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Antecedents and Consequences of Cannabis Use among Racially Diverse Cannabis Users: An Analysis from Ecological Momentary Assessment

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Abstract

Background—Cannabis remains the most commonly used illicit substance and use rates are rising. Notably, the prevalence of cannabis use disorders (CUD) nearly equals that of other illicit substance use disorders combined. Thus, the present study aimed to identify cognitive, affective, and situational predictors and consequences of ad-lib cannabis use in a racially diverse sample.

Methods—The sample consisted of 93 current cannabis users (34.4% female; 57.1% non-Hispanic Caucasian), 87.1% of whom evinced a current CUD. Ecological momentary assessment was used to collect frequent ratings of cannabis withdrawal, craving, affect, cannabis use motives, and peer cannabis use over two weeks. Mixed effects linear models examined within- and between-day correlates and consequences of cannabis use.

Results—Withdrawal and craving were higher on cannabis use days than non-use days. Withdrawal, craving, and positive and negative affect were higher immediately prior to cannabis use compared to non-use episodes. Withdrawal and craving were higher among those who

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Contributors

All authors contributed to and approve of the final manuscript.

Conflict of Interest

No conflict declared.

subsequently used cannabis than those who did not. Cannabis use resulted in less subsequent withdrawal, craving, and negative affect. Enhancement and coping motives were the most common reasons cited for use. Withdrawal and negative affect were related to using cannabis for coping motives and social motives. Participants were most likely to use cannabis if others were using, and withdrawal and craving were greater in social situations when others were using.

Conclusions—Data support the contention that cannabis withdrawal and craving and affect and peer use play important roles in the maintenance of cannabis use.

Keywords

marijuana; cannabis; withdrawal; craving; motives; ecological momentary assessment

1. INTRODUCTION

Cannabis is the most commonly used illicit drug and nearly one-fourth of users meets criteria for a cannabis use disorder (CUD; Substance Abuse and Mental Health Services Administration [SAMHSA], 2013). Rates of CUD nearly equal that of other illicit substance use disorders combined (SAMHSA, 2013). Further, cannabis use is on the rise (SAMHSA, 2013). It is therefore important to determine whether putative proximal ‘high-risk’ cannabis vulnerability factors are in fact related to use. Tension-reduction-based models of substance use (e.g., Conger, 1956) propose that substances may be used in an attempt to relieve unpleasant physical and/or emotional states such as withdrawal, craving, and negative affect. Consistent with these models (e.g., Khantzian, 1997), substance use is maintained if the desired effect is achieved (i.e., substance produces alleviation of negative state). The incorporation of ecological momentary assessment (EMA) into prospective designs is one way to test the utility of tension-reduction-based models. Benefits include: collection of data in real-world environments; minimization of retrospective recall bias; and aggregation of observations over multiple assessments facilitating within-subject assessments across time and context, permitting the examination of both predictors and consequences of use (Shiffman et al., 2008).

There is some evidence that withdrawal, craving, and negative affect are ‘high-risk’ cannabis use factors. Withdrawal is related to cannabis relapse (Cornelius et al., 2008) and was cross-sectionally related to cannabis use following a self-quit (i.e., no treatment) attempt in a pilot EMA study of 30 cannabis users (Buckner et al., 2013). Craving does not only occur in the context of withdrawal (see American Psychiatric Association [APA], 2013). Thus, it is important to assess whether craving specifically is related to use and extant data suggest it may be. THC administration decreases craving (Haney et al., 2008) and in a pilot study of 49 Florida State University (FSU) undergraduates, craving was higher prior to cannabis use and lower following use (Buckner et al., 2012a). Similarly, cannabis users report using cannabis to cope with stress and anxiety (Hathaway, 2003; Ogborne et al., 2000). Further, although both positive and negative affect were higher during cannabis use than non-use episodes in our pilot study of self-quitters, only negative affect was uniquely related to use (Buckner et al., 2013).

