Examining the influence of a negative affect induction task on self-reported cannabis use, expectancies, and problems

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Examining the Influence of a Negative Affect Induction Task on Self-Reported Cannabis Use, Expectancies, and Problems

by

Brianna R. Altman

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ABSTRACT

Substance use disorders and affective disturbances often covary. One commonly endorsed expectancy for substance use is stress relief, and using substances to cope with negative affect (NA) often covaries with greater use and problems. While strong evidence of these relations exists, NA might bias reporting of substance use due to hindered recall processes. This hypothesis warrants further research, as accurate reporting of substance-related variables is crucial in both research and treatment settings. The present study examined the influence of NA on reporting of cannabis variables using an affect-induction paradigm. Over 1,000 individuals recruited from Amazon’s MTurk participated. After reporting demographics and baseline affect, participants were randomly assigned to either a NA induction or control condition. Follow-up measures assessed post-induction affect, cannabis use, and distress tolerance (DT). Results revealed that the NA induction task significantly increased NA and decreased positive affect relative to the control condition. Participants assigned to the NA induction reported greater negative cannabis expectancies and more cannabis problems. Similarly, those with greater NA across both induction conditions reported higher average intoxication, as well as greater negative expectancies and more problems. Cannabis use and cannabis problems appeared positively related. We also found a significant moderating crossover effect of DT, such that at high levels of NA, those higher in DT reported more cannabis problems than those low in DT. These results partially support the hypothesis that NA can influence reporting of cannabis-related variables. These results also corroborate extant findings that significant positive relations exist between cannabis use and cannabis problems, as well as that DT appears to influence the link between NA and cannabis problems. Future research should continue to assess for the influence of NA in reporting of cannabis variables and focus on increasing DT to mitigate cannabis problems.
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Chapter 1: Introduction

Cannabis is the most commonly consumed illicit substance in the United States. In 2018, nearly 44 million Americans over the age of 12 reported using cannabis in the past year (Substance Abuse and Mental Health Services Administration [SAMHSA], 2019). Among these individuals, 27.7 million Americans endorse using cannabis in the past month (SAMHSA, 2019). Use of these substances is especially prevalent among emerging adults, with 35% of individuals 18 to 25 reporting cannabis consumption in the past year (SAHMSA, 2019). Perhaps this high prevalence rate is due to easier access to substances and increased social pressures on college campuses (Welsh et al., 2019). Similarly, greater movement towards cannabis legalization might make cannabis more accessible to all while decreasing perception of harms, potentially contributing to high rates of use (Hall & Weier, 2015; Parnes et al., 2018).

Although infrequent use is unlikely to be problematic, chronic use or consuming large quantities of cannabis frequently can lead to negative consequences. According to an epidemiological study of criteria for Cannabis Use Disorder (CUD) from the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) over 19.5% of lifetime cannabis users met diagnostic criteria for CUD, with 23% classifying as severe (American Psychological Association [APA], 2013; Hasin et al., 2016). Some individuals hold the perception that cannabis has less potential for addiction than other substances, such as alcohol and prescription medications (Lau et al., 2015). This work might be supported by research which finds that medical cannabis products are typically safe for treating a range of physical and mental health conditions; nevertheless, potential for mild adverse effects, including nausea, dizziness, and headaches exists (Hill, 2015; Koppel et al., 2014; Schleider et al., 2019; Steele et al., 2019; Ware et al., 2015). Problematic use of cannabis can increase one’s risk of dependence or tolerance,
produce respiratory and memory problems, and exacerbate psychopathology (Colizzi & Bhattacharyya, 2018; Hall & Degenhardt, 2009; Memedovich et al., 2018). Simultaneously, the production and distribution of newer cannabis products with greater potencies, such as edibles and dab pens, might contribute to the proliferation of negative outcomes for some users (Chu, 2014; Downey & Verster, 2014; MacCoun & Mello, 2015). The potential for negative consequences associated with cannabis use calls for an examination of consumption patterns to identify and rectify risky cannabis-related behaviors.

Individuals who cannabis use to alter their affective states might be at increased risk of experiencing cannabis-related consequences. Results of a daily diary study demonstrate that during negative affective states, individuals are more likely to use cannabis (Lex et al., 1989). In a study of medical cannabis users, 58% and 50% of participants reported using cannabis to alleviate anxiety and depression, respectively (Sexton et al., 2016). Prior work also reveals high rates of comorbidity between major depressive disorder (MDD) and CUD, such that approximately 20% of men and 36% of women meet criteria for both diagnoses during a 12-month timeframe (Kerridge et al., 2018). When experiencing negative affective states, especially depression, individuals might turn to cannabis to cope with distress; using cannabis for such purposes is associated with increased frequency of use and greater cannabis-related impairment (Hartmann & McLeish, 2020; Moitra et al., 2015). Still, other research suggests that excessive use of cannabis can increase the likelihood of developing affective disturbances or exacerbate preexisting mood conditions (Bahorik et al., 2017). These relations are not necessarily universal and might rely upon individual factors, such as expectancies about cannabis or distress tolerance abilities. Further examination of affect as it relates to self-reported cannabis use, expectancies, and experiences of problems is necessary, as literature demonstrates that affective states can
influence cognitive processes, including attention, information processing, and memories (Beck, 1967). As a result, individuals might unintentionally misrepresent their self-reported experiences based on biased recall processes when experiencing negative affect; thus, reports of cannabis intake and problems during negative affect might not be wholly accurate. A better comprehension of how negative affect influences reporting of substance use behaviors might inspire researchers and clinicians to be more cautious in their interpretations of assessments and subsequent recommendations.

Chapter 2: Background

Assessing Problematic Cannabis Use

Assessing problematic cannabis use is complicated for several reasons. Presently, most studies examining cannabis use and related problems employ self-report methods. While convenient and face-valid, self-report assessments are subject to biased responding, potentially due to social desirability, problems with question wording and response scales, and difficulties with recall (Carroll, 1995; Richter & Johnson, 2001). Moreover, due to the lack of standardized doses, differences in product potencies, limits on individuals’ estimation abilities, and variations in administration methods, results of self-report questionnaires might not be accurate (Asbridge et al., 2014; Freeman & Lorenzetti, 2020; Prince et al., 2018; van der Pol et al., 2013). Despite these caveats, researchers and clinicians continue to use self-report questionnaires to guide assessment of problematic cannabis use.

Presently, the DSM-5 defines CUD as “a problematic pattern of cannabis use leading to clinically significant impairment or distress … occurring within a 12-month period” (APA, 2013). Symptoms of CUD include using more cannabis than originally desired, failing to meet important obligations across several domains, tolerance (i.e. an individual’s reduced reaction to a
substance after continued use), and withdrawal (i.e. an emergence of symptoms related to the discontinuation of a substance), among several other indicators (APA, 2013). Approximately 20% of lifetime cannabis users will progress to meet diagnostic criteria for CUD, with males at increased likelihood for diagnosis (APA, 2013; Hasin et al., 2016). CUD is often comorbid with other psychopathology, including anxiety disorders, mood disorders, personality disorders and other substance use disorders (Kerridge et al., 2018). Moreover, CUD is associated with a host of negative sequelae, including academic and occupational impairment, interpersonal dysfunction, health concerns, and other adverse consequences, deeming rapid identification and treatment imperative (Hall & Degenhardt, 2009; Memedovich et al., 2018; Volkow et al., 2014).

Several instruments exist for screening and assessing the presence and severity of CUD (Stoner, 2016). Researchers and clinicians might use structured or semi-structured interviews, such as the Structured Clinical Interview for DSM Disorders-5 (SCID-5; First et al., 2015) or the MINI International Neuropsychiatric Interview (MINI; Sheehan et al., 2015) to diagnose CUD, cannabis abuse, and/or cannabis dependence as part of a larger diagnostic interview. Assessors might also opt for instruments specific to cannabis use, such as the Severity of Dependence Scale (SDS; van der Pol et al., 2013), the Cannabis Abuse Screening Test (CAST; Legleye et al., 2012), or the Cannabis Use Disorders Identification Test-Revised (CUDIT-R; Adamson et al., 2010). These measures focus on frequency of cannabis consumption and dependence severity. Each of these measures also provides cut-off scores for identifying CUD.

Other assessments of cannabis use capture specific problems experienced by cannabis users. For example, the Marijuana Problems Scale (MPS; Stephens et al., 1994, 2000) assesses the extent to which one experiences cannabis-induced consequences across several domains (i.e. occupational, interpersonal, medical) over the past 90 days. An adapted version of the MPS
named the Cannabis-Associated Problems Questionnaire (CAPQ; Lavender et al., 2008) allows users to report on lifetime cannabis-related problems, while indicating both the frequency and severity of such outcomes. The Marijuana Consequences Questionnaire (MACQ; Simons et al., 2012) also examines more specific negative outcomes associated with using cannabis, such as engaging in risky behaviors, experiencing blackouts, and neglecting regular self-care. Instruments such as these typically do not offer specified cut-off scores; rather, these measures are more appropriate for monitoring an individual’s level of impairment. Further, specific item endorsements can be used to inform harm reduction interventions. For example, individuals who endorse items related to occupational and academic consequences might benefit from interventions that target timing of use and quantity of consumption to mitigate the potential for cannabis use to negatively impact these responsibilities. Administering assessments to both diagnose CUD and understand specific cannabis-related problems might be especially useful for tailoring interventions to meet individuals’ specific needs, especially given that not all cannabis use is necessarily problematic.

Examinations of relations between cannabis use and cannabis problems reveal mixed findings. A recent-meta analysis indicates a moderate positive correlation between measures of cannabis use and cannabis problems, as assessed by common measures of cannabis-related negative outcomes, such as the Marijuana Problems Scale (MPS) and the Marijuana Consequences Questionnaire (MACQ; r = .367; Pearson, 2019). Thus, greater frequencies and quantities of cannabis use appear to covary with increased negative outcomes, such as interpersonal conflict, academic or occupational impairment, and psychological harms. Other work fails to find significant relations between frequent cannabis use and experiences of cannabis-related impairment, especially if users do not meet criteria for dependence (Asbridge et
al., 2014; Looby & Earleywine, 2007; Zeisser et al., 2012). Not all who use cannabis do so for the same reasons and, as such, users might experience different cannabis-related outcomes (Miller & Plant, 2002). Differing use patterns might also be due to anticipated beliefs about the effects of cannabis, which might play a role in subsequent cannabis-related outcomes. Positive expectancies about cannabis (e.g. tension reduction, coping) appear to correlate with cannabis problems in at least some studies, (Hides et al., 2008; Johnson et al., 2010). Negative expectancies (e.g. impairment, adverse behavioral effects) often covary with limited use or abstinence (Torrealday et al., 2008; Schafer & Brown, 1991), but have also been linked with more severe dependence (Connor et al., 2011). These somewhat discrepant findings suggest that while these relations are complex, perhaps there are confounds that prevent a comprehensive understanding of these associations.

Assessments of cannabis use problems are not perfect. The failure to consistently find significant relations between indices of cannabis use, expectancies, and experiences of cannabis problems raises vital questions. Are frequency and quantity of cannabis use truly unrelated to expectancies and problems? Are individuals misrepresenting their experiences with cannabis? Self-report measures facilitate both intentional and unintentional biased responding, whereby individuals misrepresent problems as less severe than reality or are unable to accurately assess their own impairment. Moreover, are existing assessments accurately capturing the consequences experienced by cannabis users? To this point, some work highlights that assessments of cannabis use problems and cut-off scores might not be robust across different types of cannabis users (Hartman et al., 2008; Piontek et al., 2008). The systematic review of brief cannabis problems measures conducted by Piontek and colleagues (2008) reveals that diagnostic cut-offs specific to certain populations should be generated to avoid making sweeping generalizations across
potentially dissimilar groups of people. Ultimately, measures of cannabis use problems should attempt to balance the need for generalizations across large groups of people while also being specific to the population being studied, as well as be optimally resistant to biased responding.

Examining the Role of Affect in Cannabis Use

For the purposes of the present work, we define affect as a comprehensive term that captures both short-term emotional reactions to stimuli, as well as longer duration mood states that are not stimuli-specific (Ekman, 1994; Gross, 2010). Individuals might use cannabis to enhance positive affect or alleviate negative affect. For some, cannabis might increase short-term enjoyment and enhance social situations; thus, these individuals might be motivated to use cannabis to achieve enhancement of positive affective states (Lee et al., 2009; Simons et al., 1998). Alternatively, given purported tension reduction abilities, individuals might use cannabis to cope with or alleviate negative affective states, including anxiety, stress, and depression (Buckner et al., 2015; Hathaway, 2003; Ogborne et al., 2003). Those who report greater coping or relaxation motives appear to use cannabis more frequently and experience higher rates of cannabis dependence and problems (Bonar et al., 2017; Blevins et al., 2016; Chabrol et al., 2004; Moitra et al., 2015; Simons et al., 1998). One study found that during episodes of cannabis use, greater negative affect was associated with greater reports of coping motives compared to when negative affect was lower (β=.06; Buckner et al., 2015). Perhaps as individuals experience more negative affect, they are less able to access other non-substance coping strategies, such as practicing mindfulness or recruiting social support, due to cognitive overload. Alternatively, during cannabis use episodes, as negative affect potentially decreases (Buckner et al., 2015), individuals might be more acutely aware of cannabis’ potential to downregulate negative emotions. Both of these hypotheses warrant further empirical validation. As coping motives for
cannabis use decrease, cannabis use and related problems appear to diminish in tandem (Banes et al., 2014). This result might inspire clinicians to target cannabis motives when helping individuals reduce their use or decrease experiences of cannabis-related problems.

