AN ABSTRACT OF THE THESIS OF

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Title: Emotion Regulation Moderates the Association Between Stress and Problematic Marijuana Use

Abstract approved:

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Objective. Marijuana is the most widely used illicit substance in the United States and in 2018 alone, an estimated 40.3 million adults reported using marijuana in the past year. As legalization for medical and recreational marijuana has been expanding, perceived risk of using marijuana has been steadily declining since the late 1980's. This is concerning since growing research suggests that marijuana use is associated with adverse health and life outcomes, such as addiction, abnormal brain development, diminished life achievement, mental health issues, and cognitive impairments. Thus, determining factors that influence marijuana use and marijuana use-related problems is critical for understanding how to effectively implement prevention, intervention, and treatment efforts. Because research has proposed that difficulties in emotion regulation is a transdiagnostic risk factor for substance use and addiction, the investigation of emotion regulation capabilities in marijuana users is warranted. Furthermore, since prior studies

suggest that stress may lead to greater marijuana use-related problems, additional research into how emotion regulation may affect these relationships is needed. Thus, the current study examines how emotion regulation moderates the association between stress and marijuana use in adults through an online survey.

Methods. 852 adults reporting any lifetime marijuana use completed an online survey through Qualtrics. Participants completed a brief demographic questionnaire including questions on age, biological sex, race/ethnicity, income, and education. Further, participants were asked to report their past 30-day use of marijuana, alcohol, nicotine, and illicit substances. To assess past month problematic marijuana use, participants completed the Marijuana Problem Scale (MPS). To assess difficulties in emotion regulation, participants completed the Difficulties in Emotion Regulation Scale (DERS). Participants completed the Perceived Stress Scale (PSS) and the Holmes-Rahe Life Stress Inventory (H-RLSI) to assess past month perceived stress and past year stressful life events, respectively. We investigated the association between scores on the DERS, PSS, and H-RLSI with scores on the MPS. Additionally, we conducted hierarchical multiple linear regression models to test whether emotion regulation, stress, and their interaction predicted problematic marijuana use.

Results. Our main results indicate scores on the DERS ($r = .53, p < .001$), PSS ($r = .13, p < .001$), and H-RLSI ($r = .32 , p < .001$) were significantly correlated with scores on the MPS. Additionally, difficulties in emotion

regulation ($B = .32$, $p < .001$), stressful life events ($B = .21$, $p < .001$), and their

interaction ($B = .07$, $p = .003$) were significant predictors of problematic

marijuana use. Finally, difficulties in emotion regulation ($B = .44$, $p < .001$),

perceived stress ($B = -.18$, $p < .001$), and their interaction ($B = -.06$, $p = .04$)

were significant predictors of problematic marijuana use. Secondary analyses

that reversed the predictor and outcome variables to test the opposite direction

of relationships revealed that problematic marijuana use predicted more

stressful life events ($B = .29$, $p < .001$) and less perceived stress ($B = -.18$, p

$< .001$), but only at high levels of emotion dysregulation.

Conclusion. These findings indicate that when examined separately, greater

difficulties in emotion regulation, experiencing more stressful life events in

the past year, and experiencing more perceived stress in the past month are

associated with greater problematic marijuana use in the past month.

However, when examining the moderating role of emotion regulation, more

stressful life events and less perceived stress predicted greater problematic

marijuana use, and these associations were stronger at higher levels of

emotion dysregulation. Finally, only among those with high levels of emotion

dysregulation, greater problematic marijuana use predicted more stressful life

events and less perceived stress, suggesting bidirectionality of effects. Overall,

these results suggest that difficulties in emotion regulation and greater stress

may be risk factors for developing problematic marijuana use, which could be

possible targets for prevention, intervention, and treatment efforts. Due to

possible bidirectionality of effects, future research would benefit from

experimental or longitudinal designs to further elucidate the complex

relationships between emotion regulation, stressful life events, perceived

stress, and problematic marijuana use.

Emotion Regulation Moderates the Association Between Stress and
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1. INTRODUCTION

Over the past several decades, marijuana has been reported as the most commonly used illicit substance in the United States, which is concerning given that approximately 9% of individuals who use marijuana become dependent. In 2018, an estimated 28 million individuals aged 12 and older reported marijuana use in the past month, which is approximately nine times more prevalent than the second most reported illicit substance (prescription pain reliever misuse; SAMHSA, 2019). As legalization for medical and recreational marijuana has been expanding, perceived risk of using marijuana has been steadily declining since the late 1980's, while prevalence of use has been steadily increasing (Schulenberg et al., 2018). These trends persist despite growing evidence that marijuana use is associated with adverse health and life outcomes, such as addiction, abnormal brain development, diminished life achievement, mental health issues, and cognitive impairments (Volkow et al., 2014; Broyd et al., 2016; Crean et al., 2011). Thus, determining factors that influence marijuana use and the escalation towards problematic marijuana use is critical for understanding how to effectively implement prevention, intervention, and treatment efforts. Because research has proposed that difficulties in emotion regulation is a transdiagnostic risk factor for substance use and addiction, the investigation of emotion regulation capabilities in marijuana users is warranted (Shadur & Lejuez, 2015; Sloan et al., 2017; Tull et al., 2015). Finally, research has found that using marijuana to cope with stress may lead to heavier marijuana use and greater marijuana use-related

problems; thus, additional research into how emotion regulation may affect these relationships is needed (Moitra et al., 2015).

1.1 Stress, Negative Affect, and Theories of Addiction

Research has consistently demonstrated an association between stress and substance use and has identified stress as one of the strongest predictors of relapse, continued drug use, increased drug craving, and greater addiction severity (Constantinou et al., 2010; Dawes et al., 2000; Kosten et al., 1986; Sinha, 2001; Brewer et al., 1998; Sinha et al., 2000; Arévalo et al., 2008). Further, studies have shown that negative affect due to stressful situations is a strong predictor of substance use initiation and frequency of use (Cyders & Smith, 2008; Henderson et al., 1998; Randall & Cox, 2001; Tarter et al., 1999). Unsurprisingly, many theories of addiction have focused on the role stress and negative affect play in the development and maintenance of addiction. Overall, the following theories of addiction emphasize reducing stress and negative affect as principal motives for substance use.

1.1.1 Negative reinforcement models of addiction

Negative reinforcement models of addiction theorize that the primary motivation for substance use is to escape from the aversive, affective components of withdrawal (McCarthy et al., 2010). While withdrawal symptoms vary across substances, common core negative affect symptoms include irritability, anxiety, and depressed mood. However, this explanation is

controversial given that withdrawal does not always predict use, and it cannot explain why individuals initiate substance use, why individuals can relapse long after detoxification, and how addiction develops to substances that do not produce severe symptoms. The reformulated negative reinforcement model expands on the original theory by adding that much of one's motivation towards using substances occurs outside of awareness and generalizes to other negative affective states not related to withdrawal (Baker et al., 2004; McCarthy et al., 2010). McCarthy et al. (2010) propose that individuals with substance use disorder use substances to escape distress, whether it is due to substance deprivation or environmental stress, a view that has been supported by other work (Koob, 2008, 2013; Koob & Le Moal, 1997).

Koob & Le Moal (1997) explain addiction as a cycle of spiraling distress that involves three stages: preoccupation/anticipation, binge/intoxication, and withdrawal/negative affect. In this model, an individual may experience a lapse in their self-regulation, which leads to substance use initiation or relapse. This results in a larger-scale breakdown of self-regulation and individuals experiencing greater emotional distress. With each lapse, their emotional distress builds, making them more likely to lapse. As an individual continues spiraling in this cycle, a shift occurs such that substances are no longer providing positive reinforcement but provide negative reinforcement through the removal of negative affective states (Khantzian, 2009; Khantzian & Albanese, 2008; Koob et al., 2004). Overall, negative reinforcement models of addiction emphasize the removal of

negative affective states as a primary motivator for substance use, which is consistent with other perspectives of addiction that incorporate stress and negative affect as motives for substance use, such as the self-medication hypothesis.

1.1.2 Self-medication hypothesis of addiction

According to the self-medication hypothesis, individuals realize that intoxication can relieve or modify various negative affective states, resulting in using substances as a form of self-medication (Khantzian, 2009; Khantzian & Albanese, 2008). It is believed that self-medication occurs due to self-regulation vulnerabilities in four psychological dimensions of life: difficulties regulating emotions, self-esteem, relationships, and behaviors, especially self-care. Thus, by using substances to self-medicate, substances may help individuals relieve negative affect and more effectively regulate their emotions. Further, these negative affective states are determinants in substance dependence and relapse (Khantzian, 2009; Khantzian & Albanese, 2008). Though using substances to regulate emotions may be initially helpful and beneficial in the short-term, using substances to regulate emotions in the long-term can put one at risk of substance use disorder and may perpetuate the spiraling cycle of addiction (Khantzian & Albanese, 2008; Koob & Le Moal, 1997). The more one uses substances to regulate emotions, the more severe the dependence, withdrawal and associated negative affect, which leads to even greater difficulties regulating emotions; thus, the cycle renews.

1.1.3 Stress-coping model of addiction

A well-supported theory commonly used to explain addiction that is similar to the self-medication hypothesis, is the stress-coping model (Shiffman & Wills, 1985; Wills & Hirky, 1996). This model has become so prominent, it has even been applied to investigate problem video game use, electronic gambling addiction, and internet addiction (Maroney et al., 2019; Thomas et al., 2009; Chou et al., 2015; Li et al., 2016). This model posits that individuals use substances to cope with life stress, because substance use helps to reduce negative affect or increase positive affect. Importantly, this model emphasizes the role of coping responses as a mediator between stress and substance use behaviors.

Furthermore, research distinguishes between two different types of stress-coping strategies: problem-focused coping strategies and emotion-focused coping strategies (Lazarus & Folkman, 1984; Monat & Lazarus, 1991). Problem-focused coping strategies involve directly removing or modifying the stressor, whereas emotion-focused coping strategies involve managing affective states that result from the stressor. Individuals who use problem-focused stress-coping strategies are less likely to develop and are more likely to overcome substance use problems compared to those who regularly use emotion-focused stress-coping strategies (Wills & Hirky, 1996). Further, while problem-focused stress-coping is considered to be protective against substance use, emotion-focused stress-coping has been linked with

increased substance use, early substance use initiation, and continued substance use (Doron et al., 2015; McConnell et al., 2014; Wills et al., 2001a, 2001b).

For example, individuals who employ more approach coping, a form of problem-focused coping and less avoidance coping, a form of emotion-focused coping, are less likely to develop substance use-related problems and experience successful recovery from substance-use related problems (Finney & Moos, 1995). In a nationally representative sample of US adolescents, problem-focused coping was associated with a lower lifetime and frequency of marijuana use, while emotion-focused coping was associated with a higher lifetime and frequency of marijuana use (Lee-Winn et al., 2018). Problem-focused stress-coping has also been linked with a lower odds of tobacco and marijuana use and was protective against the intention to use these substances, while emotion-focused stress-coping has shown the opposite relationships in adolescents (McConnell et al., 2014).

In summary, the stress/negative affect models of addiction follow a shared theme, such that substance use and addiction result from a desire to avoid, relieve, regulate, and cope with stress and negative affect. These models of addiction provide a framework for understanding how both perceptions of stress and negative affect and the experience of stressful life events may explain the development of problematic marijuana use.

1.2 Stressful Life Events and Substance Use

A common way to assess the relationship between stress and health outcomes, such as problematic substance use, is through the use of stressful life event inventories. In the Holmes-Rahe Stressful Life Events Inventory (H-RSLI; originally named the Schedule of Recent Experiences), which measures past-year stressful life events, Holmes & Rahe (1967) defined stressful events as incidents that were likely to bring readjustment-requiring changes in people's usual activities. Specific stressful life inventories have been developed to study subpopulations (e.g. children and adolescents; Grant et al., 2004) and extreme situations (e.g. the first Gulf War; Southwick et al., 1997), but overall, the common characteristic of these inventories is that they include fairly broad categories of events (e.g. divorce, financial strain) rather than more detailed descriptions of these events (Dohrenwend, 2006).

Both cross-sectional and longitudinal research on the relationship between inventoried stressful life events and health have revealed that stressful life events are associated with numerous physical and psychological problems, such as substance use (Dohrenwend, 2006; Sinha, 2008). Past research has found stressful life events to be associated with lifetime cannabis use, cannabis use disorder, heavy drinking, alcohol use disorder, and other substance use disorders (Blanco et al., 2014; Myers et al., 2014; Young-Wolff et al., 2012; Dawson et al., 2005; Keyes et al., 2012; Boden et al., 2014; Sarvet & Hasin, 2016). A longitudinal study found stressful life events to be the only correlate/predictor associated with a lower likelihood of remission

from DSM-IV drug dependence in US adults (other predictors included income, education, race, etc.; McCabe et al., 2016).

Moreover, the relationship between stressful life events and substance use and addiction has been found across other cultures outside of the US. In Botswana, Moitlakgola & Amone-P'Olak (2015) found that greater stressful life events, as measured by a modified version of the H-RLSI, predicted quantity of alcohol consumed, frequency of drinking wine, beer, liquor, and cocktails, and lifetime drunkenness. In Iran, studies have found that patients with opium use disorder experience a significantly greater number of stressful life events (e.g. illness and death of relatives, family problems, legal problems, etc.) compared to healthy controls, and these differences are present two years before substance use initiation (Askari et al., 2011; Hassanbeigi et al., 2013). Having more stressful life events has even been associated with greater internet addiction severity in Chinese adolescents (Li et al., 2016). Overall, evidence suggests that stressful life events are related to greater substance use, abuse, dependence, and addiction. Therefore, examining how stressful life events relate to problematic marijuana use is warranted.

