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DISTRESS INTOLERANCE AND CANNABIS USE: AN INITIAL EMPIRICAL INVESTIGATION

A Dissertation Presented

by

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to

The Faculty of the Graduate College

of

The University of Vermont

In Partial Fulfillment of the Requirements  
for the Degree of Doctor of Philosophy  
Specializing in Clinical Psychology

October, 2015

Defense Date: May 29, 2015  
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## ABSTRACT

Within the United States (U.S.), one-third of those who use cannabis (the most commonly used illicit drug in the U.S.), exhibit cannabis use problems significant enough to warrant a diagnosis of cannabis use disorder (CUD; Compton, Grant, Collier, Glantz, & Stinson, 2004). Data suggests that quitting cannabis is highly difficult (Copersino et al., 2006), yet, there is little empirical knowledge about the nature of factors that relate to quit processes (e.g., self-efficacy). One potentially promising variable of relevance to CUD is distress intolerance (Leyro, Zvolensky, & Bernstein, 2010). Distress intolerance is referred to as (a) the *perceived* capacity to withstand negative emotional and/or aversive states, and (b) the *behavioral act* of withstanding distressing internal states elicited by some type of stressor. Although theoretically nested within a broader network of risk and protective processes, distress intolerance is posited to be related to, though conceptually distinct from, other variables (e.g., anxiety sensitivity; emotion regulation; Leyro et al., 2010). Individuals with higher levels of distress intolerance may be prone to maladaptively respond to distress (e.g., life stressors), and attempt to avoid negative emotions and/or aversive states (e.g., use cannabis to alter the perception or impact of negative mood, or to enhance positive mood). In contrast, persons with lower levels of distress intolerance may be more able to adaptively respond to distress (e.g., seek out alternative, more adaptive coping strategies instead of using cannabis).

There is limited knowledge of the explanatory role of the inability to tolerate negative affect and other aversive internal sensations (e.g., withdrawal) in terms of CUD and the nature of the quit experience (e.g., beliefs about barriers to quitting). The aim of the present study was to examine the main and interactive effects of perceived and behavioral indices of distress intolerance in terms of cannabis quit-related variables, including (a) failed quit attempts, and duration of average time to relapse for *past* quit attempts; (b) greater severity of withdrawal symptoms experienced while quitting in the past, lower self-efficacy for abstaining, and greater perceived barriers for quitting cannabis; and (c) greater CUD problems. The sample recruited was characterized by racially and ethnically diverse (65.2% minority) adult cannabis users, many of whom had not completed college (46.5%). The sample had high rates of co-occurring psychiatric and medical illness (e.g., 36.1% had a current anxiety disorder, 26.4% had a current mood disorder, and half endorsed a medical condition), and over 25% fell below the 2013 Federal Poverty Level.

There was no empirical support for an interactive or main effect of perceived or behavioral distress intolerance for any of the dependent variables. Although previous studies did not employ most of the cannabis dependent measures utilized in the current report, the lack of significant effects in the regression models was surprising given previous work on the topic (focused largely on coping motives for cannabis use). At the bi-variate level, there was some modest evidence of a 'signal' for perceived distress intolerance for certain cannabis dependent variables; these effects ranged from small to moderate. These data suggest, at least among the present largely minority sample, neither perceived or behavioral distress intolerance are robustly related to the cannabis dependent measures. One conservative interpretation of these findings is that distress intolerance may not perform the same across all CUD samples.

Post hoc analyses focused on perceived distress intolerance subfactors relations to the dependent variables; indirect explanatory role of negative affect in perceived distress intolerance-cannabis relations; and bi-variate relations between perceived and behavioral distress intolerance with other transdiagnostic distress processes. Results suggested (a) no incremental explanatory effect for specific perceived distress intolerance subfactors; (b) a significant indirect effect of negative affect in the relation between perceived distress intolerance and certain cannabis dependent variables; and (c) consistent evidence of convergent validity for perceived distress intolerance with other transdiagnostic affective vulnerability factors. I contextualize the findings in relation to past work, and the methodology employed in the current study. I discuss how future theory-driven work that seeks to uncover the time course and patterning between distress intolerance, negative mood, and cannabis use behavior are needed. I also suggest that this work will likely have the greatest impact when the social contexts of CUD populations (e.g., social determinants of health) are more directly integrated into the theoretical models.

## ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my advisor, Dr. Michael J. Zvolensky, for his encouragement, support, and guidance in this process. He has truly and selflessly offered his advice, teaching, and time to help guide me through my research. This work was supported in part by Dr. Zvolensky's endowment from Hugh Roy and Lillie Cranz Cullen and revenue from the Anxiety and Health Research Laboratory and Substance Use Treatment Clinic.

I would like to extend my appreciation to my dissertation committee for their support and consultation in this process. Thank you for your time and your willingness to be part of my committee.

My research could not have been possible without the support from the faculty and support staff of the Psychology Department of the University of Vermont and the University of Houston. I would like to recognize everyone that helped facilitate and ease the collection and completion of my dissertation data, and supported me in this process.

Finally, I cannot find words to express the amount of support I received from family and friends. You offered me inspiration, faith, flexibility and optimism and allowed me to become the person I am today. Perhaps a quote a wise person once shared with me summarizes it best: "Ancora Imparo" ("*Still, I am learning*"— Michelangelo, age 87). To those of you who supported me throughout this process, I promise to continually seek opportunities for learning and growth.

## TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS .....	ii
LIST OF TABLES .....	v
LIST OF FIGURES .....	vi
CHAPTER 1: CANNABIS USE AND ITS DISORDERS .....	1
1.1. Developmental Stages, Prevalence, and Negative Impact.....	1
1.1.1. Developmental Stages .....	1
1.1.2. Prevalence .....	2
1.1.3. Impact.....	3
1.2. Motivation to Quit, Reasons for Quitting, and Success in Quitting .....	5
1.2.1. Motivation to Quit .....	5
1.2.2. Reasons for Quitting .....	6
1.2.3. Success in Quitting .....	7
1.3. Predictors of Cannabis Lapse and Relapse.....	8
1.3.1. Substance Use, Stress, and Coping Factors .....	8
1.3.2. Psychological Symptoms and Disorders .....	8
1.3.3. Summary .....	10
CHAPTER 2: DISTRESS INTOLERANCE: CONCEPTUALIZATION AND OPERATIONAL DEFINITION, MEASUREMENT AND RELATION TO PSYCHOPATHOLOGY.....	11
2.1. Conceptualization and Operational Definitions.....	11
2.1.1. Measurement .....	12
2.1.2. Interrelations between Self-Report and Behavioral Distress Intolerance Indices.....	13
2.1.3. Relations to Psychological Symptoms and Disorders .....	14
2.2. Distress Intolerance and Cannabis Use Behavior .....	15
2.2.1. Summary of Key Limitations .....	19
CHAPTER 3: INTEGRATING DISTRESS INTOLERANCE IN CANNABIS USE.....	21
3.1. A Working Theoretical Model .....	21
3.1.1. Perceived Distress Intolerance.....	21
3.1.2. Behavioral Distress Intolerance.....	21
3.1.2. Interplay (theoretical) between Perceived Distress Intolerance Behavioral Distress Intolerance...22	
3.1.3. Summary and Study Aims.....	23
CHAPTER 4: METHOD.....	25
4.1. Participants .....	25

4.2. Inclusion/Exclusion Criteria.....	25
4.3. Measures.....	26
4.4. Procedure.....	30
4.5. Analytic Strategy.....	30
CHAPTER 5: RESULTS .....	32
5.1. Descriptive Data.....	32
5.1.1. Living situation, Educational Background, and Financial Status .....	32
5.1.2. Cannabis Use.....	33
5.1.3. Tobacco and Alcohol Use .....	33
5.1.4. Psychiatric History .....	33
5.1.5. Physical Health .....	34
5.2. Bi-Variate Correlations .....	34
5.3. Regression Models .....	35
5.4. Post Hoc Tests.....	36
5.4.1. Perceived Distress Intolerance Subscales.....	36
5.4.2. Explanatory Role of Negative Mood.....	38
5.4.3. Conceptually-Related ‘Tolerance’ Variables .....	41
CHAPTER 6: DISCUSSION .....	44
6.1. Nature of the Sample.....	44
6.2. Primary Tests of Study Aims .....	46
6.3. Post Hoc Tests.....	49
6.4. Clinical Implications .....	52
6.5. Study Limitations and Future Directions.....	54
6.6. Summary .....	57
REFERENCES.....	58
APPENDIX .....	87
Appendix A: Description of additional post hoc measures .....	87

## LIST OF TABLES

Table	Page
Table 1: Summary of studies examining distress intolerance and cannabis .....	73
Table 2: Inclusionary and Exclusionary Criteria .....	74
Table 3: Measure Administration Schedule .....	75
Table 4: Rates of Psychopathology and Physical Illness .....	76
Table 5: Bivariate Correlations .....	77
Table 6: Hierarchical regression models for Aim 1.....	78
Table 7: Hierarchical regression models for Aim 2.....	79
Table 8: Hierarchical regression models for Aim 3.....	80
Table 9: Bivariate Correlations between Subscales of Perceived Distress Intolerance and Dependent Variables .....	81
Table 10: Hierarchical regression analyses for post-hoc tests .....	82
Table 11: Hierarchical regression models for post-hoc indirect models .....	83
Table 12: Bivariate Correlations .....	84
Table 13: Comparison study participant characteristics .....	85

## LIST OF FIGURES

Figure	Page
Figure 1: Heuristic depiction of the global experiential distress (in)tolerance construct and lower-order, domain-specific dimensions (Zvolensky et al., 2010) .....	12
Figure 2: Consort of Participant Recruitment.....	25
Figure 3: Conceptual diagram of post-hoc mediation models .....	86

## **CHAPTER 1: CANNABIS USE AND ITS DISORDERS**

### **1.1. Developmental Stages, Prevalence, and Negative Impact**

Until relatively recently, *cannabis abuse* was defined as a pattern of cannabis use that includes significant and unpleasant consequences associated with frequent cannabis use. This pattern of use needs to have occurred within a 12-month period. Examples of consequences associated with cannabis abuse include legal problems, repeated use in physically hazardous situations, and repeated social and interpersonal problems as a result of use. A central differentiating feature of cannabis abuse and dependence was that abuse only includes harmful consequences of frequent use, rather than compulsive use, tolerance, and perhaps withdrawal (APA, 1994). It also is important to note that abuse could not be diagnosed if cannabis dependence criteria had been met. This distinction highlights the more severe nature of cannabis dependence from a historical perspective. In the *relapse stage*, individuals who have attempted to stop using return to their cannabis use behavior after a period of sustained abstinence.

In 2013, cannabis-related disorders were revised by the American Psychiatric Association (2013) with the publication of the Diagnostic and Statistical Manual for Mental Disorder, 5<sup>th</sup> Edition in an effort to enhance classification, consistency, and clarity of substance use disorders. Of these changes, cannabis abuse and cannabis dependence were collapsed into one diagnostic category: Cannabis Use Disorder (CUD), defined as a pattern of problematic use of cannabis, which leads to impairment or distress, often involving recurrent use, unsuccessful cessation, craving, tolerance, and withdrawal (APA, 2013). Other substantive changes included the removal of recurrent legal problems among the diagnostic criteria, and the addition of cannabis withdrawal (APA, 2013).

#### **1.1.1. Developmental Stages**

Developmental stages of cannabis use are central to understanding the nature of CUD. One well-known and broadly used approach is that offered by Flay (1993). Flay's (1993) stage model (originally from work on tobacco) suggests substance use follows a generally well-specified sequence of behavior that includes the following stages: initiation, maintenance, and relapse. In this model, the initiation stage reflects trying cannabis on the initial few trials and further experimentation (irregular use over time). The

maintenance stage includes regular use of cannabis (ranging from weekly to daily use); it is in this stage that individuals are most apt to develop CUD.

### **1.1.2. Prevalence**

Cannabis has been the most widely used illicit substance for 40 consecutive years in the United States (U.S.; Johnston, O'Malley, Bachman, & Schulenberg, 2013), with approximately 25 million people in the U.S. (8.6% of the population) having used cannabis in the past year (Johnston, O'Malley, Bachman, & Schulenberg, 2005), and approximately 18.9 million people in the U.S. (6.1% of the population) having used cannabis in the past month (NIDA, 2012). Cannabis can be consumed by ingestion, smoking, or vaporization. There are at least 60 different cannabinoids, although the pharmacokinetics of the vast majority of these compounds are still being actively explored (Ashton, 1999). Of these, the most well known cannabinoid is tetrahydrocannabinol (THC). THC is believed to be the most potent psychoactive agent in the cannabinoid plant (Tanda & Goldberg, 2003). Cannabinoids are believed to have evolved due to their influence on mood and behavior (e.g., influence pain perception; Tanda & Goldberg, 2003). For example, there are numerous reports that cannabinoids may dampen or modulate pain responsivity and decrease somatic distress (e.g., stomach irritation; Tanda & Goldberg, 2003). Other reports suggest that cannabinoids may have a dose-dependent response in relation to anxiety (Machoulam & Parker, 2012). For example, lower doses may have anxiolytic properties, whereas higher doses may provoke an anxiogenic response (Rubino et al., 2008).

An estimated 8% of persons who have ever used cannabis will become daily users (Lopez-Quintero et al., 2011; Wagner & Anthony, 2002). According to SAMHSA's National Survey on Drug Use and Health, 7.5% of the population can be identified as current ("past month") cannabis users, making cannabis the most used (illicit) drug in the U.S. (2014). Lifetime cannabis dependence is estimated at 8.5% of the general population (Compton, Thomas, Stinson, & Grant, 2007). In 2012, NIDA reported that 4.3 million Americans met clinical criteria for dependence or abuse, which is more than twice the amount of individuals who meet dependence/abuse for prescription pain relievers (2.1 million) and four times the number for cocaine dependence/abuse (1.1 million). Rates of conditional dependence, defined as the risk for developing dependence among those who have ever used the drug, indicate that cannabis is associated

with a high rate of dependence potential (Anthony, Warner, & Kessler, 1994). For example, the relative risk of experiencing cannabis dependence given use of the drug in the past year is estimated to be 2% among adults, which is only slightly lower than that for cocaine (7.1%) and comparable to rates observed for alcohol (2%; Lopez-Quintero et al., 2011). Furthermore, greater levels of use are related to an increased risk for dependence. The rate of dependence appears to be approximately 17-18.8% among those persons using cannabis on a regular basis (weekly or daily, respectively; Cogle, Hakes, Macatee, Zvolensky, & Chavarria, in press). Moreover, some work has suggested cannabis use problems have increased, with 35% of adult cannabis users in the U.S. currently meeting criteria for CUD compared with 30% 10 years earlier, representing an increase of approximately 730,000 individuals (Compton et al., 2004; Cogle et al., in press).

Treatment and community studies have examined prevalence rates of cannabis use among samples suffering from a variety of medical and psychological problems. For example, one study found that among those seeking treatment for psychosis, approximately 23% currently used cannabis, with about half of that group currently “misusing” the drug (Hambrecht & Hafner, 2000). Another community-based study found that approximately 16% of those with spinal cord injury used cannabis (Young, Rintala, Rossi, Hart, & Fuhrer, 1995). Other work has reported that cannabis use accounted for as much as 25% of the primary drug problems of individuals seeking residential drug treatment (Fliegel et al., 1997). These studies collectively suggest that cannabis use: (1) may be overrepresented among certain “vulnerable” populations and (2) is a primary clinical and public health concern.

### **1.1.3. Impact**

Historically, cannabis has been viewed by some as a ‘less severe’ substance use problem (Stephens, 1999). Although cannabis use has probably evolved due to its influence on mood and behavior (e.g., decrease sensitivity and reactivity to pain; Bonn-Miller, Boden, Bucossi, & Babson, 2014; Lee et al., 2013), there are a number of negative correlates related to excessive use. Scientific study has, in fact, provided empirical evidence that CUD is associated with a number of clinically significant problems (Kalant, Corrigan, Hall, & Smart, 1999). Indeed, there are several empirically documented negative consequences of frequent or problematic cannabis use (typically defined as weekly or daily use), such as

increased risk of severe medical disease (e.g., Bloom, Kaltenborn, Paoletti, Camilli, & Lebowitz, 1987), myocardial infarction (Mittleman, Lewis, Maclure, Sherwood, & Muller, 2001), increased risk taking behavior (e.g., unprotected sexual intercourse; McDonald, Schleifer, Richards, & de Wit, 2003; Sussman, Stacy, Dent, Simon, & Johnson, 1996), and clinically-relevant life impairment (e.g., Coughle, Hakes, Macatee, Chavarria, & Zvolensky, in press; Leirer, Yesavage, & Morrow, 1991; Zimmerman & Schmeelk-Cone, 2003). Classic work by Lynskey and Hall (2000), for example, indicates that weekly cannabis use is related to decreased educational attainment, and others have found that weekly cannabis use is associated with reduced workplace productivity (Lehman & Simpson, 1992), as well as impaired occupational judgment (e.g., Leirer et al., 1991). Notably, studies have found that greater weekly use of cannabis is associated with increased risk of severe respiratory illnesses, particularly chronic bronchitis (Fligiel et al., 1997). Additionally, cannabis use has been linked to fatal traffic accidents and general driving impairment (Everest, Tunbridge, & Widdop, 1989) after controlling for the variance accounted for by concurrent alcohol and other substance use (Gjerde & Kinn, 1991). Data from the Drug Alert Warning Network (DAWN) indicates that cannabis also is the most commonly mentioned substance in emergency department admissions among youth (ages 12-17), the second most common for young adults (ages 18-24), and the third most for adults over age 25 (OAS, 2001).

Several lines of research have documented the co-occurring nature of negative affective states and problematic cannabis use. In one recent study, anxiety symptoms were associated with the self-reported quantity of cannabis used and cannabis-associated problems (Van Dam, Bedi, & Earleywine, 2012). Similarly, other research has suggested that heavy cannabis users report higher levels of somatization, anxiety, paranoid ideation, and psychoticism (reported via Symptom Checklist [SCL-90-R; Derogatis, 1992]; Somaini et al., 2012). Although CUD may be related to multiple forms of psychopathology, there appear to be specific sub-groups of emotionally vulnerable persons who may be at particularly heightened risk for cannabis-related problems. As one illustrative example, nearly one-third to one-fourth of people with cannabis dependence have social anxiety disorder (SAD), a higher rate than that reported for other anxiety and mood disorders (Agosti, Nunes, & Levin, 2002; Stinson, Ruan, Pickering, & Grant, 2006). After controlling for gender, some work suggests adolescents with SAD are almost seven times more likely

to develop cannabis dependence in early adulthood (Buckner et al., 2008). Other work indicates elevated social anxiety symptoms are associated with greater cannabis-related problems across a range of populations (Buckner, Bonn-Miller, Zvolensky, & Schmidt, 2007; Buckner, Heimberg, Matthews, & Silgado, 2012; Buckner, Heimberg, & Schmidt, 2011; Buckner, Mallott, Schmidt, & Taylor, 2006; Buckner & Schmidt, 2008; Buckner, Schmidt, Bobadilla, & Taylor, 2006; Buckner, Zvolensky, & Schmidt, 2012).

## **1.2. Motivation to Quit, Reasons for Quitting, and Success in Quitting**

### **1.2.1. Motivation to Quit**

Empirical evidence indicates that a large number of individuals who use cannabis on a regular basis are indeed motivated to quit. The first body of literature has evaluated treatment-seeking behavior. Here, the Drug Abuse Reporting Program (Sells, 1974) and other reports (Simpson, Savage, & Sells, 1978) first documented decades ago that a clinically significant number of individuals seek therapeutic services for 'problematic' cannabis use. Other large-scale surveys independently replicated such findings (Gerstein, & Johnson, 1999; Hubbard et al., 1989). Dennis et al. (2002), for example, reported that of “the 1.5 million adult admissions to the U.S. public treatment system in 1998, 35% were admitted for treatment of cannabis problems (p. 9).” Such rates are higher than those found for cocaine (32%), opioids, (18%), stimulants (9%), and other psychoactive substances (12%; Dennis, Babor, Roebuck, & Donaldson, 2002). Additionally, other reports involving national (representative samples) databases have found that demand for treatment of cannabis use and its disorders doubled between 1992 and 1998 (SAMHSA, 2001). It also is important to note cannabis treatment outcome studies have documented that a large number of treatment-seeking cannabis users are *not* current polysubstance abusers (Stephens, 1999; Stephens, Roffman, & Curtin, 2000). For example, Stephens et al. (1993) found that 80% of a large, cannabis dependent sample ( $n = 309$ ) did not report abuse of other substances in the past 90 days and 40% reported never abusing a drug other than cannabis. These data indicate cannabis represents a significant clinical and public health problem in its own right and commonly prompts treatment-seeking behavior even in the absence of other drug use.