There remain several gaps in our understanding of putative high-risk cannabis use maintenance factors. First, no known studies assessed momentary motives for cannabis use among users not undergoing a quit attempt. Thus, although coping, enhancement, and expansion motives tend to be most strongly related to cannabis use when assessed via retrospective assessments (e.g., Buckner et al., 2007; Simons et al., 2000), it is unknown whether these motives proximally predict use. Second, although tension-reduction-based models posit that cannabis use should result in decreases in unpleasant states, we know of no EMA studies testing whether cannabis use results in decreases in withdrawal and/or negative affect. Third, the majority of research on withdrawal has concerned individuals undergoing quit attempts, limiting information about the role of withdrawal among non-treatment seekers. Fourth, although the majority of cannabis use occurs when others are also using (Buckner et al., 2012a, 2013), it is unknown whether greater use in social situations is for social reasons and/or due to increases in cannabis withdrawal or craving in response to cannabis-related cues (e.g., peers' paraphernalia). Fifth, the vast majority of work has relied on data from predominantly Caucasian samples (e.g., Buckner et al., 2007, 2012a, 2013; Simons et al., 2000; Simons et al., 1998) or relatively small samples of diverse participants (e.g., $n = 8$; Haney et al., 2008). It is unknown whether results generalize to more racially/ethnically diverse samples.

The present study sought to further understanding of factors that maintain cannabis use in a racially diverse sample of community-recruited adult cannabis users using EMA to collect real-world data about ad-lib cannabis use episodes over a two-week period. The cross-sectional and prospective relationships between putative cannabis use vulnerability factors (e.g., cannabis withdrawal, craving, affect) and cannabis use were examined. It was predicted that these factors would be cross-sectionally and prospectively related to use. Specifically, it was predicted that (1) these symptoms would be greater on cannabis use days than non-use days, (2) these symptoms would be positively related to cannabis use at each assessment point, and (3) these symptoms at one assessment point would predict cannabis use at the next assessment point. Consistent with tension-reduction-based models, it was also predicted that cannabis use would result in subsequent reduction in the severity of these symptoms. Further, per prior work (Buckner et al., 2007; Simons et al., 2000), it was hypothesized that coping, enhancement, and expansion motives would be the most commonly reported motives for use. We also tested whether withdrawal and negative affect were significantly related to coping motivated use. Finally, we sought to extend prior EMA work (Buckner et al., 2012a, 2013) by testing whether use of cannabis by others was related to greater cannabis withdrawal, craving, and negative affect.

2. MATERIAL AND METHODS

2.1 Participants

Participants were recruited via community advertisements (e.g., flyers, newspaper ads). Interested participants completed a screening (on-line or telephone) and baseline appointment to determine eligibility. Participants were asked to refrain from cannabis use the day of their appointment. Eligibility criteria included being between 18-45 years old, past-month cannabis use (confirmed via urine sample using a 50 ng/ml positive cutoff),

cannabis as drug of choice, and no interest in, or current receipt of, substance use disorder treatment. Of the 125 people who attended a baseline appointment, 1 refused to participate and 14 were excluded due to: negative biological verification of cannabis use ($n=6$), being under the influence of cannabis during assessment ($n=1$), meeting DSM criteria for primary substance dependence other than cannabis dependence ($n=3$), and meeting criteria for other diagnoses (e.g., psychosis) that would preclude participation ($n=4$). Of the 110 participants enrolled, 8 dropped out during the monitoring period and 9 were excluded due to: equipment malfunction ($n=7$), non-compliance with protocol during check-in appointments ($n=1$), and non-compliance with EMA data collection ($n=1$; described below).

The sample consisted of 93 cannabis users (34.4% female) aged 18-36 years ($M=20.95$, $SD=2.62$). The racial/ethnic composition was: 57.1% non-Hispanic Caucasian, 24.2% African American or Black, 3.3% Hispanic Caucasian, 1.1% American Indian, 1.1% Asian, 9.9% multiracial, and 3.3% other. The majority (81.7%) were college students with 14.3% employed full-time and 40.7% employed part-time. Mean age of first cannabis use was 15.97 ($SD=2.06$; range=11-20). At baseline, participants reported using cannabis 7-90 ($M=70.0$, $SD=20.0$) days in the past 90 days. All participants endorsed at least weekly past-month use (with 81.4% endorsing daily use) and 68.8% met DSM-IV-TR criteria for cannabis dependence and 18.3% met criteria for cannabis abuse. Per DSM-IV-TR (APA, 2000), respondents meeting criteria for both abuse and dependence were classified as dependence only. Criteria for a cannabis dependence were consistent with DSM-IV (APA, 2000) with the addition of withdrawal as proposed for DSM-5 (APA, 2013). The majority (94.6%) met DSM-IV criteria for an Axis I disorder and 58.1% met criteria for at least two disorders. Primary diagnoses included cannabis dependence (48.9%), social anxiety disorder (19.6%), cannabis abuse (8.7%), alcohol use disorder (7.6%), depressive disorder (3.3%), generalized anxiety disorder (2.2%), PTSD (1.1%), and specific phobia (1.1%).

