Cannabis Use Motives in Emerging Adulthood: Using Daily Diary Method to Inform Intervention

by

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Abstract

The increasing rate of cannabis use among emerging adults is a growing public health concern in Canada. Research has shown that frequent cannabis use is associated with a myriad of negative mental health outcomes. However, little is known about the motivations or reasons behind such use in emerging adulthood. Daily diary data provides information on both the proximal and distal factors for cannabis use, which can inform interventions to prevent and treat problematic use in emerging adulthood.

The first phase of the study assessed four trait motives (coping, sleep, enjoyment, and celebration) that were hypothesized to moderate the daily relationships between negative and positive affect and cannabis use and related consequences. A sample consisting of 63 emerging adults (ages 18-25) recruited from the community completed baseline questionnaires followed by 14 daily reports on mood, motives, cannabis use, and consequences. Across the 14 days, daily negative mood was associated with greater cannabis consequences, although for those who use cannabis to cope, the strength of this relationship was greater on days when participants reported less negative mood. Enjoyment motives moderated the relationship between daily positive mood and consequences, such that the relationship was even stronger on days when participants experienced less positive mood, acting as a buffer against cannabis-related consequences.

The second phase of the study investigated the impact of using a daily diary as a self-monitoring tool to enhance motivation to change cannabis use. Additionally, at the end of the daily diary period, participants were randomly assigned to either receive a brief personalized feedback intervention or to a control condition. Although there were no differences in cannabis use or consequences between the intervention and control groups, men exhibited a significant reduction in cannabis consequences from baseline to follow-up, supporting the efficacy of self-monitoring via an electronic device as an intervention tool. Overall, findings highlight that the relationship between daily mood and cannabis motives contribute to daily cannabis consequences and ought to be considered when developing prevention and interventions for emerging adults.

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Chapter 1: Introduction and Literature Review

Cannabis Use in Emerging Adulthood

Emerging adulthood (ages 18-25; Arnett, 2000) is regarded as a critical period of social and psychological development. Demographic and societal shifts in recent decades have contributed to a lengthening of the period between late adolescence and adulthood, resulting in delayed entry into adult roles (e.g., stable employment, marriage or common law relationships, child-rearing; Arnett, 2004). Arnett (2000, 2004) identified five main psychological features that distinguish emerging adulthood from other life stages. These include identity exploration (trying out new things and figuring out who you are), instability (in education, work, relationships, and residence), self-focus (being responsible for oneself while not being responsible for others), feeling in-between (considering the self somewhere between an adolescent and an adult), and possibility (feeling optimistic about future prospects). Although many of these developmental tasks begin during adolescence and continue into young adulthood, the transitional nature of emerging adulthood sets it apart from other life stages (Arnett, 2004).

Emerging adulthood is also accompanied by significant cognitive and psychological changes (Arnett, 2000). Recent studies have shown that neuropsychological development continues well into one's 20s, especially in the prefrontal cortex area, which is associated with greater efficiencies in both emotional and cognitive processing (Johnson et al., 2009; Sowell et al., 1999; Steinberg, 2005). This continued neurobiological maturation enhances emerging adults' executive functioning, enabling them to have more complex thinking and increased capability to self-regulate emotions and cognitions (Bennett & Baird, 2006; Schulenberg et al., 2016). However, it is also during this life stage that there is a tendency to seek out novel stimulation as a way of exploration (Arnett, 1992). As such, risk taking behaviours, including substance use, tend to peak during emerging adulthood (Arnett, 2005; Rotermann, 2020; Qadeer et al., 2019).

Experimenting with substances is common during emerging adulthood, with cannabis being the second most commonly used substance by Canadian emerging adults, after alcohol (Arnett, 2005; Health Canada, 2018). In Canada, emerging adults have the highest prevalence of past year cannabis use relative to any other age group, with one-half (52%) of emerging adults (ages 20-24) reporting past year cannabis use compared with 24% among those 25 years and older (Government of Canada, 2020). Comparable rates have been found among Canadian university students, where 32% of students reported using cannabis in the past six-months with 7.6% meeting criteria for Cannabis Use Disorder (CUD; Mader et al., 2019). CUD is also more likely among the general population of emerging adults. Among those who are 18-25 years old, the 12-month prevalence of CUD is 9.8% (Han et al., 2019), meaning that one out 10 emerging adults report cannabis use that leads to significant impairment (American Psychiatric Association, 2013).

The typical developmental trajectory of cannabis use involves experimentation and use during late adolescence, peak use during emerging adulthood, followed by a decrease in use (Homel et al., 2014; Johnston et al., 2016). However, emerging adults are not a homogenous group, and inter-individual variability exists such that individuals differ in their use onset, duration, and frequency (Caldeira et al., 2012).

On October 17, 2018, Canada became the second country in the world to legalize recreational cannabis use (Government of Canada, 2018). Under the *Cannabis Act*, individuals aged 18 or 19 or older (depending on the province or territory) can possess up to 30 grams of legal cannabis or cannabis products, including edibles. Cannabis is a complex substance that can produce both positive and negative effects. While it contains over 500 components, the two psychoactive cannabinoids that have been studied most extensively are Δ^9-tetrahydrocannabinol (THC) and cannabidiol (CBD; Atakan, 2012). Cannabis potency has dramatically increased in the past several decades, with THC content rising from 4% in the 1990s to 28-40% currently (Stuyt, 2018). Some studies have shown that higher concentrations of THC may increase the risk of psychotic disorders and other mental health difficulties (Gage et al., 2016), highlighting the potential risks associated with these more potent strains.

Cannabis Consequences

Frequent cannabis use (i.e., daily or near daily use; Fischer et al., 2009) and chronic cannabis use (i.e., daily or near daily use over a period of years, Hall & Degenhardt, 2009, 2014; Fischer et al., 2009) have been associated with psychosocial, academic, occupational, and physical health consequences (George & Vaccarino, 2015; Memedovich et al., 2018; Pedersen et al., 2016a; Volkow et al., 2014).

Researchers have found that there is a dose-response relationship between cannabis use and mental health issues: lower doses may alleviate symptoms, whereas higher doses and chronic use are associated with greater mental health difficulties (Chabrol et al., 2005; Field et al., 2001; Fleming et al., 2008; Metrik et al., 2011; Morgan et al., 2012; Niesink et al., 2013). Although some individuals with mood or anxiety symptoms may be motivated to use cannabis to manage mental health difficulties (Colder et al., 2019; Sarvet et al., 2018; Sexton et al., 2016), studies have shown that using cannabis for coping reasons may actually exacerbate these symptoms. For example, Cuttler and colleagues (2018) found that even though adults who use cannabis for medicinal reasons perceived a reduction in their depression and anxiety symptoms following cannabis use, their baseline depression symptoms significantly increased over time. Similarly, Colder et al. (2019) found that using cannabis for coping reasons was associated with exacerbation of adolescents' depressive symptoms. These findings suggest that using cannabis may improve functioning in the short-term but may increase the risk for symptom worsening in the long-run.

In addition to mental health difficulties, emerging adults who frequently use cannabis are at risk for experiencing a variety of educational problems and poor post-secondary academic outcomes. Arria and colleagues (2015) found that heavier cannabis use was associated with skipping classes, lower GPA, and longer time to graduation. Moreover, a longitudinal study that investigated trajectories from age 15 to 28 found that chronic cannabis use was associated with significantly lower educational attainment, lower occupational prestige, and decreased financial earning (Thompson et al., 2019). It has been suggested that acute and long-term effects of cannabis on executive functioning, memory and learning, and information processing may contribute to academic problems in those who frequently use cannabis (Crean et al., 2011; Becker et al., 2018; Nader & Sanchez, 2016).

Other negative outcomes of cannabis use include increased risk of medical problems (Bloom et al., 1987), decreased respiratory functioning (Martinasek et al., 2016), and adverse cardiovascular effects (Subramaniam, Menezes, DeSchutter, & Lavie, 2019). Frequent cannabis use has also been associated with risk taking behaviours such as motor vehicle accidents (McDonald et al., 2003; Rogeberg & Elvik, 2016) and unprotected sexual intercourse (Buckner et al., 2018). In addition, withdrawal symptoms, self-care difficulties (poor sleep and appetite), interpersonal challenges, and financial and legal problems (Struble et al., 2019) are other commonly reported consequences of heavy and frequent cannabis use. In order to understand cannabis use-related sequalae, it is important to examine factors that may contribute to these patterns, such as motives for use.

Motivational Models of Substance Use

Motivational models provide an important theoretical foundation for examining reasons for cannabis use (Simons et al., 1998). Motivational theories rest on two tenets; first, individuals use substances to achieve certain outcomes; and second, substance use behaviour that serves different needs will be associated with different patterns of antecedents and consequences (Cooper, 1994). Individuals engage in substance use for either positive reinforcement (for example, to achieve positive affect or a "high"; Everitt & Robbins, 2005; Hyman et al., 2006) and/or for negative reinforcement (for example, to cope with negative affect or withdrawal; Koob & Le Moal, 2008). These motives (i.e., reasons for use) are important individual-level predictors of use and consequences. For example, within the alcohol field, coping motivated drinking is associated with heavier use and more negative consequences compared to drinking motivated by social or recreational reasons (e.g., Martens et al., 2008; Villarosa et al., 2018; Simons et al., 1998).

To date, theories of determinants of behaviour have significantly advanced our understanding of individual differences in motivation to use alcohol (e.g., Cooper, 1994; Cox & Klinger, 1988). Alcohol motives that have been extensively investigated include *social* (i.e., drinking to gain interpersonal reward), *enhancement* (i.e., drinking to regulate positive emotions/enjoyment), *conformity* (i.e., avoiding social rejection), and *coping* (i.e., regulating negative emotions; Cooper, 1994). These same motives have also been applied to cannabis use, with the inclusion of a fifth motive, *expansion* (i.e., enhancing perceptual or cognitive awareness), which accounts for some of the reported psychedelic properties of cannabis (Simons et al., 1998). Recently, research on cannabis motives has increased and motives have been identified as significant predictors of use patterns and mental health, especially in the emerging adult population (e.g., Bonar et al., 2017; Cloutier et al., 2019; Glodosky & Cuttler, 2020).

In 2009, Lee and colleagues developed a comprehensive measure of cannabis use motives, the Comprehensive Marijuana Motives Questionnaire (CMMQ). The CMMQ was developed among a sample of college students in the US and entailed 12 distinct factors: enjoyment, conformity, coping, experimentation, boredom, alcohol-related use, celebration, altered perception, social anxiety, relative low risk, sleep, and availability (Lee et al., 2009). In Lee's college student sample, enjoyment, boredom, relative low risk, altered perceptions, and sleep motives were found to be associated with more frequent cannabis use. However, when Blevins and colleagues administered the CMMQ to a sample of high school students, they found that only sleep and alcohol-related use were associated with more frequent use (Blevins et al., 2016b). Thus, when motives are considered traits and examined across individuals, there are some inconsistencies regarding their relationship to cannabis use. In addition, the majority of research on cannabis motives has relied on the more limited set of motives extracted from the alcohol field described above (Simons et al., 1998).

Cannabis Use Motives: Risk and Protective Factors

Emerging adults report using cannabis for a wide variety of reasons (Lee et al., 2007). Despite some conflicting findings regarding the link between cannabis use and mental health issues, a large proportion of those who use cannabis report using for management of negative affect, anxiety, and other mental health difficulties (Walsh et al., 2013, 2017). This relationship can be explained by *self-medication theory*, first introduced by Khantzian in 1977, who asserted that difficulty regulating negative emotions is an important motivator for substance use. Khantzian (1999) posited that intense negative emotions, such as anger, depression, and anxiety, could be related to the use of substances in order to reduce negative affect in individuals who experience coping difficulties. Research findings have supported this theory and demonstrated that individuals often use cannabis to alleviate negative affect and associated mental health concerns, such as anxiety, depression, stress, sleep issues, concentration difficulties, and pain (Bottorff et al., 2009; Davis et al., 2016; Hyman & Sinha, 2009; Glodosky & Cuttler, 2020; Hartmann & McLeish, 2020; Lemyre et al., 2019; Osborn et al., 2015; Stevens et al., 2021; Walsh et al., 2017). Using cannabis to cope with negative affect can result in short-term relief, but long-term reliance on cannabis may become negatively reinforcing, especially in emerging adults who are sensitive to difficult emotions and may lack other effective coping strategies (Larimer et al., 1999; Marlatt & Donovan, 2005). In the absence of other coping tools, a vicious cycle might develop where cannabis is used to cope with negative affect, resulting in increased negative affect, additional cannabis use, and so on (Buckner et al., 2020).

In contrast to negative reinforcement theories that describe using cannabis to cope or decrease uncomfortable affect, positive reinforcement theories explain cannabis use as a reward-seeking mechanism (Cooper & Haney, 2008; Miller et al., 1990). Cannabis has been found to increase mesolimbic dopamine transmission, which is believed to mediate the reward systems in the brain (Oleson & Cheer, 2012). Cannabis, similar to other substances, may be used to enhance positive affect (Cooper & Haney, 2008), and positive cannabis use expectancies (i.e., beliefs that cannabis will produce positive effects) have been found to be associated with substance use and abuse (Cooper et al., 1992; Leventhal & Scmitz, 2006). Positive affect enhancement has been found to be central in the initiation and progression of substance use, while negative affect becomes a more salient determinant at higher frequencies of use and as reliance on cannabis use develops (Robinson & Berridge, 2003).

The question remains – why do some people use cannabis and not go on to experience negative consequences, while others do? There is evidence that even though heavy and chronic cannabis use can be problematic for some emerging adults, longitudinal work found that long-term cannabis use was not associated with long-term mental and physical consequences (Fishcer et al., 2015). Motives provide one explanation for the function of cannabis use behaviour. Whereas in the beginning, cannabis use is a means to an end (e.g., to feel good, socialize, or satisfy curiosity; Kopetz et al., 2013), over time, for some individuals, cannabis use becomes an end in itself that is pursued despite negative consequences (Aarts et al., 2001). As heavier cannabis use develops, neuroadaptations occur in the brain such that individuals progress from positive to negative reinforcement (Koob & Valkow, 2010; Wycoff et al., 2018). Koob and Volkow (2016) proposed an addiction model whereby addiction is hypothesized to promote neuroadaptive changes resulting in neuroplasticity in domains of motivation and reward, memory, executive functioning, self-awareness, and stress reactivity (Koob & Valkow, 2010). The model proposes three phases of substance abuse with changes in three major neurocricuits in the brain: the binge/intoxication stage involving the basal ganglia; the withdrawal/negative affect stage related to changes in the amygdala; and the preoccupation/anticipation stage driven by changes in the prefrontal cortex. In short, all substances, including cannabis, produce an initial neuroadaptation in the form of excitability of the mesocorticolimbic dopaminergic reward system (Bloomfield et al., 2016; Koob & Volkow, 2016). Dopamine increase is associated with positive reinforcement of the rewarding properties of cannabis and other substances (Bossong et al., 2009). Over time, and with consistent use, opponent-processes responses that include decreased dopaminergic signaling result in elevation of reward thresholds drive symptoms of substance withdrawal, such as anxiety, irritability, fatigue, and low mood during abstinence from the substance (Zehra et al., 2018). Lastly, long-term dysregulation of the prefrontal cortex is associated with decreased responsiveness to non-substance sues and decrease in one’s ability to inhibit problematic behaviours (Koob & Valkow, 2016). Preclinical and clinical studies have shown that features of the three proposed stages are present in cannabis use disorder (Zehra et al., 2018).

Positive reinforcement may be more salient for individuals who use cannabis for recreational and sensation-seeking reasons (Simons et al., 2005), such as enjoyment and celebration motives, and are not “psychologically” dependent (Buckner & Schmidt, 2008; Simons & Arsens, 2007), while coping with difficult emotions and sleep difficulties might become negatively reinforcing over time (Baker et al., 2004). The former motives can be construed as protective factors while the latter are theorized to be associated with more frequent cannabis use and associated consequences. Given the high rates of cannabis use among emerging adults, it is important to differentiate between those who use cannabis and experience few consequences associated with their use (low risk cannabis use) and those who experience greater consequences (high risk cannabis use).

Risk Factors: Coping and Sleep Motives. Researchers have established that using cannabis to cope with negative affect is a strong predictor of frequent cannabis use and negative consequences in emerging adults (Buckner et al., 2020; Glodosky & Cuttler, 2020; Spradlin & Cuttler, 2019; Walsh et al., 2013, 2017). Emerging adults who reported greater coping motives also reported using larger quantities of cannabis (Bonar et al., 2017) and being more likely to endorse cannabis use disorder symptoms (Schultz et al., 2019). Brodbeck, Matter, Page, and Moggi (2007) found that young adults who used cannabis for coping reasons displayed more psychosocial distress and poorer psychological functioning compared with emerging adults who used cannabis for social reasons. Lee and colleagues (2009), who developed the Comprehensive Marijuana Motives Questionnaire (CMMQ), found that coping motives were uniquely associated with experiencing more negative consequences. Blevins and colleagues (2016b) validated the CMMQ in a sample of heavy high school students who heavily use cannabis and found that higher endorsement of coping motives was related to greater cannabis-related problems, increased internalizing and externalizing difficulties, as well as lower self-efficacy for reducing use. However, they did not find an association between coping motives and cannabis use frequency.

Greater coping motives have also been associated with higher number of endorsed cannabis dependence symptoms (Fox et al., 2011). Bonar et al. (2017) looked at daily associations between cannabis motives and use in 95 emerging adults who frequently used cannabis (used on average 17 days out of 28). They found that on days participants reported using cannabis for coping motives, they also reported larger quantities of cannabis use. Mitchell et al. (2007) found further evidence that showed that coping motives significantly related to negative affect and associated vulnerability to heavier and problematic cannabis use.

Using cannabis for sleep is another common motive for cannabis use. A recent study found that 15% of college students use cannabis as a sleep aid (Goodhines et al., 2019b). Of those who use cannabis regularly between the ages of 16 and 22, almost 70% of them reported using it for sleep purposes (Boys, Marsden, & Strang, 2001). Bonn-Miller and colleagues (2014) proposed a cyclical model whereby using cannabis to cope with sleep difficulties leads to frequent use and/or higher doses than originally intended. This then leads to gradual tolerance development that is associated with greater sleep disturbances during abstinence, which then prompts cannabis use, resulting in more frequent use and cannabis-related outcomes.

Further support for this theory comes from Blevins et al. (2016b) who found that high school students who endorsed sleep motives reported more days of cannabis use, suggesting that those who use cannabis for sleep are frequent users; however, this increased use was not associated with more cannabis-related problems. This contrasts with the findings of Lee et al. (2009) who found that sleep motives were associated with more cannabis consequences. Bohnert and colleagues (2018) administered the CMMQ among a sample of medical cannabis patients and found that sleep-related motives were associated with lower physical health functioning. A recent study by Wong et al. (2019) found that insomnia symptoms were associated with cannabis related consequences and that this relationship was mediated by lower use of protective behaviour strategies (i.e., behaviours that are used instead of substance use to reduce substance-related harm). In sum, sleep is frequently endorsed as a motive for using cannabis and is associated with expectations of improved sleep (Goodhines et al., 2019b); however, the literature is inconsistent as to whether using cannabis for sleep is associated with increased cannabis use and consequences (Campeny et al., 2020; Gates, Albertella, & Copeland, 2014; Suraev et al., 2020).

Protective Factors: Enjoyment and Celebration Motives. Enjoyment and celebration are some of the most common reasons that adolescents and young adults use cannabis (Lee et al., 2007; Dias et al., 2020). Cannabis has been shown to produce euphoric effects that do not diminish over time even in those who frequently use cannabis (D'Souze et al., 2008). Cannabis increases synaptic dopamine levels in the striatum, thereby producing euphoria and a "high" (Bossomg et al., 2009). Using cannabis for enhancement (i.e., enhancing positive affect) has been shown to be associated with higher frequency of cannabis use and more negative consequences (see Cooper et al., 2016 for a review). However, recent conceptualizations of cannabis motives have expanded and added more specific variants of enhancement that include using for enjoyment and for celebration (Ghelani, 2020; Lee et al., 2007; Lee et al., 2009). These motives may explain why certain individuals continue to use infrequently for recreational pleasure and do not go on to develop cannabis use disorder.

Only a few studies to date have examined enjoyment and celebration motives and their relationship to cannabis use. Lee et al. (2009) who first introduced these motives found that enjoyment (using for fun) was the most frequently endorsed motive by those who use cannabis. They found that enjoyment was positively associated with cannabis use but was related to fewer cannabis consequences. This contrasts their previous work in 2007 that found that using cannabis for enjoyment/fun was associated with experiencing more negative consequences.

Even less is known about using cannabis for celebration reasons. Using a substance to celebrate a special day or an occasion was drawn from alcohol research (Klein, 1992). During the development of the CMMQ, Lee et al. (2009) found that celebration motives were not associated with more frequent use. Enjoyment and celebration were associated with better mental health in individuals who use cannabis for medicinal reasons whereas coping and sleep were significantly associated with poorer mental health (Bohnert et al., 2018). These findings were supported by Blevins et al. (2016b) who found that celebration motives were associated with decreased internalizing symptoms. On the other hand, Walukevich-Dienst and Buckner (2019) found that enjoyment and celebration were significantly correlated to higher cannabis quantity and intoxication on 4/20 (i.e., April 20th, a day that celebrates cannabis), while celebration motives significantly predicted 4/20-use related problems. Thus, the literature is scarce on the roles of celebration and enjoyment motives, although these are among the top reasons for cannabis use, especially in young adults.