Another body of empirical evidence related to the 'motivation to quit' suggests that, despite the notable rates of documented treatment-seeking behavior, most persons using cannabis actually attempt to quit on their own (i.e., without seeking professional assistance; Copersino et al., 2006; Cunningham, 2000;

Weiner, Sussman, McCullar, & Lichtman, 1999). Such self-quit rates are generally similar to those observed for other substances (e.g., tobacco; Hughes et al., 1996; Lopez-Quintero et al., 2011). In fact, numerous studies have reported that by young adulthood, many individuals have made multiple cannabis quit attempts on their own. For example, studies of weekly cannabis users have indicated that by age 30, individuals have reported a range of three to seven quit attempts on their own (e.g., Copersino et al., 2006; Stephens et al., 1993). Although these 'unsuccessful quitters' may presumably ultimately seek professional treatment when they continue to fail in their quit efforts, it is not presently clear what percentage will ultimately do so and under what circumstances.

The aforementioned quit data are noteworthy in the context of the present study for at least two reasons. First, these data suggest that a large proportion of those with CUD are interested in and pursue quitting with and without professional assistance. Second, there is relatively still little empirical knowledge about the mechanisms underlying success or failure in quit attempts, leaving a major gap in clinically-relevant knowledge.

### **1.2.2. Reasons for Quitting**

Current cannabis users, ranging from monthly users to those with CUD, report multiple, concurrent reasons for quitting, and that such reasons tend to vary as a function of age, gender, race, and time (Chauchard, Levin, Copersino, Heishman, & Gorelick, 2013; Copersino et al., 2010; Goodstadt, Sheppard, & Chan, 1984; Martin, Duncan, & Zunich, 1983; Stephens, Wertz, & Roffman, 1993; Weiner et al., 1999). Among youth, legal and parental problems tend to be the most common reasons for quitting, but among adults, worry about physical and psychological effects of cannabis use is the most often cited factor for wanting to quit (Copersino et al., 2010; Martin et al., 1983; Weiner et al., 1999). For example, Copersino et al. (2006) reported that 60% of non-treatment seeking adult weekly cannabis users reported worry about health problems (both real and perceived) as a motivating factor for quitting, and 63% desired to quit in order to gain more 'self-control' over their lives. In another study, Reilly and colleagues (1998) similarly found that anxiety or depressive symptoms were the most commonly reported 'negative effects' of cannabis use and the primary reason for quitting among weekly cannabis users ( $n = 268$ ). Others have reported similar findings among both non-treatment seekers (Boyd et al., 2005) and treatment seekers

(Stephens et al., 1993); such findings do not appear to vary as a function of type of cannabis use pattern or problem (Boyd et al., 2005). Overall, available data suggest cannabis users typically express multiple reasons for quitting, with the most common and consistently reported reasons pertaining to excessive negative emotional symptoms (e.g., anxiety and depression) and impaired levels of personal self-control.

### **1.2.3. Success in Quitting**

Individuals attempting to quit cannabis experience marked difficulty whether they make a quit attempt on their own or seek professional (formal) treatment. Numerous survey studies, for example, have documented that current cannabis users, both who are and are not dependent on the drug, who try to quit on their own report difficulty in remaining abstinent and frequently fail in their efforts to remain abstinent, as indexed by their numerous quit attempts (Copersinio et al., 2006; Weiner et al., 1999). Although self-quit attempts without professional assistance tend to be the most frequently employed quit strategy (Boyd et al., 2005; Budney, Vandrey, Hughes, Thostenson, & Bursac, 2008), it is striking that, even among those who do seek professional treatment, relapse to use is a highly common experience. Indeed, in a critical review of the treatment outcome literature, McRae and colleagues (2003) concluded: “studies suggest that many patients do not show a positive treatment response, indicating that cannabis dependence is not easily treated (p. 369).” For example, one large-scale controlled study ( $n = 291$ ) found that 63% of adults receiving two of the best available intervention strategies - motivational individualized intervention or cognitive-behavioral therapy - relapsed to regular use within four months (Stephens et al., 2000). For comparison purposes, the delayed treatment (control) condition reported that 91% of individuals were not abstinent at the four-month assessment (Stephens et al., 2000). At 16 months, relapse rates among the active treatment conditions rose to 71% and 72% for the motivational individualized intervention and cognitive-behavioral therapy, respectively (Stephens et al., 2000).

Other studies have reported similar results (Copeland, Swift, Roffman, & Stephens, 2001; Stephens, 1999; Stephens et al., 1993), and clinical trials have extended such work by noting that in addition to full relapse, lapses are highly common and clinically significant. For example, Moore and Budney (2003) reported that among cannabis dependent adult outpatients receiving treatment ( $n = 152$ ), 71% lapsed (defined as any cannabis use made during a quit attempt) within six months, 46% within three

months, and 24% within one month. In this same study, 71% of lapsers ultimately experienced a full relapse (defined as four or more days of use per week; Moore & Budney, 2003). These data make clear the challenge of quitting among individuals with CUD.

### **1.3. Predictors of Cannabis Lapse and Relapse**

#### **1.3.1. Substance Use, Stress, and Coping Factors**

There has been lesser scientific work focused on predictors of success or failure in attempts to quit using cannabis. The work that has been completed in this regard has been broadly guided to varying degrees by social learning (Bandura, 1997), stress and coping (Kaplan, 1996), and behavioral economic (Bickel & Vuchinich, 2000) theories of substance use and relapse (McClure, Stitzer, & Vandrey, 2012). These studies have thus far provided a number of initial and important observations: (1) early lapses are predictive of later relapses among adult and adolescent cannabis abuse or dependent persons, regardless of whether they receive formal treatment or not (Agosti & Levin, 2007; Harrison & Asche, 2001; Latimer, Winters, Stinchfield, & Traver, 2000; Moore & Budney, 2003); (2) personal stressors (e.g., family conflict) are related to increased odds of relapse among individuals with cannabis abuse or dependence receiving outpatient treatment (Godley, Kahn, Dennis, Godley, & Funk, 2005); (3) other substance use and peers' substance use (alcohol and other drugs) are predictive of increased odds of relapse among adolescent cannabis abusing or dependent outpatients (Latimer et al., 2000); and (4) levels of personal self-efficacy (i.e., beliefs regarding one's ability to refrain from use) for abstaining from cannabis use among adults with cannabis abuse or dependence seeking treatment is modestly predictive (Stephens, Wertz, & Roffman, 1995). These data collectively indicate that substance use as well as stress and coping-related factors (e.g., self-efficacy) likely play an important role in cannabis relapse among adults and adolescents. These observations are consistent with findings from other areas of substance use disorder work (Leshner, 1999).

#### **1.3.2. Psychological Symptoms and Disorders**

Due partially to the observation that elevated psychiatric symptoms are often co-occurring among treatment-seeking cannabis users meeting criteria for abuse or dependence (Budney, Radonovich, Kiggins, & Wong, 1998; Stephens et al., 1993), studies have been conducted to ascertain whether psychological vulnerabilities, broadly defined as psychological risk factors or disorders, may be relevant to cannabis

relapse. This work is consistent with contemporary theories that posit persons with substance use disorders and co-occurring psychological vulnerabilities (e.g., high levels of negative affectivity or full-blown psychiatric disorders) are at risk for early lapse, and therefore, generally poorer treatment outcome (Brown, Lejuez, Kahler, Strong, & Zvolensky, 2005; Coombs, Kozlowski, & Ferrence, 1989; Hughes, 1993; Hughes & Brandon, 2003; Shiffman, 1993; Zvolensky & Bernstein, 2005). It is important to note from the outset that numerous studies have found that both treatment-seeking and non-treatment seeking individuals (adults and adolescents) meeting criteria for CUD generally have significantly higher rates of psychological symptoms and disorders relative to those not with CUD (Agosti et al., 2002; Arendt & Munk-Jorgensen, 2004; Bovasso, 2001; Budney et al., 1998; Copeland et al., 2001; Cogle et al., in press; Miller, Klamen, Hoffmann, & Flaherty, 1996; Rey, Sawyer, Raphael, Patton, & Lynskey, 2002; Troisi, Pasini, Saracco, & Spalletta, 1998; Zvolensky Bernstein, et al., 2006). Moreover, time sampling studies on cannabis using samples suggests that negative mood is often an antecedent to cannabis use more generally (Buckner, Zvolensky, Crosby, Wonderlich, Ecker, & Richter, 2015).

Contemporary theories of substance use relapse suggest such psychological factors, such as elevated negative emotional symptoms or disorders, could adversely impact success in quitting cannabis use. For example, co-occurring psychological problems may increase stressors as well as motivations to use cannabis to 'manage' dysregulated negative emotional states (e.g., coping-oriented motives; Zvolensky, Leen-Feldner, et al., 2006). In fact, some have argued that the management of aversive emotions may be centrally important to cessation success (Rooke, Norberg, & Copeland, 2011). Of the completed studies in this domain, as reviewed below, each has thus far focused on a relatively narrow band of psychological symptoms and disorders. Yet, the results of these investigations have converged on the same general conclusion: negative emotional and psychological symptoms are related to increased risk of cannabis relapse among current users. In one study, the presence of psychotic symptoms among psychotic disorder adult patients who were monthly cannabis users predicted cannabis relapse (Hides, Dawe, Kavanagh, & Young, 2006). In other studies, adolescents meeting criteria for cannabis abuse or dependence in outpatient psychiatric treatment were more apt to relapse to cannabis use if they had comorbid conduct disorder, depression, or attention deficit hyperactivity disorder (Grella, Hser, Joshi, & Rounds-Bryant, 2001; White

et al., 2004). Arendt and colleagues (2007) explored medical charts over time of 3,114 adult participants who received treatment for cannabis dependence in Denmark. Results indicated that cannabis dependent persons' psychiatric treatment for problems not related to substance use (i.e., other mental health problems) was prospectively associated with an increased risk of future re-entry into treatment for cannabis use.

Notably, other emerging research has focused on other factors that predict cessation outcome (Pacek & Vandrey, 2014). Here, differences in sociodemographic characteristics have also been noted, including race (identifying as African American), gender (males), and marital status (unmarried) being some of the strongest predictors of quit failure (Copersino et al., 2010; Rooke, Norberg, & Copeland, 2011).

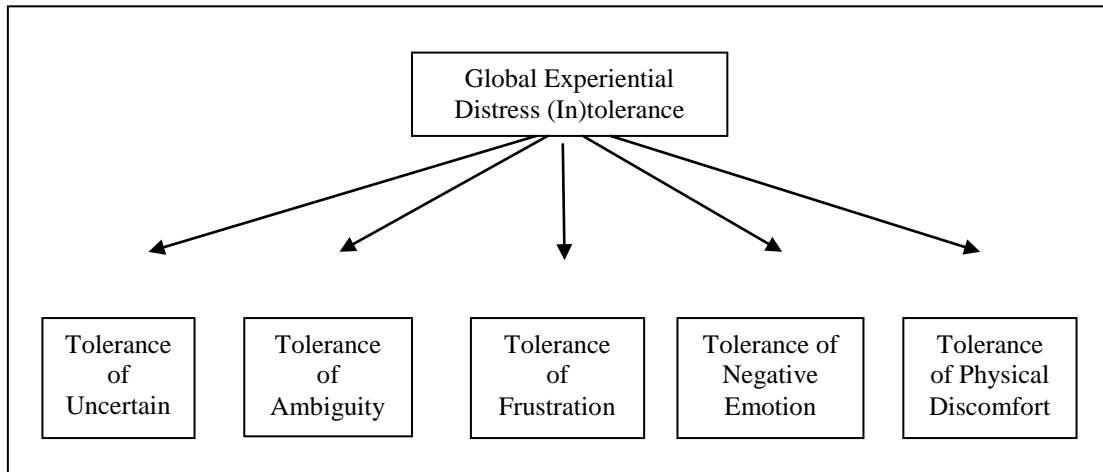
### **1.3.3. Summary**

Collectively, there is evidence that psychological symptoms (most notably, negative affect) and disorders as well as other sociodemographic variables are related to the maintenance of cannabis as well as relapse. Therefore, it appears that there is a need for a more integrative focus on individual difference factors for stress responsivity and psychological vulnerability in an effort to gain a more comprehensive understanding of lapse and relapse processes for CUD.

## **CHAPTER 2: DISTRESS INTOLERANCE: CONCEPTUALIZATION AND OPERATIONAL DEFINITION, MEASUREMENT AND RELATION TO PSYCHOPATHOLOGY**

### **2.1. Conceptualization and Operational Definitions**

One 'stress responsivity factor' of potential relevance to CUD is distress intolerance (Leyro et al., 2010; Zvolensky, Bernstein, & Vujanovic, 2011; Zvolensky & Otto, 2007; Zvolensky, Vujanovic, Bernstein, & Leyro, 2010). Distress intolerance reflects an individual's perceived or behavioral capacity to withstand experiential/subjective distress related to affective, cognitive, and/or physical states (e.g., negative affect, physical discomfort; Simons & Gaher, 2005; Zvolensky et al., 2011). Scholars have suggested it is a transdiagnostic individual difference factor for stress responsivity and psychological vulnerability (Linehan, 1993; McHugh & Otto (2011). Conceptual models of perceived distress intolerance suggest that the construct is hierarchical in nature (Zvolensky et al., 2010). Namely, there is a global "experiential distress intolerance" construct supported by other, specific lower-order constructs (e.g., frustration intolerance, depressed mood intolerance (see Figure 1). In fact, consistent with the five-factor model of Zvolensky et al. (2010), independently conducted empirical work supports this type of hierarchical perceived distress intolerance model (Bardeen, Fergus, & Orcutt, 2013). Although distress intolerance is presumably related to other emotion vulnerability processes such as anxiety sensitivity, emotion dysregulation, withdrawal phobia, experiential avoidance, among others, available work suggests it is a unique psychological construct.



**Figure 1: Heuristic depiction of the global experiential distress (in)tolerance construct and lower-order, domain-specific dimensions (Zvolensky et al., 2010)**

### 2.1.1. Measurement

Distress intolerance has been characterized by two dominant conceptual and related measurement perspectives. Specifically, distress intolerance has been studied as: (a) the *perceived* capacity to withstand aversive emotional or physical states (assessed via self-report measures; e.g., Distress Tolerance Scale [DTS; Simons & Gaher, 2005], Discomfort Intolerance Scale [DIS; Schmidt, Richey, & Fitzpatrick, 2006], and (b) the *behavioral act(s)* of withstanding distressing internal states elicited by some type of stressor (assessed via the latency to discontinue distressing tasks; e.g., mirror-tracing task, breath-holding task; Zvolensky et al., 2011). Accordingly, there have been two methodological literatures, each linked to one of these conceptual perspectives on distress intolerance.

There are numerous self-report measurements of distress intolerance measuring perceived capacity to withstand negative emotions. First, tolerance of ambiguity, which reflects the way an individual processes information about a situation when faced with vague, unfamiliar or complicated stimuli (TOA; Frenkel-Brunswik, 1948, 1951, 1959; Hoffeditz & Guilford, 1935; Furnham & Ribchester, 1995), has spanned several disciplines, such as management and organizational psychology (Herman, Stevens, Bird, Mendenhall, & Oddou, 2010). TOA, or the perceived capacity to tolerate threatening stimuli, is theoretically related to higher levels of emotional distress, such as anxiety (Leyro et al., 2010).

Intolerance of uncertainty (IU), which reflects the different emotional, cognitive, or behavioral responses people demonstrate when presented with uncertain situations and events (IU; Buhr & Dugas, 2002; Dugas, Buhr, & Ladouceur, 2004), is thought of as distinct from TOA, in that, IU reflects fear or uncertainty about events that have not yet happened, therefore serves to maintain or exacerbate perceived threat (Carleton, Gosselin, & Asmundson, 2010).

Discomfort intolerance, defined as the capacity to withstand uncomfortable physical sensations (DIS; Schmidt et al., 2006), is theorized to capture an individual's capacity to withstand aversive and uncomfortable physical or bodily states, and has been implicated in the development of anxiety psychopathology, such as fear of bodily sensations and hyper-arousal (Schmidt et al., 2006).

Distress intolerance, defined as an individual's perceived ability to withstand negative emotional states (DT; Simons & Gaher, 2005), has been described as, "one's evaluations and expectations of experiencing negative emotional states in respect to (1) tolerability and aversiveness, (2) appraisal and acceptability, (3) tendency to absorb attention and disrupt functioning, and (4) regulation of emotions, specifically, the subsequent strength of action tendencies to either avoid or immediately attenuate the experience (Simons, & Gaher, 2006)." Frustration intolerance, denoting an individual's beliefs regarding uncertainty, controllability, and aversiveness of emotions, has been connected to procrastination and irrational beliefs related to the demand that "reality *should* be what one wishes it be (Harrington, 2005)".

There also are a variety of behavioral distress intolerance measures, such as (1) physical tolerance tasks, measured in a variety of ways, capturing an individual's ability to withstand exposure to a specific type of aversive stimulus (e.g., breath-holding duration; Asmundson & Stein, 1994) and (2) cognitive-based tolerance tasks, also measured in a variety of ways, capturing an individual's ability to complete difficult and frustrating tasks which often require cognitive resources (e.g., mirror-tracing task; Strong et al., 2003).

### **2.1.2. Interrelations between Self-Report and Behavioral Distress Intolerance Indices**

McHugh and colleagues (2011) reported perceived distress intolerance measures and self-report measures of related constructs (e.g., anxiety sensitivity) were highly correlated, as were certain behavioral distress intolerance measures. However, behavioral and self-report measures (as classes) did not exhibit significant associations with one another (McHugh et al., 2011). Similarly, Bernstein, Marshall-Berenz,

and Zvolensky (2011) have reported perceived distress intolerance measures were significantly related to one another and the behavioral distress intolerance measures were significantly related to one another, although the self-report and behavioral measures were orthogonal to one another. Since these initial studies, the same patterns of findings (within class associations) have been replicated and extended to numerous populations (e.g., Ameral, Palm Reed, Cameron, & Armstrong, 2014; Anestis et al., 2012; Ellis, Vanderlind, & Beevers, 2013; Oser, Trafton, Lejuez, & Bonn-Miller, 2013).

Existing data suggest that perceived and behavioral distress intolerance indices may possibly not necessarily reflect individual differences of a common latent distress intolerance variable. Such results are in line with the perspective that the distress intolerance literature, as a whole, may be advanced by recognizing the distinction between self-report and behavioral tolerance constructs (Leyro et al., 2010). For example, it may be fruitful to conceptualize perceived distress intolerance as related to *antecedent emotion regulation* (i.e., expectancies that effect emotional or self-regulatory processes); and behavioral acts of tolerance as related to *response-focused emotion regulation* in the context of or following the onset of experiential distress (i.e., responses directed at an ongoing emotional response; Bernstein et al., 2011). This type of approach inherently integrates theory and empirical knowledge of the nature of emotional processing and regulation with distress intolerance (Bernstein et al., 2011; Webb, Miles, & Sheeran, 2012).

### **2.1.3. Relations to Psychological Symptoms and Disorders**

As reflected in the above perspective on distress intolerance, this construct may theoretically be related to aversive emotional states and may be followed by psychological or behavioral attempts to reduce the distress experienced (Simons & Gaher, 2005). In other words, intolerance of aversive somatic or affective states may amplify awareness of distress, and consequently, strengthen avoidant coping (negative reinforcement learning; McHugh & Otto, 2012). Accordingly, individuals with higher levels of distress intolerance may be more prone to maladaptively respond to distress and distress-eliciting contexts.

