internalized norms→use, PU→internalized norms→consequences, and SS→injunctive norms→use, SS→injunctive norms→consequences). The effect sizes for the indirect effects from PU to use and consequences via internalized norms suggest that the mediation effects were small, and that the effects were stronger for consequences than for use. In fact, the $R^2_{4.5}$ for the path from

Table 3. Summary of total, indirect, and direct effects of comprehensive mediation path model

	Marijuana use frequency		Negative consequences	
Variable	β	[95% CI]	β	[95% CI]
Predictor variable: Negative urgency				
Total	.015	[-.05, .09]	**.226**	**[.16, .29]**
Total indirect[a]	**.040**	**[.00, .08]**	.010	[-.02, .04]
Descriptive norms	.025	[-.004, .06]	.000	[-.01, .01]
Injunctive norms	**.008**	**[.000, .03]**	.001	[-.004, .01]
Internalized norms	.007	[-.003, .02]	.004	[-.001, .01]
Marijuana use frequency	–	–	-.009	[-.03, .01]
Descriptive norms – marijuana use frequency	–	–	.009	[-.001, .02]
Injunctive norms – marijuana use frequency	–	–	**.003**	**[.000, .01]**
Internalized norms – marijuana use frequency	–	–	.003	[-.001, .01]
Direct	-.025	[-.08, .04]	**.216**	**[.16, .28]**
Predictor variable: Positive urgency				
Total	-.033	[-.10, .04]	-.009	[-.08, .07]
Total indirect[a]	.002	[-.04, .05]	.002	[-.03, .03]
Descriptive norms	-.019	[-.05, .01]	.000	[-.01, .01]
Injunctive norms	-.008	[-.03, .001]	-.001	[-.01, .004]
Internalized norms	**.028**	**[.02, .05]**	**.015**	**[.003, .03]**
Marijuana use frequency	–	–	-.013	[-.04, .01]
Descriptive norms – marijuana use frequency	–	–	-.007	[-.02, .004]
Injunctive norms – marijuana use frequency	–	–	-.003	[-.01, .000]
Internalized norms – marijuana use frequency	–	–	**.010**	**[.01, .02]**
Direct	-.035	[-.11, .03]	-.011	[-.08, .06]
Predictor variable: Perseverance				
Total	-.069	[-.14, .001]	-.029	[-.09, .03]
Total indirect[a]	-.030	[-.07, .01]	**-.030**	**[-.06, -.003]**
Descriptive norms	-.014	[-.05, .02]	.000	[-.01, .01]
Injunctive norms	-.006	[-.02, .002]	.000	[-.01, .003]
Internalized norms	-.010	[-.02, .000]	-.005	[-.02, .000]
Marijuana use frequency	–	–	-.014	[-.04, .01]
Descriptive norms – marijuana use frequency	–	–	-.005	[-.02, .01]
Injunctive norms – marijuana use frequency	–	–	-.002	[-.01, .001]
Internalized norms – marijuana use frequency	–	–	-.003	[-.01, .000]
Direct	-.039	[-.10, .02]	.001	[-.06, .06]

Table continued

PU→internalized norms→use was negative, suggesting a suppression effect that most likely is the consequence of the high intercorrelation between the UPPS-P dimensions (Gunn et al., 2018; Stevens et al., 2018).

Of note, Stevens et al. (2018) also found a negative, although nonsignificant, indirect effect of PU on cannabis use frequency. In addition, the effect sizes for the indirect effect from SS to injunctive norms to use and consequences suggest that the mediation from injunctive norms to cannabis use frequency to consequences was of similar strength, for use and consequences. This pattern is somewhat different from Stevens et al., where SS had an indirect effect on cannabis frequency via approval and descriptive norms. The discrepancies between Stevens et al. and our findings are most likely associated with differences concerning sample formation and the dependent variables under analysis. Whereas we restricted the analytic sample to students who reported past-month cannabis use and included cannabis problems as the dependent variable, Stevens et al. assessed last-year frequency of cannabis use and the analytic sample included abstainers.