In sum, emerging adults frequently use cannabis to avoid negative experiences (coping, sleep; “risky motives”) as well as to promote positive experiences (enjoyment, celebration; “protective motives”; Cooper, 1994). Enhancement motives are related to positive affect, while coping motives to negative affect (Zvolenstky et al., 2007). Both sets of motives have been found to be differently and inconsistently associated with frequency of cannabis use and associated problems. Moreover, studies on cannabis motives to date have focused on cross-sectional representations of cannabis use, while far less is known about in-the-moment affective states related to cannabis use. Daily diary studies can address this shortcoming by measuring cognitive factors, such as motives, that may moderate the relationship between daily affect and subsequent cannabis use and consequences.

Daily Diary Studies

Because cannabis use and its outcomes vary over time, one method for assessing cannabis use and consequences that provides an ecologically valid representation of emerging adults’ cannabis use is the use of daily diaries (Gunthert & Wenze, 2012). Daily diaries are a subset of Ecological Momentary Assessment (EMA; Shiffman et al., 2008; Stone & Shiffman, 1994) methods, and typically involve repeated administration of assessments in real time while participants are in their natural environments (Shiffman et al., 2008). The prototypical EMA design assesses participants’ behaviours, feelings, or thoughts throughout the day, either during predetermined moments or on a random time schedule (Shiffman, 2007; Stone & Shiffman, 1994). The assessment is typically completed via an electronic device, such as a smartphone (Boynton & Richman, 2014). The advantage of using an application-based (‘app’) data collection method is that smartphones are typically carried by participants throughout the day and survey entries can be made directly into the device allowing for data collection in real-world environments, thereby reducing retrospective memory bias and improving data validity (Shiffman et al., 1994; Stone & Shiffman, 2002). EMA methods are well suited for the study of substance use, since substance use tends to be a discrete and episodic behaviour, making EMA an effective tool for tracking its frequency over a period of time (Shiffman, 2009). Smartphone apps can be programmed to automatically prompt participants to complete surveys, which can increase participation and adherence. Daily diary is a common subtype of EMA, where participants complete an assessment once per day for a predetermined period of time (e.g., one or two weeks) and retrospectively report on their experiences for the whole day (Shiffman, 2009). Daily diaries allow for behaviour to be recorded on a daily basis, repeatedly over time, in participants' natural environment, therefore providing accurate representations of target behaviours without overloading participants with multiple assessments per day (Shiffman, 2009).

Daily diary studies have been extensively used in studying alcohol consumption, especially in college and emerging adult populations (e.g., Boynton & Richman, 2014; Howard et al., 2015; Pearson et al., 2013). However, cannabis use is frequently studied cross-sectionally (e.g., Bonn-Miller et al., 2007; Dash & Anderson, 2015; Simons et al., 1998). Although cross-sectional and longitudinal studies have provided support to the self-medication hypothesis (Carrigan & Randall, 2003; Turner et al., 2018; van Amsterdam et al., 2018), daily report studies provide a more nuanced understanding of the impact of fluctuating variables, such as mood, on subsequent cannabis use. Cannabis use is often linked to coping with negative affect, and thus can be seen as a reactive process whereby mood and cannabis use to cope with mood would change from day to day (Testa et al., 2019). These processes highlight the importance of investigating within-person associations that take temporal relationships between variables into account.

Daily diary studies offer the ability to examine the relationship between within-person changes in affective states and cannabis use within the same day (Gunthert & Wenze, 2012). This allows for behaviour variability to be examined on two levels: intra-individual or day-to-day effects (differences within the same individual over time) and inter-individual or between-person effects (differences between individuals). For example, individuals who consistently use cannabis to cope may use cannabis more frequently than those who use cannabis for other reasons, a between-person effect. However, this differs from the question of whether people are more likely to use cannabis when they are experiencing greater negative mood relative to their usual affective state. Daily data helps to ascertain whether cannabis use is more likely to occur on days when negative affect is greater than one's own average or typical mood, therefore providing a more rigorous methodological framework to test the self-medication hypothesis.

Only a handful of studies to date have incorporated daily diaries methodologies to examine cannabis use (Votaw & Witkiewitz, 2021). Buckner and colleagues (2012) utilized an EMA approach in a college sample and found that increased urge to use predicted more cannabis use days amongst those with social anxiety. However, their study only examined one type of daily negative affect (anxiety). Hughes and colleagues (2014) conducted a descriptive daily diary study of adults who used cannabis and found that availability and social settings were correlated with frequency of use, although the study did not show other day-level associations between affect and cannabis use. Pearson, Bravo, Conner, & Parnes (2019) investigated cannabis motives among college students using a daily diary method. They found that at the within-subject level, coping, conformity, enhancement, and social motives were associated with more negative outcomes, although they failed to find any significant relationships between cannabis use motives and quantity of use. Due to limited statistical power, the researchers were unable to examine between-subject effects. More recently, Testa and colleagues (2019) found that emerging adult individuals who completed 30 daily diary days were more likely to use cannabis on days when they experienced lower positive mood than usual. Although these findings provide initial support for the important role cannabis motives have on daily-level use and consequences, questions remain regarding motives for use on an individual basis.

Research is beginning to show that various cannabis motives are associated with different use patterns and consequences. However, it remains unclear what mechanisms underlie these relationships. While these studies provide an initial foundation for understanding cannabis use in emerging adulthood, they are limited by a number of factors. Studies on emerging adult tend to focus on post-secondary student population, even though almost half (45%) of 18- to 24-year-olds in Canada do not attend college or university (Statistics Canada, 2019). A growing body of evidence suggests that non-students may experience emerging adulthood differently from students (Mitchell & Syed, 2015). Thus, there is a need for inclusive research that includes non-student experience in order to generalize to the broader population of emerging adults. In addition, post-secondary samples typically consist of students from one institution, thereby reducing generalizability. Second, participants in some studies were considered “light” users, as most of their participants reported using cannabis once per week. Daily or near-daily cannabis use is a growing phenomenon amongst Canadian emerging adults, with 25% of 20–25-year-olds who use cannabis reporting daily or almost daily use (Government of Canada, 2019). Up to 75% individuals who use cannabis on a daily or near daily basis develop dependence and experience negative consequences due to their use (Anthony, 2006). When examining factors that contribute to low and high-risk cannabis use, it is important to include emerging adults who frequently use cannabis and are likely to experience consequences associated with their cannabis use. Lastly, the cross-sectional nature of previous studies limits our ability to draw causal inferences about the temporal relationship between motives and cannabis use and consequences. No study to date has examined trait cannabis use motives along with affect, cannabis use, and related consequences on a daily basis in a sample of Canadian emerging adults. Determining these associations at both the event- and individual-level would help our understanding of the etiology of problematic cannabis use and inform the development of interventions that target these trajectories.

Motivational Interventions for Cannabis Use

Self-Monitoring Effect: Daily Diary as an Intervention for Cannabis Use

Daily diary research protocols typically consist of self-monitoring, a process whereby individuals identify that a behaviour has occurred and then record a response (DeLongis et al., 1992). Self-monitoring of behaviour has been established as an effective method for catalyzing health behaviour change by enhancing individuals' awareness of their behaviours, which often leads to reduction of the unwanted behaviour. This effect has been found in weight loss (e.g., Helsel et al., 2007; Yon et al., 2007), diet adherence

(Schnoll & Zimmerman, 2001), blood glucose management (Guerci et al., 2003), physical activity (Nicklas et al., 2014), alcohol use (Crane et al., 2018) and smoking cessation (e.g., McFall & Hammen, 1971). Self-monitoring is a key component in behavioural change as it provides insight into the relationship between internal and external factors that influence the target behaviour (Freedman et al., 2006).

Daily diary or ecological momentary assessment studies that have looked at substance use largely conceptualized self-monitoring and associated behavioural reactivity as a validity concern. There are two types of reactivity to monitoring: first, *behavioural reactivity* – the extent to which cannabis use changes as a function of daily monitoring; and second, *motivational reactivity* – the extent to which participants' readiness to change their cannabis use is affected by daily monitoring of their use. Rightfully so, if EMA produces reactivity, then data must be interpreted with caution as changes in behaviour (the dependent variable) may be in part due to reactivity itself and not the predictor variables. Moreover, if EMA is utilized to establish a base rate for a certain behaviour, then reactivity may influence the magnitude of change brought on by an intervention. However, there are methodological strategies to mitigate such concerns, such as using a baseline measure of the behaviour in question prior to EMA as well as assessing monitoring effect prior to the intervention (Hufford et al., 2002).

Although previous research has found evidence for the efficacy of self-monitoring tools in other health behaviours, it has not been as well-researched when applied to addictive behaviours, especially when reported via smartphones. For example, participants who used a mobile app for self-monitoring of physical activity exercised more frequently than participants who used a website or paper journals to track their activity (Turner-McGrievy et al., 2013). Daily self-monitoring of cannabis use, motives, and consequences may help emerging adults become aware of potentially problematic habits. Moreover, the use of a daily diary app may serve as an easy-to-use, readily accessible tool for monitoring cannabis use, resulting in increased motivation to change the behaviour and/or changes to the behaviour itself.

Personalized Feedback Intervention

In addition to self-monitoring, Personalized Feedback Interventions (PFIs) have been used in a number of studies targeting high-risk behaviours (Davis et al., 2017; Riper et al., 2011). Rooted in motivational psychology, PFIs provide individuals with personalized feedback on their self-reported behaviour, such as substance use (Walters & Neighbors, 2005). This feedback may include an overview of mean reported substance use, associated risks and consequences, and comparison of individuals’ scores to standard risk measures (Walters & Neighbors, 2005). Based on The Transtheoretical Model of Change (Prochaska & DiClemente, 1982), the rationale behind PFIs is that individuals are not always aware of their own behaviour and that providing feedback might increase awareness of their own substance use patterns and consequences, thus motivating them to change (Miller et al., 2013). Brief personalized feedback interventions have been shown to be effective in reducing alcohol frequency misuse (e.g., Gonzales & Dulin, 2015; Karno et al., 2021; Lau-Barraco et al., 2018; Martinez-Montilla et al., 2021; Paulus et al., 2021). Furthermore, a meta-analysis found that computer-delivered PFIs without professional guidance were found to be as effective as brief in-person interventions (Cadigan et al., 2015). However, few studies have looked into the same kind of motivational interventions for cannabis use, and the ones that have, tended to focus on general reduction of poly-substance use. For example, White and colleagues (2006) found that students who received either in-person or written feedback demonstrated an overall reduction in substance use, including cannabis, alcohol, and other illicit substances. Cannabis-specific PFIs have been found to reduce problematic cannabis use among students with greater readiness to change (Palfai et al., 2016), among those with greater problem distress (Walukevich-Dienst et al., 2021), and among those who frequently use cannabis (Riggs et al., 2018).

According to the transtheoretical model of behaviour change (Prochaska & DiClemente, 1982, 1992), motivation to change substance use involves a process of transitioning from not seeing the behaviour as a problem (precontemplation), to seeing a problem and weighing pros and cons of changing (contemplation), to adopting a change goal (preparation) and finally committing and taking active steps towards changing (action; Prochaska & DiClemente, 1982, 1992). Individuals may cycle through the stages before reaching the final stage of maintenance (Prochaska et al., 1988). Readiness to change may serve as an important precursor to actual changes in substance use as changes across the readiness continuum reflect increasing motivation to adjust current behaviour (Breda & Heflinger, 2007; Slavet et al., 2006). Willingness to change one's substance use has been found to be central in reducing opiate (Nosyk et al., 2010), alcohol (Carey & DeMartini, 2010; Fromme & Corbin, 2004), and cannabis use (Slavet et al., 2006; King et al., 2009; Walukevich-Dienst et al., 2021). For example, greater motivation to change cannabis use predicted lower severity of cannabis use three months post-release amongst incarcerated adolescents (Slavet et al., 2006) and greater motivation to abstain from cannabis use significantly predicted fewer days of cannabis use in a longitudinal study of adolescents attending an outpatient program (King et al., 2009). A study by Lee, Neighbors, Kilmer, and Larimer (2010) involved a personalized feedback intervention, but they failed to find an intervention effect; they did find that contemplation about cannabis use moderated the relationship between intervention and cannabis use, thereby indicating that change contemplation may be an important factor to consider in personalized feedback interventions for substance use. Motivation to change cannabis use may be a key intermediate factor that could be amenable to brief behavioural interventions, such as personalized feedback interventions (Caviness et al., 2013).

Personalized feedback interventions are typically based on summary scores where participants provide data on their own behaviours through retrospective assessments (Miller et al., 2013). Even studies that have utilized a daily diary intervention (e.g., Hooley et al., 2018), have not used participants' own reported behaviours drawn from the daily diary in the intervention. Utilizing data collected from a daily diary study provides a different perspective (i.e., feedback on daily patterns of cannabis use and motives), which may increase reliability and improve the salience of problematic cannabis use and motivate change.

Summary and Hypotheses

The current study had three primary objectives. The first objective was to examine the daily, within-person relationship between affect (negative mood and positive mood) and cannabis use and consequences and determine whether trait cannabis motives (coping, sleep, enjoyment, and celebration) moderated this relationship. The second purpose was to evaluate the potential use of daily diary methodology as a self-monitoring and awareness-enhancing tool that can contribute to changes in cannabis use. Finally, the current study evaluated the efficacy of a brief online personalized feedback as a novel intervention for frequent cannabis use.

Just as motivational models of alcohol led to further understanding of alcohol use, understanding antecedents of cannabis use can provide insight into why emerging adults use cannabis, how often, and with what consequences. Data that is captured on a daily level can provide information on proximal factors that influence cannabis use in emerging adults. This information could be used in the development of public and health policies. It could also aid our understanding of how and when to best intervene and with what therapeutic approach, as interventions that target cannabis motives are typically associated with better intervention outcomes (Blevins et al., 2016a).

Research Questions and Hypotheses

Risk Factors

Research Question 1: Do ‘risky’ trait cannabis motives (coping, sleep) moderate the relationship between daily negative affect and daily cannabis use and consequences over the 14-day period?

Hypothesis 1: Based on motivational models of substance use, it is expected that daily negative mood will be associated with increased daily cannabis use and negative consequences. This relationship will be moderated by trait cannabis motives such that participants who use cannabis for coping and sleep will report increased cannabis use and consequences on days they experience negative mood.

Protective Factors

Research Question 2: Do 'protective' trait cannabis motives (enjoyment, celebration) moderate the relationship between daily positive mood and daily cannabis use and consequences over the 14-day period?

Hypothesis 2: It is expected that daily positive mood will be associated with decreased daily cannabis use and negative consequences. This relationship will be moderated by trait cannabis motives such that participants who use cannabis for enjoyment and celebration will report decreased cannabis use and decreased negative consequences on days they experience positive mood.

Self-Monitoring Effect

Research Question 3a: Does readiness to change cannabis use change from pre-study (baseline; time point 1) to immediately post-study (after the two-week daily diary; time point 2) to one-month follow-up (time point 3) for all participants?

Hypothesis 3a: There will be a significant increase in motivation to reduce cannabis use from pre- to post-daily surveys. This change will be attributed to the monitoring effect of having participated in a daily diary study.

Research Question 3b: Do cannabis use frequency and cannabis use consequences change from pre-study (baseline; time point 1) to immediately post-study (after the two-week daily diary; time point 2) to one-month post-study (time point 3)?

Hypothesis 3b: There will be a significant decrease in cannabis use frequency and consequence from pre- to post-daily surveys. This change will be attributed to the self-monitoring effect of having participated in a daily diary study.

Brief Personalized Intervention Effect

Research Question 4: Does receiving a brief, personalized feedback intervention impact motivation to change cannabis use and willingness to utilize resources to help reduce cannabis use?

Hypothesis 4: Participants who are randomly assigned to the brief intervention group will display significantly increased motivation to change at the one-month follow-up and be more likely to accept and utilize resources to help reduce cannabis use compared with control participants.

Chapter 2: Method

Participants

A total of 208 emerging adults across Canada expressed interest in participating in the study. Of these 208, six did not meet eligibility criteria and 129 met criteria but did not reply to a request to complete the phone screening. Eligibility criteria included being between the ages of 18 and 25, having used cannabis at least twice in the past two weeks for recreational reasons, being fluent in written English, and owning a smartphone. A total of 73 participants completed the phone screening and provided consent to participate in the study. During the study, eight participants elected to withdraw. Two participants completed all study stages but did not report any cannabis use during the 14 daily diary period and were removed from analyses. See Figure 1 for the flow chart of participant inclusion and exclusion.

The final sample consisted of 63 participants who completed all study requirements and ranged in age from 19-25 years (M = 22.14, SD = 2.09). Previous research using electronic daily diaries in their methodology had similar sample sizes to the present study (e.g., Connelly et al., 2010; Connelly & Bickel, 2011; Horowitz, 2016). Follow-up rates were excellent: 84.1% (N = 53) completed the post-daily diary survey and 92.1% (N = 58) completed the one-month follow-up survey.

Figure 1

Participant Inclusion Chart

The majority (61.9%, N = 39) of participants identified as male, 36.5% (N = 23) identified as female, and one individual identified as female to male transgender. Participants reported their ethnicities as follows: 47.6% Caucasian, 33.4% Asian, 11.1% African-Canadian, 17.5% South Asian, 7.9% Middle Eastern, and 11.1% Latinx. Most of the participants reported living with their parents (52.4%). Participants reported a range of relationship statuses, with most emerging adults being in an exclusive relationship but not living together (39.7%). The majority (58.7%) of the sample were currently students while 41.3% reported not being students. Of those who identified as non-students, 48.0% had obtained a bachelor's degree or college diploma and 12.0% a master's or graduate degree. Overall, 68.2% of all participants reported being employed, either on a part-time or full-time basis. Full demographics for the sample are reported in Table 1.

Table 1

Demographic Information for Study Sample (N = 63)

Variable	*N*	%
Age		
19	9	14.3
20	8	12.7
21	8	12.7
22	11	17.5
23	7	11.1
24	7	11.1
25	13	20.6
Gender Identity		
Female	23	36.5
Male	39	61.9
Transgender (female to male)	1	1.6
Racial Identity		
African-Canadian/Black	7	11.1
Arab	5	7.9
Caucasian	30	47.6
Chinese	7	11.1
Filipino	3	4.8
Latinx	7	11.1
South Asian (e.g., Indian, Pakistani)	11	17.5
Southeast Asian (e.g., Cambodian)	1	1.6
Relationship Status		
Single, not currently dating	20	31.7
Casually dating	7	11.1
Exclusive relationship, not living together	25	39.7

Variable	*N*	%
Exclusive relationship, living together	10	15.9
Prefer not to answer	1	1.6
Current Residence Status		
University residence, single room	3	4.8
Living with roommates	13	20.6
Living alone	5	7.9
Living with parents	33	52.4
Living with other relatives	1	1.6
Living with partner/spouse	8	12.7
Student Status		
Currently students	37	58.7
Not currently students	26	41.3
Education		
Currently enrolled		
High School diploma	2	3.2
Some university/college	15	23.8
University Bachelor's degree or College diploma	11	17.5
Master's/Graduate degree	2	3.2
Professional degree	1	1.6
Not Currently enrolled – highest completed		
High School diploma	4	6.3
Some university/college	6	9.5
University Bachelor's degree or College diploma	12	19.0
Master's/Graduate degree	3	4.8
Employment		
Full-time (>30 hours/week)	17	27.0
Part-time (<30 hours/week	12	19.0
Unemployed, looking for work	8	12.7
Student, employed full-time	14	22.2
Student, not employed	11	17.5
Other	1	1.6

Note. Only those response options that were endorsed by participants were included in the table.

For Research Question 4, the study sample was divided into the intervention and control groups. The intervention (N = 32) and control (N = 31) groups were relatively similar in their demographic distribution. There were no significant differences between the groups in terms of mean age $t(61) = 1.76$, $p = .19$, distribution of gender X^2 (1, N = 63) = .48, $p = .49$, relationship status X^2 (4, N = 63) = 1.37, $p = .85$, place of residence X^2 (5, N = 63) = 2.85, $p = .72$, or student status X^2 (1, N = 63) = .38, $p = .54$.

Procedures

At the time of the data collection, recreational cannabis use was legal in Canada. Participants were recruited through print and online advertisements (see Appendix A). Print advertisements were posted on public message boards at Toronto universities (e.g., community message boards). Online advertisements were posted on provincial and national classified and public community forum websites, including Craigslist and Kijiji, as well as on social media groups on Facebook and Reddit. In circumstances that required permission to post the online advertisement (e.g., Facebook groups, Reddit groups), an email requesting this was first sent to the administrator (see Appendix B). The advertisement provided the inclusion criteria and requested participation in the study. Advertisements aimed to recruit both students and non-students to ensure that the sample was representative of a wide range of emerging adult experiences. On social media, study advertisements were posted on social media groups that consisted of college or university affiliations (e.g., University of Toronto undergraduate classes) and study demographics (e.g., Reddit groups for individuals who use cannabis in Canada). All study procedures were reviewed and approved by the Research Ethics Board at the University of Toronto.

Participant recruitment and completion of all study phases were completed during summer 2019, prior to the global COVID-19 pandemic.

