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Personality Pathology Severity and Hazardous Cannabis Use: Does Instability in Daily Life Mediate This Association?

Nicole Elizabeth Ellerbeck
Syracuse University

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Abstract

Comorbidities between personality pathology and cannabis use disorders among young adults are a growing public health concern. Young adulthood is the period in which personality pathology and associated dysfunction peak, and evidence suggests personality pathology contributes to substance abuse behaviors. However, the *specific* aspects of personality pathology that explain these associations remain unclear. Personality disorders tend to share in common three domains of dysregulation that are marked by instability in self-esteem (identity), affect, and interpersonal experiences. This study investigated whether these common domains of personality dysfunction mediated associations between personality pathology severity and patterns of cannabis use. The current study used data from a community-based sample of 186 young adults (ages 18-30; mean age = 21.09 years [*SD* = 2.35], 60% female, 72% White; 74% college students) who reported using cannabis at least twice per month over the past six months. Momentary data on psychological states and cannabis use were collected via 8 daily surveys over 21 days. Mediation analyses showed indirect effects of personality pathology severity on hazardous cannabis use through within-day instability in self-esteem and in interpersonal experiences, but not through instability in affect. Further, participants with greater personality pathology demonstrated greater instability, but instability was associated with *less* hazardous cannabis use. These unexpected results emphasize the need to consider interpersonal and identity-related constructs in research examining contributors to comorbid cannabis and personality pathology. Instability in self-esteem and in interpersonal experiences should be explored further in future studies, as they may be targets for clinical intervention in young adults with personality pathology who hazardously use cannabis.

Keywords: Personality disorders, instability, cannabis use, young adults

PERSONALITY PATHOLOGY SEVERITY AND HAZARDOUS CANNABIS USE:

DOES INSTABILITY IN DAILY LIFE MEDIATE THIS ASSOCIATION?

by

Nicole E. Ellerbeck

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Thesis

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Personality disorders and substance use disorders are highly comorbid and prevalent among young adults (APA, 2013; Chabrol, Ducongé, Casas, Roura, & Carey, 2005). These associations are not limited to clinical samples, as sub-threshold levels of personality pathology (e.g., pathological personality traits) place young adults at greater risk of substance abuse (Chabrol et al., 2005; Buckner & Cohen, 2012; Mass, Bardong, Kindl, & Dahme, 2001). These high rates of comorbidity have led to difficulty treating clients who present with both forms of psychopathology; clients with comorbid personality pathology experience worse treatment outcomes than clients without (Skodol, Oldham, & Gallaher, 1999). Longitudinal evidence suggests subthreshold and clinically severe symptoms of personality disorders precede the onset and maintenance of substance use disorders (Hasin et al., 2016; Raynal & Chabrol, 2016; Schiffman et al., 2005). *How* this occurs, however, is unclear and remains a barrier to developing effective treatments tailored to this comorbidity. Clarifying the processes that explain associations between personality pathology and substance use would allow these processes to be targeted in clinical interventions and improve treatment outcomes. Evidence suggests affective, self-esteem, and interpersonal dysregulation—three central domains of psychological functioning that are impaired in personality pathology—play roles in substance use and resulting problems (Dvorak & Day, 2014; Khantzian, 1997; Moskowitz & Young, 2008; Yang et al., 2018). However, studies have not yet examined all of these processes and their relations to substance use in the context of personality pathology. Thus, this study investigated whether these central domains of personality dysfunction mediate associations between personality pathology severity and patterns of cannabis use in a sample of young adults.

Dysregulation in affective, identity (e.g., self-esteem), and interpersonal experiences are believed to lie at the core of personality disorders, which peak in young adulthood (American Psychiatric Association, 2013; Pincus, 2010). In the context of personality pathology, dysregulation manifests not only through more extreme chronic levels of psychological states (e.g., low mean levels of positive affect), but also through within-day *instability* in these states (e.g., rapid shifts between negative and positive affects, warm and cold behaviors and perceptions, and between low and high self-esteem; APA, 2013; Dimaggio, Nicolò, Semerari, & Carcione, 2013; Morey, 2017). These realms of instability distinguish personality disorders from other psychiatric disorders and are incrementally associated with maladaptive psychosocial outcomes (e.g., psychological distress and socio-emotional dysfunction; Ebner-Priemer et al., 2007; Kamen, Pryor, Gaughan, & Miller, 2010). In fact, instability in psychological states may play a larger role than overall levels in explaining links between personality pathology and harmful behaviors with regulatory functions (e.g., nonsuicidal self-injury and eating disordered behaviors; Armey, Crowther, & Miller, 2011; Bentley, Nock, & Barlow, 2014; Côté et al., 2012; Erickson, Newman, & Pincus, 2009; Kernis, Paradise, Whitaker, Wheatman, & Goldman, 2000; Nock, 2009). Although there is substantial research exploring links between affective instability and substance use, however, few studies have examined the arguably equally important roles of instability in self-esteem and interpersonal experiences.

Substance Use and Substance Use Disorders

It is estimated that 17.8% of adults in the United States meet criteria for a substance use disorder (Grant et al., 2004). Young adults (18-30 years old) have especially high rates of substance abuse (SAMHSA, 2014), most commonly using alcohol, cannabis, and tobacco (Redonnet, Chollet, Fombonne, Bowes, & Melchior, 2012). Individuals who meet criteria for

substance use disorders continue to use one or more substances despite experiencing several forms of psychosocial dysfunction stemming from their use (APA, 2013). Dysfunction manifests via negative consequences of continued substance use, such as interpersonal and occupational dysfunction, unsuccessful attempts to reduce use, and physiological withdrawal symptoms (APA, 2013). Substance use disorders are multifaceted; diagnostic criteria include items that not only reflect substance-related problems, but also frequency and quantity used (APA, 2013; Adamson et al., 2010; Grant et al., 2003). Much research suggests that individuals who use substances frequently and heavily are at high risk of developing substance use-related problems (Adamson et al., 2010; Cuttler & Spradlin, 2018; Pearson, 2018). A standard threshold for hazardous cannabis use, which is becoming an increasingly popular substance, has not yet been established due to cannabis' illegality on a federal level (Weiss, 2018). However, recent studies suggest that cannabis users who smoke the equivalent of two or more joints on days of use experience more cannabis-related problems (e.g., health, social, legal, or financial problems due to use) than those who smoke less (Asbridge, Duff, Marsh, & Erickson, 2014; Looby & Earleywine, 2007; Zeisser et al., 2012). Although preliminary, these findings are consistent with links between excessive consumption of other substances (e.g., binge drinking) and increased risk of negative outcomes (White, Tapert, & Shukla, 2018).

Rates of cannabis use (Wu, Brady, Mannelli, Killeen, & Workgroup, 2014), cannabis use disorders (Degenhardt et al., 2013; SAMHSA, 2014), and the number of cannabis users seeking treatment for cannabis use disorders (United Nations Office on Drugs and Crime, 2015) have been rising among young adults. Most young adults in the United States report using cannabis at least once in their lifetime, with 35% reporting use in the past year, and 20% reporting use in the last month (SAMHSA, 2014). In fact, whereas rates of cannabis use are rising among young

adults, rates of alcohol use (Lanza, Vasilenko, & Russell, 2016) and binge drinking

(Guttmannova et al., 2016) are declining. Substance use disorders, especially cannabis use

disorders, are highly prevalent in individuals with personality pathology (e.g., Skodol et al.,

1999). For instance, Skodol and colleagues (1999) found that cannabis and alcohol are the most

commonly abused substances among individuals diagnosed with personality disorders. Although

much research has explored the association between personality pathology and hazardous

alcohol use (e.g., Morgenstern, Langenbucher, Labouvie, & Miller, 1997; Ruan et al., 2008; Sher

& Trull, 1994; Verheul, van den Brink, & Hartgers, 1998), research on personality pathology and

cannabis use is comparatively scarce. Given the increasing rates of cannabis use and associated

disorders among young adults (Lanza et al., 2016; Degenhardt et al., 2013), it is clinically

important to explore *why* young adults with personality pathology commonly abuse cannabis.

Personality Pathology and Substance Abuse

Epidemiological data suggests that approximately 15% of adults in the United States

meet criteria for one or more personality disorders, and an additional 12% of adults have

subthreshold levels of personality pathology (APA, 2013; Grant et al., 2004; Pulay et al., 2008).

Personality disorder symptoms peak in young adulthood (Stone, 1990; Trull, 1995), and young

adults with subthreshold and clinically severe personality pathology have strikingly high rates of

substance use and substance use disorders (Chabrol et al., 2005; Ebner-Priemer et al., 2007;

Stinson et al., 2008; Walter et al., 2009). For example, longitudinal studies suggest that over 40%

of participants with personality disorder diagnoses also meet criteria for a lifetime drug abuse or

dependence disorder (McGlashan et al., 2000). Other studies suggest even greater rates of

comorbidity (e.g., up to 78% between borderline personality disorder and a lifetime substance

use disorder within the community; DeJong, Van den Brink, Harteveld, & van der Wielen, 1993;

Tomko, Trull, Wood, & Sher, 2014). These associations are evident across a wide range of personality disorders (e.g., antisocial personality disorder, schizotypal personality disorder, and borderline personality disorder) and are not limited to clinical populations (Chabrol et al., 2005; Compton, Saha, Conway, & Grant, 2009; Raynal & Chabrol, 2016). These associations are also apparent in students and young adults from the community with elevated albeit subthreshold levels of personality pathology (e.g., Chabrol et al., 2005; Flory, Lynam, Milich, Leukefeld, & Clayton, 2002; Mass et al., 2001; Najolia, Buckner, & Cohen, 2012). For instance, Mass and colleagues (2001) found that undergraduates who use cannabis regularly demonstrate greater levels of schizotypy, relative to occasional and non-using students; similar links between pathological personality traits and markers of cannabis abuse have been replicated in other non-clinical samples (e.g., Dumas et al., 2002; Schiffman, Nakamura, Earleywine, & LaBrie, 2005) and demonstrate that this comorbidity occurs across a spectrum of personality pathology severity (i.e., at subthreshold and clinical levels).

Treating psychosocial dysfunction associated with comorbid personality and substance use psychopathology has proven difficult. Substance use disorders are primary causes of early deaths in individuals with personality pathology (Dickey, Dembling, Azeni, & Normand, 2004). When personality pathology co-occurs with substance use disorders, these dual diagnoses are associated with poorer social and emotional functioning, greater risk for suicidal behavior, higher rates of treatment dropout or non-compliance and greater rates of relapse than when alone (Compton III et al., 2003; O'Boyle & Brandon, 1998; Yen et al., 2003; Marlowe et al., 1997; Ross et al., 2003; Skodol et al., 1999). Researchers have acknowledged the challenges of efficiently treating this population and the need for specialized treatment interventions that address personality pathology in addition to substance use behaviors (Flynn & Brown, 2008). In

fact, the high rates of comorbidity between personality pathology and substance use disorders have been so evident that researchers recommend screening patients who present with substance use problems for maladaptive personality traits, to address the personality pathology in treatment (Cohen, Chen, Crawford, Brook, & Gordon, 2007; Verheul, 2001).

Longitudinal studies indicate that personality pathology may precede, maintain, and exacerbate problematic substance use (e.g., Hasin et al., 2016; Raynal & Chabrol, 2016; Schiffman et al., 2005). For instance, the likelihood of meeting criteria for a substance use disorder increases as a function of personality pathology severity, and symptoms of personality pathology precede the onset of cannabis use in young adults from the community (Schiffman et al., 2005; Pulay et al., 2008; Raynal & Chabrol, 2016). In addition, DSM-IV personality disorders, unlike Axis I disorders (e.g., mood disorders), are strongly associated with the persistence of substance use disorders over the course of three years (Hasin et al., 2016). Indeed, personality disorder criteria have strong associations with risk of developing alcohol use disorders, and these associations tend to remain stable over time (Long et al., 2017).

