TITLE:

**Cannabis Use as a Predictor and Outcome of Positive and Negative Affect in College
Students: an Ecological Momentary Assessment Study**

SHORT TITLE:

Cannabis Use, Positive and Negative Affect

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Abstract:

Background: Little is known about the associations between negative affect (NA), positive affect (PA) and cannabis use in the daily life of recreational non-treatment seeking cannabis users. Self-medication models predict that NA is a precursor of use and that NA will be relatively low shortly after use. Positive reinforcement models suggest that PA is a precursor of use and that PA will be relatively high shortly after cannabis use. These associations may be stronger among individuals with higher cannabis-related problems.

Aims: To examine the associations between (a) momentary within-person variations in NA and PA and intention to use cannabis within the next hour, (b) the within-person variations in time elapsed since last cannabis use, amount used and momentary NA and PA, and (c) to test whether cannabis-related problems moderates these associations.

Method: Eighty, more than weekly, cannabis using students at the University of Amsterdam reported on cannabis use, NA and PA three times daily for 14 consecutive days. Mixed-effects models were used to analyze the data.

Results: Within-persons, relatively high PA and low NA were associated with intention to use cannabis. Within-persons, more recent and greater amounts of cannabis use were associated with relatively high PA. More recent cannabis use was associated with relatively low NA. Cannabis-related problems did not moderate any of these associations.

Conclusions: While recent cannabis use related to higher PA and lower NA, high PA but low NA preceded use, supporting positive reinforcement rather than self-medication in this college sample of regular cannabis users.

Keywords: micro-longitudinal research designs; cannabis-related problems; mood; negative and positive affect; cannabis use; positive and negative reinforcement; college students

Introduction

Cannabis use among college students is high and linked to adverse educational and health outcomes (Gunn et al., 2018; Pearson et al., 2017; Schulenberg et al., 2020). Despite this, college students do not typically seek treatment (Buckner et al., 2010; Fernández-Artamendi et al., 2013). Cannabis users commonly use cannabis to relieve negative affect (NA, e.g., stress, depression, anxiety) and to enhance positive affect (PA, e.g., happiness, joy) (Wycoff et al., 2018). Mood fluctuations play an important role in the maintenance of substance use and addiction (Cheetham et al., 2010), but little is known about the daily-life within-person relationships between cannabis use and mood in non-treatment seeking populations. We therefore aimed to unravel the natural interplay between within-person fluctuations in cannabis use, PA, and NA in cannabis-using college students.

Mood, reinforcement and cannabis use

Positive and negative reinforcement are suggested to play different roles in trajectories of cannabis use and related problems. Positive reinforcement relates to cannabis use to enhance PA and is thought to be involved in the relative early stages of cannabis use experiences (Bresin & Mekawi, 2019). Cannabis intoxication enhances positive mood (Matheson et al., 2020) and activates brain areas involved in reward processing, but interestingly, these effects seem less pronounced in heavier users (Mason et al., 2021).

Negative reinforcement relates to cannabis use to cope with NA. Cannabis users commonly expect relaxation and reduced tension after use (Hathaway, 2003; Reilly et al., 1998) and report using cannabis to cope with stress and anxiety (Buckner et al., 2007; De Dios et al., 2010; Hathaway, 2003; Ogbome et al., 2000). While both enhancement and coping motives are common among heavy cannabis users (Buckner, 2013; Lee et al., 2007), only coping motives have been found to predict the transition from cannabis use to cannabis use disorder (CUD) (Van der Pol, Liebrechts, de Graaf, et al., 2013). Moreover, people with psychological vulnerabilities and those who experience uncomfortable psychological states are particularly likely to use cannabis to reduce situational NA (Baker et al., 2004; McDonald et al., 2003; Metrik et al., 2011).