Interested individuals were asked to send an email with their contact information in order to be contacted for a telephone screening by either the principal investigator or a trained research assistant (see Appendix C for the telephone and email screening). Participants were eligible to participate in the study if they were between the ages of 19 and 25, fluent in written English, owned a smartphone (for the daily diary app), and had used cannabis at least twice in the previous two weeks. Participants were excluded from the study if they were ever treated for cannabis use disorder, bipolar disorder, or a thought disorder, if they were unable to commit to 14 days of daily diary entries, or if they were prescribed cannabis for medical reasons. Participants were asked to provide proof of identification for age verification purposes.

Eligible participants were scheduled for a phone baseline session where they were provided with information about the study. After participants provided consent, they were sent a link to the 30-minute baseline survey (Appendix E) that included the information and consent form (Appendix D) through *Qualtrics*. Participants were then trained on downloading and using a daily diary app (RealLife Exp app by LifeData ®) on their smartphones. In order to maintain participant confidentiality, participants were provided with an email address that they used to register for the app. This email address was a "dummy" email address and did not have any connection to the participant. The “dummy” email was not used for any other purpose than to register for the app and was used to ensure participant privacy.

At 8:00 pm on the day after participants completed the baseline questionnaire and had set up their LifeData account, participants were notified to complete the first daily survey through the app on their smartphone (see Appendix F for the daily diary survey). They had a two-hour period, until 10:00pm that evening, to complete and submit the 10-minute daily survey. Emerging adults provided 14 days of daily reports in order to capture multiple instances of cannabis use. Participants were asked the same questions each day. The evening assessment asked about cannabis use from yesterday at 8:00pm until the point in time of completing the survey (approximate use within the past 24 hours). If participants reported that they had used cannabis that day/the previous day, they were asked to report on their motives for use along with consequences they experienced. Daily variables such as mood were asked about the same day along with the previous night's sleep. Procedures that enhanced adherence over the 14 days were implemented and included monitoring of participants' adherence and emailing them if they missed two days in a row of daily surveys.

At the end of the two-week daily diary study, participants were randomly assigned using an online random number generator to one of two conditions – brief personalized feedback intervention condition or control condition. The 32 participants in the intervention group received individualized personalized feedback based on information drawn from their two-week daily diary survey data. The feedback was provided as a one-page PDF file via e-mail by the primary investigator through a secure system. The feedback personalized feedback based on participants' own logged data over the previous 14 days and was similar in nature to the intervention used by Lee and colleagues (2010). Participants received feedback on their frequency of cannabis use and their most endorsed cannabis use motives along with self-reported negative consequences of cannabis use and their personal values (see Appendix H for two personalized feedback examples). The 31 participants who were randomized to the control condition did not receive any feedback. Participants also completed a brief (five minute) online questionnaire through *Qualtrics* that asked about their motivation to change cannabis use using the Contemplation Ladder (see Appendix I). Participants were also asked how likely they were to access resources for cannabis use from the provided resources sheet, which had summarized national and province-specific resources in Canada (Appendix K).

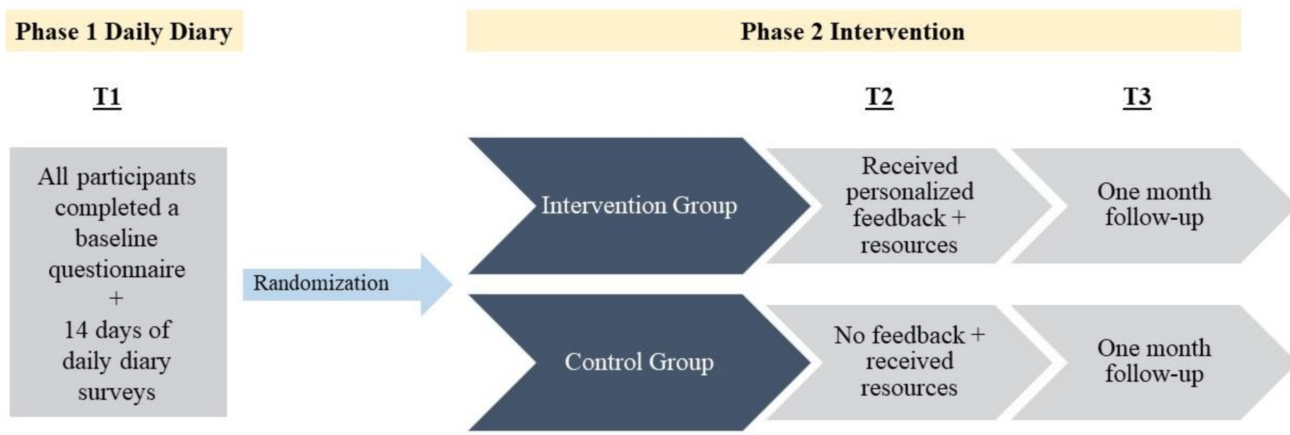
One month after they completed the daily diary portion of the study, participants were contacted and asked to complete a 10-minute follow-up questionnaire through *Qualtrics* (Appendix J). They were asked whether they accessed and/or utilized the resource sheet, which was regarded as the outcome measure. The one-month follow-up questionnaire also asked about cannabis use in the previous 14 days and 30 days, cannabis consequences, motives for use, and motivation to change cannabis use. At the end of the questionnaire, participants were provided with a debriefing note (Appendix L).

Participants were compensated for filling out the online baseline survey and receiving training for using the app (30 minutes for the survey and about 5 minutes for downloading and training on the app) and then for filling out the daily app survey for 10 minutes each day for 14 days. Participants were paid $15 for the baseline survey, $10 for each week (for completing at least five out of the seven daily surveys for that week), and a bonus $5 for completing at least 85% of the daily surveys over the 14 day period (12 out of 14 days). Participants were also paid $10 for filling out the two post-study questionnaires. In total, participants were compensated up to $50 for participating in the study. Payment was made either in cash, PayPal e-transfer, or Amazon.ca gift card at the end of the study to enhance study adherence.

At all points in the study, participants were provided with instructions to clear their browser history for privacy purposes (Appendix M). Please see the flow chart in Figure 2 for the data collection procedures summary.

Figure 2

Data Collection Procedures



Note. T1 = baseline time point; T2 = immediately following completion of the two-week daily diary; T3 = one-month following the daily diary completion (six weeks from baseline).

Measures

Baseline and Follow-Up Measures

Demographics. At baseline, participants completed a detailed demographic questionnaire, including age, gender, education, employment, income, current place of residence, and relationship status.

Cannabis Use. To assess baseline cannabis use, participants were asked to estimate the number of days they had used cannabis in the previous 30 days by completing a Timeline Followback (TLFB) that was modified for cannabis use. The TLFB was originally developed as a self-report measure of retrospective daily alcohol use (Sobell, Maisto, Sobell, & Cooper, 1979). Participants completed a retrospective account of their cannabis use over the past 30 days (i.e., 30 days before the first day of the baseline measure). For each calendar day, participants indicated ‘yes’ or ‘no’ for whether they used cannabis that day, number of use sessions in a day, estimated amount of cannabis use per session (in grams), and amount of time spent using per session (in minutes). Mode of consumption (e.g., inhalation, ingestion) per session and cannabis form (e.g., oils, leaves) per session were also indicated along with cannabis strain (e.g., indica, sativa, hybrid). The cannabis version of TLFB has been found to have high test-retest reliability for the interval of 30 days prior to interview date (Robinson et al., 2014).

Trait Cannabis Motives. Motives for using cannabis were assessed using the Comprehensive Marijuana Motives Questionnaire (CMMQ; Lee et al., 2009), which was developed among a sample of college students in the US. It is a 36-item scale that encompasses 12 motives for cannabis use: enjoyment (‘to enjoy the effects of it’), conformity (‘because you felt pressure from others who do it’), coping (‘to forget your problems’), experimentation (‘to see what it felt like’), boredom (‘because you had nothing better to do’), alcohol-related use (‘because you were under the influence of alcohol’), celebration (‘because it was a special occasion’), altered perception (‘to allow you to think differently’), social anxiety (‘because it makes you more comfortable in an unfamiliar situation’), relative low risk (‘because it is safer than drinking alcohol’), sleep ('to help you sleep'), and availability ('because it is readily available'; Lee et al., 2009). The CMMQ has been found to have satisfactory reliability and validity (Lee et al., 2009). In the current study, overall internal reliability for all items was excellent, Cronbach's α = .92. The CMMQ has been validated within a heavy cannabis-using population (Blevins et al., 2016b), and is appropriate for this study's sample.

Cannabis Consequences. Cannabis-related consequences were assessed using the 51-item Marijuana Consequences Questionnaire (MACQ; Simons et al., 2012). The MACQ assesses eight categories of cannabis-related problems and their occurrence in the past six months. These consequences include social-interpersonal ('While using marijuana I have said or done embarrassing things), impaired control ('I often used more marijuana than I originally had planned'), self-perception ('I have felt guilty about my marijuana use'), self-care ('I have been less physically active because of my marijuana use'), risk behaviours ('I have driven a car when I was high'), academic/occupational ('The quality of my work or schoolwork has suffered because of my marijuana use'), physical dependence ('I have found that I needed larger amounts of marijuana to feel any effect, or that I could no longer get high on the same amount that used to get me high'), and blackout use ('I have passed out from marijuana use'). The CMMQ was found to have satisfactory reliability and validity (Lee et al., 2009; Simons et al., 2012). Reliability for all items in this study was excellent (Cronbach's α = .91).

Cannabis Dependence. The Severity of Dependence Scale (Gossop et al., 1995) is a five-item scale that provides a score indicating severity of dependence on drugs, in this case cannabis. Each item is scored on a four-point scale (0 to 3) with higher scores indicating higher levels of dependence. For the current study, internal consistency was good (Cronbach's α = .83).

Depression. The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) is a 20-item measure that asks how often over the past week participants experienced symptoms associated with depression. Higher scores indicate greater depressive symptoms. For this study, internal consistency was good (Cronbach's α = .81).

Anxiety. The Generalized Anxiety Disorder 7-item scale (GAD-7; Spitzer et al., 2006) is a brief self-report measure that assesses generalized anxiety by asking how often during the last two weeks respondents have been bothered by each of the seven anxiety symptoms. Response options span from 0 (not at all) to 3 (nearly every day). Internal consistency of the GAD-7 is excellent (α = .92) and test-retest reliability is also good (α = .83). In this study, internal reliability was excellent (Cronbach's α = .91).

Personal Values. This measure, based on the Personal Values Card Sort (Miller et al., 2001), asked participants to choose their top three personal values out of a list of 10. The original measure contains 83 value cards. For the purpose of this study, the list was narrowed down to 10 values that were deemed most reflective of emerging adulthood experience, and these were provided to participants alongside their respective definition. They were ranked in the following order, from most frequently endorsed to least: autonomy (46.0%), dependability (39.7%), genuineness (39.7%), friendship (31.7%), faithfulness (30.2%), family (28.6%), openness (28.6%), self-acceptance (22.2%), loved (19.0%), and industry (11.1%).

Motivation to Change Cannabis Use. Participants' motivation or readiness to change their cannabis use was assessed using the Contemplation Ladder, a brief self-report measure of readiness to change substance use behaviours that uses a ladder graphic (Biener & Abrams, 1991). The ladder has 10 rungs that provide a visual representation of participants' readiness to change, with higher ladder levels corresponding to increased motivation to change (e.g., rung 0 = 'No thoughts about quitting. I cannot live without marijuana', rung 10 = 'I have changed my marijuana use and will never go back to the way I used marijuana before').

Likelihood of Using Resource list. After receiving the resource list at the end of the two-week daily diary period, participants were asked to rate how likely they were to use the resource list: 1 = extremely unlikely; 2 = somewhat unlikely; 3 = neutral; 4 = somewhat likely; 5 = extremely likely.

Resource Utilization. At the one-month follow-up point, participants reported whether they had accessed the resource list and/or utilized any of the resources: 1 = I received the list but never viewed it; 2 = I viewed the list but did not contact any organization; 3 = I viewed the list and made a plan to contact some of the organizations; 4 = I have contacted one/some of the organizations on the list; 5 = I have contacted an organization, but it was not on the list; 6 = I have made changes on my own, without using any resources.

Daily Measures

Cannabis Use. Participants were asked whether they used cannabis that day or the night before. If they reported that they had used cannabis, they were asked a series of questions about their cannabis use, same as those asked during the Cannabis TLFB (see above in the Baseline Measures section).

Positive and Negative Affect. Consistent with methods utilized by Park et al. (2004), daily mood was assessed by asking participants to respond to the question "How much do each of the following words describe your mood today?" Drawing from the Positive and Negative Affect Scale (PANAS-X; Watson & Clark, 1994) and Larsen and Diener's (1992) mood circumplex, participants responded to 15 mood descriptors that were rated on a 0-10 point scale ranging from 0 (not at all) to 10 (extremely). The positive mood variable was a summary of daily instances of feeling 'happy', 'excited', and 'cheerful'. Internal reliability was good for the positive mood subscale, Cronbach's α = .81. The negative mood variable was calculated by summing up daily feelings of 'sad', 'blue', 'anxious', 'tense', 'tired', 'lonely', 'angry', and 'shame'. Reliability for the negative mood scale was also high, Cronbach's α = .88.

Sleep Quality. The Pittsburg Sleep Quality Index (PSQI; Buysse et al., 1989) is a 19-item self-report measure that asks about sleep quality in the past month. The PSQI wording was adapted to capture sleep quality on a daily basis. For example, the time frame was changed from "During the past *month*, when have you usually gone to bed?" to "*Last night*, what time did you go to bed?" A score of 0 indicates no difficulty and a score of 3 indicates severe difficulty. Global scores range from 0 to 21 with 0 indicating no difficulty with sleep and 21 indicating severe difficulties in all sleep areas. The test's internal consistency was good (Cronbach's α = .83), and the test-retest reliability coefficients ranged from .65 to .85. In the current study, internal consistency for the daily measure of sleep was acceptable, Cronbach's α = .60.

Cannabis Consequences. The brief version of the Marijuana Consequences Questionnaire (MACQ) was used for the daily diary surveys. The brief version contains 20 items compared to the full 50-items on the MACQ. The MACQ-B was found to have a test-retest reliability coefficient of .80 as well as sufficient convergent and discriminant validity. In the current study, internal consistency for the MACQ-B was excellent (Cronbach's α = .88).

Data Analysis

Prior to analysis, the data was cleaned and organized using IBM SPSS Statistics software, version 26. Demographic frequencies, descriptive statistics, and bivariate correlations of variables of interest were analyzed using SPSS. Variables of interest were examined for significant violations from normality.

One participant who identified as trans man was included in the male group for analysis purposes. Although binary categorization of gender is not representative of current understanding and best practices for assessing gender, this was done due to the small sample size (n = 1) of the additional gender category. This study viewed gender as a social construct and did not look at biological sex as a variable of interest, therefore not posing validity concerns. In accordance with gender diversity guidelines in psychological research (Cameron & Stinson, 2019), the researcher included the participant's experience in the analyses to reflect gender diversity rather than exclude the participant's data.

Daily Diary Analysis (Research Questions 1 and 2)

Multilevel models are an extension of general linear models, and as such, similar assumptions apply (Field, 2013). Bivariate correlation analyses were conducted to examine the relationship between baseline motives (coping, sleep, enjoyment, celebration) and daily mood, cannabis use, and cannabis consequences (see Table 2 for the variables of interest and Table 4 for the bivariate correlations between the variables).

Table 2

HLM Level-1 and Level-2 Predictor Variables

Variable	*M* (*SD*)	Median	Range
Level-1			
Negative mood[a]	3.00 (1.99)	2.75	0-10
Positive mood[a]	5.21 (2.02)	5.33	0-10
Level-2			
Coping motives[b]	2.49 (1.11)	2.33	1-5
Sleep motives[b]	2.68 (1.23)	2.33	1-5
Enjoyment motives[b]	3.86 (.98)	4.00	1-5
Celebration motives[b]	2.36 (1.11)	2.00	1-5

Note. *p < .05; **p < .01; ***p < .001. [a] N = 777 daily diary surveys. [b] N = 63 individuals.

Hypotheses regarding the moderating effects of trait cannabis motives on the within-person relationship between daily mood and daily cannabis use and consequences were tested with multilevel regression modeling using HLM 8 (Raudenbush & Congdon, 2019). Multilevel modeling takes into account the non-independence of the study's 14 days of daily diary data that are nested within each participant and allows for simultaneous estimation of within-person across-day variability (daily fluctuation) as well as between-person variability (individual differences; Nezlek et al., 2001). Participants' missing data (e.g., missing a daily survey) do not pose a problem for HLM software.

In this study, two hierarchical levels were analyzed: daily negative mood, daily cannabis use, and daily negative consequences (level-1) that were nested within individual participants (level-2). The moderators were individual-level (level-2) and included four trait cannabis motives (coping, sleep, enjoyment, and celebration). The Level-1 predictors (daily negative and positive mood) were person-mean centred and the Level-2 predictors (motives) were grand-mean centred. The unconditional model tested whether relative to a person's average daily mood, experiencing higher negative mood predicted a greater likelihood of using cannabis and experiencing negative consequences. Likewise, for the positive mood hypothesis, the model tested whether greater positive mood compared to one's daily average was associated with a lower likelihood of using cannabis and experiencing fewer negative consequences. Since cannabis consequences was a count variable (total number of consequences experienced that day), a Poisson model was tested, which included an overdispersion parameter to account for zero inflation. Please see Figures 3 and 4 below for the models' representation.

Figure 3

Moderating Effects of Coping Motives and Sleep Motives on the Relationship between Daily Negative Mood and Daily Cannabis Use and Cannabis Consequences

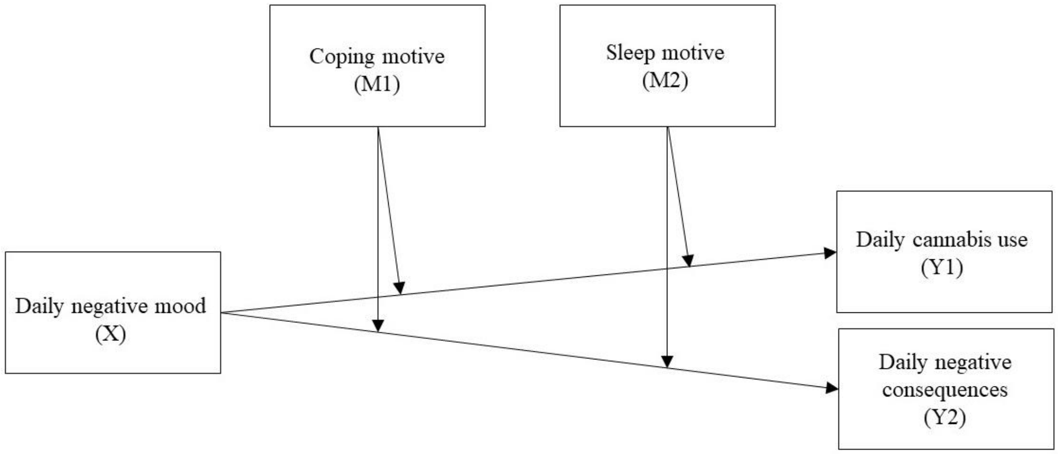
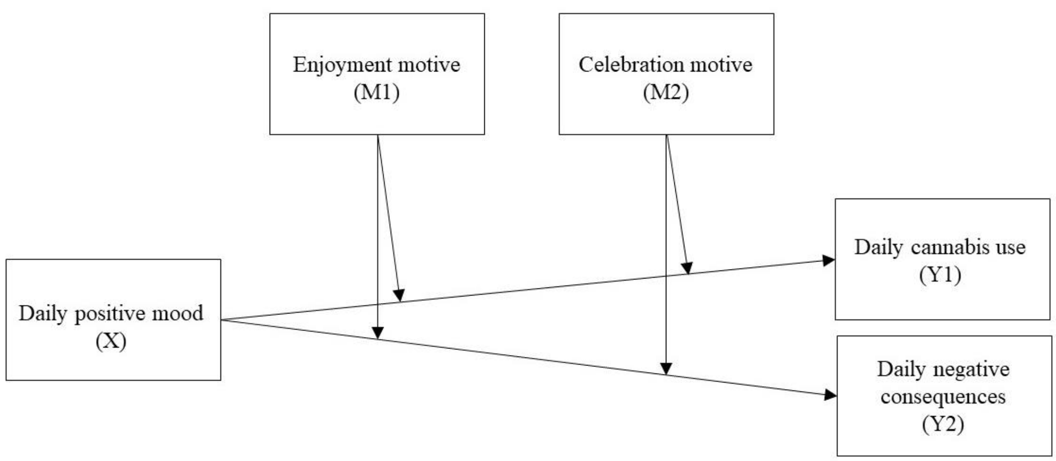


Figure 4

Moderating Effects of Enjoyment Motives and Celebration Motives on the Relationship between Daily Positive Mood and Daily Cannabis Use and Cannabis Consequences



Gender was included as a control variable as evidence in the literature pointed to it being an important determinant in cannabis use and negative consequences (Khan et al., 2013). Gender was dichotomized (1 = *male*, 2 = *female*) and included as a covariate in the four HLM models.

To test the effects of between-person variables (coping, sleep, enjoyment, and celebration motives) on the within-person relationship between daily mood and cannabis use and consequences, the Level-1 regression coefficients were regressed on the Level-2 variable (motives). Intercepts were modeled as random effects while slopes (rate of change) as fixed effects. Models were reported with robust standard errors (HLM 8 contains a “robust standard errors” table in its output thereby providing accurate results when the assumptions of multilevel regressions are violated; i.e., when the residual errors are not normally distributed; Tabachnick & Fidell, 2007).