Expectancies about the effects of cannabis might also play a role in whether individuals use cannabis when they experience varying affective states. Substance use expectancies are defined as beliefs about the effects of substances (Brown, 1993; Goldman et al., 1999). These cognitive representations differ from substance use motives, as they are less specific and can be held by non-users (Hecimovic et al., 2013; Kuntsche et al., 2010). Typically, positive expectancies about the effects of cannabis covary with increased frequency and quantity of use while negative expectancies relate to reduced use or abstinence (Connor et al., 2011; Schafer & Brown, 1991). When individuals experience negative affective states, they might turn to cannabis to alter their affect if they expect that cannabis can produce improvement. Prior work reveals small to moderate correlations between relaxation and tension reduction expectancies and heightened frequency ($r = 0.32$) and severity of cannabis use ($r = 0.28$), as indicated by endorsement of DSM-IV cannabis abuse or dependence criteria (Hayaki et al., 2010).

Furthermore, certain people might be at increased risk for cannabis use and related problems, regardless of their motives or expectancies. Individuals with a history of mental health diagnoses report using cannabis at higher rates than those without any psychiatric diagnoses (Lev-Ran et al., 2013). Anxiety and mood disturbances are often comorbid with CUD and cannabis dependence (Agosti et al., 2002). Longitudinal studies of associations between psychiatric diagnoses and cannabis use are generally mixed and appear to be plagued with methodological flaws (Lev-Ran et al., 2013; Womack et al., 2016). MDD, a diagnosis characterized by low mood, diminished interest in previously enjoyed activities, and changes in a
host of behavioral symptoms (e.g. diet, exercise, sleep), appears related to CUD (APA, 2013; Degenhardt et al., 2012; Lucatch et al., 2018). Still, other work fails to find meaningful differences in rates of MDD between cannabis users and non-users (Feingold et al., 2015; Manrique et al., 2012). While directionality of associations remain unclear, some work reports that chronic and/or heavy use of cannabis, or using cannabis to cope with distress, can exacerbate affective disturbances (Cuttler et al., 2018; Moitra et al., 2015). Notably, these changes in affect are not permanent. In fact, in a study of over 300 female emerging adults, reducing cannabis use covaried with reduced depression symptoms among those with mild ($\beta = -0.26$) and moderate to severe ($\beta = -0.50$) depression (Moitra et al., 2016). Similarly, in a randomized, double-blind, placebo-controlled trial of a medication ($N$-acetylcysteine) for individuals with CUD, decreases in cannabis use predicted improvements in depression, anxiety, and sleep problems (Hser et al., 2017). While a majority of evidence suggests a link between cannabis use and diagnostic affective disturbances, further work is needed to confirm and understand these associations.

In addition to longer standing affective disturbances, momentary negative affect also appears related to cannabis use. In a study of adolescents and young adult cannabis users, negative affect appeared significantly elevated moments prior to cannabis use compared to other times throughout the day (Shrier et al., 2014). In contrast, no changes in positive affect were observed in times preceding cannabis use. A more recent study corroborated this result by revealing that adults were more likely to use cannabis on mornings where their positive affect was lower than typical levels ($\beta = -0.197$; Testa et al., 2019). Interestingly, this effect did not hold for experiences of hostile nor anxious mood, suggesting that perhaps this effect is specific to certain types of affective states. After using cannabis, individuals reported increased positive affect and decreased negative affect, suggesting that cannabis might be used to regulate affect.
Evidence exists for both the psychological and biological effects of cannabis on affective states. Data suggest that delta$^9$-tetrahydrocannabinol (THC), among other cannabinoids, exhibits anti-depressant effects across several animal models (El-Alfy et al., 2010; Sales et al., 2018; Silote et al., 2019; Zanelati et al., 2010). Nevertheless, limited work explores the effects of cannabinoids in humans, calling for continued attention. In humans, some work reveals a dose-dependent effect of THC, where smaller doses (7.5mg) decreased self-reported distress related to the Trier Social Stress Test (TSST), and larger doses (12.5mg) appeared to have small but significant effects on increased negative affectivity (Childs et al., 2017). Variations in product compositions might influence reported effects. Recent work using Strainprint, a device that allows individuals to self-report on the effects of various strains of medical cannabis, finds that individuals report different effects based on levels of THC, the psychoactive component of the cannabis plant, and cannabidiol (CBD), the non-intoxicating element of cannabis, in products (Cuttler et al., 2018). Individuals believe low THC/high CBD products to be useful in alleviating depression symptoms while high THC/high CBD products appear to aid in decreasing stress symptoms (Cuttler et al., 2018). While more work is certainly needed, these preliminary findings suggest that cannabis might alleviate or exacerbate depression on both a biological and psychological level, perhaps dependent upon THC/CBD composition of cannabis products. These data might also inform individuals’ beliefs about cannabis and, thus, their subsequent consumption patterns.

Several theories might explain why individuals use cannabis more frequently during negative affective states. The self-medication hypothesis suggests that individuals experiencing distress might attempt to alleviate symptoms through substance use (Khantzian, 1985). When experiencing negative affect, individuals might use cannabis to mitigate their emotional distress,
potentially due to the plant’s purported tension-reduction and relaxation effects. Among individuals in states with medical marijuana laws, those with mood or anxiety disorders report self-medicating with cannabis nearly two times more than individuals living in non-medical states (Sarvet et al., 2018). Self-medication with substances is also associated with greater severity of substances problems. In a large, nationally representative sample of adults within the United States, self-medication among individuals with mood disorders increased the longitudinal risk of new-onset substance dependence, as measured by the DSM-IV-TR, three years later (AOR: 7.65; Lazareck et al., 2012). Similarly, among those with both a mood disorder and a substance use disorder at baseline, self-medication covaried with the persistence of abuse after three years (AOR = 2.47). Among this sample of individuals with mood disorders, cannabis use at baseline was highly prevalent (94% reported lifetime use, while 65% reported past year use); three years later, rates of cannabis dependence were high, with 43.7% of participants meeting dependence criteria, trailing only behind opiate dependence (44.7%; Lazareck et al., 2012). Other work reveals similar cannabis-specific findings, whereby individuals who self-medicate negative affect with cannabis are more likely to experience cannabis-induced consequences (Blevins et al., 2016; Moitra et al., 2015). Still, some data fail to find evidence of anxiolytic or antidepressant effects of cannabis, calling for further verification of the self-medication hypothesis (Tournier et al., 2003; Ross et al., 2018). Moreover, other research denies the claim that individuals self-medicate their affective disturbances with cannabis; thus, more work is needed to understand the mechanisms involved in cannabis self-medication (Arendt et al., 2007).

Taken together, prior research indicates significant relations between experiences of negative affect and cannabis use, although directionality of such relations remain undetermined. These relations might be based in biology due to the psychopharmacological components of
cannabis, or due to psychological factors. Individuals who report higher negative affectivity, or even clinical depression, might use cannabis as a means of regulating difficult or unwanted negative emotions. Given these findings, continued work is necessary to better understand these complex associations to inform prevention and intervention efforts.

**Affect Inductions and Cannabis Use**

One potential way to increase understanding of these links is through experimental research. Affect induction tasks are often implemented in psychological research to experimentally manipulate participants’ affective states (Kučera & Haviger, 2012; Martin, 1990). Using such strategies allows researchers to examine correlates of affective states in controlled environments. Comparisons of induced affect can be achieved either within-subjects, using measures of change between pre-induction and post-induction affect, or between-subjects, examining changes in a targeted affective state between those exposed to the manipulation and those not (Martin, 1990). Generally, research indicates that affect manipulation procedures have success in inducing the anticipated affective state 50-75% of the time (Martin, 1990; Westermann et al., 1996). Nevertheless, recent work calls for a more standardized definition of what it means for an individual to “respond” to an affect induction, after finding that nearly 20% of their sample did not respond to their experimental affect-induction procedure (Rottenberg et al., 2018). Through experimental affect manipulations, researchers can induce various affective states, including fear, anger, happiness, and sadness (Siedlecka & Dension, 2018). Such experimental paradigms can be particularly informative for studying causal relationships between variables in controlled environments.

Several options exist for employing affect inductions in laboratory settings. The most commonly used method is the Velten procedure, where participants are instructed to read elated
and depressed self-referential statements and encouraged to attempt to experience the requested affective state (Velten, 1968). Another regularly utilized option is the autobiographical emotional memory test, where participants are asked to remember a personally-experienced event that is consistent with a specific affective state, and in some instances, to write about the memory (Goritz & Moser, 2003; Mills & D’Mello, 2014). Other examples of affect induction procedures include watching film scenes consistent with particular affective states, reading stories designed to evoke specific emotions, or listening to music or jokes identified to induce desired mood (Joseph et al., 2020). Of note, these different affective induction tasks can be designed to induce specific emotional states, including happiness, sadness, anger, and anxiety. As it pertains to this study, only inductions producing negative affective states (e.g. sadness, anxiety) and their influence on substance use behaviors will be reviewed.

Several studies examine the influence of negative affect inductions on substance use outcomes. For instance, one study examined the influence of a negative affect induction on individuals’ consumption of non-alcoholic beer in a laboratory setting (Randall & Cox, 2001). Results demonstrated that individuals with a family history of alcohol problems experienced greater negative affectivity after the induction and consumed more non-alcoholic beer. Other work reports similar findings, with affect inductions heightening individuals’ experiences of negative affect and increasing alcohol-related variables (e.g. cravings, expectancies, use, etc.) for both those in treatment for alcohol problems and recreational alcohol users (Cooney et al., 1997; Cyders et al., 2016; Hufford, 2001). A recent meta-analysis suggests that experimentally manipulating negative affect heightens individuals’ craving for (Cohen’s $d = 0.39$) and use of (Cohen’s $d = 0.31$) alcohol (Bresin et al., 2018). These findings corroborate previous work
suggesting that individuals might be motivated to consume greater amounts of alcohol to
downregulate negative affectivity (Patrick et al., 2011).

Other work has focused on cigarettes and opiates. Among a sample of cigarette smokers,
a negative affect induction significantly increased tobacco-seeking among individuals with
depression compared to participants without depression (Hogarth et al., 2017). More recently, in
a study of 47 heroin users compared to 25 control participants, a negative affect induction task
revealed increased heroin-seeking among heroin users compared to control participants (Hogarth
et al., 2019). This effect appeared related to using heroin to cope with negative affect, as well as
with affective reactivity.

Despite some distinct motives for using one substance over another, data suggest
substantial overlap among substance use behaviors. Specifically, for alcohol and cannabis,
overlapping motives include coping, social enhancement, and calming effects (Patrick et al.,
2018; Simons et al., 2000). Further, among dual users, coping motives more strongly predict
cannabis use than alcohol use (Skalisky et al., 2019). For these reasons, studies that examine the
influence of negative affect inductions on cannabis-related variables are imperative;
nevertheless, a dearth of literature exists on the topic. To the best of this author’s knowledge,
only two studies use negative affect induction paradigms to examine their effects on cannabis-
related variables. A doctoral dissertation examined the combined influence of a negative affect
induction and emotional urgency on reports of cannabis craving (De Leo, 2013). In this study,
participants completed either a positive, negative, or neutral affect induction that involved
reading a story script and evaluating the valence of words from the story text. Afterwards,
participants were instructed to report their current craving for cannabis after being exposed to
cannabis-related pictures. Study findings revealed that the affect induction task was successful at
producing expected changes in affect (i.e. increasing negative affect for those exposed to the negative affect induction task). Although none of the interaction terms (i.e. affect condition x impulsivity measures) were significant predictors of cannabis cravings, several methodological limitations, including weaknesses in the affect induction task, might account for these null findings. A second study examines the influence of a social anxiety induction on cannabis craving among individuals with and without social anxiety disorder (SAD) (Buckner et al., 2011). Individuals with and without SAD were assigned to either complete a public speaking task (experimental condition) or reading task (control condition) and complete several questionnaires related to cannabis craving, cannabis use, social anxiety, and other measures of substance use. Results of the study revealed that for both women and participants with SAD, the speech task induced greater cannabis craving than the reading task (Cohen’s $d$’s = 2.88 and 1.66, respectively). No such effect was noted for men or individuals without SAD (Buckner et al., 2011). The results of this work suggest that an experimental anxiety induction can lead to greater cannabis craving, but perhaps only for certain individuals.

Despite the null findings of De Leo (2013), new experimental research in this area is needed to better elucidate directional relations between affective disturbances and cannabis-related variables. Based upon the extant alcohol literature and the findings of Buckner and colleagues (2011), it seems reasonable that negative affect induction tasks might increase individuals’ desires for, use of, and problems associated with cannabis. Nevertheless, choosing the right manipulations, recruiting large enough samples, and measuring all relevant covariates might prove crucial to these studies. Future work might consider looking at alternative correlates of these relations to improve the prediction of cannabis-related variables.

Relations between Affect and Self-Report Bias
While data confirm true links between negative affect and cannabis use, affect might also play an influential role in individuals’ endorsements of cannabis use and related consequences. Affective states can influence cognitive processes, including individuals’ abilities to sustain attention, process information, and encode and recall memories (Beck, 1967). Bower’s network theory of affect posits four important relations between affect and memory: “(a) memory is facilitated when mood state at learning matches mood state at recall, (b) material with affective tone that is congruent with current mood is most easily retrieved from memory, (c) material with affective tone that is congruent with current mood is most easily learned, and (d) affectively intense material is learned best” (Bower, 1981; Singer & Salovey, 1988). Further, network theories of affect propose connected pathways between knowledge nodes and emotion nodes in the brain; these pathways promote “reciprocal” activation, such that if a knowledge node is stimulated, the connected emotion node will be stimulated as well (Mills & D’Mello, 2014).