The strong associations between personality pathology and hazardous substance use are therefore evident; the mechanisms that explain these associations and these associations' directionalities, however, are unclear. For instance, it is unclear whether and how cannabis affects psychological processes associated with personality pathology—that is, whether cannabis affects psychological processes that are compromised by personality pathology and, in turn, reinforces use. It is possible that dysfunctional processes associated with personality pathology (e.g. realms of dysregulation marked by instability) promote hazardous substance use and are not being targeted in treatment; thus, it is crucial to identify the specific processes which explain associations between personality pathology and hazardous substance use behaviors, so that these

processes may be incorporated into clinical interventions. Given that personality pathology has been found to precede substance abuse, another hypothesis is that individuals with more severe personality pathology experience greater dysregulation in several associated psychological realms (i.e., affective, self-esteem, and interpersonal experiences) and in turn self-medicate through substance use. This is consistent with theory and empirical evidence, which support the notion that individuals regulate unwanted affective, interpersonal, and self-esteem experiences through the effects of substances (Khantzian, 1997, 2003; Schindler et al., 2005; Thorberg & Lyvers, 2010; Towberman & McDonald, 1993). This hypothesis is also consistent with strong links between emotional, interpersonal, and identity problems, and substance abuse (e.g., Briere & Runtz, 2002; Grilo et al., 1997; Trull et al., 2000). As will be discussed in further detail below, however, few studies have simultaneously examined how within-person variability, or instability, in these regulatory processes relate to substance use in daily life.

Affective instability, which is a pathological personality trait, has been suggested to underlie frequent comorbidities between personality pathology and substance use disorders (Krueger et al., 2011; Santangelo, Bohus, & Ebner-Priemer, 2014; World Health Organization, 2016). Indeed, emotion dysregulation— in the form of affective instability—characterizes personality pathology and may maintain substance use by motivating individuals to use substances to regulate affect (APA, 2013; Cooper, Frone, Russell, & Mudar, 1995; Russell, Moskowitz, Zuroff, Sookman, & Paris, 2007; Simons & Carey, 2002). However, emotion dysregulation may not be the only process related to personality pathology that promotes hazardous substance use behaviors. Greater personality pathology severity is believed to increase dysregulation in three realms of psychological experience – affective, self, and interpersonal dysregulation— regardless of the type of personality disorder or traits (Morey, Benson, &

Skodol, 2016). Thus, it may be fruitful to consider the role of all three dysregulation processes in the maintenance of substance use. These forms of dysregulation are characterized by acute shifts ('instability') in affective valence (pleasantness; Russell et al., 2007), in self-esteem (Zeigler-Hill, 2006; Zeigler-Hill, Clark, & Pickard, 2008), and in behaviors and perceptions (warmth and dominance across social interactions; Russell et al., 2007) among individuals with personality pathology. Studies examining dysregulation in affective arousal have been mixed, with some suggesting that some forms of personality pathology (e.g., borderline and antisocial personality disorder) are characterized by low autonomic reactivity (low arousal in response to fear-inducing stimuli; Herpertz, Kunert, Schwenger, & Sass, 1999; Raine, Lencz, Bihrle, LaCasse, & Colletti, 2000), and others suggesting the opposite (Putnam & Silk, 2005).

Treating only one domain of dysregulation (e.g. affective dysregulation) may be ineffective, as several domains may promote hazardous substance use and thus require unique treatment modules. In this context, substance use may temporarily alleviate several states of dysregulation experienced by individuals with personality pathology. In sections below, I briefly review three realms of dysregulation (affective, self-esteem, and interpersonal dysregulation) that have been linked with an array of adverse psychosocial outcomes and maladaptive behaviors in individuals with personality pathology. These behaviors have been hypothesized to function as maladaptive strategies that individuals with personality pathology use to cope with aversive psychological states and, like substance use, can be addictive due to their powerful reinforcement contingencies. It thus follows that these realms of dysregulation may similarly drive individuals with personality pathology to use substances.

Affective Instability

Research has increasingly focused on the distinct role of affective dysregulation as a risk factor for substance abuse. Affective regulation refers to how well individuals can evaluate, express, and modify their inner emotional states (Farmer & Kashdan, 2012; Gratz & Roemer, 2004; Gratz, Rosenthal, Tull, Lejuez, & Gunderson, 2006; Gross & John, 2003). In individuals with personality pathology, affective dysregulation manifests not only as chronically high levels of negative affect, but also as rapid within-day fluctuations between positive and negative affect states (Russell et al., 2007). Affective regulation is an essential component of successful psychosocial functioning in daily life (Farmer & Kashdan, 2012; Tugade & Fredrickson, 2007), and dysregulation in this domain has been linked to several negative outcomes, such as non-suicidal self-injury (Vansteelandt et al., 2013), suicidal ideation and greater number of suicide attempts (Esposito, Spirito, Boergers, & Donaldson, 2003; Rajappa, Gallagher, & Miranda, 2012; Zlotnick, Donaldson, Spirito, & Pearlstein, 1997), and greater psychological maladjustment (Gruber, Kogan, Quoidbach, & Mauss, 2013; Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007). Affective dysregulation is a defining feature of personality pathology, and extreme shifts in mood are sensitive to environmental factors (APA, 2013; Glenn & Klonsky, 2009; Herpertz et al., 1997; Hopwood, Wright, Ansell, & Pincus, 2013; Rhodewalt, Madrian, & Cheney, 1998; Sadikaj, Russell, Moskowitz, & Paris, 2010; Trull et al., 2008). For example, individuals diagnosed with borderline personality disorder not only report greater average levels of unpleasant affect, but also greater shifts in the intensity and valence of their emotional states relative to healthy controls (Russell et al., 2007). Similar findings exist across other forms of personality pathology, including narcissistic, histrionic, avoidant, dependent, and paranoid personality disorders, as well as across sub-threshold levels of personality pathology

(Bach, Anderson, & Simonsen, 2017; Fossati, Krueger, Markon, Borroni, & Maffei, 2013; Sellbom, Anderson, & Bagby, 2013; Shedler & Westen, 2004; Yen, Zlotnick, & Costello, 2002).

Affective dysregulation is aversive, an important risk factor for abuse across a wide variety of substances, and may drive several maladaptive behaviors that have regulatory functions (Axelrod, Perepletchikova, Holtzman, & Sinha, 2011; Fox, Hong, & Sinha, 2008; Vansteelandt, Probst, & Pieters, 2013; Weiss, Bold, Sullivan, Armeli, & Tennen, 2017; Yang et al., 2018). For example, Dvorak and Day (2014) found that young adults who reported greater emotion dysregulation were at greater risk of developing frequent, cannabis-related problems. Emotion regulation deficits have been observed in regular cannabis users (Zimmermann et al., 2017), and emotion regulation is one of the most frequently endorsed motives for cannabis use among young adults (Parnes, 2018). Several studies suggest cannabis users who experience affective dysregulation experience difficulty reducing their cannabis consumption and are at high risk of developing frequent cannabis-related problems (Buckner, Walukevich, Zvolensky, & Gallagher, 2017; Dvorak & Day, 2014). The notion that emotion dysregulation drives hazardous substance use is widely accepted (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Cooper et al., 1995; Hayes, Strosahl, & Wilson, 2002). Research in this area has identified links between affective dysregulation (indexed as within-day instability in affective valence) and alcohol use, and suggests these links are stronger in individuals with personality pathology (e.g., borderline personality disorder; Jahng et al., 2011). In sum, marked affective shifts that individuals with personality pathology experience may lead them to be especially prone to using substances in order to regulate these emotions. Affective dysregulation (instability) should therefore be explored as a factor that mediates associations between personality pathology and cannabis use.

Instability in Interpersonal Behaviors and Perceptions

Individuals with personality pathology frequently present with interpersonal dysregulation (APA, 2013; Skodol et al., 2011), a core hallmark of personality pathology (Hopwood et al., 2013; see Wilson, Stroud, & Durbin, 2017 for a review on interpersonal dysfunction associated with personality disorders). Whereas researchers previously theorized that the interpersonal dysfunction associated with personality pathology manifests via rigid patterns of social behavior and perceptions, recent research suggests that *instability* in behaviors and perceptions across interactions mark social dysfunction across several forms of personality pathology (e.g., borderline, histrionic, and avoidant personality disorder; Ellerbeck et al., 2016; Horowitz, 2004; Leising, Sporberg, & Rehbein, 2006; Russell et al., 2007). For example, several pathological personality traits and borderline personality disorder have been associated with variable behavioral expressions across social interactions (e.g., behaving with warmth and submissiveness in one interaction, and with coldness and dominance in the next; Russell et al., 2007; Ellerbeck & Ansell, 2015a), and this variability is in turn associated with a variety of negative outcomes, such as social maladjustment (Bagge et al., 2004), interpersonal distress (Erickson et al., 2009), social relationships that are more distant (Côté et al., 2012), and lower satisfaction in romantic relationships (Sadikaj et al., 2015). Unstable interpersonal perceptions (e.g., perceiving others as "all-good" or friendly at one moment and "all-bad" or hostile at another) is consistent with maladaptive psychological defenses (e.g., splitting) and social-cognitive deficits that have been linked with several personality disorders and pathological personality traits (Domes, Schulze, & Herpetz, 2009; Rodrigues & Ansell, 2015). Interestingly, research suggests that individuals with specific pathological personality traits and insecure attachment styles demonstrate greater variability in their behavioral warmth and dominance across social interactions, potentially to mitigate closeness in relationships (Ellerbeck & Ansell,

2015a; Ellerbeck & Ansell, 2015b). This is consistent with robust links between insecure attachment styles, personality pathology, and substance use (Dozier, Stovall, & Albus, 1999; Fairbairn et al., 2018; McCrady, 2008). Interestingly, substance use disorders have been conceptualized as an attachment disorder (Flores, 2001; Padykula & Conklin, 2010). Given that interpersonal dysregulation (i.e., instability in behaviors and perceptions) is a core hallmark of personality pathology that has been associated with attachment difficulties, examining interpersonal processes in the context of personality pathology and substance use may be fruitful.

Maladaptive interpersonal processes are hypothesized to drive reward-motivated behaviors such as hazardous substance use (Armeli, Dehart, Tennen, Todd, & Affleck, 2007; DeHart, Tennen, Armeli, Todd, & Mohr, 2009; Larimer, Palmer, & Marlatt, 1999; Mohr et al., 2001; Todd, Armeli, & Tennen, 2009). Studies examining interpersonal risk factors of substance use have focused on the role of behaviors and perceptions, but few have explicitly examined how within-day *instability* in these behaviors and perceptions relates to substance use (Florsheim & Moore, 2008; Aan Het Rot, Russell, Moskowitz, & Young, 2008). Social interactions between romantic partners with substance use disorders are characterized not only by greater overall hostility, but also variable blends of warmth and dominance, which in turn are associated with reduced relationship satisfaction (Florsheim & Moore, 2008; Floyd, Daugherty, Fitzgerald, Cranford, & Zucker, 2006). Interpersonal dysregulation is especially pronounced in individuals with personality pathology and may lead these individuals to use substances more heavily to compensate for resulting compromised interpersonal relationships. However, no research has examined associations between substance use and interpersonal instability within the context of daily life. Bridging this gap is essential, as interpersonal instability disrupts closeness in relationships to a larger extent than stable behaviors and perceptions—even when these

behaviors and perceptions are consistently hostile (Côté et al., 2012). Although interpersonal dysregulation may promote substance abuse through its effects on affect, associations between substance use and interpersonal dysregulation are only partially explained by emotion dysregulation (Armeli, Tennen, Affleck, & Kranzler, 2000). Thus, interpersonal dysregulation appears to be a related yet separate phenomenon that may lead to substance use.