Consistent with this type of perspective, distress intolerance is related to a variety of psychopathological symptoms and disorders (Leyro et al., 2010). For example, higher levels of perceived distress intolerance for negative emotional and physical stimuli are significantly related to an increased risk of a variety of negative emotional symptoms (Asmundson & Stein, 1994; Boelen & Reijntjes, 2009; Telch,

Jacquin, Smits, & Powers, 2003; Timpano, Buckner, Richey, Murphy, & Schmidt, 2009). Other work has similarly begun to link distress intolerance to specific mood and anxiety (e.g., Schmidt, Mitchell, Keough, & Riccardi, 2011) disorders and depression (Gorka, Ali, & Daughters, 2012; Tull and Gratz, 2013; Williams, Thompson, & Andrews, 2013). Furthermore, higher levels of behavioral intolerance for acute episodes of aversive states are related to substance use relapse (Brown et al., 2002), as well as eating psychopathology (e.g., bingeing/purging; Anestis, Selby, Fink, & Joiner, 2007; Lavender et al., 2015), and psychotic spectrum disorders (Nugent et al., 2014). Perhaps not surprisingly, attempting to decrease distress intolerance has become a major feature of many evidence-based psychosocial treatment programs for mood and anxiety disorders, especially those that have a transdiagnostic orientation or focus (e.g., Barlow, Allen, & Choate, 2004; Linehan, 1993; Otto, Powers, & Fischmann, 2005; Tull, Schulzinger, Schmidt, Zvolensky, & Lejuez, 2007). Moreover, distress intolerance has been found to be an explanatory process in substance use treatment (Bornovalova et al., 2012; Hsu, Collins, & Marlatt, 2013). Notably, a growing body of work has linked distress intolerance to physical illness and disease progression (Magidson et al., 2013; Oser, Trafton, Lejuez, & Bonn-Miller, 2013).

## **2.2. Distress Intolerance and Cannabis Use Behavior**

Currently, there are a highly limited number of studies examining distress intolerance and CUD or cannabis use more generally. In this next section of the document, I review relevant studies in this domain. See Table 1.

Daughters et al. (2005) first explored the relation between distress intolerance and duration of most recent abstinence attempt. Participants were included if they endorsed use of cannabis, alcohol, stimulants, sedatives, opiates, hallucinogens, PCP, or inhalants prior to entering substance treatment. A mental arithmetic task (Paced Auditory Serial Addition Task [PASAT]; Gronwall, 1977) was administered, while participant's persistence on the task was measured as an index of distress intolerance. Participants ( $n = 89$ ) were enrolled in a residential substance abuse treatment facility in Washington, DC, with a mean age of 39.2 ( $SD = 9.4$ ) years, 62.9% male, 89.9% identifying as African American and educational backgrounds ranging from not completing high school/received GED (34.8%) to completing high school (42.7%) or attending some college or technical school (22.5%; Daughters et al., 2005). After a

detailed description of the study was given, and informed consent was collected, participants were instructed that they would be paid between \$5 and \$15 at the end of the session dependent on their total score obtained from participation in the task, providing incentive indirectly related to persistence of completing the task (Daughters et al., 2005). Results suggested that duration of substance abstinence is related to persistence on the distress intolerance task after controlling for demographics, level of substance use, negative affectivity, and skill/performance on the task (Daughters et al., 2005). As this study involved poly-substance using treatment seekers, the generalizability to cannabis users per se is not known. Moreover, distress intolerance was measured using only persistence on the PASAT with a monetary reward. Thus, it is unclear if the distress intolerance index was more a measure of task persistence than distress intolerance (Leyro et al., 2010).

In other research, Simons and Gaher (2005) conducted a study ( $n = 642$ ) to develop the DTS (Simons & Gaher, 2005). Participants were recruited from two state universities (70% female;  $M_{age} = 19.90$ ,  $SD = 1.64$ ) with 89% identifying as Caucasian, 7% identifying as African American, 1% identifying as Asian, 1% identifying as multiracial, and 2% identifying as other (Simons & Gaher, 2005). Prior to participation, informed consent was obtained; research subjects were then asked to complete an internet-based assessment (Simons & Gaher, 2005). A factor analysis was conducted on the 16-items of the DTS, with results indicating the exclusion of two items; thereafter, a subsequent factor analysis was run on the remaining 14 items, finding support for a single factor solution, which accounted for 88% of the overall variance. In the validation aspect of the study, perceived distress intolerance, as measured by the DTS total score, was negatively related to both alcohol and cannabis coping motives (Simons & Gaher, 2005). These findings suggest that those who endorse high levels of perceived distress intolerance have an increased concurrent likelihood to endorse using these substances (alcohol and cannabis) because they believe it can help reduce negative affect (Simons & Gaher, 2005). The study results are perhaps most relevant to the maintenance phase of cannabis use. However, it is unclear how well these findings generalize to more severe cannabis users or if similar patterns of results would be evident for alternative measurement approaches for distress intolerance.

In another study, Buckner, Keough, and Schmidt (2007) aimed to clarify the relation between substance use (alcohol and cannabis) and depression by exploring individual differences of discomfort (Discomfort Intolerance Scale [DIS]; Schmidt et al., 2006) and perceived distress intolerance (Distress Tolerance Scale [DTS]; Simons and Gaher, 2005). The study sample was predominantly Caucasian (78.1%) and consisted of 265 undergraduate psychology students (63.3% female;  $M_{age} = 18.7$  ( $SD = 1.2$ ), with 74% reporting alcohol use in the past month, 60% reporting lifetime cannabis use, 31.3% reporting cannabis use in the past month, and 8.2% reporting daily cannabis use (Buckner et al., 2007). Results indicated that perceived distress intolerance, as measured by the DTS, was significantly associated with increased problems associated with alcohol and cannabis use, as well as increased cannabis use frequency. The study results are, again, most relevant to the maintenance phase of cannabis use. It is noteworthy that although discomfort and perceived distress intolerance were significantly negatively related, the size of association was modest ( $r = -.16$ ,  $p < .02$ ), and therefore, supports that while the two constructs are related, they are distinct (Buckner et al., 2007). Yet, this investigation did not sample expressly for cannabis users and did not ascertain whether distinct types of distress or discomfort intolerance were uniquely related to particular aspects of cannabis using behavior.

In another investigation, Zvolensky et al. (2009) examined anxiety sensitivity, distress intolerance, and fear reactivity to bodily sensations (induced in a laboratory biologic challenge paradigm) in one overarching model in relation to coping and conformity cannabis use motives among a sample of young adult cannabis users ( $n = 135$ ; 46.7% women;  $M_{age} = 20.45$ ,  $SD = 5.0$ ). In terms of ethnic background, 95% of participants identified as Caucasian, 0.7% African-American, 0.7% Asian, .7% Hispanic, 0.7% bi- or multiracial, 1.5% other, and 0.7% did not provide ethnic data. Sixty-seven percent of the sample smoked cannabis at least once per week and 24.4% smoked more than once per day. The mean age for first time cannabis use was 14.96 ( $SD = 2.2$ ) years, and the mean age of onset for regular cannabis use was 15.4 ( $SD = 4.89$ ) years. After controlling for current cannabis use frequency (past 30 days), daily cigarette smoking rate, average volume of alcohol used over the past year, negative affectivity, and other cannabis use motives, anxiety sensitivity was significantly and uniquely associated with coping and conformity motives for cannabis use. Perceived distress intolerance, measured by the DTS, evidenced significant and unique

incremental relations only to coping motives whereas fear reactivity to bodily sensations was unrelated to any cannabis use motive. These results suggest that perceived distress intolerance, as measured by the DTS, is uniquely concurrently related to coping-oriented cannabis use. As in other work, the study results are perhaps most relevant to the maintenance phase of cannabis use. It is unclear, however, if such results are applicable to: (1) desire to quit, (2) perceived ability to quit, (3) severity of withdrawal symptoms, and (4) severity of cannabis use problems.

Potter, Vujanovic, Marshall-Berenz, Bernstein, and Bonn-Miller (2011) examined the explanatory role of perceived distress intolerance in the context of posttraumatic stress symptoms severity and cannabis use coping motives in a sample of adults ( $n = 142$ ; 46.5% women;  $M_{age} = 22.18$ ,  $SD = 7.22$ ; 95.8% Caucasian, 0.7% Asian, 0.7% Hispanic/Latino, and 1.4% “other”) who endorsed exposure to a traumatic event (Criterion A; DSM-IV-TR, 2000) and reported use of cannabis in the past 30 days. Results indicated that (1) higher levels of posttraumatic stress symptom severity was significantly associated with greater levels of cannabis use coping motives; (2) posttraumatic stress symptom severity demonstrated a positive association with perceived distress intolerance; and (3) the association between posttraumatic stress symptom severity and cannabis use coping motives diminishes when perceived distress intolerance is entered into the model (Potter et al., 2011). These findings suggest that perceived intolerance of emotional distress could be an important mechanism underlying the association between posttraumatic stress and cannabis use coping motives (e.g., to manage emotional distress; Potter et al., 2011). The cross-sectional test of is one important limitation to the investigation. Additionally, this study did not focus on a severe cannabis-using population.

Bujarski, Norberg, and Copeland (2012) more recently examined the mediating role of coping motives in cannabis use-related problems and perceived distress intolerance. The sample included 118 participants collected from an Australian community sample (33.9% female;  $M_{age} = 29.84$ ,  $SD = 12.41$ ), who reported at least monthly use of cannabis. Participants completed a battery of self-report measures prior to arriving for their research visit; thereafter, the Structured Clinical Interview for the DSM-IV (SCID-IV) and Time Line follow Back (TLFB) were administered (Bujarski et al, 2012). Criteria for current (e.g., within the past month) cannabis use was met by 5.9% of the sample, while 66.9% met criteria

for cannabis dependence, with 12.7% of the sample meeting criteria for alcohol abuse and 21.2% for alcohol dependence (Bujarski et al., 2012). Results of the study indicated that (1) individuals who met criteria for a CUD were significantly less tolerant of distress compared to those without a CUD; (2) quantity of cannabis use was not related to perceived distress intolerance; and (3) females were less tolerant of distress than males. This study did not address the role of perceived distress intolerance in terms of perceptions of quitting, self-efficacy for abstaining, or consider the role of behavioral indices of distress intolerance.

In the most recent study, Dvorak and colleagues (2014) examined predictors of cannabis use and cannabis-related problems among college students recruited via email. Findings indicated a relation between perceived distress intolerance and the likelihood of experiencing a higher level of cannabis-related problems (Dvorak & Day 2014). Moreover, when behavioral and emotional indices of "emotional instability" (indexed by scales of impulsivity/self-control and sensation seeking) were modeled simultaneously, perceived distress intolerance emerged as the variable that was more strongly related to cannabis use problems.

### **2.2.1. Summary of Key Limitations**

Existing work on distress intolerance and cannabis use and its disorders has been productive, but it also is narrow in scope. Indeed, there are only a limited number of existing studies completed to date. Consequently, there are a number of key limitations of this line of research. First, existing work has not addressed the role of distress intolerance in regard to indices of quit success or failure. Thus, it is unclear if, and to what extent, perceived or behavioral distress intolerance is directly related to cannabis quit behavior.

Second, some initial work has begun to address the role of distress intolerance in regard to severity of cannabis use problems, but not yet in relation to self-efficacy for maintaining abstinence, or perceptions of barriers to quitting. Thus, it is unclear if distress intolerance, in general, is related to these other highly clinically-relevant aspects of cannabis use that may be relevant to the maintenance of cannabis use behavior.

Third, none of the past work has sought to examine perceived and behavioral indices of distress intolerance in terms of cannabis use behavior in one overarching model. Given evidence that suggests that distress intolerance may have distinct latent structure (Bernstein et al., 2011), it is possible perceived and behavioral aspects of distress intolerance may be differentially related to certain aspects of cannabis use, or even synergistically confer greater risk for certain cannabis-using problems (i.e., their combination may be more apt to be related to cannabis use problems than their singular effects).

Finally, past work has sampled predominately Caucasian samples with relatively high degrees of education. Yet, individuals below the poverty line and from racial and ethnic minority groups are at heightened risk for CUD and difficulty in quitting (Copersino et al., 2010; Johnston et al., 2013; NIDA, 2012; SAMHSA, 2014) and may endorse different motives for cannabis use (e.g., coping, social, and conformity motives are related to greater cannabis use impairment among African Americans but not Whites; Buckner, Shah, Dean, & Zvolensky, in press). Notably, the 'sampling' of cannabis using participants in previous work has been focused largely Caucasian users from middle socioeconomic strata. Moreover, past studies have not sampled exclusively for CUD, but rather, included a wider range of cannabis use as study inclusionary criteria. Therefore, it is important to evaluate the generalizability of past work to a CUD group with lower socioeconomic status who also is comprised, in part, from underrepresented ethnic minority groups. Indeed, numerous studies suggest a major contributing factor to substance use among lower socioeconomic and underrepresented groups appears to be the increased exposure to multiple stressors associated with low socioeconomic environments (e.g., low social cohesion, high unemployment), which in turn, may contribute to disruptions in emotional processes, including emotion regulatory processes (Cuevas et al., 2014; Doan & Evans, 2011; Evans & Fuller-Rowell, 2013; Reitzel et al., 2013). These findings are possibly relevant to distress intolerance because a decreased capacity to withstand stress may be related to more severe substance use behavior. At the same time, because of the 'rich stress levels' associated with lower socioeconomic environments, it remains unclear if distress intolerance will operate in the same fashion as that observed among other socioeconomic levels.

## **CHAPTER 3: INTEGRATING DISTRESS INTOLERANCE IN CANNABIS USE**

### **3.1. A Working Theoretical Model**

Based on findings and related advances relevant to distress intolerance and CUD, I constructed a preliminary integrative synergistic type of model of CUD that is theoretically most applicable to the maintenance and relapse phases of cannabis use. At its core, this model recognizes that a quit attempt is a demanding life event that challenges the individual to draw from self-regulatory skills as well as socio-environmental resources to attain and maintain abstinence.

#### **3.1.1. Perceived Distress Intolerance**

Based on extant biopsychosocial models and empirical evidence focused on distress intolerance, persons with elevated levels of perceived intolerance for negative emotional events may tend to be more emotionally reactive to stressors while quitting and coping with emotionally distressing events, thoughts, and feelings during active periods of cannabis use by trying to escape or avoid them (i.e., coping-oriented motives for cannabis use; Leyro et al., 2010). That is, the perceived expectation to not be able to effectively tolerate emotional distress may influence the type of cannabis use (e.g., using for coping-oriented motives predominately or instead of other more potentially healthy motives such as enhancement motives). To the extent an active cannabis user has higher levels of perceived distress intolerance, they may be more likely to expect or objectively experience more problems while quitting, maintain less confidence in their ability to maintain abstinence, and perhaps develop more severe use patterns. Ultimately, such perceived distress intolerance may make quitting more difficult because these individuals are already 'primed' for negative expectations about quitting before embarking in such an attempt, or be related to more severe problems of use, in part, because they may be using predominately for mood-dampening motives (coping-oriented use).

#### **3.1.2. Behavioral Distress Intolerance**

Behavioral distress intolerance also is likely to maintain explanatory value for the maintenance and relapse phases of cannabis use. Past work has shown behavioral indices of distress intolerance for cognitive stress are related to less persistence in a quit attempt among polysubstance using persons (Daughters et al., 2005). Additionally, higher levels of behavioral intolerance to acute episodes of ongoing aversive states are related to substance use relapse (Brown et al, 2002). Although there has not been a test

of behavioral distress intolerance and cannabis per se, it would be fruitful to examine the possibility that behavioral intolerance may relate to cannabis lapse and relapse, further contributing to maintenance of cannabis use. Such an observed relation may 'mimic' the experience that those with CUD may undergo while trying to abstain from cannabis, theoretically, relating to both the maintenance and relapse phases of cannabis use. For example, it may be that those who are experiencing more severe cannabis withdrawal symptoms or bodily stress re-initiate use of cannabis during their quit attempt in an effort to 'downregulate' aversive physical symptoms. Such patterns of use may strengthen a (presumably learned) relation between bodily stress and negative reinforcement-based cannabis use. Ultimately, greater behavioral distress intolerance may strengthen the negative reinforcement learning that occurs between bodily stress-coping-oriented cannabis use, perhaps contributing to more problems while quitting, less confidence beliefs about maintaining abstinence, and more severe use patterns.

### **3.1.3. Interplay (theoretical) between Perceived Distress Intolerance and Behavioral Distress Intolerance**

In addition to the potential individual roles of perceived and behavior distress intolerance, these two variables (perceived and behavioral distress intolerance) may interplay with one another in a clinically-relevant manner. As noted earlier, existing data suggest that self-report and behavioral distress intolerance indices may possibly not reflect individual differences of a common latent distress intolerance variable (e.g., they are often not correlated strongly with one another; Bernstein et al., 2011), and therefore, may benefit from recognizing the distinction between self-report and behavioral tolerance constructs (Leyro et al., 2010). Indeed, persons with CUD with higher levels of perceived distress intolerance and higher behavioral distress intolerance for interoceptive distress (e.g., aversive physical sensations) may be more likely to manifest greater (a) problems in quitting; (b) severity of cannabis use problems; and (c) severity of problems experienced while quitting and self-efficacy for abstaining from cannabis use. That is, higher levels of intolerance for internal stress (e.g., bodily perturbation) may moderate the relation between perceived distress intolerance and numerous aspects of cannabis use problems. Specifically, persons with CUD expecting greater levels of emotion or physical dysregulation due to their beliefs about tolerating such distress (perceived distress intolerance), who also cannot as effectively tolerate such distress (behavioral

distress intolerance), may be more likely to interpret or objectively experience distressing symptoms as more severe. Conversely, higher levels of an ability to tolerate emotional or physical dysregulation may attenuate the relative risk for more CUD problems because they have a greater ability to tolerate aversive internal experiences that may trigger a return to coping-oriented use.

#### **3.1.4. Summary and Study Aims**

Overall, the primary aim of the present study was to examine the main and interactive effects of perceived and behavioral indices of distress intolerance in terms an array of clinically-relevant cannabis quit-related variables.

First, it was hypothesized that among persons with current CUD, perceived (measured using Distress Tolerance Scale [DTS]; Simons & Gaher, 2005) and behavioral (measured using a voluntary breath-holding task; Asmundson & Stein, 1994) distress intolerance variables would interact to be significantly and uniquely associated (a) more failed quit attempts (lifetime quit failure index); and (b) shorter duration of average time to relapse for *past* quit attempts (measured in hours), reported for both the most recent quit attempt (within the past year), as well as longest period of abstinence ever achieved. The expected form of the interaction was posited to be that higher perceived and behavioral distress intolerance would be associated with greater failed quit attempts and shorter duration of time to relapse.

Second, it was hypothesized that among active cannabis users with CUD, perceived (measured using DTS) and behavioral (measured using a voluntary breath-holding task) distress intolerance variables would interact to be significantly associated (a) greater severity of cannabis withdrawal symptoms experienced while quitting in the past; (b) lower self-efficacy for abstaining from cannabis use; and (c) greater perceived barriers for quitting. The expected form of the interaction was, again, such that higher perceived and behavioral distress intolerance will be associated with greater greater severity of quit problems, lower self-efficacy, and greater perceived barriers for quitting.

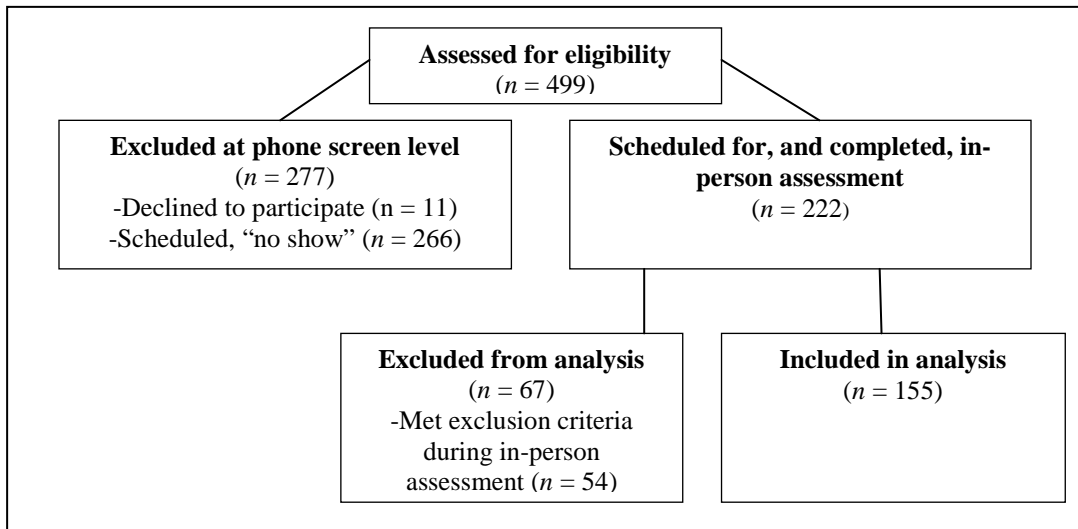
Finally, it was hypothesized that among active cannabis users with CUD, perceived (measured using DTS) and behavioral (measured using a voluntary breath-holding task) distress intolerance variables would interact to be uniquely associated with more severe cannabis use problems. The expected form of the

interaction was such that higher perceived and behavioral distress intolerance will be associated with greater CUD problems.