Consistent with network theories of affect, evidence suggests the existence of affect-congruent memory effects, whereby individuals are more likely to remember information that matches their current affective state (Blaney, 1986; Bower, 1981; Loeffler et al., 2013). A meta-analysis suggests that depressed individuals tend to better remember negative information, while non-depressed individuals are more likely to recall positive information (Peckham et al., 2010). Even experiences of momentary negative affect appear to bias recall processes (Chepenik et al., 2007; Natale & Hantas, 1982). Still, not all studies generate consistent findings, as some work suggests no differences in memory recall between those with depression and those without (Hasher et al., 1985). Other work points to the idea that individuals in negative affective states might attempt to repair their affect by recalling positive memories instead (Rusting & DeHart, 2000). Nevertheless, this combination of cognitive theory and empirical work suggest that affect

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has the potential to alter one’s memory. This finding is especially problematic if it leads to inaccuracies in reporting on psychological measures.

Experimentally manipulating affect in the laboratory provides additional support for evidence of affect-congruent biases. Many laboratory-based affect-induction tasks, including the commonly employed Autobiographical Emotional Memory Task (AEMT), are grounded in network theories of affect, suggesting that activation of affect nodes in the brain might subsequently trigger activation of knowledge nodes (Bower, 1981; Mills & D’Mello, 2014). In one study, during experimentally manipulated negative affective states, participants took longer to remember happy memories compared to sad memories (Teasdale & Fogarty, 1979). Subsequent work reveals similar findings (Teasdale & Taylor, 1981; Teasdale & Russell, 1983). Such recall biases might translate to inaccurate reporting on psychological measures. For instance, one study found that inducing negative affect among female undergraduate students led to increases in reports of lifetime depression and dysthymia symptoms when compared to those in the happy affect induction (Goodwin & Sher, 1993). Similarly, in a study of college-aged women, those with high body dysmorphia who received a negative affect induction reported increased body size estimation and heightened body dysmorphia post-induction than those assigned to receive a neutral mood induction (Baker et al., 1995). Such work calls into question how negative affect inductions might influence other psychologically-relevant constructs.

Very few studies have examined the influence of affect on reports of substance-related variables. One study examined relations between affect and reports of positive alcohol expectancies using both correlational and experimental procedures (Hufford, 2001). First, using naturally occurring affect, findings demonstrated that experiences of negative affect covaried with greater endorsement of positive alcohol expectancies ($r = 0.31$). Furthermore, after
experimentally manipulating affect through a negative affect induction, exposed participants endorsed more positive global effects of alcohol as well as more tension reduction and relaxation expectancies (Hufford, 2001). Given that holding such positive expectancies relates to experiences of alcohol-induced negative consequences, the finding that affect influences individuals’ endorsements of positive alcohol expectancies is concerning (McBride et al., 2014; Pedersen et al., 2014). Subsequent work built upon these findings by demonstrating that the effects of affect manipulations on reports of alcohol expectancies might be differentially experienced based on ones’ motives for consuming alcohol (Birch et al., 2004). When exposed to a negative affect induction, only individuals who endorsed coping motives for alcohol use reported greater tension relief expectancies. Alternatively, when individuals who used alcohol for enhancement purposes were exposed to a positive affect induction, they reported higher reward expectancies. This finding suggests that while affect can bias reporting of alcohol expectancies, other variables might determine the extent of this effect. Although no work has examined changes in reported use and consequences variables after affect manipulations, these results highlight the potential for negative affect inductions to alter self-reports of substance use expectancies, which covary with problematic substance use.

**Linking Negative Affect and Cannabis Use Through Distress Intolerance**

One’s ability to abstain from problematic cannabis use when experiencing negative affect might depend on several factors, including one’s level of social support, repertoire of adaptive coping strategies, and capacity to tolerate distress. Distress tolerance refers to an individual’s ability to “experience and withstand challenging negative psychological states (Simons & Gaher, 2005).” Those with lower levels of distress tolerance might be unable to endure difficult
emotions; as a result, these individuals might actively seek out ways to alter these feelings (Bliesner, 2010).

Individuals who are intolerant of distress might turn to substance use to modulate emotional discomfort (Simons & Gaher, 2005). In fact, prior work reveals significant associations between distress intolerance and alcohol and cannabis motives, use, and related negative consequences (Buckner et al., 2007; Bujarski et al., 2012; Howell et al., 2010). Other work reveals gender differences in these relations, where depressed females, but not males, who consume substances and have low levels of distress tolerance also report higher rates of substance use problems (Ali et al., 2015). Distress tolerance also appears to moderate the relation between depression symptoms and problematic alcohol use, with a significant relation between depression and alcohol problems only appearing for those low in distress tolerance (Gorka et al., 2012). Perhaps one’s experience of depressed mood need not necessarily relate to negative consequences of alcohol use; instead, this link might only exist for those who do not possess the skills to adequately withstand uncomfortable feelings (i.e. low distress tolerance).

Research also highlights links between distress intolerance and cannabis use (Buckner et al., 2007; Bujarski et al., 2012; Farris et al., 2016). Lower levels of distress tolerance appear to covary with greater coping motives for cannabis when experiencing negative mood states ($r = -0.29$; Peraza et al., 2019). Moreover, using cannabis for such purposes appears related to an increased propensity for cannabis-related problems, including greater withdrawal symptoms ($r = 0.40$) and more barriers to cessation ($r = 0.56$; Peraza et al., 2019). This finding raises the question of whether distress intolerance might be an indirect risk factor for negative cannabis-related outcomes. Several studies corroborate these moderate sized links between distress intolerance, coping motives for cannabis use, and cannabis-related problems (Buckner et al.,
2007; Farris et al., 2016). Although several studies examine relations between levels of distress tolerance, affect, and cannabis use variables, to this author’s knowledge, no studies have looked at whether distress intolerance might moderate the link between experimentally-manipulated negative affect and, reported or experienced, cannabis use or related problems.

On the one hand, high distress tolerance might act as a buffer against potential affect-related bias on self-report measures of cannabis-related variables. On the other hand, should distress tolerance be a significant mediator of associations between negative affect and cannabis outcomes, psychological interventions might focus on increasing distress tolerance to mitigate maladaptive use during negative affective states. Individuals low in distress tolerance might use cannabis in problematic ways when experiencing negative affective states, perhaps as a means of medicating their distress (via the self-medication hypothesis). Higher rates of distress tolerance might act as a buffer of the link between negative affect and cannabis problems, perhaps by increasing individuals’ capacities to withstand their negative emotions. Several studies support targeting distress intolerance during clinical interventions designed to reduce problematic substance use (Bornovalova et al., 2012; Brown et al., 2014; Reese et al., 2019).

The Current Study

Extant literature reveals relations between negative affect and cannabis use, although directionality is yet to be confirmed. A true phenomenon might occur whereby individuals experiencing negative affect use more cannabis, perhaps via a self-medication hypothesis or to avoid uncomfortable feelings. Greater use for such purposes might lead to more cannabis-related impairment. If this is the case, an individual’s capacity to tolerate distress might play a role in the link between experiences of negative affect and cannabis-related outcomes. Clinical interventions can then target increasing distress tolerance to buffer against cannabis problems.
Alternatively, negative affective states might bias recall processes, leading individuals to inaccurately over-report their prior experiences through a negatively-biased cognitive framework. Biased responding congruent with negative affective states might lead individuals to be unfairly referred to higher levels of care based on their self-reported experiences of problems. Should this be the case, researchers should consider the co-occurrence of affective disturbances and cannabis use when interpreting assessments of cannabis-related variables. Ultimately, more experimental work is needed to better disentangle the complicated associations between negative affect and cannabis use.

The present study is comprised of two parts. First, we conducted a pilot study to assess the feasibility and effectiveness of an online negative affect induction. Second, we used the negative affect induction task to examine the influence of induced negative affect on reports of cannabis use, expectancies, and problems among a sample of substance users. We recruited participants from Amazon’s MTurk platform. Participants were randomly assigned to receive either a negative affect induction condition (“write about a situation that was very sad or upsetting to you”) or a control condition (“list as many potential uses for a pen as possible”). After completing the experimental tasks, participants were asked to complete a subsequent measure of affect, measures related to their use of and beliefs about cannabis, and a brief distress tolerance instrument. The proposed work had the following hypotheses:

1) Individuals exposed to the negative affect induction task (experimental condition) will report greater negative affect and lower positive affect from pre- to post-task than those exposed to the control condition

2) Individuals in the experimental condition will report:
2.1) Greater cannabis use (frequency, quantity, average levels of intoxication) than those in the control condition

2.2) More positive cannabis expectancies (e.g. relaxation and tension reduction) than those in the control condition

2.3) Greater problems (as measured by both the CAPQ and CUDIT) than those in the control condition

3) Significant positive relations will exist between:

3.1) Reports of negative affect and cannabis use (e.g. frequency, quantity, average intoxication), cannabis expectancies (e.g. global negative effects, relaxation and tension reduction), and cannabis-induced problems (as measured by both the CAPQ and CUDIT)

3.2) Cannabis use (e.g. frequency, quantity, average intoxication), cannabis expectancies (e.g. global negative effects, tension reduction) and cannabis-induced problems (as measured by both the CAPQ and CUDIT)

4) Distress tolerance will serve as a moderator of

4.1) The relation between self-reported negative affect and substance use, such that the association between self-reported negative affect and use will be greater for individuals lower in distress tolerance

4.2) The relation between self-reported negative affect and substance use problems, such that the association between self-reported negative affect and cannabis problems will be greater for individuals lower in distress tolerance

Chapter 3: Methods

Pilot Study Procedure
We first conducted a pilot study to confirm the feasibility and effectiveness of the online negative affect induction using participants recruited from Amazon’s MTurk platform.

**Participants**

Only English speaking individuals over the age of 18 were considered eligible to participate in the study. Participants were recruited from Amazon’s MTurk platform. MTurk is a crowdsourcing platform regularly used to recruit representative samples of individuals for participation in paid research surveys. Upon meeting eligibility criteria and providing informed consent, participants completed a survey hosted on Qualtrics, an online survey platform. After providing demographic information and answering questions about current affect (I-PANAS-SF, as described below), participants were randomly assigned to receive either the experimental condition (negative affect induction task) or the control condition, both of which took five minutes to complete. Participants in both conditions then completed the same measure of affect (I-PANAS-SF) post-induction. Individuals who participated in the pilot study were not eligible for participation in the follow-up study. Participants were compensated with $0.10 for their participation. This pilot study received approval from the University at Albany Institutional Review Board.

**Main Study Procedure**

**Participants**

Participants were also recruited from Amazon’s MTurk platform. Individuals interested in participation read a brief description of the study. Those interested in participating were directed to the Qualtrics-hosted survey. Upon clicking the survey link, individuals were directed to the informed consent, which contained important information regarding study rationale, risks and benefits, and researcher contact information. Individuals were also informed of the presence of attention checks in the study; failure to correctly answer attention check questions resulted in
forfeiture of compensation. After reading the informed consent, individuals were asked to provide their agreement with the survey terms. Those who provided consent were then directed to three questions used to determine survey eligibility. Only individuals over the age of 18 and who endorsed lifetime use of both alcohol and cannabis were invited to complete the rest of the survey. Those who did not meet eligibility criteria were thanked for their time and directed to the end of the survey. Those who provided informed consent and met eligibility criteria, completed the 15-minute long survey, which included questions about participant demographics, a 5-minute long experimental task (negative affect induction or control condition), two measures of affect (one prior to the experimental task and one following the experimental task), a distress tolerance questionnaire, and items related to alcohol and cannabis use. Only the cannabis use variables were analyzed for the purposes of this study. Participants who successfully completed the survey were compensated $0.50 for their participation. Study procedures were approved by the University at Albany Institutional Review Board.

Affect Induction. Individuals were randomly assigned to receive either a negative affect induction or a control condition based on their date of birth. Those with even birth dates were assigned to complete an Autobiographic Emotional Memory Task, designed to induce a negative affective state (AEMT; Strack et al., 1985). This task has also been referred to as an Imagination Mood Induction Procedure (Westermann et al., 1996), Autobiographical Recall Procedure (Göritz & Moser, 2006), and/or a Directed Writing Task (Dunn & Schweitzer, 2005). Participants with even birthdates responded to the prompt, “Please take about 5 minutes to describe a situation that was very sad or upsetting for you. Describe it in such a way that a person reading the description would also become sad or upset just from hearing about the situation.” Previous work validates the use of such autobiographical writing tasks to induce negative moods.
(Westermann et al., 1996; Mills & D’Mello, 2014). Participants with odd birthdates responded to the prompt, “Please take about 5 minutes to describe in detail as many potential uses of a pen as you can. Describe the potential uses in such a way that a person reading your response would be able to understand them.” Participants in both conditions typed out responses to their assigned task and were not permitted to continue the survey until five minutes had elapsed. Additionally, participants in both conditions were required to provide a response with a minimum of 180 characters to ensure that they adequately responded to the prompt. Participant responses were reviewed to ensure that responses were original (i.e. not copied from other identifiable sources) and sufficiently addressed the assigned task. Participants whose responses did not sufficiently address the assigned task were excluded from analysis.