Instability in Self-Concept

Identity disturbances are the third domain of dysregulation that characterize personality pathology (Tolpin, Gunthert, Cohen, & O'Neill, 2004; Zeigler–Hill & Abraham, 2006; Zeigler-Hill, Chadha, & Osterman, 2008; Zeigler□Hill et al., 2008), and may be an additional process that explains substance use. Regulation of one's sense of self reflects the extent to which individuals effectively manage their self-concept; that is, how they view and feel about themselves across situations (Hopwood et al., 2013). Individuals with personality pathology experience notable identity disturbances (Hopwood et al., 2013), and this realm of dysregulation can present as self-esteem instability in daily life. Self-esteem instability reflects the extent to which an individual has a "strong (vs. weak) sense of self" (p. 1583, Kernis, 2005) and differentiates between personality pathology and other psychopathologies (APA, 2013; Fukushima & Hosoe, 2011; Kanske et al., 2016; Peled, Bar-Kalifa, & Rafaeli, 2017; Rhodewalt et al., 1998; Santangelo et al., 2017; Zeigler–Hill & Abraham, 2006). Indeed, people with stable and high levels of self-esteem demonstrate better-developed self-concepts and better psychosocial functioning compared to those with unstable levels of self-esteem (Kernis, 2005).

Pathological narcissism and features of borderline personality disorder have been associated with greater self-esteem instability in community and clinical samples (Fukushima & Hosoe, 2011; Geukes et al., 2017; Rhodewalt et al., 1998; Santangelo et al., 2017; Tolpin et al.,

2004; Zeigler–Hill & Abraham, 2006). Self-esteem instability is uniquely associated with psychosocial outcomes and suggests one's sense of self-worth is highly contingent on environmental factors; this may subsequently lead to maladaptive behaviors, such as hazardous drug use (Crocker, 2002; Kernis, 2005; Roberts & Monroe, 1992; Savin-Williams & Demo, 1983; Waschull & Kernis, 1996). Researchers have acknowledged the reinforcing effects of substance use on self-esteem, as substance use can temporarily increase levels of self-esteem (Khantzian, 1987; Khantzian & Khantzian, 1984). Instability in self-esteem may lead individuals to engage in hazardous substance use in order to cope with resulting unpleasant affective states (Khantzian, 1997; Shedler & Block, 1990). It is important to note that although self-esteem and affect tend to covary, they are distinct constructs and not necessarily dependent on the existence of one another (Nezlek, 2005).

Although much literature has highlighted the relevance of *low* self-esteem to hazardous substance use, no research to date has examined how self-esteem *instability* promotes hazardous substance use in individuals with personality pathology (e.g., Baumeister, Campbell, Krueger, & Vohs, 2003; Dielman, Campanelli, Shope, & Butchart, 1987; Stein, Leslie, & Nyamathi, 2002). Fluctuations in self-esteem are especially evident in individuals with personality pathology, and these individuals may find substance use particularly reinforcing. Frequent and marked within-day shifts in self-esteem (e.g., feeling good versus badly about oneself depending on the context) are more psychologically threatening than patterns that are more stable (Seery, Blascovich, Weisbuch, & Vick, 2004), and substance use may regulate self-esteem (Khantzian, 1997). It is important to note that self-esteem instability is evident in not only clinical populations with personality disorder diagnoses, but also in community samples with features of personality pathology, such as pathological narcissistic traits (Zeigler–Hill & Abraham, 2006; Zeigler-Hill et

al., 2008). Thus, self-esteem instability may be a symptom of personality pathology that explains hazardous substance use even in individuals with sub-threshold levels of personality pathology.

Intensive Repeated Measurement and Intraindividual Variability

Research on instability in psychological states is often conducted using intensive repeated measurement designs because they allow one to examine intraindividual variability in states across time. Much intensive repeated measurement research has examined affective, self, and interpersonal dysregulation in daily life by examining *intraindividual variability* in affective, self, and interpersonal states. Intraindividual variability reflects the extent to which an individual's psychological states and/or behaviors fluctuate over time. In other words, someone with high affective intraindividual variability would report greater shifts in the intensity and/or type of affect across time points compared to someone with low affective intraindividual variability. As mentioned earlier, instability in all three of these processes have also been linked with maladaptive behaviors which alleviate momentary disruptions in these states (e.g., nonsuicidal self-injury and restrictive eating; Adrian, Zeman, Erdley, Lisa, & Sim, 2011; Brown, Comtois, & Linehan, 2002; Hilt, Nock, Lloyd-Richardson, & Prinstein, 2008; Vansteelandt et al., 2013).

Intensive repeated measurement in daily life minimizes the effects of retrospective bias on reports (Stone et al., 1998) and advantageously allows assessment of psychological states and behaviors *in the moment*. With regard to measures that are administered at one time-point to assess dynamic constructs (i.e. affective lability), Beal and Weiss (2003) have stated, "It is clear that many relationships at the aggregate level are really summaries of processes that play out at a momentary level within defined time frames" (p. 442, Beal & Weiss, 2003). An immense amount of research has used intensive repeated measurement to clarify dynamic psychological

processes that are linked with various forms of psychopathology, such as personality disorders (Aan Het Rot, Hogenlst, & Schoevers, 2012; Moskowitz & Young, 2006; Ram, Conroy, Pincus, Hyde, & Molloy, 2012; Roche, Pincus, Rebar, Conroy, & Ram, 2014; Russell et al., 2007; Shiffman, Stone, & Hufford, 2008; Trull & Ebner-Priemer, 2009). However, no studies have yet used intensive repeated measurement data to *simultaneously* examine several realms of dysregulation in relation to personality pathology and hazardous substance use.

Study Aims and Hypotheses

Affective, self-esteem, and interpersonal dysregulation are core hallmarks of personality pathology that may explain the concerningly high rates of substance abuse among young adults, who have the highest rates of personality disorders. Previous studies examining psychological processes linked with substance use have predominantly focused on the role of affective dysregulation rather than multiple clinically relevant realms of dysregulation (i.e., interpersonal and self-dysregulation). This is problematic, given that the presence of interpersonal and self-esteem dysregulation are shared across many forms of personality pathology (APA, 2013) and are frequently targeted in treatment to reduce psychosocial distress and impairment (Kohut, 2013; Linehan, 2014; Morey et al., 2011). These realms of dysregulation have been found to drive several harmful behaviors that serve self-soothing and regulatory functions (e.g., nonsuicidal self-injury) and may be overlooked targets for clinical intervention (Santangelo et al., 2017).

The goals of the proposed study were to: 1) Determine whether unstable interpersonal, self, and affective regulatory processes in daily life mediate associations between personality pathology severity and the quantity and frequency of cannabis use, and 2) Clarify the directionality of these associations. The current study used intensive repeated measurement data

from cannabis users to examine whether within-day instability in affective, self-esteem, and interpersonal experiences and their average levels mediate associations between self-reported personality pathology severity and facets of cannabis use (i.e., frequency of use over 21 days, total quantity used over 21 days, and maximum quantity used within one day. First, indirect effects of personality pathology severity on facets of cannabis use when each affective, interpersonal, and self-esteem mediator was considered in isolation were examined. Then, models tested whether indirect effects were maintained when all other affective, self-esteem, and interpersonal mediators are simultaneously controlled for. Finally, models with significant indirect effects were tested in the reverse direction in order to clarify the directionality of these effects. Based on previously identified associations between personality pathology, psychological instability, and quantity and frequency of cannabis use, and cannabis-related problems (Simons & Carey, 2002; Gillespie et al., 2018; Russell et al., 2007; Wright, Hopwood, & Simms, 2015; Zeigler-Hill, 2011), it was hypothesized that all indices of instability (especially instability in affective valence) and mean affective valence (low positive affect) would mediate positive associations between personality pathology severity and hazardous cannabis use. Given that aversive affective valence states (i.e., low positive affect) and fluctuations in these states may drive heavier and more frequent cannabis use (Dvorak & Day, 2014; Parnes, 2018), it was also hypothesized that mean affective valence and instability would be the strongest mediators of the aforementioned associations. Due to the lack of research examining associations between instability in affective arousal and cannabis use, no hypotheses were made about the potential mediating role of (instability in) affective arousal.

Importance and Clinical Implications

In sum, longitudinal studies suggest that the presence of personality pathology adversely affects the trajectory of substance use outcomes; however, the processes that explain these associations are poorly understood. This will be the first study to simultaneously examine several psychological processes that may explain associations between personality pathology and hazardous cannabis use. Findings from the current study will ideally inform clinicians of the most salient and impactful pathological processes to target in substance users with comorbid personality pathology. If study results suggest that associations between personality pathology and substance use are better explained by other mechanisms (e.g., self-esteem or interpersonal dysregulation), this may warrant adjustments in treatment recommendations for young adults with comorbid personality and substance use psychopathology.

Method

Participants

Data were collected in the parent study (R01DA039924), which examined naturalistic experiences of 265 young adults (mean age = 21.09 [*SD* = 2.33], 56% female, 66% Caucasian, 92.50% college students) from the university community. Participants were compensated with cash, prorated based on the number of laboratory sessions and naturalistic surveys completed. Participants were eligible if they were: (1) 18-30 years of age; (2) used cannabis at least 2 occasions per month for the past 6 months; (3) able to read and write in English; (4) able to provide negative toxicology screenings for substances except cannabis, nicotine, alcohol, and prescribed medications at intake. Participants were ineligible if they: (1) met criteria for a current or past severe substance use disorder (dependence) other than nicotine; (2) had any current Axis I psychiatric disorders with acute symptoms (i.e. psychosis, suicidal, homicidal, current mania) that required treatment or medication; (3) were pregnant or nursing women. A subset of 180

participants (mean age = 21.09 [SD = 2.35], 58% female, 72% Caucasian, 92.80% college students) who reported cannabis use over the 21-day intensive repeated measurement period were selected for data analysis (see Data Analytic Strategy).

Study Procedures

All study procedures were approved by the Institutional Review Board at Syracuse University. Participants provided informed consent and demographic data at an initial intake appointment via interview. At a second appointment ("day 0" of the intensive repeated measurement period), participants downloaded an app (Metricwire) onto their smartphones (or received a study smartphone if they did not have a compatible phone) and were trained on how to complete the following 21-day intensive repeated measurement phase of the study. A research assistant and the participant practiced completing all survey items together to standardize interpretations of survey items across all participants (e.g., definitions of "face-to-face or voice-to-voice" social interactions). After completing the 21-day naturalistic phase of the study, participants returned to the laboratory for their third and final appointment to complete personality pathology assessments (including a structured clinical interview of personality disorders that was conducted by a trained research assistant) and to receive compensation for their (up to $339) participation.

Of the 265 participants who provided informed consent, 23 did not participate in the intensive repeated measurement phase of the study due to eligibility issues or due to withdrawing from the study prior to their second appointment. Eight participants withdrew or were withdrawn by the principal investigator during the intensive repeated measurement phase due to non-responsiveness. 17 participants did not complete the personality pathology index because it was

added to the study after their participation, leaving 217 participants who provided data on personality pathology and naturalistic states over 21 days.