The relation between mood states and cannabis use is likely dynamic, transient, and variable within individuals. Intoxication from cannabis inhalation roughly peaks after 30 minutes and clears after 4 hours, but depends on cannabis dose, product, and use history (Noble et al., 2019). Ecological momentary assessments (EMA; Shiffman et al., 2008) can capture these dynamic intra-individual processes. Despite the prevalence peak of cannabis use during young adulthood (UNODC, 2020), and large proportion not seeking help (Buckner et al., 2010; Fernández-Artamendi et al., 2013), most EMA studies in cannabis users focused on clinical samples (Wycoff et al., 2018).

Moreover, findings in community based samples are mixed (Wycoff et al., 2018); NA was higher before cannabis use in a sample of mostly college students (Buckner et al., 2015), but Chakroun et al., (2010) found depressed mood to negatively relate to subsequent cannabis use, and Tournier et al., (2003) found no association between anxiety and subsequent use. Two studies reported lower NA (Buckner et al., 2015;

Trelaor Padovano & Miranda, 2018), one study reported no relation with NA (Buckner, Crosby, Wonderlich, et al., 2012), and one study reported higher anxiety (Tournier et al., 2003) after cannabis use.

In relation to PA, two studies reported relatively high PA before cannabis use (Buckner et al., 2015; Chakroun et al., 2010). However, after cannabis use, one study found increases in PA states (e.g. stimulation, sedation, and high; Trelaor Padovano & Miranda, 2018), while another study did not find an association (Buckner et al., 2015).

Moderating role of cannabis-related problems

When comparing EMA results from clinical and community based samples, evidence for negative reinforcement is most consistent in clinical samples (Wyckoff et al., 2018).

Sensitization to cannabis' acute rewarding effect is thought to occur at relatively early stages of cannabis use, but as use persists, NA may be more common both as a determinant (e.g., withdrawal) and as a consequence of cannabis use (Kesner & Lovinger, 2021). In turn, the development of tolerance would reduce the direct effects of cannabis use on mood (Kesner & Lovinger, 2021). We know of only one EMA study that tested how cannabis-related problems interact with momentary mood and cannabis use. In a sample of 85 regular, mostly teenage, cannabis users recruited from the community, participants with higher cannabis use disorder (CUD) severity reported sharper increases in PA (e.g. stimulation) and sharper decreases in craving following cannabis use relative to those with fewer CUD symptoms (Trelaor Padovano & Miranda, 2018).

The current study

Literature on the relation between mood, cannabis use and cannabis-related problems is limited with few studying at-risk community samples such as college students, the co-

occurrence of PA and NA, and the moderating role of cannabis-related problems. As such, we aimed to assess i) whether within-person fluctuations in momentary PA and NA predict intention to use cannabis within the next hour, ii) whether within-person fluctuation in time elapsed since last cannabis use and amount of cannabis used predict momentary PA and NA, and iii) whether cannabis-related problems moderates these associations in college students. Expanding previous work examining the moderating role of CUD on the associations between cannabis use and feelings of stimulation, sedation, tension, craving, and high (Trelaor Padovano & Miranda, 2018), we included other mood states (PA and NA), a broader measurement of cannabis-related problem severity, and tested students living in an environment of cannabis decriminalization.

Based on evidence that i) negative reinforcement is not consistently related to cannabis use in community samples (Wycoff et al., 2018), ii) may be specific to individuals with psychological vulnerabilities (Baker et al., 2004; McDonald et al., 2003; Metrik et al., 2011) and iii) that cannabis intoxication enhances positive mood (Matheson et al., 2020), particularly in occasional, non-chronic and heavy users (Mason et al., 2021), we hypothesized that when a student experiences relatively high PA, but not high NA, s/he would be more likely to intend to use cannabis within the next hour compared to when the same person reports lower levels of PA (H1). Furthermore, we expected that when relatively less time passed since last cannabis use and after use of a relatively high quantity of cannabis, students would report more PA (H2a), and less NA (H2b), compared to when the same student reported more hours elapsed and lower quantity used. Based on theoretical (Kesner & Lovinger, 2021) and empirical (Trelaor Padovano & Miranda, 2018) research related to sensitization to cannabis' acute rewarding effect, we expected associations between PA and

cannabis use to be stronger in students with higher levels of cannabis-related problems (H3a). Finally, associations between NA and cannabis use would particularly emerge in students with more severe cannabis-related problems (H3b).