**Measures**

**Affect (Both in pilot and main study).** Both prior to and immediately following the experimental/control tasks, participants completed the International-Positive and Negative Affect Schedule-Short Form (I-PANAS-SF; Thompson, 2007). This 10-item measure asks participants to report on the extent to which they are presently experiencing positive (e.g. “inspired,” “alert,” “excited,” “enthusiastic,” and “determined”) and negative (e.g. “afraid,” “upset,” “nervous,” “scared,” and “distressed”) affective states. The response scale for items ranges from 1 (“Very slightly or not at all”) to 5 (“Extremely”). Individual items of the two subscales were summed to generate global “Positive” and “Negative” affect scores. Cronbach’s alpha was calculated for each administration of this measure; internal consistency values ranged from .824 to .841 across administrations, indicating strong internal reliability.

**Cannabis Use.** All participants recruited for the main study reported lifetime use of cannabis. Individuals first answered if they were current cannabis users (“Yes”/”No”) and reported the
number of days since their last use of cannabis. Next, participants reported the average number of days per week they consume cannabis (0-7), the number of times they consumed cannabis during the past week (for current users) or during an average week (for past users), quantity of cannabis consumed per month (ranging from “Less than 1/8 ounce” to “Greater than 2 ounces”), average intoxication during a typical use session (ranging from 0 (“Not at all”) to 7 (“Extremely”)), and the type of cannabis products participants typically consume (e.g. flower, dabs, edibles, etc.). For the purposes of data analysis, data from both current users and non-current-users were aggregated.

*Cannabis-Related Problems*. To assess individuals’ experiences of cannabis-induced consequences, participants completed both an adapted version of the Marijuana Problems Scale (MPS; Stephens et al., 1994, 2000), called the Cannabis-Associated Problems Questionnaire (CAPQ; Lavender et al., 2008) and the Cannabis Use Disorders Identification Test - Revised (CUDIT-R; Adamson & Sellman, 2003; Adamson et al., 2010). The CAPQ (Lavender et al., 2008) is a modified version of the 19-item MPS that allows participants to report on lifetime cannabis problems on a larger response scale to increase variance in participant responses. The CAPQ assesses cannabis-related consequences across interpersonal, occupational, medical, and psychological domains. Individuals are presented with the prompt, “Has cannabis ever caused you …?” and asked to endorse individual items on a scale from 0 (“No”) to 5 (“Yes, very many times or a serious problem.”) Items are summed to create a global index of cannabis-related problems. Cronbach’s alpha for this measure was .972. This measure can be found in its entirety in the appendix.

The CUDIT-R contains eight items which assess individuals’ use of cannabis and their experiences of related problems over the past six months (Adamson & Sellman, 2003; Adamson
et al., 2010). To be included in CUDIT-R analyses, participants had to endorse being current cannabis users and report that their last use of cannabis was within the past 180 days. The CUDIT-R was developed by adapting the Alcohol Use Disorders Identification Test for cannabis users (AUDIT; Adamson & Sellman, 2003). Items assess use (e.g. frequency, amount of time spent intoxicated per day), problems (e.g. inability to fulfill responsibilities, use cannabis in risky situations), and whether the individual has ever considered reducing their use. Seven of the eight items are scored on a scale from 0-4, with 0 indicating minimal impairment and 4 indicating substantial impairment. The last item, regarding individuals’ thoughts about reducing use or abstaining from cannabis use, is scored either a 0 (“Never”), 2 (“Yes, but not in the past six months”) or 4 (“Yes, during the past six months.”) Scores on the CUDIT-R can range from 0 to 32, with scores greater than 12 indicating the likelihood of cannabis use disorder (Adamson et al., 2010). Recent work confirms the strong psychometric properties of the CUDIT-R in a sample of college students, including high internal consistency, and evidence of concurrent and discriminant validity (Schultz et al., 2019). Cronbach’s alpha (.831) demonstrated strong internal consistency. The CUDIT-R can be found in its entirety in the appendix.

**Cannabis Expectancies.** To examine individuals’ beliefs about using cannabis, participants completed two subscales of the Marijuana Effect Expectancy Questionnaire (MEEQ; Schafer & Brown, 1991). The MEEQ asks individuals to report on their anticipated beliefs about using cannabis products across several domains, including cognitive and behavioral impairment, relaxation and tension reduction, social and sexual facilitation, perceptual and cognitive enhancement, global negative effects, and craving and physical effects. For the purposes of this study, only the “relaxation and tension reduction” and “global negative effects” subscales were administered. Eight items comprised the “relaxation and tension reduction” subscale and nine
items comprised the “global negative effects” subscale. Individuals responded to items on a response scale from 1 (“Strongly Disagree”) to 5 (“Strongly Agree”). Items from each subscale were aggregated to generate subscale scores. Across studies, the MEEQ evidences strong internal reliability (Aarons et al., 2001; Galen & Henderson, 1999). In the present work, Cronbach’s alpha of the relaxation and tension reduction subscale was .884 and Cronbach’s alpha of the global negative effects subscale was .891. The subscales used from the MEEQ can be found in the appendix.

**Distress Tolerance.** Participants completed the Distress Tolerance Scale-Short Form (DTS-SF; Garner et al., 2017). The DTS-SF is a four-item self-report measure assessing individuals’ abilities to withstand negative affect states. Individuals responded to items on a scale from 1 (“Strongly Disagree”) to 5 (“Strongly Agree.”). These items were then summed to create a total score, where higher scores are indicative of greater distress tolerance ability. Prior work confirms the high internal reliability and convergent validity of the DTS-SF (Garner et al., 2017). Cronbach’s alpha was .833, indicating strong internal reliability.

**Additional Measures.** Beyond the scope of the present study, individuals were also presented with questions related to their use of alcohol, alcohol-related expectancies, and experiences of alcohol-induced consequences.

**Statistical Analyses**

Study hypotheses and proposed methods are outlined below:

1) Individuals exposed to the negative affect induction task (experimental condition) will report greater negative affect and lower positive affect from pre- to post-task than those exposed to the control condition

2) Individuals in the experimental condition will report:
2.1 Greater cannabis use (frequency, quantity, average levels of intoxication) than those in the control condition

2.2 More positive cannabis expectancies (e.g. relaxation and tension reduction) than those in the control condition

2.3 Greater problems (as measured by both the CAPQ and CUDIT) than those in the control condition

3) Significant positive relations will exist between:

3.1 Reports of negative affect and cannabis use (e.g. frequency, quantity, average intoxication), cannabis expectancies (e.g. global negative effects, relaxation and tension reduction), and cannabis-induced problems (as measured by both the CAPQ and CUDIT)

3.2 Cannabis use (e.g. frequency, quantity, average intoxication), cannabis expectancies (e.g. global negative effects, tension reduction) and cannabis-induced problems (as measured by both the CAPQ and CUDIT)

4) Distress tolerance will serve as a moderator of

4.1 The relation between self-reported negative affect and substance use, such that the association between self-reported negative affect and use will be greater for individuals lower in distress tolerance

4.2 The relation between self-reported negative affect and substance use problems, such that the association between self-reported negative affect and cannabis problems will be greater for individuals lower in distress tolerance
In addition, we conducted two post-hoc analyses, looking at whether or not the experimental and control groups differed on distress tolerance, as well as examining bivariate correlations between negative affect and distress tolerance.

All data analyses employed SPSS Version 26.0. To test hypothesis 1, we conducted an independent samples t-test to determine whether pre-to-post experimental- or control-task negative and positive affect endorsements significantly differed between those in the experimental and control conditions. Similarly, for hypothesis 2, independent samples t-tests were run to examine differences in cannabis use, cannabis expectancies, and cannabis problems between those assigned to the experimental and control conditions. Relevant assumptions of independent samples t-tests include normality of the dependent variables and homogeneity of variance. We assessed for univariate and multivariate outliers using standardized Z-scores and Mahalanobis distances, respectively. Fifteen cases on the “cannabis use per week” variable were windsorized to fall within 3.29 standard deviations of the mean (Barnett & Lewis, 1994; Osborne, 2013). All variables evidenced skew less than +/-2, suggesting that no variable transformations were necessary (Gravetter & Wallnau, 2014).

For hypothesis 3, we employed bivariate correlations to determine whether indices of cannabis use, cannabis expectancies, cannabis problems, and negative affect covaried. We expected to find significant positive correlations between indices of cannabis use, tension reduction expectancies, and cannabis problems; however, we also predicted that those who hold greater negative cannabis expectancies will report less use and fewer problems. In terms of negative affect, we expected that individuals reporting more negative affect will report greater use, stronger cannabis expectancies, and higher numbers of cannabis problems. The relevant assumptions of Pearson correlations are as follows: continuous variables, related data, absence of
outliers, normality, and linearity. Prior to analysis, data were checked to ensure conformation to these assumptions. No outliers were identified and all variables evidenced normality as indicated by skew less than +/- 2.

Finally, to test hypothesis 4, we conducted two hierarchical multiple regressions to determine whether distress tolerance moderated relations between self-reported negative affect and cannabis use, as well as cannabis-induced consequences. For hypothesis 4.1. (predicting cannabis use), step one of the regression analysis included self-reported negative affect as measured by the I-PANAS-SF and distress tolerance as measured by the DTS-SF. Step two of the model included the interaction term of self-reported negative affect multiplied by distress tolerance. We used a similar method to test hypothesis 4.2, instead using cannabis-related problems as the dependent variable. The interaction terms were computed to determine whether the associations between self-reported negative affect and cannabis use/related-problems differed based on levels of distress tolerance. To reduce the potential for multicollinearity, all predictor variables were standardized prior to the calculation of the interaction term and before entry into the regression model. An examination of tolerance and variance inflation factors (VIF) suggested that the data did not exhibit substantial multicollinearity, with all tolerance indices greater than .20 and VIF indices less than 5 (Hair et al., 2011).

**Power Analysis**

To determine an appropriate sample size for this study, we conducted several power analyses using G*Power 3.1. For hypothesis 1, prior work suggests that negative affect inductions covary with increases in negative affect \( (r = .052; \text{Westermann et al., 1996}) \). This value corresponds to a Cohen’s \( d \) of approximately 1.22. Using an alpha error level of probability of .05 and power of .80, a total sample of 20 (10 per group) would be needed to
detect an effect of this size. For hypotheses 2.1, 2.2, and 2.3, negative affect inductions appear related to reports of greater craving for alcohol (Cohen’s $d = 0.39$) and use of alcohol (Cohen’s $d = 0.31$; Bresin et al., 2018). Using a Cohen’s $d$ of .35, $\alpha = 0.05$, and $\beta = 0.20$, a power analysis indicates that an acceptable a priori sample size would be 204 (102 per group).

For hypothesis 3, a recent meta-analytic review suggests that cannabis use variables covaried with cannabis-induced problems with a medium effect size ($r = .367$; Pearson, 2019). A power analysis using this effect size, $\alpha = 0.05$, and $\beta = 0.20$, calls for a total a priori sample of 43 participants. However, literature suggests that correlations in samples with less than 250 participants might be unstable, dictating a much larger sample for this analysis (Schönbrodt & Perugini, 2013). Finally, for the two moderation analyses in hypothesis 4, prior work shows the interaction of distress tolerance and depressive symptoms significantly predicted changes in alcohol problems ($\beta = -0.33$; Gorka et al., 2012). Using this effect size estimate, $\alpha = 0.05$, and $\beta = 0.20$, a power analysis suggests using a sample size of 51 individuals. Taken together, these various power analyses call for a minimum total sample size of 204 participants to be adequately powered to run each of these statistical tests. Nevertheless, a larger sample might be necessary as effects of negative affect on cannabis-related variables might not be as pronounced as those on alcohol variables.

Chapter 4: Results

Pilot Study

Descriptives. A total of 398 individuals were directed to begin the study. Of these participants, 34 were removed for failing to accurately answer attention check questions. An additional 71 participants were removed for terminating the study prior to completion. Nine other participants were excluded from analyses for providing copied, inappropriate, or irrelevant responses to the
experimental and control tasks. Our final analytic sample was comprised of 284 participants. Of
this sample, the majority identified as White (N = 166, 58.5%), cisgender females (N = 156,
54.9%), with an average age of 34.96 (SD = 10.92, Range = 18-77; See Table 1).

Skew for all relevant pilot study variables was less than +/- 2. Upon conducting a missing
values analysis, less than 5% of cases had missing data. Additionally, a non-significant Little’s
MCAR test indicated that the missing data occurred completely at random. To address missing
data, cases with missing data were removed (N = 7).

Effectiveness of the Negative Affect Induction. To examine the effectiveness of the
experimental condition in inducing negative affect, an independent samples t-test was performed
comparing those assigned to the experimental condition (negative affect induction) and control
condition (list potential uses of a pen). At baseline, there were no significant differences between
the two groups on the I-PANAS-SF negative affect scale (t = .26, p = .793) or positive affect
scale (t = -.38, p = .703). Compared to those assigned to the control condition, those assign
ed to the experimental condition reported greater negative affect from pre- to post-induction (t =
6.520, p < .001, Cohen’s d = .79; M_{neg affect} = 1.27, SD_{neg affect} = 3.12, M_{control} = -.85, SD_{control} =
2.14). Similarly, those exposed to the experimental condition also reported less positive affect
from pre-to-post induction compared to those in the control condition (t = -5.024, p < .001,
Cohen’s d = .62; M_{neg affect} = -3.22, SD_{neg affect} = 5.289, M_{control} = -.36, SD_{control} = 3.88).