Intensive Repeated Measurement Procedures

The intensive repeated measurement phase of the study involved completing 8 electronic surveys per day over the course of 21 days. Participants were instructed to complete one event-contingent survey as soon as they woke up and another in the evening before going to bed. In addition, they completed six randomly prompted surveys throughout the day between 9 AM and 9 PM. All surveys were time-stamped and contained items that assessed momentary levels of self-esteem and affect. Additionally, all surveys prompted participants to report the occurrence of any of the following events: Face-to-face or voice-to-voice social interactions, and any unprescribed substance use. If participants endorsed any of those events, survey logic branched to items that examined characteristics of these events (e.g., substance use quantity). Filler items were used across surveys to ensure that participants who did not endorse these events received a similar number of survey items as those who did. Participants were paid $50 for attending the intake appointment, $1 per waking or randomly prompted survey, $2 per end of day survey, and were given a bonus for each week of 95% or greater compliance ($50 per week) during the 21-day period.

Measures

Laboratory measures.

Demographics. Participants reported demographic information, including age, *sex* (0 = *female*, 1 = *male*), race (0 = *Caucasian,* 1 = *African American*, 2 = *Hispanic*, 3 = *Other*, 4 = *Asian*), ethnicity (0 = *Not Hispanic/Latino*, 1 = *Hispanic/Latino*), highest level of education completed (1 = *Grade school*, 2 = *Vocational training beyond high school*, 3 = *Some college*, 4 =

Four-year college/university degree, 5 = *Graduate or professional degree*), and annual

household income (1 = *Less than $25,000*, 2 = *$25,000-$34,999*, 3 = *$35,000-$44,999*, 4 =

$45,000-$54,999, 5 = *$55,000-$69,999*, 6 = *$70,000-$84,999*, 7 = *$85,000-$99,999*, 8 =

$100,000-$149,999, 9 = *Greater or equal to $150,000*).

   Personality pathology severity (self-report). The Levels of Personality Functioning

Scale-Self Report (LPFS-SR) is an 80-item self-report instrument that assesses personality

pathology severity, and was developed in accordance with the Alternative Model for DSM-5's

conceptualization of personality disorders (APA, 2013; Bender, Morey, & Skodol, 2011; Morey,

2017; Morey et al., 2011; Morey, Bender, & Skodol, 2013). Items on this measure tendencies

that are stable over time and across many situations (Morey et al., 2011; Morey et al., 2013).

Responses to items range from 1 ("Totally False, Not at all True") to 4 ("Very True"), with

higher scores indicating greater impairment in one or more of four subcomponents of

personality: Empathy, intimacy, self-direction, and identity. Established non-clinical norms

suggest that scores exceeding 308.8 (1 SD above the mean) reflect sub-clinical problems and that

scores exceeding 347.1 (1.5 SDs above the mean) reflect clinically significant dysfunction

(Morey et al., 2013; Morey, 2017). These four domains of personality dysfunction are highly

interrelated, correlated with other personality disorder constructs, and rotate down to a single

factor in oblique rotations, suggesting they cumulatively capture a single homogeneous

dimension of personality pathology severity (Hopwood, Good, & Morey, 2018; Zimmermann et

al., 2015). Raw items from each subscale were weighted and then summed to produce a total

score, which reflects a global index of personality pathology severity that was used in analyses.

This measure has demonstrated good reliability and convergence with a wide variety of

assessments that have commonly been used to assess for the presence and severity of personality

pathology; these assessments include clinician-rated DSM-IV personality disorders (Morey et al., 2013), DSM-5 pathological personality traits (Few et al., 2013), global psychosocial functioning (Morey et al., 2013), and features of borderline personality disorder on the Personality Assessment Inventory (Morey, 2017). Consistent with prior studies, Cronbach's alpha coefficient (α = .924) suggested excellent internal consistency among items (Hopwood et al., 2018; Morey et al., 2017; Zimmermann et al., 2015).

Personality pathology severity (clinical interview). The Structured Clinical Interview for DSM-5 Personality Disorders (SCID-5-PD; First, Williams, Benjamin, & Spitzer, 2016) is a semi-structured diagnostic interview that can be used to make personality disorder diagnoses either categorically (present versus absent) or dimensionally, and was conducted at the intake appointment by graduate research assistants who were trained and supervised by the principal investigator. Categorical diagnoses are dependent on whether participants meet the threshold number of clinically significant criteria for one or more personality disorders in DSM-5. This measure was used in descriptive and correlation analyses to examine the distribution of forms of personality pathology (i.e., categorical personality disorder diagnoses) and their associations with other study variables. Dimensional interview-based scores of personality pathology severity were computed by summing all subthreshold (ratings of "1") and clinically significant (ratings of "2") personality disorder criteria. Additionally, participants were coded according to whether they: (1) Met diagnostic criteria for at least one categorical DSM-5 Personality Disorder and (2) Met at least one diagnostic criterion of any categorical personality disorder (as evidenced by a rating of "2").

Intensive Repeated Measures.

During the 21-day intensive repeated measurement period, participants reported occasions of cannabis and other substance use as well as momentary psychological states and behaviors (e.g., impulsivity, affect, and risky behaviors). For the sake of parsimony, only measures used in the current analyses are discussed below.

Frequency of cannabis use over 21 days. Each randomly prompted and event-contingent survey asked participants to indicate whether or not they used cannabis since their last survey. Frequency of cannabis use (in days) over 21 days was computed by summing the total number of days participants reported using any amount of cannabis over this period. Greater frequency of cannabis use is associated with greater risk for a cannabis use disorder (Compton et al., 2009), severity of cannabis dependence (Piontek, Kraus, & Klempova, 2008), and greater risk of experiencing several acute and chronic adverse health outcomes (Fischer et al., 2017).

Total quantity of cannabis consumed over 21 days. The total quantity of cannabis consumed was computed by summing the number of reported cannabis hits over 21 days for each participant. If participants reported an occasion of cannabis use on any of their eight daily surveys, they were asked to report the number of cannabis "hits" they consumed since their last survey ("How many marijuana hits have you used since your last survey?"). Response options ranged from "1" to "50 or more". This method is consistent with prior research (Shrier, Walls, Rhoads, & Blood, 2013; van der Pol et al., 2014) and the suggestions of Gray and colleagues (2009), who recommend quantifying cannabis as precisely as possible (i.e. in hits or puffs). The quantity of cannabis consumed over the course of several days or weeks has been found to predict cannabis-related problems such as dependence independent of frequency of use (Chen, Kandel, & Davies, 1997; Grant & Pickering, 1998; Stephens, Babor, Kadden, Miller, & Group, 2002; Walden & Earleywine, 2008; Zeisser et al., 2012)

Maximum quantity of cannabis consumed within one day. The maximum number of cannabis hits consumed within any one day was computed for each participant based on their reports over 21 days. This index is based on findings that suggest cannabis users who consumed greater quantities within any single day tend to experience more cannabis-related problems than those who consume less and may reflect a similar and risky counterpart to binge drinking (Asbridge et al., 2014; Greenfield, 2000; Greenfield, Nayak, Bond, Ye, & Midanik, 2006).

Momentary Affect. Participants rated their current levels of affect by responding to two items. Emotions can be mapped onto two dimensions, which comprise the affective circumplex (Posner, Russell, & Peterson, 2005; Russell, 1980; see Figure 1 for a graphical representation of the affective circumplex). The first dimension, *valence*, indicates how pleasant an emotion is. *Arousal* indicates how behaviorally activating (i.e., physiologically arousing) an emotion is. A variety of experience sampling studies have examined instability in affective states using the affective circumplex as a framework (Feldman, 1995; Pettersson, Boker, Watson, Clark, & Tellegen, 2013; Russell et al., 2007; Weiss, Nicholas, & Daus, 1999), and research has found strong convergence between the affective circumplex and other measures of emotion (e.g., Positive and Negative Affect Schedule; Watson, Clark, & Tellegen, 1988). Thus, participants responded to two similarly phrased items ("RIGHT NOW . . . I feel:"). Visual analogue scale (VAS) responses to both items ranged from 1 to 100, with both items differing with respect to their endpoint labels ("Unpleasant — Pleasant" and "Sleepy — Aroused/Activated").

Momentary Self-Esteem. Experience sampling studies have measured self-esteem levels using the Single-Item Self-Esteem Scale (Maher et al., 2013; Robins, Hendin, & Trzesniewski, 2001). This measure has similar convergent and discriminant validity with lengthier measures of self-esteem, and correlates strongly with the Rosenberg Self-Esteem Scale (Robins et al., 2001).

In accordance with the Single-Item Self-Esteem Scale, participants rated their current levels of self-esteem by responding to one item: "RIGHT NOW . . . My self-esteem is:". Responses ranged from 1 ("Very low") to 100 ("Very high") on a VAS.

Momentary Interpersonal Behaviors and Perceptions. Interpersonal behaviors and perceptions can be mapped onto the Interpersonal Circumplex (IPC), which organizes them on two orthogonal dimensions (Gifford & O'Connor, 1987; Leary, 1957; Moskowitz & Zuroff, 2005; Wiggins, 2003). Dominance reflects the extent to which individuals behave in an assertive or controlling manner toward others. Friendliness reflects the extent to which individuals behave in a cooperative and caring manner toward others. Many experience sampling studies have used the IPC as a framework to explore the stability of interpersonal behaviors and perceptions in daily life, and this method has been adapted for use on smartphones (Ansell, Laws, Roche, & Sinha, 2015; Conner, Tennen, Fleeson, & Barrett, 2009; p. 200, Côté & Moskowitz, 1998; Moskowitz, Suh, & Desaulniers, 1994; Russell et al., 2007). Studies that incorporate informant reports have demonstrated that this is a reliable and valid method of measuring interpersonal behaviors and perceptions across different contexts (Foltz, Morse, & Barber, 1999; Moskowitz & Zuroff, 2005; Ready & Clark, 2002; Roche et al., 2014).

Thus, participants rated the dominance (versus submissiveness) of their interpersonal behaviors during recent social interactions by responding to, "THINKING BACK ON THE INTERACTION . . . Rate how YOU acted during the interaction". Responses ranged from 1 ("Submissive") to 100 ("Dominant"). Participants rated the warmth (versus coldness) of their recent interpersonal behaviors by responding to an additional item ("THINKING BACK ON THE INTERACTION . . . Rate how YOU acted during the interaction"). Responses on this item ranged from 1 ("Distant") to 100 ("Friendly"). Participants rated their social perceptions of

others during recent interactions by responding to two similar items. Both items contained identical instructions ("THINKING BACK ON THE INTERACTION . . . Rate how THE OTHER PERSON acted during the interaction"), and the items' VAS endpoints similarly varied from 1 to 100 ("Distant — Friendly" versus "Submissive — Dominant").

Measurement of Instability in Daily Life. Intensive repeated measurement studies have operationalized intra-individual variability in several psychological states and interpersonal behaviors using several methods (see Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009 for a review of methods; Jahng, Wood, & Trull, 2008; Moskowitz & Zuroff, 2004; Russell, et al., 2007). For example, Russell and colleagues (2007) operationalized within-person variability in interpersonal behaviors by calculating the standard deviation in each individual's self-reported scores. Although this method provides a decent estimate of each individual's overall variability throughout a given time period, it neglects to account for temporal dependencies and the ordering of scores (Ebner-Priemer et al., 2009). To provide an example of this method's limitations, imagine that we calculate the affective instability for two individuals using this method (outlined by Moskowitz & Zuroff; 2004). Person A reports high and stable levels of positive affect during the first week of the study and reports low and stable positive affect during the second week. Person B, on the other hand, frequently alternates between high and low levels of positive affect at a momentary (within-day) level. Comparing these individuals' affective instability using the method outlined by Moskowitz and Zuroff (2004) may accurately estimate the *overall* magnitude of within-person variability over a two-week span, but this method would not inform the extent to which individuals' scores vary moment-to-moment. These individuals may have identical within-person variability scores, but the *stability* of their scores vary across time and have different clinical implications. For instance, Person B's pattern of emotional

instability indicates that (s)he is likely more emotionally reactive than Person A and may benefit from clinical interventions that target rapid emotional shifts.