1.2.1 Stressful life events and marijuana use

Stressful life events, such as childhood adversities, family dysfunction, social disadvantage, trauma, and other negative life events may put individuals at risk for early onset marijuana use, greater coping-motivated use, and cannabis use disorder (Myers et al., 2014; see Hyman & Sinha, 2009 for a

review). Longitudinal data from the National Epidemiological Study of Alcohol and Related Conditions has shown past-year stressful life events to be associated with an increased risk of cannabis use disorder and lifetime cannabis use (Myers et al., 2014; Blanco et al., 2014). Furthermore, past year stressful life events have been found to predict the transition from frequent marijuana use to marijuana dependence (van der Pol et al., 2013).

In an effort to identify trajectories of marijuana use from adolescence to adulthood based on the change in frequency of marijuana use, Windle & Wiesner, (2004) found five groups: *Abstainers, Experimental Users, Decreasers, Increasers,* and *High Chronics*. Of the five groups, *High Chronics* reported the greatest number of stressful life events, while abstainers had the least, suggesting that stressful life events may play a role in maintaining marijuana use across adolescent development into adulthood. In another study examining common stressful life events and adolescent substance use, Low et al. (2012) found that romantic breakup stress and family disruption was associated with marijuana use in the past six months. Recently, research found that stressful life events during the year before childbirth was associated with greater odds of women's marijuana use during the perinatal period (Allen et al., 2020). These studies suggest that experiencing more stressful life events may put an individual at risk for greater marijuana use, more marijuana use-related problems, and an increased risk for cannabis use disorder. Though, because individuals may experience

the same stressful life event differently, it is also important to consider how

perceived stress may relate to problematic marijuana use.

1.3 Perceived Stress and Substance Use

Perceived stress can be conceptualized as the degree to which an

individual appraises a situation in their life to be stressful (Cohen et al., 1983).

Further, how one copes with stress impacts how they perceive their stress

(Cohen et al., 2000; Muller & Spitz, 2003). Adaptive stress-coping strategies,

such as problem-focused coping is associated with less perceived stress, while

substance use is associated with greater perceived stress (Muller & Spitz,

2003). For example, Arévalo et al., (2008) found that more perceived stress

was associated with higher addiction severity among women receiving

treatment for addiction. Leonard et al. (2015) found that past 30-day substance

use was associated with high levels of perceived stress and emotion-focused

coping in high school students. These students also reported substance use as

a dominant emotional coping strategy for stress relief, with alcohol and

marijuana being reported as the primary substances used. Perceived stress has

also been associated with a higher likelihood of hazardous drinking or

alcohol-related problems, the likelihood of recent cocaine use, and the

likelihood of recent benzodiazepine use in a sample of individuals in

methadone maintenance treatment programs (Moitra et al., 2013).

1.3.1 Perceived stress and marijuana use

Research has also found greater perceived stress to be associated with more problematic marijuana use. For example, Spradlin & Cuttler, (2019) found that among college students, perceived stress was significantly associated with experiencing more marijuana-use related problems. Further, this relationship was also mediated by coping motives, suggesting that these individuals may be using marijuana to cope with their perceived stress. Similarly, Liao et al., (2019) surveyed individuals who either were currently or formerly in treatment for marijuana use, or self-identified as past-year heavy users who had been reducing their marijuana use over the past year. They found that more problematic marijuana use was significantly associated with higher levels of perceived stress. Though, it is possible that a more complex relationship exists beyond just perceived stress and problematic marijuana use. Ketcherside & Filbey (2015) found that among current heavy marijuana users, perceived stress was significantly associated with more problematic marijuana use, which was mediated by depression and anxiety. These findings indicate that the role of negative affect should also be considered when investigating the relationship between perceived stress and problematic marijuana use. Thus, to further understand the association between stress and problematic marijuana use, it is important to investigate individual differences that could moderate this relationship, such as emotion regulation abilities.

1.4 Emotion Regulation and Substance Use

Emotion regulation refers to one's ability to monitor, evaluate, modify, and control one's emotions to accomplish one's goals; this process can influence the duration and intensity with which one experiences emotional arousal, the types of emotions experienced, and one's responses to emotional experiences (Thompson, 1994). Difficulties in emotion regulation have been implied as central to the development and maintenance of a range of psychopathologies, including post-traumatic stress disorder, depression, anxiety, eating disorders, borderline personality disorder, and substance use disorders (Aldao et al., 2010; Aldao & Nolen-Hoeksema, 2010; Berking et al., 2014; Sloan et al., 2017; Tull et al., 2007; Bickel et al., 2018; Cheetham et al., 2010). Specifically, multiple studies have suggested difficulties in emotion regulation as a transdiagnostic risk factor underlying substance use, addiction, and comorbid psychopathology (Bickel et al., 2018; Cheetham et al., 2010; Shadur & Lejuez, 2015; Sloan et al., 2017; Tull et al., 2015).

Many studies have found poor emotion regulation to be associated with substance use. For example, greater difficulties in emotion regulation have been related to greater alcohol misuse, greater alcohol-related consequences, and alcohol craving and the maintenance of alcohol use in alcohol dependent patients (Tripp & McDevitt-Murphy, 2015; Tripp et al., 2015; Dvorak et al., 2014; Petit et al., 2015). In patients with chronic pain, greater difficulties in emotion regulation have been associated with a greater risk of opioid misuse (Lutz et al., 2018). Also, difficulties in emotion

regulation have been found to be associated with self-reported addiction to opioids and explains the relationship between negative affectivity and non-medical use of opioids (Bakhshaie et al., 2019). Further, tobacco smokers report greater difficulties in emotion regulation compared to non-smokers, and greater difficulties in emotion regulation have been associated with greater tobacco withdrawal symptoms and a slower decline in tobacco withdrawal symptoms over a 12-week quit attempt in treatment-seeking smokers (Faulkner et al., 2020; Rogers et al., 2019). While these studies demonstrate an association between greater difficulties in emotion regulation and substance use outcomes, it is also important to determine in what contexts emotion regulation may be most related to substance use. Thus, examining emotion regulation as a moderator variable can provide additional insight into how it impacts problematic substance use.

1.4.1 Emotion regulation as a moderator variable

Two relatively independent traditions have been developed to address emotion management (Peña-Sarrionandia et al., 2015). The first, the emotion regulation tradition, focuses on the process by which individuals influence when and how they experience and express their emotions. The second, the emotional intelligence (EI) tradition, focuses on emotion regulation as an individual differences ability, rather than a basic process, and argues that an individuals' instances of emotion regulation are not completely independent of each other (Mayer & Salovey, 1997). The EI approach explains how

individual differences may influence how one perceives, understands, and regulates their emotions in a relatively consistent manner across situations, which may explain why some individuals experience emotions more often or intensely, than others (Extremera & Rey, 2015). Further, this could also help explain why difficulties in emotion regulation have been found to underlie so many psychopathologies and has been proposed to be a transdiagnostic risk factor (Aldao et al., 2010; Aldao & Nolen-Hoeksema, 2010; Berking et al., 2014; Sloan et al., 2017; Tull et al., 2007; Bickel et al., 2018; Cheetham et al., 2010; Shadur & Lejuez, 2015; Tull et al., 2015). Thus, through the lens of the EI framework, research can identify which individuals may be most vulnerable to experiencing various outcomes, such as substance use, by assessing emotion regulation as a moderator variable.

Individual differences in emotion regulation have been found to moderate the relationship between various psychological factors and substance use outcomes. For example, Wills et al. (2011) examined emotional self-control (defined as the cognitive ability to reduce excessive arousal and deal with negative emotions) and poor emotion regulation (which they explain originates from different processes, such as emotional reactivity and difficulties inhibiting negative thoughts) in relation to adolescent substance use. They found that the interaction between lower emotional self-control and poorer emotion regulation predicted greater problematic substance use in an adolescent sample (Wills et al., 2011). In cigarette smokers, emotion regulation moderated the relationship between past-year psychopathology and

the likelihood of smoking relapse, such that no past-year psychopathology and lower difficulties in emotion regulation predicted a lower likelihood of relapse; thus, the authors suggest that smokers with emotion regulation difficulties may have challenges quitting (Farris et al., 2016). Emotion regulation has also been found to moderate the relationships between various cognitive behavioral therapies and treatment outcomes (substance use and PTSD symptom severity) in individuals with substance use disorder and PTSD (Hien et al., 2017). In marijuana users, an interaction was found between emotion dysregulation and risk seeking, such that risk seeking may increase vulnerability for marijuana-related consequences at lower levels of emotion dysregulation, though at higher levels, there were no significant differences in marijuana-related consequences between high and low risk taking individuals (Kentopp et al., 2019). The authors conclude that at high levels of emotion dysregulation, the effect of emotion dysregulation overpowers that of risk seeking. Additionally, emotion dysregulation moderates the relationship between coping-motivated drinking and problematic alcohol use, such that as individuals report more emotion dysregulation, this relationship strengthens (Chandley et al., 2014). Emotion regulation has even been found to moderate the relationship between coping motivates and problematic gambling (Marchica et al., 2020). These studies show that it is important to consider emotion regulation as a moderator between various psychological factors and substance use outcomes. In addition to these studies, research has also investigated, more specifically,

whether emotion regulation moderates the relationship between stress and substance use.

1.4.2 Interaction between emotion regulation and stress

Difficulties in emotion regulation may be an important moderator variable when considering the relationship between stress and problematic substance use, given that emotion regulation is one potential key ability that can reduce stress symptoms (Salovey et al., 1999; Sapolsky, 2007). Furthermore, it is possible that emotion regulation has a stress-buffering effect by buffering the negative effects of stressful events (Salovey et al., 1999; Wranik et al., 2007). Therefore, the impact of stress on outcomes, such as problematic substance use, may be attenuated in individuals who can better regulate their emotions during stressful events (Lazarus, 2006); in this way, emotion regulation serves as a coping resource to reduce stress and negative affect when under stress (Salovey et al. 1999). Thus, when viewing emotion regulation as a personal resource, or individual difference, that may have a buffering effect on deleterious effects of stress, observing how the interaction between stress and emotion regulation impacts psychological outcomes is warranted.

Research has found complex relationships between stress and emotion regulation. For example, maladaptive emotion regulation strategies have been found to predict a stronger affective response, but a blunted endocrine stress response, when participants were tasked with a stress-inducing test; the

authors suggest that these individuals with difficulties in emotion regulation exhibit impaired endocrine response and elevated negative affect when faced with stress, which may put them at an increased risk of psychopathology (Krkovic et al., 2018). Similarly, another study found that for female adolescents, difficulties in emotion regulation were prospectively associated with blunted anticipatory cortisol, which was associated with elevated substance use (Kliewer et al., 2016). Additionally, research has found emotion regulation to moderate the relationship between perceived stress and well-being, such that when males reported greater perceived stress, those with less difficulties in emotion regulation reported greater subjective happiness and lower depression symptoms than those with greater difficulties regulating emotions. (Extremera & Rey, 2015). Also, emotion dysregulation moderated the relationship between greater PTSD symptoms and increased aggression in incarcerated methamphetamine users (Wahlstrom et al., 2015). These studies reveal complex relationships between emotion regulation and stress, which have also been found in the substance use literature.

Several studies have investigated whether the interaction between emotion regulation and stress predict substance use outcomes, and findings support emotion regulation as an important moderator. For example, Poon et al. (2016) found that emotion regulation moderated the relationship between stress reactivity and substance use, such that adolescents who demonstrated both low levels of cortisol reactivity following a stressful parent-child interaction task and greater difficulties in emotion regulation were more likely

to use substances. In a sample of 106 young adult women, posttraumatic stress symptoms prospectively predicted substance use severity 8 months later, but only when emotion dysregulation moderated this relationship (Tull et al., 2015). Moreover, difficulties in emotion regulation have been found to moderate the relationship between acculturative stress and alcohol use in Latinx individuals, such that acculturative stress was associated with alcohol use among those with high, but not low, emotion dysregulation (Paulus et al., 2019). Finally, experiential avoidance, a maladaptive emotion regulation strategy, has been found to moderate the relationship between PTSD symptom severity and cannabis dependence, such that higher levels of PTSD was associated with a greater risk of cannabis dependence, but only in individuals exhibiting more experiential avoidance (Bordieri et al., 2014).

In sum, these studies suggest that difficulties in emotion regulation could moderate the relationship between stress and substance use. Thus, because a complex relationship may exist between stress and emotion regulation in the context of substance use, it is critical to examine how these interactions found between emotion regulation difficulties and stress in other substance-using populations may extend to problematic marijuana use.

1.4.3 Emotion regulation and marijuana use

Several studies report that marijuana users experience difficulties in emotion regulation. For example, Zimmermann et al., (2017) investigated emotion regulation in male regular marijuana users using a modified version

of an evaluated event-related cognitive reappraisal fMRI paradigm. They found that marijuana users exhibited impaired emotion regulation on the behavioral level and showed atypical neural activity during reappraisal of negative affect compared to controls. The authors conclude that their impairment in utilizing cognitive reappraisal, an adaptive emotion regulation strategy, when experiencing negative affect could represent either a consequence of, or risk factor for, regular marijuana use. It is possible that marijuana users may have difficulties understanding the emotions they feel and identifying the origins of their emotions, given that lower levels of emotional clarity, an adaptive facet of emotion regulation, has been associated with higher levels of marijuana consumption and abuse (Limonero et al., 2006; Dorard et al., 2008). Further, the interaction between lower levels of emotional clarity and a higher use of cognitive reappraisal has been found to predict problematic marijuana use (Boden et al., 2013). The authors suggest that individuals engaging in problematic marijuana use may have difficulties identifying which emotions should be targeted by cognitive reappraisal, resulting in them downplaying emotions that they should instead be using as a guide to cease their problematic marijuana use.