Our findings also seem to support the role of college cannabis beliefs (or internalized norms) as a proximal mediator of personality–cannabis outcomes associations (Hustad et al., 2014; Pearson & Hustad, 2014; Pearson et al., 2018). Albeit the effect size of the mediation was small, it was still significant when accounting for the multifaceted nature of impulsivity. The Problem Behavior Theory (PBT; Jessor, 1987) has been suggested as a useful theoretical framework to understand the indirect effect of impulsivity-like facets on cannabis variables via perceived norms (Stevens et al., 2018). The PBT explains problem or deviant behavior as a

TABLE 3. *Continued*

	Marijuana use frequency		Negative consequences	
Variable	β	[95% CI]	β	[95% CI]
Predictor variable: Premeditation				
Total	-.057	[-.13, .02]	-.045	[-.11, .02]
Total indirect[a]	-.011	[-.06, .03]	-.023	[-.05, .01]
Descriptive norms	-.007	[-.04, .03]	.000	[-.01, .01]
Injunctive norms	.001	[-.01, .01]	.000	[-.003, .01]
Internalized norms	-.005	[-.02, .01]	-.003	[-.01, .003]
Marijuana use frequency	–	–	-.017	[-.04, .01]
Descriptive norms – marijuana use frequency	–	–	-.002	[-.02, .01]
Injunctive norms – marijuana use frequency	–	–	.000	[-.003, .01]
Internalized norms – marijuana use frequency	–	–	-.002	[-.01, .002]
Direct	-.046	[-.11, .01]	-.022	[-.08, .04]
Predictor variable: Sensation seeking				
Total	**.068**	**[.01, .13]**	**.070**	**[.01, .13]**
Total indirect[a]	.035	[-.001, .07]	**.025**	**[.001, .05]**
Descriptive norms	.023	[-.004, .05]	.000	[-.01, .01]
Injunctive norms	**.012**	**[.002, .03]**	.001	[-.01, .01]
Internalized norms	.000	[-.01, .01]	.000	[-.01, .01]
Marijuana use frequency	–	–	.012	[-.01, .03]
Descriptive norms – marijuana use frequency	–	–	.008	[-.001, .02]
Injunctive norms – marijuana use frequency	–	–	**.004**	**[.001, .01]**
Internalized norms – marijuana use frequency	–	–	.000	[-.003, .004]
Direct	.033	[-.02, .09]	.044	[-.01, .10]
Predictor variable: Descriptive norms				
Total	**.126**	**[.02, .23]**	**.148**	**[.04, .26]**
Indirect via marijuana use frequency	–	–	**.149**	**[.10, .20]**
Direct	**.126**	**[.02, .23]**	-.001	[-.10, .10]
Predictor variable: Injunctive norms				
Total	**.416**	**[.30, .52]**	.055	[-.05, .16]
Indirect via marijuana use frequency	–	–	**.045**	**[.01, .09]**
Direct	**.416**	**[.30, .52]**	.010	[-.07, .10]
Predictor variable: Internalized norms				
Total	**.155**	**[.10, .21]**	**.135**	**[.07, .20]**
Indirect via marijuana use frequency	–	–	**.055**	**[.03, .08]**
Direct	**.155**	**[.10, .21]**	**.080**	**[.02, .14]**

Notes: Significant associations are in **bold** for emphasis and were determined by a 95% bias-corrected, standardized, bootstrapped confidence interval (CI) (based on 10,000 bootstrapped samples) that does not contain zero. [a]Reflects the combined indirect associations within the model.

result of transactions between the personality system and the perceived environmental system.

Impulsive individuals may interpret the environment according to their personality and, for instance, may be more likely to affiliate together or to self-select into more risky environments (e.g., associating with peers more prone to perceive the college years as a time for using cannabis or to approve cannabis use), which in turn influences their cannabis use (Stevens et al., 2018). Positive effects from substance use seem more salient for those higher in PU (Settles et al., 2010), whereas the tendency to act rashly when experiencing intense emotional states, coupled with internalized college beliefs, increased the risk for substance use problems (LaBrie et al., 2014). Possibly, PU places college students at higher risk for cannabis problems by increasing the saliency of some internalized college beliefs. It has been also suggested that SS increases (Hustad et al., 2014) or potentiates (LaBrie et al., 2014) the perceived importance/salience of norms, suggesting that individuals higher in SS are more prone to use substances in high-risk situations (e.g., when it is illegal).