The Mean Square Successive Differences (MSSD; von Neumann, Kent, Bellinson, & Hart, 1941) technique has been proposed as a solution to this limitation (Jahng et al., 2008; Ebner-Priemer et al., 2009). The MSSD advantageously takes into account not only the *overall variability* of scores across time, but also the *ordering* of changes in scores (temporal dependency); that is, the extent to which scores are more (or less) predictable from one timepoint to the next (Ebner-Priemer et al., 2009). High temporal dependency indicates that an individual's scores are more predictable, relative to another person whose scores demonstrate low temporal dependence. The MSSD is also ideal for detecting small or larger changes between scores in any direction (e.g. increases or decreases; Ebner-Priemer et al., 2009). Thus, the MSSD reflects *how much* individuals tend to vary from moment-to-moment and also the temporal stability of these changes over time. The MSSD is calculated by squaring the differences between all successive occasions, and then averaging these differences. The MSSD will be calculated for each index of instability. Specifically, MSSD scores will be calculated to reflect instability in affective valence, affective arousal, behavioral interpersonal dominance, behavioral interpersonal warmth, perceived interpersonal dominance, perceived interpersonal warmth, and self-esteem.

Data Analytic Strategies

Missing data procedures. To minimize bias from large amounts of missing data, the following participants were excluded: Three who failed to respond to over 10% of items on the personality questionnaire (over 30% of items), seven who had survey compliance rates of less than 50%, eight who reported less than two interactions within 150 minute intervals, and one participant who reported using alcohol on one day but failed to report the quantity used. These

procedures are consistent with those of recent intensive repeated measurement studies examining instability in daily life (Lavender et al., 2016; Santangelo et al., 2017; Solhan, Trull, Jahng, & Wood, 2009; Wen, Schneider, Stone, & Spruijt-Metz, 2017). 18 participants who did not report any cannabis use were excluded from analyses testing cannabis variables, leaving 180 participants for main data analyses. Consistent with prior recommendations for handling item-level missingness within self-report data (Fox-Wasylyshyn & El-Masri, 2005), case mean substitution was used to impute missing items on the personality pathology severity scale. Case mean substitution is a single imputation method that replaces missing values of a case by the case's mean of all other non-missing items (Raymond, 1986). This method has been found to be robust when data are randomly or systematically missing on 20% of the items (Roth & Switzer, 1999).

Means and instability indices for affective, self-esteem, and interpersonal variables. To create seven composite mean scores that aggregate reports on each affective, self-esteem, and interpersonal dimension, each individual's scores on the two items related to affect (valence and arousal), interpersonal behavior (behavioral warmth and dominance), interpersonal perception (perceived warmth and dominance), and one self-esteem item were averaged across all intensive repeated measurement occasions over 21 days. Consistent with prior intensive repeated measurement research, each participant's mean square rooted successive differences (RMSSDs) were calculated for the four interpersonal (behavioral warmth and dominance, and perceived warmth and dominance), two affective (affective valence and arousal), and one self-esteem item (Ebner-Priemer, Santangelo, & Bohus, 2016; Ebner-Priemer et al., 2007; Lavender et al., 2016; Santangelo et al., 2017; Serre, Fatseas, Swendsen, & Auriacombe, 2017; Solhan et al., 2009). First, squared successive differences (SSDs) were obtained by computing differences of

consecutive assessments of the momentary affect, interpersonal, and self-esteem ratings, and then squaring these differences. To ensure that SSDs reflected acute variability in scores across a consistent within-day timeframe across participants, SSDs were computed for intervals ≤ 150 minutes between assessments. To address positively skewed distributions of the SSDs, I extracted the square root per Santangelo and colleagues' recommendations (2016). Lastly, I extracted the person-centered mean square rooted SSD (RMSSD) by separately averaging affective, interpersonal, and self-esteem SSDs for each participant.

Descriptive analyses. SPSS, version 21 (IBM, Armonk, New York) was used to perform all descriptive analyses. Pearson's product moment coefficients were computed to explore associations between self-reported personality pathology severity, clinical interview-based indices of personality pathology severity, cannabis use, and all indices of affect, interpersonal behaviors and perceptions, and self-esteem.

Overview of mediation analyses. Simple and parallel multiple mediator models were used for main analyses using repeated measurement data only for participants who endorsed using cannabis over the 21-day naturalistic period ($n = 180$). Mediator models examined indirect associations of self-reported personality pathology severity on cannabis use variables (frequency, quantity, and maximum quantity consumed within one day) through affective, interpersonal, and self-esteem instability. All indirect associations were tested with ordinary least squares regression analysis using Hayes' PROCESS Macro for SPSS (Hayes, 2018). To minimize inflation of Type I error rates when testing several hypotheses involving three cannabis use variables, a Bonferroni correction was applied within all mediation analyses, with the alpha level set to .01667 (.05/3). Significance of the estimated mediated/indirect (ab), direct (c'), and total (c) effects were tested using 98.333% Confidence Intervals (CIs) based on 10,000 percentile

bootstrap samples. Significance of mediation effects was examined by computing the proportion of the total effect accounted for by the indirect effect; to account for potential suppression effects, the total effect was computed by summing the absolute values of all paths.

Simple mediation models. Simple mediation analyses were performed to examine indirect associations through each mediator in isolation. Each of the seven affective, self-esteem, and interpersonal instability scores and their respective means (e.g., mean self-esteem over 21 days) were separately entered as mediators of associations between self-reported personality pathology severity (X) and each cannabis use variable (Y; frequency, total quantity, or maximum quantity consumed within a single day). Covariates included baseline demographic variables (age, sex, and race).

Parallel multiple mediation models. Parallel multiple mediation analyses were performed to test whether indirect effects observed in simple mediator models remained significant when all indices of instability were simultaneously entered as mediators. Each model consisted of the antecedent variable (personality pathology severity), each cannabis use consequent variable (frequency of use, total quantity used, or maximum quantity used within a single day), and all seven instability scores. Covariates included baseline demographic variables (age, sex, and race) and mean variables associated with each of the seven mediators (e.g., mean self-esteem over 21 days). Pairwise comparisons of specific indirect effects were used to compare the relative strengths of each statistically significant mediator.

Power analysis. A priori power analyses for mediation models were computed based on prior studies examining associations between personality pathology and cannabis use (e.g., Distel et al., 2012; Stinson, Ruan, Pickering, & Grant, 2006). It was estimated that mediation models would account for approximately 12% of the variance in the outcomes of interest (i.e., cannabis

use variables). Prior studies suggested that associations between personality pathology and

frequency and quantity of cannabis use (*c* paths) were medium-in-size ($r = .35$; Chabrol,

Ducongé, Casas, Roura, & Carey, 2005; Chabrol, Melioli, & Goutaudier, 2015; Compton,

Conway, Stinson, Colliver, & Grant, 2005; Distel et al., 2012; Flory et al., 2002; Gillespie et al.,

2018; Hasin et al., 2016; Raynal & Chabrol, 2016; Stinson et al., 2006), associations between

personality pathology and indices of instability (*a* paths) were medium-in-size ($r = .41$;

Fukushima & Hosoe, 2011; Geukes et al., 2017; Houben et al., 2016; Kanske et al., 2016;

Marwaha et al., 2018; McClintock & McCarrick, 2017; Rhodewalt et al., 1998; Richetin, Preti,

Constantini, & De Panfilis, 2017; Russell et al., 2007; Santangelo et al., 2014; Santangelo et al.,

2017; Santangelo et al., 2018; Soldz, Budman, Demby, & Merry, 1993; Solhan et al., 2009;

Wright et al., 2015; Zeigler-Hill & Abraham, 2006; Zeigler-Hill, Myers, & Clark, 2010), and

associations between indices of instability and cannabis use (*b* paths) were medium-in-size ($r = $

.30; Buckner et al., 2017; Simons, 2002; Simons & Carey, 2006; Vilhena-Churchill & Goldstein,

2014). Empirical estimates of sample sizes needed to achieve .80 power with medium-sized

specific indirect effects and percentile bootstrapping suggest a required sample size of 78 (Fritz

& MacKinnon, 2007). Therefore, our sample size of 180 participants should afford sufficient

power to detect indirect effects in mediation models if they exist.

     Sensitivity analyses. Heavy alcohol use is common among young adults (Naimi et al.,

2003) and may not share the same underlying mechanistic processes as cannabis use. To

examine the sensitivity of results to patterns of heavy alcohol use, mediation models were re-run

after excluding heavy drinkers. Consistent with guidelines established by the National Institute

of Alcohol Abuse and Alcoholism (NIAAA, 2018), high risk heavy drinking was defined as

consuming over 21 standard drinks (for females), or over 42 standard drinks (for males) over the

course of 21 days. 50 heavy alcohol users were excluded, resulting in a sample of 130 cannabis users for sensitivity analyses.

Reversed analyses. To examine the direction of indirect effects that emerged, mediation models demonstrating significant indirect effects were re-tested in the reverse direction (cannabis use variables → personality pathology severity). Mediators and covariates were identical to aforementioned mediation models.

Results

Descriptive Characteristics

Means, standard deviations, and frequencies of study variables are presented for both data analytic samples in Table 1 (sample for primary data analyses) and Table 2 (sample for sensitivity analyses). As shown in Table 1, the majority of participants who used cannabis at least once over the intensive repeated measurement period were female, Caucasian, and currently attending college. Over half of the sample (64.40%) met at least one clinically significant personality disorder criteria (rating of "2" on the Structured Clinical Interview for DSM-5). Approximately 13% of participants met criteria for one or more categorical personality disorders, and the most common diagnoses were obsessive compulsive personality disorder (5.6%), borderline personality disorder (3.3%) and antisocial personality disorder (3.3%). On average, participants used cannabis 9.39 days, consumed 74.11 hits over 21 days, and consumed 13.67 hits on their days of heaviest use. Prevalence of categorical personality disorders derived from clinical interviews were consistent with the prevalence observed in national epidemiological studies (approximately 10%). However, a strikingly high number of participants' (97.78%) levels of *self-reported* personality pathology severity was below average and sub-clinical threshold (*M*

= 212, *SD* = 49.71), suggesting discrepancies between self-report and interview-based indices of personality pathology.

Bivariate Pearson correlation coefficients of study variables for the sample of 180 cannabis users are presented in Table 3. The magnitude and direction of intercorrelations among study variables remained qualitatively similar after excluding heavy drinkers; thus, intercorrelations for the sensitivity analysis sample were omitted from the current manuscript. Moderate to strong intercorrelations were observed among the proposed mediator variables (affective, self-esteem, and interpersonal indices), suggesting that collinearity may increase sampling variance and reduce detection of an indirect effect when multiple mediators are simultaneously included within the same model (Hayes, 2018). As hypothesized, self-reported personality pathology severity was moderately positively associated with instability in all affective, interpersonal, and self-esteem dimensions except for instability in affective arousal. Self-reported personality pathology severity was moderately negatively associated with mean levels of self-esteem, mean affective valence (more unpleasant affect), mean behavioral warmth, and mean perceived warmth, which was also consistent with hypotheses. Additionally, self-reported personality pathology severity was strongly positively correlated with dimensional scores of personality pathology severity derived from the clinical interview, suggesting moderate convergence between the two measures.