Methods

Procedure

The study protocol was approved by the ethics committee of the University of Amsterdam. A recruitment notice and study description was posted to first-year psychology students enrolled at the University of Amsterdam. Interested students signed up online, gave online informed consent, gave contact details, and checked off eligibility criteria: 18+ years of age; smoking cannabis joints at least weekly to ensure cannabis use during the study period and reduce heterogeneity in effects of cannabis intoxication by mode of use. Eligible students received a link to the online baseline survey. In the subsequent fourteen days, three daily surveys were sent at 11:00, 15:00, and 19:00, which had to be completed within 2 hours. Participants filling $\geq 80\%$ ($n = 67$) of daily surveys were rewarded 3 Psychology Research Credits. Participants who completed $\leq 30\%$ of daily surveys ($n = 11$) were excluded from analyses (Delespaul, 1995). Additionally, four participants were excluded as they reported no cannabis use during the study period. On average, respondents filled in 33.8 daily surveys, were 21 years ($S.D. = 3.14$), and were 35% male/65% female.

Measures

Baseline measures included age and sex (male, female, other. None of the respondents entered 'other'). Cannabis use-related problems were assessed with the 8-item Cannabis Use Disorder Identification Test-revised (CUDIT-R; Adamson et al., 2010). Items ranged

from 0-4 and were summed, resulting in total scores between 0-32 (Cronbach alpha = 0.74). CUDIT-R is a reliable measure for identifying at-risk cannabis use among non-treatment seeking college students (Schultz et al., 2019).

For descriptive purposes, duration, frequency and quantity of cannabis use, and cannabis use treatment history were assessed. Alcohol use problems were assessed with the 10-item Alcohol Use Disorder Identification Test-revised (AUDIT; Saunders et al., 1993). Items ranged from 0-4 and were summed, resulting in total scores between 0-40 (Cronbach alpha = 0.78). General mental health was assessed with the 20-item DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure—Adult (DSM-5 CCSM; American Psychiatric Association, 2013), excluding the substance use items. The DSM-5 CCSM measures severity of a broad range of mental health symptoms during the past 2 weeks and is a viable tool for evaluating psychopathology in non-treatment college student (Bravo et al., 2018). Items ranged from 0 (never) to 4 (always) and were summed, resulting in a total score between 0-80 (Cronbach alpha = 0.88).

Momentary affect assessments: in each EMA survey participants were asked how strongly they currently felt the following emotions adopted from PANAS (Watson et al., 1988) from 1 (not at all) to 5 (a great deal): happy, enthusiastic, proud, excited, worried, lonely, stressed, and nervous. Reliability analyses according to Generalizability Theory showed that the loneliness item lowered reliability substantially and we thus excluded this item before saving the average PA and NA scores. Reliabilities were excellent at the between-person level (PA = 0.98; NA = 0.97) but lower at the within-person level (PA = 0.62; NA = 0.54), potentially due to small clusters (Geldhof et al., 2014).

Momentary cannabis use assessments: In each EMA survey participants were asked whether they intended to use cannabis within the next hour (0 = no, 1 = yes) and whether they had used cannabis since the last EMA survey (0 = no, 1 = yes). Those who confirmed cannabis use since last EMA were asked how long ago they last used cannabis (30 minutes interval answer categories, from 0 = 0 minutes to 16 = >480 minutes) and how much they used in grams (participants that did not use were coded as missing).

Statistical analysis

We used logistic mixed-effects models to estimate associations of PA and NA (predictors) with the intention to use cannabis within the next hour (dependent variable). Linear mixed-effects models were used to estimate associations of time elapsed since last cannabis use and grams used (predictors) with PA and NA respectively (dependent variables). The following ICCs based on unconditional models showed substantial variance in the outcome variables occurring within individuals: intention to use cannabis: 0.31; PA: 0.52, NA: 0.39.