2.2 Baseline Measures

Diagnoses were determined via the *Structured Clinical Interview for DSM Disorders* (First et al., 2007) administered by trained clinical psychology graduate students and reviewed with a licensed clinical psychologist. Diagnostic reliability of primary CUD diagnoses was established by comparing original diagnoses with diagnoses made for a randomly selected 20% of the sample by trained students blind to initial diagnoses. Percent agreement was 92.3%.

Frequency of cannabis use during the 90 days prior to baseline was assessed with the *Timeline Follow Back* (Sobell and Sobell, 1996). Participants reported for each day how many cigarette-sized joints of cannabis they used. This measure has demonstrated good psychometrics (Fals-Stewart et al., 2000).

2.3 EMA Measures

EMA assessments were completed on a personal desk assistant (PDA) using Satellite Forms 5.2 by Pumatech. Three types of assessments were collected from all participants (Wheeler and Reis, 1991): *signal contingent* (in response to a signal from the PDA at six semi-random times within 20 minutes of the following anchor times: 9:20am, 11:40am, 1:00pm, 3:20pm,

5:40pm, and 7:20pm), *interval contingent* (at bedtime), and *event contingent* (immediately prior to using cannabis). The same questions were presented regardless of assessment type.

Marijuana Withdrawal Checklist (Budney et al., 2003) assessed 15 withdrawal symptoms during participants' most recent period of abstinence from 0 (*not at all*) to 3 (*severe*). This measure has been successfully adapted for use in EMA, with good internal consistency (Buckner et al., 2013). Internal consistency in the current sample was good ($\alpha=.87$).

Momentary cannabis craving was rated from 0 (*no urge*) to 10 (*extreme urge*) as in prior EMA work (Buckner et al., 2012a, 2013). This scale strongly correlated with the four factors of *Marijuana Craving Questionnaire* (Heishman et al., 2001) in prior work (Buckner et al., 2011).

Positive and Negative Affect Scale (Watson et al., 1988) consists of the positive and negative affect subscales each consisting of 10 emotions. Participants rated each emotion felt in the moment from 1 (*very slightly or not at all*) to 5 (*extremely*). Scales have achieved acceptable internal consistency in EMA work (Buckner et al., 2013). Internal consistency in the current sample was excellent (negative affect $\alpha=.91$, positive affect $\alpha=.94$).

Marijuana Motives Measure (MMM; Simons et al., 1998) was modified such that participants checked a box next to each of 25 items that corresponded with their reason for using cannabis during use episodes (as per Buckner et al., 2013). The MMM has demonstrated good psychometrics (e.g., Zvolensky et al., 2007).

Cannabis use—Because participants were instructed to complete an EMA assessment immediately prior to cannabis use, participants indicated whether they were about to use cannabis (yes or no). “Yes” responses were considered cannabis use episodes. This measure is related to retrospective accounts of cannabis use (Buckner et al., 2012b). Participants were also asked if they were alone or if any other person was present and if with others, whether others were using or about to use cannabis (per Buckner et al., 2012a, 2013).

2.4 Procedures

Study procedures were approved by the University's Institutional Review Board and informed consent was obtained prior to data collection. Participants were trained on PDA use. They were instructed to not complete assessments when it was inconvenient (e.g., in class) or unsafe (e.g., driving) and asked to respond to any PDA signals within one hour if possible.

Consistent with other EMA protocols (e.g., Crosby et al., 2009), participants completed two days of practice data (not used for analyses) then returned to the lab to receive feedback on compliance. Participants then completed EMA assessments for two weeks, as this timeframe appears sufficient to monitor substance use (Buckner et al., 2012a, 2013; Freedman et al., 2006). Participants were paid \$25 for completing the baseline assessment and \$100 for each week of EMA data completed. A \$25 bonus was given for completing at least 85% of the random prompts.