Several unexpected associations (and lack thereof) emerged. First, self-reported personality pathology severity was not associated with any indices of cannabis use. Second, self-reported personality pathology severity was moderately negatively associated with mean affective arousal, which has had mixed relations with several forms of personality pathology. More surprisingly, some indices of cannabis use were negatively associated with dimensions of

interpersonal instability, whereas others were positively associated. For example, the total number of cannabis hits consumed (total quantity) was weakly-to-moderately negatively associated with instability in behavioral dominance and instability in perceptions of others' dominance. Conversely, frequency of cannabis use was strongly positively associated with instability in perceptions of others' warmth and instability in perceptions of others' dominance. It is notable that cannabis use variables were associated with interpersonal variables but not with any indices of affect or self-esteem.

Simple Mediation Models

Aggregated psychological processes. As shown in Figure 3, Panel A, there was a significant negative indirect effect of personality pathology severity on the frequency of cannabis use through mean affective valence, B = -.011, SE = .005, 95% CI [-.024, -.0002], but not through any other averaged psychological variables. This indirect effect accounted for 30.56% of the total effect, B = -.011, SE = .005, 95% CI [-.0238, -.0002]. However, specific indirect effects emerged in unexpected directions; participants with more severe personality pathology experienced more overall unpleasant affect over 21 days which, in turn, was associated with *less* frequent cannabis use over this time period. The indirect effect did not remain significant after excluding heavy alcohol users (Figure 3, Panel B). Several models testing average psychological variables (i.e., mean affective valence, mean behavioral warmth, mean perceptual warmth) yielded marginally significant positive direct effects, suggesting that personality pathology severity is directly related to more frequent cannabis use through independent pathways (i.e., not merely through average levels of unpleasant affect).

Instability in psychological processes. Consistent with *a priori* hypotheses, there were significant negative indirect effects of personality pathology severity on the total quantity of

cannabis consumed through instability in self-esteem, in behavioral dominance, in perceptual warmth, and instability in perceived dominance (Figure 4, Panels A-E). Inconsistent with *a priori* hypotheses, affective instability did not mediate any associations between personality pathology severity and cannabis use variables. Of note, the specific indirect effects associated with significant mediators were in unexpected directions; for example, participants with more severe personality pathology experienced more unstable self-esteem, which in turn was associated with *less* cannabis consumed over 21 days. These indirect effects through instability in self-esteem (B = -.107, SE = .054, 98.333% CI [-.266, -.006]), instability in behavioral dominance (B = -.141, SE = .062, 98.333% CI [-.325, -.031]), instability in perceived warmth (B = -.079, SE = .037, 98.333% CI [-.195, -.014]), and instability in perceived dominance (B = -.106, SE = .052, 98.333% CI [-.267, -.018]) accounted for 46.93%, 47.80%, 46.20%, and 46.90% of the total effect, respectively (Figure 4, Panels A-D). There was a similar negative indirect effect of personality pathology severity on maximum quantity of cannabis consumed within one day through instability in perceived dominance (B = -.013, SE = .007, 98.333% CI [-.032, -.0006]), and this indirect effect accounted for 86.67% of the total effect (Figure 4, Panel E).

After heavy drinkers were excluded, only indirect effects through instability in behavioral dominance (B = -.176, SE = .073, 98.333% CI [-.388, -.043]) and instability in perceived warmth (B = -.106, SE = .050, 98.333% CI [-.253, -.010]) remained and accounted for 37.77% and 32.52% of the total effects, respectively (Figure 5, Panels A-B). As evidenced by non-significant direct effects across models, personality pathology did not appear to influence the total number of cannabis hits consumed independent of its effects on any of these four indices of instability.

Parallel Multiple Mediation Models

There was no evidence of indirect effects between personality pathology severity and cannabis use through psychological instability when instability in all domains (and their corresponding means) were simultaneously controlled for; this was also the case when heavy drinkers were excluded.

Reversed Simple Mediator Models

When significant indirect effects were tested in the reverse direction (cannabis use variables → personality pathology severity), several indirect effects of total cannabis quantity on personality pathology severity emerged through instability in behavioral dominance (B = -.040, SE = .014, 98.333% CI [-.077, -.010]), instability in perceived warmth (B = -.022, SE = .010, 98.333% CI [-.0484, -.0033]), and instability in perceived dominance (B = -.030, SE = .012, 98.333% CI [-.0639, -.0057]), and these indirect effects accounted for 47.62%, 45.83%, and 46.88% of the total effect, respectively (Figure 6, Panels A – C). A similar negative indirect effect of maximum quantity of cannabis consumed on personality pathology severity was observed through instability in perceived dominance (B = -.178, SE = .083, 98.333% CI [-.4129, -.0166]), and this indirect effect accounted for 85.99% of the total effect (Figure 6, Panel D). As shown in Figure 6, Panels A-D, participants who used cannabis more heavily reported *less* instability in these interpersonal domains, and less instability was in turn associated with more severe personality pathology.

When heavy drinkers were excluded, only the indirect effect through instability in behavioral dominance remained (B = -.045, SE = .015, 98.333% CI [-.085, -.014]), accounting for 37.19% of the total effect (Figure 6, Panel E). As evidenced by the lack of direct effects across these models, patterns of cannabis consumption did not appear to influence personality pathology severity independently of each interpersonal pathway. These findings suggest

personality pathology and cannabis use may reciprocally impact one another through their effects on instability in interpersonal behaviors and perceptions.

Post-hoc Analyses

Post-hoc simple and parallel multiple mediation analyses were performed to examine potential differences in results after transforming skewed variables and excluding three items measuring instability in self-esteem and affect from self-report personality pathology severity scores. Prior to conducting the first set of post-hoc simple and parallel multiple mediation analyses, values of asymmetry and kurtosis among variables were examined across all four datasets to examine the presence of univariate distributions. All variables with values for asymmetry and/or kurtosis that were either below -2 or above +2 were transformed, consistent with prior recommendations (George, 2011; Gravetter & Wallnau, 2008; Trochim & Donnelly, 2005). Log(10) transformations were applied to variables that did not include zero within their ranges of values, whereas Log(x+1) transformations were applied to variables that did include zero within their range of values (Bartlett, 1947).

For the second set of post-hoc mediation analyses, three items from the Levels of Personality Functioning Scale-Self Report (Morey et al., 2016; Morey, 2017) which captured instability in affect ("My emotions rapidly shift around") and self-esteem ("Events in my life can really change whether or not I feel good about myself"; "I tend to feel either really good or really bad about myself") were excluded from total personality pathology severity scores to minimize conflation between instability mediators and self-reported personality pathology severity. The results of post-hoc models remained qualitatively the same as the main results described above.

Discussion

The goal of the current study was to clarify whether affective, interpersonal, and self-esteem dysregulation (i.e., instability) mediate associations between personality pathology severity and quantity/frequency of cannabis use. In line with prior research and theory, it was hypothesized that individuals with greater personality pathology severity would experience greater instability (i.e., dysregulation) in all three realms of experience and, in turn, report heavier cannabis use. Additionally, it was hypothesized that mean levels of negative affect and instability in affective valence would most strongly mediate these associations, relative to other mediators. With regard to patterns of cannabis use, simple mediation analyses revealed that instability in self-esteem, behavioral dominance, perceived warmth, and mean affective-valence each transmitted effects of personality pathology severity on several indices of cannabis use. However, findings were inconsistent with the hypotheses in several ways. First, although several realms of dysregulation (i.e., interpersonal and self-esteem instability) and mean unpleasant affect mediated relations between personality pathology severity and cannabis abuse, these indirect effects were surprisingly *negative*. Second, all aforementioned indirect effects disappeared when parallel multiple mediation models simultaneously accounted for all other means and indices of instability. Finally, instability in affective valence was hypothesized to be the strongest mediator, relative to all other indices of instability and means; however, affective instability did not mediate *any* relations between personality pathology severity and facets of cannabis use, whereas interpersonal and self-esteem variables did. This in of itself is novel, as most substance use literature focuses solely on affective instability rather than multiple other relevant psychological variables, such as instability in self-esteem and interpersonal experiences. Additional implications of these findings and their clinical relevance are described in sections below.

The Role of Mean Affective Valence

Contrary to literature suggesting that unpleasant affect is *positively* associated with substance abuse and personality pathology, findings showed that individuals with more severe personality pathology characterized by more unpleasant affect overall used cannabis *less* frequently during the study period. This is consistent with a large amount of literature which suggests some individuals are prone to engaging in risky behaviors (e.g., hazardous substance use) during moments of positive affect in order to enhance these positive experiences (*positive urgency*; see Smith & Cyders, 2016 for a review). Of note, the positive direct effect of personality pathology severity on cannabis use suggests those with more severe personality pathology used cannabis more frequently through an independent pathway that was unrelated to unpleasant affect.

The Role of Self-Esteem Instability

Another unexpected finding is that individuals with more severe personality pathology associated with self-esteem instability used cannabis less heavily. Self-esteem instability has been linked with hypersensitivity to social evaluations, poorer social support, and negative representations of the self (e.g., Zeigler-Hill, 2011). Perceived social disapproval of risky cannabis use from peers has been found to inhibit the progression of cannabis use to problematic levels (Butters, 2004; Chabrol et al., 2006) and may have an especially strong impact on individuals with unstable self-esteem, such as those with features of narcissistic personality disorder and borderline personality disorder (Fukushima & Hosoe, 2011; Santangelo et al., 2017; Zeigler-Hill et al., 2010).

The Role of Instability in Interpersonal Behaviors and Perceptions

Personality pathology severity indirectly influenced two indices of cannabis use through its effects on instability in behavioral dominance and instability in perceived warmth. These indirect effects remained after heavy drinkers were excluded, suggesting that they are generalizable to cannabis users who are not heavy drinkers. As expected, individuals with more severe personality pathology behaved in more erratically submissive—dominant ways and perceived others to be more erratically cold—warm across interactions. However, this interpersonal instability was related to *less* cannabis use consumed within one and over 21 days. When these indirect effects were tested in the opposite direction, heavier cannabis users reported *less* instability in their behavioral dominance, and this greater stability was in turn related to less severe personality pathology.

One possible explanation is that cannabis users with greater personality pathology are motivated to use cannabis heavily to mitigate interpersonal dysregulation (i.e., instability in behaviors and perceptions) associated with more severe forms of personality pathology. This is consistent with the notion that individuals use substances to regulate one or more psychological realms of dysregulation, and with cannabis's experimental effects on social processes (Foltin & Fischman, 1988; Janowsky et al., 1979). Interestingly, there is evidence that Δ^9-tetrahydro-cannabinol (THC), the intoxicating psychoactive ingredient of cannabis, acutely weakens expressions of dominance in individuals who are typically more dominant and reduces expressions of submissiveness in individuals who are more submissive (Miczek & Barry, 1974). Thus, it is possible that heavier cannabis use blunted the extremity of participants' submissive—dominant behaviors across interactions, thereby producing lower scores on the instability index and, in turn, less severe self-reported personality pathology. However, this does not necessarily imply that cannabis improves interpersonal functioning among these individuals. For example,

experimental findings investigating the acute effects of cannabis on social functioning (Janowsky et al., 1979) suggest that although cannabis users report behaving more warmly and empathetically when intoxicated, others rate them as being less genuine and empathic.