Models distinguished within-person from between-person variation (Hoffman & Stawski, 2009). Between-person versions of each of the momentary independent variables were created by group-mean centering. Within-person versions of these variables were then created by subtracting the person mean variable from the raw scores. Both between-person and within-person variables were entered into models, facilitating inferences about the associations between (1) the momentary fluctuations of PA and NA within persons and intention to use cannabis and (2) fluctuations in time elapsed since

last cannabis use and amount use within individuals and momentary experiences of NA and PA, while controlling for between-person differences in these associations.

Recent use may be associated with mood and intention to use cannabis. We therefore controlled for whether or not respondents had used cannabis since the last EMA in the models predicting intention to use cannabis. Additional covariates in all models included: age, sex, whether momentary assessments were on a weekday or weekend, assessment time (morning [referent], afternoon, evening), and a linear study period time trend. Beyond testing the main effect hypotheses, moderation of within-person independent variables of interest by cannabis-use problems was also tested. Listwise deletion of observations with missing values was used.

Random intercepts and slopes models were estimated using a first-order autoregressive covariance structure to account for autocorrelation in repeated measures. Marginal R^2 was reported for estimate of explained variance (Nakagawa & Schielzeth, 2013). To measure local effect sizes (Raudenbush & Bryk, 2002), the difference in within-person intercept variance between models with and without momentary affect predictors (model predicting intention to use cannabis), and with and without time passed since last use and grams used (models predicting PA and NA), but with all other covariates was calculated. The difference was divided by the within-person intercept variance of the models without the within-person measures.

Results

Sample descriptives

On average participants used cannabis for 1.6 years (S.D. = 1.25), 3.4 days per week (S.D. = 2.04), 2 grams per week (S.D. = 1.86) and reported smoking 1.85 joints on use days (S.D. = 1.19). Two participants had ever received cannabis treatment.

The average CUDIT-R was 11.6 (S.D. = 5.13), AUDIT was 8.1 (S.D. = 4.89), and DSM5-CCSM was 15.6 (S.D. = 8.82, see Table 1). Excluded and included participants did not significantly differ by gender, age, cannabis use rates, CUDIT-R or AUDIT scores, but excluded participants had higher DSM5-CCSM scores (means 25.8 vs. 15.6, $p < 0.001$).

Descriptive summary of momentary data

Intention to use cannabis within the next hour was reported on 17% ($n = 469$) of the sampled time points (Table 1). Average PA was 2.22 (S.D. = 0.02), NA was 1.75 (S.D. = 0.01), time since last use was 3.3 hours (mean = 6.60, each unit representing a 30 min increment, S.D. = 0.20), and grams of cannabis use was 0.60 (S.D. = 0.48).

[Table 1]

Intention to use cannabis & affect (H1)

The model predicting intention to use explained 25% of the variance (Table 2).

Participant had a higher likelihood of reporting intention to use cannabis in the next hour when s/he reported relatively high PA compared to low PA (OR = 1.721, $p < 0.001$), and relative low NA compared to high NA (OR = 0.761, $p = 0.021$). Yet, the local effect size for within-person variables of interest (NA and PA) was small ($= 0.10$).

In addition, intention to use was higher during the afternoon (OR = 2.931, $p = 0.001$) and evening (OR = 8.075, $p < 0.001$) compared to the morning, decreased over the

course of the study ($OR = 0.980, p = 0.001$), and was higher among participants who reported use since last EMA survey ($OR = 1.530, p = 0.005$).

[Table 2]

Positive affect, time since last use & quantity of use (H2a)

The model predicting PA, including participants reporting cannabis use since the last EMA survey, explained 8% of the variance (Table 3, model 1a). PA was higher when participants reported relative less time since last use ($B: -0.020, p = 0.006$) and when using relatively high quantities of cannabis ($B: 0.022, p = 0.019$). Within-person NA was negatively related to PA ($B: -0.263, p < 0.001$). The local effect size for the within-person variables was small ($= 0.01$).