Marijuana users with greater difficulties in emotion regulation are more apt to use marijuana as a coping mechanism (Bonn-Miller et al., 2008, 2011). Further, difficulties in emotion regulation mediate the relationship between post-traumatic stress symptom severity and coping-motivated marijuana use, suggesting that individuals experiencing high stress may use

marijuana to cope with stress and negative affect due to a lack of ability in regulating their emotions (Bonn-Miller et al., 2008, 2011). This is concerning as research has found emotion dysregulation to be a risk factor for marijuana-use related problems (Blanchard et al., 2018; Dvorak & Day, 2014; Kentopp et al., 2019; Simons et al., 2000; Simons & Carey, 2002; Vilhena-Churchill & Goldstein, 2014). Therefore, if individuals experiencing greater stress use marijuana to cope with stress and regulate negative affect, these individuals may be at risk of problematic marijuana use and vulnerable to falling into the spiraling cycle of addiction (Khantzian & Albanese, 2008; Koob & Moal, 1997). Moreover, coping-motivated marijuana use has been found to mediate the relationship between emotion dysregulation and problematic marijuana use, further suggesting that problematic use may occur in individuals with difficulties in emotion regulation because they choose to use marijuana as a coping mechanism for stress and negative affect (Vilhena-Churchill & Goldstein, 2014). Thus, using marijuana to cope with stress in lieu of utilizing adaptive emotion regulation strategies may put an individual at an increased risk of greater marijuana use-related problems. Finally, emotion dysregulation mediates the relationship between depression, anxiety, and suicidal ideation and problematic marijuana use, further suggesting that a pathway to problematic use could be through an inability to effectively regulate negative emotions (Orr et al., 2019). Overall, research suggests that the development of problematic marijuana use could be attributed to users' difficulties in emotion regulation, and a need to better regulate negative affect when under stressful

conditions (Blanchard et al., 2018; Dvorak & Day, 2014; Simons et al., 2000; Simons & Carey, 2002; Vilhena-Churchill & Goldstein, 2014).

While some studies have examined emotion regulation as a process by which stress and substance use outcomes are related, examining emotion regulation as an individual difference through the EI framework is appropriate, given that the impact of stress on outcomes can be altered depending on individual differences in emotion regulation ability (Bonn-Miller et al., 2008, 2011; Lazarus, 2006). Further, since emotion regulation can be seen as a personal stress-coping resource specific to a given individual, the EI framework allows us to determine whether individual differences in emotion regulation can buffer or exacerbate the effect of stress on problematic substance use. Furthermore, because research has examined emotion regulation as a moderator variable between stress and other substance use outcomes, the moderating role of emotion regulation should be investigated in the relationship between stress and problematic marijuana use (Boden et al., 2013; Bordieri et al., 2014; Paulus et al., 2019; Poon et al., 2016; Tull et al., 2015). Finally, because emotion dysregulation is considered a transdiagnostic risk factor underlying many psychopathologies and comorbid psychopathologies, it is reasonable to adopt the EI framework that considers emotion regulation to be an individual difference that is relatively consistent across situations (i.e. psychopathologies; Aldao et al., 2010; Aldao & Nolen-Hoeksema, 2010; Berking et al., 2014; Sloan et al., 2017; Tull et al., 2007; Bickel et al., 2018; Cheetham et al., 2010; Shadur & Lejuez, 2015; Tull et al.,

2015). From this framework, the current study can determine if difficulties in emotion regulation as a transdiagnostic risk factor in other psychopathologies could also extend to problematic marijuana use (Bickel et al., 2018; Cheetham et al., 2010; Shadur & Lejuez, 2015; Sloan et al., 2017; Tull et al., 2015). Thus, the current study uses the EI framework to understand how individual differences in emotion regulation may relate to problematic marijuana use. In this way, we can identify individuals most at-risk for problematic marijuana use in response to stress.

1.5 The Current Study

1.5.1 Conceptual model

Taking together the current literature on stress, emotion regulation, and marijuana use, it is possible that the interaction between difficulties in emotion regulation and stress play a role in predicting problematic marijuana use (see Figure 1). First, as earlier described, previous studies have found a relationship between stressful experiences and/or perceptions of stress and problematic marijuana use (Blanco et al., 2014; Hyman & Sinha, 2009; Ketcherside & Filbey, 2015; Liao et al., 2019; Myers et al., 2014; Spradlin & Cuttler, 2019; van der Pol et al., 2013). Second, research has found relationships between difficulties in emotion regulation and problematic marijuana use (Blanchard et al., 2018; Boden et al., 2013; Dorard et al., 2008; Dvorak & Day, 2014; Limonero et al., 2006; Simons et al., 2000; Simons & Carey, 2002; Vilhena-Churchill & Goldstein, 2014). Finally, the literature

shows emotion regulation to be an important moderator variable between stress and substance use outcomes, such that individuals with difficulties in emotion regulation, have an impaired ability to control emotions during stressful situations (Kliewer et al., 2016; Krkovic et al., 2018; Poon et al., 2016; Tull et al., 2015). These findings indicate that high stress and difficulties with emotion regulation could be a significant predictor of substance use, whereas the relationship between stress and substance use could be weaker for individuals with fewer emotion regulation difficulties. Thus, in line with prominent theories in addiction, it is possible that individuals experiencing greater difficulties in emotion regulation may turn to marijuana during stressful experiences in order to relieve stress and regulate negative affect; in this way, these individuals may become at risk of developing problematic marijuana use (Baker et al., 2004; Khantzian, 2009; Khantzian & Albanese, 2008; Koob, 2008, 2013; Koob & Moal, 1997; McCarthy et al., 2010). Because no research to date has jointly tested the role of stressful life events, perceived stress, emotion regulation, and their interaction in predicting problematic marijuana use, there is a significant need in addressing such relationships.

Figure 1

Conceptual Model
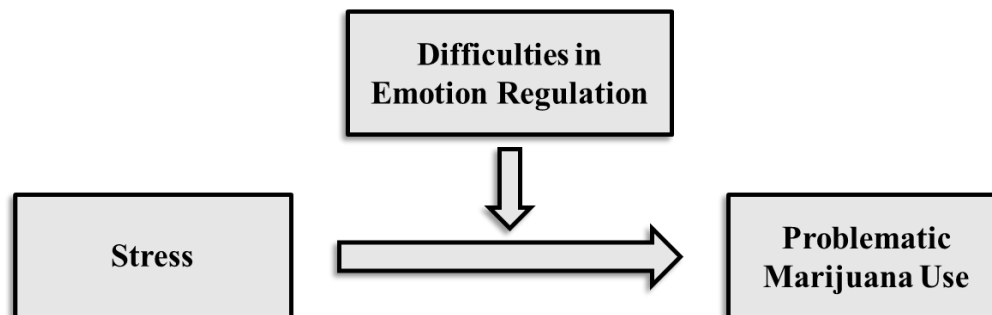
1.5.2 Rationale for the current study

Previous studies have established emotion regulation to be associated with problematic substance use, and as an important moderator variable for relationships between various psychological factors and substance use (Tripp et al., 2015; Tripp & McDevitt-Murphy, 2015; Dvorak & Day, 2014; Petit et al., 2015; Lutz et al., 2018; Bakhshaie et al., 2019; Faulkner et al., 2020; Rogers et al., 2019; Farris et al., 2016; Hien et al., 2017; Chandley et al., 2014). Moreover, research has examined how the interaction between stress and emotion regulation impacts other substance use, though it remains unclear whether this interaction holds within marijuana users (Paulus et al., 2019; Poon et al., 2016; Tull et al., 2015). Thus, the current study aims to close this gap by identifying how individual differences in emotion regulation impact the relationship between stress and problematic marijuana use in order to best understand who is at risk of developing problematic marijuana use.

Further, studies examining emotion regulation and substance use primarily use substance use frequency and quantity of use as outcomes, which may not accurately reflect problematic substance use, an outcome more closely related to substance abuse, dependence, and substance use disorder (Limonero et al., 2006; Paulus et al., 2019; Poon et al., 2016; Tull et al., 2015). For example, the literature is mixed on whether there exists a link between frequency of marijuana use and health-related quality of life (i.e. perceived satisfaction and functioning in both mental and physical health domains; Liao et al., 2019). While some frequent marijuana users may develop marijuana use-related problems, such as diminished life satisfaction and achievement, and problems in social activities, others may not experience similar problems (Lev-Ran et al., 2012; Volkow et al., 2014; Hasin, 2018). When Liao et al. (2019) assessed both frequency of use and problematic marijuana use, they found that more severe problematic use fully mediated the relationship between marijuana use frequency and the mental domain of health-related quality of life; thus, problematic marijuana use may serve as a more informative indicator when measuring outcomes, such as mental health.

Finally, literature that has examined stress and marijuana use investigated different types of stress, such as early life stress, perceived stress, stressful life events, post-traumatic stress symptom severity, etc. independently, but rarely directly compared how they may be differentially related to problematic marijuana use (Allen et al., 2020; Liao et al., 2019; Low et al., 2012; van der Pol et al., 2013; Windle & Wiesner, 2004). Because

research suggests that stressful life events and perceived stress measure different aspects of stress, they may be differentially related to problematic marijuana use (Kingston et al., 2012). Further, Luhmann et al. (2020) argue that since the effects of stressful life events on psychological outcomes differ depending on their characteristics (i.e. type or valence of the stressful event), both stressful life events and perceived characteristics (i.e. subjective experience) of stressful life events should be assessed. Thus, we investigated both stressful life events and perceived stress in order to make direct comparisons in the moderating role of emotion regulation on the association between stress and problematic marijuana use. These various gaps in the literature have motivated the current study's objectives.

1.5.3 Study Objectives

The current study aimed to investigate emotion regulation, stress, and marijuana use in adults through an online cross-sectional survey with the following three aims. For Aim 1, we intended to replicate previous research that has reported an association between stress and problematic marijuana use, and greater difficulties in emotion regulation and problematic marijuana use. For Aim 2, we investigated whether the interaction between difficulties in emotion regulation and past-year stressful life events predicted past-month problematic marijuana use. Finally, for Aim 3 we tested whether the interaction between difficulties in emotion regulation and past-month perceived stress predicted past-month problematic marijuana use.

1.5.4 Hypotheses

First, we predicted that greater difficulties in emotion regulation, more stressful life events, and greater perceived stress would be associated with greater problematic marijuana use. Next, based on the research described above, we predicted there would be an interaction between stress (both stressful life events and perceived stress) and difficulties in emotion regulation, which would predict problematic marijuana use; specifically we hypothesized that greater stress would predict greater problematic marijuana use, and that in individuals with greater difficulties in emotion regulation, this relationship would be stronger. We did not have any specific hypotheses regarding whether there would be a difference between perceived stress versus stressful life events and the moderating role of emotion regulation in predicting problematic marijuana use.

2. METHODS

2.1 Participants

See Table 1 for a complete description of sample demographics. A total of 1,586 individuals participated in the current study. After excluding individuals who reported no lifetime marijuana use and data cleaning, a final sample of *N*=852 was reached. One participant was excluded because they were the only participant reporting "Other" as their biological sex, and sex was ultimately chosen as a covariate for analyses (see analytic plan in section 2.4 Data Analysis). This sample was primarily male (63%), with an average

age of 26.88 (*SD*=6.71). Participants primarily identified their racial background as White (65.5%), followed by Black or African American (19.1%), and American Indian/Alaska Native (4.6%). Approximately 32.2% identified their ethnicity as Spanish, Hispanic or Latinx. In the past 30 days, participants reported using marijuana 9.46 days, on average (*SD*=8.51). Participants were recruited through flyers, word of mouth, snowball sampling, social media advertising, and SONA, the university's research subject pool. Flyers were posted in the community, in locations such as marijuana dispensaries, bars, coffee shops, the public library, grocery stores, and university/college campuses. Social media advertising included posting our recruitment flyer on Facebook, Instagram, Snapchat, and Craigslist. Additionally, students attending a Pacific Northwest university were able to access the survey through SONA in order to gain credit towards courses in which they were enrolled. Eligible participants were age of majority, and currently living in the U.S. or territories in which age of majority is 18 years of age or older. Furthermore, exclusionary criteria included not being a U.S. citizen, or inadequate knowledge of the English language (e.g. not fluent), assessed through multiple choice questions about the study's aims in the electronic consent form prior to survey completion.

Table 1

Demographics, Substance Use Characteristics, and Scores on Primary Variables

	Total (*N*=852)
Demographics	*M(SD)* or %
Age	26.88(6.71)
Sex (% Male)	63.0%
Ethnicity	
Hispanic/Latinx	32.2%
Not Hispanic/Latinx	66.8%
Unknown	1.0%
Race	
White	65.6%
Black or African American	19.1%
American Indian or Alaskan Native	4.6%
Asian	3.8%
More than One Race	3.5%
Native Hawaiian/Other Pacific Islander	2.0%
Other	1.2%
Unknown	0.2%
Income	
$0	1.1%
$0-$5,000	2.7%
$5,000-$10,000	5.6%
$10,000-$50,000	16.9%
$50,000-$75,000	41.9%
$75,000-$100,000	19.6%
>$100,000	12.2%
Highest Level of Education	
Some High School	0.4%
High School Diploma/GED	6.2%
Trade/Technical/Vocational Training	8.5%
Some College	35.6%
Associate's Degree	14.7%
Bachelor's Degree	27.8%
Some Graduate School	4.8%
Graduate School or Professional Degree	2.1%

Table 1. (Continued)

Past 30-Day Substance Use	
Marijuana Use Days[a]	9.46(8.51)
Alcoholic Drinks[b]	6.89(14.59)
Cigarettes[c]	10.66(93.46)
E-Nicotine Use Days[d]	1.40(4.87)
Illicit Substances[e]	.14(1.08)
Scores on Predictor and Outcome Variables	
MPS Total Score	12.76(10.12)
DERS Total Score	97.56(19.93)
H-RLSI Total Score	150.49(112.84)
PSS Total Score	26.71(5.68)

[a]Number of days marijuana was used in the past 30 days. [b]Number of drinks consumed in the past 30 days. [c]Number of cigarettes consumed in the past 30 days. [d]Number of days e-nicotine products were used in the past 30 days. [e]Number of times illicit substances other than cannabis products were used in the past 30 days. Scores on the Marijuana Problem Scale (MPS) are between 0-38. Scores on the Difficulties in Emotion Regulation Scale (DERS) are between 36-180. Scores on the Holmes-Rahe Life Stress Inventory (H-RLSI) are between 0-1466. Scores on the Perceived Stress Scale (PSS) are between 0-56.