2.5 Data Analyses

Analyses were conducted using mixed effects functions in SPSS version 22.0. Models were random intercept, random slope designs that included a random effect for subject. Pseudo R-squared values were calculated using error terms from the unrestricted and restricted models as described by Kreft and de Leeuw (1998). The cross-sectional and prospective relationships of predictors (withdrawal, craving, affect) to cannabis were evaluated in four separate ways. At the *daily* level, generalized linear models (GLM) with a logistic response function were used to compare mean levels of predictors on cannabis use days (1) to non-use days (0). Data were aggregated by participant and day, creating average ratings for predictor variables for each participant on each day. At the *concurrent momentary* level, GLMs evaluated whether momentary levels of predictor variables were related to cannabis use at that time point. At the *prospective* level, GLMs evaluated whether predictors at one time point predicted cannabis use at the next time point. Models also tested whether cannabis use at one time point predicted withdrawal, craving, and affect at the next time point. GLM was also used to evaluate whether momentary levels of withdrawal symptoms and negative affect were related to coping motives at that time point. Also, pre- and post-cannabis use predictors were modeled using linear, quadratic, and cubic effects centered around the first cannabis use of the day. These models included a random effect for subjects, and fixed effects for minutes prior to/after cannabis use, minutes² prior to/after cannabis use, minutes³ prior to/after cannabis use, as well as interactions between these time components and pre/post cannabis use status.

Compliance was assessed via mean percentage of random prompts, of end of day assessments, and of both random and end of day assessments completed per participant. Consistent with prior work (Hopper et al., 2006), one participant was excluded for completing less than 20% of assessments. Remaining participants completed a mean of 85.8% ($SD=18.4\%$; range=23%-98%) of random signals, 60.7% ($SD=23.4\%$; range=7%-100%) of end of day assessments, and 67.6% ($SD=17.8\%$; range=26%-95%) of both random and end of day assessments, with compliance rates slightly higher on cannabis use days (69.1%) than non-use days (63.8%). These rates are comparable to other EMA studies of cannabis users (Buckner et al., 2012a, 2013). Participants completed 5,176 signal contingent ($M=56.1$, $SD=15.1$ per participant), 777 interval contingent ($M=8.5$, $SD=3.2$ per participant), and 1,084 event contingent ($M=13.1$, $SD=11.5$ per participant) assessments. Signal contingent assessments were completed on average 29.3 ($SD=54.8$) minutes after the signal occurred.

3. RESULTS

3.1 Patterns of Cannabis Use

Participants recorded 1,934 cannabis use entries ($M=22.1$, $SD=14.3$ per participant), suggesting some cannabis use was recorded during signal and interval contingent assessments. Participants reported an average of 2.1 ($SD=2.3$) cannabis use episodes per day and 71% of all entries occurred on cannabis use days. Figure 1 graphically presents percent of days on which cannabis use occurred (1a), time of day use occurred (1b), and number of times cannabis was used on cannabis use days (1c). Cannabis use was only slightly more

likely to occur during weekends versus weekdays. Use appears most likely to occur in the afternoon and evening hours (especially from 7-8PM). The majority (65%) of cannabis use days consisted of using more than once.

3.2 Cannabis Withdrawal

Average withdrawal ratings were higher on cannabis use days than non-use days (Table 1). Also, withdrawal was higher when participants were about to use cannabis than when they were not about to use. Prospectively, withdrawal was higher among those who subsequently used cannabis than those who did not. Cannabis use resulted in less subsequent withdrawal, $\beta = -.48$, $SE = .16$, $p = .004$. The temporal pattern between cannabis withdrawal and use was next examined by determining patterns of withdrawal before and after cannabis use (Figure 2). Cannabis withdrawal increased at a significant rate prior to cannabis use, $F(1, 3222.67) = 39.16$, $p < .001$. Withdrawal also decreased at a significant rate following cannabis use, $F(1, 3220.79) = 57.22$, $p < .001$. The most commonly reported cannabis withdrawal symptom during use episodes were craving (74.0%), nervousness/anxiety (38.0%), irritability (29.9%), and restlessness (24.9%). The most common withdrawal symptom rated as “moderate” or “severe” were craving (44.1%), nervousness/anxiety (11.0%), restlessness (11.0%), shakiness (10.5%), and irritability (10.1%).