## CHAPTER 4: METHOD

### 4.1. Participants

One-hundred fifty-five adults (29% female), who were actively using cannabis and met criteria for CUD, were recruited through newspaper and community flyer advertisements targeting individuals interested in participating in research related to their current cannabis use and past their past quit experiences in Houston, Texas. See Figure 2 for a CONSORT diagram.



**Figure 2: Consort of Participant Recruitment**

Of the 155 participants, 110 (71%) were male and 45 (29%) were female. The mean age of participants was 37.2 years ( $SD = 11.7$  years). Twenty percent of participants identified their ethnicity as Hispanic or Latino. The majority of participants (61.9%) were Black or African American, with the remainder of the participants identifying as White (29%), Asian (2.6%), American Indian or Alaskan Native (0.6%). The remaining 5.8% of the sample did not provide data on their race or ethnicity.

### 4.2. Inclusion/Exclusion Criteria

Participants were (1) between 18 and 65 years of age, (2) met DSM-IV criteria for current CUD, (3) were active user of cannabis (operationally defined as smoking at least three days per week for a period of at least the prior six months), and (4) reported at least two previous self-defined cannabis quit attempts,

with one of the attempts occurring in the past year (i.e., an effort to help ensure participants with quit attempts were sampled).

Participants were excluded from the study based on evidence of: (1) current suicidal or homicidal ideation, (2) current psychosis, (3) limited mental competency (not oriented to person, place, or time), (4) the inability to give informed, voluntary, written consent to participate, (5) *current* professional treatment for CUD or other substance use problems (i.e., participants were not excluded for past cannabis or substance use treatment), (6) recent legal mandate limiting cannabis use [e.g., incarceration during their ‘quit attempt’], (7) use of cannabis explicitly for a medical disorder, or (8) pregnancy or current breastfeeding. See Table 2.

### 4.3. Measures

Demographics Questionnaire. Participants completed a demographics form, which was used to capture the age, race, ethnicity, sex, gender, sexual orientation, education level, economic status, current occupation, and marital status of participants.

Medical Problems. Participants completed a brief medical history questionnaire that focused on medical conditions relevant to criteria for the study (example item: *please indicate if you have ever been diagnosed with any of the following: asthma*). Medical conditions that were listed on the scale included the following: epilepsy, stroke, head injury, heart problems (tachycardia, heart murmur), hypertension, diabetes, allergies, asthma, and respiratory disease. This medical checklist has been used successfully in past work among clinical and nonclinical populations as part of laboratory screening protocols (Farris, Zvolensky, Otto, & Leyro, in press; Zvolensky et al., 2004) and was used in the current dissertation to exclude research participants based on study criteria as well as to assess for some common medical problems.

Structured Clinical Interview-Non-Patient Version for DSM-IV (SCID-IV-NP; First, Spitzer, Gibbon, & Williams, 1995). The SCID-IV-NP is a structured diagnostic interview that assesses Axis I psychopathology according to the DSM-IV-TR (First et al., 1995). Diagnostic exclusions and prevalence of current Axis I diagnoses (e.g., substance use disorders, mood disorders, and anxiety disorders) was determined using the SCID-IV-NP (First et al., 1995). In the current dissertation, the SCID-IV-TR was

used to determine the presence of CUD. Random reliability checks of 20% of cases were conducted to establish diagnostic agreement rates between interviewers. Reliability checks were conducted by trained and supervised post-bac research assistants or doctoral-level clinical psychology graduate students for diagnostic agreement. No cases of disagreement were observed.

Distress Tolerance Scale (DTS; Simons & Gaher, 2005). The DTS (Simons and Gaher, 2005) is a 14-item measure that assesses ones' evaluation and expectation of experiencing negative emotion on a five-point likert scale (*1= Strongly Agree to 5= Strongly Disagree*; example item: *There's nothing worse than feeling distressed or upset*). The DTS, self-reported measurement of perceived distress intolerance, includes four subscales: (1) perceived ability to *tolerate* emotional distress (example item: *Feeling distressed or upset is unbearable to me*); (2) the degree level an individual's attention is *absorbed* by negative emotions (example item: *My feelings of distress are so intense that they completely take over*); (3) efforts to *regulate* affect in an effort to reduce distress (example item: *I'll do anything to stop feeling distressed or upset*); and (4) subjective *appraisal* of distress (example item: *I am ashamed of myself when I feel distressed or upset*). The DTS yields good internal consistency with stable measurement over a 6-month period (alpha coefficient = .89; Simons and Gaher, 2005). Internal consistency for the total score of the DTS in the present study was excellent ( $\alpha = .91$ ), and was adequate for all four subscales ( $\alpha$  ranges = .69-.79).

Breath-Holding Task (Asmundson & Stein, 1994). The breath-holding task (Asmundson & Stein, 1994) is a behavioral assessment of distress intolerance. During the task, participants were read a standardized script instructing them on how to complete the task. In general, participants would inhale as deeply as possible and then exhale once a full breathe is achieved. At the completion of the exhalation, the participant, again, would breath in as deeply as possible and holds their breath as long as they can. The length of time the participant is able to hold their breath was collected via a digital stopwatch. The task was then repeated after a three minute rest period. For the purposes of this study, duration of the second breathholding trial was used as the behavioral index of distress intolerance; this second score provides a more reliable index than the first trial (correlation between time one and time two:  $r = .85$ ). Importantly, recent research has suggested breath-holding duration maintains unique explanatory value relative to physical health problems, active substance use, and anxiety sensitivity in the prediction of other distress

intolerance processes, such as discomfort intolerance and mirror-tracing task persistence (Hogan, Farris, Brandt, Schmidt, & Zvolensky, 2014). In the current study, the observed range of breath holding time ranged from 1 to 96 seconds, with an average of 43 seconds ( $SD = 22$  seconds).

Self-efficacy for Quitting (SEQ; Marlatt & Gordon, 1985). The SEQ is a 19-item measure based on the Marlatt and Gordon (1985) categories of relapse situations (e.g., being with others who are using) which measures the degree to which one feels confident in their ability to not use marijuana across different 'high risk' situations on a likert-type scale ( $1 = not\ at\ all\ confident$  to  $7 = extremely\ confident$ ). The SEQ measures a single dimension of self-efficacy for quitting and has high internal consistency (alpha coefficients ranging from .89-.94 when used for pre-treatment and post-treatment, respectively). Internal consistency for the SEQ in the present study was excellent ( $\alpha = .90$ ).

Marijuana Problems Scale (MPS; Stephens, Roffman, & Curtin, 2000). The MPS is a psychometrically sound 19-item list of negative social, occupational, physical, and personal consequences associated with marijuana use in the past 90 days (Stephens et al., 2000). Respondents are asked to rate the level of problems associated with their cannabis use on a likert-type scale ( $0 = no\ problem$  to  $2 = serious\ problem$ ) in response to problems such as, "*problems between you and your partner,*" or "*legal problems.*" Internal consistency for the MPS in the present study was good ( $\alpha = .89$ ).

Marijuana Withdrawal Checklist (MWC; Budney, Novy, & Hughes, 1999). The MWC is a 22-item self-report questionnaire that assesses the presence of marijuana withdrawal symptoms (example item: "*decreased appetite,*" "*irritability*") on a four-point likert-type scale ( $0 = Not\ at\ all$  to  $4 = Severe$ ) during respondents most recent quit attempt. In the current study, the internal consistency for the MWC was excellent ( $\alpha = .93$ ).

Barriers of Cannabis Cessation Scale (BCCS). The BCCS is conceptually informed by the Barriers of Cessation Scale (BCS; Macnee & Talsma, 1995), a 19-item measure that captures a respondent's perceived barriers to cigarette smoking cessation (Macnee & Talsma, 1995). Items on the BCS were adapted to fit perceived barriers specific to cannabis cessation (example item: "*being addicted to marijuana*"), while some wording from the original measure was retained (example item: "*fear of failing to quit successfully*"). In total, 18 items from the original measure were adapted for participants to respond

to barriers of cessation for cannabis by our research team with permission from the authors of the original scale. Consistent with the original questionnaire, respondents were asked to report the level of agreement they had with each statement (e.g., 0 = *not a barrier/not applicable* to 3 = *large barrier*). Internal consistency for the BCCS in the present study was excellent ( $\alpha = .91$ ).

Marijuana Smoking History Questionnaire (MSHQ; Bonn-Miller & Zvolensky, 2009). The MSHQ is a self-report instrument that measures respondents' cannabis use history with questions pertaining to cannabis smoking rate, age of onset at initiation, years of being a 'regular' cannabis smoker, and other descriptive information (e.g., number of past quit attempts). The MSHQ was used at the appointment to assess cannabis smoking use history, patterns of use, and interest in and nature of quit experiences.

Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988). Negative affectivity was assessed using the 20-item Positive and Negative Affect Schedule (PANAS), which asks research participants to indicate on a likert-type scale (1 = *very slightly or not at all* to 5 = *extremely*) how they generally feel according to a list of various feelings and emotions (example items: *Interested, Nervous, Ashamed*; Watson et al., 1988). The scale measures two factors, negative and positive affect, with both scales demonstrating high levels of internal consistency (alpha coefficients for the positive and negative affect scales are .86 and .87, respectively; Watson et al., 1988). Internal consistency for the PANAS in the present study was excellent ( $\alpha = .96$ ).

Alcohol Use Disorders Identification Test (AUDIT; Babor, de la Fuente, Saunders, & Marcus, 1992). The AUDIT is a 10-item self-report screening measure developed for the World Health Organization to identify individuals whose alcohol use is hazardous (Babor, de la Fuente, Saunders, & Grant, 1992). There is a large body of literature attesting to the psychometric properties of the AUDIT (e.g., Saunders, Aasland, Babor, de la Fuente, & Grant, 1993). The AUDIT total score was utilized to characterize problematic alcohol use within the current sample and recommended employed gender-specific cut-points (Saunders et al., 1993). Within the current sample, internal consistency was excellent ( $\alpha = .90$ ).

Fagerstrom Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). The FTND is a six-item scale that assess tobacco dependence. In the current study, the FTND total score was used to characterize participant levels of tobacco dependence. The FTND has been generally found to have high test-retest reliability (Heatherton et al., 1991), but internal consistency that is only adequate ( $\alpha = .60$ ).

#### **4.4. Procedure**

Participants who responded to the study advertisements were first screened by telephone in order to determine whether or not the potential participant met the initial inclusion or exclusion criteria (see Table 2). Thereafter, participants who were 'potentially eligible' were scheduled for an in-person baseline assessment. Participants were asked to not use cannabis prior to the assessment. In addition, participants were asked to provide the time of their last use of cannabis. During the baseline appointment, participants provided written informed consent, and then, were interviewed using the SCID-NP to establish inclusion criteria of CUD. Those who met inclusion criteria continued on to the baseline assessment, which consisted of self-report questionnaires and distress intolerance tasks (see Table 3). At the completion of the assessment, participants were compensated with a \$20.00 gift card for their time (approximately 3 hours). All participants provided written informed consent prior to initiating study procedures. The study protocol was approved by Institutional Review Board at the University of Houston. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975.

#### **4.5. Analytic Strategy**

Data analysis was completed with SPSS Statistics 22. Data that were not entered directly by participants via an internet-based survey ([www.Qualtrics.com](http://www.Qualtrics.com)) was double entered by (independent) researcher assistants in two separate databases and compared for consistency. Data that were entered directly by participants were downloaded directly from the data service. All data points were first screened for outliers by examining descriptive data, and verifying that observed values fell within the expected range of scores for each variable. Any data point identified as an outlier, which could not be resolved by examining the raw data, was deleted. Thereafter, data was screened for normality by examining histograms,

plots, and values of skewness and kurtosis. Several of the variables of interest demonstrated either skewness or kurtosis (i.e., longest quit duration, most recent quit duration, and cannabis use problems (Stephens et al., 2000); therefore, LOG10 transformations were performed.

First, descriptive data on the study variables were explored in terms of frequency of endorsement. Second, a series of bi-variate correlations was conducted to examine associations between study variables. Then, to test the main and interactive effects of perceived distress intolerance (DTS total score) and behavioral distress intolerance (breath holding duration) on the criterion variables, a moderation analysis using PROCESS macro (Hayes & Preacher, 2013) was conducted. In the first step of each model, covariates were entered that were found to maintain a significant bivariate correlation with the designated dependent variables. Next, perceived distress intolerance and behavioral distress intolerance were simultaneously entered in the second step. Finally, the interaction term between perceived distress intolerance and behavioral distress intolerance was entered at the third step. In the case of missing data, listwise deletion was applied, resulting in sample sizes ranging from 148 to 155 across analyses.

## CHAPTER 5: RESULTS

### 5.1. Descriptive Data

#### 5.1.1. Living Situation, Educational Background, and Financial Status

The current sample largely self-identified as living in an urban area (64.5%) with the remaining sample identifying as either living in sub-urban (23.9%) or rural areas (10.3%). The majority of the sample identified their relationship status as single (68.4%), followed by married (8.4%), divorced (7.1%), widowed (3.2%), or separated (2.6%). Only 14.8% of the sample completed college, with 5.8% attending graduate school. Of those remaining, 46.5% completed part of college, 26.1% completed high school or equivalent, and 5.2% completed less than 8 years of education. Participants reported on their highest occupations level: executive (0.6%), manager/professional (24.5%), administrative (6.5%), clerical (7.7%), skilled (32.9%), semi-skilled (19.4%), unskilled (6.4%), and never worked (1.9%).

Employment status was as follows: full-time employment (18%), part-time employment (31%), dependent on spouse/student (9%), recipient of public assistance (13%); 29% of the sample did not find this question “applicable.” In the past three years, 16% of the sample was employed “virtually all of the time,” 34% was employed “most of the time,” 27% was employed “half of the time” to “less than half of the time,” and 23% was employed “briefly” or “not at all,” with 40% of the sample having “no limitations for employment,” 18% “attending school,” and the remainder of the sample identifying house responsibilities, job market, retirement, physical illness, psychopathology, or institutionalization as reasons limiting employment (42%).

In regard to income level, 16.8% of the sampled chose not to provide data related to their finances. The remaining sample fell within the following income ranges: \$0 to \$4,999 (17.4%), \$5,000 to \$9,999 (10.3%), \$10,000 to \$14,999 (18.1%), \$15,000 to \$24,999 (11.6%), \$25,000 to \$34,999 (13.5%), \$35,000 to \$49,999 (10.3%), \$50,000 to \$74,999 (0.6%), and greater than \$75,000 (1.3%). Therefore, approximately 70% of the sample (conservatively estimated) earned less than \$35,000 per year, a value consistent with most poverty categorizations in the US (Evans & Fuller-Rowell, 2013; Kendzor et al., 2010; Reitzel et al., 2011).

### **5.1.2. Cannabis use**

On average, participants smoked on 6 days per week, with a mean of 26 episodes of cannabis use per week (range: 2 - 77,  $SD = 26.2$ ), and the average years of cannabis use was 14.2 ( $SD = 11.2$  years). Average age of first use was 15.6 years old (range: 6-33,  $SD = 3.9$  years), with an average age of 19.7 indicated as the age when regular cannabis use was initiated (range: 3-47,  $SD = 5.5$  years). Overall, the majority of participants indicated they most commonly consumed cannabis in the form of a joint (52.9%) or blunt (24.5%), others reported most common use via a “bowl” (12.3%), bong (7.7%), “one-hitter” (1.3%), or vaporizer (0.6%); one participant did not complete the question, and none of the participants indicated ingestion as their primary method of cannabis consumption. About half of participants indicated they typically smoke cannabis alone (49.7%), the other half stated a preference of smoking with two to three people (47.7%), and only 2.6% reported smoking cannabis with a group of more than three people. On average, participants reporting using 3.8 times per week (range: 0-20,  $SD = 3.05$ ), with 30% of the sample indicating they smoked cannabis more than once per week, and 61% of sample indicating they smoked cannabis more than once per day. The remaining 9% of sample indicated they were using cannabis once per week or less; in these instances, reasons for 'non-use' were reported to be financially-driven (i.e., the person lacked the financial resources to purchase cannabis).

### **5.1.3. Tobacco and Alcohol Use**

In terms of tobacco use, 59.2% of the sample identified as a current cigarette smoker, with an average level of nicotine dependence of 3.36 ( $SD = 1.71$ ), indicating low to moderate levels of nicotine dependence (Heatherton et al., 1991). The average AUDIT score for the sample was 8.99 ( $SD = 8.4$ ), indicating, on average, harmful levels of alcohol use (Saunders et al., 2006). Of the 79% of participants that endorsed harmful patterns of alcohol use based upon AUDIT criteria, 59% were a current smoker (tobacco).

### **5.1.4. Psychiatric History**

In terms of psychopathology, participants were assessed for the presence of current (past year) anxiety, substance use, and mood diagnoses. The most common clinical conditions were anxiety disorders, with 36.1% of the sample meeting criteria for an anxiety disorder ( $n = 56$ ), 19% meeting criteria for an

anxiety and mood disorder, and 9% meeting criteria for an anxiety disorder and an additional substance use disorder (see Table 4). Of those with an anxiety or related type of disorder (dissociative psychopathology), the most common condition was posttraumatic stress disorder (PTSD; 21.3%), followed by a specific phobia (5.2%), generalized anxiety disorder (3.2%), social anxiety disorder (2.6%), panic disorder (1.9%), anxiety disorder not otherwise specified (1.3%), and obsessive-compulsive disorder (0.6%). In terms of mood disorders, 26.4% met criteria for a mood disorder, 12.3% of the sample met criteria for a co-occurring mood and anxiety disorder, and 5.8% met criteria for a mood disorder and a substance use disorder. Of those with a mood disorder, the most common condition was major depressive disorder (16.1%), followed by dysthymia (5.8%), bipolar I (2.6%), and bipolar II (1.9%). Only a minority of participants met criteria for a substance use disorder (5.8%), but no other Axis I disorder, and none met criteria for poly substance abuse or dependence, operationalized per the DSM-IV-TR criteria. Overall, 25% of the sample met criteria for more than one Axis-I disorder in the past year.

#### **5.1.5. Physical Health**

In terms of physical health problems, 56.1% of current sample identified one or more current physical health disorders via the brief checklist, including respiratory problems, diabetes, heart condition, hypertension, epilepsy, or head trauma. Interestingly, 18.1% of the sample indicated they currently have physical symptoms that they believed are caused by smoking cannabis, 2.6% of the sample indicated they believe smoking cannabis aggravates a current disease or illness, and 30.6% of participants endorsed receiving 'relief from cannabis' for physical symptoms, or a disease or illness (see Table 4).

### **5.2. Bi-Variate Correlations**

Table 5 lists the bivariate correlations among the study variables. First, as expected, perceived distress intolerance was significantly negatively related to cannabis withdrawal ( $r = -.21, p < .01$ ), perceived barriers to cannabis cessation ( $r = -.24, p < .01$ ), and severity of cannabis use problems ( $r = -.17, p < .05$ ). The relation of perceived distress intolerance with cannabis withdrawal, perceived barriers to cannabis cessation, and severity of cannabis use problems were small to moderate using conventional benchmarking indices (Cohen, 1988). In contrast to prediction, perceived distress intolerance was not significantly related to total lifetime quit attempts ( $r = .09$ ), longest abstinence duration ever achieved ( $r = -$

.05), or abstinence duration during the most recent quit attempt ( $r = .12$ ). Perceived distress intolerance was positively, but not significantly, related to total lifetime quit attempts ( $r = .09$ ) and recent abstinence duration ( $r = .15$ ).

Second, in regard to behavioral distress intolerance, in contrast to expectation, no significant relations were observed with the criterion variables ( $r$ 's range:  $-.11$  to  $-.03$ ).

Third, as expected, there was no significant association between the perceived distress intolerance and behavioral distress intolerance variables.