2.2 Procedure

Participants were able to complete the survey through an anonymous Qualtrics link. Multiple survey safeguards were utilized to minimize the risk of robots and fast responders from completing the survey. For example, "reCaptcha" was implemented at the start of the survey to prevent robots from completing the survey. Further, the "Prevent Ballot Box Stuffing" option in Qualtrics was used to prevent a single participant from taking the survey more than once. Also, to maintain anonymity of the participants, they entered their email address in a second survey (in order to receive compensation), which they could only access if they completed the main survey; this was ensured

through Qualtric's "HTTP Referer Verification option". Finally, we monitored the data for potential robots and fast responders throughout the entire data collection process, which took place from October – November 2019.

Upon accessing the survey link, participants began by reading a description of the research, and before asking if they consent to take part in the study, the survey included questions that assessed comprehension of consent information by asking participants two questions about the consent form (i.e. "What is the purpose of this research survey?" and "What are the potential risks of participating in this research study?") After consenting, they were presented with an eligibility verification and eligible participants (i.e. 18 years or older, live in a U.S. state or territory where age of majority is 18 years or older) then began the online survey. The survey included questions about demographics, substance use, and psychosocial functioning.

At the end of the survey, a debriefing statement appeared. SONA participants were compensated with research credit required in their classes. Non-SONA participants were compensated with an electronic $5 Amazon gift card and entered into a raffle to win an electronic $100 Amazon gift card. The survey took approximately 60 minutes to complete; however, time of completion was likely influenced by the number of measures participants were asked to complete (e.g. participants who reported no history of substance use did not complete substance use-related measures).

2.3. Measures

2.3.1 Demographic questionnaire

Participants filled out a brief demographic questionnaire that included questions on biological sex, income (e.g. selecting a range of household income, such as $50,000 - $75,000, from a list of options,), education (e.g. selecting highest earned degree, such as bachelor's degree, from a list of options), race (e.g. selecting race participants identified with from a list of options), and ethnicity (e.g. selecting whether or not an individual identified as someone of Hispanic/Latinx/Spanish origin). See Appendix for full demographic questions.

2.3.2 Measures of past 30-day substance use

Participants were asked to report their past 30-day use, past year use, and lifetime use of marijuana, alcohol, nicotine, and illicit substances. Questions related to each substance were only completed by eligible participants who had reported any lifetime use of that substance (e.g. only participants who reported any lifetime use of alcohol completed alcohol-related questions). When answering questions about alcohol use, a visual depiction was given to participants, so that they understood what constitutes one standard drink (see Appendix). Nicotine-related questions asked about frequency of cigarette and electronic nicotine product use, such as e-cigarettes, vapes, and Juul. These questions can be found in the Appendix.

Additional questionnaires were completed by participants to assess marijuana use.

2.3.3 Measures of marijuana use

Eligible participants who reported any lifetime use of marijuana completed the Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU; Cuttler & Spradlin, 2017). Previous research has established the factor structure, reliability, and validity of this measure (Cuttler & Spradlin, 2017). The DFAQ-CU measures frequency, age of onset, and quantity of cannabis use. It also includes questions about different forms of cannabis used, methods of use, and the range of THC levels participant typically use. The measure includes pictures of marijuana flower to aide in participant's estimations of their quantity of use (in grams). For the current study, questions on past 30-day use and lifetime marijuana use were examined.

Participants who endorsed cannabis use in the past six months completed the Cannabis Use Disorder Identification Test -Revised (CUDIT-R; Adamson & Sellman, 2003). Previous research has established the predictive power and sensitivity of the measure's ability to screen for cannabis abuse and dependence (Adamson & Sellman, 2003*).* The CUDIT-R asks participants about negative consequences related to their cannabis use in the past six months (e.g. How often during the past 6 months did you find that you were not able to stop using cannabis once you started?) Specifically, we used the

screener question, "Have you used any cannabis over the past six months?"
for later data cleaning procedures.

Participants who reported any lifetime use or marijuana completed the
Marijuana Problem Scale (MPS; Stephens et al., 2000). Previous research has
established the internal reliability of this measure (Stephens et al., 2000,
2004). This measure includes 19 questions that ask about negative
consequences related to one's marijuana use. They are rated as no problem
(0), minor problem (1), or serious problem (2) over the past month with a total
count of problems indicating severity ratings. The total score of the MPS is
acquired through summing the points across all 19 questions; total MPS score
was used as the dependent variable in the main aims of the current study. We
chose this questionnaire based off previous research that has used this
measure to assess problematic marijuana use and because it asks participants
about problems related to marijuana use experienced in the past month, which
aligns with the timeline of the Perceived Stress Scale (see analytical plan in
section 2.4 Data Analysis; Ketcherside & Filbey, 2015; Liao et al., 2019;
Moitra et al., 2015; Spradlin & Cuttler, 2019).

2.3.4 Measure of emotion regulation

The Difficulties in Emotion Regulation Scale was used to assess
participants' self-reported ability to regulate their emotions. (DERS; Gratz &
Roemer, 2004). Previous research has found this measure to have high
internal consistency, good test-retest reliability, and adequate construct and

predictive validity (Gratz & Roemer, 2004). This measure includes 36 items that ask how often statements regarding participants' ability to regulate emotion apply to them. They are rated as almost never (1), sometimes (2), about half the time (3), most of the time (4), and almost always (5). This measure yields a total score and 5 subscale scores for nonacceptance of emotional responses, difficulty engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. The total score was used as an independent variable in the analytical plan described in section 2.4 Data Analysis.

We chose this measure because of its primary focus on the regulation of negative emotional states, which gives it clinical relevance and makes it an appropriate choice when relating emotion regulation to problematic marijuana use (Gratz & Roemer, 2004). Further, this aligns with our conceptual model that is based off models of addiction that emphasize the role of negative affect in addiction (Baker et al., 2004; Khantzian, 2009; Khantzian & Albanese, 2008; Koob, 2008, 2013; Koob & Le Moal, 1997; McCarthy et al., 2010). Finally, we chose this measure because a large body of substance use research has used it to assess emotion regulation in relation to marijuana, alcohol, injectable substances, tobacco, opioids, and other substances (Kentopp et al., 2019; Dvorak et al., 2014; Paulus et al., 2019; Simons et al., 2017; Mackesy-Amiti & Donenberg, 2020; Faulkner et al., 2020; MacIntyre et al., 2018;

Farris et al., 2016; Rogers et al., 2019; Lutz et al., 2018; Bakhshaie et al., 2019; Hien et al., 2017; Tull et al., 2015).

2.3.5 Measures of stress

Participants completed the Holmes-Rahe Life Stress Inventory, also known as the Social Readjustment Rating Scale or Schedule of Recent Experiences (H-RLSI; Holmes & Rahe, 1967). The H-RLSI includes a list of stressful life events and participants are instructed to endorse the events they have experienced in the past year. Previous research has established the reliability and validity of this measure (Gerst et al., 1978; Holmes & Rahe, 1967). There are 43 different life events, each with a different point value (e.g. death of a spouse = 100, minor violations of the law = 11). A score of 150 or less indicates relatively low stress past-year stress and low susceptibility to stress-induced health problems, 150 to 300 implies a moderate level of past-year stress and a 50% chance of a major stress-induced health problem in the next two years, and 300 points or more implies a high level of past-year stress and about 80% chance of a major stress-induced health problem in the next two years (Holmes & Rahe, 1967). The total sum score was used as the independent variable in the analytical plan described in section 2.4 Data Analysis.

The H-RLSI was chosen to assess stressful life events because this measure defines past-year stressful experiences as incidents that are likely to bring readjustment-requiring changes in people's usual activities (which

would be problematic marijuana use, in our hypotheses). Additionally, given that the original purpose of this measure was to inventory fundamentally important environmental events that were found (through analyzing patient's charts) to frequently precede illness onsets, we choose this measure, in-line with our hypothesis that stressful life events predict problematic marijuana use (Dohrenwend, 2006; Holmes & Rahe, 1967). Finally, this measure was also chosen because it assesses stressful life events that occurred relatively recently (i.e. past year) in order to align with the time-frame used in the PSS and MPS as closely as possible (see analytical plan in section 2.4 Data Analysis).

Participants also completed the Perceived Stress Scale (PSS; Cohen et al., 1983). The PSS includes statements to determine participants' perceived stress in the past month. Previous research has established the reliability and validity of this measure (Cohen et al., 1983; Lee, 2012). There are 14 questions that ask participants the degree to which situations in one's life are appraised as stressful. They are rated as never (0), almost never (1), sometimes (2), fairly often (3), and very often (4) and a total score is calculated by reversing scoring items 4, 5, 7, & 8 and then summing across all scale items. The total sum score was used as the independent variable in the analytical plan described in section 2.4 Data Analysis.

We chose this measure because it is suggested for examining the role of nonspecific appraised stress as a risk factor for disease and behavioral disorders (Cohen et al., 1983). This aligns with our aim in examining the role of greater perceived stress as a risk factor for problematic marijuana use.

Further, it can be used to assess how moderators of the stress/pathology operate (in this case how emotion regulation could moderate stress and problematic marijuana use; Cohen et al., 1983). Further, we chose this measure because it aligns with the timeline of past 30 day problematic marijuana use assessed by the MPS and because previous research has used it to assess perceived stress and its association with the MPS (Ketcherside & Filbey, 2015; Liao et al., 2019; Spradlin & Cuttler, 2019).

2.4 Data Analysis

Participants' responses were excluded from our final analyses if they violated at least one of five rules that were established prior to any analyses. The first rule excluded any participant who completed the survey in 5 minutes or less. Wood et al. (2017) recommend that in online samples, researchers remove participants who complete survey questions at rates faster than 1 second per item (i.e. for our survey, that would mean removing participants who completed it in 145 seconds or less). Though, based on average completion time (40 minutes) by research assistants, we decided to take a more conservative approach, and exclude anyone who completed the survey in 5 minutes or less. This resulted in 119 of 1,586 participants being excluded. Our second rule excluded anyone who reported no lifetime marijuana use, which resulted in 367 participants being excluded. Our third rule excluded anyone who reported different ages when asked about their current age at two different points during the survey; 71 participants broke this rule. Our fourth

rule excluded anyone who reported their past-day 30 marijuana use to be greater than their lifetime marijuana use; 12 participants broke this rule. Finally, our fifth rule excluded any participants who reported that they either: 1) did use cannabis in the past six months on the CUDIT-R, but reported their last cannabis use was more than one year ago on the DFAQ-CU, or 2) did not use cannabis in the past six months on the CUDIT-R, but indicated their last cannabis use was less than one month ago on the DFAQ-CU; 129 participants broke this rule.

For all statistical analyses, SPSS Version 26.0 (IBM Corp., 2019) was used and alpha was set to .05. To assess our three aims, we used correlational analysis and hierarchical multiple linear regression. Further, to determine covariates to include in our regression models, correlational analysis, independent samples t-test, and ANOVAs were used to assess the possible relationships between our primary variables of interest, demographic variables, and substance use variables. Finally, as the cross-sectional nature of the data prevents us from determining the direction of the effects, all significant moderations were reconducted by reversing the predictor and outcome variables to test the opposite direction of relationships; this decision was based on a recent study that reversed the predictor and outcome variables in a moderation analysis (Glodosky & Cuttler, 2020).

2.4.1 Analyses for aim 1

The objective for Aim 1 was to replicate previous findings in the literature showing difficulties in emotion regulation, stressful life events, and perceived stress to be positively correlated with problematic marijuana use. Correlational analysis (Pearson's *r*) was used to assess the relationships between difficulties in emotion regulation (as measured using the DERS) and problematic marijuana use (as measured using the MPS), stressful life events (as measured using the H-RLSI) and MPS, and perceived stress (as measured using the PSS) and MPS.

2.4.2 Analyses for aim 2

The objective of Aim 2 was to test whether difficulties in emotion regulation, stressful life events, and their interaction predicts problematic marijuana use. Hierarchical multiple linear regression was used to assess whether difficulties in emotion regulation (as measured using the DERS), stressful life events (as measured using the H-RLSI), and their interaction predicted problematic marijuana use (as measured using the MPS). Covariates were entered into the first block of the regression in order to control for these variables. The DERS and H-RLSI were mean-centered and added into the second block to assess whether they were significant predictors of scores on the MPS after controlling for covariates entered in block 1. Finally, the interaction term for the DERS and H-RLSI was added into the third block to

assess whether it was a significant predictor of scores on the MPS above and beyond the main effects and covariates.

2.4.3 Analyses for aim 3

The objective of Aim 3 was to test whether difficulties in emotion regulation, perceived stress, and their interaction predicts problematic marijuana use. Hierarchical multiple linear regression was used to assess whether difficulties in emotion regulation (as measured using the DERS), perceived stress (as measured using the PSS), and their interaction predicted problematic marijuana use (as measured using the MPS). Covariates were entered into the first block of the regression in order to control for these variables. The DERS and PSS were mean-centered and added into the second block to assess whether they were significant predictors of scores on the MPS after controlling for covariates entered in block 1. Finally, the interaction term for the DERS and PSS was added into the third block to assess whether it was a significant predictor of scores on the MPS above and beyond the main effects and covariates.

2.4.4 Addressing assumptions for multiple linear regression

We confirmed that there was a linear relationship between our independent variables (i.e. scores on the DERS, H-RLSI, and PSS) and dependent variable (i.e. scores on the MPS) by observing scatter plots for each independent variable and the dependent variable. To evaluate for

multicollinearity, correlational analysis was used between scores on the DERS, PSS, and HRLSI and an *a priori* level of < 0.70 was established to determine whether these constructs were relatively independent measures (Nunnally, 1994); all correlations were below this cut-of. Moreover, analysis of collinearity statistics showed this assumption was met, as Variance Inflation Factor scores were well below 10, and tolerance scores above .2 (statistics were approximately 2 and .6 respectively). Next, to assess whether the values of the residuals are independent, we examined the Durbin-Watson statistic. These statistics showed that this assumption was met in our models, as the obtained values were close to 2 (approximately 1.8). To determine if the variances of the residuals were constant, we observed plots of standardized residuals vs. standardized predicted values. These showed no obvious signs of funneling, suggesting the assumption of homoscedasticity were met. To ascertain whether the values of the residuals were normally distributed, we observed P-P plots for the models, which suggested that this assumption was met. Finally, we confirmed there are were no influential cases biasing the models, give than Cook's Distance values were all under 1, suggesting individual cases were not unduly influencing the models. Because assumptions of linear regression were met, parametric tests were used for all analyses.