Effect size calculations for the multilevel models utilized methods suggested by Peugh (2010) and Woltman et al. (2012). For Level-1 variables, the predictor model was compared to the null model for reductions in within-person residual variation. For Level-2 variables, the Level-1 predictor model was compared to the model containing Level-2 predictors (motives) for reductions in between-person residual variation.

Baseline and Follow-Up Data Analysis

Baseline and follow-up variables were examined for normal distribution using SPSS. See Table 3 for the baseline and follow-up variables.

Self-Monitoring Effect as Measured by Motivation to Change Cannabis Use (Research Question 3a). A one-way repeated-measures ANOVA was run to examine the sample’s mean readiness to change cannabis use at the study’s three time points (T1, T2, T3) as measured by the Contemplation Ladder.

Self-Monitoring Effect as Measured by Cannabis Use and Consequences (Research Question 3b). The next analysis looked at whether a monitoring effect was present where participants' cannabis use and associated consequences had decreased as a result of having monitored their use through the daily diary app. For the paired-samples *t* test variables, difference variables were created and checked for normalcy (i.e., T1 Consequences minus T3 Consequences; T1 TLFB minus T3 TLFB). For the difference variables, neither difference scores exceeded recommended skewness levels. The consequences difference score had a high kurtosis, indicating a heavy tail (positively skewed). However, when the histogram and Q-Q plot were examined, it appeared that the difference scores were normally distributed. Similarly, the TLFB difference score had high kurtosis and appeared to be somewhat positively skewed but largely normally distributed. The Shapiro-Wilks test of normalcy was significant for both variables, therefore not fully meeting the assumption of normally distributed difference scores, which could reduce power. Since the other test assumptions were met (i.e., cases represented a random sample, scores on test variables were independent of each other within each time point), a paired-samples *t* test was run in SPSS to examine mean differences in the timeline follow-back cannabis use and negative consequences between baseline (T1) and one-month follow-up (T3) points.

Intervention and Control Groups Outcomes (Research Question 4). For the research questions that concerned the mean differences between the intervention and control group, preliminary analyses were conducted to evaluate demographic baseline comparability between the two groups using Pearson's chi-square for categorical data and independent *t* tests for continuous data (previously reported in the Demographics section). An independent samples *t* test was run to examine the difference between the intervention and control groups in terms of willingness to accept resources at T2 and actual utilization of resources at T3.

Table 3

Baseline and Follow-Up Variables

Variable	*M (SD)*	Range
Baseline cannabis use days (in past 30 days)	16.59 (8.70)	0-30
One-month follow-up cannabis use days (in past 30 days)	15.24 (9.90)	0-30
Baseline cannabis consequences	12.33 (8.74)	0-50
One-month follow-up cannabis consequences	8.72 (8.24)	0-50
Likelihood of using resources	2.04 (1.11)	1-5
Number of resources utilization	2.33 (1.31)	1-6
T1 Motivation to change	5.02 (2.24)	0-10
T2 Motivation to change	4.86 (2.47)	0-10
T3 Motivation to change	5.12 (2.51)	0-10

Note. *$p < .05$; **$p < .01$; ***$p < .001$. T1 = baseline, T2 = at the end of the two-week daily diary, T3 = one-month follow-up.

Chapter 3: Results

Descriptive Statistics for Baseline and Follow-Up Variables

Sample Characteristics for Cannabis Use and Consequences

At baseline, participants reported their estimated cannabis use in the previous 30 days. On average, participants reported using cannabis on 16.6 days (55.3%, SD = 8.44, range 1-30 days). Men (M = 19.03, SD = 7.25) reported significantly higher number of use days compared to women (M = 12.70, SD = 9.10), $t(60) = 3.02$, $p = .004$. When asked about how much time they spent using cannabis, 11.1% reported using for less than an hour a day. The majority (63.5%) reported using for less than half the day while a quarter (25.4%) reported using between half of the day to all day. In terms of modes of administration, participants reported mostly smoking cannabis (88.9%) and vaping (67.8%). Almost half (46.1%) reported using edibles at least sometimes. Other modes of administration, tinctures (11.1%) and sublingual oils (6.4%), were less frequently reported. In terms of cannabis strain use frequency, 76.2% of participants reported using indica at least sometimes, 84.1% used sativa, and 76.2% used a sativa-indica hybrid. Four participants (6.3%) did not know the strain they were using. Men reported using significantly more indica than women, $t(56) = 2.17$, $p = .035$, whereas women reported using more hybrid strains, $t(56) = -2.85$, $p = .006$.

In terms of cannabis-related consequences, the most frequently reported cannabis-related consequences for the sample were impaired control, self-perception, and physical dependence. The mean number of total consequences reported by the sample at baseline was 12.54 (SD = 8.88, reported range 1-38). Total number of cannabis-related consequences was also assessed at the one-month follow-up survey and was reported as

8.72 (*SD* = 8.24, reported range 1-29). Men reported significantly higher number of cannabis consequences at baseline (*M* = 15.54, *SD* = 9.14) compared to women (*M* = 7.70, *SD* = 6.03), $t(60) = 3.36$, $p = .001$. However, although men reported experiencing more cannabis consequences at the one-month follow-up (*M* = 9.94, *SD* = 8.55), the number of consequences was not significantly different than that reported by women (*M* = 6.73, *SD* = 7.46), $t(56) = 1.46$, $p = .15$.

Cannabis Dependence

In terms of cannabis dependence as measured by the SDS, the average score for the sample was 3.0 (*SD* = 2.70). Sixty-eight percent of participants reported a score of 4 or greater, which is indicative of cannabis dependence (Martin, Copeland, Gates, & Gilmour, 2006).

Motivation to Change Cannabis Use

Motivation to change cannabis use was assessed at three time points throughout the study (possible range 0-10 with 10 being highest motivation to change). At baseline, mean motivation to change was 4.98 (*SD* = 2.20). After having completed the two-week daily diary period, participants' mean motivation to change was slightly lower at 4.81 (*SD* = 2.45). Lastly, mean motivation to change at the one-month follow-up increased to 5.19 (*SD* = 2.47). The differences in motivation to change over the three time points were not statistically significant.

Descriptive Statistics for Daily Diary Variables

Overall, daily diary survey compliance was excellent. Participants responded to 772 of the 878 daily surveys (87.9%). On average, participants completed 12.22 days of 14 daily surveys (*SD* = 1.83). On the days they completed the survey, participants reported using cannabis on 440 days (57.0%) and experiencing at least one cannabis-related consequence on 283 cannabis use days (64.3%).

Daily Cannabis Use and Consequences

Participants used cannabis on average 2.4 times per use day (*SD* = 1.75). In terms of cannabis modes of administration, the majority of cannabis use days (92.5%) involved smoking cannabis (i.e., joint, bong, pipe or hookah), whereas cannabis vaporizing (20.4%) and ingesting (11.8%) occurred on fewer days. For cannabis strains, participants used indica on 39.3% of days, sativa on 26.8% of days, hybrid sativa-indica on 37.9% of days and on 16.1% of days the strain was unknown. The percentages are more than 100 as participants may have used more than one mode or strain of cannabis each day. Across the 14 days, the most frequently endorsed cannabis consequences were self-care (49.8%), physical dependence (29.9%), and impaired control (23.9%). The mean number of cannabis consequences experienced daily was 2.83 (*SD* = 3.71, range 0-14).

Sleep

Participants rated their sleep quality on a daily basis regardless of their cannabis use that day. The mean reported global sleep score on the PSQI measure was 5.28 (*SD* = 3.86, range 0-21), with a score of 5 or greater indicating poor sleep (Buysse et al., 1989). Participants reported poor sleep quality on half (50.3%) of the daily diary days.

Daily Diary Analyses: Testing the Models

Bivariate correlations were used to examine the relationship between the primary variables of interest: baseline cannabis motives, mean daily negative mood, mean daily positive mood, daily cannabis use, and daily cannabis-related consequences (see Table 4). Daily variables reflect aggregate scores (i.e., summarized across the 14 days of daily diary reports). Negative mood, coping and sleep motives were positively associated with cannabis consequences but not cannabis use frequency. Positive mood was negatively associated with cannabis consequences but not cannabis use frequency. Since mean daily cannabis use was not statistically correlated with the independent variables, cannabis use frequency as an outcome variable was removed from the models. The daily consequences variable was significantly correlated with the predictors and remained in the model.

Table 4

Bivariate Correlations between Baseline Motives, Baseline Consequences, Daily Mood, Cannabis Use Days, and Daily Cannabis-Related Consequences

Variable	*M (SD)*	1	2	3	4	5	6	7	8
1. Coping motives	2.49 (1.11)	–	–	–	–	–	–	–	–
2. Sleep motives	2.68 (1.23)	.45**	–	–	–	–	–	–	–
3. Enjoyment motives	3.86 (0.98)	-.03	-.20	–	–	–	–	–	–
4. Celebration motives	2.37 (1.11)	.22	.19	.24	–	–	–	–	–
5. Negative mood[a]	2.94 (1.63)	.59**	.36**	-.04	.23*	–	–	–	–
6. Positive mood[a]	5.21 (1.26)	-.34**	-.07	-.02	.03	−.46**	–	–	–
7. Cannabis use days[b]	6.98 (4.07)	.18	.40**	-.002	−.16	−.09	−.04	–	–
8. Daily consequences[a]	2.67 (3.13)	.56**	.36**	-0.09	.21	.55**	-.35*	.09	–
9. Baseline consequences	12.54 (8.88)	.53**	.29*	-.06	.19	.34**	-.32**	.15	.73**

Note. $n = 63$. *$p < .05$; **$p < .01$. [a] Aggregated mean daily diary scores. [b] Sum of cannabis use days over the14-day diary period.

HLM Risk Factors Models

HLM analysis was run to examine the within- and between-person relationship between daily negative mood and daily cannabis-related consequences and the moderating effect of coping and sleep motives. The results of the HLM analyses are presented in Table 5. HLM model formulas can be found in Appendix N.

Unconditional (Null) Model. First, the unconditional (null) model containing only the outcome variable was examined to confirm that the variability in the outcome variable was significantly different than zero. The unconditional model was significant, $\chi^2(62) = 2614.83$, $p < .001$. The Intra-Class Correlation (ICC) variance components were then assessed to calculate the ratio of the between-group variance to the total variance ($ICC = \frac{\tau_{00}}{\tau_{00} + \sigma^2}$). The variance component coefficient for Level-1 was $\sigma^2 = 1.10$ and for Level-2 was $\tau_{00} = 1.38$, resulting in $ICC = 0.444$. The ICC from the unconditional model indicates that 44.4% of the variance in daily cannabis consequences was due to within-person effects and 55.6% due to between-person effects.

Random Intercepts Model. As variance existed at both levels, predictor variables were individually added at each level. The relationship between the Level-1 predictor (daily negative mood) and the outcome variable (consequences) was tested. Daily negative mood (group-centred) was added to the model to yield accurate estimates of the intercepts. Results showed that daily negative mood was positively associated with daily cannabis-related consequences, $b = 0.10$, $p < .001$. Participants' daily consequences were higher when they experienced more negative mood relative to their average mood. The results indicate that daily negative mood explains 4.54% of the variance in daily cannabis consequences.

Means as Outcomes Model. The next step was to test the relationship between the Level-2 predictors (coping motives, sleep motives) and outcome variable. The two motives were entered separately into the model as grand-centred predictors, resulting in the Level-2 intercept being equal to the grand mean of the outcome variable. The regression coefficient relating baseline coping motives to daily cannabis consequences was positive and statistically significant, $b = 0.58$, $p < .001$. Cannabis-related consequences were higher in participants who endorsed using cannabis for coping with difficult emotions relative to participants who were lower on coping motive. Effect size was calculated as follows:

$$r^2 = \frac{(\tau^2_{null} - \tau^2_{means})}{\tau^2_{null}} = \frac{(1.38 - 0.93)}{1.38} = .326$$

The results indicate that coping motives explained 32.6% of the between-person variance in cannabis consequences. There was also a significant positive main effect of baseline sleep motives on cannabis-related consequences, $b = 0.34$, $p < .001$, indicating that consequences were higher in participants who reported using cannabis for sleep purposes. Effect size was calculated to be $r^2 = .087$, indicating that sleep motives explained 8.70% of the between-person variance in cannabis consequences. Gender, a proposed control variable, was not significant.

Random Intercepts and Slopes Model. The final step was to test the interactions between the Level-1 predictor variable (daily negative mood) and the Level-2 predictors (coping motives, sleep motives). HLM results revealed that the interaction was significant for baseline coping motives, $b = -0.06$, $p = .006$. This suggests that as hypothesized, the degree to which participants endorsed coping motives moderated the relationship between daily negative mood and daily cannabis consequences. As can be observed in Figure 5, individuals with increased baseline coping experienced more consequences due to their cannabis use across the negative affect spectrum, compared with individuals in the low coping group. However, the degree to which cannabis consequences increased as a function of negative affect was stronger for those with *lower* coping motives. Trait sleep motives did not significantly moderate the relationship between daily negative mood and daily cannabis consequences, $b = 0.004$, $p = .790$.

Table 5

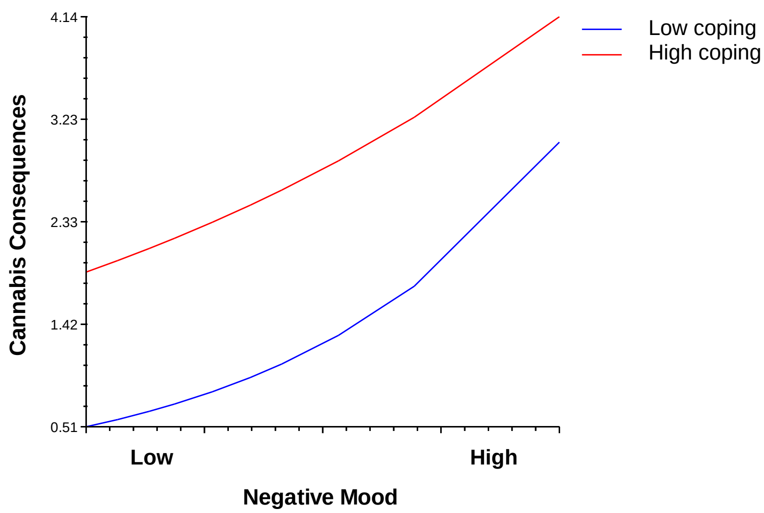
The Relationship Between Daily Mood and Cannabis Consequences Moderated by Motives

Predictor	Coefficient	*SE*	*t*-ratio	*df*	*p*
β_{00} Intercept	**0.99**	**0.13**	**7.53**	**62**	**< .001**
Level-1 main effects					
β_{10} Negative mood	**0.10**	**0.03**	**3.73**	**374**	**< .001**
β_{20} Positive mood	**-0.06**	**0.02**	**-3.65**	**374**	**< .001**
Level-2 main effects					
β_{01} Coping motives	**0.58**	**0.08**	**7.05**	**61**	**< .001**
β_{02} Sleep motives	**0.34**	**0.09**	**3.88**	**61**	**< .001**
β_{03} Enjoyment motives	-0.12	0.14	-0.87	61	.387
β_{04} Celebration motives	0.15	0.13	1.17	61	.246
Level-2 control variable					
β_{05} Gender	-0.26	0.18	-1.46	61	.150
Cross-level interactions					
β_{11} Negative mood x Coping motives	**-0.06**	**0.02**	**-2.79**	**373**	**.006**
β_{21} Negative mood x Sleep motives	0.004	0.01	0.27	373	.790
β_{31} Positive mood x Enjoyment motives	**-0.03**	**0.01**	**-2.86**	**373**	**.004**
β_{41} Positive mood x Celebration motives	**-0.02**	**0.01**	**-2.60**	**373**	**.010**

Note. The outcome variable is daily number of cannabis consequences. This represents a unit-specific model with robust standard errors. Significant coefficients are bolded.

Figure 5

Moderation of Coping Motives on the Within-Person Relationship between Daily Negative Mood and Cannabis Consequences



Note. Low coping β = -0.82 (25th percentile); high coping β = 0.85 (75th percentile). Negative mood and coping variables are mean-centred.

HLM Protective Factors Models

HLM analysis was run to examine the within- and between-person relationship between daily positive mood and daily cannabis-related consequences and the moderating effect of enjoyment and celebration motives. Results are presented in Table 5.

Unconditional (Null) Model. The null model was the same as in the previous HLM analysis since the outcome variable was the same.

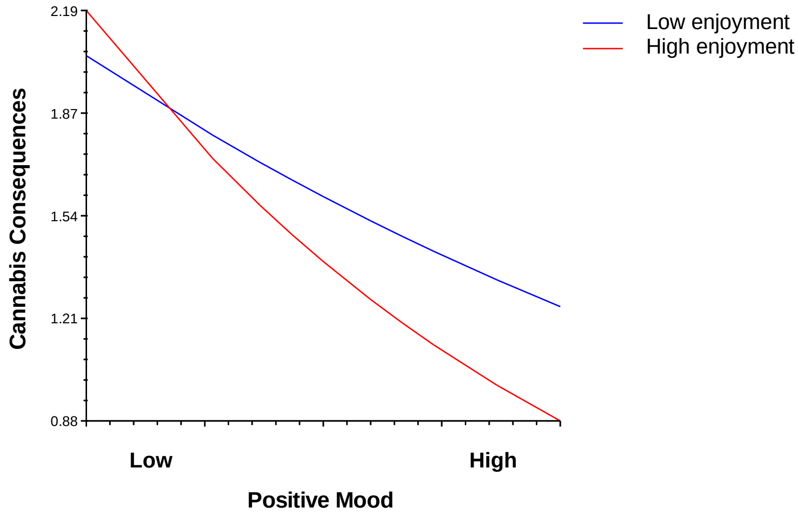
Random Intercepts Model. The relationship between the Level-1 predictor (daily positive mood) and the outcome variable was tested. Daily positive mood (group-centred) was added to the model. Daily positive mood was significantly negatively associated with daily cannabis-related consequences. Participants' daily consequences were lower when they experienced more positive mood relative to their average mood. The results indicate that daily positive mood explains 2.73% of the variance in daily cannabis consequences.

Means as Outcomes Model. The next step was to test the relationship between the Level-2 predictors (enjoyment motives, celebration motives) and the outcome variable. The two motives were entered separately into the model as grand-centred predictors. The regression coefficient relating baseline enjoyment and celebration motives to daily cannabis consequences was not significant. Gender, a proposed control variable, was not a significant control variable.

Random Intercepts and Slopes Model. The final step was to test for the interactions between the Level-1 predictor variable (daily positive mood) and the Level-2 predictors (enjoyment motives, celebration motives). As hypothesized, enjoyment motives significantly moderated the relationship between daily positive mood and cannabis consequences, $b = -0.03$, $p = .004$. Increased endorsement of baseline enjoyment motives was associated with fewer daily consequences on days when participants' mood was more positive than their average mood. The strength of this relationship was greater on days when participants experienced *less* positive mood, thus supporting the hypothesis that enjoyment motives were associated with reduced cannabis consequences. The moderation effect of enjoyment motives is illustrated in Figure 6.

Figure 6

Moderation of Enjoyment Motives on the Within-Person Relationship between Daily Positive Mood and Cannabis Consequences

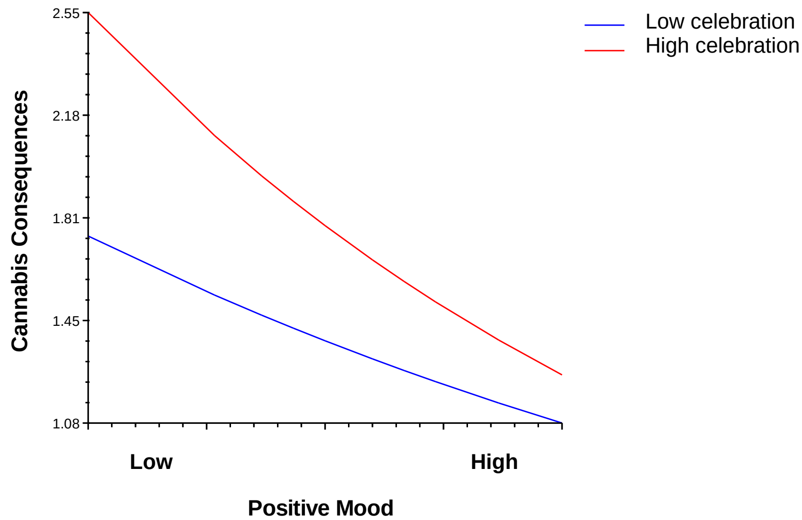


Note. Low enjoyment β = -0.53 (25th percentile); high enjoyment β = 0.80 (75th percentile). Positive mood and enjoyment variables are mean-centred.

Celebration trait motives significantly moderated the relationship between daily positive mood and cannabis consequences, b = -0.23, p = .010. However, findings were opposite to what was originally hypothesized. Those who scored high on celebration motives reported more cannabis consequences on days when they experienced *less* positive mood. Mood had less of an effect on daily consequences in those who were in the ‘low celebration’ category. The moderation effect of celebration motives is illustrated in Figure 7.

Figure 7

Moderation of Celebration Motives on the Within-Person Relationship between Daily Positive Mood and Cannabis Consequences



Note. Low celebration β = -0.36 (25th percentile); high celebration β = 0.64 (75th percentile). Positive mood and celebration variables are mean-centred.