Fourth, also as expected, a significant negative association between perceived distress intolerance and negative affect was observed ( $r = -.34, p < .01$ ). Yet, behavioral distress intolerance and negative affect were not correlated.

Finally, several significant associations were observed between the possible covariates and dependent variables. First, respiratory conditions were related to cannabis withdrawal ( $r = .18, p < .05$ ). Second, negative affectivity was significantly associated with cannabis withdrawal ( $r = .34, p < .01$ ), self-efficacy for quitting cannabis use ( $r = .20, p < .05$ ), perceived barriers to cannabis cessation ( $r = .32, p < .01$ ), and severity of cannabis use problems ( $r = .33, p < .01$ ); these relations were generally moderate to large (Cohen, 1988). Gender also was significantly negatively associated with cannabis withdrawal ( $r = -.22, p < .01$ ) and perceived barriers to cannabis cessation ( $r = -.16, p < .01$ ), such that women were more likely than men to indicate higher levels of cannabis withdrawal and report greater barriers to cannabis cessation.

### 5.3. Regression Models

Aim 1. No covariates were identified in this model based upon bi-variate relations for lifetime quit attempts. In the first step, perceived distress intolerance and behavioral distress intolerance were entered, but they were not significant predictors of lifetime quit attempts ( $R^2 = .02, F(3, 149) = .97, p = .41$ ). The interaction term also was not significant (see Table 6).

For longest abstinence duration achieved, again, no covariates were employed due to the lack of significant bi-variate relations. Also, perceived distress intolerance and behavioral distress intolerance were

not significant predictors of abstinence duration ( $R^2 = .02$ ,  $F(3, 149) = .82$ ,  $p = .48$ ). The interaction term was not significant (see Table 6).

For duration of abstinence during most recent quit attempt (see Table 6), no significant effects were evident for the main or interactive effects of perceived distress intolerance and behavioral distress intolerance (see Table 6).

Aim 2. At the first step in the model, negative affectivity accounted for a significant amount of variance in relation to cannabis withdrawal ( $\beta = .62$ ,  $p < .001$ ), whereas gender approached, but did not reach, traditional statistical significance ( $\beta = -5.81$ ,  $p = .06$ ). In step two, no significant effects were evident for perceived distress intolerance or behavioral distress intolerance. The interaction term was not significant (see Table 7).

For self-efficacy for quitting, negative affectivity accounted for a significant amount of variance at step one in the model ( $\beta = .45$ ,  $p < .05$ ). No other significant effects were observed (see Table 7).

In terms of perceived barriers to cannabis cessation, negative affectivity was a significant predictor at step one ( $\beta = .45$ ,  $p < .01$ ; see table 7). No other significant effects were observed (see Table 8).

Aim 3. Regarding cannabis use problems, negative affectivity, entered as the only covariate in step one, was a significant predictor ( $\beta = .01$ ,  $p < .001$ ). Distress intolerance, breath holding duration, or the interaction term were not significant predictors (see Table 8).

## **5.4. Post Hoc Tests**

### **5.4.1. Perceived Distress Intolerance Subscales**

Due to the lack of significant effects for the hypotheses as well as the lack of significant effects in general, I sought to further explore the data with a select number of theoretically-driven post hoc analyses. The first examination focused on the bi-variate relations between perceived distress intolerance subscales and the dependent variables (see Table 9). The underlying logic being that it is possible that at least for perceived distress intolerance, specific subfactors may maintain stronger relations to the dependent variables than the total score (i.e., specific facets of distress tolerance may showcase stronger [or weaker] relations to particular cannabis use variables). To further explore these relations, all subscales from the distress intolerance scale (DTS; Simons & Gaher, 2005), used as the measurement of perceived distress

intolerance, were included. As described earlier in the Method Section, the DTS includes four subscales: (1) perceived ability to *tolerate* emotional distress (example item: *Feeling distressed or upset is unbearable to me*); (2) the degree level an individual's attention is *absorbed* by negative emotions (example item: *My feelings of distress are so intense that they completely take over*); (3) efforts to *regulate* affect in an effort to reduce distress (example item: *I'll do anything to stop feeling distressed or upset*); and (4) subjective *appraisal* of distress (example item: *I am ashamed of myself when I feel distressed or upset*).

The absorption subscale was significantly negatively related to cannabis withdrawal ( $r = -.25, p < .01$ ), perceived barriers to cannabis cessation ( $r = -.26, p < .01$ ), and cannabis use problems ( $r = -.21, p < .05$ ). Second, the perceived distress intolerance appraisal subscale was significantly negatively related to cannabis withdrawal ( $r = -.23, p < .01$ ) and perceived barriers to cannabis cessation ( $r = -.24, p < .01$ ). Third, the perceived distress intolerance *regulation* subscale was negatively related to cannabis withdrawal ( $r = -.21, p < .05$ ) and perceived barriers to cannabis cessation ( $r = -.20, p < .05$ ). Fourth, the perceived distress intolerance tolerance subscale was significantly negatively related to cannabis withdrawal ( $r = -.17, p < .05$ ) and perceived barriers to cannabis cessation ( $r = -.21, p < .05$ ). None of the four perceived distress intolerance subscales were associated with lifetime quit index, longest abstinence duration, or abstinence duration during most recent quit attempt. Notably, the perceived distress intolerance subscales, as would be expected, were significantly interrelated to one another (range of  $r$ 's: .57-.89; range of shared variance: 32%-79%).

Because significant perceived distress intolerance subscale effects were observed, I next sought to explore whether the perceived distress intolerance facets (subscales) were related to the dependent variables. Accordingly, wherein significant bi-variate relations were observed, a regression model was conducted with negative affectivity entered as a covariate at the first step and the perceived distress intolerance subscales (rather than the total score) entered at the second step (simultaneous entry). Therefore, the dependent measures for these analyses were: cannabis withdrawal, perceived barriers to cannabis cessation, and severity of cannabis use problems.

For cannabis withdrawal, negative affectivity was the only significant predictor ( $\beta = .34, p < .001$ ). None of the perceived distress intolerance subscales evidenced significant incremental relations with cannabis withdrawal (Table 10).

For cannabis use problems, again, only negative affectivity was significant predictor ( $\beta = .34, p < .001$ ; see Table 10).

For perceived barriers to cannabis cessation, negative affectivity was the only significant predictor ( $\beta = .32, p < .001$ ; Table 10).

#### **5.4.2. Explanatory Role of Negative Mood**

A second set of theoretically-driven post hoc tests were then completed given the most consistent relation observed across analyses was between negative mood and a select number of the cannabis dependent variables. Specifically, the potential explanatory role of negative affect in the association between perceived distress intolerance and cannabis dependent variables was completed. I focused on negative affect and perceived distress intolerance because these two variables showcased the strongest relations at the bi-variate level with a select number of the cannabis dependent measures and there was no robust evidence of a direct effect for distress intolerance in relation to the dependent variables (as noted in the primary results of the primary aims and first set of post hoc tests).

Bootstrapping via the Indirect Macro (Preacher & Hayes, 2008), a computational tool for observed variable mediation analysis, was employed. As a non-parametric method, bootstrapping estimates the sampling distribution of an estimator based on resampling with replacement. The indirect effect was computed for the sample, resulting in an empirically generated sampling distribution (Shrout & Bolger, 2002). Four models were tested for the cannabis variables of cannabis withdrawal ( $Y_1$ ), self-efficacy for quitting ( $Y_2$ ), barriers to cannabis cessation ( $Y_3$ ), and severity of cannabis use problems ( $Y_4$ ) employed as criterion variables. Perceived distress intolerance (total score on the DTS) was selected as the predictor variable and negative affect as the proposed explanatory variable. Ten thousand bootstrap re-samplings were conducted to detect the indirect effect of the proposed predictor on the outcome variable through the proposed mediator (i.e., the product of the beta coefficients of path  $a$  and path  $b$ ; see Figure 3). A bootstrap-

confidence interval that does not include zero provides evidence of a significant indirect effect (Preacher & Hayes, 2008).

Regression results for paths *a*, *b*, *c*, and *c'* are presented in Table 11, which correspond to each of the four post hoc models.

The total effect model with cannabis withdrawal was significant ( $R^2_{y1,x} = .12$ ,  $df = 1, 150$ ,  $F = 19.90$ ,  $p < .001$ ; path *c*), as was the full model with the explanatory variable ( $R^2_{M,x} = .13$ ,  $df = 2, 149$ ,  $F = 10.94$ ,  $p < .001$ ). The direct effect (path *c'*) of perceived distress intolerance in terms of cannabis withdrawal after controlling for the explanatory variable was non-significant. Regarding the test of the indirect effect, higher levels of perceived distress intolerance (e.g., less ability to tolerate distress) was predictive of greater levels of cannabis withdrawal symptoms, indirectly, through higher levels of negative affect (effect  $a*b$ ).

For self-efficacy for quitting cannabis, the total effect model for SEQ ( $R^2_{y2,x} = .12$ ,  $df = 1, 152$ ,  $F = 20.32$ ,  $p < .001$ ) and the full model with the explanatory variable accounted for significant variance ( $R^2_{M,x} = .05$ ,  $df = 2, 151$ ,  $F = 4.19$ ,  $p < .05$ ). The direct effect of perceived distress intolerance on self-efficacy for quitting, after controlling for the explanatory variable, was non-significant. Higher scores of perceived distress intolerance were predictive of lower self-efficacy through greater negative affect.

Regarding perceived barriers for quitting cannabis, the total effects model accounted for significant variance ( $R^2_{y3,x} = .11$ ,  $df = 1, 148$ ,  $F = 18.04$ ,  $p < .001$ ). The direct effect of perceived distress intolerance on barriers to cannabis cessation only approached significance after controlling for the explanatory variable. The indirect effect was estimated and revealed that perceived distress intolerance was predictive of greater perceived barriers to cannabis cessation indirectly through greater levels of negative affect.

In regard to severity of cannabis use problems, results indicated that the total effects model predicted significant variance in severity problems ( $R^2_{y4,x} = .12$ ,  $df = 1, 151$ ,  $F = 20.18$ ,  $p < .001$ ). The full model with the explanatory variable predicted significant variance in severity of cannabis use ( $R^2_{M,x} = .12$ ,  $df = 2, 150$ ,  $F = 9.93$ ,  $p < .001$ ). The direct effect of perceived distress intolerance for cannabis use severity, controlling for the explanatory variable, was non-significant. The indirect effect was estimated and

indicated that higher levels of perceived distress intolerance was predictive of greater self-reported severity of cannabis use indirectly through greater levels of negative affect.

Finally, each of the four 'explanatory variable' models was compared to alternative models as a method of further strengthening interpretation. In the first alternative model, the proposed outcome and explanatory variable were reversed; in the second model, the predictor and explanatory variable were reversed. Comparing alternative models with alternative variable sequences is recommended as an additional test of the hypothesized order of influence among the study variables in the absence of a prospective study design (Preacher & Hayes, 2008; Shrout & Bolger, 2002). Tests of the indirect effects in these reversed explanatory variable models were, again, estimated based on 10,000 bootstrap re-samples.

In terms of cannabis withdrawal, an alternative model wherein perceived distress intolerance was the indirect predictor and negative affect as the direct predictor variable was evaluated. The total ( $B = .74$ ,  $SE = .16$ , 95% CI [.41, 1.06]) and direct effect ( $B = .66$ ,  $SE = .17$ , 95% CI [.31, 1.01]) of negative affect for cannabis withdrawal were statistically significant with a non-significant indirect effect of perceived distress intolerance ( $B = -.14$ ,  $SE = .11$ , Bootstrapped 95% CI [-.35, .07]). In the second alternative model, perceived distress intolerance was the direct predictor and cannabis withdrawal was the explanatory variable in the prediction of negative affect. The total ( $B = -.21$ ,  $SE = .05$ , 95% CI [-.30, -.12]), direct ( $B = -.17$ ,  $SE = .05$ , 95% CI [-.26, -.08]) and indirect effect of perceived distress intolerance ( $B = -.04$ ,  $SE = .02$ , Bootstrapped 95% CI [-.08, -.01]) for negative affect were statistically significant. Importantly, the confidence interval for the indirect effect ( $a*b$ ) did not include zero; therefore, there was empirical evidence for a putative bi-directional relation between negative affect and cannabis withdrawal (although as measured, these two constructs may tap a highly similar construct with a 'common negative affect core').

For self-efficacy for quitting, the total ( $B = .44$ ,  $SE = .17$ , 95% CI [.90, .77]) and direct effect ( $B = .52$ ,  $SE = .18$ , 95% CI [.16, .88]) of negative affect for self-efficacy for quitting were statistically significant with a non-significant indirect effect of perceived distress intolerance ( $B = .15$ ,  $SE = .18$ , Bootstrapped 95% CI [-.07, .37]). In the second alternative model, wherein perceived distress intolerance was the direct predictor, the total ( $B = -.21$ ,  $SE = .05$ , 95% CI [-.30, -.12]), direct effect ( $B = -.21$ ,  $SE = .06$ , 95% CI [-.30, -.12]) and indirect effect ( $B = .00$ ,  $SE = .01$ , Bootstrapped 95% CI [-.02, .03]) of perceived distress

intolerance on negative affect were statistically significant. Importantly, the confidence interval for the indirect effect ( $a*b$ ), included zero. The alternative mediation model was not significant. Consequently, there was empirical support for negative affect explaining the relation between perceived distress intolerance and self-efficacy for quitting.

In terms of barriers to cannabis cessation, the total ( $B = .51, SE = .13, 95\% CI [.26, .77]$ ) and direct effect ( $B = .43, SE = .13, 95\% CI [.16, .69]$ ) of negative affect on perceived barriers to cannabis cessation were statistically significant with a non-significant indirect effect of perceived distress intolerance ( $B = -.15, SE = .08, \text{Bootstrapped } 95\% CI [-.31, .01]$ ). In the second alternative model, the total effect of perceived distress intolerance ( $B = -.20, SE = .05, \text{Bootstrapped } 95\% CI [-.29, -.11]$ ), which was identified as the direct predictor, and the direct effects ( $B = -.16, SE = .05, \text{Bootstrapped } 95\% CI [-.26, -.07]$ ), with barriers to cannabis cessation identified as the indirect predictor, yielded significant paths in the prediction of negative affect. The indirect path was also significant ( $B = -.04, SE = .02, \text{Bootstrapped } 95\% CI [-.08, -.01]$ ), and the confidence interval for this path excluded zero, supporting a possible bi-directional relation between negative affect and perceived barriers to cannabis cessation.

Finally, for severity of cannabis use problems, a similar pattern of findings emerged: both the total ( $B = .00, SE = .00, 95\% CI [.00, .01]$ ) and direct effect ( $B = .00, SE = .00, 95\% CI [.00, .01]$ ) of negative affect in relation to perceived barriers to cannabis cessation were statistically significant, but the indirect effect of perceived distress intolerance was non-significant ( $B = .00, SE = .001, \text{Bootstrapped } 95\% CI [.00, .00]$ ). However, in the second alternative model, with perceived distress intolerance identified as the direct predictor, the total effect ( $B = -.21, SE = .05, \text{Bootstrapped } 95\% CI [-.30, -.12]$ ), direct effect ( $B = -.18, SE = .04, \text{Bootstrapped } 95\% CI [-.27, -.09]$ ), and indirect effect ( $B = -.03, SE = .12, \text{Bootstrapped } 95\% CI [-.07, -.01]$ ) in the prediction of negative affect, were significantly explained by severity of cannabis problems. The confidence interval for the indirect path excluded zero.

#### **5.4.3. Conceptually-Related Transdiagnostic 'Tolerance' Variables**

Given the nascent developmental stage of research on distress intolerance in relation to cannabis use behavior, a final set of exploratory bi-correlations were computed that focused on the bi-variate relation between related variables and the designated cannabis dependent variables as well as negative affect. I also

computed zero-order relations between the perceived and behavioral distress intolerance variables and these conceptually-related tolerance variables. The additional transdiagnostic 'tolerance-related variables' included specifically fear of detox (Detox Fear Survey Schedule-27 [DFSS-27; Gentile & Milby, 1992]), experiential avoidance (Multidimensional Experiential Avoidance Questionnaire [MEAQ; Gamez et al. 2011]), anxiety sensitivity (Anxiety Sensitivity Index-III [ASI-3; Taylor et al., 2007]), discomfort intolerance (Discomfort Intolerance Scale [DIS; Schmidt et al., 2006]), and emotion dysregulation (Difficulties in Emotion Regulation Scale [DERS; Gratz & Roemer, 2004]). The bi-variate correlations are reported in Table 12. Descriptions of the post-hoc measures and their internal consistency in the current sample can be found in the Appendix.

The DTS was significantly negatively related to all of the post-hoc measures albeit to varying degrees: fear of detox ( $r = -.22, p < .01$ ; shared variance = 5%), experiential avoidance ( $r = -.36, p < .01$ ; shared variance = 13%), anxiety sensitivity ( $r = -.36, p < .01$ ; shared variance = 13%), discomfort intolerance ( $r = -.19, p < .05$ ; shared variance = 4%), and emotion dysregulation ( $r = -.52, p < .01$ ; shared variance = 27%). In contrast, the only significant association with the behavioral index of distress intolerance was anxiety sensitivity ( $r = -.20, p < .05$ ; shared variance = 4%).

Fear of detox was associated with three of the cannabis-related dependent measures: cannabis withdrawal, perceived barriers to cannabis cessation, and severity of cannabis problems ( $r$ 's range: .30-.61,  $p < .01$ ). Fear of detox was also significantly related to negative affect ( $r = .20, p < .05$ ).

Experiential avoidance was associated with four of the cannabis dependent measures: cannabis withdrawal, self-efficacy for quitting, perceived barriers to cannabis cessation, and severity of cannabis problems ( $r$ 's range: .19-.37,  $p < .05$ ). Experiential avoidance also was significantly related to negative affect ( $r = .40, p < .01$ ).

Anxiety sensitivity was significantly related at the bi-variate level to cannabis withdrawal, self-efficacy for quitting, perceived barriers to cannabis cessation, and severity of cannabis problems ( $r$ 's range: .21-.49,  $p < .05$ ). Anxiety sensitivity also was significantly related to negative affect ( $r = .34, p < .01$ ).

Discomfort intolerance was only associated with cannabis withdrawal ( $r = .25, p < .01$ ). Discomfort intolerance was not associated with negative affect at the bivariate level.

Emotion dysregulation was associated with three of the cannabis-related dependent measures: cannabis withdrawal, perceived barriers to cannabis cessation, and severity of cannabis problems ( $r$ 's range: .26-.39,  $p < .01$ ). Emotion dysregulation was also associated with negative affect ( $r = .54$ ,  $p < .01$ ).

## **CHAPTER 6: DISCUSSION**

The current study empirically evaluated perceived and behavioral distress intolerance among CUD and key aspects of the quit experience (e.g., problems in quitting, beliefs about barriers in quitting). Specifically, I examined the main and interactive effects of perceived and behavioral indices of distress intolerance in terms of (a) lifetime history of CUD quit success; (b) severity of withdrawal problems experienced while quitting and self-efficacy for abstaining from cannabis; and (c) severity of cannabis use problems among active users with CUD from diverse backgrounds. I first briefly discuss the nature of the sample recruited. I then present the key findings from the investigation and attempt to contextualize them relative to past work and possible explanatory factors for them. I thereafter discuss the results from post hoc tests, synthesize the findings across the analyses completed, and finally, present key limitations of the study and points for future study.

### **6.1. Nature of the Sample**

The sample recruited was racially and ethnically diverse (65.2% minority) adult cannabis users. The majority of participants had not completed college (46.5%), and over 25% of the sample fell well-below the 2013 Federal Poverty Level (FPL) threshold (FPL = \$11,490; U.S. Department of Health and Human Services, 2015). In fact, the majority of the sample reported annual incomes between the FPL and \$34,999 (43.2%) and only 18% of the sample indicated they were currently employed full-time. The sample had high rates of co-occurring psychiatric illness and medical disease. For example, 36.1% met criteria for a current anxiety disorder, 26.4% met criteria for a current mood disorder, and a little over half of the current sample endorsed one or more current medical conditions (notably, measured via a truncated list of medical problems). Overall, the sample was highly diverse, low-income, had low levels of educational attainment, was under-employed, and met criteria for a high number of psychological and medical conditions.