Main Study

Data Cleaning. Little MCAR’s test was significant (Chi Square = 12308.709, df = 11486, p <
.001), indicating that some data were not missing completely at random; nevertheless, no cases
had more than 5% missing data. Given the large sample size of this study, this finding was
anticipated (Van Buuren, 2018). To address missing data, pairwise deletion was used to maintain
overall analytic power. Fifteen cases on the “cannabis use per week” variable were windsorized to fall within 3.29 standard deviations of the mean. No other variables evidenced skew greater than +/- 2. Bonferroni-adjusted p-values were used to account for inflations in Type I error due to multiple comparisons. Other specific tests of assumptions for analyses are detailed within the hypotheses sections below.

**Descriptives.** A total of 2,393 individuals provided initial informed consent. A total of 697 participants denied use of either alcohol, cannabis, or both; these participants were deemed ineligible for participation and were directed to the end of the study. An additional 385 participants terminated the study prior to completing all study questionnaires. One hundred and twenty nine participants were excluded from analyses for failure to respond correctly to at least two attention check questions. Those who failed only one attention check (N = 150) were retained for analyses, given the large number of items in this study. Finally, those who failed to accurately respond to the experimental/control tasks (e.g. provided a nonsense answer), or whose qualitative responses had been copied directly from other identifiable sources (e.g. Google, Wikipedia), were excluded from analyses; 63 and 26 individuals were removed from the experimental and control conditions, respectively.

The final analytic sample consisted of 1,094 individuals. This sample comprised of primarily cisgender females (N = 583, 53.4%) with a mean age of 36.38 (SD = 11.47, Range = 18-80). The sample was predominantly Caucasian (N = 791, 72.4%), followed by Black/African American (9.8%), Asian (6.5%), Hispanic/Latino (5.0%), Native American (2.9%), and multiracial (2.7%). The majority of this sample had a Bachelor’s degree (N = 484, 44.3%), with 16.2% having more education and 39.1% endorsing less education. See Table 1 for a comparison of sample demographics between the pilot and main study.
While all participants reported lifetime use of cannabis, 51.4% (N = 561) endorsed current use. Follow-up questions queried use in average number of days per week, grams of cannabis used per month on average, and average level of intoxication during use. Across both current and past users, on average, participants reported using cannabis 3.45 days per week (SD = 2.56, Range = 0-7), consuming approximately .25 ounces or 7 grams per month (SD = .56, Range = “less than 1/8 ounce” – “greater than two ounces”), and attaining a moderate level of intoxication (Mean = 3.83, SD = 1.69, Range = 0-7). Current users reported more frequent average cannabis use per week, consuming greater average quantities per month, and attaining higher levels of average intoxication than past users (t’s ranging from 4.68 to 9.23, all p’s < .001, Cohen’s d effect sizes ranging from .29 to .56).

Hypothesis 1. To test hypothesis one, two independent samples t-tests were conducted to examine differences in both negative and positive affect (as measured by the I-PANAS-SF) pre-to-post induction between the experimental and control conditions. No significant differences in positive affect (t = 1.54, df = 1075, p = .125) nor negative affect (t = 1.73, df = 1075, p = .092) were noted between groups prior to the experimental and control tasks. For changes in positive affect, 311 participants (53.9%) in the experimental condition and 195 (40.5%) in the control condition experienced reductions in positive affect following the experimental or control tasks. For changes in negative affect, 287 participants (50%) in the experimental condition and 71 (14.8%) in the control condition experienced increases in negative affect following the experimental or control tasks.

Those who received the negative affect induction significantly increased in their negative affect (t = 11.11, df = 1020 p < .001, Cohen’s d = .67; M_{negative affect} = 1.23, SD_{negative affect} = 3.34, M_{control} = -.72, SD_{control} = 2.32) and decreased in their positive affect (t = - 6.93, df = 1020, p <
pre-to-post induction compared to those who received the control condition. Given a significant Levene’s test \((F = 36.67, p < .001)\) for the pre-to-post induction change in negative affect compared across conditions, adjusted degrees of freedom are reported for that analysis.

**Hypothesis Two.**

To test hypotheses 2.1, 2.2, and 2.3, we conducted 7 independent samples t-tests to examine differences in reported cannabis use, expectancies, and problems between those assigned to the experimental and control conditions. A Bonferroni-adjusted p-value \((p < .007)\) was employed to control for potential inflations in Type I error due to multiple comparisons (Wilcoxon, 2013). See Table 2.

2.1. First, we conducted three independent samples t-tests to examine differences in reported average cannabis use frequency (days per week), average quantity (grams per month), and average intoxication (0 “not at all” to 7 “extremely”) between those assigned to the negative affect induction and those assigned to the control condition. No significant findings appeared for any of these analyses \((t’s \text{ ranging from } -0.66 \text{ to } 0.69; \text{ all } p’s > .51)\).

2.2. Two independent samples t-tests were conducted to examine differences between those assigned to the experimental and control conditions on reported cannabis expectancies (e.g. MEEQ relaxation/tension reduction and global negative effects subscales). A significant Levene’s test for equality of variances required the reporting of adjusted degrees of freedom for the MEEQ global negative effects subscale \((F = 12.88, p < .001)\). Only the global negative effects subscale revealed significant differences; those assigned to the experimental condition reported significantly more negative effects expectancies than those assigned to the control...
condition, with a small effect size ($t = 3.84, df = 1051.53, p < .001, \text{Cohen’s } d = .24; M_{\text{experimental}} = 21.52, S{D}_{\text{experimental}} = 8.87, M_{\text{control}} = 19.53, S{D}_{\text{control}} = 7.82$).

2.3 Two additional independent samples t-tests assessed differences in cannabis-related problems, as measured by the CUDIT and the CAPQ, between the experimental and control conditions. For both analyses, significant Levene’s tests for equality of variances called for the reporting of adjusted degrees of freedom. Results suggested that for CAPQ scores, those assigned to the experimental condition reported significantly greater cannabis-related impairment than those assigned to the control condition with a small effect size ($t = 2.90, df = 1005.40, p < .004, \text{Cohen’s } d = .18; M_{\text{experimental}} = 20.60, S{D}_{\text{experimental}} = 23.63, M_{\text{control}} = 16.53, S{D}_{\text{control}} = 20.90$). Given the Bonferroni-adjusted p-value of .007, the t-test comparing CUDIT scores between conditions did not qualify as significant, although those in the experimental condition reported greater CUDIT scores than those in the control condition ($t = 2.33, df = 730, p = .02$).

**Hypothesis Three.**

To assess hypothesis three, bivariate correlations assessed relations among indices of cannabis use (e.g. frequency per week, quantity per month, and average intoxication), cannabis expectancies (e.g. tension reduction and global negative effects), measures of cannabis-related problems (e.g. CUDIT, CAPQ) and negative affect. Only correlations with $p$-values less than .001 were considered significant.

3.1 We first examined how negative affect (assessed post-experimental or control condition) covaried with indices of cannabis use, cannabis-related expectancies, and cannabis problems. We found significant positive correlations between negative affect and cannabis intoxication ($r = .177$), global negative effect expectancies ($r = -.339$), and both CAPQ ($r = .505$) and CUDIT ($r = .359$) scores (all $p$’s < .001).
Significant positive correlations were found among almost all cannabis-related variables (r’s ranging from .129 to .692; all p’s < .001). Data revealed two significant inverse correlations between cannabis use per week and global negative effect expectancies (r = -.130) and tension reduction expectancies and global negative effect expectancies (r = -.127; both p’s < .001). Two correlations were not considered to be significant when compared to the Bonferroni adjusted p-value of .001: cannabis use per month and negative effect expectancies (r = -.09; p = .004) and tension reduction expectancies and CAPQ scores (r = .005; p = .873). See Table 3 for correlations.

**Hypothesis Four.**

4.1 We first conducted a hierarchical multiple regression to examine the effects of negative affect (post-experimental and control tasks) and distress tolerance, as well as their interaction, on cannabis use frequency (average days of use per week). The interaction term was tested to determine if the association between negative affect and cannabis use frequency differed based on individuals’ abilities to tolerate distress. The order of entry was as follows: step 1 = negative affect, step 2 = distress tolerance, step 3 = interaction term of negative affect by distress tolerance.

Results of this analysis are reported in Table 4. The first model step, which included the effect of negative affect, was significant (adjusted $R^2 = .004$, $F(1, 913) = 4.75$, $p < .05$). Step two, which included the main effects of negative affect and distress tolerance, resulted in an increase in explained cannabis use frequency variance (adjusted $R^2 = .011$, $F_{change}(1,912) = 5.87$, $p < .01$). The overall model, which included the two main effects variables and the interaction term, did not account for significant incremental variance in predicting cannabis use frequency (adjusted
Given that the overall model was not significant, no further model examination was conducted.

4.2 We conducted a second hierarchical multiple regression to examine the impact of negative affect (post-experimental and control tasks) and distress tolerance, plus their interaction, on cannabis-related problems (assessed by the CAPQ). We examined the interaction term to assess whether the association between negative affect and cannabis problems differed based on individuals’ distress tolerance capacities. The order of entry followed the previous analysis, with the main effect of negative affect entered on step 1, distress tolerance on step 2, and the interaction term on step 3.

The results for this second hierarchical regression analysis are reported in Table 5. The first step of this model, which included negative affect was significant (adjusted $R^2 = .251$, $F(1,985) = 331.83, p < .001$). The second step of the model, which included both main effects variables, did not contribute incremental variance to predicting cannabis-related problems (adjusted $R^2 = .252$, $F_{change}(1,984) = 1.673, p = .196$). Nevertheless, the final model step, which included both main effect terms and the interaction term, was significant (adjusted $R^2 = .260$, $F_{change}(1,983) = 11.86, p < .01$). In this final step, the main effect of negative affect post-induction and the interaction term were statistically significant predictors. Results suggested that only negative affect, but not distress tolerance, significantly predicted greater cannabis-related problems. Nevertheless, these variables should be interpreted within the context of the significant interaction term. To interpret this significant interaction, model-based estimates were used to generate Johnson-Neyman confidence bands for plotting the condition effect of distress tolerance through the PROCESS Macro Version 3.5 (Hayes, 2018). The plotting of these conditional effects revealed a crossover effect on the association between negative affect and cannabis-
related problems. At low levels of distress tolerance, those reporting low levels of negative affect appeared to report greater cannabis-related problems than those reporting higher levels of distress tolerance. Conversely, at higher levels of negative affect, those low in distress tolerance reported fewer cannabis-related problems than those with higher levels of distress tolerance. Squared semi-partial correlations revealed that removal of the negative affect variable and the interaction term would result in 23% and 1% reductions in predictive ability for cannabis-related problems, respectively. See Figure 1.

**Post-hoc Analyses.**

We conducted two post-hoc analyses to determine how distress tolerance differed among those assigned to the experimental versus control condition, as well as to examine how distress tolerance covaried with negative affect. First, those assigned to the experimental group reported lower levels of distress tolerance compared to the control group ($t = -4.90$, $df = 1084$, $p < .001$, Cohen’s $d = .29$; $M_{\text{experimental}} = 12.18$, $SD_{\text{experimental}} = 4.05$, $M_{\text{control}} = 13.40$, $SD_{\text{control}} = 4.14$). Additionally, results revealed a significant inverse correlation ($r = -.311$, $p < .001$), suggesting that as negative affect increased, individuals’ reported distress tolerance scores decreased.

**Chapter 5: Discussion**

Data consistently highlight the frequent co-occurrence of affective dysregulation and cannabis use. A review of 19 ecological momentary assessment (EMA) studies highlights that momentary negative affect appears elevated immediately prior to cannabis use, followed by a decline in negative affect after use (Wycoff et al., 2018). Other work reports that those with depression have 130% greater odds of reporting lifetime cannabis use and a 216% greater likelihood of endorsing daily cannabis use (Gorfinkel et al., 2020). Similarly, recent work highlights that among a sample of Veterans with CUD, nearly 67% also qualified for a depression diagnosis
(Ecker et al., 2020). This co-occurrence of affective disturbances and cannabis use is associated with poorer CUD treatment outcomes and higher relapse rates post-treatment (Tomko et al., 2020; White et al., 2004). These findings call for further exploration of associations between negative affect and cannabis-related variables, given their implications in treatment outcomes.

While a plethora of research documents relations between negative affect and substance use, to the author’s knowledge, no prior work has used an experimental paradigm to examine the impact of momentary negative affect on reporting of cannabis variables. This work is imperative, as data suggest that momentary negative affect can influence both recall and reporting of several psychologically-relevant variables, such as depression, body size, and body dysmorphia (Baker et al., 1995; Goodwin & Sher, 1993). Such findings are consistent with Bower’s network theory of affect, which posits that activation of emotion nodes in the brain can subsequently stimulate connected knowledge nodes (Bower, 1981). While this work has not previously been extended to examine how momentary negative affect influences reporting of substance use, some studies suggest that negative affect can influence craving for substances (Bresin et al., 2018). The present work expands on existing findings to assess whether momentary negative affect can bias reporting of cannabis-related variables. Given the importance of accurate self-report in research and treatment settings, this work represents a crucial step in ensuring that individuals’ self-reported endorsements of cannabis use are not conflated by experiences of negative affect.

