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Associations Between Cannabis Use Characteristics, Impulsivity, and Mindfulness

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Abstract

Dual-process theories of addiction have suggested that drug use behavior is influenced by the interaction between an automatic system, which uses affective and motivational significance to appraise stimuli rapidly, and a reflective system, which includes conscious emotion regulation and decision making. The current study examined the constructs of impulsivity and mindfulness, selected to approximate the automatic and reflective systems, respectively, and their associations with cannabis use characteristics. Research suggests deficits in impulsivity and mindfulness are hallmark characteristics of substance use. However, evidence supporting this association specific to cannabis use is inconsistent. A community sample of adults (N = 289, 137 female) completed an online survey that included the Short UPPS-P (SUPPS-P) impulsiveness questionnaire, Mindfulness Attention Awareness Scale (MAAS), and questions about cannabis use and cannabis-related problems. A logistic regression in the full sample revealed that SUPPS-P Lack of Premeditation and MAAS total scores, as well as alcohol consumption, were significant positive predictors of cannabis user status (i.e., use in the past 30 days). In the subsample of cannabis users (n = 87), no significant associations were revealed between impulsivity or mindfulness and cannabis use frequency. No impulsivity or mindfulness variables emerged as significant predictors of cannabis-related problems in users; although, consistent with prior studies, the association with SUPPS-P Negative Urgency approached significance. Alcohol-related problems were associated with cannabis-related problems as well. These findings extend the previous literature and have implications in identifying risk for problematic/disordered use as well as improving upon interventions and treatment approaches for problematic cannabis use.

Keywords: cannabis, impulsivity, mindfulness

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Substance use is a common occurrence in the United States. The 2017 National Survey on Drug Use and Health (NSDUH) estimated 30.5 million individuals were ongoing illicit drug users, indicating that they had used an illicit drug in the past month. Cannabis was the most frequently used illicit drug as it was used by 26 million people nationwide (Center for Behavioral Health Statistics and Quality [CBHSQ], 2018). Unfortunately, a proportion of individuals in the United States exhibit a transition from recreational to disordered drug use patterns. Roughly 24 million individuals in the United States are diagnosed with a substance use disorder (SUD; Substance Abuse and Mental Health Services Administration [SAMHSA], 2018). Approximately 17 million of these individuals are diagnosed with alcohol use disorder and the remaining 7 million have another type of drug use disorder (SAMHSA, 2018). On average, 9% of individuals who use cannabis will develop cannabis use disorder (CUD) within their lifetime (Walsh et al., 2017). Recent epidemiological research suggests prevalence rates of 2.5% for current and 6.3% for lifetime CUD (Hasin et al., 2019). These rates reflect approximately 6.7 million and 16.8 million individuals, respectively, which is an increase from prior estimates (CBHSQ, 2010). Overall, it is estimated that thirty percent of United States cannabis users demonstrate CUD symptoms, even when the number of symptoms displayed do not constitute a diagnosis (Hasin et al., 2015). There are also indications of significant increases in the prevalence of CUD (SAMHSA, 2019). In addition, CUD is the most prevalent SUD among young adults (18-25) in treatment (CBHSQ, 2018; Cousijn et al., 2015).

The use of many drugs (e.g., cocaine, opioids, & sedatives) has remained fairly constant over the years (United Nations Office of Drugs and Crime [UNODC], 2017), this is not the case for cannabis. In fact, cross-sectional data has revealed that global cannabis use estimates have

increased over the past decade (UNODC, 2017) and that cannabis use is much more frequent among adolescents and young adults (Lin et al., 2020) as well as adults with disabilities (Apollonio et al., 2019), and men (CBHSQ, 2017). Increased rates of cannabis use are also associated with an increase in the number of negative consequences related to cannabis use. Both physical and mental health can be influenced by a variety of cannabis use patterns (Hasin, 2018; Pattij et al., 2008). Although somewhat controversial, evidence suggests consistent alterations in cognitive and behavioral processes associated with the quantity, frequency, and chronicity of cannabis use (Curran et al., 2016; Nader & Sanchez, 2017). While there is ample evidence that CUD is associated with a variety of negative outcomes, including pronounced comorbidity (Hall, 1998; Hall & Solowij, 1998; Radhakrishnan et al., 2014), negative consequences are highly associated with non-disordered cannabis use as well (Hasin, 2018). Longer duration and increased frequency of cannabis use are associated with poorer socio-economic status, reduced academic achievement, and problematic cannabis use - in which one's cannabis use negatively impacts their life, but does not reach the level of impairment associated with CUD (Cousijn et al., 2015; Walsh, et al., 2017). At the time of writing, 22 states legalized cannabis for medicinal use and 13 states (e.g., Alaska, California, Colorado, Maine, Massachusetts, and Vermont) legalized non-medical ("recreational") use (DISA Global Solutions, 2020). Given that cannabis is legalized for medical and recreational use in a number of states and that cannabis use is only likely to increase in the foreseeable future (Haug et al., 2017; Wadsworth & Hammond, 2018), it is important to understand the potential effects of and risk factors underlying cannabis use in order to enhance intervention and treatment.

Delta-9-tetrahydrocannabinol (THC) is the primary psychoactive ingredient in cannabis and recent research suggests that THC levels are at an all-time high since the 1980's (Chandra et

al., 2019; ElSohly et al., 2016; Sciences of Engineering & Medicine, 2017). THC binds to cannabinoid 1 receptors (CB1) which are located in a variety of spots throughout the brain (Eggan & Lewis 2007; Kano et al., 2009). Although CB1 receptors are located throughout the brain, they are most densely populated in the prefrontal cortex (PFC) and have been implicated in multiple executive cognitive functions, which includattention, impulse regulation, goal and reward seeking behaviors, mood regulation, and memory (Cohen & Weinstein, 2018).

Indeed, major theoretical frameworks considering the development and maintenance of substance use and addiction emphasize the importance of neurocognitive mechanisms. In particular, the dual-process model (e.g., Wiers et al., 2007; Wiers & Stacy, 2006) theorizes that addictive behavior is influenced by an overactive impulsive system, which uses affective and motivational significance to appraise stimuli rapidly, and an underactive reflective system, which monitors cognitive processes associated with conscious emotion regulation, decision making, and expected outcomes. Research has demonstrated that independent neural mechanisms are associated with these systems. For instance, evidence suggests that brain regions directly associated with the nucleus accumbens (NAcc), ventromedial prefrontal cortex (vmPFC), and the mesolimbic dopamine system have relevance in automatic processes that are characteristic of the impulsive system (Hölzel et al., 2007; Hölzel et al., 2011). On the other hand, regions in the lateral prefrontal cortex (lPFC) are more closely related to attentional control, deliberative assessment of outcomes, and execution of self-control when suppressing impulsive behavior, which are all characteristics representative of the reflective system in the dual process model (see McClure & Bickel, 2014 for review). A substantial body of research suggests that disordered use is associated with drug-related alterations and impairment in these neurocognitive processes (Gruber et al., 2015; Lundqvist et al., 2005). A multitude of studies have examined these

processes via self-report constructs, behavioral paradigms, and psychophysiological/neuroimaging techniques (Hagen et al., 2017; Viola et al., 2019; Zilverstand et al., 2018). The current study aimed to examine the self-reported (trait) constructs of impulsivity and mindfulness and their associations with cannabis use and cannabis-related problems. These constructs were selected to approximate the impulsive and reflective systems given that impulsive personality traits tend to manifest as automatic and often affectively driven behavior and mindfulness tends to involve more deliberative self-awareness.

Impulsivity and Mindfulness

Impulsivity is a multifaceted construct that is characterized by behavior with little forethought, reflection, or deliberation of the outcomes (Gruber & Yurgelun-Todd, 2005). Although impulsive behavior can be assessed through the use of both self-report and behavioral measurements, there has been exhaustive psychometric research on self-report assessments of impulsivity, of which there are many (e.g., Barratt Impulsiveness Scale BIS-11; Patton et al., 1995). In 2001, the UPPS Impulsive Behavior Scale was developed by Whiteside and Lynam in order to provide a more comprehensive measure of impulsivity. The UPPS scale was constructed based on factor analysis of items from existing self-report impulsivity measures and the original analysis resulted in the identification of four dimensions of impulsivity: 1) Urgency: acting rashly under the influence of a negative emotional state; 2) Lack of Premeditation: to act without planning; 3) Lack of Perseverance: inability to sustain attention on a given task; and 4) Sensation Seeking: the desire to seek out novel and exhilarating experiences regardless of the associated risk (Whiteside & Lynam, 2001). The UPPS measure of impulsivity was later modified by Whiteside and Lynam (2005) to include a fifth facet identified as Positive Urgency. This fifth facet is defined as the tendency to act rashly under the influence of a positive emotional state

(Cyders et al., 2007). Following the production of the UPPS-P, a 20-item short form was developed and validated (SUPPS-P; Cyders et al., 2014). The SUPPS-P assesses the same original dimensions and is now one of the most widely used self-report measures of impulsivity, precisely because it captures the multi-faceted nature of the construct. Researchers have highlighted the importance of using a comprehensive assessment impulsivity and therefore, the UPPS is one of most commonly used impulsivity assessments relative to substance use (Whiteside et al., 2005). Given the above considerations, the SUPPS-P was used to assess the multi-faceted nature of impulsivity in the current study.