A notable characteristic of the sample is that a high percentage of participants reported below-average severity on the self-report measure of personality pathology than would be expected from non-clinical norms (Morey et al., 2016). However, rates of clinician-rated personality disorder diagnoses were consistent with epidemiological norms (Grant et al., 2004; Pulay et al., 2008). The disagreement between clinician-based and self-reported personality pathology severity suggests cannabis users with more severe personality pathology may perceive subjective benefits of use on psychosocial functioning and are potentially unaware of impairment rooted in personality pathology.

The recruited sample was heterogeneous with regard to recent *and* cumulative patterns of cannabis use; for example, whereas some participants endorsed regular use since adolescence, others reported beginning to use in young adulthood; similarly, the sample was comprised of both regular (over once per week) and recreational (once per week or less) users. Thus, it is unclear whether subgroups (e.g., light irregular users versus heavy frequent users) within this sample are confounding the current results.

Null Indirect Effects in All Parallel Multiple Mediator Models

When all seven affective, interpersonal, and self-esteem instability variables were simultaneously entered as mediators while controlling for mean levels of these processes, however, there was no evidence of any indirect effects. Consistent with theory and presented correlation analyses, affective, self-esteem, and interpersonal processes may be intimately interrelated. When several correlated mediators are included within the same regression model

(i.e., parallel multiple mediation model), collinearity between mediators increases sampling variance when estimating their unique relationships with an outcome, thereby reducing the likelihood that an indirect effect will be detected (p. 201, Cohen, West, & Aiken, 2014; Darlington & Hayes, 2016; Hayes, 2018). It is thus possible that these dynamic processes are so intimately intertwined (e.g., perhaps mutually influencing one another's effects in models) that their unique effects must be observed using more advanced statistical approaches (e.g., multilevel modeling) that better account for temporally sensitive dynamic interplays between processes.

Psychosocial Treatment Implications

One of the most novel findings of the current study is that affective instability did not mediate any relations between personality pathology severity and cannabis use. Several widely used clinical interventions (e.g., dialectical behavior therapy and attachment-oriented therapy) address substance abuse among personality disorders by emphasizing affective dysregulation as the primary target for treatment (Flores, 2004; Linehan, 2014). In the current study, however, self-esteem and interpersonal dysregulation played a greater role in accounting for the association between personality pathology severity and cannabis use. This unexpected finding suggests that we may need to modify treatment interventions for treatment-seeking cannabis users with personality pathology comorbidity in order to address these additional realms of dysregulation (e.g., exploring the subjective function(s) of cannabis use in relation to interpersonal experiences and self-esteem, and aiming to reduce these forms of dysregulation). In addition, the predominant motives which underlie use may differ between substances, and may explain some of these findings. For example, although expansion motives are frequently reported among cannabis users (i.e., using cannabis to expand awareness of oneself and the environment),

they are not reported by alcohol users (Simons, Correia, Carey, & Borsari, 1998). It may be fruitful to explore cannabis-use motives in the specific context of personality pathology, as these motives may explain why individuals with greater personality pathology tend to gravitate toward using cannabis in particular.

Potential Limitations

A notable strength of the proposed study resides within its purpose, which is to clarify the mechanisms that explain the link between personality pathology and cannabis use. However, there are several potential limitations of the current study. First, the direction of indirect effects through interpersonal mediators (i.e., whether personality pathology severity leads to cannabis abuse or vice versa) remains unclear due to the cross-sectional nature of study variables. It is possible that personality pathology and cannabis use reciprocally affect one another; according to opponent process theory, substance use—especially heavy and prolonged use—disrupts the homeostatic system and activates regulatory homeostatic effects that oppose the substance's effects (Koob & Bloom, 1988; Solomon, 1977). These homeostatic mechanisms may drive the development of tolerance and dependence and motivate use over time; indeed, cannabis withdrawal syndrome is strongly associated with personality disorders (Livne, Schmulewitz, Lev-Ran, & Hasin, 2019). Second, the sample was mainly comprised of undergraduate students who reported very low personality pathology severity, and results may not be generalizable to non-student and non-clinical samples. Finally, it is important to acknowledge that the severity of personality pathology does not reflect the form or "flavor" of personality pathology, per say. Evidence suggests individuals with certain forms of severe personality pathology (e.g., features of borderline personality disorder and antisocial personality disorder; Gillespie et al., 2018) are more likely to use cannabis and subsequently develop problems, whereas individuals with other

features of personality pathology are *less* likely to use cannabis. One explanation may be that

although different types of personality pathology are generally characterized by greater

instability in several psychological domains relative to healthy controls (Adrian et al., 2011;

Brown et al., 2002; Hilt et al., 2008; Vansteelandt et al., 2013), specific forms of personality

pathology vary with respect to *when*, *how*, *why*, and *to what extent* these fluctuations typically

occur (Hopwood et al., 2013; Peled et al., 2017; Young, Klosko, & Weishaar, 2003). For

example, an individual with features of borderline personality disorder may erratically alternate

between detached-avoidant (cold-submissive) and reassurance-seeking (warm-dominant)

behaviors when faced with perceived abandonment (Gunderson, 1996), whereas an individual

with features of primary psychopathy may demonstrate unwavering high levels of dominance

across interactions (Benning, Patrick, Hicks, Blonigen, & Krueger, 2003). Indeed, prior results

suggest that different pathological personality traits are associated with different degrees of

intraindividual variability in social behaviors and perceptions (Ellerbeck & Ansell, 2015a).

Given that the current analyses indexed personality pathology severity and not the form(s) of

personality pathology, it is possible that idiosyncratic features such as pathological personality

traits moderate associations observed in these analyses.

Future Directions

The current study offers a first step in clarifying which psychological processes mediate

the link between personality pathology severity and cannabis use in the context of daily life. Our

results suggest that personality pathology severity and cannabis use may reciprocally influence

one another through their effects on social processes, but this remains unclear due to the cross-

sectional nature of study constructs. Nevertheless, these findings emphasize the salient role of

interpersonal processes in explaining associations between personality pathology and cannabis

use. Cannabis has been found to affect social processes such as interpersonal behaviors and perceptions, and these effects may be especially reinforcing to individuals with personality pathology who experience interpersonal dysregulation (Foltin & Fischman, 1988; Janowsky et al., 1979; Miczek & Barry, 1974). Examining these processes longitudinally would clarify the directionality of these effects, which would guide treatment recommendations and, ideally, facilitate better treatment outcomes. Exploring dynamic psychological processes in relation to different forms of personality pathology may also be crucial, as the degree and domain(s) of instability that drive cannabis use may differ depending on the presence of specific features or personality traits. Finally, given that the current study examined current but not *cumulative* use, a next step would be to clarify whether these results differ between users with and without extensive histories of use.

Table 1

Descriptive Statistics of Sample Characteristics for 180 Cannabis Users

Demographic Variables	M	SD	Range	N	%
Sex					
Male	—	—	—	72	40
Female	—	—	—	108	60
Annual Household Income					
< $25,000	—	—	—	74	41.1
$25,000-$34,999	—	—	—	11	6.1
$35,000-$44,999	—	—	—	9	5
$45,000-$54,999	—	—	—	1	.6
$55,000-$69,999	—	—	—	12	6.7
$70,000-$84,999	—	—	—	8	4.4
$85,000-$99,999	—	—	—	17	9.4
$100,000-$149,999	—	—	—	20	11.1
≥ $150,000	—	—	—	27	15
Age	21.09	2.35	18-30		
18-19	—	—	—	75	41.7
20-21	—	—	—	62	34.44
22-23	—	—	—	25	13.89
24-25	—	—	—	9	5
26-27	—	—	—	4	2.22
28-30	—	—	—	5	2.78
Race					
Caucasian	—	—	—	129	71.7
African American	—	—	—	15	8.3
Hispanic	—	—	—	12	6.7
Asian	—	—	—	13	7.2
Other	—	—	—	11	6.1

Education Completed					
Grade School (≤ 6 years)	—	—	—	2	1.1
High School (10-12 years)	—	—	—	15	8.3
Vocational Training (beyond high school)	—	—	—	1	.6
Some College (< 4 years)	—	—	—	133	73.9
Four-Year College/University degree	—	—	—	21	11.7
Graduate or Professional Degree				8	4.4
Ethnicity					
Hispanic or Latino	—	—	—	12	6.7
Not Hispanic or Latino	—	—	—	168	93.3

Substance Use Variable	M	SD	Range	N	
Cannabis Use					
Cannabis Use Frequency[a]	9.39	6.29	1-21	—	
Cannabis Use Total Quantity[b]	74.11	91.51	1-483	—	
Cannabis Use Maximum Quantity[c]	13.67	13.45	1-68	—	

Variable	M	SD	Range	Average Number of Reports
Self-Esteem				
Mean Self-Esteem	68.37	15.66	23.83-98.83	113.28
Instability in Self-Esteem	10.38	5.01	2.05-30.07	96.13
Affective Valence				
Mean Affective Valence	70.45	14.38	33.96-99.14	114.05
Instability in Affective Valence	11.99	5.86	1.13-31.11	97.16
Affective Arousal				
Mean Affective Arousal	57.61	15.40	19.31-91.58	114.10
Instability in Affective Arousal	16.90	6.26	3.87-35.09	97.15
Interpersonal Behaviors				
Mean Interpersonal Warmth	79.76	10.70	34.29-99.97	59.33
Instability in Interpersonal Warmth	11.00	8.13	0-50	36.44

	M	SD	Range	N	%
Mean Interpersonal Dominance	54.13	8.68	34.38-86.85		59.34
Instability in Interpersonal Dominance	11.00	8.13	0-50		36.45
Interpersonal Perceptions					
Mean Interpersonal Warmth	79.93	10.32	30.24-99.70		59.32
Instability in Interpersonal Warmth	11.27	8.10	0-56.80		36.41
Mean Interpersonal Dominance	55.92	8.06	30.67-86.31		59.34
Instability in Interpersonal Dominance	12.65	7.25	1.51-40.40		36.41
Personality Pathology Variable	*M*	*SD*	*Range*	*N*	*%*
Interview				—	—
Dimensional PD Criteria Sum[d]	11.21	10.95	0-46	—	—
Avoidant PD	1.14	1.82	0-8	—	—
Dependent PD	.49	1.08	0-8	—	—
Obsessive Compulsive PD	2.73	2.90	0-13	—	—
Paranoid PD	1.06	1.99	0-9	—	—
Schizotypal PD	.56	1.20	0-7	—	—
Schizoid PD	.45	1.45	0-11	—	—
Histrionic PD	.97	1.75	0-10	—	—
Narcissistic PD	1.27	2.26	0-11	—	—
Borderline PD	1.82	3.00	0-13	—	—
Antisocial PD	.72	1.91	0-14	—	—
Clinically Significant PD Feature(s)[e]	—	—	—	116	64.40
Avoidant PD	—	—	—	33	18.3
Dependent PD	—	—	—	20	11.1
Obsessive Compulsive PD	—	—	—	75	41.7
Paranoid PD	—	—	—	32	17.8
Schizotypal PD	—	—	—	17	9.4
Schizoid PD	—	—	—	12	6.7
Histrionic PD	—	—	—	30	16.7
Narcissistic PD	—	—	—	34	18.9

Borderline PD	—	—	—	49	27.2
Antisocial PD	—	—	—	22	12.2
Met Criteria for ≥ 1 PD Diagnosis[f]	—	—	—	24	13.3
Avoidant PD	—	—	—	1	.6
Dependent PD	—	—	—	1	.6
Obsessive Compulsive PD	—	—	—	10	5.6
Paranoid PD	—	—	—	1	.6
Schizotypal PD	—	—	—	1	.6
Schizoid PD	—	—	—	1	.6
Histrionic PD	—	—	—	1	.6
Narcissistic PD	—	—	—	2	1.1
Borderline PD	—	—	—	6	3.3
Antisocial PD	—	—	—	6	3.3
PD Not Otherwise Specified	—	—	—	0	0
Self-Report					
Personality Pathology Severity[g]	212	49.71	133-392.50	—	—

Note. Participants who did not use cannabis over the 21 day period were excluded. All mean indices (e.g., mean affective valence) variables were computed using all reports across 21 days. All instability indices (e.g., instability in affective valence) were calculated for all reports within 150 minutes of each other. [a]Total number of days used cannabis over 21 days. [b]Total number of cannabis hits consumed over 21 days. [c]Maximum number of cannabis hits consumed within any single day over 21 days. [d]Dimensional sum of all subthreshold (ratings of "1") and clinically significant (ratings of "2") Personality Disorder criteria met across all categorical Personality Disorders, based on the Structured Clinical Interview for DSM-5 Personality Disorders (SCID-5-PD; First et al., 2016). [e]Met at least one diagnostic criterion (rating of "2", which indicates the presence of a clinically significant feature) of categorical

Personality Disorders, based on the SCID-5-PD (First et al., 2016). [f]Met diagnostic criteria for at least one categorical DSM-5

Personality Disorder, based on SCID-5-PD (First et al., 2016). [g]Self-reported personality pathology severity, based on a self-report

measure of personality dysfunction (Levels of Personality Functioning Scale; Morey, 2017; APA, 2013).