The purpose of the present study was to examine the impact of negative affect on individuals’ endorsements of cannabis use, expectancies, and cannabis-related problems. After completing demographic questions and a measure of positive and negative affect, participants were randomly assigned to complete either a negative affect induction (e.g. an autobiographical emotional memory task) or a control condition (e.g. list potential uses for a pen) based on their
date of birth (even vs. odd). Following these tasks, participants completed follow-up measures of affect, cannabis use, cannabis expectancies, cannabis-related consequences, and distress tolerance. Consistent with our hypotheses, we found that those assigned to the negative affect induction significantly increased in negative affect and significantly decreased in positive affect, compared to those assigned to a control condition, in both a pilot study and the main study.

Follow-up analyses revealed that those assigned to the experimental condition reported more global negative effect expectancies and greater CAPQ scores than those assigned to the control condition. Significant positive bivariate correlations were noted between negative affect and cannabis intoxication, negative cannabis effect expectancies, and cannabis-related problems. Similarly, we found evidence of significant positive correlations between cannabis use and cannabis-related problems, such that those who reported more frequent use, greater quantities of use, and greater average cannabis intoxication also reported greater cannabis problems. Finally, distress tolerance appeared to moderate the relation between negative affect and CAPQ scores, with a significant crossover effect. At low levels of negative affect, those with higher distress tolerance report lower CAPQ scores than those with lower distress tolerance. Alternatively, at higher levels of negative affect, those with higher distress tolerance reported higher CAPQ scores than those with lower distress tolerance. Nevertheless, this interaction effect only accounted for 1% of the variance in CAPQ scores. Although not all of the study hypotheses were supported, the results of this work reveal important findings about relations between momentary negative affect, distress tolerance, and reporting of cannabis-related variables. Further explanation of study hypotheses are detailed below.

**Pilot Study**
While we did not specify any hypotheses for our pilot study, we aimed to examine the feasibility and effectiveness of the online negative affect induction task. As anticipated, there were no significant group differences at baseline between those randomly assigned to the experimental and control conditions. Participants who were randomly assigned to complete the autobiographical emotional memory task (experimental condition) experienced significant increases in negative affect and decreases in positive affect from pre-to-post induction, compared to those assigned to complete the control condition (Cohen’s $d$ ranging from .68 to .72). These findings appear consistent with those noted in the literature and suggest that the negative affect induction task was successful in its aims (Martin, 1990; Westermann et al., 1996).

Not all participants assigned to receive the negative affect induction experienced changes in affect pre-to-post induction. Of the 136 participants assigned to receive the negative affect induction, only 72 experienced an increase in negative affect (52.9%). Importantly, this low percentage of affect responders is consistent with the literature, whereby affect manipulation procedures range in effectiveness from approximately 50-70% in inducing the intended affective state (Martin, 1990; Westermann et al., 1996). While we instituted procedures to increase the effectiveness of our internet-based affect-induction procedure (detailed below), there are several possible explanations for this moderate effectiveness rate. First, it is plausible that participants did not engage fully in the task and thus, did not experience the affective state they were asked to imagine. To prevent this, the researchers asked participants to detail their negative autobiographical emotional memory in writing with a minimum character count, and participants were not permitted to proceed to the next task until five minutes had elapsed. Nevertheless, it is possible that participants did not devote substantial effort or emotional energy to the task to experience the intended affective state. Another potential explanation is that while participants
might have experienced a change in their affect, the change might not have been immediately noticeable to them. Given that participants completed the I-PANAS-SF immediately prior to and immediately following the induction task, subtle changes in affect might not have been noticed by the participants and/or captured by this measure. Future replications of this work might consider adding additional negative affect induction enhancers (e.g. sad music, sad images/videos) and/or assessing changes in affect differently in an attempt to increase the prevalence of affect responders.

**Hypothesis 1**

Our first hypothesis stated that the individuals assigned to receive the negative affect induction would report greater negative affect and less positive affect from pre- to post-task than those assigned to the control condition. As expected, at baseline, there were no significant differences in positive or negative affect between those assigned to the experimental condition and those assigned to the control condition. Random assignment to either condition ensured that potential confounding characteristics (e.g. pre-experiment affect states, mental health diagnoses, including depression) were evenly distributed across conditions. Results of two independent samples t-tests revealed significant between-condition results, such that those assigned to the negative affect induction reported higher levels of negative affect and lower levels of positive affect from pre-to-post induction compared to those assigned to the control condition. Effect sizes for these t-tests were in the moderate range (.43 and .67), suggesting that participants experienced substantial changes in their affect due to the influence of the negative affect induction. Although these changes are substantial, participants exposed to the control condition might also have experienced changes in their affective states, potentially due to the control condition task or due to other stimuli in participants’ immediate environments. Given a lack of consistent control
conditions for affect induction tasks in the literature, the researchers devised a control condition for the purposes of this study whereby participants reported creative uses for a pen. While this task was not intended to induce any affective states among participants, it is plausible that some participants might have experienced changes in their affect as a result of engaging in this task. Future work could employ alternative control conditions to assess for differences based on control condition tasks.

While many participants in the experimental condition did experience changes in affect, not all did. Of those assigned to receive the experimental condition, 50% experienced increases in negative affect while 53.9% experienced reductions in positive affect. In addition, 187 participants (31.3% of the sample) assigned to the experimental condition experienced both increases in negative affect and decreases in positive affect. In comparison, this effect was found in only 30 participants (6% of the sample) assigned to the control condition. These findings corroborate those noted in the extant literature, as well as in our pilot study, whereby negative affect inductions are only successful in inducing the desired affect between 50-70% of the time (Martin, 1990; Westermann et al., 1996). Several hypotheses could explain this finding. As previously alluded to, it is possible participants did not devote enough emotional effort to the induction to experience changes in affect, or, that the changes in affect were not immediately noticeable to participants. Future work should continue to examine the effectiveness of internet-based affect inductions, determine enhancement strategies, and implement them.

**Hypothesis 2**

Our second hypothesis was three-fold. We expected that those assigned to the experimental condition would report greater cannabis use, greater expectancies for tension reduction, and greater cannabis-related problems than those assigned to the control condition. This hypothesis
was consistent with available literature suggesting an affect-congruent memory effect, whereby individuals in negative affective states might have increased ease of access to memories congruent with their present affective states, illustrative of a cognitive network theory of affect (Blaney, 1986; Bower, 1981; Loeffler et al., 2013). Given random assignment to the experimental and control conditions, we did not expect differences in any cannabis-related variables at baseline between groups; thus, we anticipated that any group differences that appeared were likely attributable to the affect induction task. Data revealed significant between-groups differences: those assigned to the experimental condition reported significantly greater global negative effect expectancies, as well as greater cannabis-related problems (as measured by the CAPQ) with small effect sizes (.18 to .24).

The former finding was somewhat unexpected: individuals assigned to engage in the negative affect induction task reported having greater negative effect expectancies than those assigned to the control condition. Examples of negative effect expectancies include: “Marijuana makes me say things I do not mean,” “Marijuana can cause me to become depressed and disappointed with myself,” and “Marijuana can cause my feelings to change from happy to sad.” Initially, we had hypothesized that when experiencing greater negative affect, participants might endorse greater tension reduction expectancies as a way to modulate their emotional experience, given that this result had been previously published in the alcohol literature (Hufford, 2001). While this finding was not aligned with our initial hypotheses, there are several potential explanations for this finding. First, given the theory of affect-congruent memory (Bower, 1981; Blaney, 1986; Loeffler et al., 2013), it is plausible that individuals who were primed to experience negative affect (those assigned to the experimental condition) might have been more easily able to recall negative beliefs about cannabis given biased recall processes. Additionally,
while we did not assess for cannabis use motives in the present work, participants’ reasons for using cannabis might have influenced their responses to these questions. Given that tension reduction and relaxation are the most commonly endorsed motives for cannabis use in both naturalistic and treatment studies (Green et al., 2003; Hyman & Sinha, 2009), we expected that participants would report greater tension-reduction expectancies when experiencing negative affect. However, it is plausible that participants instead had other motives for using cannabis, including social, expansion, or fun/enjoyment motives. Because these motives might be unrelated to negative affect, it is possible that individuals who use for these reasons might not have experienced an increase in accessibility of tension reduction expectancies and instead were better able to identify negative expectancies related to use. Future work might expand on the present study by also assessing for cannabis use motives.

Interestingly, participants assigned to the experimental condition reported greater cannabis-related problems as measured by the CAPQ, but not the CUDIT, compared to the control condition. This finding partially upheld our hypothesis. While the CAPQ captures psychosocial consequences related to cannabis use, the CUDIT identifies individuals with possible CUD. Although both measures capture problems associated with use, the questions on the CAPQ might be more open to interpretation and thus, more susceptible to bias. For instance, the CAPQ asks individuals to report on their experience of “financial difficulty” associated with cannabis use on a scale ranging from “No” to “Yes, very many times or a serious problem.” For this question, respondents must first be aware of potential relations between their cannabis use and financial difficulties and then report the occurrence and severity of this concern. In contrast, an example question from the CUDIT is: “How often do you use cannabis?” with answer options ranging from “Never” to “4 or more times a week.” As compared to the example CAPQ
question, the CUDIT question leaves considerably less room for interpretation. Thus, it is plausible that the CAPQ might be more susceptible to affect-related bias. Given that both the CAPQ and CUDIT are often used in research and clinical capacities, these implications are paramount. Many individuals present with both CUD and comorbid affective conditions, including major depressive disorder (MDD). In light of these results, professionals should opt to use measures with less susceptibility to the influence of negative affect, such as the CUDIT. Alternatively, collecting information about participants’ affective states might help to determine if self-report endorsements are valid indicators of individuals’ true experiences.

Another potential explanation for these findings is due to the differing time frames with which cannabis problems were assessed. The CAPQ assesses lifetime cannabis-related problems while the CUDIT only gauges cannabis-related impairment in the past six months; thus, the CAPQ analysis included in the entire sample, while only individuals who reported using cannabis in the past 180 days were included in the CUDIT analysis. It is plausible that the CAPQ introduces additional bias by assessing cannabis problems over the lifetime, as opposed to in the past 180 days. Research confirms that individuals are less accurate in reporting instances of depression and mania symptoms over time, highlighting evidence of a retrospective recall bias in mental health questionnaires broadly (Boschloo et al., 2013; Patten et al., 2012). While no available literature asserts a “gold standard” time frame for assessing cannabis-related impairment, it is plausible that negative affect might compound the influence of recall bias, making retrospective reporting even less accurate. Alternatively, it is also possible that non-current users might have been more likely to use in ways that are problematic, as opposed to current users. These users might have been more likely to “quit” cannabis use after experiencing
greater consequences. Continued research in this area might assess how the assessment time frame influences participant responses.

Hypothesis 3

Additionally, we hypothesized that we would find significant positive correlations between negative affect and cannabis related variables (e.g. use, expectancies, and problems). Existing research highlights significant relations between affect, cannabis use, and problems. Those reporting greater negative affect also report more frequent use, potentially due to coping motives for use or positive cannabis-related expectancies; further, using for such motives is associated with increased problems (Buckner et al., 2013; de Dios et al., 2010; Farris et al., 2014; Glodosky & Cuttler, 2020). Other work reveals that individuals experience significant reductions in negative affect, depression, anxiety, and stress following cannabis use (Cuttler et al., 2018).

With regard to this literature, we anticipated that when we activated negative affect, this might prime participants to report more use, greater positive cannabis-related expectancies, and greater cannabis-related impairment. Our results revealed partial support for this hypothesis: negative affect significantly positively covaried with average intoxication scores, negative cannabis effect expectancies, and cannabis problems as assessed by both the CUDIT and CAPQ.

Despite our significant finding that negative affect positively correlated with average intoxication, to the author’s knowledge, no work has examined the role of negative affect as a correlate or predictor of cannabis intoxication. Given the purported antidepressant effects of cannabis (El-Alfy et al., 2010; Sales et al., 2018; Silote et al., 2019; Zanelati et al., 2010), coupled with individuals’ expectancies that cannabis can induce tension reduction and related motives for use (Buckner et al., 2015; Hayaki et al., 2010), individuals experiencing negative affect might attempt to achieve higher levels of intoxication to alleviate distress. Although we
did not find significant relations between negative affect and frequency or quantity of cannabis use, one potential hypothesis is that individuals might choose cannabis products with higher THC content when experiencing more negative affect. This assertion is supported by research that reveals individuals expect high THC/low CBD products to alleviate stress (Cuttler et al., 2018). Alternatively, individuals might opt for cannabis consumption methods that produce greater levels of intoxication (e.g. dabs, bongs) when experiencing negative affect. Further confirmation of this work might allow researchers to better understand the mechanisms of the link between negative affect and cannabis intoxication.

Furthermore, we found that greater negative affect covaried with significantly greater negative effect expectancies, as well as greater cannabis-related problems on both the CAPQ and CUDIT. For the significant correlation between negative affect and negative effect expectancies, this result might be considered additional support for an affect-congruent memory effect, whereby individuals are more likely to recall information consistent with their current affective state (Blaney, 1986; Bower, 1981; Loeffler et al., 2013). Nevertheless, other explanations might exist for this result. While limited work has examined how cannabis expectancies covary with affective states, the implications of a recent review suggest that this relation might differ depending upon individuals’ use patterns (Wycoff et al., 2018). During experiences of negative affect, users who are trying to cut back or abstain from cannabis might have different expectancies than individuals who are in the process of becoming heavier users or initiating use for the first time. Continued examination of how expectancies might change in relation to negative affect is necessary to better understand these links.