Mindfulness is conceptualized as the ability to focus one's attention on the present moment in a non-judgmental, non-reactive, and tolerant manner (Baer, 2011; Karyadi et al., 2014; Paltun et al., 2017). One core characteristic of mindfulness that has been identified time and time again is the receptive state of mind in which sensitive awareness of, or attention to, what is currently happening in the present allows an individual to simply observe what is taking place on a moment-by-moment basis. Like impulsivity, there are multiple aspects which compose the broader mindfulness construct, and therefore, multiple measures have been developed. Perhaps the two most common are the Mindfulness Attention Awareness Scale (MAAS), which has been used repeatedly in clinical and research settings with the specific purpose of assessing moment-by-moment attention (Karyadi et al., 2014) and the Five Facet Mindfulness Questionnaire (FFMQ), a self-report measure that examines distinct aspects of mindfulness including observing, describing, acting with awareness, judging, and non-reactivity (Baer et al., 2006). After the original version in 2006, a short form of the FFMQ was developed by Bohlmeijer et al. (2011). The MAAS is the oldest and most widely used valid measure of dispositional mindfulness; it is brief (15 items) and has been validated for use in a variety of

populations including, cancer patients, college students, adults, and children (Brown et al., 2015). Specifically, the MAAS examines differences in mindful states over time and taps into conscious thought related to self-regulation and other areas of well-being (Brown & Ryan, 2003; Black et al., 2011). To construct the MAAS, Ryan and Brown (2003) specifically chose statements that reflected mindlessness based on the theory that individuals are more often mindless than they are mindful (Van Dam et al., 2010). Factor analysis of the MAAS has supported its strong unidimensional factor structure (e.g., Brown & Ryan, 2003). Given that cannabis use is associated with neural changes in the PFC which are thought to lead to deficits in cognitive function such as switching and sustaining attention (Yanes et al., 2018), the current study used the MAAS to assess the core attentional aspect of the mindfulness construct relative to cannabis use and cannabis-related problems.

Research examining the relationship between impulsivity and mindfulness has produced rather consistent findings. A study conducted by Murphy and MacKillop (2011) sought to examine the relationship between impulsivity and mindfulness via the UPPS-P and FFMQ respectively, and how they relate to alcohol use in young adults. As expected, results revealed that impulsivity and alcohol use held positive associations, while mindfulness and alcohol use were negatively associated. In addition, Negative Urgency demonstrated strong negative relationships with mindfulness whereas Sensation Seeking was positively associated with mindfulness. In 2013, Reid et al. produced similar results to Murphy and MacKillop's study in that a negative relationship between impulsivity and mindfulness was demonstrated even though Reid et al. (2013) utilized a completely different sample (i.e., those diagnosed with hypersexuality and controls) and different measures of impulsivity and mindfulness (i.e., NEO Personality Inventory Revised and the Freiburg Mindfulness Inventory respectively). Lattimore

et al., (2011) conducted two studies related to eating behaviors in which they sought to clarify the relationships among impulsivity, mindfulness, and trait disinhibition (i.e., the tendency to respond to the positively reinforcing properties of food). Unsurprisingly, the first study indicated that trait disinhibition was negatively associated with mindfulness; the second study replicated and extended this finding by showing that impulsivity mediated the relationship between mindfulness and trait disinhibition. Andreu et al. (2018) explored the relationship between mindfulness and a behavioral measure of impulsivity, a Go-NoGo task, in cigarette smokers. They demonstrated a negative relationship between impulsivity and mindfulness in that heightened response inhibition (lower impulsivity) was strongly associated with increased levels of mindfulness. Taken together, the research generally demonstrates that impulsivity and some of the specific impulsivity facets (e.g., Negative Urgency) have strong negative associations with mindfulness, although Murphy and MacKillop (2011) reported that Sensation Seeking (a factor of impulsivity) was positively associated with mindfulness.

Given that impulsivity and mindfulness seem to be negatively related, a number of studies have examined how mindfulness-based interventions (MBIs) can be used to improve mental health symptoms in disorders characterized by impulsivity, such as SUDs. For instance, several studies have suggested MBIs ameliorate substance use and craving via alterations in cognition (Black et al., 2011; Bowen & Marlatt, 2009; Bowen & Kurz, 2011; Chapman et al., 2018; Davis et al., 2015; Froeliger et al., 2017; Russel et al., 2015), affect (Geschwind et al., 2011; Spears et al., 2017; Wadlinger & Isaacowitz, 2010), and core psychophysiological processes of self-regulation and reward processing (Garland, Carter, Ropes, & Howard, 2012; Garland, Froeliger, & Howard, 2014, Garland & Howard, 2018; Moss et al., 2015; Priddy et al., 2018). Interestingly, Korponay et al. (2019) specifically explored the effects of an eight-week

MBI on measures of impulsivity and reported no reductions in impulsivity via a Go/No-Go task or on the BIS-11. Additionally, examination of fMRI data revealed there were no significant changes in the neural correlates associated with impulse control. Similarly, there have been other studies that have directly examined the effects of MBI on measures of impulsivity and demonstrated relatively little to no effects (Mantzios & Giannou, 2014; Patton et al., 2019). However, one study in methadone patients did show that an eight-week mindfulness-based relapse program (MBRP) was associated with significant reductions in impulsivity via the BIS-11 (Yaghubi et al., 2017). And, perhaps more relevant to the current study, Deplus et al. (2016) reported decreases in specific facets of UPPS-P impulsivity, Negative Urgency and Lack of Perseverance, as a result of an MBI for enhancing emotion regulation in adolescents and thus, further underscoring the importance of comprehensively assessing impulsivity.

Unsurprisingly, across multiple forms of measurement and types of samples, there appears to be relatively consistent evidence of a negative association between trait impulsivity and mindfulness (Lattimore et al., 2011; Lyvers et al., 2014; Peters et al., 2011). It seems that these constructs are not simply opposite ends of a single continuum as correlations among the two constructs are moderate. This may provide further support for the idea that the constructs of impulsivity and mindfulness may fit well within the two systems of the dual process model. For example, the impulsive system is driven by affective and motivational processes, which may be well represented by both UPPS-P urgency facets, given the significant influence that affect seems to have on behaviors driven by the impulsive system. The impulsive system is also associated with automatic behavior that is characterized by a lack of conscious forethought. Thus, Lack of Premeditation may be a fair representation of the automaticity that is characteristic of the impulsive system. The MAAS is composed of items that tap into conscious awareness of

one's emotional state and focusing of attention in the moment. These characteristics should align well with the self-awareness, deliberative thought, and self-control characteristics of the reflective system. Despite the prior research on these constructs and their potential association with the dual process model systems, no studies to date have examined the relationship between mindfulness, impulsivity, and cannabis use specifically.

Impulsivity and Cannabis Use

It has been implied that cannabis use leads to a number of acute (Lane et al., 2005; Morrison et al., 2009; Ramaekers et al., 2006) and long-term (Pope et al., 2001; Pope et al., 2002; Pope et al., 2003; Solowij, 2002) impaired cognitive abilities. Impairments have been noted in basic motor function and have extended to complex executive functions such as the ability to plan ahead, organize, problem solve, pay attention, and control one's emotions and behavior (Crean et al., 2011). The severity of impairment is thought to be dependent on the quantity, recency, frequency, age of onset and duration of cannabis use (Office of the Surgeon General, 2019; Shrivastava et al., 2011; Solowij et al., 1995).

A core function that seems to be associated with cannabis use is the ability to control impulsive behavior (Crean et al., 2011). A number of studies examining the associations between impulsivity and cannabis use in dependent (Delibas et al., 2017) and non-dependent, problematic users (Day et al., 2013; Destrée et al., 2018; Huertas et al.,2019; Lopez-Vergara et al., 2019; Round et al., 2020), via the BIS-11, have produced similar results in that higher levels of impulsivity are frequently associated with cannabis use. This is also the case in studies that have used both dependent and non-dependent samples for comparison (Zhou et al., 2019). In addition, as noted earlier, Sensation Seeking is a construct that is included in the UPPS conceptualization of impulsivity. Historically it has often been assessed independently from impulsivity.