Negative affect, time since last use & amount of use (H2b)

The model predicting NA in participants reporting cannabis use since the last EMA survey explained 10% of the variance (Table 3, model 2a). NA was higher when participants reported relative more time since last use ($B: 0.017, p = 0.005$). Within-person amount of use was not associated with NA ($p = 0.868$). Within-person PA was negatively related to NA ($B: -0.271, p < 0.001$). The local effect size for the within-person variables was small ($= 0.06$). Participants reported higher NA in the afternoon ($B: 0.154, p = 0.010$) and evening ($B: 0.173, p = 0.007$) and lower NA on weekends ($B: -0.094, p = 0.023$).

[Table 3]

Cannabis-related problems (H3)

Cannabis-related problems related to higher intentions to use cannabis during the study period ($OR = 1.135, p < 0.001$), but cannabis-related problems did not moderate the

relation between PA and NA and intention to use (Table 2, model 1b). Cannabis-related problems were not related to PA or NA and did not moderate any of the associations between affect, hours passed since last cannabis use, and amount used (Table 3, model 1b and 2b).

The AUDIT and DSM-5 Self-Rated Level 1 Cross-Cutting Symptom score were included for descriptive purposes. In control analyses we added these variables to the mixed effects models. Their inclusions did not change the main result in any substantial way and thus the more parsimonious models were kept (see supplementary Table S1 and S2).

Discussion

This study aimed to elucidate the dynamic interplay between affect and cannabis use in the daily life of cannabis using college students. Confirming our hypotheses, relatively high PA related to higher intentions to use cannabis within the next hour and PA was higher the less time passed since last use and after using relatively higher quantities. While NA was lower the less time passed since last use, unexpectedly, low NA related to higher intentions to use and quantity of use was not associated with NA. Moreover, in contrast to our hypothesis, cannabis-related problems did not moderate any of the associations. Participants reported using cannabis on 82% of the time points following reports of intention to use, showing a strong relation between intention to use and actual use. This suggests that, although effect size was small, use may be maintained by high PA but not high NA in college students that use 3-4 days per week on average.

With 42.5% scoring 8 or higher on the AUDIT and 35% scoring 13 or higher on the CUDIT-R, a substantial proportion of the sample were at risk for an alcohol or

cannabis use disorder and may be in need of treatment (Adamson et al., 2010). However, mental health appeared better (DSM-5 CCSM = 15.6) than what has been reported in the general student college population (DSM-5 CCSM = 26.4, also excluding substance use items; Bravo et al., 2018). Our results echo results from two previous EMA studies that found heightened PA preceding use (Buckner et al., 2015; Chakroun et al., 2010). Regarding NA, our results suggest that in young weekly cannabis with signs of problematic cannabis and alcohol use, but with relatively low other mental health problems, cannabis use to prevent or deal with NA is unlikely to be a strong explanatory factor for cannabis use. Combined with previous evidence (Chakroun et al., 2010; Wycoff et al., 2018), results suggests that cannabis self-medication may be less common in college students, compared to users with longer and more problematic cannabis use histories who may be more likely to use cannabis outside social contexts. Yet, at least one study among (mainly) college students of which 87% had a CUD, found evidence in support of the NA/self-medication model of cannabis use (Buckner et al., 2015).

Multiple factors could contribute to the discrepancies between our and previous studies, including variability in use, severity of cannabis-related problems, measures and cannabis legislation. We failed to find evidence for moderations of mood-cannabis relations by cannabis-related problems and severity of cannabis use-related problems appears somewhat lower than reported in Buckner et al. (2015). Nevertheless, a study in weekly young cannabis users with a roughly similar history of cannabis use did find cannabis' positive reinforcing effects to be higher with higher CUD severity (Trelaor Padovano & Miranda, 2018). While the CUDIT-R allows measurements of particularly large variability in cannabis use-related problems, it cannot be used as a diagnostic