The positive association between negative affect and increased cannabis-related problems is well documented in the literature, with data highlighting significant positive relations between
depression, anxiety, stress, and cannabis problems (Buckner et al., 2007; Spradlin & Cuttler, 2019). While we did not assess for participants’ motives for cannabis use, a commonly endorsed reason for using cannabis is to alleviate stress and tension (Buckner et al., 2015; Hathaway, 2003; Ogborne et al., 2003). Using for such motives is commonly associated with cannabis problems (Bonar et al., 2017; Blevins et al., 2016; Chabrol et al., 2004; Moitra et al., 2015; Simons et al., 1998), potentially because individuals become reliant on the plant for coping with distress. While our finding is not novel, this association corroborates previous research calling for cannabis-focused treatment to target negative affect-related use as a means of mitigating cannabis-induced problems.

We also examined correlations between indices of cannabis use (e.g. frequency per week, quantity per month, and average intoxication) and cannabis problems, as measured by both the CUDIT and CAPQ. We also expected to find significant positive correlations between cannabis tension reduction expectancies, use, and problems and significant negative correlations between cannabis global negative effect expectancies, use, and problems. Correlations ranged from relatively weak (e.g. $r = -0.130$ between negative effect expectancies and cannabis use per week) to strong (e.g. $r = 0.621$ between quantity consumed per month and frequency of use per week) among study variables.

Overall, it appeared as though more frequent use, greater quantities of use, and higher average intoxication covaried positively with cannabis-induced consequences. These findings largely corroborate those documented in the literature, where individuals who report greater use also experience more frequent and extreme consequences (Pearson, 2019). Nevertheless, other work suggests that greater frequency of use need not necessarily relate to heightened experiences of problems (Asbridge et al., 2014; Looby & Earleywine, 2007; Zeisser et al., 2012). While our
findings do suggest positive relations between use and problems, future work might attempt to better understand these relations. Continuing to assess motives for use, patterns of use (day versus night, alone versus in social contexts), and differences in methods of use (e.g. flower products versus edibles versus concentrates) might help elucidate these discrepant findings.

The correlations between the expectancies variables and cannabis outcomes (e.g. use and problems) reveal a more complex story. First, we found that tension reduction expectancies and global negative effect expectancies were significantly weakly inversely related. This finding was anticipated, as participants who expect negative outcomes related to their cannabis use are unlikely to also expect cannabis to have soothing or calming effects. Next, data revealed significant positive correlations between the MEEQ “tension reduction” subscale and all indices of cannabis use, as well as CUDIT scores, but not CAPQ scores. Extant literature corroborates this finding whereby cannabis users who anticipate tension reduction from their use tend to report greater cannabis use and, in some studies, experience more problems (Buckner et al., 2013; Grant et al., 2016; Hayaki et al., 2010). One potential explanation for this finding is that those who believe cannabis will help them relax might become reliant on the substance for stress reduction (Buckner et al., 2013). In clinical settings, professionals might help to correct these expectancies by providing psychoeducation or offering alternative relaxation skills, such as paced breathing or progressive muscle relaxation, in order to help diminish negative effects associated with use.

The finding that tension reduction expectancies relate positively to CUDIT scores but not CAPQ scores is somewhat perplexing. One potential explanation is that the CUDIT includes items related to use (e.g. frequency and hours intoxicated) while the CAPQ only assesses specific consequences related to use. Given the significant positive correlations between use items in the
present work and tension reduction expectancies, it is plausible that these expectancies specifically relate to the use-related items of the CUDIT. Another possibility is that tension reduction expectancies specifically correlate with some items of the CAPQ, but not others. Recent work has found that the CAPQ has four distinct factors: decreased productivity, poorer self-concept, interpersonal and financial difficulties, and negative physical health-related symptoms (Altman et al., 2021). It is possible that tension reduction expectancies specifically relate to some factors, such as decreased productivity, but not others. Future research might examine these relations more thoroughly to help explain this null result.

Additionally, among our sample, MEEQ “global negative effect expectancies” were negatively associated with cannabis use frequency and quantity, but positively correlated with average cannabis-related intoxication, and both measures of cannabis problems. Prior work confirms that negative cannabis-related expectancies appear inversely related to cannabis use, but positively associated with negative cannabis-induced consequences (Buckner et al., 2013; Connor et al., 2011; Foster et al., 2016). Foster and colleagues (2016) found that these relations appeared associated with motives for use, such that the strength of these relations changed based on whether people endorsed using cannabis to cope. Although we did not assess motives for use in the present work (to minimize participant burden), the results of Foster and colleagues suggest that understanding peoples’ reasons for use might help explain how their beliefs about cannabis (i.e. expectancies) relate to their use patterns and experiences of problems. A better understanding of these relations might help researchers and clinicians modify inaccurate cannabis expectancies or offer alternative coping strategies to mitigate potential consequences.

The finding that those who held greater negative expectancies reported greater average intoxication and greater problems warrants further attention, especially given the inverse
relations between negative effect expectancies and use. Similar findings have been documented in the literature (Buckner et al., 2013; Foster et al., 2016). One possible explanation is that users who have experienced consequences related to use might be more attuned to negative aspects of their cannabis use resultingly (Hayaki et al., 2010). Alternatively, users who endorse greater negative expectancies might use cannabis in riskier ways that were not necessarily captured through our cannabis use indices. For instance, it is possible that users who expect greater negative effects of cannabis prefer to use dabs (i.e., highly concentrated forms of cannabis), which might be particularly related to some cannabis consequences, including tolerance and withdrawal symptoms (Loflin & Earleywine, 2014; Meier, 2017). Dabs users might also experience greater intoxication, which appears to be a better predictor of cannabis-related problems when compared to cannabis use quantity (Loflin & Earleywine, 2014). Experiences with dabs and negative outcomes might make global negative effect expectancies more salient for these users. To expand upon this work, future studies might seek to better understand individuals’ negative cannabis expectancies, given their significant relations with cannabis problems.

**Hypothesis 4.**

Hypothesis 4 was also twofold. We predicted that distress tolerance (as measured by the DTS-SF) would moderate relations between negative affect (measured by post-induction negative affect scale of the I-PANAS-SF) and cannabis use frequency (assessed via days per week), as well as negative affect and cannabis-related problems (as measured by the CAPQ). Many individuals use cannabis for coping motives, especially those experiencing heightened negative affect, and greater coping motives are associated with increased cannabis use (Brodbeck et al., 2007; Buckner & Zvolensky, 2014). Using cannabis to cope with anxiety, depression, or stress appears also appears related to higher levels of cannabis problems and dependence.
symptoms (Buckner, 2013; Buckner & Zvolenksy, 2014; Fox et al., 2011). Previous work also suggests that individuals lower in distress tolerance (or higher in distress intolerance) experience greater problems, and coping motives appear to mediate this association (Bujarski et al., 2012; Farris et al., 2016). Based on this literature, we anticipated that individuals higher in distress tolerance would show weaker relations between negative affect, cannabis use, and problems.

We did not find evidence that distress tolerance scores moderated the link between negative affect and cannabis use frequency. Nevertheless, we did find significant main effects for the roles of negative affect post-induction and distress tolerance scores independently. Negative affect scores post-induction appeared to significantly positively predict cannabis problems. Prior work confirms positive associations between negative affect (e.g. anxiety, depression, and stress) and cannabis use, especially for those who use cannabis to cope (Hyman & Sinha, 2009; Spradlin & Cuttler, 2019; Temple et al., 2014). Additionally, distress tolerance appeared to inversely predict cannabis-related problems in the present work; participants who endorsed higher distress tolerance reported less cannabis use. Again, this finding is corroborated by previously documented work (Buckner et al., 2015; Hasan et al., 2015). While we did not find evidence of a moderating effect, continued examination of these main effects can inform future research and clinical intervention.

Finally, we conducted a second hierarchical multiple regression to examine whether distress tolerance moderated the link between post-induction negative affect and CAPQ scores. Results revealed a significant interaction term, indicative of moderation. When experiencing low levels of negative affect, those with higher levels of distress tolerance reported fewer cannabis problems compared to those lower in distress tolerance. This finding is intuitive; distress tolerance appears to serve as a buffer against cannabis-related problems during instances when
negative affect is low. Alternatively, when experiencing high levels of negative affect, those reporting higher distress tolerance reported greater cannabis problems compared to those lower in distress tolerance. Surprisingly, prior work documents similar findings with regard to discomfort tolerance (i.e. one’s capacity to tolerate unpleasant physiological sensations) moderating the relation between depression symptoms and cannabis problems (Buckner et al., 2007). In this study, those with higher discomfort tolerance capacity were prone to more cannabis problems during heightened depression. While distress tolerance appears to buffer against low levels of negative affect, perhaps a paradoxical effect emerges during periods of high negative affect. Individuals experiencing intense negative affect might not be able to access their distress tolerance skills at that time and thus, might use cannabis maladaptively as a means of coping. Future work should examine and attempt to replicate this finding as a means of better understanding these complex relations. Moreover, the squared semi-partial correlation for this moderation effect only accounted for 1% of the variance in CAPQ scores. In light of this significant finding, the result should be interpreted cautiously given this unimpressive effect size.

Post-Hoc Analyses

Two post-hoc analyses revealed that those assigned to the negative affect induction reported lower levels of distress tolerance compared to those assigned to the control condition, as well as that negative affect significantly inversely covaried with distress tolerance. Taken together, these findings suggest that during periods of higher negative affect, individuals appear to report feeling less tolerant of distress. Prior work corroborates these findings of inverse relations between negative affect and distress tolerance, especially amongst substance users (Abrantes et al., 2008; Kiselica et al., 2014; Manning et al., 2018). These findings might be supported by individuals’ coping motives for use, such that individuals low in distress tolerance
appear to use substances to cope with high negative affect (Buckner et al., 2016; Farris et al., 2016). Longstanding disturbances in negative affect, such as those seen in depression and other mood disorders, also appear to inversely relate to distress tolerance, providing additional support for these relations (for a review, see Lass & Winer, 2020).

On the one hand, it is plausible that inducing negative affect leads people to underreport their true distress tolerance capacities, as consistent with affect-congruent memory theory. Perhaps during periods of increased negative affectivity, participants are more likely to recall more times they have been unable to tolerate distressing emotions, due to negative-affect related bias. Alternatively, it is also plausible that individuals lower in distress tolerance are most reactive to experiences of negative affect. Further experimental work in this area might allow for a greater understanding of how momentary experiences of negative affect influence individuals’ reporting of their distress tolerance capacities. Additionally, future work might benefit from examining other measures of distress tolerance, including behavioral tasks such as the Mirror Tracking Persistence Task (Stronger et al., 2003) or the Paced Auditory Serial Addition Task (Lejuez et al., 2003), to determine how experiences of induced negative affect might covary with both self-reported and behavioral distress tolerance.

**Interpretation of Null Findings**

While this study yielded some significant findings, several of the null findings warrant further examination and assessment. A number of explanations can account for the non-significant findings in the present work. For instance, with regard to hypotheses 1 and 2, not all participants experienced changes in negative affect as a result of exposure to the experimental condition. Additionally, we did not find significant differences between participants assigned to the experimental and control conditions on several outcome variables (e.g. cannabis use, tension
reduction expectancies, etc.). One potential explanation is that participants did not actively engage in the negative affect induction task and, as such, did not experience negatively-biased recall processes. Another possibility is that the control condition might have incidentally induced increases in negative affect, potentially minimizing any between-group negative affect-related differences. While it is possible that there is not a true effect of negative affect on recall and reporting of cannabis use variables, confounding factors related to study design (e.g. the experimental task, specific questionnaires employed) might have obscured any true differences we might have otherwise noted.

Additionally, we did not find evidence that distress tolerance significantly moderated the relation between negative affect and cannabis use. One potential explanation for this finding is that there was insufficient variability in the dependent variable (use frequency) to allow us to find an effect. Future work might use other cannabis outcome measures, such as number of uses in the past week or month, to allow for greater variability. A second potential explanation is that participants might have misrepresented their ability to tolerate distress, potentially due to self-report biases. The average score on the distress tolerance measure was 12.73, with scores ranging from 4-20 and higher scores indicating greater distress tolerance. While many participants rated their distress tolerance abilities as moderate, it is possible that some participants might have overrepresented their ability to tolerate distress to portray themselves more positively, or due to inaccuracies in their assessment of their distress tolerance skills. Future work might incorporate behavioral measures of distress tolerance to corroborate participants’ self-report. Finally, it is also possible that distress tolerance actually serves as a mediator of the association between negative affect and cannabis use. Prior work finds that distress tolerance mediates relations between mental health diagnoses (e.g. depression, PTSD) and addictive behaviors (e.g. alcohol
use, cannabis problems, problematic smartphone use; Buckner et al., 2007; Elhai et al., 2018; Holliday et al., 2016). Although we did not examine distress tolerance as a mediator in the present work, future studies might assess this possibility.

**Limitations**

In light of the significant findings in this study, there are several limitations worthy of consideration. First, given the online, anonymous, self-report nature of this present study, participants could have purposefully misrepresented themselves and their experiences. Several factors could have influenced the present findings, including social desirability. While the anonymous nature of this work likely buffered against socially desirable responding, individuals might have been motivated to misrepresent aspects of their experiences in order to meet eligibility criteria and receive compensation for participation. Should participants have misrepresented themselves, the accuracy of these findings might raise questions.