Of note, the mediated effects were found to be invariant across sex and across different countries/cultures. This sex invariance is somehow different from that reported in U.S. college students by Stevens et al. (2018), who described that the effect of SS on cannabis use, via descriptive norms, was greater in men than in women. The main results found in

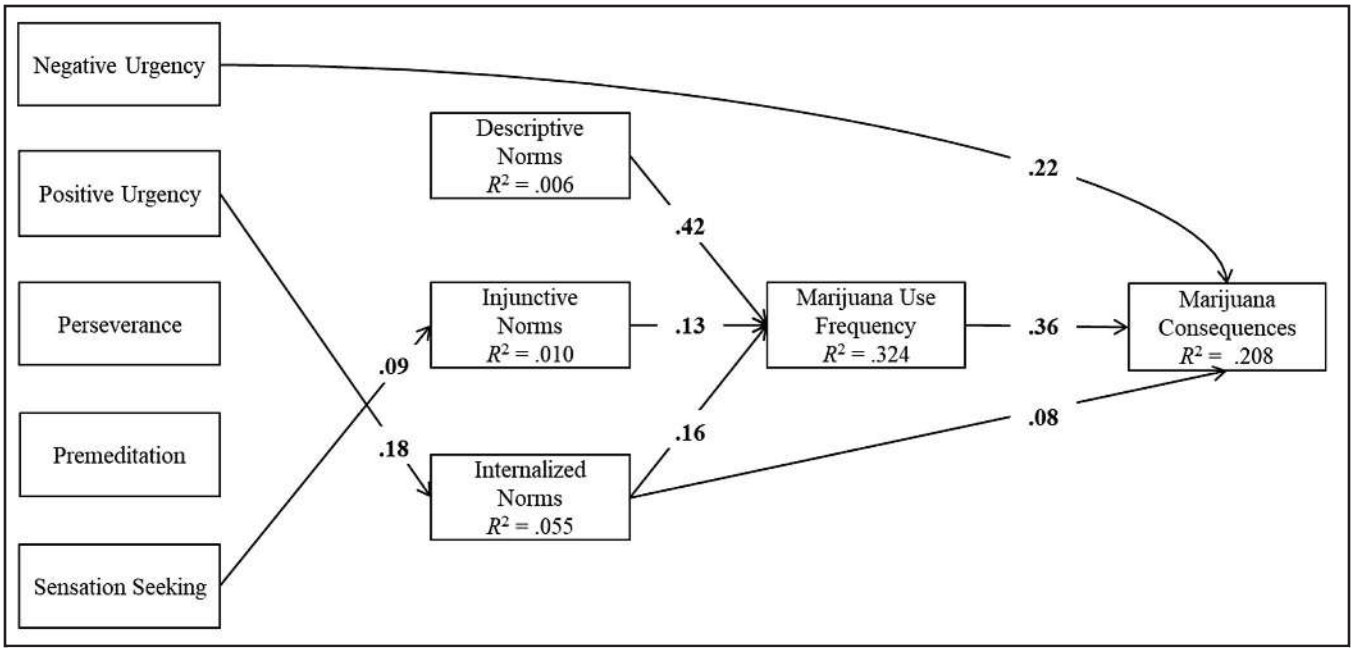

FIGURE 1. Depicts the significant standardized effects of the comprehensive mediation path model tested in the total sample (n = 1,175). Significant associations were determined by a 95% bias-corrected, standardized, bootstrapped confidence interval (based on 10,000 bootstrapped samples) that does not contain zero. The disturbances among perceived norms (descriptive norms, injunctive norms, and internalized norms) were allowed to correlate. Nonsignificant path coefficients are not shown in the figure for reasons of parsimony but are available on request.

Stevens et al. (2018) were, however, fairly consistent with our findings. Specifically, these authors reported that those students scoring high in impulsivity exhibited higher descriptive norms and more perceived use or approval by friends. These scores were, in turn, associated with greater use of cannabis.

Despite significant correlations between cannabis use frequency and consequences in all countries, the magnitude of the effect was lower in the U.S. sample than in the other samples, illuminating potential avenues of research. Bravo et al. (2019b) found that—despite similar drinking patterns—students from Spain exhibited significantly higher alcohol-related negative consequences than counterparts from the United States. This variation is likely associated with cultural features (Olafsdóttir et al., 2009; Prashad et al., 2017). Perceived risk associated with regular cannabis use is much greater in Argentinean and European adolescents (European School Survey Project on Alcohol and Other Drugs, 2016) than in U.S. adolescents (Schulenberg et al., 2019), and this variable significantly predicts cannabis use (Miech et al., 2017) and the awareness of potential problems and enhances seeking for treatment (United Nations Office on Drugs and Crime, 2016). Other cultural factors, such as more college students living with family members in Argentina than in the United States, may also play a significant role in the differences found. It is reasonable to expect greater salience of cannabis-related problems among college students living with family members.