Accordingly, there is consistent evidence using these independent measures that suggests Sensation Seeking is a significant predictor of cannabis use in both young adults (Trocki et al, 2009; Quinn & Harden, 2012) and adolescents (Arnett & Balle-Jensen, 1993; Jaffee & D'Zurilla, 2009; Castellanos-Ryan et al., 2013; Felton et al., 2015). Although these findings related to cannabis use, impulsivity, and the related construct of Sensation Seeking, have been relatively consistent, the aforementioned studies failed to use a comprehensive measure of impulsivity (e.g., the UPPS).

A handful of research teams have focused on the relationship between cannabis use and impulsivity via variations of the original UPPS measure (e.g., UPPS-P, Short UPPS-P) and have suggested that impaired impulse control is associated with cannabis use as well as the negative consequences of use. In 2016, VanderVeen et al. conducted a meta-analysis that concluded that being a cannabis user was significantly related to all facets of impulsivity on the UPPS-P, with the exception of Lack of Perseverance, in an adolescent sample. They also proposed that Sensation Seeking, Lack of Planning, and Positive Urgency were significant predictors when identifying adolescents most at risk for experiencing negative consequences associated with cannabis. Glowacz and Schmits (2017) also found Sensation Seeking significantly predicted the maintenance of cannabis use in emerging adults trying to quit. Finally, Tercek (2008) reported that Sensation Seeking was significantly associated with the frequency of cannabis use among male and female adolescent detainees (i.e., adjudicated delinquent or awaiting trial).

Other studies that have examined facets of the UPPS-P have supported an important role for Lack of Premeditation in cannabis use. For example, this facet of impulsivity has been associated with self-reported cannabis use in adolescents (Patouris et al., 2016) as well as knowledge of newer cannabis consumption methods (e.g., vape-pen; Frohe et al., 2018) among

college students. Although there are positive correlations between Lack of Premeditation and cannabis use in general, significantly negative correlations have been identified between problematic cannabis use and Lack of Premeditation (Stautz & Cooper, 2014). There have also been reports which state that greater Lack of Premeditation predicts maintenance of current cannabis consumption patterns among emerging adult males who have tried to stop using and started again or who have never tried to stop use (Glowacz & Schmits, 2017).

It should also be mentioned that recent evidence has emerged which suggests Negative Urgency is one of the best predictors of lifetime cannabis use (Pang et al., 2014) as well as problematic cannabis use in veteran (Gunn et al., 2020), adolescent (Stautz & Cooper, 2014; Tomko et al., 2016), and young adult users (Rømer Thomsen et al., 2018). This remains the case in college students when trait negative affect and distress tolerance are taken into account (Kaiser et al., 2012). Additionally, it has been found that Negative Urgency mediates the relationship between childhood maltreatment and problematic cannabis use in late adolescence (Wardell et al., 2016). Another study considering the mediating role of Urgency (negative and positive) on cannabis and alcohol use in a community sample of adults supported the association between Negative Urgency and problematic cannabis use, albeit as a mediator between depression and cannabis problems. Additionally, both Negative Urgency and Positive Urgency were significant moderators of depression and cannabis problems; this moderation role was not identified for alcohol (Um et al., 2019).

Other studies have reported alternate facets of impulsivity as being associated with cannabis use characteristics. For instance, Robinson et al. (2014) found that only Positive Urgency predicted cannabis use during one's lifetime among high school students. Further, using a sample of frequent cannabis using adults, Luba et al. (2018) demonstrated a relationship

between Positive Urgency and the amount of cannabis used per month, although this association was mediated by cannabis use expectancies (i.e., expecting stimulant-related effects contrary to sedative effects before, during, and after using cannabis). Rather than predicting cannabis use frequency, Stautz and Cooper (2014) examined the associated cannabis problems in a school sample of adolescents and found that Positive Urgency significantly predicted the intensity of experienced problems via the Cannabis Problem Questionnaire for Adolescents (Proudfoot et al., 2010).

Unlike the studies mentioned previously, Tomko et al. (2016) used a sample of treatment seeking adolescents aged 12 - 18 years old and found that Lack of Perseverance was strongly associated with cannabis use problems, whereas Negative Urgency was associated with cannabis use frequency. Contrary to the aforementioned findings, some of the latest research considering impulsivity via the UPPS-P and other self-report measures (Vergés et al., 2019) has implied that UPPS-P factors are not independently predictive of cannabis use problems in Chilean adolescents; rather, higher order factors of rash impulsivity and reward drive, were revealed as significant predictors.

Much of the research supports that there is a relationship between cannabis use factors and facets of impulsivity, although there are clearly some inconsistencies across studies using the UPPS measures. However, Sensation Seeking, and potentially Positive Urgency, seem to be the UPPS-P facets of impulsivity most related to cannabis use and the frequency at which it is consumed, particularly in adolescent samples. Additionally, it has been suggested that Negative Urgency is the strongest predictor when considering cannabis use problems in users. Given the mixed findings considering which facets of impulsivity are most related to cannabis use and

cannabis-related problems, further research may be useful in helping to determine which associations seem to be most consistent.

Mindfulness and Cannabis Use

Difficulty executing mindful behavior is often driven by internal and external stressors (Bonn-Miller et al., 2010. There is consistent evidence that suggests impairments in mindfulness are common among individuals who recreationally use substances (Karyadi et al., 2014). Multiple studies have implicated automatic attention processes as a hallmark characteristic of substance use (Anselme & Robinson, 2020; O'Neill et al., 2020; Pennington et al., 2020). It has also been demonstrated that mindfulness enhances attention control and reduces automaticity. Given the former statement, it is thought that decreased mindfulness contributes to problematic drug use and addiction. Of note, trait mindfulness tends to be negatively associated with substance use in a variety of samples ranging from college students to adult treatment samples.

Studies that have examined the relationship between mindfulness and substance use have included cannabis users, but few have examined the relationship between trait mindfulness and cannabis use specifically. Some studies investigating the relationship between mindfulness and substance use have tried to identify which facets of mindfulness are most related to reduced use in undergraduate samples (Cavicchioli et al., 2018; Seleghim & Gherardi-Donato, 2020; Single et al., 2019). For example, Cavicchioli et al. (2018) investigated how the Non-Judging and Nonreactivity facets of the FFMQ relate to disordered substance use. Results suggested that neither of these facets were significantly associated with any of the examined drug use disorders, which included CUD. On the other hand, Single et al. (2019) found that in college students the Acting with Awareness, Non-judging, and Nonreactivity subscales of the FFMQ were significant predictors of decreased drug use, via the Alcohol, Smoking and Substance Involvement

Screening Test-Modified (ASSIST; World Health Organization, 2002), four months into the semester when controlling for use at the beginning of the semester. Similarly, Seleghim and Gherardi-Donato (2020) used the ASSIST to measure drug use and found alcohol, tobacco, and cannabis were the most commonly used substances among a nursing student sample. However, they demonstrated that a singular facet of mindfulness, Non-Reactivity, positively predicted combined drug use during the last three months. It should also be noted that the findings did not support associations between lifetime drug use and any other mindfulness scales. An all-female, college student sample utilized by Tarantino et al. (2015) study revealed that mindfulness was negatively correlated with a greater intensity of drug use related problems on the Drug Use Disorder Identification Test (Drug Use Disorder Identification Test DUDIT; Berman et al., 2002). However, it is imperative to note that this association was not seen in women with high levels of self-control.

Studies that have examined mindfulness and its association with substance use in general have suggested that decreased mindfulness is a characteristic more common in users than non-users. The studies specific to cannabis use are few, and it seems like the evidence for decreased mindfulness among cannabis users is tentative at best. For example, Bonn-Miller et al. (2010) reported no association between the Kentucky Inventory of Mindfulness Skills assessment (Baer et al., 2004) and past month cannabis use in a community sample of adults with a history of trauma. However, they did find a negative association between Non-Judgmental acceptance and cannabis coping motives.

Unlike Bonn-Miller et al. (2010), the following studies used the MAAS to examine the associations between mindfulness and cannabis use directly. Gonzalez et al. (2009) recruited an adult cigarette (nicotine) smoking sample and found no association between cannabis use in the

past month and MAAS scores. In addition to the use of adult samples, a couple of studies have also examined the relationship between mindfulness and cannabis among individuals involved in higher education. For instance, Black et al. (2011) identified a negative association between participant MAAS scores and cannabis use frequency over the past 4 months in first year medical school students. On the other hand, when considering cannabis problems, Phillip (2010) found a weak but significant negative correlation between the MAAS and problems associated with cannabis in an undergraduate sample, although when analyses were limited to participants that had used in the past 28 days, there was no longer a significant association. A recent study (Lin et al., 2020) conducted in a community sample which consisted of both adolescent and young adult frequent cannabis users (e.g., used 3 or more times/week) further supported the findings of Phillip (2010) in that the results suggested higher trait mindfulness was associated with fewer related cannabis use problems. Additionally, this research team noted that increased levels of mindfulness were correlated with fewer quit attempts.