instrument similar to that used in previous research (Trelaor Padovano & Miranda, 2018). Furthermore, discrepancies may relate to differences in how mood was assessed. Trelaor Padovano & Miranda (2018) measured stimulation (e.g., energized, excited), which differs from our items. To prevent fatigue and scale floor effects, daily surveys were kept brief and excluded particularly extreme emotions. This rendered our NA items more related to anxiety than depression or general NA, whereas the Buckner et al (2015) also included measures of depressed and anger states (e.g., upset, guilty, hostile, distressed). Given the mixed literature regarding associations between cannabis use and anxiety (Buckner, Crosby, Silgado, et al., 2012; Tournier et al., 2003), future research should test a wider range of NA items and study their potential differential association with cannabis use.

Regional and cultural differences may also play a role. Our sample included international students (i.e., 22 Dutch, 18 German, 27 from other European countries, 13 outside Europe) and Amsterdam has a long history of liberal cannabis attitudes and policies, which differ from the ruling cannabis policies for participants in other studies. All participants smoked cannabis joints, the homogeneous method of administration being a strength. However, cannabis potency [$\sim 16\%$ tetrahydrocannabinol (THC)] is relatively high in the Netherlands (T. P. Freeman et al., 2019; Niesink et al., 2015) and while smoking pure cannabis is most popular in the US, combining cannabis with tobacco is popular in Europe (Russell et al., 2018). Method and product of use, as well as attitudes towards cannabis use likely impact the association between cannabis and mood.

Other characteristics of cannabis use revealed by our study include a negative time trend for intentions to use. Post-hoc analysis indicated that actual cannabis use also decreased

over the course of the study ($OR = 0.985, p = 0.004$). Answering questions regarding cannabis use may trigger self-awareness, influencing participants' experiences or responses (Heron & Smyth, 2010; Kramer et al., 2014). Moreover, intention to use was higher later in the day, showing that cannabis was mainly used in the evening. NA was lower on weekends akin to the *weekend effect* typically found in college students (Ryan et al., 2010). NA was higher in the afternoon and evening, similar to what has been found in other studies (Murray et al., 2002). Exploring this finding further is beyond the scope of this study, but the experiences of stressful or other negative events may be more common in the afternoon and evening, which in turn may trigger NA (Watson et al., 1999).

Limitations

Our EMA assessments were signal-contingent to capture naturally occurring mood fluctuations throughout the day, and as such, we were not able to test whether mood changes from before to after immediate use. Furthermore, our last daily assessment was sent at 19:00, which may have missed capturing some cannabis using events. Future studies with respondent-initiating reporting when they intend to use and later signal-contingent time assessments should be conducted as they may be more sensitive to detect mood responses right after cannabis use.

As discussed above, we tested students from the University of Amsterdam, and future studies are needed to test if our result generalize to other student populations and jurisdictions. The observed cannabis-affect associations may also depend on mode of cannabis administration and tetrahydrocannabinol (THC) versus Cannabidiol (CBD) concentrations (A. M. Freeman et al., 2019). Despite participants indicating they smoked cannabis joints, we did not include detailed momentary assessments on method of use

and product. A controlled cannabis intoxication study including manipulation by THC/CBD concentration and mode of administration could add essential information to the mechanisms of cannabis use. As of yet, there is only limited evidence that CBD alters THC's effects on mood (A. M. Freeman et al., 2019).

We did not measure expectancies, motivation (including medical motivation) or social context of use, which may be important moderating and mediating factors of the relationships between cannabis use and mood (Wyckoff et al., 2018). Medical use is probably uncommon in our sample as it is generally associated with older age groups, and compared to other countries the number of registered medical cannabis users is low in the Netherlands (Hazekamp & Heerdink, 2013).

Finally, while this study answers a general call to include momentary questions regarding amount used (Wyckoff et al., 2018), the measure may be unreliable (Van der Pol, Liebrechts, De Graaf, et al., 2013). Since the focus was on within-subjects differences it is, however, expected that any related bias should be minimal; while there may be differences between individuals related to what 1 gram of cannabis looks like, the estimates are likely to be similar within the individual.