3.3 Cannabis Craving

Average craving ratings were higher on cannabis use days than non-use days (Table 1). Also, craving was higher when participants were about to use cannabis than when they were not about to use. Craving was higher among those who subsequently used cannabis than those who did not, and cannabis use resulted in less subsequent craving, $\beta = -.17$, $SE = .08$, $p = .045$. Craving increased significantly prior to cannabis use, $F(1, 2048.93) = 33.11$, $p < .001$, and decreased significantly following cannabis use, $F(1, 2051.36) = 90.89$, $p < .001$ (the form of the graph was similar to Figure 2).

3.4 Affect

Positive, but not negative affect, was greater on cannabis use days than non-use days (Table 1). Both positive and negative affect were greater when participants were about to use cannabis than when they were not about to use. Contrary to expectation, neither positive nor negative affect was related to subsequent cannabis use. Cannabis use resulted in less subsequent negative affect, $\beta = -.66$, $SE = .17$, $p < .001$, but not subsequent positive affect, $\beta = -.46$, $SE = .30$, $p = .128$. Negative affect increased at a significant rate prior to cannabis use, $F(1, 3253.77) = 9.43$, $p = .002$, and decreased at a significant rate following cannabis use, $F(1, 3251.39) = 15.27$, $p < .001$ (the form of the graph was similar to Figure 2).¹ Positive affect did not significantly change before use, $F(1, 3247.73) = 0.71$, $p = .401$, nor did it significantly change after use, $F(1, 3245.84) = 2.87$, $p = .090$.

3.5 Reasons for Use

At the item-level, the most common reasons for cannabis use were “to get high,” “because I like the feeling,” “because it gives me a pleasant feeling,” “because it's fun,” and “to forget my worries” (Table 2). Over 75% of cannabis use occurred for enhancement motives.

Coping motives were the next most common motive category (occurring in over 60% of cannabis use episodes), followed by expansion, social, and conformity motives.

During cannabis use episodes, withdrawal was significantly, momentarily related to coping motives, $\beta=.07$, $SE=.01$, $p < .001$. Specifically, when withdrawal was high (greater than 1 SD above the sample mean), coping motives were cited as a reason to use in 74.2% of cannabis use episodes, compared to 58.0% of use episodes when withdrawal was lower (less than the sample mean). Withdrawal was also significantly related to social motives, $\beta=.07$, $SE=.03$, $p=.012$, such that when withdrawal was high, social motives were cited in 27.5% of use episodes compared to 21.9% of use when withdrawal was lower. Withdrawal was unrelated to using for conformity, $\beta=.02$, $SE=.03$, $p=.575$, enhancement, $\beta=.02$, $SE=.02$, $p=.421$, and expansion $\beta=-.03$, $SE=.02$, $p=.152$, motives.

During cannabis use episodes, negative affect was significantly, momentarily related to using for coping motives, $\beta=.06$, $SE=.02$, $p < .001$. Specifically, when negative affect was high (greater than 1 SD above the sample mean), coping motives were cited as a reason to use in 77.0% of cannabis use episodes, compared to 57.8% of use episodes when negative affect was lower (less than the sample mean). Negative affect was also significantly related to using for social motives, $\beta=.07$, $SE=.03$, $p=.009$, such that when negative affect was high, social motives were cited in 33.4% of use episodes compared to 11.8% of use when negative affect was lower. Negative affect was unrelated to using for conformity, $\beta=.04$, $SE=.02$, $p=.115$, enhancement, $\beta=.00$, $SE=.02$, $p=.946$, and expansion $\beta=-.01$, $SE=.02$, $p=.478$, motives.

3.6 Peer Influence

Participants were significantly more likely to use cannabis in social situations than when alone, $\beta=1.05$, $SE=.12$, $p<.001$, $pseudo R^2=.047$. Specifically, 61.2% of cannabis use occurred in social situations. In social situations, participants were significantly more likely to use if others were using, $\beta=4.52$, $SE=.33$, $p<.001$, $pseudo R^2=.528$. In fact, 94.5% of cannabis use in social situations occurred when others were using.