Although non-clinical samples seem to be the most commonly used in research that examines mindfulness and cannabis use characteristics, there has been demonstrated interest in other populations. For instance, among a sample of United States veterans, who endorsed CUD according to the DSM-IV standards, and were also looking to quit using cannabis, Hasan (2016) reported that participant MAAS scores were not associated with any of the cannabis use variables. Dakwar and colleagues (2011) reported MAAS scores were inversely correlated with multiple substance use categories, including cannabis use, in men and women seeking substance use treatment. It should also be noted that polydrug users in this study typically produced lower mean scores on the MAAS relative to mono drug users. Trait mindfulness, as measured by the MAAS, was found to be negatively associated with cannabis and other drug use in outpatients

(Paltun et al., 2017). However, it is imperative to note that trait mindfulness was significantly lower in the patients that had a history of using drugs other than cannabis. Moreover, participants that were successfully abstinent at a six-week follow-up (as indicated by negative urine screens for cannabis) scored significantly higher in trait mindfulness at baseline.

Other studies have explored how effective MBIs are in addressing cannabis use. For instance, after a combined mindfulness meditation (MM) and motivational interview (MI) intervention, non-treatment seeking female cannabis users between the ages of 18 - 29 reported significantly fewer days of cannabis use three months after the intervention when compared to control participants (de Dios et al., 2012). In another study (Dakwar & Levin, 2013), researchers demonstrated that eight out of fourteen cannabis dependent patients achieved abstinence after participating in a ten-week mindfulness-based psychotherapy program. Although both of these were preliminary studies, they suggest that an intervention designed to increase mindfulness resulted in a decrease in cannabis use, further supporting the idea of a negative association between mindfulness and cannabis use. Overall, the inconsistent findings regarding mindfulness and cannabis use across a multitude of samples is somewhat surprising given the evidence of decreased mindfulness in substance users more broadly. Thus, future research specifically examining cannabis use characteristics and their association with mindfulness is needed.

Current Study

When examining impulsive behavior in cannabis users via the SUPPS-P three factors appear to be consistently associated with cannabis use characteristics: Sensation Seeking, Negative Urgency, and Lack of Premeditation. Sensation Seeking and Lack of Premeditation seem to be predictive of cannabis use in non-clinical samples whereas Negative Urgency looks to be most relevant for use patterns and cannabis-related problems in users. However, the other

facets of Positive Urgency or Lack of Perseverance have also been implicated. Regardless of some of the inconsistencies in the research findings, it is widely believed that impulsivity in general and specific facets of the SUPPS-P are indeed related to cannabis use frequency and the associated drug-related problems. Hence, one of the goals of this current study was to clarify some of the inconsistencies in the research surrounding the relationship between impulsivity and cannabis use.

Mindfulness is another characteristic that is relevant to recreational and disordered drug use. The general conclusion stemming from research on mindfulness and substance use is that lower levels of mindfulness are associated with an increased frequency of drug use and the number of related problems. What seems to be inconsistent is whether or not decreased mindfulness is specifically related to cannabis use frequency and its associated problems. Finally, there is evidence that the constructs of impulsivity and mindfulness are moderately related, but few studies have examined the association between these factors and cannabis use characteristics while taking into account the role of the other construct.

Thus, hypotheses for the current study were as follows:

Hypothesis 1: Sensation Seeking and Lack of Premeditation, as assessed by the SUPPS-P, will be significantly associated with cannabis user status (reported cannabis use in past 30 days), while controlling for mindfulness.

Hypothesis 2: Mindfulness, as assessed by the MAAS, will be significantly negatively associated with cannabis user status, while controlling for multiple facets of impulsivity.

Hypothesis 3: In cannabis users (those reporting use in the past 30 days), increased levels of Negative Urgency will be associated with cannabis use frequency and cannabis use related problems (CUDIT-R scores), while controlling for mindfulness.

Hypothesis 4: In cannabis users (those reporting use in the past 30 days), decreased levels of mindfulness will be associated with cannabis use frequency and cannabis use related problems (CUDIT-R scores), while controlling for multiple facets of impulsivity.

Method

Participants

Originally, participants (N = 319) were recruited via an online undergraduate participant pool and physical flyers posted on campus grounds. Each participant completed a survey in exchange for either course credit or an entry into a drawing for a gift card. Participants had to be age 18 or older to participate. Of the 319 participants, 26 were removed due to insufficient data on the main study measures (e.g., did not complete the MAAS and/or SUPPS-P). Another 3 cases were deleted because an individual took the survey twice and gave different responses while another participant's responses were recorded twice. The final participant was excluded due to unreliable answers on the SUPPS-P (e.g., answered every question with the same response) in addition to getting 4 attention check questions wrong. The final sample (N = 289) consisted of 137 females, 148 males, 3 individuals who identified as non-binary or third gender, and one person who did divulge their gender. Of these 289 individuals, 147 (50.8%) reported never using cannabis in their lifetime and 87 (30.1%) reported using cannabis at least once within the past 30 days. This past 30-day cannabis user group was composed of 39 females and 48 males. When the cannabis user group (M=22.21, SD=6.66) was compared to the non-cannabis user group (M=20.36, SD=3.09) they were found to be significantly older t (286) = 3.21, $p < .05$. The cannabis user group also included a smaller proportion of participants identifying as Asian [$\chi^2(1,289) = 8.35$, p=.003] and greater proportion of participants identifying as Black or African American [$\chi^2(1,289) = 5.83$, p=.016]. There were no significant differences in the proportion of

participants identifying as any other race/ethnicity categories. Of note, about 20% of the past 30-day users reported using drugs other than cannabis for recreational purposes over the past 30 days. The most commonly endorsed substances were hallucinogens (16.1%) and stimulants (4.6%) which were followed by cocaine (2.3%), sedatives (2.3%), and opioids (1.1%). Given prior research that has examined the influence of polydrug use in relation to impulsivity and mindfulness (Dakwar et al., 2011; Paltun et al., 2017) the proportion of the sample that reported polydrug use was calculated. Out of the 289 participants, 32.9% reported no use of any drug or alcohol in the past 30 days, 34.9% reported using only alcohol in the past 30 days, and 21.1% reported the use of both cannabis and alcohol in the past 30 days. A few participants reported the use of hallucinogens along with alcohol and cannabis (4.8%), as well as the use of multiple drugs, which included cannabis and alcohol, but excluded hallucinogens (e.g., sedatives, stimulants; 3.5%), and lastly, others reported the use of cannabis only (2.8%). Preliminary analyses in the full sample indicated a significant group difference on the MAAS, $F(5,282) = 3.66$, $p < .01$. Post hoc analyses indicated that those who reported the use of multiple drugs excluding hallucinogens exhibited significantly lower scores on the MAAS relative to other use groups (*p's*<.05). The drug use groupings among participants who reported cannabis use in the past 30-days indicated a similar effect for the MAAS, $F(3,83) = 4.42$, $p < .01$, with the hallucinogen polysubstance users exhibiting lower scores (*p's*<.05). Cannabis users, that used multiple drugs excluding hallucinogens, trended towards using cannabis significantly less in the past 30 days when compared to other drug use groups that reported using cannabis, $F(3,83) = 2.54$, $p = .062$.

As expected, the cannabis user group reported significantly greater alcohol consumption $t(286) = 7.32$, $p < .001$, and higher SIP-A scores $t(286) = 4.74$, $p < .001$, $SD = 1.70$). See Table 1

for detailed demographic information. In addition to the other comparisons, preliminary analyses were run to compare gender on all major variables. Females reported experiencing more alcohol related problems in both the full $t(283) = 17.16$, $p < .05$, $SD = 4.45$ and user sample $t(87) = 18.95$, $p < .001$, $SD = 7.81$ as well as increased cannabis related problems in the user sample $t(87) = 9.54$, $p < .05$, $SD = 7.79$). Given these differences and gender differences in prior literature considering the major variables, supplemental analyses including gender were conducted for all hypotheses; however, these results indicated no effect of gender or changes in the main findings.