Because the present study employed a descriptive design (one sample and no comparison group), I first attempted to benchmark the sample relative to past studies on distress intolerance and CUD (see Table 1). Here, a number of observations warrant comment (see Table 13 for comparison study participant characteristics). First, five of the seven previous studies included samples with the vast majority identifying

as White or Caucasian (78.1-95.8%). Bujarski and colleagues' (2012) study included 74% who identified their Nationality as Australian. Daughters and colleagues (2005) reported on the only underrepresented group (89.9% identified as African American), yet this study only included a behavioral measure of distress intolerance (PASAT; Lejuez, Kahler, & Brown, 2003), and none of the other measurements that were included in the current study. Second, four out of the seven previous studies included samples with a majority of female participants. In terms of education, only one study reported participant's level of education, with the remaining studies either under-reporting (e.g., "*sample consisted of undergraduates,*" or "*university recruitment*"), or not reporting data on education ( $n = 3$ ).

With regard to substance use, 61% of the current sample reported cannabis use more than once per week, with the sample averaging 14.2 for total years of cannabis use. A little more than half of the sample reported current tobacco use (59.2%), but demonstrated low to moderate levels of nicotine dependence (Heatherton et al., 1990). In addition, 45% of the sample endorsed harmful patterns of alcohol use (Saunders et al., 2006), with 59% of those participants endorsing concurrent tobacco use. The comparison studies reported wide variations in terms of cannabis use. For ease of comparison, sample characteristics of all studies, presented in Table 13, include percent of weekly cannabis users, when those data were available (weekly cannabis use ranged from 8-100%). Across the four studies that reported alcohol use, drinking averages within the samples were above normative cutoffs for non-clinical samples (Saunders et al., 2006; White & Labouvie, 1989), and thus, arguably largely consistent with the current sample. Tobacco use was underreported across comparison studies, with the only other study reporting similar rates of tobacco use (55.1%) to those that were observed in the current sample. This latter finding is also consistent with related research focused on cannabis-tobacco interplay (Lee, Budney, Brunette, Hughes, Etter, & Stanger, 2014). Similarly, only one other study, conducted within an in-patient recovery facility, reported concurrent weekly substance use (cocaine = 55%; opiates = 38%), which was much higher than what was observed in the current community sample (cocaine = 4.5%); presumably due to the treatment setting recruitment site. Lastly, no other studies employed breath holding as a measure of behavioral distress intolerance, yet most ( $n = 6$ ) comparison studies utilized the DTS as a measurement of perceived distress tolerance, with total scores ranging from 0-3.65. Two studies reported lower levels of negative affectivity among their sample,

and one study demonstrated comparable levels ( $M = 17.27$ ). Overall, relative the vast majority of past work on this topic, the present sample appears to represent somewhat of a group of CUD individuals by being more diverse and from a lower socioeconomic background.

## **6.2. Primary Tests of Study Aims**

In regard to the primary study aims, there was no empirical support for the interactive or main effects of perceived (DTS) or behavioral (breath-holding duration) distress intolerance for any of the dependent variables (Aims 1-3). Although previous studies did not utilize the cannabis dependent measures in the current report, the lack of significant effects in the regression models was nonetheless surprising given previous work on the topic (focused largely on coping motives for cannabis use), including studies that employed the DTS (Table 1). That said, at the bi-variate level, there was some modest evidence of a 'signal' for perceived distress intolerance for certain cannabis dependent variables. Specifically, perceived distress intolerance was significantly negatively related to cannabis withdrawal, perceived barriers to cannabis cessation, and severity of cannabis use problems; these effects ranged from small to moderate in effect size (Cohen, 1988). However, as noted from the outset, once adjusting for the tendency to experience negative affect, there was no 'incremental effect' of perceived distress intolerance with these dependent measures. Moreover, no other significant relations were observed for perceived distress intolerance and the other cannabis dependent variables. Similarly, there was no evidence at the bi-variate level for behavioral distress intolerance (indexed by breath-holding duration) being related to the dependent variables.

The data from the primary study aims collectively suggest, at least among the present largely minority sample who had low income and limited education, neither perceived or behavioral distress intolerance related in a robust fashion with the cannabis dependent measures. Therefore, one (conservative) interpretation of these findings is that distress intolerance may not perform the same way across all CUD samples. Although highly speculative, the increased exposure to multiple stressors associated with low socioeconomic environments (e.g., violence, low social cohesion, high unemployment) may be related to a distinct etiology of distress intolerance. For example, persons from lower socioeconomic environments may indeed have to be more tolerant of higher levels of and multi-level stressors that are inherent to many of such contexts, and therefore, this construct may not relate in the same manner (or strength) with

substance use behavior such as cannabis. One potentially fruitful next step would be to explore the nature of distress tolerance (measured from a multi-method framework) as a function of varying levels of socioeconomic levels and other social determinants of health (e.g., subjective social status, financial strain). It also may be useful to explore whether distress intolerance interplays with social determinants of health, which characterize many low income environments, for cannabis use behavior and even other forms of substance use. In fact, there is some evidence that related transdiagnostic constructs, such as anxiety sensitivity, may exacerbate the influence of social determinants of health (e.g., subjective social status) in relation to poorer mental health among underrepresented and low income groups (e.g., Latinos; Zvolensky et al., in press). Drawing from such work, it is conceivable that distress intolerance may similarly interact with social determinants of health in relation to substance use behavior among health disparity groups, such as the one recruited for the present study. Additionally, as I measured only two types of distress intolerance (DTS and breath-holding duration), it is not possible to assume similar relations (or lack thereof) would be evident for other types of distress intolerance described in theoretical (Zvolensky et al., 2010) and empirical (Bardeen et al., 2013) models of the construct. Therefore, exploration of other distress intolerance constructs in the hierarchical model would be a useful next research step. Another non-mutually exclusive possible explanation may center on the level of understanding of what distress tolerance 'means' among the sample studied (i.e., comprehension of the written items) for the perceived distress intolerance construct. To better understand this type of issue, qualitative research on distress intolerance may be useful to help clarify what this construct represents among underrepresented groups, especially those with limited education and lower socioeconomic status.

Although not a primary study aim, a number of other points related to the primary aims warrant comment. First, there was no significant association between perceived distress intolerance and behavioral distress intolerance. This finding is consistent with past work that has examined interrelations between perceived and behavioral indicators of distress intolerance (Bernstein et al., 2011; McHugh et al., 2011). Therefore, while theoretically related, the variables are empirically not interrelated at the bi-variate level. Future work is needed to continue to unravel the nature and interrelation between perceived and behavioral

distress intolerance and what these associations (or lack thereof) mean to theoretical models of the construct.

Within this same context, there also should be more direct mention of the measurement of the distress intolerance measures. Specifically, the DTS appeared to perform largely as expected. Specifically, the internal consistency of the total score, and to lesser extent subscales, was excellent to adequate, it maintained convergent validity with negative affect and other transdiagnostic tolerance-related constructs, and showed (some) expected relations with certain cannabis dependent measures. There also appeared to be adequate variability in the measure among the present sample when benchmarked to previous cannabis studies using this assessment device. These data collectively lend credibility to the DTS as a measure of perceived distress intolerance among the present sample.

In line with past work, breath-holding trials were highly interrelated (Bernstein, Trafton, Ilgen, & Zvolensky, 2008). This finding is consistent with past work that has found breath holding duration to be highly reliable over short and longer periods of time (e.g., a one-year time period) and generally comparable to the stability observed for personality characteristics (e.g., Groth-Marnat & Mullard, 2010) and certain physiologic measures (e.g., heart rate variability; Bertsch et al., 2012). Additionally, although past work has found breath holding duration to maintain unique explanatory value in relation to other behavioral distress tolerance measures (Hogan et al., 2014), smoking cessation outcomes (Hajek, 1991) and lapse behavior (Kahler, McHugh, Metrik, Spillane, & Rosenow, 2013), relapse risk in gambling (Daughters et al., 2005), and fear reactivity to bodily sensations (Asmundson & Stein, 1994; Eifert, Zvolensky, Sorrell, Hopko, & Lejuez, 1999; Roth, Wilhelm, & Trabert, 1998), this measurement may also tap other features that do not exclusively align with distress tolerance processes. For example, some work has found cognitive processes related to threat interpretation are related to breath holding duration (Brandt, Johnson, Schmidt, & Zvolensky, 2012; Eke & McNally, 1996); data fully consistent with the negative bi-variate relations with anxiety sensitivity observed in the current report. Other studies have found breath-holding duration is not related to performance on neurobehavioral tests loading on cognitive and/or behavioral inhibitory resources (Sutterlin et al., 2013); presumably, a prerequisite for a process that involves an active and effortful withstanding of stressful states (Alpher & Blanton, 1991). Moreover, breath holding duration has not

always been a consistent predictor of substance use or emotional vulnerability (Zvolensky, Feldner, Eifert, & Brown, 2001). The present study naturally cannot fully address the validity of breath holding duration as a behavioral measure of distress intolerance. However, there was little association with this measure at the bi-variate level with other distress intolerance processes, medical problems, and no notable relations to the cannabis dependent measures (the latter not necessarily being the best indicator of validity because of the lack of research on this topic). Future work is needed to further elucidate the underpinnings of breath holding duration to better understand its potential role in models of distress intolerance and its clinical correlates, such as substance use behavior.

Second, negative affect was consistently significantly associated with several of the cannabis dependent measures, including withdrawal symptoms, self-efficacy for quitting cannabis, perceived barriers for cannabis cessation, and cannabis use problems. The effect sizes were moderate in size, suggesting some degree of potential theoretical and clinical significance. At the same time, there was no direct relation between negative mood and other cannabis use variables focused on quit length or attempts, an issue perhaps influenced, in part, by the retrospective recall of (past) quit behavior. These data are nonetheless generally consistent with a large empirical literature linking negative mood states and psychopathology (anxiety/depressive conditions) and CUD (e.g., Agosti et al., 2002; Arendt & Munk-Jorgensen, 2004; Bovasso, 2001; Budney et al., 1998; Copeland et al., 2001; Miller, Klamen, Hoffmann, & Flaherty, 1996; Rey et al., 2002; Zvolensky, et al., 2006). Yet, to the best of my knowledge, the present data extend such work to cannabis use variables not previously studied in relation to negative mood (i.e., self-efficacy for quitting cannabis and perceived barriers for cannabis cessation). These data continue to highlight the close interconnection between negative mood and substance use disorders generally. There is an obvious need to continue to explore the time course and patterning of relations between negative mood and CUD using prospective and laboratory (experimental) methodologies.

### **6.3. Post Hoc Tests**

I conducted post hoc tests due to the lack of empirical support for the primary study aims. As with any post hoc test, these results should be considered with caution, as they are, by definition, exploratory in nature. The first set of analyses focused on the subscales of the perceived distress intolerance construct and

the cannabis dependent measures. As noted in the Results Section, the underlying logic was that it is possible that for perceived distress intolerance, specific subfactors may maintain stronger relations to the dependent variables than the total score (i.e., specific facets of distress tolerance may showcase stronger or weaker relations to particular cannabis use variables). Results indicated the absorption subscale was significantly negatively related to the most cannabis dependent measures ( $n = 3$ ; cannabis withdrawal, perceived barriers to cannabis cessation, and cannabis use problems), although all of the subscales were related to at least two dependent measures (i.e., cannabis withdrawal and perceived barriers to cannabis cessation). None of the four perceived distress intolerance subscales were associated with lifetime quit index, longest abstinence duration, or abstinence duration during most recent quit attempt. The subsequent regression analyses attempted to examine the DTS subscales incremental association relative to negative affectivity with the cannabis dependent measures wherein a significant bi-variate relation was detected. None of these models provided empirical support for a direct relation (incremental) for the cannabis dependent measures. These findings, in conjunction with those from the primary study aims, continue to provide little to no empirical support for a direct relation between perceived distress intolerance and the studied cannabis dependent measures among the current sample.

The second series of post hoc tests were theoretically-oriented on an indirect effect. Specifically, the potential explanatory role of negative affect in the association between perceived distress intolerance and cannabis dependent variables was completed. These tests focused on only those cannabis dependent measures wherein there was a significant bi-variate relation between negative affect and a specific cannabis variable; namely, cannabis withdrawal, self-efficacy for quitting, perceived barriers to cannabis cessation, and severity of cannabis use problems. Greater levels of perceived distress intolerance were predictive of higher levels of cannabis withdrawal symptoms, lower self-efficacy for quitting, and higher perceived barriers to cannabis cessation, indirectly, through greater levels of negative affect. However, confidence intervals for models that included severity of cannabis use problems were inclusive of zero. Therefore, mediation was not observed (Hayes, 2013).”

Alternative models, used to explore the findings due to the cross sectional nature of the data, supported a simple explanatory model for the indirect effects of perceived distress intolerance for self-

efficacy for quitting cannabis through the presence of negative mood. In regard to withdrawal symptoms and perceived barriers to cannabis cessation, the alternative models suggested a putative bi-directional relation between negative affect and these cannabis dependent variables. Specifically, these data suggest that one's perception about their to manage distressing or aversive stimuli (greater perceived distress intolerance) may, in turn, be related to greater cannabis withdrawal symptoms and perceived barriers to quitting in the context of higher levels of negative affect. However, this relation is apt to be bi-directional nature (Warner, 2012). Overall, the tests of model specificity suggest potentially complex relations between perceived distress intolerance and the studied cannabis dependent variables. It is possible that future research would benefit by using time sampling tactics to further probe the relations between perceived distress intolerance and cannabis variables, such as those studied here, over the course a specific epoch of time (e.g., two weeks) or during a designated quit attempt.

A final set of bi-variate relations were computed between other transdiagnostic, tolerance-related constructs and the cannabis dependent measures. This series of post hoc analyses were aimed at placing some broader 'explanatory parameters' on the distress intolerance variables that were modeled by relating them to other variables that may serve similar functions. For perceived distress intolerance, there were, as would be expected and found in past work, significant bi-variate relations to fear of detox, experiential avoidance, anxiety sensitivity, discomfort intolerance, and emotion dysregulation (Leyro et al., 2010). The strongest interrelation was between perceived distress intolerance and emotion dysregulation, which may partially be due to overlapping item content for the emotional non-acceptance subscale of the DERS (Gratz & Roemer, 2004). These data would be consistent with convergent (concurrent) validity of the DTS. Yet, the only significant association with the behavioral index of distress intolerance was anxiety sensitivity; a finding in line with past work (Asmundson & Stein, 1994), and perhaps, reflective of the more narrow 'fear of internal somatic perturbation' arguably at the center of the anxiety sensitivity construct (McNally, 2002). These data also could be considered in line with discriminant and convergent (concurrent) validity of breath-holding duration in the current CUD sample. Overall, the bi-variate relations between perceived and behavioral distress intolerance and related tolerance constructs were consistent with expectation and lends some further empirical credibility to their construct validity among the present sample.

The related transdiagnostic tolerance variables showcased largely similar, but not fully uniform, relations to the cannabis dependent measures. Specifically, all the measures, with the sole exception of discomfort intolerance, were significantly related to cannabis withdrawal and perceived barriers for cannabis cessation. Experiential avoidance, anxiety sensitivity, and emotion dysregulation each were additionally related to self-efficacy for quitting and severity of cannabis use problems in the expected direction. No variables were related to quit attempts or duration of time in quitting. Because there is still relatively little work on many of these transdiagnostic constructs among CUD populations (e.g., Johnson, Mullin, Marshall, Bonn-Miller, & Zvolensky, 2010), these data may therefore usefully prompt scholars to explore the relative utility of these factors in the maintenance and relapse of cannabis processes in future work. Here, it may be useful to continue to model multiple manifest indicators of distress intolerance and related transdiagnostic variables in one model rather than focus exclusively on one of these variables (Ameral, Palm, Cameron, & Armstrong, 2014). Indeed, there is some preliminary empirical evidence that stress sensitivity and tolerance may be hierarchically arranged (e.g., Bernstein, Zvolensky, Vujanovic, & Moos, 2009; McHugh & Otto, 2011).

#### **6.4. Clinical Implications**

In the absence of direct support for the primary study aims, there is arguably little clinical implication of the distress intolerance factors studied for the cannabis dependent measures studied among the population that was sampled. Yet, perceived distress intolerance showcased some consistent bi-variate relations with cannabis withdrawal, perceived barriers to cannabis cessation, and severity of cannabis use problems. These small to moderate effects, in conjunction with the observed relations to negative mood, suggest it may be useful to assess perceived distress tolerance (measured via the DTS) among CUD populations because it is related to certain cannabis use processes and could be targeted in intervention programming. That said, post hoc analyses revealed similar, and even stronger relations in certain cases, for these same (and other variables) in terms of other transdiagnostic affective vulnerability processes, such as fear of detox, experiential avoidance, and anxiety sensitivity. As noted in the preceding section, these data may suggest future work may be better suited to explore these other affective vulnerability processes in CUD research/practice, an area of work which is, in fact, starting to occur for certain variables such as

experiential avoidance (e.g., Buckner, Zvolensky, Farris, & Hogan, 2014) and anxiety sensitivity (e.g., Zvolensky et al., 2006; Zvolensky et al., 2009).

Perhaps the most interesting clinical implication for perceived distress intolerance centers on the indirect post hoc analyses. These data suggest, at least for perceived distress intolerance, scholars could usefully consider its relation to negative affect and vice versa to better understand the nature of cannabis use processes. To the extent distress intolerance is directly or indirectly related to cannabis use variables via negative affect, targeted interventions that seek to reduce distress intolerance and negative emotional states would be important to facilitate change in cannabis processes. Also, even if bi-directional relations exist between perceived distress intolerance and negative affect (which is apt to be the case), interventions addressing these variables in a coherent theoretical model may be useful to consider. Interestingly, there is some work starting to integrate distress intolerance in substance use treatment. As one example, Bornoalova and colleagues (2012) developed a brief distress intolerance intervention (Skills for Improving Distress Intolerance; SIDI), as an adjunctive therapy for low-income, mostly minority (90% African American) patients receiving care at a residential substance treatment program. The SIDI intervention included an emotional exposure component, allowing patients to practice skill development and ability to tolerate emotional experiences in the context of negative mood (Bornoalova et al., 2012). Bornoalova (2012) found that the two comparison treatment groups that the SIDI intervention was tested against both demonstrated similar reductions in negative mood during the course of treatment to the SIDI group. Yet, the SIDI group was the only condition that showed a significant reduction in their behavioral distress intolerance (mirror-tracing task; Strong et al., 2003; PASAT; Lejuez, Kahler, & Brown, 2003). Because this study employed behavioral distress intolerance measurement with a monetary incentive for task persistence (Bornoalova et al., 2012) and did not measure perceived distress intolerance, the extent to which it can be compared to the current sample is unclear. Yet, it provides one illustration of a type of treatment model that addresses distress intolerance substance use behavior. Related types of work have similarly focused on improving distress intolerance via emotional acceptance in treatment paradigms for tobacco (Brown et al., 2013; Zvolensky, Bogiaizaian, Salazar, Farris, & Bakhshaie, 2014). Other non-addictive oriented treatment studies have reported that increases in distress intolerance during treatment for

mood/anxiety disorders are related to better clinical outcomes (McHugh, Kertz, Weiss, Baskin-Sommers, Hearon, & Bjorgvinsson, 2014; Williams, Thompson, & Andrews, 2013).

### **6.5. Study Limitations and Future Directions**

There are several limitations not already noted that warrant comment. First, the current investigation was cross-sectional in design and represents a 'snap-shot' of the relations observed among the present sample. Due to the design, the direction and causal nature of the predictor and dependent variables cannot be interpreted within the context of the current study. As noted earlier, future work might examine these relations prospectively to elucidate the directional effects of the observed relations. Second, some the findings from the current study may have been influenced by shared method variance as a result of utilizing self-report measures to assess the main study constructs (although not all). Outside of additional 'multi-method approaches' (which were employed), field and laboratory assessment of distress intolerance or experimental manipulation of the construct may be particularly informative. For example, scholars could explore how distress intolerance relates prospectively to time to first cannabis lapse using time sampling methods during an actual quit attempt, or inversely, how distinct periods of cannabis deprivation (e.g., no use for 24 hours, no use for 12 hours, no use for 6 hours) relates to distress intolerance across a range of laboratory tests that vary in the content of distress (e.g., pain versus frustration versus arousal). Third, the assessment of cannabis withdrawal cannot be understood to be a 'pure index' of withdrawal because there was no measurement of change in withdrawal symptoms. In all likelihood, the cannabis withdrawal measure, as employed here, taps the report of negative affect and cannabis withdrawal symptoms. Future research could usefully build upon this work by exploring distress intolerance when measuring withdrawal in the context of cannabis use in quit paradigms or laboratory protocols that manipulate duration of abstinence from cannabis use.