Conclusion

In this sample of weekly cannabis users from a university sample, little evidence was found for the self-medication model whereas results were in line with positive reinforcement models. Clearly, more research is needed that directly tests whether cannabis use is more driven by PA than NA, including a broader range of affect measures and studying the potential moderating role of methods of use, cannabis product, severity of use and CUD, and cultural factors. If our results replicate, it can have implication for

prevention and treatment; among young college students with relatively high CUD risk, cannabis use to deal with NA and self-medication may have limited value for identifying individuals that need professional help. Identification of treatment needs in college students may need to consider other factors, such as personality traits as previously suggested (Chakroun et al., 2010).

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Table 1: sample characteristics

	N	Mean (SD) or n (%)	Range
Socio-demographic background			
Age, mean (S.D.)	80	21.5 (3.14)	19-37
Male, n (%)	80	28 (35.00)	0-1
Health related background			
CUDIT-R, mean (S.D.)	80	11.6 (5.13)	2-25
AUDIT, mean (S.D.)	80	8.1 (4.89)	2-24
DSM-5 CCSM, mean (S.D.)	80	15.6 (8.82)	3-57
Cannabis use history			
Duration of use (years), mean (S.D.)	80	1.6 (1.25)	0-5
Cannabis use days per week, mean (S.D.)	80	3.4 (2.04)	0-7
Grams per week, mean (S.D.)	80	2.0 (1.86)	0.2-10
Joints per use day, mean (S.D.)	80	1.85 (1.19)	0.5-6
Is/was ever in cannabis use treatment, n (%)	80	2 (2.50)	0-1
Daily attributes			
Intention to use cannabis, n (%)	2818	469 (16.64)	0-1
Time past since last cannabis use, mean (S.D.)	803	6.60 (0.20)	0-16
Grams used since last EMA survey, mean (S.D.)	791	0.60 (0.48)	0.2-4
Positive affect, mean (S.D.)	2818	2.22 (0.02)	1-5
Negative affect, mean (S.D.)	2818	1.75 (0.01)	1-5

Note: S.D. = Standard Deviation; EMA = Ecological Momentary Assessment; CUDIT-R = Cannabis Use Disorder Identification Test-revised, AUDIT = Alcohol Use Disorder Identification Test; DSM-5 CCSM = DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure—Adult

Table 2. Results from mixed effects models predicting intention to use cannabis in the next hour, N = 80

	Model 1a: main effects only				Model 1b: interactions included			
	OR	P value	95% Conf. Interval		OR	P value	95% Conf. Interval	
Fixed effects								
Between positive affect	0,882	0,597	0,555	1,404	0,884	0,603	0,556	1,407
Within positive affect	1,721	< 0.001	1,384	2,141	1,571	0,124	0,884	2,794
Between negative affect	1,866	0,059	0,976	3,566	1,865	0,059	0,976	3,566
Within negative affect	0,761	0,021	0,604	0,959	0,891	0,701	0,493	1,608
Used cannabis since last survey	1,530	0,005	1,140	2,053	1,522	0,005	1,133	2,043
Age	1,026	0,607	0,931	1,131	1,026	0,606	0,931	1,131
Male	0,915	0,778	0,495	1,693	0,914	0,774	0,494	1,691
Weekend vs. weekday	1,258	0,079	0,973	1,627	1,257	0,081	0,972	1,625
Linear time trend	0,980	0,001	0,969	0,992	0,980	0,001	0,969	0,992
Afternoon [morning = referent]	2,931	< 0.001	2,062	4,166	2,942	< 0.001	2,068	4,184
Evening [morning = referent]	8,075	< 0.001	5,772	11,297	8,083	< 0.001	5,776	11,311
CUDIT-R	1,135	< 0.001	1,072	1,202	1,133	< 0.001	1,070	1,200
Within positive affect * CUDIT-R					1,007	0,740	0,965	1,051
Within negative affect * CUDIT-R					0,988	0,576	0,947	1,031
Intercept	0,003	< 0.001	0,000	0,061	0,003	< 0.001	0,000	0,062
Marginal R ²	0,249				0,247			