Table 1
Sample Demographics [Mean (SD)]

	User Past 30 Days ($N = 87$)	Non-User Past 30 Days (N=202)	Full Sample ($N = 289$)
Gender (% female) [a, b]	44.8	48.7	48.8
Age (years)[c*]	22.21 (6.65)	20.36 (3.09)	20.91 (4.54)
Race/Ethnicity (%) [d]			
Asian**	4.6	18.3	14.2
Black/African American*	12.6	5.9	8.0
Hispanic/Latinx	5.7	4.5	4.8
Native Hawaiian or Pacific Islander	0	.04	0.3
White/Caucasian	66.7	61.4	63.3
Other/Mixed	10.1	8.9	9.4
Highest Education Level (%) [e]			
Did Not Complete High School	0	0.4	0.3

High school/GED	17.5	24.8	22.6
Some College	61.6	58.9	60.2
Associate's Degree	8.1	4.5	5.5
Bachelor's Degree	10.5	9.9	10.0
Master's Degree	0	1	0.7
Advanced Graduate Work/Ph.D.	2.3	0	0.7
Past 30-Day Cannabis Use Score	3.86 (2.44)	--	1.16 (2.23)
CUDIT-R Score	9.26 (6.67)	--	--
Past 30-Day Drug Use Other Than Cannabis	20.7	4.0	9.0
Alcohol QF*	2.82 (1.70)	1.31 (1.56)	1.77 (1.74)
SIP-A Score*	17.70 (5.65)	16.31 (2.33)	16.95 (3.57)

Note. CUDIT-R = Cannabis Use Disorder Identification Test - Revised; SUPPS-P = Short UPPS-P Impulsive Behavior Scale; MAAS = Mindfulness Attention Awareness Scale; SIP-A = Short Inventory of Problems – Alcohol; QF = Quantity x Frequency

[a] Three participants identified as non-binary or third gender in Non-User Past 30 Day Group.
[b] One participant did not disclose gender in Non-User Past 30 Day Group
[c] One participant did not disclose age in Non-User Past 30 Day Group
[d] One participant did not disclose race in Non-User Past 30 Day Group
[e] One participant did not disclose highest level of education in Non-User Past 30 Day Group
* $p < .05$ ** $p < .01$

Measures

Participant Demographics.

Participants were asked to report their sex assigned at birth, age in years, race and/or ethnicity (e.g., Asian, Black, Latinx, White, etc…). Individuals also reported the highest level of

education they received. Response options extended from not completing high school to participating in advanced graduate work or receiving a PhD.

Short UPPS-P Impulsive Behavior Scale (SUPPS-P).

The SUPPS-P consists of 20 items that assess five facets of impulsivity which include: 1) Negative Urgency; 2) Lack of Perseverance; 3) Lack of Premeditation; 4) Sensation Seeking; and 5) Positive Urgency. Responses to the items are rated on a 1 - 4 Likert scale. Response options include, 1: 'Agree Strongly'; 2: 'Agree Some'; 3: 'Disagree Some'; 4: 'Disagree Strongly'. Items are scored in a way such that higher scores suggest increased levels of impulsivity. For the current study, the mean response for each subscale was used and Cronbach's α for the subscales ranged from 0.67 - 0.82 in the full sample. In the cannabis user group Cronbach's α values on the subscales ranged from 0.68 - 0.78.

The Mindfulness Attention Awareness Scale (MAAS).

The MAAS was developed and validated to quantify the frequency of open and receptive attention to and awareness of ongoing events and experience in adults. The 15 items on the MAAS are rated on 1 - 6 likert scale in which responses range from 1: 'almost always' to 6: 'almost never'; these items are supposed to represent factors of dispositional (or trait) mindfulness. To score the scale, a mean of the 15 items is computed. Higher scores reflect higher levels of dispositional mindfulness (Brown & Ryan, 2003). In the full sample Cronbach's α for the MAAS Total score was 0.92; for the user sample α was 0.89.

Cannabis, Alcohol, and Other Drug Use Questions

In addition to the questions described previously, participants also reported information regarding how often and how much they used cannabis over the past 30 days, if they had ever used other drugs (e.g., psychedelics, methamphetamine, crack, etc.) over the past 30 days, and

how often they used alcohol in the past 30 days with the follow-up question of how many drinks one usually consumed during a drinking session in the past 30 days (e.g., 1 shot of liquor, 1 glass of wine, 1 bottle of beer). Response options for cannabis and alcohol use frequency were scored as follows Never (0), Once in the past 30 days (1), Once every other week (2), Once a week (3), Two times a week (4), Three to four times a week (5), Five to six times a weeks (6), Every day (7). This variable related to cannabis use served as the primary measure of cannabis use frequency. For alcohol quantity, participants were asked to report the typical number of standard drinks consumed during a drinking session in the past 30 days. An Alcohol quantity x frequency (QF) variable was computed as the product of multiplying the participant's reported values for how often they drank in the past 30 days and how many standard drinks they typically consumed when they did drink over the past 30 days (Gmel et al., 2006). Because this Alcohol QF variable was not normally distributed (in either sample), it was subjected to a square root transformation for subsequent analyses.

Cannabis Use Disorder Identification Test - Revised (CUDIT-R).

The Cannabis Use Disorder Identification Test - Revised (CUDIT-R) consists of 8 items that consider domains such as consumption, dependence, cannabis-related problems, and psychological issues (Adamson et al., 2010). The CUDIT-R was completed by participants that indicated cannabis use in the past 30 days. It is used to assess the severity of use as well as problematic cannabis-related-behavior. Response options on question one (i.e., How often do you use cannabis?) ranged from: 0 = Never; 1 = Monthly or less; 2 = Two to four times a month; 3 = Two to three times a week; 4 = Four or more times a week. Question two corresponded to how many hours in a typical day an individual is high. Response options on this question ranged from: 0 = Less than one; 1 = One or two; 2 = Three or four; 3 = Five or six; 4 = Seven or eight.

Questions three through seven inquired about how often one experienced various problems due to their cannabis use (e.g., whether or not a participant had ever been involved in a physically hazardous situation while high). Response options on these questions ranged from: 0 = Never; 1 = Less than monthly; 2 = Monthly; 3 = Weekly; 4 = Daily or almost daily. Lastly, question eight considered if an individual had ever tried cutting down or quitting the use of cannabis. Response options ranged from: 0 = Never; 2 = Yes, but not in the past six months; 3 = Yes, during the past six months. A higher total score on this measure is indicative of greater instances of cannabis use problems. In the user sample, Cronbach's α for this measure was 0.83.

Short Inventory of Problems-Alcohol (SIP-A).

The original 15-item Short Inventory of Problems (SIP-A) was developed and validated to quantify the consequences associated with drinking (Allensworth-Davies, Cheng, Smith, Samet, & Saitz, 2012). Items that make up the SIP are rated such that a response of "0" corresponds to "no" and "1" to "yes". The total score on the SIP can range from 0 - 15 and indicates the severity of consequences associated with drinking. A number of studies have reported a strong association between problematic cannabis and alcohol use in adolescent, adult, and veteran populations (Gunn et al. 2020; Jones et al., 2018). The association between the SIP-A score and the major dependent variables was assessed to determine whether it should have been included in the analyses as a covariate. In the full sample, Cronbach's α for this measure was 0.89 and in the user sample α was equal to 0.92.

Data Analysis

Descriptives were run on all relevant variables in both samples (past 30 days cannabis use, CUDIT-R, five SUPPS-P subscales, MAAS, Alcohol QF, and SIPA) and were examined for normality including cutoffs for skewness and kurtosis. For descriptive purposes, demographic

characteristics were compared between the past 30-day cannabis user and non-user groups using independent samples t-tests and chi square analyses. Bivariate correlations between all relevant variables were conducted in the full and past 30-day cannabis user samples. A logistic regression was run in the full sample to address associations between impulsivity and mindfulness scores and past 30 days cannabis user status (0=non-user in past 30 days, 1=cannabis user in past 30 days) controlling for past 30 days alcohol consumption (Alcohol QF). In the cannabis user sample, two linear regression models were conducted to examine associations between cannabis variables, impulsivity, and mindfulness. In the first model, cannabis use frequency in the past 30 days was the dependent variable whereas impulsivity and mindfulness scores served as independent variables, while controlling for past 30 days alcohol consumption (Alcohol QF scores). In the second model, cannabis-related problems (CUDIT-R scores) served as the dependent variable and impulsivity and mindfulness scores served as independent variables, while controlling for alcohol problems (SIPA scores). Alcohol-related covariates were selected to be consistent with the cannabis-related dependent variable for each model (e.g., alcohol use (Alcohol QF) in models related to cannabis use).