Additionally, the online nature of this work precludes an understanding of how these findings might extend to daily life circumstances. In a treatment setting, it is plausible that an individual experiencing more negative affect might underreport their experiences of substance-related problems; however, other factors might also influence this relation, including the intensity of the negative affect, the recency of the negative affect-inducing event, the format of the questionnaires (e.g. self-report, in-person interview), and the individual’s feelings about pursuing substance-related treatment. Given these possibilities, it is imperative to replicate this work in laboratory and treatment settings. Furthermore, these data might also call for the concurrent assessment of affect when assessing individuals’ substance use and related experiences.

**Future Directions**
Despite the aforementioned limitations, the findings of these study support additional research with regard to relations between negative affect, reporting of cannabis-related variables, and distress tolerance. First, continued work in this area should focus on disentangling the complicated relations between negative affect, recall, and reporting of substance use variables. Ecological momentary assessment (EMA) data could enrich and extend the findings of the present work. Using EMA data, researchers could request that participants report on their cannabis use in the moment for a one-week period, induce negative affect one week later among half the sample, and assess participants’ accuracy in their reporting of their cannabis use in the previous week. Such a study might help differentiate true discrepancies in recall related to the negative affect induction from inaccurate reporting of cannabis use unrelated to induced negative affect in the control group.

The findings of the present work also call for researchers and clinicians alike to consider the role of negative affect in reporting of substance-related problems. In treatment settings and research studies, practitioners and scientists collect data about substance use problems without acknowledging the various biases that might have influenced reporting, including negative affect. Should the results of this study be replicated, these findings call for concurrent assessment of negative affect, given known relations to substance-induced problems. Understanding participants’ affective states might provide clarity about whether or not someone’s self-report of their substance problems is biased. Professionals in research and/or clinical settings might consider using measures less sensitive to affect-related bias, such as the CUDIT instead of the CAPQ, to minimize potential affect-related bias.

The present work also calls for continued examination of distress tolerance, especially as it relates to negative affect and substance use. While continued work is needed on links between
negative affect, distress tolerance, and cannabis use, increasing distress tolerance skills among cannabis users might help to mitigate problems associated with use. Given the crossover moderation effect we noted in the present study for relations between distress tolerance, negative affect, and cannabis problems, specific focus might be devoted to offering individuals high in distress tolerance skills to use when experiencing negative affect, such as mindfulness, to prevent adverse cannabis consequences.

Finally, the potential influence of cannabis use on memory processes warrants mention, as it relates to the present findings. Data consistently confirm that, at least during acute intoxication, cannabis impairs verbal and working memory processes (Schoeler & Bhattacharyya, 2013; Volkow et al., 2016). While studying the impact of cannabis use on memory is complex, research also suggests that heavy or chronic cannabis users appear to have greater difficulties with various aspects of the memory process, including encoding, storage, and retrieval (Solowij & Battisti, 2008). Working memory related impairment appears to be worse for individuals who start using cannabis earlier (e.g. prior to the age of sixteen; Becker et al., 2010), although causal mechanisms are yet to be confirmed and other confounding variables (e.g. co-occurring psychiatric illness) might influence these relations. While more research is certainly needed, it is plausible that using cannabis might influence recall and reporting processes regardless of the influence of retrospective recall bias or negative affect-induced bias. Thorough assessments of cannabis use, problems, and negative affect that also assess current intoxication and age at first use could help disentangle these effects.
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Van der Pol, P., Liebregts, N., de Graaf, R., Korf, D. J., van den Brink, W., & van Laar, M.


<table>
<thead>
<tr>
<th></th>
<th>Pilot Sample (N = 284)</th>
<th>Final Sample (N = 1,094)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (M; SD)</td>
<td>34.96 (10.92)</td>
<td>36.38 (11.47)</td>
</tr>
<tr>
<td>Gender (N; % Cisgender Female)</td>
<td>156; 54.9%</td>
<td>583; 53.4%</td>
</tr>
<tr>
<td>Race (N; % White)</td>
<td>166; 58.5%</td>
<td>791; 72.4%</td>
</tr>
<tr>
<td>Education (N; % Bachelor’s or greater)</td>
<td>178; 62.7%</td>
<td>661; 60.5%</td>
</tr>
</tbody>
</table>
Table 2. Independent Samples T-Tests Comparing the Experimental and Control Groups on Use, Expectancies, and Problems

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group – Mean (SD)</th>
<th>Control Group – Mean (SD)</th>
<th>t</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days per week</td>
<td>3.41 (2.53)</td>
<td>3.51 (2.60)</td>
<td>-.66</td>
<td>.01</td>
</tr>
<tr>
<td>Quantity per month</td>
<td>4.06 (4.32)</td>
<td>4.03 (4.45)</td>
<td>.11</td>
<td>.01</td>
</tr>
<tr>
<td>Average intoxication</td>
<td>3.82 (1.67)</td>
<td>3.86 (1.71)</td>
<td>.69</td>
<td>.02</td>
</tr>
<tr>
<td>Tension reduction</td>
<td>28.15 (6.85)</td>
<td>28.22 (6.84)</td>
<td>-.18</td>
<td>.01</td>
</tr>
<tr>
<td>Tension reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>expectancies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global negative effect</td>
<td>21.52 (8.87)</td>
<td>19.53 (7.82)</td>
<td>3.84*</td>
<td>.24</td>
</tr>
<tr>
<td>expectancies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CUDIT scores (current</td>
<td>11.08 (6.75)</td>
<td>9.94 (6.40)</td>
<td>2.33*</td>
<td>.17</td>
</tr>
<tr>
<td>users only</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPQ scores</td>
<td>20.60 (23.63)</td>
<td>16.53 (20.90)</td>
<td>2.90*</td>
<td>.18</td>
</tr>
<tr>
<td>Note. * p &lt; .001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Correlations between indices of cannabis use, cannabis expectancies, cannabis problems, and negative affect

<table>
<thead>
<tr>
<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CAPQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. CUDIT</td>
<td>.607**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Cannabis use per week</td>
<td>.162** .460**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Quantity per month</td>
<td>.129** .336** .621**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Average level of intoxication</td>
<td>.293** .381** .312** .274**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Relaxation expectancies</td>
<td>.005 .259** .317** .251** .187**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Negative effect expectancies</td>
<td>.692** .384** -.130** -.090** .167** -.127**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Negative Affect</td>
<td>.505** .376** .057 .018 .177** .021 .464**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. ** p < .01
Table 4. Multiple Regression Results: Predicting Cannabis Use Frequency

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>CI (95%)</th>
<th>sr²</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>.64</td>
<td>.46</td>
<td>.05</td>
<td>-0.26, 1.54</td>
<td>.00</td>
</tr>
<tr>
<td>DT</td>
<td>-1.10*</td>
<td>.45</td>
<td>-.09</td>
<td>-1.98, -0.21</td>
<td>.00</td>
</tr>
<tr>
<td>NA x DT</td>
<td>.49</td>
<td>.43</td>
<td>.04</td>
<td>-0.36, 1.34</td>
<td>.00</td>
</tr>
<tr>
<td>Intercept</td>
<td>11.07</td>
<td>.44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{adjusted } R^2 = .01 \quad \text{F}_{\text{change}}(1,911) = 1.30 \quad p = .26
\]

*Note.* *p* < .05
Table 5. Multiple Regression Results: Predicting Cannabis Use Problems

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>CI (95%)</th>
<th>$sr^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>11.65**</td>
<td>.68</td>
<td>.51</td>
<td>10.33, 12.98</td>
<td>.23</td>
</tr>
<tr>
<td>DT</td>
<td>-.43</td>
<td>.65</td>
<td>-.02</td>
<td>0.51, -1.71</td>
<td>.00</td>
</tr>
<tr>
<td>NA x DT</td>
<td>2.16*</td>
<td>.63</td>
<td>.10</td>
<td>0.93, 3.39</td>
<td>.01</td>
</tr>
<tr>
<td>Intercept</td>
<td>11.07</td>
<td>.44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted $R^2 = .26$  $F_{change} (1,983) = 11.86$  $p < .01$

*Note. *$p < .01; **p < .001*
Figure 1. Moderating Effect of Distress Tolerance on the Link between Negative Affect and Cannabis Problems (CAPQ Scores)
Appendix

Cannabis Associated Problems Questionnaire (CAPQ)

Has marijuana ever caused you?

<table>
<thead>
<tr>
<th></th>
<th>Yes, but only once or a very minor problem</th>
<th>Yes, but only a couple of times or a minor problem</th>
<th>Yes, a few times or moderate problems</th>
<th>Yes, many times or a somewhat serious problem</th>
<th>Yes, very many times or a serious problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems between you and your partner</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Problems in your family</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>To neglect your family</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Problems between you and your friends</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>To miss days at work or to miss class</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>To lose a job</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>To have lower productivity</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Medical problems</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Withdrawal symptoms</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Blackouts or flashbacks</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Memory loss</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Difficulty sleeping</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Please mark “Yes, but only a couple of times or a minor problem.”</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Financial difficulties</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Yes, but only once or a very minor problem</th>
<th>Yes, but only a couple of times or a minor problem</th>
<th>Yes, a few times or moderate problems</th>
<th>Yes, many times or a somewhat serious problem</th>
<th>Yes, very many times or a serious problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>To have a lower energy level</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>To feel bad about your use</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Lowered self-esteem</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>To procrastinate</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>To lack self-confidence</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

93
### Cannabis Use Disorders Identification Test – Revised (CUDIT-R)

#### How often do you use cannabis?

- **Never**
- **Monthly or less**
- **2-4 times a month**
- **2-3 times a week**
- **4 or more times a week**

#### How many hours were you “stoned” on a typical day when you had been using cannabis?

- **Less than 1**
- **1 or 2**
- **3 or 4**
- **5 or 6**
- **7 or more**

#### How often during the past 6 months did you find that you were not able to stop using cannabis once you had started?

- **Never**
- **Less than monthly**
- **Monthly**
- **Weekly**
- **Daily or almost daily**

#### How often during the past 6 months did you fail to do what was normally expected from you because of using cannabis?

- **Never**
- **Less than monthly**
- **Monthly**
- **Weekly**
- **Daily or almost daily**

#### How often in the past 6 months have you devoted a great deal of your time to getting, using, or recovering from cannabis?

- **Never**
- **Less than monthly**
- **Monthly**
- **Weekly**
- **Daily or almost daily**

#### How often in the past 6 months have you had a problem with your memory or concentration after using cannabis?

- **Never**
- **Less than monthly**
- **Monthly**
- **Weekly**
- **Daily or almost daily**

#### How often do you use cannabis in situations that could be physically hazardous, such as driving, operating machinery, or caring for children?

- **Never**
- **Less than monthly**
- **Monthly**
- **Weekly**
- **Daily or almost daily**

#### Are you currently paying attention to this survey?

- **Yes**
- **No**

#### Have you ever thought about cutting down, or stopping, your use of cannabis?

- **Never**
- **Yes, but not in the past 6 months**
- **Yes, during the past 6 months**
Marijuana Effect Expectancy Questionnaire (MEEQ)

The following questions ask about the effects of marijuana. Reach each question carefully and respond according to your own personal thoughts, feelings, and beliefs about marijuana now. We are interested in what you think about marijuana, regardless of what other people might think. Whether or not you have had actual experiences with marijuana, you are to answer in terms of your beliefs about marijuana. There are no right or wrong answers.

<table>
<thead>
<tr>
<th></th>
<th>Disagree Strongly</th>
<th>Disagree Somewhat</th>
<th>Uncertain</th>
<th>Agree Somewhat</th>
<th>Agree Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>I get a sense of relaxation from smoking marijuana.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking marijuana makes me less tense or relieves anxiety; it helps me to unwind.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marijuana makes me carefree, and I do not care about my problems as much.</td>
<td></td>
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</tr>
<tr>
<td>I am not concerned about how others evaluate me when I am on marijuana.</td>
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<tr>
<td>When I smoke marijuana I do not feel insecure.</td>
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</tr>
<tr>
<td>Marijuana makes me say things I do not mean.</td>
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</tr>
<tr>
<td>The sky is green.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Marijuana tastes and smells bad.</td>
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<tr>
<td>I have a happy, good feeling when I smoke marijuana.</td>
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</tr>
<tr>
<td>Statement</td>
<td>Disagree Strongly</td>
<td>Disagree Somewhat</td>
<td>Uncertain</td>
<td>Agree Somewhat</td>
<td>Agree Strongly</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------------------</td>
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<td>----------------</td>
</tr>
<tr>
<td>Marijuana causes me to lose control and become careless.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Marijuana makes it easier to escape from problems and responsibilities.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Marijuana can cause me to become depressed and disappointed with myself.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Marijuana can make my feelings change from happy to sad.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Marijuana can make me angry and possibly violent.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>After the “high” of smoking marijuana, I feel down.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Marijuana makes me critical and short-tempered.</td>
<td>○</td>
<td>○</td>
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<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Marijuana makes me calm.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I am more relaxed in social situations if I have been smoking marijuana.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Smoking marijuana is similar to being “high” from drinking alcohol.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Distress Tolerance Scale – Short Form (DTS-SF)

Please respond to each statement as honestly as possible. Please note that this scale ranges from 1 (Strongly agree) on the left to 5 (Strongly disagree) on the right.

<table>
<thead>
<tr>
<th>Statement</th>
<th>1 (Strongly Agree)</th>
<th>2 (Agree)</th>
<th>3 (Neither Agree Nor Disagree)</th>
<th>4 (Disagree)</th>
<th>5 (Strongly disagree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>My feelings of distress are so intense that they completely take over.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being distressed or upset is always a major ordeal for me.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>I can't handle feeling distressed or upset.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>I'll do anything to stop feeling distressed or upset.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
</tbody>
</table>