3. RESULTS

3.1 Results for Aim 1

Pearson's correlations revealed that difficulties in emotion regulation ($r = .53$, $p < .001$), stressful life events ($r = .32$, $p < .001$), and perceived stress ($r = .13$, $p < .001$) were significantly correlated with problematic marijuana use (Table 2). Thus, experiencing greater difficulties in emotion regulation, experiencing more stressful life events in the past year, and reporting higher perceived stress in the past month were all related to experiencing more marijuana-related problems.

Table 2

Correlations (Pearson's r) between Primary Variables

	1	2	3	4
1. MPS	1			
2. H-RLSI	0.32	1		
3. PSS	0.13	0.13	1	
4. DERS	0.53	0.17	0.53	1

Note. All *p*'s < .001. MPS = Marijuana Problem Scale. H-RLSI = Holmes-Rahe Life Stress Inventory. PSS = Perceived Stress Scale. DERS = Difficulties in Emotion Regulation Scale.

3.2 Results Assessing Covariates

Pearson's correlations revealed that age ($r = .29$, $p < .001$), past 30-day cannabis use ($r = .08$, $p = .03$), past 30-day alcoholic drinks ($r = -.31$, $p < .001$), and past 30-day e-nicotine use ($r = -.17$, $p < .001$) were significantly correlated with problematic marijuana use. Further, independent samples *t*-test revealed that problematic marijuana use differed significantly by biological

sex ($t = 12.52$, $p < .001$), such that males ($M = 15.82$, $SD = 9.77$) reported

approximately two times as many problems as females ($M = 7.56$, $SD = 8.46$).

Four separate one-way ANOVAs were conducted and significant group

differences on problematic marijuana use for race, ethnicity, income,

education level were found (all p's $< .001$; see Table 3).

Using these covariates, we conducted six total hierarchical regression

models to test Aim 2 and 3. The first two hierarchical regression models

(Models 1 and 2) were primary analyses for Aims 2 and 3; these only included

the six demographic variables (age, biological sex, race, ethnicity, income,

and highest level of education) and past 30-day marijuana use as covariates.

The second two hierarchical regression models (Models 3 and 4) served as

secondary analyses and also included past 30-day alcoholic drinks and past

30-day e-nicotine use as covariates; the purpose of these secondary analyses

were to help identify whether emotion regulation moderated the association

between stress and problematic marijuana use above and beyond co-occurring

alcohol and e-nicotine use in this sample. Our final two hierarchical regression

models (Models 5 and 6) served as secondary analyses and reversed the

predictor and outcome variables for Models 1 and 2 if significant moderations

were found to test the opposite direction of relationships.

Table 3

Average Scores, Groups Differences, and Correlations with the Marijuana Problem Scale

Demographics	Total (N=852) M(SD)	r, t, or F	p
Age		r=.29	**<.001**
Sex		12.52	**<.001**
Male	15.82(9.77)		
Female	7.56(8.46)		
Ethnicity		36.10	**<.001**
Hispanic/Latinx	16.84(9.36)		
Not Hispanic/Latinx	10.87(9.91)		
Unknown	7.78(8.71)		
Race		17.07	**<.001**
Native Hawaiian/Other Pacific Islander	18(7.97)		
Black or African American	17.36(8.60)		
American Indian or Alaskan Native	16.51(8.37)		
White	12.20(10.31)		
Other	5.30(5.72)		
More than One Race	3.53(4.36)		
Asian	3.44(3.88)		
Unknown	1.00(1.41)		
Income		33.41	**<.001**
0.00	0.78(1.20)		
$0-$5,000	3.17(3.97)		
$5,000-$10,000	5.04(6.71)		
$10,000-$50,000	11.69(8.74)		
$50,000-$75,000	17.04(9.94)		
$75,000-$100,000	12.41(9.37)		
>$100,000	6.80(8.42)		
Highest Level of Education		39.28	**<.001**
Some High School	17.33(1.53)		
High School Diploma/GED	5.66(7.45)		
Trade/Technical/Vocational Training	13.92(6.36)		
Some College	8.07(8.41)		
Associate's Degree	12.50(9.47)		
Bachelor's Degree	19.59(10.02)		
Some Graduate School	16.85(7.07)		
Graduate School or Professional Degree	9.61(10.16)		

Table 3. (Continued)

Past 30-Day Substance Use		
Marijuana Use Days[a]	$r=.08$	**0.03**
Alcoholic Drinks[b]	$r= -.31$	**<.001**
Cigarettes[c]	$r=-.03$	0.33
E-Nicotine Use Days[d]	$r=-.17$	**<.001**
Illicit Substances[e]	$r<.01$	0.96

Note. Bold *p*-values indicate significant group differences on the Marijuana Problem Scale (MPS) or significant correlations with scores on the MPS. [a]Number of days marijuana was used in the past 30 days. [b]Number of drinks consumed in the past 30 days. [c]Number of cigarettes consumed in the past 30 days. [d]Number of days e-nicotine products were used in the past 30 days. [e]Number of times illicit substances other than cannabis products were used in the past 30 days.

3.3 Results for Aim 2

Regression Model 1 tested whether stressful life events, emotion regulation, and their interaction predicted problematic marijuana use. We included the demographic variables and past 30-day marijuana use as covariates and found a significant regression equation ($F(28,823) = 41.47$, $p <.001$) with an R Square of .59. (see Table 4 for the model summary). Difficulties in emotion regulation ($B = .32$, $p < .001$), stressful life events ($B = .21$, $p <.001$) and their interaction ($B = .07$, $p = .003$) were significant predictors of problematic marijuana use (see Table 5 for all coefficients in the model). As Figure 2 shows, the relationship between stressful life events and problematic marijuana use strengthens as difficulties in emotion regulation increase. To probe the interaction, simple slopes analysis was used by looking one standard deviation above and below the mean for difficulties in emotion regulation. The relationship between stressful life events and problematic marijuana use remained significant at both high levels of emotion

dysregulation ($B = .28$, $p < .001$) and low levels of emotion dysregulation ($B = .14$, $p < .001$).

Table 4

Model Summary for Model 1: Effects of Difficulties in Emotion Regulation, Stressful Life Events, and their Interaction on Problematic Marijuana Use

Model Summary									
	R	R^2	Adj. R^2	Std. Error of the Estimate	R^2 Change	F Change	df1	df2	Sig. F Change
Block 1	0.67	0.44	0.43	7.67	0.44	26.19	25.00	826.00	**<.001**
Block 2	0.76	0.58	0.57	6.66	0.14	136.11	2.00	824.00	**<.001**
Block 3	0.77	0.59	0.57	6.63	0.01	8.94	1.00	823.00	**.003**

Table 5

Model 1: Effects of Difficulties in Emotion Regulation, Stressful Life Events, and their Interaction on Problematic Marijuana Use

		Coefficients							Correlations		
		Unstandardized		Standardized			95% CI for B				
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
Block 1	(Constant)	3.38	3.20		1.06	0.29	-2.91	9.67			
	Age	0.08	0.04	0.05	1.96	0.05	0.00	0.16	0.29	0.07	0.04
	Sex	-2.50	0.54	-0.12	-4.64	<.001	-3.56	-1.44	-0.39	-0.16	-0.10
	Hispanic/Latinx	2.30	0.56	0.11	4.13	<.001	1.21	3.39	0.28	0.14	0.09
	Unknown (Hispanic/Latinx)	0.19	2.31	0.00	0.08	0.93	-4.34	4.72	-0.05	0.00	0.00
	White	1.87	2.23	0.09	0.84	0.40	-2.50	6.24	-0.08	0.03	0.02
	Black or African American	4.78	2.31	0.19	2.07	0.04	0.25	9.32	0.22	0.07	0.05
	American Indian or Alaskan Native	6.67	2.50	0.14	2.66	0.01	1.76	11.58	0.08	0.09	0.06
	Asian	-2.37	2.53	-0.04	-0.93	0.35	-7.34	2.61	-0.18	-0.03	-0.02
	More than One Race	-2.33	2.52	-0.04	-0.92	0.36	-7.26	2.61	-0.17	-0.03	-0.02
	Native Hawaiian/Other Pacific Islander	6.50	2.82	0.09	2.30	0.02	0.96	12.04	0.07	0.08	0.05
	Unknown (Race)	-2.15	5.17	-0.01	-0.42	0.68	-12.30	8.00	-0.06	-0.01	-0.01
	Some High School	7.16	4.29	0.04	1.67	0.10	-1.25	15.57	0.03	0.06	0.04
	High School Diploma/GED	-0.13	1.98	0.00	-0.06	0.95	-4.01	3.76	-0.18	0.00	0.00
	Trade/Technical/Vocational Training	1.22	1.92	0.03	0.64	0.52	-2.54	4.99	0.03	0.02	0.01
	Some College	0.46	1.76	0.02	0.26	0.80	-2.99	3.90	-0.34	0.01	0.01
	Associate's Degree	1.79	1.76	0.06	1.01	0.31	-1.68	5.25	-0.01	0.04	0.02
	Bachelor's Degree	5.82	1.72	0.26	3.38	0.001	2.44	9.21	0.42	0.12	0.08
	Some Graduate School	3.63	1.97	0.08	1.84	0.07	-0.24	7.49	0.09	0.06	0.04
	$0	-0.69	2.35	-0.01	-0.30	0.77	-5.30	3.91	-0.12	-0.01	-0.01
	$0-$5,000	-0.90	1.57	-0.01	-0.57	0.57	-3.98	2.18	-0.16	-0.02	-0.01
	$5,000-$10,000	1.19	1.21	0.03	0.98	0.33	-1.19	3.57	-0.19	0.03	0.02
	$10,000-$50,000	4.04	0.91	0.15	4.44	<.001	2.25	5.82	-0.05	0.15	0.10
	$50,000-$75,000	4.48	0.80	0.22	5.57	<.001	2.90	6.05	0.36	0.19	0.13
	$75,000-$100,000	1.29	0.87	0.05	1.48	0.14	-0.42	3.00	-0.02	0.05	0.03
	Marijuana Use Days[a]	-0.03	0.03	-0.03	-1.20	0.23	-0.09	0.02	0.08	-0.04	-0.03
Block 2	Centered DERS Scores	0.16	0.01	0.32	12.57	<.001	0.14	0.19	0.53	0.40	0.28
	Centered H-RLSI Scores	0.02	0.00	0.21	8.18	<.001	0.01	0.02	0.32	0.27	0.18
Block 3	DERS X H-RLSI	0.00	0.00	0.07	2.99	0.003	0.00	0.00	0.15	0.10	0.07

Note. DERS = Difficulties in Emotion Regulation Scale. H-RLSI = Holmes-Rahe Life Stress Inventory

[a]Number of days marijuana was used in the past 30 days.

Figure 2

Difficulties in Emotion Regulation Moderate the Relationship Between Stressful Life Events and Problematic Marijuana Use
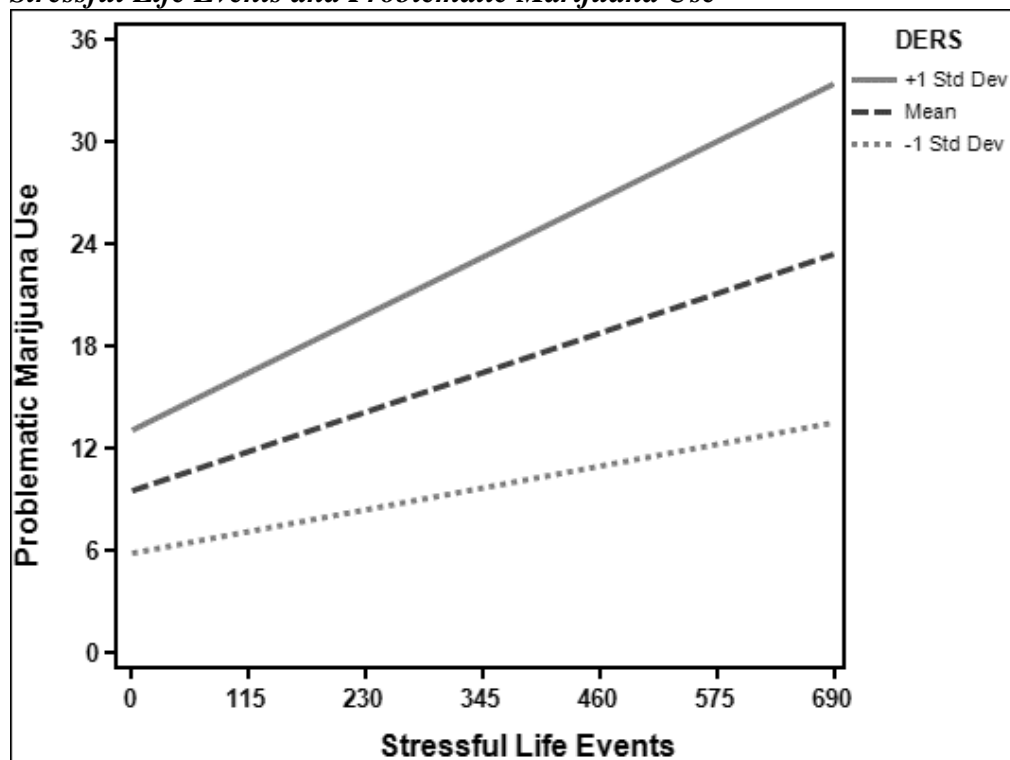
Note. DERS = Difficulties in Emotion Regulation Scale.