Results

Preliminary Analyses

No skew values greater than the absolute value of two and kurtosis values greater than the absolute value of three existed for any variable other than past 30 days cannabis use and past 30 days Alcohol QF in the full sample. The Alcohol QF was also leptokurtotic in the cannabis user sample, thus the Alcohol QF score was subjected to a square root transformation.

In the full sample, a point biserial correlation was conducted between cannabis use status, all SUPPS-P subscales, the MAAS score, and the transformed Alcohol QF variable (Table 2). No

significant correlations were revealed between cannabis use status and any of the SUPPS-P subscales (*r*'s ranged from -.06 to .10). Low to moderate significant positive correlations were identified between cannabis use status and the MAAS score (*r* = .15) as well and Alcohol QF (*r* = .40). Consistent with prior studies on the SUPPS-P, many of the intercorrelations among the SUPPS-P subscales were significantly associated with correlations ranging from low to moderate (*r* = -.39 - .62). The intercorrelations among the SUPPS-P subscales in the current sample were relatively similar to those seen in prior research (Cyders et al., 2014). The MAAS score was significantly negatively correlated with all SUPPS-P subscales with the exception of Lack of Perseverance (*r*=.13). Finally, alcohol consumption (Alcohol QF) was significantly correlated with cannabis user status (*r*=.40) and SUPPS-P Sensation Seeking (*r*=.15), both of which are consistent with prior research (Curcio & George, 2011, Metrik et al., 2018; Subbaraman & Kerr, 2015).

Table 2
Correlations between Past 30-Day Cannabis Use Status, SUPPS-P Subscales, MAAS, and Alcohol QF in Full Sample (*N*=289)

	1[a]	2	3	4	5	6	7
1. Past 30-Day Cannabis Use Status	--						
2. SUPPS-P: Negative Urgency	.00	--					
3. SUPPS-P: Lack of Perseverance	.07	-.16**	--				

4. SUPPS-P: Lack of Premeditation	.10†	.25**	.19**	--			
5. SUPPS-P: Sensation Seeking	.07	.11†	-.27**	.01	--		
6. SUPPS-P: Positive Urgency	-.06	.62**	-.39**	.30**	.32**	--	
7. MAAS Score	.15*	-.45**	.13*	-.19**	-.18**	-.47**	--
8. Alcohol QF	.40**	-.02	-.04	.01	.15*	-.01	.07

Note. SUPPS-P = Short UPPS-P Impulsive Behavior Scale; MAAS = Mindfulness Attention Awareness Scale; QF = Quantity x Frequency

[a] Point biserial correlation; 0 = non-cannabis user, 1 = cannabis user in past 30 days

† $p < .10$; *$p < .05$; **$p < .01$

Bivariate correlations were run amongst the 87 cannabis users who had reported using in the past 30 days. The variables examined included past 30 days cannabis use frequency, CUDIT-R scores (severity of cannabis use problems), all SUPPS-P subscales, MAAS score, and Alcohol QF (Table 3). Only SUPPS-P Negative urgency (r=.25) and SIP-A scores (r=.66) were significantly correlated with CUDIT-R scores. None of the SUPPS-P, MAAS, or SIP-A scores were correlated with cannabis use frequency in the cannabis user subsample. Once again, the SUPPS-P intercorrelations were low to moderate (r's ranging from -.34 to .46) and most were negatively correlated with the MAAS score (r's ranging from -.43 to .18). SIP-A scores were

significantly correlated with Negative Urgency (*r*=.24) and negatively correlated with MAAS scores (*r*=-.24).

Table 3

Correlations between Past 30 Days Cannabis Use Frequency, CUDIT-R, SUPPS-P Subscales, MAAS, and SIP-A in Past 30-Day Cannabis Users (*N*=87)

	1	2	3	4	5	6	7	8	9
1. Past 30-Day Cannabis Use Frequency	--								
2. CUDIT-R Total Score	.57**	--							
3. SUPPS-P: Negative Urgency	-.02	.25*	--						
4. SUPPS-P: Lack of Perseverance	.02	.08	-.13	--					
5. SUPPS-P: Lack of Premeditation	-.02	.10	.15	.26*	--				
6. SUPPS-P: Sensation Seeking	.04	.00	.08	-.34**	-.22*	--			
7. SUPPS-P: Positive Urgency	-.18	-.10	.46**	-.34**	.26*	.37**	--		
8. MAAS Score	.13	-.14	-.43**	.18†	-.12	-.32**	-.52**	--	
9. Alcohol QF	-.11	-.11	-.11	.02	.07	.11	.02	.11	--
10. SIP-A	.18†	.66**	.24*	.10	.13	.05	-.07	-.24*	.02

Note. CUDIT-R = Cannabis Use Disorder Identification Test - Revised; SUPPS-P = Short UPPS-P Impulsive Behavior Scale; MAAS = Mindfulness Attention Awareness Scale; SIP-A = Short Inventory of Problems - Alcohol; QF = Quantity x Frequency

† $p < .10$; *$p < .05$; **$p < .01$

Associations between Impulsivity, Mindfulness, and Cannabis User Status

Results of the binary logistic regression indicated a significant association between being a cannabis user in the past 30 days and Lack of Premeditation, mindfulness, and alcohol consumption, $\chi^2(7)=57.92$, $p<.001$. Specifically, higher SUPPS-P Lack of Premeditation scores [OR (95% CI)=1.90 (1.01, 3.57), $p=.046$], MAAS Total Scores [OR (95% CI)=1.51 (1.06, 2.16), $p=.022$], and Alcohol QF [OR (95% CI)=1.67 (1.41, 1.98), $p<.001$] were associated with greater probability of being a cannabis user in the past 30 days.

Table 4
Associations between Impulsivity, Mindfulness, and Cannabis User Status ($N = 289$)

Predictors	*B*	*SE B*	OR	95% CI OR
SUPPS-P: Negative Urgency	.35	.26	1.42	0.86, 2.34
SUPPS-P: Lack of Perseverance	.28	.37	1.32	0.64, 2.74
SUPPS-P: Lack of Premeditation*	.64	.32	1.90	1.01, 3.56
SUPPS-P: Sensation Seeking	.25	.21	1.29	0.84, 1.97
SUPPS-P Positive Urgency	-.32	.31	0.73	0.40,1.32
MAAS Total Score*	.41	.18	1.51	1.06, 2.12
Alcohol QF***	.51	.09	1.67	1.41, 1.98

% cannabis user in past 30 days	29.8

Note. SUPPS-P = Short UPPS-P Impulsive Behavior Scale; MAAS = Mindfulness Attention Awareness Scale; QF = Quantity x Frequency;

† $p < .10$; *p<.05; ***p<.001

Associations between Impulsivity, Mindfulness, and Cannabis Use Frequency in Users

Despite the lack of correlations with cannabis use frequency, we moved forward with conducting the a priori regression model with cannabis use frequency as the dependent variable. Thus, it was not surprising that this model was not significant F (7, 79) = 1.02, p = .423, R^2= .083, suggesting none of the predictor variables were associated with cannabis use frequency in the past 30 days in the cannabis user subsample (Table 5). However, it is worth noting that the association between Positive Urgency and cannabis use frequency did approach significance (β = -.27, p = .08).

Associations between Impulsivity, Mindfulness, and CUDIT-R Scores in Users

The second regression model was significant F (8, 77) = 9.58, $p < .001$, R^2= .462, and accounted for 46 % of the variance in CUDIT-R scores (Table 5). Alcohol-related problems (SIP-A) were significantly associated with cannabis use problems (β = .61, $p < .001$). The association between Negative Urgency and cannabis use problems approached significance (β = .18, p = .085). All other variables were not significantly associated with CUDIT-R scores.

Table 5

Associations between Impulsivity, Mindfulness, and Cannabis Use Frequency in Cannabis Users ($N = 87$)

Outcome and predictors	*b*	*F*	R^2
1. Past 30 Days Cannabis Use Frequency		(7, 79) = 1.02, $p = .42$	.08
SUPPS-P: Negative Urgency	.11		
SUPPS-P: Lack of Perseverance	-.04		
SUPPS-P: Lack of Premeditation	.12		
SUPPS-P: Sensation Seeking	.20		
SUPPS-P: Positive Urgency	-.27†		
MAAS Score	.13		
Alcohol QF	-.14		
2. CUDIT-R Score		(7, 79) = 9.62, $p<.001$	.46
SUPPS-P: Negative Urgency	.17†		
SUPPS-P: Lack of Perseverance	-.02		
SUPPS-P: Lack of Premeditation	.04		
SUPPS-P: Sensation Seeking	.05		
SUPPS-P: Positive Urgency	-.16		
MAAS Score	.01		
SIP-A Score	.61***		

Note. CUDIT-R = Cannabis Use Disorder Identification Test - Revised; SUPPS-P = Short UPPS-P Impulsive Behavior Scale; MAAS = Mindfulness Attention Awareness Scale; QF = Quantity x Frequency; SIP-A = Short Inventory of Problems - Alcohol

† $p<.10$; *$p<.05$; ***$p<.001$

Discussion

The main goal of the current study was to clarify some of the inconsistencies in the research surrounding the relationship between impulsivity, mindfulness, and cannabis use. Results in the full sample indicated a significant association between endorsing the use of cannabis in the past 30 days and Lack of Premeditation, greater mindfulness, and more alcohol consumption. In participants that reported cannabis use in the past 30 days, none of the impulsivity or mindfulness variables were significantly associated with cannabis use frequency. However, alcohol-related problems (SIP-A) were significantly associated with cannabis use problems (CUDIT) and the association between Negative Urgency and cannabis use problems approached significance. These findings build on prior research that has examined the influence of impulsivity and mindfulness on cannabis use.