Limitations

Several limitations should be considered. First, the cross-sectional nature of the study impedes establishing temporal associations between variables. Noteworthy, previous prospective studies (Bravo et al., 2018) demonstrated that normative perceptions (i.e., college drinking culture) significantly and prospectively mediated the association between impulsivity facets (as measured by the UPPS-P model). Second, because of low endorsement of some PIMCES items in the Uruguay sample, we combined the Uruguay and Argentina samples. Both countries, however, have a large cultural heritage overlap, which is reflected in key elements of daily/college life and family organization.

Of note, participants from Argentina and Uruguay exhibited statistically similar values on most of the variables, although a significant difference in SS was found between the Argentinean and the Uruguayan samples. However, it should be noted that the absolute difference between the mean scores in SS was small and only 30 people who used cannabis filled out the UPPS-P for Uruguay, raising the possibility that this difference was spurious. The finding is, of course, intriguing, and further studies—with more adequate sample sizes—should examine this potential country-related difference.

The sampling method (e.g., e-mail listings, online invitations via social networks, pool of students) limits the generalization of the present findings to students who respond to

these types of recruitment strategies. In addition, the online recruitment impeded calculating the participation rate, preventing us from calculating the likelihood of nonresponse bias. Another limitation refers to potential biases associated with self-reporting substance use and, particularly, with social desirability. Further, we did not analyze the effect of routes of cannabis administration. The use of cannabis combined with tobacco is more prevalent in European than in American countries, whereas the use of vaporizers is highly prevalent in the United States (Hindocha et al., 2016). These differences likely affect how much cannabis is consumed (Barrus et al., 2016), the length/intensity of intoxication (Giombi et al., 2018), and the type/number of experienced consequences (Fairman, 2015; Jones et al., 2018; Ream et al., 2008).

It is possible that the present findings would significantly vary in samples of college students representing other Spanish-, English-, and Dutch-speaking countries/territories. For example, the college system in Chile (a Spanish-speaking South American country) resembles the U.S. college system (e.g., has tuition) but differs from those of Argentina or Uruguay (where ≥85% attend tuition-free colleges). Similarly, despite both being English-speaking countries, the college system in Australia does not include social organizations like sororities/fraternities and its students typically attend universities relatively close to home.

These and other differences, including variations in health systems (Prashad et al., 2017), warrant extending and replicating the present findings in other countries/cultures. Last, because we used a similar grid to measure participants' cannabis use and social norms (descriptive and injunctive), we cannot rule out that the pronounced association between these variables was driven by a common method bias. However, previous studies using other assessment tools also found large correlations between frequency of cannabis use and social norms (Buckner, 2013; Ecker et al., 2019; LaBrie et al., 2010).

Clinical implications and conclusions

Cannabis use and related consequences are determined by a range of individual difference variables and personal beliefs about behavior. Personality factors (e.g., impulsivity-like traits) and normative perceptions work in concert to drive cannabis use, which in turn portends risk for consequences. When taken together in a comprehensive model, the strongest predictor of consequences was, unsurprisingly, cannabis use. However, this effect varied across countries, with the European samples having an effect that was nearly double the U.S. sample and substantially greater than the South American sample. Although these findings warrant replication, intervention efforts in European countries may need to focus attention on attenuating cannabis use, whereas American countries may need to place greater emphasis on other factors beyond cannabis use alone.

Although there were some interesting findings related to descriptive and injunctive norms, the strongest effects were found for perceptions about cannabis use being part of the college experience. College administrators and other stakeholders could work together with clinicians and public health experts to develop social norms campaigns targeting this perception specifically. Changing the perception that cannabis use is central to the college experience may be an efficient way to reduce cannabis use and consequences on a large scale. Although our findings should be taken with caution, considering our low sample sizes across several countries and the small effect sizes of the mediation effects, the present study could be considered a first step toward analyzing this important question and should stimulate future cross-cultural work on mechanisms of substance use.

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