3.4 Results for Aim 3

Regression Model 2 tested whether perceived stress, emotion regulation, and their interaction predicted problematic marijuana use. We included the demographic variables and past 30-day marijuana use as covariates and found a significant regression equation ($F(28,823) = 37.80$, $p <.001$) with an R Square of .56 (see Table 6 for the model summary). Difficulties in emotion regulation ($B = .44$, $p < .001$), perceived stress ($B = -.18$, $p <.001$) and their interaction ($B = -.06$, $p = .04$) were significant predictors of problematic marijuana use (see Table 7 for all coefficients in the

model). As Figure 3 shows, the relationship between perceived stress and

problematic marijuana use weakens as difficulties in emotion regulation

decrease. To probe the interaction, simple slopes analysis was used by looking

one standard deviation above and below the mean for difficulties in emotion

regulation. The relationship between perceived stress and problematic

marijuana use remained significant at both high levels of emotion

dysregulation (B = -.22, p < .001) and low levels of emotion dysregulation (B

= -.15, p <.001). Specifically, lower levels of perceived stress were related to

greater problematic marijuana use, but the relationship was weaker for

individuals reporting fewer difficulties in emotion regulation.

Table 6

Model Summary for Model 2: Effects of Difficulties in Emotion Regulation,
Perceived Stress, and their Interaction on Problematic Marijuana Use

Model Summary									
	R	R^2	Adj. R^2	Std. Error of the Estimate	R^2 Change	F Change	df1	df2	Sig. F Change
Block 1	0.67	0.44	0.43	7.67	0.44	26.19	25.00	826.00	**<.001**
Block 2	0.75	0.56	0.55	6.82	0.12	110.66	2.00	824.00	**<.001**
Block 3	0.75	0.56	0.55	6.80	0.002	4.32	1.00	823.00	**0.04**

Table 7

Model 2: Effects of Difficulties in Emotion Regulation, Perceived Stress, and their Interaction on Problematic Marijuana Use

|		Coefficients					95% CI for B		Correlations		
		Unstandardized		Standardized							
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
Block 1	(Constant)	8.15	3.31		2.46	**0.01**	1.65	14.65			
	Age	0.04	0.04	0.03	0.98	0.33	-0.04	0.13	0.29	0.03	0.02
	Sex	-2.10	0.56	-0.10	-3.77	**<.001**	-3.20	-1.01	-0.39	-0.13	-0.09
	Hispanic/Latinx	2.45	0.57	0.11	4.30	**<.001**	1.33	3.58	0.28	0.15	0.10
	Unknown (Hispanic/Latinx)	-0.07	2.37	0.00	-0.03	0.97	-4.73	4.58	-0.05	0.00	0.00
	White	0.35	2.30	0.02	0.15	0.88	-4.17	4.87	-0.08	0.01	0.00
	Black or African American	2.72	2.39	0.11	1.14	0.25	-1.97	7.41	0.22	0.04	0.03
	American Indian or Alaskan Native	4.43	2.59	0.09	1.71	0.09	-0.65	9.51	0.08	0.06	0.04
	Asian	-4.54	2.62	-0.09	-1.73	0.08	-9.68	0.60	-0.18	-0.06	-0.04
	More than One Race	-1.27	2.57	-0.02	-0.49	0.62	-6.31	3.77	-0.17	-0.02	-0.01
	Native Hawaiian/Other Pacific Islander	5.37	2.91	0.07	1.84	0.07	-0.35	11.08	0.07	0.06	0.04
	Unknown (Race)	-4.30	5.32	-0.02	-0.81	0.42	-14.75	6.14	-0.06	-0.03	-0.02
	Some High School	2.77	4.39	0.02	0.63	0.53	-5.85	11.40	0.03	0.02	0.01
	High School Diploma/GED	-3.08	2.02	-0.07	-1.53	0.13	-7.04	0.88	-0.18	-0.05	-0.04
	Trade/Technical/Vocational Training	-2.86	1.95	-0.08	-1.47	0.14	-6.70	0.97	0.03	-0.05	-0.03
	Some College	-2.47	1.80	-0.12	-1.38	0.17	-6.00	1.05	-0.34	-0.05	-0.03
	Associate's Degree	-0.23	1.81	-0.01	-0.13	0.90	-3.78	3.32	-0.01	0.00	0.00
	Bachelor's Degree	4.35	1.79	0.19	2.43	**0.02**	0.84	7.85	0.42	0.08	0.06
	Some Graduate School	2.53	2.03	0.05	1.25	0.21	-1.45	6.51	0.09	0.04	0.03
	$0	0.62	2.42	0.01	0.26	0.80	-4.12	5.36	-0.12	0.01	0.01
	$0-$5,000	-0.30	1.61	0.00	-0.18	0.85	-3.46	2.87	-0.16	-0.01	0.00
	$5,000-$10,000	1.79	1.24	0.04	1.45	0.15	-0.63	4.22	-0.19	0.05	0.03
	$10,000-$50,000	4.35	0.93	0.16	4.68	**<.001**	2.53	6.18	-0.05	0.16	0.11
	$50,000-$75,000	4.57	0.83	0.22	5.53	**<.001**	2.95	6.20	0.36	0.19	0.13
	$75,000-$100,000	1.76	0.89	0.07	1.98	**0.05**	0.02	3.51	-0.02	0.07	0.05
	Marijuana Use Days[a]	-0.03	0.03	-0.02	-0.93	0.35	-0.08	0.03	0.08	-0.03	-0.02
Block 2	Centered DERS Scores	0.22	0.02	0.44	14.34	**<.001**	0.19	0.26	0.53	0.45	0.33
	Centered PSS Scores	-0.33	0.06	-0.18	-5.86	**<.001**	-0.44	-0.22	0.13	-0.20	-0.14
Block 3	DERS X PSS	0.00	0.00	-0.06	-2.08	**0.04**	-0.01	0.00	-0.26	-0.07	-0.05

Note. DERS = Difficulties in Emotion Regulation Scale. PSS = Perceived Stress Scale.

[a]Number of days marijuana was used in the past 30 days.

Figure 3

Difficulties in Emotion Regulation Moderate the Relationship Between
Perceived Stress and Problematic Marijuana Use
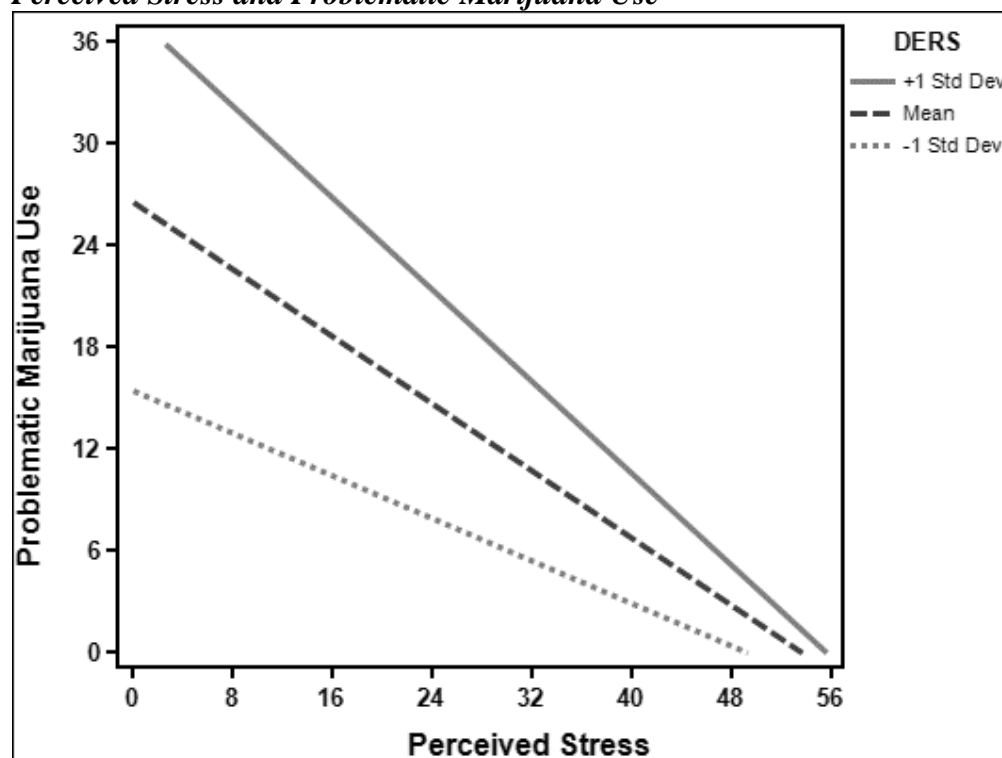
Note. DERS = Difficulties in Emotion Regulation Scale.

3.5 Results for Secondary Hierarchical Regression Analyses

Like Model 1, regression Model 3 tested whether stressful life events,

emotion regulation, and their interaction predicted problematic marijuana use,

though more covariates were added. In addition to demographic variables and

past 30-day marijuana use, we also added past 30-day alcoholic drinks and e-

nicotine use as covariates and found a significant regression equation

($F(30,821) = 39.57$, $p < .001$) with an R Square of .59. (see Table 8 for the

model summary). Difficulties in emotion regulation ($B = .31$, $p < .001$),

stressful life events ($B = .21$, $p < .001$) and their interaction ($B = .07$, $p = .003$)

were significant predictors of problematic marijuana use (see Table 9 for all

coefficients in the model).

Table 8

Model Summary for Model 3: Effects of Difficulties in Emotion Regulation, Stressful Life Events, and their Interaction on Problematic Marijuana Use, with Substance Use Covariates

Model Summary									
	R	R^2	Adj. R^2	Std. Error of the Estimate	R^2 Change	*F* Change	df1	df2	Sig. F Change
Block 1	0.67	0.45	0.44	7.60	0.45	25.37	27.00	824.00	**<.001**
Block 2	0.77	0.59	0.57	6.62	0.13	132.04	2.00	822.00	**<.001**
Block 3	0.77	0.59	0.58	6.59	0.004	8.94	1.00	821.00	**.003**

Table 9

Model 3: Effects of Difficulties in Emotion Regulation, Stressful Life Events, and their Interaction on Problematic Marijuana Use, with Substance Use Covariates

		Unstandardized		Standardized			95% CI for B		Correlations		
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
Block 1	(Constant)	4.71	3.22		1.47	.14	-1.60	11.02			
	Age	0.08	0.04	0.05	1.96	.05	0.00	0.16	0.29	0.07	0.04
	Sex	-2.49	0.54	-0.12	-4.63	**<.001**	-3.54	-1.43	-0.39	-0.16	-0.10
	Hispanic/Latinx	2.13	0.55	0.10	3.84	**<.001**	1.04	3.22	0.28	0.13	0.09
	Unknown (Hispanic/Latinx)	-0.22	2.30	0.00	-0.10	.92	-4.74	4.30	-0.05	0.00	0.00
	White	1.98	2.21	0.09	0.90	.37	-2.36	6.33	-0.08	0.03	0.02
	Black or African American	4.71	2.30	0.18	2.05	**0.04**	0.20	9.22	0.22	0.07	0.05
	American Indian or Alaskan Native	6.59	2.49	0.14	2.65	**0.01**	1.70	11.48	0.08	0.09	0.06
	Asian	-2.18	2.52	-0.04	-0.86	.39	-7.13	2.77	-0.18	-0.03	-0.02
	More than One Race	-1.81	2.50	-0.03	-0.72	.47	-6.73	3.10	-0.17	-0.03	-0.02
	Native Hawaiian/Other Pacific Islander	6.41	2.81	0.09	2.28	**0.02**	0.90	11.91	0.07	0.08	0.05
	Unknown (Race)	-1.89	5.14	-0.01	-0.37	.71	-11.98	8.21	-0.06	-0.01	-0.01
	Some High School	6.25	4.27	0.04	1.46	.14	-2.13	14.63	0.03	0.05	0.03
	High School Diploma/GED	-0.88	1.98	-0.02	-0.44	.66	-4.77	3.01	-0.18	-0.02	-0.01
	Trade/Technical/Vocational Training	0.57	1.92	0.02	0.30	.76	-3.19	4.34	0.03	0.01	0.01
	Some College	-0.28	1.76	-0.01	-0.16	.87	-3.74	3.17	-0.34	-0.01	0.00
	Associate's Degree	0.97	1.77	0.03	0.55	.59	-2.51	4.44	-0.01	0.02	0.01
	Bachelor's Degree	4.90	1.74	0.22	2.82	**0.01**	1.49	8.30	0.42	0.10	0.06
	Some Graduate School	2.70	1.97	0.06	1.37	.17	-1.18	6.58	0.09	0.05	0.03
	$0	0.30	2.35	0.00	0.13	.90	-4.32	4.91	-0.12	0.00	0.00
	$0-$5,000	-1.04	1.56	-0.02	-0.67	.51	-4.11	2.03	-0.16	-0.02	-0.01
	$5,000-$10,000	1.05	1.21	0.02	0.87	.38	-1.32	3.42	-0.19	0.03	0.02
	$10,000-$50,000	3.67	0.91	0.14	4.03	**<.001**	1.89	5.46	-0.05	0.14	0.09
	$50,000-$75,000	4.14	0.81	0.20	5.13	**<.001**	2.55	5.72	0.36	0.18	0.11
	$75,000-$100,000	0.92	0.87	0.04	1.05	.29	-0.79	2.63	-0.02	0.04	0.02
	Marijuana Use Days[a]	-0.02	0.03	-0.02	-0.83	.41	-0.08	0.03	0.08	-0.03	-0.02
	Alcoholic Drinks[b]	-0.06	0.02	-0.09	-3.46	**0.001**	-0.09	-0.03	-0.31	-0.12	-0.08
	E-Nicotine Use Days[c]	0.02	0.05	0.01	0.43	.67	-0.08	0.12	-0.17	0.01	0.01
Block 2	Centered DERS Scores	0.16	0.01	0.31	12.19	**<.001**	0.13	0.18	0.53	0.39	0.27
	Centered H-RLSI Scores	0.02	0.00	0.21	8.25	**<.001**	0.01	0.02	0.32	0.28	0.18
Block 3	DERS X H-RLSI	0.00	0.00	0.07	2.99	**0.003**	0.00	0.00	0.15	0.10	0.07

Note. DERS = Difficulties in Emotion Regulation Scale. H-RLSI = Holmes-Rahe Life Stress Inventory

[a]Number of days marijuana was used in the past 30 days. [b]Number of drinks consumed in the past 30 days. [c]Number of days e-nicotine products were used in the past 30 day

Like Model 2, regression Model 4 tested whether perceived stress,

emotion regulation, and their interaction predicted problematic marijuana use,

though more covariates were added. In addition to demographic variables and

past 30-day marijuana use, we also added past 30-day alcoholic drinks and e-

nicotine use as covariates and found a significant regression equation

($F(30,821) = 35.73$, $p < .001$) with an R Square of .57. (see Table 10 for the

model summary). Difficulties in emotion regulation ($B = .43$, $p < .001$) and

perceived stress ($B = -.17$ $p < .001$) were significant predictors of problematic

marijuana use, but their interaction was not ($B = -.05$, $p = .09$ (see Table 11

for all coefficients in the model).