Note: OR = Odds Ratio; CUDIT-R = Cannabis Use Disorder Identification Test-revised

Table 3. Results from mixed effects models predicting positive and negative affect, N = 80

Model 1a: positive affect (main effects only)					Model 1b: positive affect (interaction included)				Model 2a: negative affect (main effects only)				Model 2b:negative affect (interaction included)			
		95% Conf. Interval					95% Conf. Interval				95% Conf. Interval				95% Conf. Interval	
	B	P value			B	P value			B	P value			B	P value		
Fixed effects																
Between hours past since last cannabis use	0,021	0,692	-0,082	0,124	0,022	0,677	-0,081	0,124	-0,037	0,282	-0,106	0,031	-0,037	0,287	-0,105	0,031
Within hours past since last cannabis use	-0,020	0,006	-0,035	-0,006	-0,026	0,116	-0,059	0,006	0,017	0,005	0,005	0,030	0,025	0,057	-0,001	0,050
Between grams used	0,045	0,425	-0,065	0,155	0,045	0,426	-0,065	0,155	0,021	0,584	-0,054	0,096	0,021	0,575	-0,053	0,096
Within grams used	0,022	0,019	0,004	0,040	0,056	0,100	-0,011	0,124	0,002	0,868	-0,016	0,020	-0,057	0,093	-0,124	0,010
Model 1a & 1b: Between negative affect / Model 2a & 2b: Between positive affect	-0,112	0,514	-0,447	0,224	-0,114	0,504	-0,449	0,221	-0,039	0,631	-0,200	0,121	-0,037	0,653	-0,198	0,124
Model 1a & 1b: within negative affect / Model 2a & 2b: within positive affect	-0,263	< 0.001	-0,334	-0,193	-0,260	< 0.001	-0,331	-0,189	-0,271	< 0.001	-0,342	-0,200	-0,267	< 0.001	-0,339	-0,196
Age	-0,034	0,195	-0,084	0,017	-0,034	0,192	-0,084	0,017	-0,021	0,239	-0,056	0,014	-0,021	0,230	-0,056	0,013
Male	0,194	0,226	-0,121	0,509	0,197	0,219	-0,117	0,511	-0,103	0,339	-0,315	0,109	-0,103	0,339	-0,315	0,108
Weekend vs. weekday	-0,073	0,080	-0,155	0,009	-0,074	0,079	-0,156	0,008	-0,094	0,023	-0,175	-0,013	-0,092	0,026	-0,173	-0,011
Linear time trend	0,003	0,162	-0,001	0,007	0,003	0,185	-0,001	0,007	0,002	0,227	-0,001	0,006	0,002	0,188	-0,001	0,006
Afternoon [morning = referent]	0,032	0,581	-0,082	0,146	0,031	0,589	-0,083	0,146	0,154	0,010	0,037	0,272	0,155	0,010	0,038	0,272
Evening [morning = referent]	0,099	0,116	-0,025	0,223	0,098	0,121	-0,026	0,222	0,173	0,007	0,046	0,300	0,172	0,008	0,046	0,299
CUDIT-R	-0,008	0,633	-0,041	0,025	-0,006	0,716	-0,041	0,028	-0,013	0,239	-0,035	0,009	-0,015	0,206	-0,037	0,008
Within hours past * CUDIT-R					0,000	0,683	-0,002	0,003					-0,001	0,498	-0,002	0,001
Within grams used * CUDIT-R					-0,002	0,289	-0,007	0,002					0,004	0,073	0,000	0,008
Intercept	2,750	0,007	0,767	4,733	2,730	0,007	0,740	4,719	2,624	< 0.001	1,368	3,880	2,638	< 0.001	1,379	3,897
Marginal R ²	0,082				0,082				0,096				0,098			

Note: CUDIT-R = Cannabis Use Disorder Identification Test-revised