Self-Monitoring Effect

Readiness to change cannabis use as measured by the Contemplation Ladder was assessed at three time points (baseline, post-daily diary period, and one-month follow-up). The mean ladder values were 4.98 (*SD* = 2.20), 4.81 (*SD* = 2.45), and 5.19 (*SD* = 2.47), respectively. These values roughly corresponded to a value of 5 on the ladder, which falls within the contemplation stage of change according to the transtheoretical model of health behaviour change (Prochaska & Diclemente, 1982).

A one-way repeated-measures ANOVA was conducted to examine whether there were any differences in mean motivation to change across the three time points. Motivation to change cannabis use was not significantly different across the three time points, F (2,95) = .55, p = .58.

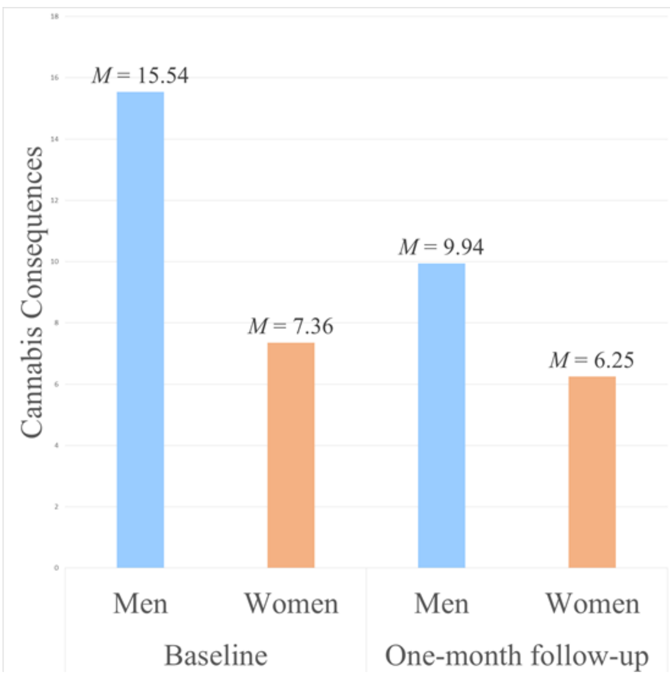
To examine whether self-monitoring cannabis use impacts patterns of use, estimated cannabis use in the past 30 days assessed at baseline was compared to past 30-day cannabis use at the one-month follow-up. In addition, to assess the impacts of daily monitoring during the daily diary period, differences in cannabis use from week 1 to week 2 were also examined. A paired sample *t* test found that the mean number of days of cannabis use in the past month did not differ between baseline (*M* = 16.59, *SD* = 8.70) and the one-month follow-up (*M* = 15.24, *SD* = 9.89), $t(57) = 1.22$, $p = .23$. The mean percentage of days used by participants on week 1 of the daily diary was then compared with that of week 2. A paired-samples *t* test found that on week 1, participants reported using on average on 61.2% of the days or about 4.3 days (*SD* = 29.7), while they reported using significantly less cannabis on week 2 (54.3% or about 3.8 days, *SD* = 33.5), $t(57)$ = 2.84, p = .006. Similar results were found for mean differences in consequences reported on week 1 versus week 2. A paired-samples *t* test showed that the average number of reported cannabis consequences on week 2 (M = 8.64, SD = 16.5) was significantly lower than week 1 (M = 11.7, SD = 17.4), $t(57) = 3.10$, $p = .003$.

Analyses were also run to examine differences in the mean number of cannabis-related consequences participants reported between baseline (M = 12.33, SD = 8.74) and one-month follow-up (M = 8.72, SD = 8.24) to further support the self-monitoring hypothesis. A paired-samples *t* test was conducted and it was found that participants reported significantly less negative consequences at the one-month follow-up, $t(57) = 3.37$, $p = .001$. Further analyses examined gender as a potential explanatory variable for the reduction in negative consequences over time since previous research has found gender differences in cannabis-related consequences (e.g., Khan et al., 2013; Lev-Ran et al., 2012). Separate paired-samples *t* tests were conducted for women and men. Men reported significantly reduced number of consequences from baseline (M = 15.25, SD = 8.87) to one-month follow-up (M = 8.55, SD = 1.42), $t(35) = 3.58$, $p = .001$. However, women did not significantly differ in their reported cannabis consequences over time from baseline (M = 6.13, SD = 1.31) to follow-up (M = 7.46, SD = 1.59), $t(21) = .65$, $p = .53$. These results are presented in Figure 8.

As men reported a significantly higher number of cannabis use days compared to women at baseline, a one-way multivariate analysis of covariance (MANCOVA) was conducted to test whether baseline cannabis use days accounted for the relationship between gender and baseline cannabis consequences. Gender was entered as a between-subjects variable, cannabis consequences was the within-subjects variable (baseline vs. follow-up) and baseline cannabis use was entered as a covariate. The covariate (baseline cannabis use days) was not statistically significant (F = 1.05, df = 2, p = .36), but there was a significant effect for gender (F = 4.06, df = 2, p = .02). This result indicates that gender, and not baseline cannabis use days, explained the difference between men and women in terms of their differences in reported cannabis-consequences.

Figure 8

Change in Cannabis-Related Consequences over Time between Men and Women



Brief Personalized Intervention Effect

There were no significant differences between the intervention group and control group in terms of the hypothesized outcome variables. An independent samples t test was conducted and there was no significant difference between the intervention group (M = 4.00, SD = 1.17) and control group (M = 3.93, SD = 1.09) in their mean reported likelihood of using the provided resources list following the two-week daily diary period, *t*(52) = -.23, *p* = .82. The control (*M* = 2.30, *SD* = 1.34) and intervention groups (*M* = 2.04, *SD* = 1.20) did not differ in their actual utilization of the offered resource list at the one-month follow-up, *t*(56) = .79, *p* = .43. In addition, there was no significant difference between the intervention group (*M* = 4.64, *SD* = 2.34) and control group (*M* = 4.96, *SD* = 2.58) in terms of mean reported motivation to change cannabis use at the end of the daily diary period, *t*(51) = .48, *p* = .64. There was also no significant difference between the intervention group (*M* = 4.89, *SD* = 2.23) and control group (*M* = 5.47, *SD* = 2.67) in their motivation to change at the one-month follow-up time point, *t*(56) = .88, *p* = .38. Finally, there was no significant difference between the intervention group (*M* = 10.11, *SD* = 9.83) and control group (*M* = 7.43, *SD* = 6.30) in their mean cannabis consequences at the one-month follow-up time point, *t*(56) = -1.24, *p* = .22.

Chapter 4: Discussion

General Discussion

The purpose of the current study was to test a motivational model of cannabis use in a sample of Canadian emerging adults. Specifically, the study tested whether individual differences in four motives (coping, sleep, enjoyment, and celebration) were associated with within-person associations between daily affect and cannabis use and consequences. Furthermore, the use of a daily diary methodology was assessed as a potential health behaviour self-monitoring tool to enhance awareness and motivation to change cannabis use. Lastly, the use of brief personalized feedback was investigated as an intervention aimed at increasing motivation to change cannabis use.

Although other studies have examined cross-sectional associations between motives, cannabis use, and negative consequences (Benschop et al., 2015; Bonn-Miller and Zvolensky, 2009b; Schlossarek et al., 2016; Simons et al., 1998; Zvolensky et al., 2007), the current study is one of few to investigate same-day relationships in the form of a daily diary, thereby offering a more nuanced analysis of the within-person relationship between affect and cannabis outcomes. Much of the research to date on daily affect in the context of cannabis use has focused on anxiety (de Dios et al., 2010) or depression (Wycoff et al., 2018), whereas the present study utilized a broader definition of negative and positive affect that included several emotional states. Studies have shown that aggregated estimates of daily affect may be more reliable than single item affect measures (Wycoff et al., 2018) that are often viewed as dispositional tendencies rather than affective antecedents of substance use (Bhushman et al., 2012). Negative and positive affect are rarely composed of a single emotion (Watson et al., 1988), and the use of multiple items allowed for variations in affect to be captured on a daily basis, as these have been found to be important predictors of cannabis use (Shrier et al., 2014; Trull et al., 2016). Additionally, the current study utilized a more nuanced measure of baseline cannabis motives that extended beyond the five-motive model (Simons et al., 1998), which is most often used in other studies, but does not capture the full continuum of reasons that individuals engage in cannabis use (Bonar et al., 2017). Finally, the current study examined a risk-protective framework in regards the nature of the associations between affect, cannabis use and motives. That is, given the significant prevalence of cannabis use among emerging adults and the need for a harm reduction approach that differentiates between problematic and non-problematic use, the current study explored potential low-risk or protective motives and high-risk motives.

In the current study, none of the four motives of interest were significantly associated with cannabis use frequency. A couple of explanations may clarify these non-significant findings. First, studies of individuals who infrequently use cannabis have found cross-sectional associations between cannabis use motives and frequency of use (Bonn-Miller et al., 2007; Marshall et al., 2019; Zvolensky et al., 2007, 2009), but other studies have demonstrated null effects (Banes et al., 2014; Blevins et al., 2016a; Bohnert et al., 2018). Blevins et al. (2016a) noted that motives assessments, such as the one used in the current study, typically measure multiple motives simultaneously and individuals who use cannabis frequently tend to score high on a large number of motives. This reduces the specificity of each motive as it relates to cannabis use and highlights the weakness of using frequency of cannabis use as a measure of problematic use in those who frequently use cannabis. This study only included emerging adults who frequently used cannabis (i.e., those who used cannabis at least twice in the past two weeks) and it might be that this restricted range of cannabis use patterns limited the emergence of findings regarding the relationship between motives and cannabis use. Establishing meaningful relationships between motives and cannabis use may require examining participants with a wider range of cannabis, including those who use cannabis on an infrequent or casual basis (Fox et al., 2011). Second, the daily cannabis frequency measure used in this study was a single-item, novel measure (participants were asked whether they had used cannabis that day or not for a total number of reported days of use). Since its psychometric properties are undetermined, it is plausible that this measure did not fully reflect the relationship between cannabis motives and use outcomes, and that additional information relating to quantity or amount used is necessary to assess cannabis consumption. This issue of self-reported substance use is particularly problematic in studying cannabis use as there is variability in methods of use as well as the amounts of psychoactive compounds (see Prince et al., 2018 for a brief literature review of cannabis use measurement). For example, some emerging adults may use a large amount of CBD-heavy cannabis in tincture form before bed for sleep purposes while others may smoke smaller quantities of THC-heavy cannabis via rolled joints throughout the day for coping or boredom reasons – these two scenarios may have different impacts on the person in terms of degrees of intoxication, quantity and frequency of use, and potential negative outcomes. Given this complexity, future researchers may wish to include both frequency and quantity measures to fully capture participants' cannabis use.

The findings regarding cannabis consequences revealed a greater impact of motives on this cannabis outcome. The first research question examined whether baseline coping and sleep motives moderated the relationship between daily negative affect and cannabis consequences. On a between-person level, greater endorsement of coping motives was associated with experiencing greater daily cannabis consequences, a finding that is in line with previous research (Buckner, 2013; Lee et al., 2009; Moitra et al., 2021; Phillips et al., 2017; Simons et al., 2005). From a within-person perspective, on days when participants reported greater negative mood, they also reported experiencing more cannabis consequences, although not greater cannabis use. This is consistent with previous research on the relationship between negative affect and cannabis consequences (Bottoroff et al., 2009; Glodosky & Cuttler, 2020; Hartmann & McLeish, 2020; Walsh et al., 2017) and provides further evidence for a self-medication model of cannabis consequences (Buckner et al., 2019).

In addition to the direct effects of both coping motives (between-person) and negative affect (within-person) on cannabis consequences, the relationship between daily negative affect and cannabis consequences was moderated by between-person coping motives. However, the findings were somewhat different than hypothesized where the degree to which cannabis consequences increased as a function of negative affect (the slope) was stronger for those with *lower* coping motives. For those lower in coping motives, relative increases in negative affect have a greater impact on experiences of cannabis consequences that day. That is, those who are regularly using cannabis to cope may experience more consequences in general and therefore be less impacted by a change in negative affect on any given day. For those with lower coping motives, experiencing lower mood may contribute to greater consequences because it represents greater deviation from the norm. That is, an individual may not typically use cannabis to cope with negative affect, but on a day when their mood deviates significantly from its average, then cannabis may be used for this purpose, resulting in more consequences than normal. This finding highlights some of the disadvantages of using a trait motives perspective; what people do on average or on a typical day (i.e., does not use cannabis to cope) may be different from what they do within the context of a specific event or stressor (i.e., on a day when negative affect varies from their average). Because this is a novel finding, more research is needed to substantiate this result in other populations and with a deeper examination of both state- and trait-based motives.

The hypothesized relationship between daily negative affect, cannabis consequences, and sleep motives was partly met. Similar to coping motives, greater endorsement of between-person sleep motives was positively associated with greater daily negative consequences. This is consistent with previous findings that show that using cannabis as a sleep aid is associated with experiencing more negative consequences (Babson et al., 2013; Bohnert et al., 2018; Goodhines et al., 2019a; Lee et al., 2009; Stevens et al., 2021; Wong et al., 2019; Yurasel et al., 2020). However, contrary to hypotheses, trait sleep motives were not a significant moderator of the within-person relationship between daily negative mood and cannabis consequences. A recent daily diary study by Goodhines et al. (2019a) found similar results: participants who used cannabis as a sleep aid reported more negative cannabis consequences, but their study also failed to find significant cross-level moderation effects of sleep on cannabis-related outcomes. This lack of moderation effect suggests that within-person variability might be a better explanation rather than a between-person, trait-motives difference; that is, that other proximal state changes other than negative affect, that are more specific to sleep motives, such as sleep quality, may be associated with cannabis consequences (Goodhines et al., 2019). From a theoretical perspective, it could also be argued that using cannabis to manage sleep difficulties overlaps with using cannabis to cope. Benschop et al. (2015) extended the Marijuana Motives Measure (MMM; Simons, 1998) and added a new subscale, routine motives, that included sleep, boredom, relaxation, and habit. However, factor analysis led to the deletion of sleep motives as it cross-loaded onto the MMM coping motives factor, meaning the two factors were measuring similar constructs. Health motives that included using cannabis for sleep, proposed by Chabrol and colleagues (2017), were also hypothesized to overlap with coping reasons for cannabis use. Emerging adults who use cannabis for sleep purposes are very likely to use for general coping reasons, as was observed in this study with both motives being highly correlated with one another. Thus, the null findings related to sleep motives may be attributed to the lack of specificity in the daily negative affect measure as well as to coping motives in general being the main explanatory factor, rather than sleep motives. Considering that cannabis sleep motives are relatively new compared with other more empirically established motives, more research is needed to advance our understanding of emerging adults' daily cannabis use as a sleep aid.

The second research question examined whether baseline enjoyment and celebration motives moderated the relationship between daily positive affect and cannabis consequences. The second hypothesis proposed that a distinct set of motives (enjoyment, celebration) would be associated with lower cannabis consequences and would moderate the relationship between daily positive affect and daily cannabis use and consequences. Similar to previous findings in this area (Dias et al., 2020; Lee et al., 2009; Phillips et al., 2017), using cannabis for enjoyment was the most frequently endorsed reason for using cannabis amongst emerging adults in the current sample. Enhancement of positive emotions (i.e., enjoyment motives) has been shown to be a positive reinforcer of cannabis use that is associated with frequent and problematic use (Dash & Anderson, 2015; Dias et al., 2020; Simons et al., 1998). However, the current study did not find a significant association between enjoyment motives and problematic cannabis use, similar to prior findings (e.g., Marshall et al., 2020; Phillips et al., 2017). The non-significant main effect association between enjoyment motives and problematic or frequent cannabis use calls into question the "riskiness" of emerging adults who use cannabis for enjoyment reasons and warrants further research to understand these discrepant findings.

Although there was no main effect of enjoyment motives on cannabis consequences, enjoyment motives did significantly moderate the within-person relationship between daily positive mood and cannabis consequences, such that participants who typically used cannabis for enjoyment experienced significantly *fewer* cannabis-related consequences on days their mood was more positive relative to their average mood. This is a unique finding that challenges the assumption that high endorsement of all cannabis motives is risky (Bonn-Miller et al., 2007) and suggests that, for those who frequently use cannabis, being in a better mood and using cannabis for enjoyment is associated with fewer cannabis problems. This may reflect a tendency for those with higher enjoyment motives to engage in less harmful use patterns on days when their mood is better. That is, because they are using cannabis to enhance an already positive mood, there may be less of a need to overuse cannabis or engage in multiple episodes of cannabis use.

Similar to the enjoyment motives, celebration motives were also hypothesized to moderate the relationship between daily positive affect and cannabis use and consequences, such that celebration would be associated with reduced cannabis use and consequences. Although previous research found that using cannabis for celebratory purposes was associated with better mental health functioning compared to other cannabis use motives (Bohnert et al., 2018), these findings did not emerge in the present study – between-person celebration motives were not significantly associated with daily cannabis consequences. However, between-person celebration motives significantly moderated the within-person relationship between positive affect and negative consequences. The moderation analysis showed that the within-person relationship between positive affect and cannabis consequences was greater for those who typically use cannabis for celebration purposes. This is somewhat opposite to the moderating impact of enhancement motives on the positive mood-cannabis consequences relationship. It could be that the dissonance between experiencing less positive mood while using to celebrate (a positive occasion) results in experiencing more cannabis-related problems. Individuals in this case might overuse in an attempt to improve their mood and use more cannabis than they intended, resulting in more negative consequences. Some studies have shown that celebratory alcohol drinking is associated with higher levels of alcohol use (using to ‘blackout’) and harm (Glindemann et al., 2007; Neighbors et al., 2012; Riordan et al., 2016; Riordan et al., 2019). Very little work has investigated celebration as a motive, both in the alcohol and cannabis use research fields. More research is needed to discover the mechanisms underlying the relationship between using cannabis for celebratory purposes and consequences of use.

The third research question examined the use of a daily diary methodology as a tool for motivational enhancement for cannabis use change, cannabis use frequency, and cannabis consequences. Participants' average cannabis use days decreased during the two-week daily diary period, with mean use being significantly lower during the second week (about 3.8 days of the week) compared with the first week (about 4.3 days of the week). Additionally, it was found that participants' mean reported cannabis-related consequences significantly decreased from the first to the second week. The finding that participants used significantly less cannabis and experienced fewer negative consequences, despite not being instructed to change their cannabis use, suggests that self-monitoring via a daily diary app may be an effective tool for behaviour change through awareness enhancement.

Interestingly, emerging adult men experienced greater responsiveness to self-monitoring, with men showing significant reductions in negative consequences from baseline to follow-up. This is a unique finding as previous research has not found gender differences in self-monitoring of health behaviours (e.g., Bertholet et al., 2019; Reingle Gonzales et al., 2017; Perrine & Aloise-Young, 2004; Turner-McGrievy et al., 2012). One possible explanation for the gender difference might be differential cannabis use treatment outcomes, with men typically faring better than women (Sherman et al., 2015). Another possible explanation could be that women and men differ in what motivates them to change their cannabis use, with men in this case reducing their cannabis consequences in response to the self-monitoring (Chauchard et al., 2013). Other factors that were not included in the present study, such as self-efficacy for change, might explain the observed gender difference (Litt et al., 2015). Findings point to daily monitoring of behaviour with the use of a smartphone app as a possible awareness-enhancing tool that can help reduce negative consequences in frequent emerging adults who use cannabis, specifically men.

Despite the widespread use of mobile smartphones and apps in our lives, the field of substance use has only just begun to make use of apps as a method of prevention, assessment, or treatment of substance use disorders (Cohn et al., 2011; Colbert et al., 2020). Using technological advances such as smartphone apps provides opportunity for interventions that are low-cost, accessible, user-friendly, and effective. Interventions using real-time apps (i.e., provision of an intervention for a behaviour as it occurs in real time; Cohn et al., 2011) have demonstrated improved health outcomes in other fields (e.g., Bertholet et al., 2017; Reback et al., 2018), with some research showing positive outcomes in alcohol use (Colbert et al., 2020; Garnett et al., 2021). However, research on the use of ecological momentary intervention for substance use is still in early stages (Bertholet et al., 2017; Scott et al., 2017; Thompson et al., 2020) with very few offering support for cannabis use (Ramo et al., 2015). One intervention app that had been developed for cannabis use was APTT (Assess, Plan, Track, and Tips; Albertella et al., 2019). The use of APTT, which allowed participants to set goals, track their use, and view their personalized feedback, was associated with reductions in cannabis use, cannabis problems, and severity of dependence. This app provides preliminary evidence in support of smartphone-delivered cannabis use interventions with further research being needed to develop accessible and feasible tools for emerging adults wishing to manage their cannabis use.

The fourth and final research question assessed whether receiving a brief, personalized feedback intervention would enhance participants' motivation to change their cannabis use and willingness to utilize resources. The current study is one of the first to examine a brief personalized feedback intervention (PFI) for emerging adults who frequently use cannabis. It was hypothesized that participants who were randomly assigned to the brief intervention group would display significantly increased motivation to change their cannabis use at the one-month follow-up and be more likely to accept and utilize resources to help reduce their cannabis use compared with control group participants. Contrary to the fourth hypothesis, there was no benefit of the PFI relative to a no intervention control. A number of factors ought to be considered when interpreting these findings. First, although brief, web-based personalized feedback interventions for alcohol use have been promising (e.g., Bewick et al., 2008; Doumas & Andersen, 2009; Walters et al., 2007), results have been less consistent for cannabis use. A recent meta-analysis assessed the effectiveness of web-based interventions for cannabis use; while it was found that this type of intervention reduced cannabis use frequency when compared with control groups, the effect size was small (Hoch et al., 2016). Moreover, only a handful of web-based interventions consisted of a single session PFI. Lee and colleagues (2010) conducted a one-session web-based PFI for cannabis use in a college sample and their intervention group did not significantly differ from the control group in terms of cannabis use or cannabis-related problems. Similarly, individuals who received The Marijuana eCHECKUP TO GO (e-TOKE; San Diego State University Research Foundation, 2009), a web-based PFI, did not significantly reduce their cannabis use frequency compared with the control participants (Elliott et al., 2014; Palfai et al., 2014).