Table 10

Model Summary for Model 4: Effects of Difficulties in Emotion Regulation,
Perceived Stress, and their Interaction on Problematic Marijuana Use, with
Substance Use Covariates

	Model Summary								
	R	R^2	Adj. R^2	Std. Error of the Estimate	R^2 Change	F Change	df1	df2	Sig. F Change
Block 1	0.67	0.45	0.44	7.60	0.45	25.37	27.00	824.00	**<.001**
Block 2	0.75	0.57	0.55	6.79	0.11	104.59	2.00	822.00	**<.001**
Block 3	0.75	0.57	0.55	6.78	0.002	2.92	1.00	821.00	.09

Table 11

Model 4: Effects of Difficulties in Emotion Regulation, Perceived Stress, and their Interaction on Problematic Marijuana Use, with Substance Use Covariates

		Unstandardized		Standardized			95% CI for B		Correlations		
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
Block 1	(Constant)	9.02	3.33	0.00	2.71	**0.01**	2.49	15.56	0.00	0.00	0.00
	Age	0.04	0.04	0.03	1.01	0.31	-0.04	0.13	0.29	0.04	0.02
	Sex	-2.12	0.56	-0.10	-3.80	**<.001**	-3.21	-1.03	-0.39	-0.13	-0.09
	Hispanic/Latinx	2.33	0.57	0.11	4.07	**<.001**	1.21	3.46	0.28	0.14	0.09
	Unknown (Hispanic/Latinx)	-0.48	2.37	0.00	-0.20	0.84	-5.14	4.17	-0.05	-0.01	0.00
	White	0.45	2.30	0.02	0.20	0.84	-4.05	4.96	-0.08	0.01	0.00
	Black or African American	2.71	2.38	0.11	1.14	0.26	-1.97	7.39	0.22	0.04	0.03
	American Indian or Alaskan Native	4.42	2.58	0.09	1.71	0.09	-0.64	9.49	0.08	0.06	0.04
	Asian	-4.36	2.61	-0.08	-1.67	0.10	-9.49	0.77	-0.18	-0.06	-0.04
	More than One Race	-0.92	2.56	-0.02	-0.36	0.72	-5.95	4.11	-0.17	-0.01	-0.01
	Native Hawaiian/Other Pacific Islander	5.28	2.90	0.07	1.82	0.07	-0.42	10.98	0.07	0.06	0.04
	Unknown (Race)	-4.03	5.31	-0.02	-0.76	0.45	-14.45	6.39	-0.06	-0.03	-0.02
	Some High School	2.17	4.39	0.01	0.49	0.62	-6.45	10.78	0.03	0.02	0.01
	High School Diploma/GED	-3.66	2.02	-0.09	-1.81	0.07	-7.64	0.31	-0.18	-0.06	-0.04
	Trade/Technical/Vocational Training	-3.30	1.95	-0.09	-1.69	0.09	-7.14	0.53	0.03	-0.06	-0.04
	Some College	-3.02	1.80	-0.14	-1.67	0.09	-6.56	0.52	-0.34	-0.06	-0.04
	Associate's Degree	-0.81	1.82	-0.03	-0.45	0.66	-4.38	2.76	-0.01	-0.02	-0.01
	Bachelor's Degree	3.70	1.80	0.16	2.06	0.04	0.17	7.23	0.42	0.07	0.05
	Some Graduate School	1.88	2.04	0.04	0.92	0.36	-2.12	5.88	0.09	0.03	0.02
	$0	1.36	2.43	0.01	0.56	0.58	-3.41	6.13	-0.12	0.02	0.01
	$0-$5,000	-0.47	1.61	-0.01	-0.29	0.77	-3.63	2.70	-0.16	-0.01	-0.01
	$5,000-$10,000	1.70	1.23	0.04	1.37	0.17	-0.73	4.12	-0.19	0.05	0.03
	$10,000-$50,000	4.10	0.93	0.15	4.38	**<.001**	2.26	5.93	-0.05	0.15	0.10
	$50,000-$75,000	4.35	0.83	0.21	5.22	**<.001**	2.71	5.98	0.36	0.18	0.12
	$75,000-$100,000	1.50	0.89	0.06	1.67	0.09	-0.26	3.25	-0.02	0.06	0.04
	Marijuana Use Days[a]	-0.02	0.03	-0.02	-0.73	0.47	-0.08	0.04	0.08	-0.03	-0.02
	Alcoholic Drinks[b]	-0.05	0.02	-0.07	-2.62	**0.01**	-0.08	-0.01	-0.31	-0.09	-0.06
	E-Nicotine Use Days[c]	0.04	0.05	0.02	0.76	0.45	-0.06	0.14	-0.17	0.03	0.02
Block 2	Centered DERS Scores	0.22	0.02	0.43	14.00	**<.001**	0.19	0.25	0.53	0.44	0.32
	Centered PSS Scores	-0.31	0.06	-0.17	-5.52	**<.001**	-0.42	-0.20	0.13	-0.19	-0.13
Block 3	DERS X PSS	0.00	0.00	-0.05	-1.71	0.09	-0.01	0.00	-0.26	-0.06	-0.04

Note. DERS = Difficulties in Emotion Regulation Scale. PSS = Perceived Stress Scale.

[a]Number of days marijuana was used in the past 30 days. [b]Number of drinks consumed in the past 30 days. [c]Number of days e-nicotine products were used in the past 30 day

3.5.1 Results for reversed hierarchical regression models

In order to test the opposite direction of relationships for the

significant moderations found in Models 1 and 2, Models 5 and 6 reversed the

predictor and outcomes variables for Models 1 and 2. Model 5 tested whether problematic marijuana use, emotion regulation, and their interaction predicted stressful life events. We included the demographic variables and past 30-day marijuana use as covariates and found a significant regression equation ($F(28,823) = 13.51$, $p <.001$) with an R Square of .32 and significant R Square Change for both the main effects (.09, $p <.001$) and their interaction (.04, $p <.001$). Difficulties in emotion regulation ($B = .22$, $p < .001$), problematic marijuana use ($B = .29$, $p <.001$), and their interaction ($B = .26$, $p < .001$) were significant predictors of stressful life events. As Figure 4 shows, the relationship between problematic marijuana use and stressful life events strengthens as difficulties in emotion regulation increase. To probe the interaction, simple slopes analysis was used by looking one standard deviation above and below the mean for difficulties in emotion regulation. The relationship between problematic marijuana use and stressful life events remained significant at high levels of emotion dysregulation ($B = .58$, $p < .001$), but was no longer significant at low levels of emotion dysregulation ($B= -.006$, $p =.94$). Specifically, more problematic marijuana use was related to more stressful life events, but only for individuals reporting more difficulties in emotion regulation.

Figure 4

Difficulties in Emotion Regulation Moderate the Relationship Between Problematic Marijuana Use and Stressful Life Events
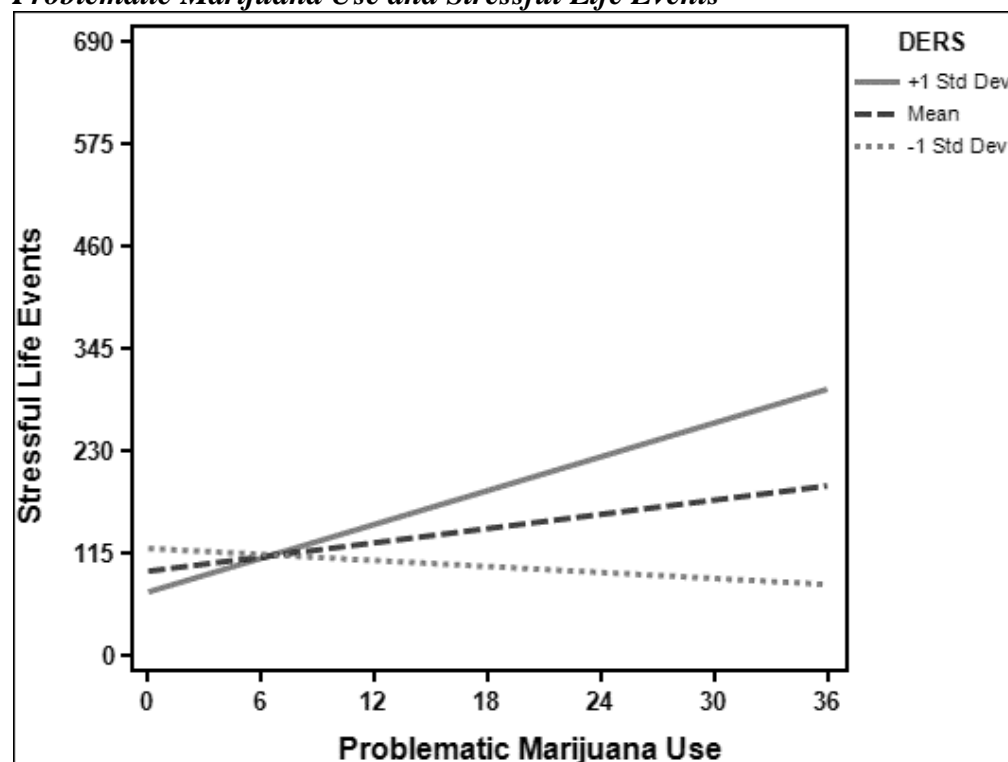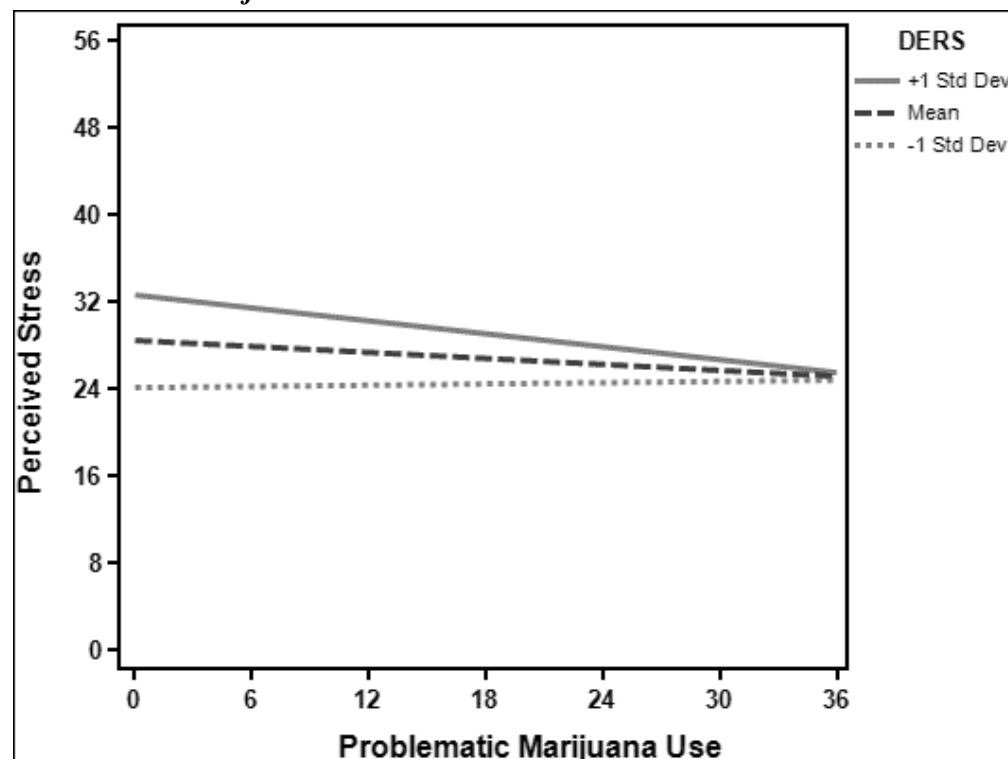

Note. DERS = Difficulties in Emotion Regulation Scale.

Model 6 tested whether problematic marijuana use, emotion regulation, and their interaction predicted perceived stress. We included the demographic variables and past 30-day marijuana use as covariates and found a significant regression equation ($F(28,823) = 17.93$, $p <.001$) with an R Square of .38 and significant R Square Change for both the main effects (.30, $p <.001$) and their interaction (.01, $p <.001$). Difficulties in emotion regulation ($B = .56$, $p < .001$), problematic marijuana use ($B = -.18$, $p <.001$), and their interaction ($B = -.15$, $p < .001$) were significant predictors of perceived stress. As Figure 5 shows, the relationship between problematic marijuana use and

perceived stress strengthens as difficulties in emotion regulation increase. To probe the interaction, simple slopes analysis was used by looking one standard deviation above and below the mean for difficulties in emotion regulation. The relationship between problematic marijuana use and perceived stress remained significant at high levels of emotion dysregulation ($B = -.35$, $p < .001$), but was no longer significant at low levels of emotion dysregulation ($B= -.002$, $p =.97$). Specifically, more problematic marijuana use was related to less perceived stress, but only for individuals reporting more difficulties in emotion regulation.

