



Positive and negative affect following marijuana use in naturalistic settings: An ecological momentary assessment study



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HIGHLIGHTS

- We used momentary assessment to assess change in affect following marijuana use.
- Overall, negative affect (NA) was higher and positive affect unchanged after marijuana use.
- After marijuana use to cope/conform, NA was highest and declined abruptly.
- Participants with dependence had increased positive affect after marijuana use.

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1. Introduction

1.1. Marijuana epidemiology

Marijuana is the most commonly used illicit drug in the United States, with the lifetime prevalence of use among U.S. high school students increasing from 22.7% in 1991 to 30.0% in 2015 (Miech, Johnston, O'Malley, Bachman, & Schulenberg, 2016). Marijuana use is associated with educational underachievement, cognitive impairment, diminished life satisfaction and achievement, chronic bronchitis, increased risk of psychosis disorder among those at risk, and addiction (Volkow, Compton, & Weiss, 2014). As commercial interests begin to promote and distribute marijuana, the public health experience with alcohol and tobacco has established the need to be proactive in identifying behavioral motivations for using marijuana, and monitoring health consequences associated with its use (Caulkins & Kilmer, 2016).

1.2. Affect and marijuana use

Young people report a number of marijuana use motives, including social conformity, coping with negative affect, and sensory alteration (Aarons, Brown, Stice, & Coe, 2001; Simons, Correia, Carey, & Borsari, 1998). Affect-related motives for marijuana use seem to be particularly salient because tension reduction and relaxation motives have been associated with more frequent marijuana use (Buckner & Schmidt, 2008), and coping motives for marijuana use have been associated with psychopathology symptoms, and distress (Brodbeck, Matter, Page, & Moggi, 2007).

The association between elevated negative affect, coping motives for using marijuana, and subsequent marijuana use is consistent with the self-medication hypothesis (Khantzian, 1997). Under the self-medication hypothesis, persons experiencing overwhelming affective extremes use substances to regulate their affect. However, it is not clear

Abbreviations: EMA, ecological momentary assessment; NA, negative affect; PA, positive affect; PANAS, positive-affect negative-affect schedule

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that use of substances such as marijuana actually produce relief from dysregulated affect. At least one theory suggests that use of marijuana may lead to continued elevated anxiety, resulting in a vicious cycle of continued substance use (Stewart & Conrod, 2008).

Further, there is potential for a cycle of positive reinforcement of marijuana use from increased positive affect following its use. Marijuana has been shown to produce feelings of euphoria, not blunted by frequent use (D'Souza et al., 2008). Drugs of addiction, including marijuana, have been shown to release dopamine into the striatum, a key process in the brain's reward system (Bossong et al., 2009), producing a physiological trigger for continued use. Repeated use of substances under these circumstances may begin to modify brain reward and stress systems, with the potential to develop dependence (Edwards & Koob, 2010).

1.3. Existing research on affect and marijuana use

Affective states are difficult to study using recall survey methods. Ecological Momentary Assessment (EMA) studies use real-time data collection methods to capture time-specific information about psychological and environmental factors in naturalistic settings (Schwartz & Stone, 2007). For example, Shrier, Ross, and Blood (2014) used EMA to examine affective states immediately preceding marijuana use, compared to times distant from marijuana use, for youth and young adult frequent marijuana users. They found negative affect was higher in time periods immediately antecedent to marijuana use compared to background time periods distant from marijuana use, thus providing some support for a self-medication model of marijuana use. Several other EMA and field studies have found anxiety and increased negative affect preceding marijuana use, perhaps acting as a trigger for use of the substance under the self-medication hypothesis (Bhushan, Blood, & Shrier, 2012; Buckner, Crosby, Silgado, Wonderlich, & Schmidt, 2012; Johnson, Bonn-Miller, Leyro, & Zvolensky, 2009; Shrier, Walls, Kendall, & Blood, 2012; Wills, Sandy, Shinar, & Yaeger, 1999).