Fourth, because of the low educational levels of the sample, there is a possible concern (briefly noted earlier) about level of comprehension/understanding of the assessment material. I did not formally measure reading level, and therefore, it is not possible to explicate the nature of this possible issue. Future work would benefit from addressing this matter in order to more comprehensively examine the role of distress intolerance in cannabis use behavior. Fifth, there was a larger number of males relative to females

in the sample. The reason for this selection bias is not clear. Future work may usefully sample males and females at an equivalent proportion to better gauge the applicability of distress intolerance to males/females. Also related to generalizability, because the sample was from underrepresented groups and lower socioeconomic levels, applicability to other social strata segments and ethnic groups may not be possible. Studies could possibly move the field forward further by modeling distress intolerance across different sociocultural and socioeconomic segments of the cannabis using population in future work to address this matter, as it is not likely cannabis use (or, other substance use) functions the same across individuals. Indeed, the combination of social inequities that diminish access to reward with inherent limitations in reward responsivity (characteristic of drug using populations) may produce increases in the motivation to use cannabis to obtain reinforcement. Therefore, the 'reinforcing nature of cannabis' may vary as a function of socioeconomic status or social determinants of health. Sixth, there was no biochemical assessment of cannabis use and related substance use. Cannabis use behavior has many different facets (e.g., amount, quality, method of consumption). Although self-report measures for frequency and quantity of cannabis use are currently employed widely, continued efforts to strengthen measurement of cannabis use is paramount. Researchers are currently testing alternative methods for quantifying self-reported cannabis use (Norberg, Mcakenzie, & Copeland, 2011). Future studies could minimally incorporate biochemical 'verification' to cross-index its relation to self-reported use.

Seventh, I employed a modified version of a perceived barriers to cannabis cessation scale (adapted from tobacco research) to index perceptions of barriers related to quitting cannabis. This construct represents a novel area of cannabis research, but results from this measure should be considered in light of the fact that this scale, unlike the others employed, has not been tested in a psychometrically rigorous fashion yet. That said, the scale did appear to perform largely as expected by showcasing consistent significant relations to some of the other cannabis use variables (see Table 5; cannabis use problems) and demonstrating a high level of internal consistency. Future work could possibly examine the potential explanatory utility of perceived barriers for cannabis cessation in treatment or self-quit paradigms after further psychometric development/testing (e.g., factor analysis, test-retest reliability). Eighth, for the measurement of physical health problems, I relied on a brief checklist from our team that lists only some of

the more common medical problems in studies of substance use that may be contraindicated for participation in laboratory studies in our research. Outside of the validity of self-reporting medical problems (people may be unaware of certain conditions, confuse them with other disorders, etc.), there is a truncated range for endorsement. Given the high rate of endorsement for the problems listed, it may prompt scholars to further explore the interplay of medical disease with affective vulnerability processes in the context of CUD. Here, syndemic models, which seek to explore relations between substance use, physical health, and mental health problems, contributing to excess burden of disease, could be a useful method of guidance. In other words, examining the synergistic effect of the presence of multiple-morbidities, as was evident in the current sample, may help inform clinical interventions to improve and provide health care among unique sub-sets of the population at greater risk for poor health outcomes (Gonzalez-Guarda, & Florom-Smith, 2011). Ninth, also related to measurement, the FTND had low levels of internal consistency; an issue often apparent with this measure (Korte, Capron, Zvolensky, & Schmidt, 2013). Yet, Cronbach alpha values are fairly sensitive to the number of items in each scale and it is not uncommon to find lower Cronbach values with shorter scales (e.g., scales with less than 10 items, such as the six-item FTND (DeVellis, 2003).

Tenth, as noted at the outset of the post hoc test section of the Discussion, I ran many analyses to further explore the data in the absence of support for the main hypotheses. Although exploratory efforts such as these are often useful in generating new insights into the phenomena under study, they come with an inherent cost: the uncorrected number of tests yields a risk of interpretative error (Type I error). The best approach for future study would therefore be to use the results from the post hoc tests as a 'starting point' for an a priori test(s) and novel data collection. Eleventh, I measured a relatively broad range of cannabis dependent variables. That said, I did not measure all possible cannabis change or quit processes. Future work could continue to explore distress intolerance in relation to other cannabis use processes, such as craving, motivation to quit, outcome expectancies, reward sensitivity, and related constructs. Finally, it is worth noting that the quit duration variables (total lifetime quit attempts, longest abstinence duration ever achieved, or abstinence duration during the most recent quit attempt) were not related in a robust fashion with any of the other primary predictor or dependent variables (including other cannabis use variables).

These findings prompt broad-based caution in the validity of these variables. It may simply be challenging for an individual, especially a person with CUD, to recall in a reliable and valid way their quit history. To address this matter, prospective modeling of quit behavior will be necessary.

### **6.6. Summary**

The present study explored perceived and behavioral distress intolerance factors in relation to an array of cannabis use variables among a CUD sample who was highly diverse, low-income, had low levels of educational attainment, and high levels of psychological and medical problems. The study was designed to build off past work and provide a novel test of an interactive model. The work sits on the backdrop of emerging efforts in the substance use disorder field to isolate transdiagnostic affective vulnerability processes that may undergrid problematic substance use behavior and its co-occurrence with psychopathology (Leventhal & Zvolensky, 2015). Yet, the present results yielded no empirical support for the synergistic effect of perceived and behavioral distress intolerance factors in relation to the studied cannabis use variables among the studied sample. Although several caveats, detailed earlier, suggest some degree of caution to be placed in these (null) findings, post hoc tests suggested potentially clinically and theoretically interesting effects. Perhaps most notably, the explanatory role of negative mood in the context of perceived distress intolerance and certain cannabis variables highlights the general importance of understanding the interconnection between negative affect, tolerance for distress, and substance use disorders. Future theory-driven work that seeks to uncover the time course and patterning between distress intolerance, negative mood, and cannabis use behavior are needed. In such a pursuit, it will likely remain imperative to consider the social context of affective vulnerabilities processes in relation to cannabis use behavior and the multiple types of health and psychological problems that often characterize health disparity subgroups at greatest risk for substance use disorder problems.

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**TABLES**

**Table 1: Summary of studies examining distress intolerance and cannabis**

	<b>Study Characteristics</b>	<b>Measures of distress intolerance</b>	<b>Summary of major findings</b>
Daughters et al., 2005	( <i>n</i> = 89; 37.1% male <i>M</i> <sub>age</sub> = 39.2, <i>SD</i> = 9.4; years; 89.9% African American)	Paced Auditory Serial Addition Task (PASAT; Gronwall, 1977; Lejuez, Kahler, & Brown, 2003)	Results suggest that duration of substance abstinence is related to persistence on the distress intolerance task.
Simons & Gaher, 2005	( <i>n</i> = 642; 70% female; <i>M</i> <sub>age</sub> = 19.90, <i>SD</i> = 1.64; 89% Caucasian, 7% African American, 1% Asian, 1% multiracial, 2% other)	Distress Tolerance Scale (DTS; Simons & Gaher, 2005)	Findings suggest that those who endorse high levels of distress intolerance have an increased concurrent likelihood to use these substances (alcohol and cannabis) because they believe it can help reduce negative affect.
Buckner et al., 2007	( <i>n</i> = 265; 63.3% female; <i>M</i> <sub>age</sub> = 18.7 <i>SD</i> = 1.2; 78.1% Caucasian)	Distress Tolerance Scale (DTS; Simons & Gaher, 2005) Discomfort Intolerance Scale (DIS; Schmidt et al., 2006)	Results indicated that distress intolerance is significantly associated with increased problems associated with alcohol and cannabis use, as well as increased cannabis use frequency.
Zvolensky et al., 2009	( <i>n</i> = 135; 46.7% women; <i>M</i> <sub>age</sub> = 20.45, <i>SD</i> = 5.0; 95% Caucasian, .7% African-American, .7% Asian, .7% Hispanic, .7% bi- or multiracial, 1.5% other)	Distress Tolerance Scale (DTS; Simons & Gaher, 2005) Diagnostic Sensations Questionnaire (DSQ; Sanderson, Rapee, & Barlow, 1988, 1989)	Results suggest that perceived distress intolerance is uniquely concurrently related to coping-oriented cannabis use.
Potter et al., 2011	( <i>n</i> = 142; 46.5% women; <i>M</i> <sub>age</sub> = 22.18, <i>SD</i> = 7.22; 95.8% Caucasian, 0.7% Asian, 0.7% Hispanic/Latino, and 1.4% “other”)	Distress Tolerance Scale (DTS; Simons & Gaher, 2005)	Results suggest that those who endorse a lower perceived ability to withstand emotional distress may experience higher levels of posttraumatic stress symptoms, and as a result, use cannabis to manage emotional distress.
Bujarski et al., 2012	( <i>n</i> = 118; 33.9% women; <i>M</i> <sub>age</sub> = 29.84, <i>SD</i> = 12.41; 74% reported Australia as their country of birth)	Distress Tolerance Scale (DTS; Simons & Gaher, 2005)	Results suggest that individuals who are highly intolerant of distress may experience more problematic patterns of cannabis use.
Dvorak et al., 2014	( <i>n</i> = 817; 64.5% women; <i>M</i> <sub>age</sub> = 20.14, <i>SD</i> = 2.36; 92.04% Caucasian, 3.79% Asian, 1.22% African American, and 2.95% “other”)	Distress Tolerance Scale (DTS; Simons & Gaher, 2005) UPPS-P Impulsive Behaviors Scale (Cyders et al., 2007)	When considered simultaneously, distress intolerance compared with behavioral impulsivity, was related to more problems related to marijuana use, rather than frequency or quantity of use, which was associated with behavioral self-regulation.

**Table 2: Inclusionary and Exclusionary Criteria**

<b>Criteria</b>	<b>Included</b>	<b>Excluded</b>
Between the ages of 18-65	<b>X</b>	
Current diagnosis of cannabis abuse or dependence	<b>X</b>	
Active cannabis user (e.g., use three days/per week)	<b>X</b>	
Two or more cannabis quit attempts, with at least one occurring in the past year	<b>X</b>	
Ability to give informed, voluntary, written consent	<b>X</b>	
Current suicidal or homicidal ideation		<b>X</b>
Current psychosis		<b>X</b>
Limited competency		<b>X</b>
Involved in current professional drug-related treatment		<b>X</b>
Legal mandate limiting cannabis use, related to reported quit attempt		<b>X</b>
Use of cannabis for a medical disorder		<b>X</b>
Pregnant or currently breastfeeding		<b>X</b>

**Table 3: Measure Administration Schedule**

Measure	Administration		Mode of Measure
	Phone Screen	Baseline	
<b>Screening/Cannabis History</b>			
Marijuana History Questionnaire	x	x	Dependent variable
Demographics Questionnaire		x	Covariate
Medical Problems	x	x	Descriptive measure
SCID-NP		x	Used to determine eligibility
<b>Motives/Quit Strategies</b>			
Self-efficacy for Quitting		x	Dependent variable
Marijuana Problems Scale		x	Dependent variable
Barriers to Cannabis Cessation		x	Covariate
Marijuana Withdrawal Checklist		x	Dependent variable
<b>Psychological Symptoms</b>			
Positive and Negative Affect Scale		x	Covariate
<b>Distress Intolerance</b>			
Distress Tolerance Scale		x	Primary predictor variable
Breath-Holding Task		x	Primary predictor variable
<b>Related Distress Intolerance Constructs (Post-hoc)</b>			
Detox Fear Survey Schedule-27		x	Post-hoc Comparison
Multidimensional Experiential Avoidance Questionnaire		x	Post-hoc Comparison
Anxiety Sensitivity Index III		x	Post-hoc Comparison
Discomfort Intolerance Scale		x	Post-hoc Comparison
Difficulties in Emotion Regulation Scale		x	Post-hoc Comparison

**Table 4: Rates of Psychopathology and Physical Illness**

<b>PSYCHOPATHOLOGY</b>		<b>Total</b>	<b>Percent %</b>
	<b>Anxiety Disorders</b>		
	Posttraumatic Stress Disorder	33	21.3%
	Specific phobia	8	5.2%
	Generalized Anxiety Disorder	5	3.2%
	Social Anxiety Disorder	4	2.6%
	Panic Disorder	3	1.9%
	Obsessive-compulsive Disorder	1	0.6%
	Anxiety disorder not otherwise specified	2	1.3%
			<i>Total = 36.1%</i>
	<b>Mood Disorders</b>		
	Dysthymia	9	5.8%
	Bipolar I/II	7	4.5%
	Major Depressive Disorder	25	16.1%
			<i>Total = 26.4%</i>
	<b>Substance Use Disorders</b>		
	Alcohol Use Disorder	21	13.5%
	Cocaine Use Disorder	7	4.5%
			<i>Total = 18%</i>
<b>PHYSICAL ILLNESS</b>			
	<b>Medical Conditions</b>		
	Respiratory Conditions	55	35.5%
	Head Injury	18	11.6%
	Diabetes	9	5.8%
	Heart Problems	3	1.9%
	Hypertension	25	16.1%
	Epilepsy	3	1.9%

**Table 5: Bivariate Correlations**

	Mean(SD) or % Possible Range/ Observed Range	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
<b>1. Poly Substance</b>	82% (no) --/--	--												
<b>2. Respiratory Condition</b>	64.5% (no) --/--	-.16*	--											
<b>3. NA</b>	19.72(8.19) 4-46/4-46	-.01	.20*	--										
<b>4. Gender</b>	29% female --/--	.14	-.27**	-.11	--									
<b>5. BHT</b>	43(22) --/1-96	-.14	.09	-.03	.22**	--								
<b>6. DTS</b>	3.05(1.02) 1-5/1-5	.03	-.01	-.34**	.07	-.06	--							
<b>7. Lifetime Quit Index</b>	4.96(2.77) 0-9/1-9	-.01	-.01	.04	-.01	-.09	.09	--						
<b>8. Longest Quit Duration</b>	14948.75 --/0-262980	.07	-.02	-.02	-.05	-.09	-.05	.02	--					
<b>9. Recent Quit Duration</b>	689.81 --/0-8760	.15	-.04	-.03	-.10	-.08	.12	.09	-.02	--				
<b>10. MWC</b>	20.78(17.60) 0-96/0-76	-.05	.18*	.34**	-.22**	-.10	-.21**	.04	-.04	-.09	--			
<b>11. SEQ</b>	56.06(17.62) 19-95/19-95	-.05	.13	.20*	-.05	-.11	.03	.12	-.08	.13	.21**	--		
<b>12. BCCS</b>	23.89(13.20) 0-54/0-53	-.07	.06	.32**	-.16*	-.03	-.24**	.05	-.14	.01	.50**	.08	--	
<b>13. MPS</b>	27.06(6.96) 19-57/19-53	.05	-.00	.33**	.08	-.04	-.17*	.11	.07	.04	.39**	.17*	.44**	--

Notes: \* =  $p < 0.05$ ; \*\* =  $p < 0.01$ . Poly substance = concurrent regular use of tobacco, alcohol or other substances (coded as, *no other substance use* = 0, or, *other concurrent substance use* = 1); Respiratory Condition = presence of a respiratory condition, including asthma, chronic bronchitis, allergies (coded 0 = no condition, or 1 = one or more conditions endorsed); NA = Positive and Negative Affect Scale – Negative Affect subscale (Watson et al., 1988); Gender = sex participant identified with, percent listed is female (coded as, female = 0, or, male = 1); DTS = Distress Tolerance Scale Total Score (Simons & Gaher, 2005); BHT= latency to end the 2<sup>nd</sup> trial of the breath holding task (Asmundson & Stein, 1994)Lifetime Quit Index = total number of lifetime quit attempts; Longest Quit Duration = duration in days of longest abstinence period ever achieved; Recent Quit Duration = duration in days of most recent abstinence period; MWC = Marijuana Withdrawal Checklist – Total Score (Budney et al., 1999); SEQ = Self-Efficacy Questionnaire – Total Score (Marlatt & Gordon, 1985); BCCS = Barriers to Cannabis Cessation Scale – Total Score; MPS = Marijuana Problems Scale – Total Score (Stephens et al., 2000).

**Table 6: Hierarchical regression models for Aim 1**

<b>Model 1: Lifetime Quit Index</b>						
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>Coeff.</i> †	<i>SE</i>	<i>t</i>
<i>Step 1</i>	.14	.02				
Perceived Distress Intolerance				.05	.04	1.27
Behavioral Distress Intolerance				.02	.03	.61
<i>Step 2</i>			.01			
Perceived * Behavioral				-.00	.00	-.93
<b>Model 1: Longest Quit Index</b>						
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>Coeff.</i> †	<i>SE</i>	<i>t</i>
<i>Step 1</i>	.15	.02				
Perceived Distress Intolerance				.02	.01	1.76
Behavioral Distress Intolerance				.01	.01	1.16
<i>Step 2</i>			.01			
Perceived * Behavioral				-.00	.00	-1.35
<b>Model 1: Recent Quit Index</b>						
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>Coeff.</i> †	<i>SE</i>	<i>t</i>
<i>Step 1</i>	.13	.02				
Perceived Distress Intolerance				.02	.01	1.07
Behavioral Distress Intolerance				.02	.01	1.45
<i>Step 2</i>			.01			
Perceived * Behavioral				-.00	.00	-1.45

Notes: \**p* < .05, \*\**p* < .01, † = unstandardized regression coefficient Lifetime Quit Index = total number of lifetime quit attempts; Longest Quit Duration = duration in days of longest abstinence period ever achieved; Recent Quit Duration = duration in days of most recent abstinence period; Perceived Distress Intolerance = Distress Tolerance Scale – Total Score (Simons & Gaher, 2005); Behavioral Distress Intolerance = latency (duration) to end the second trial of the breath holding task (Asmundson & Stein, 1994); Perceived \* Behavioral = interaction term of perceived and behavior distress intolerance.

**Table 7: Hierarchical regression models for Aim 2**

<b>Model 1: Cannabis Withdrawal (MWC)</b>						
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>Coeff.</i> †	<i>SE</i>	<i>t</i>
<i>Step 1</i>	.42	.17**				
Gender				-5.81	3.16	-1.84
NA				.62**	.18	3.41
Respiratory				2.77	2.99	.93
<i>Step 2</i>						
Perceived Distress Intolerance				-.26	.04	1.27
Behavioral Distress Intolerance				-.17	.03	.61
<i>Step 3</i>			.01			
Perceived * Behavioral				-.00	.00	.64
<b>Model 1: Self-Efficacy for Quitting (SEQ)</b>						
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>Coeff.</i> †	<i>SE</i>	<i>t</i>
<i>Step 1</i>	.24	.06*				
NA				.45*	.19	2.39
<i>Step 2</i>						
Perceived Distress Intolerance				.21	.24	.85
Behavioral Distress Intolerance				-.01	.21	-.07
<i>Step 3</i>			.00			
Perceived * Behavioral				-.00	.00	-.42
<b>Model 1: Barriers to Cannabis Cessation (BCCS)</b>						
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>Coeff.</i> †	<i>SE</i>	<i>t</i>
<i>Step 1</i>	.38	.14**				
Gender				-3.50	2.32	-1.51
NA				.46**	.14	3.33
<i>Step 2</i>						
Perceived Distress Intolerance				-.07	.18	-.41
Behavioral Distress Intolerance				.07	.16	.43
<i>Step 3</i>			.00			
Perceived * Behavioral				-.00	.00	-.32

Notes: \**p* < .05, \*\**p* < .01, † = unstandardized regression coefficient. MWC = Marijuana Withdrawal Checklist (Budney et al., 1999); SEQ = Self-Efficacy Questionnaire (Marlatt & Gordon, 1985); BCCS = Barriers to Cannabis Cessation Scale; Gender = sex participant; NA = Positive and Negative Affect Scale – Negative Affect subscale (Watson et al., 1988); Respiratory = respiratory condition; Perceived Distress Intolerance = Distress Tolerance Scale (Simons & Gaher, 2005); Behavioral Distress Intolerance = breath holding duration (Asmundson & Stein, 1994); Perceived \* Behavioral = interaction term.