Associations with Cannabis User Status

It has been widely supported that impulsivity is related to cannabis use frequency and the associated drug-related problems. Specifically, multiple studies have reported positive associations between Sensation Seeking and cannabis use, thus suggesting that Sensation Seeking may be an important cannabis use risk factor. However, in the current study, Sensation Seeking was not a significant predictor of whether or not an individual was a recent cannabis user. Despite the fact that a number of studies have suggested that Sensation Seeking may be an important predictor of cannabis use (VanderVeen et al., 2016), none of the studies that actually used a variation of the UPPS measure found a significant association between Sensation Seeking and cannabis use characteristics. Given the findings of this study, it is important to note that a recent study (Lozano et al., 2018) suggested that the Sensation Seeking and Lack of

Perseverance facets on the short version of the UPPS were not equivalent to the original full version. So, when considering the Sensation Seeking facet, the original UPPS and short version may not quite assess the exact same construct. Thus, it is possible that the Sensation Seeking construct as assessed by the SUPPS-P in the current study is slightly different from the measures used in other studies.

SUPPS-P Lack of Premeditation was the only aspect of impulsivity that was significantly associated with cannabis user status. Given that our sample primarily consisted of young adults, this finding is consistent with prior studies conducted in adolescents (Patouris et al., 2016; Stautz & Cooper, 2014) and emerging adults (Glowacz & Schmits, 2017) that found Lack of Premeditation to be associated with cannabis use. Along with the current result, these studies strengthen the evidence suggesting that a lack of forethought specifically, may be an important risk factor for cannabis use in youth and young adults. From a theoretical perspective, it's possible that the Lack of Premeditation could be relevant for the automaticity aspect of the dual process impulsive system; however, further psychometric work may be necessary to explore this idea.

There exists a substantial literature which supports a negative association between mindfulness and drug use, so it was expected that mindfulness, as assessed by the MAAS, would be a significant negative predictor of cannabis user status, while controlling for multiple facets of impulsivity. Unexpectedly, higher participant MAAS Total Scores were associated with a greater likelihood of being a cannabis user in the past 30 days. This contradicts the overarching substance use literature which generally states that those who use drugs tend to be less mindful. This also does not support the idea of mindfulness serving as an indication of an underactive reflective system per the dual process model of addiction. However, the prior findings with

regard to cannabis use specifically are more mixed in that some research teams have found negative associations while others report no associations between cannabis use and mindfulness. Moreover, the meta-analysis conducted by Karyadi et al (2014) reported that the negative association with mindfulness was stronger for alcohol and tobacco use relative to cannabis use. Thus, although unexpected, it is possible the current finding of higher trait mindfulness as a predictor of cannabis use status may not entirely contradict prior research.

Increased mindfulness is one of the keystone effects when considering the use of hallucinogens (e.g., Ayahuasca, Lysergic Acid Diethylamide; LSD, Psilocybin, N-dimethyltryptamine; DMT, etc.), especially in ceremonial or medical settings. It is quite possible that the set (mind set) and setting (physical place drug is being done) play an important role in the health outcomes associated with using cannabis. This may help explain why cannabis use status was associated with increased levels of mindfulness in our sample. Cannabis is thought to produce subjective experiences which consist of a wide range of psychoactive drug effects (e.g., stimulant, depressant, and hallucinogenic; National Institute on Drug Abuse, 2020). A recurring theme among people who use cannabis to treat physical and mental ailments, with or without a prescription, are the key benefits it brings them which include, but are not limited to, an increased sense of well-being, harmonious existence, and mindfulness (National Academies of Sciences, Engineering, and Medicine; NASEM, 2017). The current findings of increased mindfulness and cannabis use status may be somewhat consistent with the discussion of psychedelic substances' strong, positive relationship with mindfulness in that increased mindfulness is associated with fewer drug use problems and increased quality of life (Heuschkel & Kuypers, 2020; Madsen et al., 2020; Soler et al., 2018; Soler et al., 2015). Perhaps when cannabis consumption leads to a cognitively enriching experience, like psychedelics often do,

increased mindfulness is an associated factor. It doesn't seem as though the positive effects of cannabis, when used in a ritualistic or medical manner, have been studied in healthy individuals and this may be one of the reasons our findings are somewhat different from the existing literature examining mindfulness and cannabis use. However, our participants were not asked in what context or manner they used cannabis, although it is worth noting that in our cannabis user group, the most frequently endorsed drug category, other than alcohol, was hallucinogens. The context of the cannabis use as well as motivations to use might be useful information to gather in a future study in this area.

Initially one would not intuitively think that increased levels of mindfulness would be present in individuals who also demonstrated Lack of Premeditation. Indeed, MAAS scores and Lack of Premeditation were significantly negatively, albeit weakly, correlated in our sample. However, the essence of mindfulness, according to the MAAS, is keeping one's attention focused on the current moment. Perhaps when other impulsivity factors and alcohol consumption are taken into account, it is the case that those who tend to me more mindful and hence present, are less likely to plan for the future. If mindfulness is thought about in this particular manner, then it is not surprising that a lack of planning and increased levels of mindfulness may both be characteristics of cannabis users. Additionally, emotional regulation and stress seem to arise as two major factors that are responsible for decreased levels of mindfulness as it relates to drug use. Perhaps it is the combination of decreased emotional regulation (Cavicchioli et al., 2018) and high levels of stress (Praissman, 2008) that are better predictors of someone being a cannabis user in the past 30 days rather than low levels of mindfulness.

Associations with Cannabis Use Frequency and Problems in Cannabis Users

The current study hypothesized that the Negative Urgency subscale of the SUPPS-P would be significantly associated with the frequency of cannabis in the past 30 days in the subsample of cannabis users; however, this was not the case. Contrary to prior studies, none of the impulsivity or mindfulness variables was significantly associated with cannabis use frequency in the cannabis user subsample. Although the results in the full sample imply that Lack of Premeditation is a driving factor for using cannabis, once someone is engaged in using cannabis, this, and other impulsivity factors may no longer be as relevant when considering the pattern of use.

Based on the prior literature it was also hypothesized that increased levels of Negative Urgency would predict the intensity of cannabis use related problems (CUDIT-R scores) in cannabis users. In the current subsample of recent users Negative Urgency did approach significance as a predictor of CUDIT-R scores. Although, not significant, it seems quite possible that with a larger sample of cannabis users, this result would be consistent with prior studies (Gunn et al., 2020; Kaiser et al., 2012; Pang et al., 2014; Rømer Thomsen et al., 2018; Stautz & Cooper, 2014; Tomko et al., 2016; VanderVeen et al., 2016; Wardell et al., 2016) and supports a consensus suggesting that difficulties coping with negative mood states are related to experiencing more detrimental consequences of cannabis use. This finding also seems to be consistent with the affectively driven behavior that is thought to characterize an underactive impulsive system in the dual process model. Further support of this idea comes from Um et al. (2019) which demonstrated Negative Urgency moderates the relationship between cannabis use problems and negative mood states (e.g., depression). Therefore, assessment of Negative

Urgency may be important for preventing the progression from recreational cannabis use to problematic use.