Figure 5

Difficulties in Emotion Regulation Moderate the Relationship Between Problematic Marijuana Use and Perceived Stress

Note. DERS = Difficulties in Emotion Regulation Scale.

4. DISCUSSION

The current study investigated whether emotion regulation and stress predicted problematic marijuana use, and if individual differences in emotion regulation moderated the relationship between stress and problematic marijuana use. Experiencing greater difficulties in emotion regulation, more past year stressful life events, and greater perceived stress were all significantly associated with experiencing more problematic marijuana use. Specifically, difficulties in emotion regulation and stressful life events were moderately correlated with problematic marijuana use, while perceived stress was only weakly correlated with problematic marijuana use. Thus, in line with Aim 1, the current study replicated previous studies finding greater stressful life events, greater perceived stress, and greater difficulties in emotion regulation to be associated with greater problematic marijuana use (Myers et al., 2014; Blanco et al., 2014; van der Pol et al., 2013; Spradlin & Cuttler, 2019; Liao et al., 2019; Ketcherside & Filbey, 2015; Kentopp et al., 2019; Bordieri et al., 2014; Dorard et al., 2008; Boden et al., 2013; Blanchard et al., 2018; Dvorak & Day, 2014; Simons et al., 2000; Simons & Carey, 2002; Vilhena-Churchill & Goldstein, 2014; Orr, 2019).

Furthermore, difficulties in emotion regulation, stressful life events, and their interaction significantly predicted problematic marijuana use. This suggests that both difficulties in emotion regulation and stressful life events may be risk factors for developing problematic marijuana use. Additionally, emotion regulation moderated the relationship between stressful life events

and problematic use, such that as individuals exhibit more difficulties in emotion regulation, the relationship between stressful life events and problematic marijuana use strengthens. Thus, individuals with difficulties regulating emotions and who experience greater stressful life events may be among those at highest risk for developing problematic marijuana use. Though, after reversing the predictor and outcome variables in Model 5, more problematic marijuana use predicted more stressful life events, though only in individuals high in emotion dysregulation. These results suggest that there may be bidirectionality of effects, such that marijuana-related problems (e.g. problems between you and your partner, missed days at work) could contribute towards the occurrence of stressful life events (e.g. divorce, being fired at work).

Though perceived stress was positively correlated with problematic marijuana use, when examining emotion regulation as a moderator of the relationship between perceived stress and marijuana use, it was found that at low levels of perceived stress, problematic marijuana use was highest for those with greater difficulties in emotion regulation. However, at high levels of perceived stress individual differences in emotion regulation capacity had a weaker effect on the association between perceived stress and problematic marijuana use. Thus, independently emotion regulation and perceived stress were each positively related to problematic marijuana use, but once both perceived stress and emotion regulation were added into the model as

predictors, perceived stress and problematic marijuana use were negatively related.

It is possible that among those with greater difficulties regulating emotions, marijuana use may effectively decrease levels of perceived stress to an extent that these individuals may not feel the need to actively solve the problems that originally caused their perceived stress. Thus, these individuals may be engaging in emotion-focused coping, such that they are using marijuana to cope with the stress and negative emotions associated with their marijuana-related problems, as opposed to solving the problems themselves (Lazarus & Folkman, 1984; Monat & Lazarus, 1991). This would also be in line with previous studies finding emotion-focused coping to be associated with being more likely to develop and less likely to recover from substance use problems (Finney & Moos, 1995; Wills & Hirky, 1996). Thus, these individuals may experience problems related to their marijuana use but may not perceive these problems to be stressful. When reversing the predictor and outcome variables in Model 6, more problematic marijuana use predicted less perceived stress, though only at high levels of emotion dysregulation, suggesting a bidirectional effect. Thus, it is possible that more problematic marijuana users could have lower perceptions of stress, and low perceived stress could increase problematic marijuana use. The relationship between less perceived stress and more problematic marijuana use may not be as strong in individuals experiencing less difficulties in emotion regulation because these

individuals may not be as likely to engage in emotion-focused coping, since they are better at regulating their emotions.

This explanation could also be valid when considering our findings that, in individuals experiencing greater difficulties in emotion regulation, more stressful life events predicted more problematic marijuana use. Stressful life events and the perceived stress associated with them may lead to using marijuana to regulate negative affect and stress. As individuals experience more stressful life events and learn that marijuana can be used as a stress-coping resource, they may be more likely to use marijuana to decrease their perceived stress and negative affect, which would be in-line with negative reinforcement, self-medication, and stress-coping theories of addiction (Baker et al., 2004; Khantzian, 2009; Khantzian & Albanese, 2008; Koob, 2008, 2013; Koob & Moal, 1997; McCarthy et al., 2010). Then, these individuals, through negative reinforcement, may continue to use marijuana to decrease perceived stress and negative affect to an extent to which they would rather deal with emotions related to the problem (emotion-focused coping), as opposed to solving the problem itself (problem-focused coping). Thus, over time, individuals may learn to use marijuana to decrease perceived stress and negative affect related to marijuana-related problems, instead of solving the problems themselves.

This could also explain results from Model 5 that found problematic marijuana use to predict more stressful life events, but only in those higher in emotion dysregulation. It is possible that this may only occur in individuals

high in emotion dysregulation because these individuals may have difficulties regulating negative affect and stress related to marijuana-related problems, use marijuana to regulate affect and stress associated with those problems (emotion-focused coping) and neglect solving the problems themselves, resulting in problems developing into more stressful life events. In this way, more emotionally dysregulated individuals may experience greater problematic marijuana use as a result of both more stressful life events and less perceived stress and may experience more stressful life events and less perceived stress as a result of more problematic marijuana use. Assuming bidirectionality of effects, individuals with greater difficulties in emotion regulation may engage in a cycle similar to the cycle of addiction described by Koob & Le Moal (1997); in the face of stress, these individuals may use marijuana to decrease stress and negative affect, experience problems because of their use, which leads to greater stress and negative affect and makes them more likely to lapse and use marijuana, continuing the cycle.

While difficulties in emotion regulation, perceived stress, and their interaction significantly predicted problematic marijuana use in regression Model 2, their interaction no longer remained significant predictors after including past 30-day drinks and e-nicotine use in Model 4. Moreover, greater past 30-day drinks was a significant predictor of experiencing *less* problematic marijuana use for both Model 3 (stressful life events) and Model 4 (perceived stress) and showed a moderate, significant, negative correlation with problematic marijuana use. It is possible that individuals with less past-30 day

drinks show greater problematic marijuana use because the questions on the

MPS are specific to marijuana use. Thus, possibly individuals who drank

more in the past month are experiencing similar problems listed on the MPS,

but instead attribute those problems to their alcohol use instead of their

marijuana use, and thus have lower scores on the MPS. Furthermore, it is

possible that as individuals use more marijuana, they drink less. For example,

a longitudinal study assessing college substance use across two years found a

negative association between overall percent of marijuana use days and daily

alcohol consumption, which the authors suggest indicates that individuals who

are heavy marijuana users generally drink less, but marijuana users may be

more likely to drink more on days where they use both substances (Gunn et

al., 2018). Another study examined daily patterns of marijuana and alcohol

use in those with alcohol use disorder (AUD) alone, cannabis use disorder

(CUD) alone, or both AUD and CUD (Metrik et al., 2018). They found that

those with CUD alone were less likely to drink heavily vs. moderately,

whereas those with AUD alone and those with both AUD and CUD were

more likely to drink heavily vs. moderately. Also, Alley et al. (2020) found

that recreational marijuana legalization was associated with decreased binge

drinking prevalence among students 21 and older, further suggesting a

substitution effect.

4.1 Strengths of the Current Study

To our knowledge, the current study was the first study to date to assess emotion regulation, stressful life events, and perceived stress in a sample of marijuana users. The inclusion of both stressful life events and perceived stress has allowed us to make direct comparisons between different aspects of stress, which has shown that these aspects do indeed relate to problematic marijuana use differentially. Moreover, to the best of our knowledge, the current study was the first to assess individual differences in emotion regulation as a moderator for the relationships between stressful life events and problematic marijuana use and perceived stress and problematic marijuana use. Furthermore, we assessed problematic marijuana use as a primary variable of interest, instead of frequency or quantity of use. Interestingly, past 30-day marijuana use was not a significant predictor of problematic marijuana use in any of our hierarchical regression models, which suggests that frequency of use may not accurately reflect problematic use, and thus may not be as informative of an indicator when measuring outcomes, such as mental health. Finally, we were able to collect a large, diverse sample of US adults 18 years and older, which allows our results to generalize to all types of marijuana users (i.e. infrequent users, frequent users, heavy users, etc.).

4.2 Limitations and Future Directions

There are several limitations to this study design. As this study is a cross-sectional, observational study, there was no way of addressing the directionality of potential relationships between emotion regulation, stress, and adult marijuana use. Research has found that marijuana use may be associated with a dysregulated hypothalamic-pituitary-adrenal axis (Cservenka et al., 2018); thus, there is the possibility that marijuana use may impact stress levels, which opposes the current study's hypothesis of greater stress being a risk factor for problematic marijuana use. In attempt to address bidirectionality of effects, predictor and outcome variables were reversed in our main models, and results do suggest bidirectionality of effects. Longitudinal and experimental designs would better be able to address the question of causality.

Additionally, the study was only able to assess difficulties in self-reported emotion regulation, which may be influenced by an individual's willingness and/or ability to accurately report on emotional responses (McKay, 2008). The use of both behavioral and self-report measures of emotion regulation in the same study may provide a more accurate and comprehensive assessment of this complex and multi-faceted construct (McHugh et al., 2011). Moreover, it is possible that there is construct overlap between the scales used for the primary variables. For example, the Holmes-Rahe Life Stress Inventory has "Fired at work" as an item, while the Marijuana Problem Scale has "To lose a job" as a problem related to

marijuana use. Using more objective measures, such as behavioral measures of emotion regulation and biological measures of stress would help minimize such an issue.

Further, future studies may consider using a more comprehensive stressful life events inventory that also assesses the perceived characteristics of those stressful life events, such as the new measure, the Event Characteristics Questionnaire, given that individuals may experience the same event differently and these characteristics may differentially relate to health outcomes (Luhmann et al., 2020). In this way, researchers can better understand what characteristics of stressful life events may be most related to or predict problematic marijuana use. Future studies could also consider assessing biomarkers of stress in response to a stress-evoking task in a laboratory setting to determine how physiological stress response may relate to problematic marijuana use. Thus, the results from the current study can help inform future longitudinal and experimental studies that may be interested in implementing a task-based measure of emotion regulation and physiological measures of stress.

Other avenues of future research include examining sex as a moderating role on the relationship between emotion regulation, stress, and problematic marijuana use. The current study found significant group differences for problematic marijuana use between males and females, such that males exhibited approximately two times the amount of problems as females, on average. Because sex differences in emotion regulation have been

found, future studies could examine if sex moderates the relationship found between emotion regulation and problematic marijuana use (McRae et al., 2008; Nolen-Hoeksema & Aldao, 2011; Zimmermann & Iwanski, 2014). Finally, future research could investigate whether different facets of emotion regulation are related to problematic marijuana use or moderate the relationship between stress and problematic marijuana use to more fully grasp the extent to which emotion regulation contributes to these processes.

4.3 Conclusions

In summary, the current study found more stressful life events and greater difficulties in emotion regulation to be predictors of experiencing more problematic marijuana use, while less perceived stress predicted more problematic marijuana use in those with greater difficulties in emotion regulation. Individual differences in emotion regulation moderated the relationship between stress and problematic marijuana use, such that as individuals experience more emotion dysregulation, the positive effect of stressful life events on problematic marijuana use strengthens, while the negative relationship between perceived stress and problematic marijuana use strengthens. Further, problematic marijuana use predicted more stressful life events and less perceived stress, but only in those higher in emotion dysregulation. These findings highlight the importance of examining both emotion regulation and stress and comparing different aspects of stress in relation to marijuana-use outcomes. Moreover, the current study demonstrates

the moderating role of emotion regulation in the relationship between stress and problematic marijuana use. Thus, treatment and intervention efforts could benefit from focusing on teaching adaptive emotion regulation strategies and stress-management techniques to marijuana users seeking to get help for their marijuana use.

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6. Appendices

Appendix A. Demographic Questionnaire

1. What is your age in years?

2. What is your biological sex?
> Male
> Female
> Other

3. Do you consider yourself to be Spanish/Hispanic/Latinx?
> Hispanic or Latinx
> Not Hispanic or Latinx
> Unknown

4. What is your race?
> American Indian/Alaska Native
> Asian
> Native Hawaiian/Other Pacific Islander
> Black or African American
> White
> More than one race
> Unknown
> Other

5. What is your estimated household annual gross income?
> $0
> $0-$5,000
> $5,000-$10,000
> $10,000-$50,000
> $50,000-$75,000
> $75,000-$100,000
> >$100,000

6. What is your highest level of education?
> some high school, no diploma
> high school diploma or GED
> trade/technical/vocational training
> some college
> associate's degree
> bachelor's degree
> some graduate school graduate school or professional degree (e.g. PhD, MD, JD)

Appendix B. Past 30-Day Substance Use Questions

1. Approximately how many days of the past month did you use cannabis?

2. Approximately how many drinks did you have in the past 30 days?

3. During the past 30 days, how many cigarettes did you smoke?

4. During the past 30 days, on how many days have you used an electronic nicotine product, even one or two times? (Electronic nicotine products include e-cigarettes, vape pens, personal vaporizers and mods, e-cigars, e-pipes, e-hookahs, Juul, and hookah pens).

Appendix C. Standard Alcoholic Drink Visual Aide

| 12 fl oz of regular beer | = | 8–9 fl oz of malt liquor (shown in a 12 oz glass) | = | 5 fl oz of table wine | = | 1.5 fl oz shot of 80-proof distilled spirits (gin, rum, tequila, vodka, whiskey, etc.) |

about 5% alcohol — about 7% alcohol — about 12% alcohol — 40% alcohol

The percent of "pure" alcohol, expressed here as alcohol by volume (alc/vol), varies by beverage.