Second, PFIs are often provided within the context of a brief motivational interview, which has been shown to be an efficacious intervention for substance use (Borsari et al., 2014; Colby et al., 2018; DiClemente et al., 2017; Joseph & Basu, 2017; Walters et al., 2009). However, PFIs that rely on written feedback only, without a therapist-delivered motivational interviewing component, may not be sufficient for producing change in emerging adults who frequently use cannabis (White et al., 2007). This may be especially true for individuals who use substances more frequently, as personalized feedback interventions have been found to be more beneficial for individuals who use substances infrequently compared with individuals who use more heavily (Carey et al., 2007). In contrast, therapist-delivered interventions allow for more tailored feedback that can be adapted to participants' substance use frequency, consequences, as well as their stage of change and self-efficacy to embark on such a change, which are important targets for improving outcomes in health behaviour research (Noar et al., 2007; Schulz et al., 2012). In addition, motivation to change might only be one facet required to produce cannabis use change, and multiple strategies that include cognitive, behavioural, motivational, and pharmacotherapuetic may be needed to reduce harm associated with heavy cannabis use (Sherman & McRae-Clark, 2016).

In sum, the present study's participants' frequent use along with the limited nature of the study's intervention may have made it more difficult to see intervention effects. Future intervention studies could explore ways to make web-based PFIs more engaging and interactive with emerging adults who frequently use cannabis, in addition to testing the efficacy of in-person PFIs.

Clinical Implications

The study's findings have important implications for prevention and intervention, particularly in the context of recreational cannabis legalization in Canada, where comprehensive harm reduction initiatives are vital for the prevention of cannabis-related harms (Mader et al., 2019). It is notable that over half of the participants identified as current post-secondary students. The high rates of cannabis use among this sample is concerning when considering the possible impact of regular use on students' academic work and achievement. Past studies have found associations between frequent cannabis use and higher dropout rates, increased class absences, lower academic performance, and lower academic self-efficacy (Arria et al., 2015; Fergusson et al., 2003; Phillips et al., 2015). Addressing frequent and problematic cannabis use in the post-secondary environment through dedicated programs is critical to student retention, academic achievement, and overall well-being.

The current findings also provide important information for motivational-based approaches to the prevention and treatment of problematic cannabis use. Psychoeducation and provision of evidence-based resources such as Canada's Lower-Risk Cannabis Use Guidelines (LRCUG; Fischer et al., 2017) ought to be made available to emerging adults to educate on behaviours that could reduce risky use, such as choice of cannabis products (using lower THC-content), modality of consumption (using vaporizers and edibles rather than smoking), and lower frequency of use, amongst others.

Given that cannabis motives have been shown to be related to treatment outcomes (Banes et al., 2014; Blevins et al., 2016b; Buckner et al., 2018) and can become malleable following treatment (Blevins et al, 2016a), motivational enhancement interventions for problematic cannabis use may target individuals' perceived motives and their associated outcomes.

The current findings highlight coping and sleep motives as particularly risky in regards to cannabis consequences. Reduction in using to cope has been associated with reduction in cannabis consequences (Banes et al., 2014). Addressing the use of cannabis for these reasons may be particularly important for working with emerging adults who are using cannabis regularly and want to reduce the harms associated with their cannabis use (Bravo et al., 2020; LaBrie et al., 2008). For example, emerging adults' perceptions of their reduced capacity to tolerate negative affect may be a cognitive risk factor combined with the tendency to rely on cannabis for emotion regulation (Farris et al., 2016). Individuals who use cannabis to cope may benefit from intervention strategies that provide support for managing negative affect. Cognitive therapy techniques may be utilized to challenge such thinking styles along with dialectical-behavioural approaches for tolerating and regulating difficult emotions as a way of developing alternative coping strategies that do not rely on substance use (Larimer et al., 1999; Marlatt & Gordon, 2005).

One example of a motives-based intervention is *PreVenture* (Conrod et al., 2010). Given that some personality traits have been associated with substance use motives (Hudson, Wekerle, & Stewart, 2015), a brief intervention that targets these shared risk factors such as *PreVenture* may reduce risky substance use (Conrod, 2016). *PreVenture* combines cognitive behavioural therapy and motivational interviewing strategies to reduce the use of substances for coping (Conrod et al., 2013). *PreVenture* has been shown to improve cannabis-related knowledge, decrease cannabis use, and reduce cannabis-related harms (Conrod et al., 2010; Newton et al., 2018). Thus, interventions that enhance emerging adults' adaptive coping when faced with stressors or distress may be an effective way to reduce problematic cannabis use.

Since celebration motives are often related to specific dates (e.g., 4/20) or special occasions (Walukevich-Dienst & Buckner, 2019), these high-risk events may be a helpful time to intervene, especially on post-secondary campuses (Neighbors et al., 2012). Colleges and universities can anticipate times students will be more likely to use cannabis and provide prevention-oriented information and harm-reduction programs in anticipation of these holidays and high-risk celebratory events.

Although more research is needed to pinpoint the exact mechanisms that contribute to positive impacts of self-monitoring, the current findings highlight the positive impacts of self-monitoring as a tool for change. This is consistent with other research in the health behaviour domain, where self-monitoring has been widely supported, especially for those in the pre-contemplative and contemplative stages of change (Cohen et al., 2013). Self-monitoring provides individuals with a simple way to identify and track the behaviour they would like to change, and by doing so, helps clarify and justify the need for treatment (Hufstedler & Varghese, 2020; King & Boswell, 2019). Encouraging individuals who use cannabis to track and monitor their use may help to increase awareness of use and associated consequences, especially for men, and can serve as a starting point for emerging adults seeking to change their cannabis use and its consequences, along with other evidence-based interventions.

Limitations and Future Directions

Despite the novel findings in this study, there are a number of limitations that should be noted. First, participants self-selected into the study, which may limit the generalizability of some of the present study's findings. Although the sample was relatively heterogeneous in terms of age, gender, student status, and ethnicity, the size of the sample restricted the ability to conduct further analyses within smaller subsections of the sample. Future research using a larger sample may offer a more comprehensive understanding of the associations between cannabis motives and outcomes in emerging adulthood.

An additional limitation was the use of a design that did not allow full exploration of the temporal relationships of within-person variables. Although we can establish that affect and cannabis were linked within a day, a more intensive EMA procedure is needed to fully establish temporal precedence. Additionally, assessment of motives was done at the between person level, which does not allow for examining the specific effects of daily motives on cannabis outcomes. Investigating the temporal relationship between mood, motives, and use and consequences on a daily basis may provide more nuanced insight into these relationships. For example, recent research by Buckner et al. (2019) found that weekday (but not weekend) coping motives were associated with increased frequency of cannabis use, suggesting that individuals may cope with weekday stressors via cannabis but utilize other coping tools or experience fewer stressors during the weekend. Thus, daily context is an important factor to consider in the relationship between cannabis motives and use.

A growing literature has demonstrated that protective behavioural strategies (PBS). PBS are defined as harm-reduction behaviours that are used before, during, after, or instead of substance use to reduce substance use and/or consequences (Martens et al., 2005; Prince et al., 2013). Originally utilized with alcohol use, researchers have now also identified cannabis-related PBS. The Protective Behavioral Strategies for Marijuana (PBSM; Pedersen et al., 2016b) scale describes strategies that encourage reducing frequency of use (e.g., “Only use one time during a day/night”), reducing quantity of use (e.g., “Limit the amount of marijuana you smoke in one sitting”), changing method of use (e.g., “Avoid using marijuana in concentrated forms…to avoid getting too high”), and reducing risky use (e.g., “Use marijuana only among trusted peers”). Increasing number of studies have found that the use of cannabis PBS is associated with decreased cannabis use frequency, quantity, consequences, and CUD symptoms (Bravo et al., 2017; Richards et al., 2021; Pearson, Bravo, & Protective Strategies Study Team, 2019; Wong et al., 2019). Research on PBS for substance use to date has focused on cross-sectional designs (Pearson et al., 2013); however, studies are now showing that episode-level PBS use is predictive of reduced cannabis use quantity (Prince et al., 2020). Future daily processes research is needed to clarify what protective strategies emerging adults find most effective with consideration of motives as well as various cannabis use contexts.

Additionally, the sample was comprised of individuals using for recreational purposes and may not be generalized to emerging adults using for medical reasons. Legalization in Canada may blur the lines between medicinal and recreational cannabis use, as emerging adults could purchase from a recreational vendor and use for medicinal reasons (Hawley et al., 2020). Thus, future research should include individuals who use cannabis solely for recreational reasons, those who use only for medicinal reasons, and those who use for both, to help clarify current understanding of cannabis use motives (Bohnert et al., 2018).

Finally, the study did not examine participants' use of other substances during the study, including alcohol use. Co-use of cannabis and alcohol, both concurrent and simultaneous, is highly prevalent (Choi et al., 2018; Metrik et al., 2018; Suerken et al., 2014). Among Canadian youth who use substances, over half report using more than one substance (i.e., concurrent use; Zuckermann et al., 2019). The majority (82%) of Canadian high school students who use cannabis also report past month alcohol use (Romano et al., 2019). Similarly, more than three-quarters (77%) of adults who use cannabis at least weekly use alcohol simultaneously (i.e., using both substances during the same episode), thus usually using cannabis with alcohol (Subbaraman & Kerr, 2015). Given the high concurrent use of cannabis with other substances (Leatherdale & Ahmed, 2010; Tzilos et al., 2014), future daily diary work could benefit from examining whether emerging adults use other substances to cope with negative affect.

Despite these limitations, the present study highlighted how cannabis motives can be differentially related to cannabis use and consequences. It also demonstrated the valuable effect of self-monitoring of substance use as a tool for change, especially among emerging adult men. Given that motives are malleable cognitive factors that can be targeted in therapy, there is a need to develop interventions that address common reasons emerging adults have for frequent and problematic cannabis use, in particular, using to cope, along with effective management of difficult emotions. In view of the high rates of recreational cannabis use in Canada, now more so than ever before, future research should continue to investigate the broad range of cannabis motives and their relationship to cannabis use frequency and outcomes in the emerging adult population.

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Appendices

Appendix A: Recruitment Advertisement

University of Toronto Logo	**The Psychology of Emerging Adulthood Research Lab (PEARL) Logo**

RESEARCH PARTICIPANTS NEEDED FOR A STUDY ON

Marijuana Use in Emerging Adulthood

IF YOU ARE:

- ✓ 18-25 years old
- ✓ Use marijuana/cannabis regularly (at least twice in the past 2 weeks) for non-medicinal reasons
- ✓ Fluent in written English
- ✓ Own a smartphone

Up to $50 in compensation!

Participation can be done all online!

Please contact us to determine if you are eligible to participate in this study!

By Phone: 416-409-9072
By Email: Danielle.Kofler@mail.utoronto.ca

Replies to this ad are confidential

Appendix B: Request to Post Ad

Hello,

My name is Danielle Kofler and I am currently a doctoral student in Clinical & Counselling Psychology at the Ontario Institute for Studies in Education (OISE), University of Toronto. I am conducting a research study on motives for marijuana use among Canadian emerging adults (aged 18-25). The study consists of an online survey and filling out a daily survey for two weeks on a smartphone. Participants are can be compensated for up to $50 for participating in the study. This study was reviewed and approved by the Research Ethics Board at the University of Toronto, and is being supervised by Dr. Abby Goldstein, Associate Professor of the Department of Applied Psychology and Human Development at OISE, University of Toronto. Individuals who are interested in participating can find all relevant information to the study in the informed consent form that will be provided to them upon contacting myself at the email provided on the advertisement.

I am writing to request permission to post my study advertisement in your [name of group] group/establishment. Please let me know if you would be okay with this. Alternatively, if you would like to post it in the group/establishment on my behalf, I can send the advertisement to you as a direct message.

Thanks so much and looking forward to hearing back from you!
Danielle

Appendix C: Telephone and Email Screen

C1. Telephone Script

Thank you for your interest in our study.
We ask all interested people to answer a few questions to determine whether they are eligible for the study. You don't need to give us any other identifying information.
Do you have a few minutes now to answer these questions?

1. **How old are you?** _____________ (must be 18-25)
2. **How many days in the past 2 weeks have you used marijuana?** ____ (must be at least twice)
3. **On any of those days, did you use marijuana for medicinal purposes/as prescribed by a physician?** Yes/No (must be No; only recreational use)
4. **Do you own a smartphone?** Yes/No (must be Yes)
5. **Are you fluent in written English?** Yes/No (must be Yes)

If ineligible – Unfortunately, you don't meet the eligibility criteria for the study. Thank you for taking the time to speak with us.

If eligible – You are eligible to participate in the study. The study involves an online questionnaire that should take about 30 minutes to complete. You will download an app and be trained on how to use, which should take 5 minutes. You will fill out a daily survey through the app for 7-10 minutes a day for 14 days. You will be paid $15 for the online survey, $10 for each week (for completing at least five out of the seven daily surveys for that week), and a bonus $5 for completing 85% of the daily surveys over the 14 day period (12/14 days). You will also be paid $10 for filling out a post-study questionnaire. In total, you could be compensated up to $50 for participating in the study. Payment will be made either in cash, PayPal e-transfer, or Amazon.ca gift card at the end of the study. Are you still interested? *(If interested, schedule a time to book the baseline appointment)*

C2. Email Script

Hi ___________,

Thank you for your interest in our study! Our eligibility criteria are as follows:
1) You are between the ages of 18-25 (we will ask to see government issued ID)
2) You have used marijuana at least twice in the past two weeks
3) Your marijuana was not prescribed for medicinal use
4) You own a smartphone
5) You are fluent in written English

Information about the study:
If you are eligible to participate in the study, the study will involve an online questionnaire that should take about 30 minutes to complete. You will download an app and be trained on how to use, which should take 5 minutes. You will fill out a daily survey through the app for 7-10 minutes a day for 14 days. You will be paid $15 for the online survey, $10 for each week (for completing at least five out of the seven daily surveys for that week),

and a bonus $5 for completing 85% of the daily surveys over the 14 day period (12/14 days). You will also be paid $10 for filling out a post-study questionnaire. In total, you could be compensated up to $50 for participating in the study. Payment will be made either in cash, PayPal e-transfer, or Amazon.ca gift card at the end of the study.

Please let me know if you are interested and provide your phone number, so we can set up a time to chat and get you started.

Best,
Danielle

Appendix D: Information Letter and Consent Form

UNIVERSITY OF TORONTO
OISE | ONTARIO INSTITUTE FOR STUDIES IN EDUCATION

Title of study: Cannabis use motives in emerging adulthood: Using daily diary method to inform intervention

Consent to participate in a research study:
The purpose of an informed consent form is to ensure that you understand the purpose of the study and the nature of your involvement. The informed consent must provide sufficient information so you have the opportunity to decide if you would like to participate in the study.

Your participation in this study is voluntary and you may withdraw from the study at any time. The study is described below. This description includes information about the risks, inconvenience, or discomfort that you might experience. Participating in the study might not benefit you directly, but the goal of the research is to help us better understand how motives for marijuana use influence use and negative consequences so that we can develop programs to help emerging adults who are struggling with their marijuana use.

Investigator:
Danielle Kofler, M.A., Ph.D. Candidate in Clinical and Counselling Psychology
Applied Psychology and Human Development, OISE/University of Toronto

Supervisor:
Abby Goldstein, Ph.D., C. Psych., Associate Professor
Applied Psychology and Human Development, OISE/University of Toronto

Purpose:
- The purpose of this study is to better understand motives for marijuana use during emerging adulthood (i.e., 18-25 years old), the stage of development between adolescence and adulthood
- We hope to better understand the reasons emerging adults use marijuana and the impact those reasons and use may have on emerging adults' wellbeing
- We are interested in looking at how marijuana use, motives, consequences, and other factors interact on a daily basis over a period of 14 days
- We also hope to investigate whether personalized feedback influences willingness to accept resources to change problematic marijuana use
- By understanding emerging adults' motives for marijuana use, we can have a better understanding of the ways in which emerging adults use marijuana and some of this information could be used to better support those who are in fact experiencing problems with their use to reduce associated harms
- We hope that a total of 50 emerging adults will participate in this study

Who can participate?

You may participate in this study if you:

- Are between the ages of 18 and 25
- Use marijuana regularly (at least twice in the past two weeks), for non-medicinal purposes
- You own a smartphone
- You are fluent in written English

<u>What will you be asked to do?</u>
This study involves three phases, each described below.

1. Initial baseline assessment and training on the use of the daily survey mobile application (app)
2. Providing 14 days of reporting using the daily survey app
3. Completing a short post-study survey online

First, you be asked to download and become familiarized with the daily survey app. We want to ensure that you are comfortable using the app and doing the daily surveys before we end the Vidyo/phone/in-person conversation. Once that is done, you will be sent a link to an online self-report questionnaire that you will complete on a computer in your home or in the lab. You will be provided with a unique study ID code. This survey will take you approximately 30-45 minutes to complete and will include questions about your marijuana use, mental health, sleep, and emotional functioning. We will also ask you some questions about your background, such as your age, gender, and relationship status.

During the 14 days that you are completing the daily surveys, the principal investigator will be in regular email contact with you. The investigator will contact you every few days to see how you are doing with the self-reporting and to answer any questions you might have. The investigator will also be in contact with you if you miss two days of the survey in a row. If you miss three consecutive surveys, we will assume you are intending to withdraw from the study and will contact you via email or telephone to confirm whether you have indeed withdrawn.

Once the 14 days are over, we will send you an email to confirm that you have completed the 14 days of daily surveys. You will then be randomly chosen to a) receive feedback about your daily reporting, or b) not receive feedback. You will be asked to complete a 5 minute survey. One month later, you will be contacted again by the investigator and asked to complete a brief online survey that should take you about 5 minutes to complete.

<u>What is daily reporting?</u>
The daily reporting we are doing will be done electronically through an app that you will download to your mobile device today. The app will send you a signal each day to remind you to fill out the survey between the hours of 8 and 10 pm. You will be asked the same questions each day. These questions ask you about your mood, anxiety, and sleep THAT DAY and about your use of marijuana, motives for use, and consequences from THE DAY/NIGHT BEFORE. So, if you are filling out the survey on a Monday, you will be answering questions about your mood and anxiety from Monday and any marijuana use and sleep from Sunday night.

How will I be compensated?

This study requires you to take approximately 45 minutes today (30 minutes for the online survey and 5-10 minutes for training on the app), and then 7-10 minutes each day for 14 days, along with a five minute survey at the end of the study. We want to be sure you are compensated for the time you are putting in to the study. You will be compensated $15 today for filling out the online baseline survey and receiving training for using the app. As a thank you for your ongoing efforts, you will be paid $10 for each week you complete at least 5 out of the7 daily surveys (total of $20 for the two weeks of daily surveys). We will also give you a bonus $5 for completing 85% of the daily surveys over the two week period (completing at least 12 out of 14 days). You will also be paid $10 for filling out the post-study questionnaire. In total, you have the opportunity to receive $50 for participating in the study. Payment will be made either in cash, PayPal e-transfer, or Amazon.ca gift card at the end of the study.

Are there any risks or benefits?

By contacting the investigator about this study and/or participating in this study others can infer that you have used marijuana. There will be a brief period of time between your initial contact to the investigator and confirmation of receipt of compensation during which your name and contact information will remain in the email account associated with this study on personal marijuana use.

By completing the daily reports of your marijuana use and motives, consequences of your use, mental health, and sleep, you may begin to notice some patterns that were not apparent before. For example, you may notice that your mood is low for several days in a row or that you are using marijuana more often than you thought. If you notice difficulties in any of these areas, it may be helpful to talk to someone about this. At the end of the study, you will be provided with contact information for several helpful resources so that you can talk to someone if you wish.

There is also some risk associated with reporting on an illegal behaviour (i.e. marijuana use) due to possible external pressure to disclose identifiable information (e.g., a subpoena or in connection with a legal proceeding). If this situation were to arise, we would resist disclosing any information about you and would immediately contact our institutional supports and legal counsel.

The risks noted above may also be a benefit to participating in the study. You might get a better understanding of your patterns of mental health, sleep, and marijuana use. In addition, having a list of resources and information on where to access support may be helpful to you (or a loved one/friend) in the future.

In terms of broader benefits, your participation in this study will help us gain a better understanding of how we can best support emerging adults to reduce problematic marijuana use and facilitate overall wellbeing in emerging adulthood and into adulthood.

How will my confidentiality be protected?

All the data you provide is confidential. You will not be required to put your name on the questionnaires and your name (or other identifying information) will not be used in any reports or presentations that arise from the study. We will store your first name and contact information (i.e., email address and phone number) separately from your survey data. We will assign you an ID code that you can use each time you complete a survey and we will use the ID code to match your data from today with your daily diary responses. We will retain a master list that includes your name, contact information and ID code and this will be stored separately from your data. Only research personnel affiliated with the study will have access to these separate encrypted and password-protected data files and ID codes. Your contact information will be promptly deleted upon completion of the final survey or should you request this to be done by contacting the principal investigator of the study (Danielle Kofler) directly. Once the file containing your first name and contact information has been deleted, only the ID code will be used to connect your initial survey responses with the corresponding daily diary entries and final survey responses. Should you decide to withdraw your data after we have deleted your name and contact information, you will be asked to provide your ID code as we will not be able to locate or delete your data within the file without it. All contact information is stored on a secure, password-protected memory key in a locked filing cabinet at the University of Toronto.