Withdrawal was greater when others were using cannabis compared to social situations when others were not using, $\beta=1.17$, $SE=.43$, $p=.009$, $pseudo R^2=.022$. Craving was also greater when others were using compared to social situations when others were not using, $\beta=1.82$, $SE=.24$, $p<.001$, $pseudo R^2=.004$. Whether others were using did not impact participant negative affect, $\beta=0.07$, $SE=.29$, $p=.817$, $pseudo R^2=.000$, or positive affect, $\beta=0.15$, $SE=.58$, $p=.803$, $pseudo R^2=.000$.

4. DISCUSSION

The current study tested tension-reduction-based models of cannabis use (Conger, 1956) by simultaneously examining predictors and consequences of cannabis use in a racially diverse sample of cannabis users. Findings contribute to our understanding of cannabis use in several substantial ways. First, withdrawal, craving, and affect were robustly related to cannabis use. Second, use resulted in decreases in withdrawal, craving, and negative affect. Third, participants were especially vulnerable to using cannabis for enhancement and coping

motives. Fourth, the majority of use occurred when others were also using, and withdrawal and craving were greater when others were using.

Cannabis withdrawal and craving were related to cannabis use in all four of our tests of these relations, providing strong support for the contention that withdrawal and craving play important roles in substance use (e.g., Marlatt and Gordon, 1980). Consistent with laboratory studies (Haney et al., 2008, 2004), cannabis use resulted in less subsequent withdrawal and craving. Consistent with tension-reduction models, negative affect was greater when participants were about to use cannabis and use resulted in less negative affect. Cannabis use did not impact subsequent positive affect, suggesting that use may be maintained by decreases in negative affect not by increases in positive affect. Interestingly, negative affect was unrelated to enhancement motives, suggesting that users do not necessarily use cannabis to feel good during times they are feeling increased negative affect. Rather, they appear to use to decrease negative affect. Taken together, our results suggest that withdrawal, craving, and negative affect may serve as important maintenance factors in cannabis use per tension-reduction-based models. Data highlight the importance of clinical skills aimed at teaching patients more adaptive strategies to manage these symptoms.

Enhancement and coping motives were the most common reasons given for cannabis use. That coping motives were quite common is concerning given that coping motives are robustly related to more cannabis-related problems (Buckner, 2013). It is interesting that enhancement motives were cited so frequently given that use did not result in increased positive affect. This finding is somewhat counter to prior EMA work finding that enhancement motives lead to increases in positive affect after drinking alcohol (Piasecki et al., 2014) and has important clinical implications. CUD patients may benefit from psychoeducation that although they may want to use cannabis to increase their positive affect, data suggest positive affect does not increase after using cannabis. As predicted, withdrawal and negative affect were significantly related to coping motivated use. They were also related to using for social motives, which may reflect a coping strategy to seek social support during emotionally difficult times.

Consistent with retrospective (Reilly et al., 1998) and EMA reports (Buckner et al., 2012a, 2013), the majority of cannabis use occurred in social situations, especially when others were also using. Withdrawal and craving were greater when others were using. Notably, nearly 40% of cannabis use occurred while participants were alone, which is concerning given that solitary cannabis use is related to greater cannabis-related impairment (van der Pol et al., 2013). Our observed rate of solitary cannabis use is greater than the rate we obtained in our pilot study of FSU undergraduates, in which only 23% of use occurred alone (Buckner et al., 2012a) and may reflect that the current sample represents a more impaired group, with higher rates of CUD than in our pilot study (87% vs 63%).

Notably, our sample consisted of frequent cannabis users with high rates of CUD. Thus, identification of vulnerability factors related to cannabis use in this sample of frequent cannabis users is particularly important given frequent cannabis use is related to more cannabis-related impairment (e.g., Buckner, 2013; Coffey et al., 2003; Simons et al., 1998, 2005). That our sample of frequent, disordered cannabis users was not treatment-seeking

reflects that the majority of individuals with CUD do not seek treatment (Stinson et al., 2006). However, future work is necessary to test whether withdrawal, craving, affect, and peer use are related to lapse and/or relapse among patients in CUD treatment and those undergoing self-quit attempts.