It was also expected that mindfulness would be negatively associated with cannabis use frequency as well as the associated problems in recent cannabis users. Neither of these hypotheses were supported in the current subsample. Overall, mindfulness was not significantly related to either cannabis use frequency or cannabis problems in recent users, in fact the correlations between these factors were relatively weak. It is worth reiterating that although there is substantial literature indicating decreased mindfulness in substance users, the literature specific to mindfulness and cannabis use is quite small and relatively inconsistent. Even in samples characterized by substance use disorders, the findings related to mindfulness and cannabis use were not as compelling as those related to mindfulness and other substance use (Dakwar et al., 2011; Paltun et al., 2017). Notably, the current cannabis user subsample was largely characterized by non-disordered users. Per the CUDIT screening cutoffs, 54% of the recent user subsample did not even meet the cutoff for hazardous use (i.e., they had a score less than 8). Perhaps it is the case that cannabis use is not associated with decreased mindfulness in the same way as with other substances of abuse, especially when the cannabis is used to treat an ailment (e.g., pain or seizures) rather than just for recreational use. Our participants were not asked to divulge why they used cannabis, but five participants did report having a card for medicinal cannabis. It could be the case that, regardless of having a medical card, a number of the current study's participants were using cannabis to ameliorate some symptom of a disease/disorder which has caused a discernible level of discomfort in their lives. In addition, at least one prior study in college students (Phillip, 2010) also found no association between mindfulness and cannabis use characteristics once the sample was limited to recent users. Thus,

although higher trait mindfulness predicted cannabis user status in the full sample, perhaps once individuals are using cannabis it is not a major factor that drives the pattern of use.

Finally, it should be noted that the results surrounding alcohol and cannabis use turned out as one would expect. Alcohol consumption and alcohol-related problems (SIP-A scores) were significantly associated with cannabis variables in both the full and recent cannabis user samples. Additionally, there were positive and significant associations between Alcohol QF, SIP-A Scores, and cannabis variables. All of these associations are consistent with a broader literature on the comorbidity of cannabis and alcohol use and provided justification for the need to control for alcohol-related variables in the present study.

Strengths and Limitations

A strength of the current study was examining associations between impulsivity, mindfulness, and cannabis variables in both a general sample and those who had used in the past 30 days to provide a more "fine-tuned" look at the associations. This study also took into account the influence of alcohol use and related problems, which was not consistent across all past studies. However, the study could have benefited from a larger sample, particularly in terms of the number of participants who reported use in the past 30 days. Perhaps with a larger sample some of the associations that approached significance would be better delineated and we would have more confidence in those hypotheses that were not supported (e.g., Sensation Seeking and cannabis use status). The inclusion of more finely tuned cannabis groups or greater variability in cannabis use characteristics as a result of increased sample size is another aspect that could have been accomplished during this study.

One accomplishment of this study was the inclusion of both impulsivity and mindfulness to examine their influence on cannabis use status, frequency, and problems. Given these findings

and prior literature, it does not seem likely that it is solely impulsivity or mindfulness that would account for being a cannabis user, the frequency at which cannabis is used, or the associated problems. In saying that, a future study could include additional constructs such as emotional regulation and distress tolerance, which are known to be associated with drug use in general and may have associations with characteristics of cannabis use.

Another strength of the study was the use of a comprehensive assessment of the multi-faceted impulsivity construct. However, the study might have benefitted from a similar approach to the assessment of mindfulness. The MAAS was selected due to its use in prior studies and because it specifically focuses on the ability to engage and switch attention on a moment by moment basis, which seemed most relevant to the reflective system concept described in dual process theory. However, future studies may want to explore other mindfulness measures that provide a more comprehensive assessment of mindfulness such as the FFMQ.

Although the sample was relatively balanced in terms of male and female gender, these results cannot be extrapolated to those identifying as non-binary, transgender, third gender, etc. Another limiting factor of this study is that roughly two-thirds of the sample identified as White so when considering a general college age population, only rather limited conclusions can be drawn because of the limited diversity. No information was collected on other demographic factors that have demonstrated influence on substance use behavior (e.g., socioeconomic status). In saying that, it is likely that because most, but not all, of this sample was recruited via a college campus, it is rather unlikely that there was great variability amongst these factors. This study was also limited in terms of age given that almost 75% of the full sample was 21 years old or younger and this percentage was reduced to 66% in the cannabis user group. Thus, the findings may not generalize to all cannabis users. It is also important to mention that although the number of

polydrug users in the current sample was too low to draw many inferential conclusions, the fact that there were some differences in mindfulness is consistent with prior studies that have suggested polydrug users may be a unique group (Alfonso et al., 2011; Carroll & Lustyk, 2017; Valls-Serrano et al., 2016). These results further underscore the need to explore polydrug use in relation to these major variables. In addition, the current results suggest that the use of hallucinogens may be important, particularly for examining mindfulness. Moreover, another relevant factor may be the motivations for cannabis use in polysubstance users (e.g., healing vs. party contexts).

Finally, in terms of future research, the associations between these constructs and underlying mechanisms could also be explored more thoroughly with the inclusion of neural (e.g., event-related potential or neuroimaging) and behavioral measures of impulsivity and mindfulness. It is likely that other assessment domains could pick up on minute differences in brain function that self-report measures simply cannot accomplish. There are several studies which have gone beyond using self-report measures to assess impulsivity among cannabis users. For instance, Clark et al. (2009) suggested that cannabis users, when compared to drug naïve controls, experience disruptions in reflection impulsivity, which is defined as a tendency to consider and deliberate over alternative solutions to problems (Kagan, 1966). Although the previous study only used one assessment of impulsivity, others have recognized the importance of using multiple tasks to address the distinct facets. For instance, Gonzalez et al. (2012) measured differences in performance on the Iowa Gambling Task (IGT), Go-Stop task, Monetary Choice Questionnaire, and the Balloon Analogue Risk Task between cannabis users and non-user controls. It turned out that this study failed to find significant differences on any of the behavioral measures of impulsivity between the groups. These studies highlight the importance

of utilizing behavioral measures of impulsivity that can be used in accordance with self-report measures to provide a more comprehensive measure of the impulsivity construct.

Although impulsivity has several direct behavioral measures to assess the construct, there do not seem to be many direct behavioral measures of mindfulness. However, some research teams have suggested that the mindfulness-based programs have positive effects on health. In saying that, there is very little information on the immediate physiological effects of mindful practices (e.g., breathwork or meditation). In 2006, it was suggested that a meditative body scan (a mindfulness-based stress reduction practice) was significantly associated with immediate changes in respiration for both males and females and decreases in diastolic blood pressure for women (Ditto et al., 2006). Perhaps this study suggests that factors such as respiratory rate, blood pressure, and heart rate variability are important physiological indicators of the health outcomes associated with mindfulness. Because mindfulness is negatively associated with indications of physiological distress such as increased heart, breathing rate, and reduced heart rate variability, these could be candidates for tangible indications of the construct (Coffey & Hartman, 2008; Ostafin et al., 2013). Lastly, studies have reported consistent negative associations among attentional bias tasks and self-report of mindfulness such as the FFMQ (Garland et al., 2011) as well as reduced drug-oriented attentional bias after participation in a mindfulness-oriented intervention (Garland et al., 2017). Thus, at least in drug users, it's possible that attentional bias tasks could serve as appropriate indirect measures of the mindfulness construct. Clearly more extensive study is necessary to further elucidate the usefulness of behavioral and/or physiological assessments of mindfulness.

Conclusion

This study found that Lack of Premeditation and mindfulness were associated with cannabis user status. The results also tentatively support that Negative Urgency may be an important factor for associated cannabis use problems in users. These findings emphasize that constructs such as mindfulness and specific aspects of impulsivity may be relevant for identifying those at risk; but given that the direction of the mindfulness finding was different from prior studies, it's likely important to consider other factors such as motivation to use and emotional distress. The unexpected mindfulness finding may also indicate that either mindfulness, as measured in the current study, is not an appropriate indication of the dual process reflective system or that the dual process model itself may not be the best theoretical framework for cannabis use specifically as the motivations to use may differ somewhat from other drugs of abuse. Rather, the current results may suggest that once an individual begins using cannabis, it is important that they consume cannabis in the appropriate mind set and physical setting in order to gain the benefits from mindful use while avoiding the risk for disordered use. This may decrease instances of using under the influence of negative emotional states, which is thought to be increasingly associated with problematic use and could slow down or altogether stop the transition from recreational to disordered use. Thus, it seems as though the interactive roles impulsive and mindful behaviors are important considerations depending on the stages of use (Dakwar & Levin, 2013; de Dios et al., 2012).

Overall, these findings partially replicate and expand the prior literature yet demonstrate that there is still need for further study surrounding this topic. Research on the associations between cannabis use characteristics, impulsivity, and mindfulness would be beneficial in identifying which facets are most influential for identifying those at risk and how treatment

procedures can be best structured and implemented to target disordered or problematic use processes. Furthermore, an increase in the number of studies considering how the associations between cannabis use, impulsivity, and mindfulness differ among disordered, problematic, non-problematic, illegal medicinal (use for ailment/no Rx), and legal medicinal (use for ailment/has Rx) use, is necessary. In doing this, health outcomes associated with cannabis use can start to be fully understood.

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