To better protect your privacy, we recommend that you delete all study-related communications from your computer, electronic device, email, and messaging program. This can be done by clearing your cache, cookies and browser history on your computer and then deleting any study-related emails and instant messages from your computer and mobile device. After you complete the 14 days of daily surveys you can delete the survey app from your mobile device.

Limits to confidentiality:
Under certain rare circumstances, we may need to inform individuals outside of the study about your responses. Specifically, we are required to report the following: If you indicate that you are at risk for suicide or that you intend to seriously harm another person or if you disclose knowledge or suspicion of child abuse or neglect. Representatives from the University of Toronto research ethics program may have confidential access to your data to ensure participant protection procedures are being followed.

Can I refuse or withdraw?
As noted above, you may refuse to participate in this study. You may choose to skip questions you find uncomfortable without penalty. If you decide to participate now, but then later decide you are no longer interested, you may withdraw from the study at any time. If you withdraw from the study during the online survey, we will still provide you with contact information for resources where you can go to talk to someone if you have any concerns about your alcohol use or about problems with anxious or depressed mood or marijuana use. However, if you choose to withdraw, you will only be compensated for the surveys completed prior to date of withdrawal. If you choose to withdraw from the study following the submission of a survey, we will provide you with an ID code that you can keep and use to identify your data in order to have it removed. In this case we ask that you contact us, provide us with your ID code (listed in the email sent to you with the link to the baseline survey) and let us know that you would like your data removed from the study. As noted above, following completion of the final survey we will delete the file containing your name and contact information. Therefore, we will not be able to locate or delete your data without you providing your ID code.

Questions?
Should you have any questions about the study, or if any issues arise because of your participation in the study, please feel free to contact the investigator or faculty advisor:

Ms. Danielle Kofler, M.A., Ph.D. Candidate
Department of Applied Psychology and Human Development
Ontario Institute for Studies in Education, University of Toronto
252 Bloor Street West
Toronto, ON M5S 1V6
Telephone: (416) 409-9072
E-mail: danielle.kofler@mail.utoronto.ca

Dr. Abby L. Goldstein, C. Psych.
Department of Applied Psychology and Human Development
OISE, University of Toronto
252 Bloor Street West
Toronto, ON M5S 1V6
Telephone: (416) 978-0703
Email: abbyl.goldstein@utoronto.ca

Should you have any questions about your rights as a research participant, please feel free to contact the Office of Research Ethics at the University of Toronto:

Office of Research Ethics, University of Toronto
Telephone: (416) 946-3273
Email: ethics.review@utoronto.ca

I have read the above form and understand the conditions of my participation.
I have asked all my questions and they have been answered by the research staff to my satisfaction.
I have the contact information of whom to call if I have questions in the future.
My participation in this study is voluntary, and if for any reason, at any time, I wish to leave the study I may do so without having to give an explanation and with no penalty whatsoever. I am also aware that the data gathered in this study are confidential.

- ○ I consent and confirm the above.
- ○ I do not consent (will take to debriefing page).

Appendix E: Online Baseline Questionnaire

Demographics Questions:

1. What is your gender?
   - ☐ Male
   - ☐ Male to female transgender
   - ☐ Female
   - ☐ Female to male transgender
   - ☐ Unsure
   - ☐ Prefer not to disclose
   - ☐ [or] please specify_______________________

2. How would you describe your ethnicity? (Select one):
   - ☐ Aboriginal (e.g., First Nations, Metis)
   - ☐ White
   - ☐ South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)
   - ☐ East Asian (e.g., Chinese, Japanese, Korean)
   - ☐ South East Asian (e.g., Cambodian, Indonesian, Laotian, Vietnamese, etc.)
   - ☐ Filipino
   - ☐ Latin American/Hispanic
   - ☐ West Indian (e.g., Guyanese, Trinidadian, etc.)
   - ☐ Black (e.g., African, Haitian, Jamaican, Somali, etc.)
   - ☐ Arab / West Asian (e.g., Armenian, Egyptian, Iranian, Lebanese, Moroccan, etc.)
   - ☐ Other (please specify) _______________________________

3. Growing up, what was the primary language spoken at home? ___________

4. Year of birth: _________

5. What is your relationship status?
   - ☐ Single
   - ☐ Casually dating
   - ☐ In an exclusive relationship
   - ☐ Common law
   - ☐ Engaged
   - ☐ Married
   - ☐ Separated
   - ☐ Divorced
   - ☐ Widowed
   - ☐ Other: ______

6. Where do you current live?
   - ☐ University residence with roommate
   - ☐ University residence single room
   - ☐ Apartment with roommates
   - ☐ Apartment alone
   - ☐ Living with parents
   - ☐ Living with other relatives

- ☐ Living with partner
- ☐ Living with spouse
- ☐ Other living arrangement: __________ (please enter)

7. Are you currently in school? Yes/No
   a) If **yes**, what level?
   - ☐ High school (grade 9 to grade 12)
   - ☐ Completing my General Educational Development (GED)
   - ☐ Community college
   - ☐ University
   - ☐ Graduate school (post university)
   - ☐ Other: __________ (please enter)

   b) If **not currently in school**, what is the highest level of education you have completed?
   - ☐ High school (grade 9 to grade 12)
   - ☐ Completing my General Educational Development (GED)
   - ☐ Community college or trade school
   - ☐ University
   - ☐ Graduate school (post university)
   - ☐ Other: __________ (please enter)

8. What is your employment status?
   - ☐ Full-time employment (30 or more hours/week)
   - ☐ Part-time employment (less than 30 hours/week)
   - ☐ Unemployed (out of work but looking for work)
   - ☐ Student employed part-time or full-time
   - ☐ Student not employed
   - ☐ Retired
   - ☐ Homemaker
   - ☐ Other (please specify) ____________________

9. If **employed**, what is your yearly income?
   - ☐ Less than $20, 000
   - ☐ $20, 000 - $40, 000
   - ☐ $40, 000 - $60, 000
   - ☐ $60, 000 - $80, 000
   - ☐ $80, 000 - $100, 000
   - ☐ $100,000 +

10. What is your mother's highest level of education? (Select one)
    - ☐ Grade School
    - ☐ High School Diploma or GED
    - ☐ College or Trade School
    - ☐ Some University
    - ☐ University undergraduate degree
    - ☐ Post graduate degree
    - ☐ Don't know/not sure

11. What is your father's highest level of education? (Select one)
    - ☐ Grade School

- ☐ High School Diploma or GED
- ☐ College or Trade School
- ☐ Some University
- ☐ University undergraduate degree
- ☐ Post graduate degree
- ☐ Don’t know/not sure

Timeline Followback (TLFB):

INSTRUCTIONS for Filling Out the 30-Day Marijuana Use Calendar:
To help us evaluate your marijuana use, we need to get an idea of what your marijuana use was like in the past 30 days. To do this, we would like you to fill out the attached calendar.

- Filling out the calendar is not hard!
- Try to be as accurate as possible.
- We recognize you won't have perfect recall. That's OKAY.

WHAT TO FILL IN

- USE/NO USE: For each day on the calendar, please indicate **yes** or **no** whether you used marijuana or not.
- AMOUNT and TIME/SESSION(S): For each day that you did use marijuana, please enter the **number of use sessions**, the **amount** of marijuana you used (in grams) per session, and amount of **time** (in minutes) per session.
- MODE OF CONSUMPTION and FORM / SESSION(S): For each day that you did use marijuana, please also enter the **mode of consumption** used (e.g., inhalation, ingestion) per session, and the **form** of marijuana (e.g., hashish, oils, leaves) per session.
- STRAIN: indicate the strain of marijuana used (e.g. sativa, indica, hybrid, unknown) per session.

It's important that something is typed in the AMOUNT box for every day, even if it is a "0".

YOUR BEST ESTIMATE

- We realize it isn't easy to recall things with 100% accuracy.
- If you are not sure whether you consumed 0.5 or 1 gram or whether you used on a Thursday or a Friday, give it your best guess! What is important is that 0.5 or 1 gram is very different from 3 or 5. The goal is to get a sense of how frequently you used, how much you used, and your patterns of use.

HELPFUL HINTS

- If you have an appointment book/agenda you can use it to help you recall your marijuana use.
- On the next page, you will indicate certain holidays, personal events, special occasions, etc. that will help you recall your use over the past 30 days. These events will be preloaded into the assessment to help you remember your behaviours.
- If you have regular use patterns you can use these to help you recall your use. For example, you may have a daily or weekend/weekday pattern, or use more in

the summer or on trips, or you may use on Wednesdays after work. You may typically smoke when watching a particular TV show on Thursday nights or when hanging out with a certain group of friends you only see every other week.
- Again, we realize it isn't easy to recall things with 100% accuracy. Just do the best you can to remember your behaviour over the past month.

Enter calendar example

On the next page you'll fill in marker days.

MARKER DAYS

Before you are presented with the calendar, please take a moment to recall certain holidays, birthdays, newsworthy events and other personal events that are meaningful to you FROM THE PAST 30 DAYS. These (whether involving marijuana use or not) can assist in the recall of your behaviour over the past month. Please consider national holidays (such as Thanksgiving Day [October 13th], Halloween [October 31st], Boxing Day [December 26th]), important school dates like the day classes started, major sporting events like Blue Jays, Leafs or Raptors games, major news events, your own or others' birthdays, vacation beginning and end dates, or other dates of important personal events (such as changing jobs, moving to a new place, the start or end a romantic relationship).

An example is provided:

Enter calendar example – completed with markers

Please enter up to 10 personal marker days in the calendar below.

Calendar with participant's marker days added

Remember:

- USE/NO USE = yes/no
- SESSION(S) = number of use sessions
    - AMOUNT = amount of marijuana you used (in grams) per session
    - TIME = amount of time (in minutes) per session
    - MODE OF CONSUMPTION = mode (inhalation, ingestion, etc.) per session
    - FORM = form of marijuana (hashish, oils, leaves, etc.) per session
    - STRAIN = strain of marijuana use per session (indica, sativa, hybrid)

Please make sure to fill out all 30 days of the calendar. On the final page of the calendar, you will be able to click "calendar complete" to advance to the next portion of the survey.

Interactive calendar

Marijuana Motives Questionnaire (CMMQ)

Here is a list of reasons people give for using marijuana. Thinking of all the times you use marijuana, how often would you say that you use marijuana for each of the following reasons?

Item	Never/ Almost never (1)	Some of the time (2)	Half of the time (3)	Most of the time (4)	Always/ Nearly always (5)
1. To enjoy the effects of it					
2. Because it is fun					
3. To feel good					
4. Because you felt pressure from others who do it					
5. Because you didn't want to be the only one not doing it					
6. To be cool					
7. To forget your problems					
8. Because you were depressed					
9. To escape from your life					
10. Because you were experimenting					
11. Because you were curious about marijuana					
12. To see what it felt like					
13. Because you had nothing better to do					
14. To relieve boredom					
15. Because you wanted something to do					
16. Because you were drunk					
17. Because you were under the influence of alcohol					
18. Because you had gotten drunk and weren't thinking about what you were doing					
19. To celebrate					
20. Because it was a special day					
21. Because it was a special occasion					
22. Because you want to alter your perspective					
23. To allow you to think differently					
24. So you can look at the world differently					

25. Because it makes you more comfortable in an unfamiliar situation					
26. To make you feel more confident					
27. Because it relaxes you when you are in an insecure situation					
28. Because it is safer than drinking alcohol					
29. Because it is not a dangerous drug					
30. Because there are low health risks					
31. To help you sleep					
32. Because it helps make napping easier and enjoyable					
33. Because you are having problems sleeping					
34. Because it is readily available					
35. Because you can get it for free					
36. Because it is there					

<u>Marijuana Consequences Questionnaire (MACQ)</u>

Below is a list of things that sometimes happen to people either during, or after they have used marijuana. Next to each item below, please indicate in either the YES or NO column to indicate whether that item describes something that has happened to you **IN THE PAST 6 MONTHS.**

Item	Yes	No
1. While using marijuana I have said or done embarrassing things.		
2. The quality of my work or schoolwork has suffered because of my marijuana use.		
3. I have felt badly about myself because of my marijuana use.		
4. I have driven a car when I was high.		
5. I have felt in a fog, sluggish, tired, or dazed the morning after using marijuana.		
6. I have passed out from marijuana use.		
7. I have taken foolish risks when I have been high.		
8. I have felt very sick to my stomach or thrown up after using marijuana.		
9. I have gotten into trouble at work or school because of marijuana use.		
10. I often used more marijuana than I originally had planned.		
11. My marijuana use has created problems between myself and my boyfriend/girlfriend/spouse/parents, or other near relatives.		
12. I have been unhappy because of my marijuana use.		
13. I have gotten into physical fights because of my marijuana use.		

14. I have spent too much time using marijuana.		
15. I have not gone to work, or have missed classes or school because of using marijuana, being high, or after effects (feeling hung-over).		
16. I have felt like I needed a hit of marijuana after I'd gotten up (that is, before breakfast).		
17. I have become very rude, obnoxious, or insulting after using marijuana.		
18. I have felt guilty about my marijuana use.		
19. I have damaged property or done something disruptive like setting off a fire alarm, or other things like that after using marijuana.		
20. Because of my marijuana use, I have not eaten properly.		
21. I have been less physically active because of my marijuana use.		
22. I have had trouble sleeping after stopping or cutting down on marijuana use.		
23. My boyfriend/girlfriend/spouse/parents have complained to me about my marijuana use.		
24. I have woken up in an unexpected place after using marijuana.		
25. I have found that I needed larger amounts of marijuana to feel any effect, or that I could no longer get high on the same amount that used to get me high.		
26. As a result of marijuana use, I neglected to protect myself or partner from an STD or unwanted pregnancy.		
27. I have neglected obligations to family, work, or school because of my marijuana use.		
28. I often have ended up using marijuana on nights when I had planned not to use marijuana.		
29. When using marijuana I have done impulsive things that I regretted later.		
30. I often have found it difficult to limit how much marijuana I use.		
31. My marijuana use has gotten me into sexual situations I have later regretted.		
32. I have not been able to remember large stretches of time while using marijuana.		
33. While using marijuana I have said harsh or cruel things to someone.		
34. Because of my marijuana use, I have not slept properly.		
35. My physical appearance has been harmed by my marijuana use.		
36. I have said things while using marijuana that I later regretted.		
37. I have awakened the day after using marijuana and found I could not remember a part of the evening before.		
38. I have been overweight because of my marijuana use.		
39. I haven't been as sharp mentally because of my marijuana use.		
40. I have received a lower grade on an exam or paper than I ordinarily could have because of marijuana use.		
41. I have tried to quit using marijuana because I thought I was using too much.		
42. I have felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down on marijuana use.		
43. I have not had as much time to pursue activities or recreation because of my marijuana use.		
44. I have injured someone else while using marijuana or high.		

45. I often have thought about needing to cut down or to stop using marijuana.		
46. I have had less energy or felt tired because of my marijuana use.		
47. I have had a blackout after using marijuana heavily (i.e. could not remember hours at a time).		
48. Using marijuana has made me feel depressed or sad.		
49. I have felt panicked or paranoid after using marijuana.		
50. I have lost motivation to do things because of my marijuana use.		

Severity of Dependence Scale (SDS)

Choose the answer that best applies to how you have felt about your use of marijuana **over the last 12 months**.

Item	Never/ Almost never (0)	Sometim es (1)	Often (2)	Always/ Nearly always (3)
(1) Did you think your use of cannabis was out of control?				
(2) Did the prospect of missing a dose of cannabis makes you anxious or worried?				
(3) Did you worry about your use of cannabis?				
(4) Did you wish you could stop the use of cannabis?				
(5) How difficult did you find it to stop, or go without cannabis?				

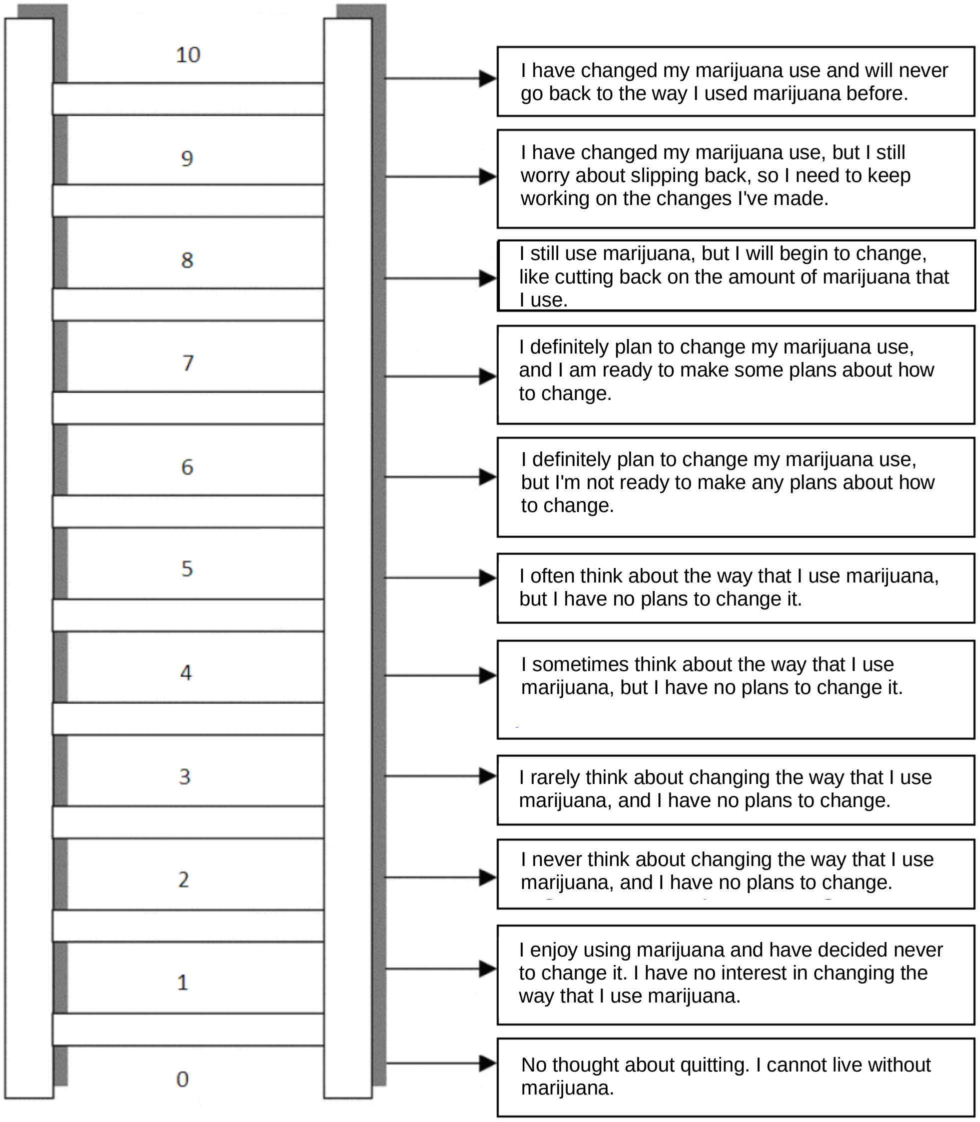
Personal Values

Below is a list of 10 personal values and their definitions. Choose the 3 values that are most important to you.

1. **Autonomy**: to be self-determined and independent
2. **Dependability**: to be reliable and trustworthy
3. **Faithfulness**: to be loyal and true in relationships
4. **Family**: to have a happy, loving family
5. **Friendship**: to have close, supportive friends
6. **Genuineness**: to act in a manner that is true to who I am
7. **Industry**: to work hard and well at my life tasks
8. **Loved**: to be loved by those close to me
9. **Openness**: to be open to new experiences, ideas, and options
10. **Self-acceptance**: to accept myself as I am

Marijuana Contemplation Ladder

Each rung of this ladder shows where a person might be in thinking about changing their marijuana use. Select the number that best matches where you are now.


10
I have changed my marijuana use and will never go back to the way I used marijuana before.
9
I have changed my marijuana use, but I still worry about slipping back, so I need to keep working on the changes I've made.
8
I still use marijuana, but I will begin to change, like cutting back on the amount of marijuana that I use.
7
I definitely plan to change my marijuana use, and I am ready to make some plans about how to change.
6
I definitely plan to change my marijuana use, but I'm not ready to make any plans about how to change.
5
I often think about the way that I use marijuana, but I have no plans to change it.
4
I sometimes think about the way that I use marijuana, but I have no plans to change it.
3
I rarely think about changing the way that I use marijuana, and I have no plans to change.
2
I never think about changing the way that I use marijuana, and I have no plans to change.
1
I enjoy using marijuana and have decided never to change it. I have no interest in changing the way that I use marijuana.
0
No thought about quitting. I cannot live without marijuana.