**Table 8: Hierarchical regression models for Aim 3**

<b>Model 1: Cannabis Problems (MPS)</b>						
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	Coeff. †	<i>SE</i>	<i>t</i>
<i>Step 1</i>	.37	.13**				
NA				.00**	.00	4.11
<i>Step 2</i>						
Perceived Distress Intolerance				-.00	.00	-.90
Behavioral Distress Intolerance				-.00	.00	-.89
<i>Step 3</i>			.00			
Perceived * Behavioral				.00	.00	.85

Notes: \**p* < .05, \*\**p* < .01, † = unstandardized regression coefficient. MWC = Marijuana Withdrawal Checklist (Budney et al., 1999); SEQ = Self-Efficacy Questionnaire (Marlatt & Gordon, 1985); BCCS = Barriers to Cannabis Cessation Scale; Gender = sex participant; NA = Positive and Negative Affect Scale – Negative Affect subscale (Watson et al., 1988); Respiratory = respiratory condition; Perceived Distress Intolerance = Distress Tolerance Scale (Simons & Gaher, 2005); Behavioral Distress Intolerance = breath holding duration (Asmundson & Stein, 1994); Perceived \* Behavioral = interaction term.

**Table 9: Bivariate Correlations between Subscales of Perceived Distress Intolerance and Dependent Variables**

	Mean(SD) or % Possible Range/Observed Range	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
<b>1. DTS Total Score</b>	3.05(1.02) 1-5/1-5	--											
<b>2. DTS Absorption</b>	3.01 (0.96) 1-5/1-5	.85**	--										
<b>3. DTS Appraisal</b>	3.22 (5.77) 1-5/1-5	.89**	.79**	--									
<b>4. DTS Regulation</b>	2.98 (1.18) 1-5/1-5	.79**	.57**	.64**	--								
<b>5. DTS Tolerance</b>	2.99 (1.22) 1-5/1-5	.85**	.69**	.67**	.65**	--							
<b>6. Lifetime Quit Index</b>	4.96(2.77) 0-9/1-9	.09	.08	.08	.05	.06	--						
<b>7. Longest Quit Duration</b>	14948.75 --/0-262980	-.05	.00	-.09	-.06	-.02	.02	--					
<b>8. Recent Quit Duration</b>	689.81 --/0-8760	.12	.10	.14	.09	.13	.09	-.02	--				
<b>9. MWC</b>	20.78(17.60) 0-96/0-76	-.21**	-.25**	-.23**	-.21*	-.17*	.04	-.04	-.10	--			
<b>10. SEQ</b>	56.06(17.62) 19-95/19-95	.03	.04	.05	-.06	.00	.12	-.07	.12	.21**	--		
<b>11. BCCS</b>	23.89(13.20) 0-54/0-53	-.24**	-.26**	-.24**	-.20*	-.21*	.05	-.14	.02	.51**	.08	--	
<b>12. MPS</b>	27.06(6.96) 19-57/19-53	-.17*	-.21**	-.15	-.08	-.12	.11	.07	.04	.40**	.17*	.44**	--

Notes: \* =  $p < 0.05$ ; \*\* =  $p < 0.01$ . DTS Total Score= Distress Tolerance Scale – Total Score (Simons & Gaher, 2005); DTS Absorption= Distress Tolerance Scale – Absorption Subscale (Simons & Gaher, 2005); DTS Appraisal= Distress Tolerance Scale – Appraisal Subscale (Simons & Gaher, 2005); DTS Regulation= Distress Tolerance Scale – Regulation Subscale (Simons & Gaher, 2005); DTS Tolerance = Distress Tolerance Scale – Tolerance Subscale (Simons & Gaher, 2005); Lifetime Quit Index = total number of lifetime quit attempts; Longest Quit Duration = duration in days of longest abstinence period ever achieved; Recent Quit Duration = duration in days of most recent abstinence period; MWC = Marijuana Withdrawal Checklist – Total Score (Budney et al., 1999); SEQ = Self-Efficacy Questionnaire – Total Score (Marlatt & Gordon, 1985); BCCS = Barriers to Cannabis Cessation Scale – Total Score; MPS = Marijuana Problems Scale – Total Score (Stephens et al., 2000).

**Table 10: Hierarchical regression analyses for post-hoc tests**

<b>Model 1: Cannabis Withdrawal (criterion)</b>							
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>B</i>	<i>SE</i>	$\beta$	<i>t</i>
<i>Step 1</i>	.34	.12**					
Negative Affectivity				.74	.16	.34**	4.48
<i>Step 2</i>	.38	.14	.02				
DTS Absorption				-.77	.71	-.15	-1.08
DTS Appraisal				.14	.43	.05	.34
DTS Regulation				-.89	.74	-.13	-1.20
DTS Tolerate				.34	.57	.07	.60
<b>Model 2: Cannabis Problems (criterion)</b>							
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>B</i>	<i>SE</i>	$\beta$	<i>t</i>
<i>Step 1</i>	.34	.12**					
Negative Affectivity				.00	.00	.34**	4.43
<i>Step 2</i>	.36	.13	.01				
DTS Absorption				-.01	.00	-.19	-1.38
DTS Appraisal				.00	.00	.09	.69
DTS Regulation				.00	.00	.05	.45
DTS Tolerate				.00	.00	.01	.08
<b>Model 3: Barriers to Cannabis Cessation (criterion)</b>							
	<i>R</i>	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> change	<i>B</i>	<i>SE</i>	$\beta$	<i>t</i>
<i>Step 1</i>	.31	.09**					
Negative Affectivity				.51	.13	.32**	4.03
<i>Step 2</i>	.36	.13	.03				
DTS Absorption				-.47	.53	-.12	-.87
DTS Appraisal				.02	.32	.01	.07
DTS Regulation				-.46	.56	-.09	-.82
DTS Tolerate				-.03	.43	-.09	-.82

Notes: \* =  $p < 0.05$ ; \*\* =  $p < 0.01$ . DTS Absorption = Distress Tolerance Scale – Absorption Subscale (Simons & Gaher, 2005); DTS Appraisal = Distress Tolerance Scale – Appraisal Subscale (Simons & Gaher, 2005); DTS Regulation = Distress Tolerance Scale – Regulation Subscale (Simons & Gaher, 2005); DTS Tolerance = Distress Tolerance Scale – Tolerance Subscale (Simons & Gaher, 2005); Cannabis Withdrawal = Marijuana Withdrawal Checklist (Budney et al., 1999); Barriers to Cannabis Cessation = Barriers to Cannabis Cessation Scale; Cannabis Problems = Marijuana Problems Scale (Stephens et al., 2000).

**Table 11: Hierarchical regression models post hoc mediation models**

Y	Model	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i>	CI (lower)	CI (upper)
1	DTS → NA (a)	-.21	.05	-4.46	< .001	-.29	-.12
	NA → MWC (b)	.66	.17	3.77	< .001	.31	1.01
	DTS → MWC (c')	-.14	.10	-1.30	.19	-.35	.07
	NA → MWC (c)	-.27	.10	-2.64	< .01	-.48	-.07
	DTS → NA → MWC (a*b)	-.14	.05			-.25	-.05
2	DTS → NA (a)						
	NA → SEQ (b)	.52	.18	1.37	< .01	.16	.88
	DTS → SEQ (c')	.15	.11	1.37	.17	-.07	.37
	NA → SEQ (c)	.04	.11	.40	.69	-.17	.25
	DTS → NA → SEQ (a*b)	-.11	.04			-.20	-.04
3	DTS → NA (a)						
	NA → BCCS (b)	.43	.13	3.22	< .01	.16	.69
	DTS → BCCS (c')	-.15	.08	-1.88	.06	-.31	.01
	NA → BCCS (c)	-.24	.08	-3.02	< .01	-.39	-.08
	DTS → NA → BCCS (a*b)	-.08	.03			-.17	-.03
4	DTS → NA (a)						
	NA → MPS (b)	.00	.00	3.97	< .001	-.00	.01
	DTS → MPS (c')	.00	.00	-.55	.58	-.00	.00
	NA → MPS (c)	.00	.00	1.94	.05	-.00	.00
	DTS → NA → MPS (a*b)	.00	.00			-.00	.00

*Notes:* Path  $\underline{a}$  is equal across all models; therefore, it is presented only in the model with  $Y_1$  to avoid redundancies. N for analyses of models  $Y_1$  included 152 cases,  $Y_2$  included 154 cases,  $Y_3$  included 150 cases, and analyses for  $Y_1$  included 153 cases. The standard error and 95% CI for  $a*b$  are obtained by bootstrap with 10,000 re-samples. DTS (Distress Tolerance Scale Total Score; Simons & Gaher, 2005) is the independent variable ( $X$ ), NA (Positive and Negative Affect Scale – Negative Affect subscale; Watson et al., 1988) is the mediator ( $M$ ), and MWC ([ $Y_1$ ] Marijuana Withdrawal Checklist – Total Score; Budney et al., 1999), SEQ ([ $Y_2$ ] Self-Efficacy Questionnaire – Total Score; Marlatt & Gordon, 1985), BCCS ([ $Y_3$ ] Barriers to Cannabis Cessation Scale – Total Score), and MPS ([ $Y_4$ ] Marijuana Problems Scale Total Score; Stephens et al., 2000) are the outcome variables. CI (lower) = lower bound of a 95% confidence interval; CI (upper) = upper bound; → = affects.

**Table 12: Bivariate Correlations**

	Mean(SD) or % Possible Range/ Obs. Range	1.	2.	3.	4.	5.	6.	7.	8.	10.	11.	12.	13.	14.	15.	16.
1. NA	19.72(8.19) 4-46/4-46	--														
2. BHT	45.03(24.66) --/1-151	-.03	--													
3. DTS	3.05(1.02) 1-5/1-5	-.34**	-.06	--												
4. Fear of Detox	28.55(20.24) 0-80/0-80	.20*	-.10	-.22**	--											
5. MEAQ	203.46(112.8) 0-372/108-301	-.40**	-.12	-.36*	.38**	--										
6. ASI- III	17.96(14.92) 0-72/0-72	.34**	-.20*	-.36**	.46**	.53**	--									
7. DIS	15.57(4.70) 0-30/3-28	-.02	-.14	-.19*	.11	.20*	.20*	--								
8. DERS	81.67(23.04) 36-180/40-140	.54**	-.05	-.52**	.41**	.59**	.46**	.07	--							
10. Life time Quit Index	4.96(2.77) 0-9/1-9	.04	-.09	.09	.05	-.01	.05	-.01	-.06	--						
11. Longest Quit Dur.	14948.75 --/0-262980	-.02	-.09	-.05	-.13	-.15	.07	-.06	.08	.02	--					
12. Recent Quit Dur.	689.81 --/0-8760	-.03	-.10	.12	.04	.02	-.12	.03	.08	.09	-.02	--				
13. MWC	20.78(17.60) 0-96/0-76	.34**	-.10	-.21**	.52**	.37**	.49**	.25**	.39**	.04	-.04	-.09	--			
14. SEQ	56.06(17.62) 19-95/19-95	.20*	-.05	.03	.04	.19*	.21**	.06	.12	.12	-.08	.13	.21**	--		
15. BCCS	23.89(13.20) 0-54/0-53	.32**	-.03	-.24**	.61**	.32**	.32**	.13	.26**	.05	-.14	.01	.50**	.08	--	
16. MPS	27.06(6.96) 19-57/19-53	.33**	-.04	-.17*	.30**	.22*	.30**	-.05	.33**	.11	.07	.04	.39**	.17*	.44**	--

Notes: \* =  $p < 0.05$ ; \*\* =  $p < 0.01$ . NA = Positive and Negative Affect Scale – Negative Affect subscale (Watson et al., 1988); BHT= latency to end the 2<sup>nd</sup> trial of the breath holding task (Asmundson & Stein, 1994); DTS = Distress Tolerance Scale – Total Score (Simons & Gaher, 2005); Fear of Detox = Detox Fear Survey Schedule-27 (Milby et al, 1987); MEAQ = Multidimensional Experiential Avoidance Questionnaire – Total Score (Gamez, Kotov, Ruggero, & Watson, 2011); ASI-III = Anxiety Sensitivity Index III – Total Score (Taylor et al., 2007); DIS = Discomfort Intolerance Scale – Total Score (Schmidt et al., 2006); DERS = Difficulties in Emotion Regulation Scale – Total Score (Gratz & Roemer, 2004); AAQ = Acceptance and Action Questionnaire – Total Score (Hayes et al., 2004); MAAS = Mindful Awareness and Attention Scale – Total Score (Brown & Ryan, 2003); Life time Quit Index = total number of lifetime quit attempts; Longest Quit Dur. = duration in days of longest abstinence period ever achieved; Recent Quit Dur. = duration in days of most recent abstinence period; MWC = Marijuana Withdrawal Checklist – Total Score (Budney et al, 1999); SEQ = Self-Efficacy Questionnaire – Total Score (Marlatt & Gordon, 1985); BCCS = Barriers to Cannabis Cessation Scale – Total Score; MPS = Marijuana Problems Scale – Total Score (Stephens et al., 2000).

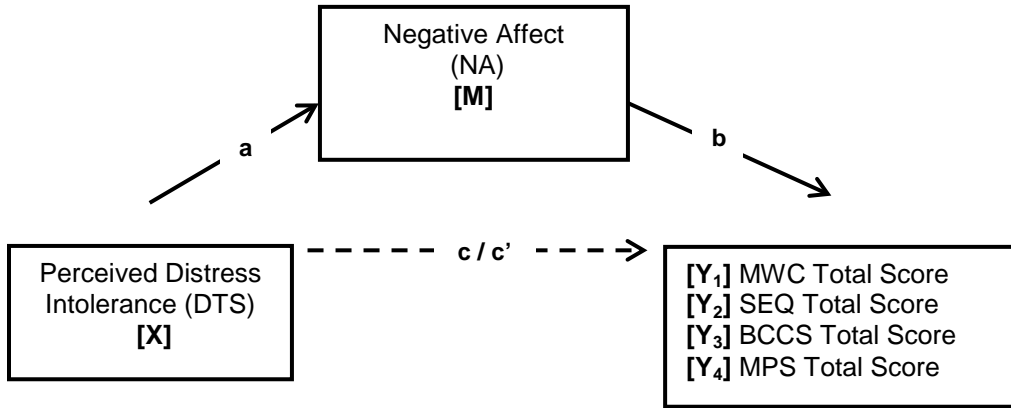
**Table 13: Comparison study participant characteristics**

	Age	Sex	Race	Education	DTS	NA	Alcohol Use	Tobacco Use	Other Substance Use	Cannabis Use
Comparison Study	M (SD)	% female	% minority	% college completer	M (SD)	M (SD)	M (SD) or % weekly use	% tobacco user	% other weekly use	% weekly use
Daughters et al., 2005 (n = 89)	39.2 (9.4)	62.9%	89.9%	0%	NA	NA	55.1%	NA	Cocaine = 55% Opiates = 38%	30.4%
Simons & Gaher, 2005 (n = 89)	19.90 (1.64)	70%	9%	University sample	3.43 (0.76)	2.29 (0.64)	RAPI 32.54 (10.96)	NA	NA	***3.22 (1.26)
Buckner et al., 2007 (n = 89)	18.7 (1.2)	63.3%	NA (78.1% Caucasian)	University sample	*8.63 (3.14) range issue	NA	RAPI 50.04 (14.01)	NA	NA	8.2%
Zvolensky et al., 2009 (n = 89)	20.45 (5.0)	46.7%	4.2%	Did not report	3.65 (0.74)	17.27 (4.97)	AUDIT 11.85 (NA)	63%	NA	67%
Potter et al., 2011 (n = 89)	22.18 (7.22)	46.5%	1.4%	Did not report	3.48 (0.83)	NA	NA	NA	NA	****4.64
Bujarski et al., 2012 (n = 89)	29.84 (12.41)	33.9%	NA (74% Australian)	Did not report	**3.32 (0.91), 3.53 (0.92)	NA	NA	NA	NA	100%
Dvorak et al., 2014 (n = 89)	20.14 (2.36)	64.5%	5.01%	Did not report	0.00 (0.87)	1.94 (0.67)	NA	NA	NA	***** 0.83 (2.59)
Current Sample (n = 155)	37.2 (11.7)	29%	65.1%	20.6%	3.05 (1.02)	19.72 (8.19)	AUDIT 8.99 (8.4)	59.2%	Cocaine = 4.5%	100%

Notes: NA = data not reported in original journal article; \* = author reported DTS total score. For comparison to the current study, the statistic can be divided by four (the number of subscales), to yield an approximate mean of 2.16; \*\* = author reported DTS total score by gender; first mean is for females; \*\*\* = authors employed a frequency mean using the following scale: 0 = *never used in my life*, to 6 = *used more than 300 days*; \*\*\*\* = authors employed a frequency mean using the following type scale, ranging from 0 to 8 (0 = *no use in the past 30 days*, 4 = *use once or more per week*, 8 = *used more than once per day*; \*\*\*\*\* = authors used an ‘intensity’ scale, assessing average cannabis use during four possible time-points, for each day of the week, for a 6-month period.

FIGURES

Figure 3: Conceptual diagram of post-hoc indirect models



Notes: *a* = Effect of *X* on *M*; *b* = Effect of *M* on *Y<sub>i</sub>*; *c' <sub>i</sub>* = Direct effect of *X* on *Y<sub>i</sub>* controlling for *M*; *a\*b* = Indirect effect of *M*; four separate models were conducted for each criterion variable (*Y<sub>1-4</sub>*).

## APPENDIX

### Appendix A: Description of additional post-hoc measures

Detox Fear Survey Schedule-27 (DFSS-27; Gentile & Milby, 1992). The DFSS is a 27-item self-report measurement of an individual's level of fear related to physical, emotional, and social consequences of withdrawal, which exacerbate the experience of withdrawal process leading to more failed detoxification attempts (Gentile & Milby, 1992). The measure assesses fear of detoxification on a five-point likert-type scale, ranging from 0 (*not disturbed at all*) to 4 (*very much disturbed*). The DFSS-27 was created to assess for pathological phobia of opioid detoxification (sample item: *scared of becoming re-addicted*), which was revised by Milby et al. (1987) to include a semi-structured interview, which was not employed for the current study. In the current investigation, for the scope of the current project, all self-report items that were directly relevant only to opioid detoxification were removed (e.g., "*being told at the nursing station you have almost completed detox*"), resulting in 20 remaining items that were general to all substance use. Internal consistency for the DFSS in the present study was excellent ( $\alpha = .93$ ).

Multidimensional Experiential Avoidance Questionnaire (MEAQ; Gamez et al., 2011). The MEAQ is a 62-item measure of experiential avoidance. Items are rated from 1 (*strongly disagree*) to 6 (*strongly agree*). The MEAQ consists of six subscales: (1) Distress Aversion; (2) Behavioral Avoidance; (3) Distraction and Suppression; (4) Repression and Denial; (5) Procrastination; and (6) Distress Endurance. The summed responses yield a total score, consisting of all sub-scale items. The MEAQ demonstrates convergence with other measures of experiential avoidance (Gamez et al., 2011). In the present sample, internal consistency was adequate for the global MEAQ total score ( $\alpha=.95$ ).

Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2007). The ASI-3 is an 18-item self-report measure that assess the degree to which a respondents fears the potential negative consequences of anxiety-related symptoms and sensations (sample item: "*It scares me when my heart beats fast*") on a 5-point Likert-type scale from 0 (*very little*) to 4 (*very much*). In the current investigation, the ASI-3 had excellent internal consistency ( $\alpha = .92$ ).

Discomfort Intolerance Scale (DIS; Schmidt et al., 2006). The DIS is a 5-item self-report measure that assesses the degree to which a respondent agrees with statements related to their perceived intolerance of physical distress or discomfort (sample item: “*I take extreme measures to avoid feeling physically uncomfortable*”) on a 7-point Likert-type scale from 0 (*not at all like me*) to 6 (*extremely like me*). The DIS has demonstrated consistent psychometric properties as observed in past work (see Schmidt et al., 2006). Internal consistency for the DIS in the present study was adequate ( $\alpha = .79$ ).

Difficulties in Emotional Regulation Scale (DERS; Gratz & Roemer, 2004). The DERS is a 36-item assessment of emotion dysregulation. Items are rated from 1 (*almost never*) to 5 (*almost always*). In the current investigation, the DERS total sum score was used. Consistent with past work (Gratz & Roemer, 2004), the scale demonstrated excellent adequate internal consistency in the current sample ( $\alpha=.92$ ).