Results should be considered in light of limitations. First, data were collected via self-report and future work could benefit from a multi-method/multi-informant approach. Second, we did not collect data on quantity of cannabis consumed, nor did we collect data on the use of other substances during the monitoring period. Third, though recruited from the community, the sample was comprised of undergraduate students. Although young adults are the most vulnerable to cannabis use and CUD (Stinson et al., 2006), future study is needed to examine whether the observed relations generalize to other cannabis-using populations. For instance, use in the late evening/early morning hours may be more typical of students than other populations. Fourth, we did not delineate whether craving and negative affect occurred only in the context of withdrawal or whether it also occurred during other times and future research is necessary to determine whether withdrawal findings reflect the strong relations of craving and negative affect to cannabis use. Fifth, future work with larger samples could use structural equation models to test complex, reciprocal relations between cannabis use and these affective, cognitive, and social predictors of use.

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Highlights

- Predictors & consequences of cannabis use were examined in racially diverse sample
- Withdrawal and craving were robustly related to cannabis use
- Withdrawal, craving, and negative affect were higher prior to and lower after use
- Enhancement and coping motives were the most common reasons cited for use
- Withdrawal and craving were greater in social situations when others were using

Figure 1.

(A) Days of the week that cannabis was used, (B) time of day when cannabis was used, and (C) number of times cannabis used per cannabis use day.

Figure 2.
Withdrawal levels pre- and post-cannabis use.

Table 1

Relations of Craving, Withdrawal, and Affect to Cannabis Use when assessed by (1) Whether Cannabis was Used that Day, (2) Momentary Relations between Predictors and Cannabis Use, and (3) Whether Predictors at One Assessment Point Predicted Cannabis Use at Next Assessment Point

	Cannabis use	No cannabis use				
Predictor	<i>M (SD)</i>	<i>M (SD)</i>	β	<i>SE</i>	<i>p</i>	pseudo <i>R</i> ²
Cannabis Use Day Status						
Withdrawal	3.94 (5.34)	2.56 (3.97)	.07	.02	<.001	.014
Craving	4.67 (2.75)	3.10 (2.58)	.22	.04	<.001	.054
Negative affect	13.47 (5.77)	12.79 (4.61)	.03	.02	.126	.002
Positive affect	21.08 (9.58)	19.34 (9.09)	.02	.01	.052	.005
Momentary Cannabis Use ^a						
Withdrawal	4.87 (5.75)	3.17 (4.75)	.06	.01	<.001	.017
Craving	5.52 (2.54)	3.73 (2.72)	.36	.02	<.001	.073
Negative affect	14.11 (6.39)	13.03 (5.16)	.03	.01	.002	.006
Positive affect	21.84 (9.58)	20.19 (9.39)	.02	.01	.012	.005
Subsequently Used Cannabis						
Withdrawal	4.17 (5.34)	3.47 (5.02)	.03	.01	.005	.002
Craving	5.16 (2.62)	4.02 (2.78)	.15	.02	<.001	.027
Negative affect	13.57 (5.93)	13.24 (5.41)	.01	.01	.442	.000
Positive affect	21.71 (9.98)	20.39 (9.34)	.01	.01	.075	.002

^aRefers to endorsement that participant is about to use cannabis at the same assessment point that predictor was assessed.

Table 2

Reasons for Cannabis Use during Cannabis Use Episodes

Reason for Use	% Endorsement
Coping Motives	62.7
To forget my worries.	21.0
Because it helps me when I feel depressed or nervous.	11.1
To cheer me up when I am in a bad mood.	13.1
To forget about my problems.	9.2
Because I feel more self-confident and sure of myself.	8.4
Social Motives	17.7
Because it helps me enjoy a party.	4.3
To be sociable.	2.5
Because it makes social gatherings more fun.	9.6
Because it improves parties and celebrations.	3.4
To celebrate a special occasion with friends.	4.9
Conformity Motives	2.8
Because my friends pressure me to use cannabis.	0.9
So that others won't kid me about not using cannabis.	0.6
To fit in with the group I like.	0.7
To be liked.	1.4
So I won't feel left out.	0.6
Enhancement Motives	77.7
Because I like the feeling.	52.9
Because it's exciting.	18.4
To get high.	65.5
Because it gives me a pleasant feeling.	38.4
Because it's fun.	33.5
Expansion Motives	22.8
To know myself better.	6.8
Because it helps me be more creative and original.	11.2
To understand things differently.	15.6
To expand my awareness.	15.3
To be more open to experiences.	11.5