Appendix F: Daily Diary Survey

Daily Mood

Please indicate to what extent you felt this way TODAY:

Item	Not at all (0)	A little (1)	Moderately (2)	Quite a bit (3)	Extremely (4)
1. Sad					
2. Anxious					
3. Happy					
4. Tired					
5. Active					
6. Bored					
7. Shame					
8. Excited					
9. Relaxed					
10. Quiet					
11. Lonely					
12. Tense					
13. Angry					
14. Blue					
15. Cheerful					

The Pittsburgh Sleep Quality Index (PSQI) – modified for daily survey

The following questions relate to your sleep from last night.

Last night,
1. When did you go to bed last night? _______ (time in AM/PM)
2. How long (in minutes) did it take you to fall asleep? _______ (minutes)
3. What time did you wake up this morning? _______ (time in AM/PM)
4. a) How many hours of actual sleep did you get? _______ (hours)
   b) How many hours were you in bed? _______ (hours)
5. Did you take medicine (prescribed or "over the counter") to help you sleep? Yes/No

6. **Last night**, did you have had trouble sleeping because you	Not at all (0)	A little (1)	Moderately (2)	Quite a bit (3)
a) Could not go to sleep within 30 minutes				
b) Woke up in the middle of the night or early morning				
c) Had to get up to use the bathroom				
d) Coughed or snored too loudly				
e) Could not breathe comfortably				
f) Felt too cold				
g) Felt too hot				
h) Had bad dreams				

i) Had pain				
j) Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s):				
7. **Today**, have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. **Today**, how much of a problem has it been for you to keep up enthusiasm to get things done?				
9. How would you rate last night's sleep quality overall?	Very good (0)	Fairly good (1)	Fairly bad (2)	Very bad (3)

Marijuana Use

Please remember that we are interested in your marijuana use since the last time you filled in the survey. So, if you filled in the survey last night at 8:10 pm, then we are interested in your marijuana use starting from last night at 8:00pm up to right now.

1. Did you use marijuana today/last night?
- ☐ Yes
- ☐ No

2. If YES, how many times (sessions) did you use marijuana today?
- ☐ 1 session
- ☐ 2 sessions
- ☐ 3 sessions
- ☐ 4 sessions
- ☐ 5 sessions
- ☐ 6+ sessions

3. Please indicate time spent using marijuana per session: _____ (in minutes)

4. Please indicate the mode of consumption per session (you may indicate more than one):
- ☐ Smoking/inhalation – bong
- ☐ Smoking/inhalation – pipe
- ☐ Smoking/inhalation – joint
- ☐ Smoking/inhalation – hookah
- ☐ Vapourizing
- ☐ Ingestion – edibles
- ☐ Ingestion – oils
- ☐ Other: _______

5. Please indicate form of marijuana used per session (you may indicate more than one):
- ☐ Hashish
- ☐ Oils

- ☐ Leaves
- ☐ Other: ________

6. Please indicate marijuana <u>strain</u> used per session (you may indicate more than one):
- ☐ Sativa
- ☐ Indica
- ☐ Sativa/Indica Hybrid
- ☐ Unknown

Marijuana Motives Questionnaire (CMMQ) – Short Version

Please indicate the reasons for having used marijuana today.

Item	Yes (1)	No (0)
1. To enjoy the effects of it [enjoyment]		
2. Because you didn't want to be the only one not doing it [conformity]		
3. To forget your problems [coping]		
4. To see what it felt like [experimentation]		
5, Because you had nothing better to do [boredom]		
6. Because you were drunk [alcohol]		
7. To celebrate (e.g. a special occasion) [celebration]		
8. To allow you to think differently [altered perception]		
9. Because it relaxed you when you were in an insecure situation [social anxiety]		
10. Because it is safer than alcohol [relatively low risk]		
11. Because you were having problems sleeping/to help you sleep [sleep]		
12. Because you had it [availability]		

Brief Marijuana Consequences Questionnaire (B-MACQ)

Next to each item below, please either YES or NO whether that item describes something that has happened to you **LAST NIGHT/TODAY as a result of your marijuana use from last night/today.**

Item	Yes	No
1. The quality of my work or schoolwork suffered because of my marijuana use.		
2. I drove a car when I was high.		
3. I felt in a fog, sluggish, tired, or dazed the morning after using marijuana.		
4. I felt unhappy because of my marijuana use.		
5. I got into a physical fight because of my marijuana use.		
6. I spent too much time using marijuana.		
7. I felt like I needed a hit of marijuana after I'd gotten up (that is, before breakfast).		
8. I became very rude, obnoxious, or insulting after using marijuana.		
9. I was less physically active because of my marijuana use.		
10. I had trouble sleeping after stopping or cutting down on marijuana use.		
11. I neglected obligations to family, work, or school because of my marijuana use.		
12. When using marijuana I did impulsive things that I regretted later.		
13. I woke up the day after using marijuana and found I could not remember a part of the evening before.		
14. I wasn't as sharp mentally because of my marijuana use.		

15. I received a lower grade on an exam or paper than I ordinarily would have because of marijuana use.		
16. I tried to quit using marijuana because I thought I was using too much.		
17. I felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down on marijuana use.		
18. I thought about needing to cut down or to stop using marijuana.		
19. I had less energy or felt tired because of my marijuana use.		
20. I lost motivation to do things because of my marijuana use.		

Appendix G: Post-Study Emails to Participants

G1. Email to Intervention Group (post daily-diary)

Congratulations! You have completed the 14 day study. Please click on the following survey link for your feedback and a short survey:

Your survey link:
Your study ID code:

Overall, you did a great job with the daily surveys. You will be paid $15 for filling out the online baseline survey, $10 for each completed week (x2 = $20), plus an additional $5 for doing a great job, for a total of $40.

In one month, we will contact you to fill out a brief 10 minute survey. You will earn an additional $10 for completing the follow-up survey. You can choose to be paid the $40 now or wait one month and be paid $50 after you complete the follow-up survey. How would you like to be paid? We offer Amazon.ca gift cards, cash, or PayPal e-transfer.

Thank you again for participating in our study!

G2. Email to Control Group (post daily-diary)

Congratulations! You have completed the 14 day study. Please click on the following link for a short survey:

Your survey link:
Your study ID code:

Overall, you did a great job with the daily surveys. You will be paid $15 for filling out the online baseline survey, $10 for each completed week (x2 = $20), plus an additional $5 for doing a great job, for a total of $40.

In one month, we will contact you to fill out a brief 10 minute survey. You will earn an additional $10 for completing the follow-up survey. You can choose to be paid the $40 now or wait one month and be paid $50 after you complete the follow-up survey. How would you like to be paid? We offer Amazon.ca gift cards, cash, or PayPal e-transfer.

Thank you again for participating in our study!

G3. One-Month Post-Study Email to All Participants

Hi _________,

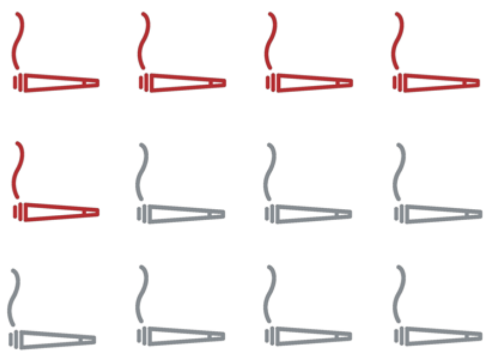
I hope you're doing well!
It's been one month since you completed the 14 daily diary study on marijuana use. As previously mentioned, we would like for you to complete a brief 5 minute online survey. To thank you for your time, you will be paid $10 for completing the survey. You can be paid via Amazon.ca gift card, cash, or PayPal e-transfer.

Your survey link:
Your study ID code:

Please let me know if you have any questions.

Thank you again for taking a part in our study!

YOUR MARIJUANA USE



You reported using marijuana on 5 out of 12 days in the past two weeks.

4 HOURS

AVERAGE DAILY TIME SPENT USING MARIJUANA

On average you used marijuana **2** times per day

ALTHOUGH YOU REPORTED USING MARIJUANA FOR:

- ENJOYMENT
- SOCIAL ANXIETY
- BECAUSE YOU HAD IT

YOU REPORTED

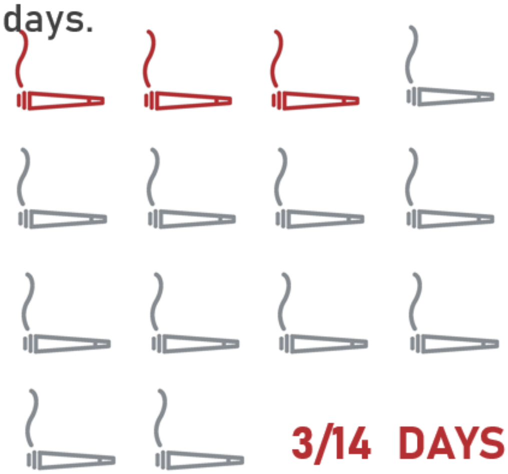
Needing to use first thing in the morning

Having less energy

Being less physically active

YOUR MARIJUANA USE

Over the past two weeks, you **reported using marijuana** on 3 out of 14 days.



3/14 DAYS

REASONS

You reported the following reasons for using marijuana:

- ENJOYMENT
- COPING WITH ANXIETY
- EXPERIMENTATION

ALTHOUGH YOUR TOP **VALUES** ARE:

Industry
to work hard and well at my life tasks

Genuineness
to act in a manner that is true to who I am

ON THE DAYS YOU USED MARIJUANA, YOU REPORTED:

lower quality of work

not feeling mentally sharp

decreased energy and motivation to get things done

Appendix I: Two-Week Follow-Up Questionnaire

I1. Post-Daily Diary Questionnaire – Intervention Group

Participants will be taken to this survey when they complete the 14 daily diary surveys. This is an example of a personalized feedback intervention.

Based on your app input, you reported using marijuana on 10 out of the last 14 days. During the past two weeks, you reported using marijuana for 10 out of the 14 days. Only 10% of young adults in Canada (aged 20-24) report using marijuana on a daily basis. One thing that was noticed over the past two weeks is that you were highly motivated to use marijuana for sleep purposes. However, when we look at your sleep quality and fatigue, sleep seems to continue to be a problem area for you. You also indicated experiencing negative consequences in the academic and interpersonal domains of your life as a result of your marijuana use.

A. Would you be interested in receiving a resource sheet that outlines contact information for mental health and substance use services across Ontario, Canada?

- ○ Yes, I would like to receive the resource list *(taken to resource sheet)*
- ○ No, I would not like to receive the resource list at this time.

B. Motivation Ladder

Each rung of this ladder shows where a person might be in thinking about changing their marijuana use. Select the number that best matches where you are now.

INSERT MOTIVATION LADDER IMAGE

I2. Post-Daily Diary Questionnaire – Control Group

A. Would you be interested in receiving a resource sheet that outlines contact information for mental health and substance use services across Ontario, Canada?

- ○ Yes, I would like to receive the resource list *(taken to resource sheet)*
- ○ No, I would not like to receive the resource list at this time.

B. Motivation Ladder

Each rung of this ladder shows where a person might be in thinking about changing their marijuana use. Select the number that best matches where you are now.

INSERT MOTIVATION LADDER IMAGE

Appendix J: One-Month Follow-Up Questionnaire

One Month Follow-Up Questionnaire – All Participants

A. Resource List Utilization

It has been 1 month since you completed the 14 daily diary survey about marijuana use. If you recall, you received/did not receive *[intervention vs. control group]* a resource list.

If you received a resource list, to what extent did you utilize the resources?

- ☐ I received the list but never viewed it.
- ☐ I viewed the list but did not contact any organization.
- ☐ I viewed the list and made a plan to contact some of the organizations.
- ☐ I viewed the list and have contacted an organization(s): ___________
- ☐ I have contacted one/some of the organizations on the list: __________

B. Marijuana Use

During the past 14 days, please estimate how many days did you use marijuana?
______ (days)

During the past 30 days, please estimate how many days did you use marijuana?
______ (days)

C. Motivation Ladder

Each rung of this ladder shows where a person might be in thinking about changing their marijuana use. Select the number that best matches where you are now.

INSERT MOTIVATION LADDER IMAGE

D. Marijuana Consequences

Next to each item below, please indicate in either the YES or NO column to indicate whether that item describes something that has happened to you **IN THE PAST 30 DAYS.**

INSERT MACQ from baseline

E. Marijuana Motives

Here is a list of reasons people give for using marijuana. Thinking of all the times you use marijuana, how often would you say that you use marijuana for each of the following reasons?

INSERT CMMQ from baseline

Substance Use Resources

MA - Marijuana Anonymous

Learn about the MA program and/or discuss your marijuana use with others experiencing problems related to their use online or in-person.

Website: https://www.marijuana-anonymous.org

SMART Recovery

Learn about the SMART Recovery program and/or discuss your marijuana use with others online or in-person.

Website: http://www.smartrecovery.org

ConnexOntario

Free provincial helplines through which Information and Referral Specialists provide confidential and anonymous support, health information, and referral services (including contact information for services and supports within the caller's community if requested) relating to problems with gambling, alcohol, other drugs, and mental health over the phone or via website chat.

Tel: Ontario Problem Gambling Helpline: 1-888-230-3505
Drug and Alcohol Helpline: 1-800-565-8603
Mental Health Helpline: 1-866-531-2600

Availability (for all the above): 24 hours/day, 7 days/week

Website: http://www.connexontario.ca/
Ontario Problem Gambling Helpline: http://www.opgh.on.ca/
Drug and Alcohol Helpline: http://www.drugandalcoholhelpline.ca/
Mental Health Helpline: http://www.mentalhealthhelpline.ca/

Availability (for all the above): 24 hours/day, 7 days/week

National Mental Health Resources

Canadian Centre on Substance Abuse: Treatment Services

Search for treatment services relating to gambling and drug use across Canada using this database.

Website: http://www.ccsa.ca/Eng/Topics/SubstancesAndAddictions

Canada Alcohol and Drug Rehab Programs
Provides a free online directory of alcohol, drug, and gambling rehabilitation programs across Canada.

Website: http://www.canadadrugrehab.ca/

eMentalHealth.ca
You can search for resources (e.g., helplines) across Canada using this database.
e.g., Search: *Type in* > "Telephone Crisis Lines"; Where: *Type in* > Name of your Province

Website: http://www.ementalhealth.ca/

Telephone Helplines

Gerstein Crisis Centre Telephone Call Line
Free, voluntary, and confidential crisis intervention service over the phone and in-person, 24 hours a day, 7 days a week.
Tel: 416-929-5200

Distress Centre Telephone Call Line
Crisis line offering free services for individuals in distress who require urgent emotional care and for individuals who have been physically or sexually assaulted or who are at risk of being assaulted
Tel:
Distress Centre Central: 416-598-0166
Distress Centre North York: 416-486-3180
Distress Centre Scarborough: 416-439-0744
Distress Centre Peel: 905-278-7208

Mental Health Service Information Ontario (MHSIO)
Information about mental health services and supports in communities across Ontario
Tel: 1-866-531-2600
Website: www.mhsio.on.ca

Questions/Concerns About This Study

Should you have any questions or concerns about the study or if any issues arise because of your participation, please feel free to contact the Principal Investigator or Faculty Advisor:

Danielle Kofler **Email: danielle.kofler@mail.utoronto.ca**
Investigator **Phone: (416) 409-9072**

Dr. Abby Goldstein **Email: abbyl.goldstein@utoronto.ca**
Faculty Advisor **Phone: (416) 978-0703**

Appendix L: Debriefing Note

THANK YOU!

First, we want to thank you for your participation in this research. This study could not have happened without the involvement of emerging adults and we appreciate the time you took to be part of this work.

The purpose of this study was to better understand marijuana use patterns, motives, and consequences influence emerging adults. We hope this research was beneficial to you and that you learned something about your own patterns of behaviour and willingness to change behaviour. The overall goal of this research is to increase understanding of emerging adults' motives for marijuana use and to develop interventions and other programs to facilitate healthy transitions into adulthood.

Do you have any questions about the study?
If you have questions or wish to receive any additional information about the study, including summaries of our research findings and other resources related to this work, please feel free to contact the Principal Investigator, Danielle Kofler, at danielle.kofler@mail.utoronto.ca or the Faculty Supervisor, Dr. Abby Goldstein, at abbyl.goldstein@utoronto.ca or visit the Psychology of Emerging Adulthood Research Lab (PEARL) website at www.individual.utoronto.ca/agoldstein.

Appendix M: Clear Browser Instructions

THANK YOU FOR PARTICIPATING IN OUR STUDY!

To ensure confidentiality, we recommend doing the following, which will help remove any survey-related information from your computer and smartphone.

1. Delete any survey-related e-mails

   - Delete the email you sent and received from the ‘inbox,’ ‘sent’ and ‘trash’ folders of your email

2. Delete the daily survey app (RealLife Exp ®)

   - Android: Go to Apps shortcut at the bottom of screen → Click and hold on app → Menu will show the option to ‘Uninstall’ → Choose ‘Uninstall’ → App will be deleted

   - iPhone: Locate app on screen → Click and hold on app → App will wiggle → Click little X at the top left corner → App will be deleted

* Please feel free to save the Resource Sheet to your computer for future reference if you prefer

3. Clear the recent callers and/or callers list on your telephone or videoconference interface (if applicable)

Appendix N: HLM Model Equations

UNCONDITIONAL (NULL) MODEL:

Level-1 Model: $E(CONSEQUENCES_{ti}|\pi_i) = \lambda_{ti}$

$\log[\lambda_{ti}] = \eta_{ti}$

$\eta_{ti} = \pi_{0i}$

Level-2 Model: $\pi_{0i} = \beta_{00} + r_{0i}$

Mixed Model: $\eta_{ti} = \beta_{00} + r_{0i}$

Model 1: Negative mood (X), coping motives (M), and cannabis consequences (Y).

FULL MODEL:

Level-1 Model: $E(CONSEQUENCES_{ti}|\pi_i) = \lambda_{ti}$

$\log[\lambda_{ti}] = \eta_{ti}$

$\eta_{ti} = \pi_{0i} + \pi_{1i}*(NEGMOOD_{ti})$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(COPING_i) + r0_i$

$\pi_{1i} = \beta_{10} + \beta_{11}*(COPING_i)$

Mixed Model: $\eta_{ti} = \beta_{00} + \beta_{01}*COPING_i + \beta_{10}*NEGMOOD_{ti} + \beta_{11}*COPING_i*NEGMOOD_i + r_{0i}$

Model 2: Negative mood (X), sleep motives (M), and cannabis consequences (Y).

FULL MODEL:

Level-1 Model: $E(CONSEQUENCES_{ti}|\pi_i) = \lambda_{ti}$

$\log[\lambda_{ti}] = \eta_{ti}$

$\eta_{ti} = \pi_{0i} + \pi_{1i}*(NEG\_M_{ti})$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(CMMQ\_SLE_i) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(CMMQ\_SLE_i)$

Mixed Model: $\eta_{ti} = \beta_{00} + \beta_{01}*CMMQ\_SLE_i + \beta_{10}*NEG\_M_{ti} + \beta_{11}*CMMQ\_SLE_i*NEG\_M_{ti} + r_{0i}$

Model 3: Positive mood (X), enjoyment motives (M), and cannabis consequences (Y).

FULL MODEL:

Level-1 Model: $E(CONSEQUENCES_{ti}|\pi_i) = \lambda_{ti}$

$\log[\lambda_{ti}] = \eta_{ti}$

$\eta_{ti} = \pi_{0i} + \pi_{1i}*(POS\_M_{ti})$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(CMMQ\_ENJ_i) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(CMMQ\_ENJ_i)$

Mixed Model: $\eta_{ti} = \beta_{00} + \beta_{01}*CMMQ\_ENJ_i + \beta_{10}*POS\_M_{ti} + \beta_{11}*CMMQ\_ENJ_i*POS\_M_{ti} + r_{0i}$

Model 4: Positive mood (X), celebration motives (M), and cannabis consequences (Y).

FULL MODEL:

Level-1 Model:	E($CONSEQUENCES_{ti}$|π_i) = λ_{ti}
	log[λ_{ti}] = η_{ti}
	$\eta_{ti} = \pi_{0i} + \pi_{1i}*(POS\_M_{ti})$
Level-2 Model:	$\pi_{0i} = \beta_{00} + \beta_{01}*(CMMQ\_CEL_i) + r_{0i}$
	$\pi_{1i} = \beta_{10} + \beta_{11}*(CMMQ\_CEL_i)$
Mixed Model:	$\eta_{ti} = \beta_{00} + \beta_{01}*CMMQ\_CEL_i + \beta_{10}*POS\_M_{ti} +$ $\beta_{11}*CMMQ\_CEL_i*POS\_M_{ti} + r_{0i}$

Effect Size Calculations

Null model (only with Y = Consequences): $ICC = \frac{\tau_{00}}{\tau_{00} + \sigma^2}) = \frac{1.38}{1.38 + 1.10}$ =.444

Negative mood effect size: $r^2 = \frac{(\sigma^2_{null} - \sigma^2_{random})}{\sigma^2_{null}} = \frac{(1.10-1.05)}{1.10}$ = .0454

Positive mood effect size: $r^2 = \frac{(\sigma^2_{null} - \sigma^2_{random})}{\sigma^2_{null}} = \frac{(1.10-1.07)}{1.10}$ = .0273

Coping main effect: means as outcomes model

$$r^2 = \frac{(\tau^2_{null} - \tau^2_{means})}{\tau^2_{null}} = \frac{(1.38-0.93)}{1.38} = .326$$

Sleep main effect: means as outcomes model

$$r^2 = \frac{(\tau^2_{null} - \tau^2_{means})}{\tau^2_{null}} = \frac{(1.38-1.26)}{1.38} = .087$$