Many of these studies have found complex interactions between individual trait characteristics, baseline psychopathology symptoms, and contextual factors that modify the association between affect and marijuana use (Buckner, Bonn-Miller, Zvolensky, & Schmidt, 2007; Buckner, Crosby, Wonderlich, & Schmidt, 2012; Cheetham, Allen, Yücel, & Lubman, 2010; Hussong & Hicks, 2003; Shoal & Giancola, 2003). Of particular note, Buckner, Bonn-Miller, Zvolensky, and Schmidt (2007) found that social anxiety was associated with marijuana use, but only when motivated by coping or conforming expectations in contrast to other marijuana use motives. In addition, Cheetham, Allen, Yücel, and Lubman (2010) found that the association between affective states and marijuana use was modified by the stage of engagement with marijuana: onset, risky use, and addiction. Given these previous findings of contextual (e.g. motivational) and physiological (e.g., addiction) interactions between affective states and marijuana use, it is important that studies of affect following marijuana use evaluate effect modification (i.e., changes in the association across strata), particularly with regard to marijuana use motives and stage of use.

1.4. Objectives of this study

In this study, we sought to determine how positive and negative affect change following marijuana use among adolescents and young adults who are frequent users of marijuana. We examined changes in mean affect in time periods subsequent to marijuana use, compared to time periods immediately antecedent to marijuana use, as well as background time periods distant from marijuana use. Finally, we explored whether these associations were modified by coping motives or marijuana dependence.

2. Materials and method

2.1. Participants

Details of the study sample and procedures have been reported previously (Shrier, Walls, Kendall, & Blood, 2012). Briefly, forty-four primary care patients of two adolescent/young adult medical clinics who reported marijuana use at least twice a week were enrolled upon consent, of whom 41 (93%) provided EMA data (two participants were lost to follow up; one did not follow the EMA protocol). Participants were not enrolled if under the influence of marijuana at the time of the interview. The institutional review board of the participating hospital approved the study protocol with a waiver of parental permission for participants under the age of 18.

2.2. Procedures

Participants completed a baseline interview that assessed marijuana use history and psychopathology symptoms. Next, participants were trained to use a personal digital assistant (PDA; Palm Tungsten E2, Palm Inc., Sunnyvale, CA) that was programmed with the Configurable Electronic Real-Time Assessment System (CERTAS) program (PICS, Inc., Reston, VA); all other functions were locked out. The PDA was programmed to signal at random times within 3-hour intervals during each participant's waking hours, approximately 4–6 signals/day. In addition to random prompts, participants were instructed to complete a report immediately prior to and following marijuana use. All reports contained measures of positive and negative affect. The participants used the devices for approximately 12–14 days of data collection. Participants were compensated up to \$140 based on the proportion of study activities completed and reimbursed for travel to and from study visits (participants were not compensated based on frequency of marijuana use).

2.3. Measures

2.3.1. Positive and negative affect

Positive and negative affect (PA and NA) were measured using an abbreviated form of the Positive Affect-Negative Affect Schedule (PANAS) (Shrier et al., 2011; Watson, Clark, & Tellegen, 1988). Participants were asked to “indicate to what extent you currently feel each of the next 12 feelings” using a 5-point Likert-type scale (*not at all, a little, moderately, quite a bit, extremely*). PA was taken as the sum of responses for feelings *interested, strong, proud, alert, inspired, and determined* (Cronbach's alpha = 0.84); NA was taken as the sum of responses for *distressed, upset, guilty, scared, hostile, and irritable* (Cronbach's alpha = 0.86). We used the mean and standard deviation of positive and negative affect for each individual from their signal-prompted reports to calculate individual z-scores as the outcome measures.

2.3.2. Covariates and effect modifiers

Covariates and potential effect modifiers were identified from a review of previous research (Buckner, Crosby, Silgado, Wonderlich, & Schmidt, 2012; Cornelissen et al., 2005; Miech, Johnston, O'Malley, Bachman, & Schulenberg, 2016; Watson, Clark, & Tellegen, 1988). Personal attributes were measured at baseline and included age at the baseline interview - dichotomized at the median into 15 to 17 years (youth) (UNDESA, 2013) and 18 to 24 years (young adult) (The Society for Adolescent Health and Medicine, 2017); race/ethnicity recorded as White non-Hispanic, Black/African-American non-Hispanic, Hispanic, or other or mixed race/ethnicity, and dichotomized as white or non-white; sex; baseline depressive symptoms measured with Beck's Depression Inventory-II (BDI-II; Cronbach alpha = 0.91) (Beck, Steer, & Brown, 1996); baseline anxiety measured with the State-Trait Anxiety Inventory (STAI; Cronbach alpha = 0.74) (Spielberger, Gorsuch, & Lushene, 1970); cannabis dependence disorder with

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