Table 2

Descriptive Statistics of Sample Characteristics for 130 Cannabis Users, Excluding 50 Heavy Drinkers (Sensitivity)

Demographic Variable	*M*	*SD*	*Range*	*N*	*%*
Sex					
Male	—	—	—	57	43.8
Female	—	—	—	73	56.2
Annual Household Income					
< $25,000	—	—	—	53	40.8
$25,000-$34,999	—	—	—	10	7.7
$35,000-$44,999	—	—	—	8	6.2
$45,000-$54,999	—	—	—	1	.8
$55,000-$69,999	—	—	—	9	6.9
$70,000-$84,999	—	—	—	5	3.8
$85,000-$99,999	—	—	—	11	8.5
$100,000-$149,999	—	—	—	14	10.8
≥ $150,000	—	—	—	19	14.6
Age					
18-19	—	—	—	56	43.1
20-21	—	—	—	41	31.54
22-23	—	—	—	21	16.15
24-25	—	—	—	6	4.62
26-27	—	—	—	2	1.54
28-30	—	—	—	4	3.08
Race					
Caucasian	—	—	—	86	66.2
African American	—	—	—	13	10
Hispanic	—	—	—	9	6.9
Asian	—	—	—	11	8.5
Other	—	—	—	11	8.5

Education Completed					
Grade School (≤ 6 years)	—	—	—	1	.8
High School (10-12 years)	—	—	—	14	10.8
Vocational Training (beyond high school)	—	—	—	1	.8
Some College (< 4 years)	—	—	—	91	70.0
Four-Year College/University degree	—	—	—	15	11.5
Graduate or Professional Degree				8	6.2
Ethnicity					
Hispanic or Latino	—	—	—	10	7.7
Not Hispanic or Latino	—	—	—	120	92.3

Substance Use Variable	M	SD	Range	N	
Cannabis Use					
Cannabis Use Frequency[a]	9.03	6.26	1-22	—	
Cannabis Use Total Quantity[b]	74.22	96.12	2-483	—	
Cannabis Use Maximum Quantity[c]	13.75	13.75	1-68	—	

Variable	M	SD	Range	Average Number of Reports
Self-Esteem				
Mean Self-Esteem	68.38	15.80	31.54-98.83	112.49
Instability in Self-Esteem	10.29	5.01	2.05-30.07	94.95
Affective Valence				
Mean Affective Valence	71.24	14.40	33.96-99.14	113.18
Instability in Affective Valence	11.48	5.70	1.13-31.11	95.88
Affective Arousal				
Mean Affective Arousal	58.72	15.03	20.68-91.58	113.25
Instability in Affective Arousal	16.46	6.40	3.87-35.09	95.92
Interpersonal Behaviors				
Mean Interpersonal Warmth	80.57	10.42	34.29-99.97	55.75
Instability in Interpersonal Warmth	10.85	8.21	0-50	33.10

	M	SD	Range	N	%
Mean Interpersonal Dominance	53.65	8.30	34.38-86.85	55.77	
Instability in Interpersonal Dominance	12.03	7.55	1.00-36.50	33.12	
Interpersonal Perceptions					
Mean Interpersonal Warmth	80.59	10.38	30.24-99.70	55.76	
Instability in Interpersonal Warmth	10.52	7.30	0-48	33.08	
Mean Interpersonal Dominance	55.59	8.01	30.67-86.31	55.76	
Instability in Interpersonal Dominance	12.33	7.56	2.00-40.40	33.05	
Personality Pathology Variable	*M*	*SD*	*Range*	*N*	*%*
Interview				—	—
Dimensional PD Criteria Sum[d]	11.48	10.95	0-46	—	—
Avoidant PD	1.19	1.81	0-8	—	—
Dependent PD	.52	1.15	0-8	—	—
Obsessive Compulsive PD	2.81	2.81	0-11	—	—
Paranoid PD	1.09	2.06	0-9	—	—
Schizotypal PD	.62	1.27	0-7	—	—
Schizoid PD	.44	1.26	0-8	—	—
Histrionic PD	1.02	1.83	0-10	—	—
Narcissistic PD	1.14	2.20	0-11	—	—
Borderline PD	2.01	3.24	0-13	—	—
Antisocial PD	.81	2.06	0-14	—	—
Clinically Significant PD Feature(s)[e]	—	—	—	86	66.20
Avoidant PD	—	—	—	27	20.8
Dependent PD	—	—	—	16	12.3
Obsessive Compulsive PD	—	—	—	58	44.6
Paranoid PD	—	—	—	23	17.7
Schizotypal PD	—	—	—	13	10.0
Schizoid PD	—	—	—	9	6.9
Histrionic PD	—	—	—	21	16.2
Narcissistic PD	—	—	—	22	16.9

Borderline PD	—	—	—	34	26.2
Antisocial PD	—	—	—	17	13.1
Met Criteria for ≥ 1 PD Diagnosis[f]	—	—	—	17	13.1
Avoidant PD	—	—	—	1	.8
Dependent PD	—	—	—	0	0
Obsessive Compulsive PD	—	—	—	7	5.4
Paranoid PD	—	—	—	0	0
Schizotypal PD	—	—	—	0	0
Schizoid PD	—	—	—	0	0
Histrionic PD	—	—	—	1	.8
Narcissistic PD	—	—	—	1	.8
Borderline PD	—	—	—	5	3.8
Antisocial PD	—	—	—	5	3.8
PD Not Otherwise Specified	—	—	—	0	0
Self-Report Personality Pathology Severity[g]	210.23	49.73	133-392.50	—	—

Note. Participants who did not use cannabis over the 21 day period and 50 heavy drinkers (women who consumed over 21 standard alcoholic drinks over 21 days and men who consumed over 42 standard alcoholic drinks over 21 days; USDHHS, 2005) were excluded. All mean indices (e.g., mean affective valence) variables were computed using all reports across 21 days. All instability indices (e.g., instability in affective valence) were calculated for all reports that were within 150 minutes of each other.

[a]Total number of days used cannabis over 21 days. [b]Total number of cannabis hits consumed over 21 days. [c]Maximum number of cannabis hits consumed within any single day over 21 days. [d]Number of clinically significant Personality Disorder criteria met (ratings of "2" indicating clinically severe impairment) across all categorical Personality Disorders, based on the Structured Clinical Interview

for DSM-5 Personality Disorders (SCID-5-PD; First et al., 2016). [e]Dimensional sum of all subthreshold (ratings of "1") and clinically significant (ratings of "2") Personality Disorder criteria met across all categorical Personality Disorders, based on SCID-5-PD (First et al., 2016). [f]Fully met criteria for at least one categorical DSM-5 Personality Disorder, based on SCID-5-PD (First et al., 2016); 0 = did not meet criteria, 1 = did meet criteria. [g]Self-reported personality pathology severity, based on a self-report measure of personality dysfunction (Levels of Personality Functioning Scale; Morey, 2017; APA, 2013).

Table 3

Summary of Intercorrelations for Primary Variables in Sample of 180 Cannabis Users

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Mean Self-Esteem	—																	
2. Mean Affective Valence	.83**	—																
3. Mean Affective Arousal	.66**	.71**	—															
4. Mean Behavioral Warmth	.59**	.70**	.50**	—														
5. Mean Behavioral Dominance	.04	.02	.13	.06	—													
6. Mean Perceived Warmth	.54**	.64**	.43**	.95**	.02	—												
7. Mean Perceived Dominance	.01	-.01	.04	.10	.74**	.10	—											
8. Instability in Self-Esteem	-.47**	-.46**	-.33**	-.25**	.28**	-.22**	.29**	—										
9. Instability in Affective Valence	-.37**	-.56**	-.50**	-.29**	.12	-.23**	.22**	.70**	—									
10. Instability in Affective Arousal	-.07	-.15*	-.40**	.06	.06	.10	.15*	.46**	.56**	—								
11. Instability in Behavioral Warmth	-.44**	-.48**	-.41**	-.33**	.01	-.21**	.04	.43**	.47**	.28**	—							
12. Instability in Behavioral Dominance	-.13	-.21**	-.11	-.16*	.16*	-.13	.30**	.45**	.45**	.33**	.32**	—						
13. Instability in Perceived Warmth	-.37**	-.45**	-.37**	-.31**	.06	-.31**	.08	.44**	.49**	.25**	.65**	.24**	—					
14. Instability in Perceived Dominance	-.17*	-.19**	-.09	-.12	.12	-.10	.22**	.44**	.35**	.27**	.36**	.64**	.34**	—				
15. Cannabis Use Frequency[a]	.04	.11	.03	.11	.03	.13	-.03	-.12	-.09	.06	< .001	-.13	.72**	.48*	—			
16. Cannabis Use Total Quantity[b]	.02	.08	-.01	.11	-.02	.13	-.07	-.13	-.11	.04	-.03	-.20**	-.14	-.19*	.72**	—		
17. Cannabis Use Maximum Quantity[c]	.03	.08	< .001	.09	-.02	.11	-.05	-.11	-.08	.05	-.05	-.13	-.14	-.18*	.54**	.87**	—	
18. Sum of Personality Disorder Severity Rating[d]	-.26**	-.24**	-.16*	-.20**	.05	-.16*	.01	.17*	.30**	.08	.29**	.21**	.21**	.15*	.15	.09	.08	—
19. Personality Pathology Severity (S-R)[e]	-.42**	-.45**	-.28**	-.40**	.02	-.37**	.05	.34**	.36**	.12	.26**	.31**	.28**	.27**	.10	.01	.03	.57**

Note. Participants who did not use cannabis over the 21 day period were excluded. [a]Total number of days used cannabis over 21 days.

[b]Total number of cannabis hits consumed over 21 days. [c]Maximum number of cannabis hits consumed within any single day over 21

days. [d]Dimensional sum of all subthreshold (ratings of "1") and clinically significant (ratings of "2") Personality Disorder criteria met

across all categorical Personality Disorders, based on SCID-5-PD (First et al., 2016). [e]Self-reported personality pathology severity,

based on a self-report measure of personality dysfunction (Levels of Personality Functioning Scale; APA, 2013; Morey, 2017). *$p <$
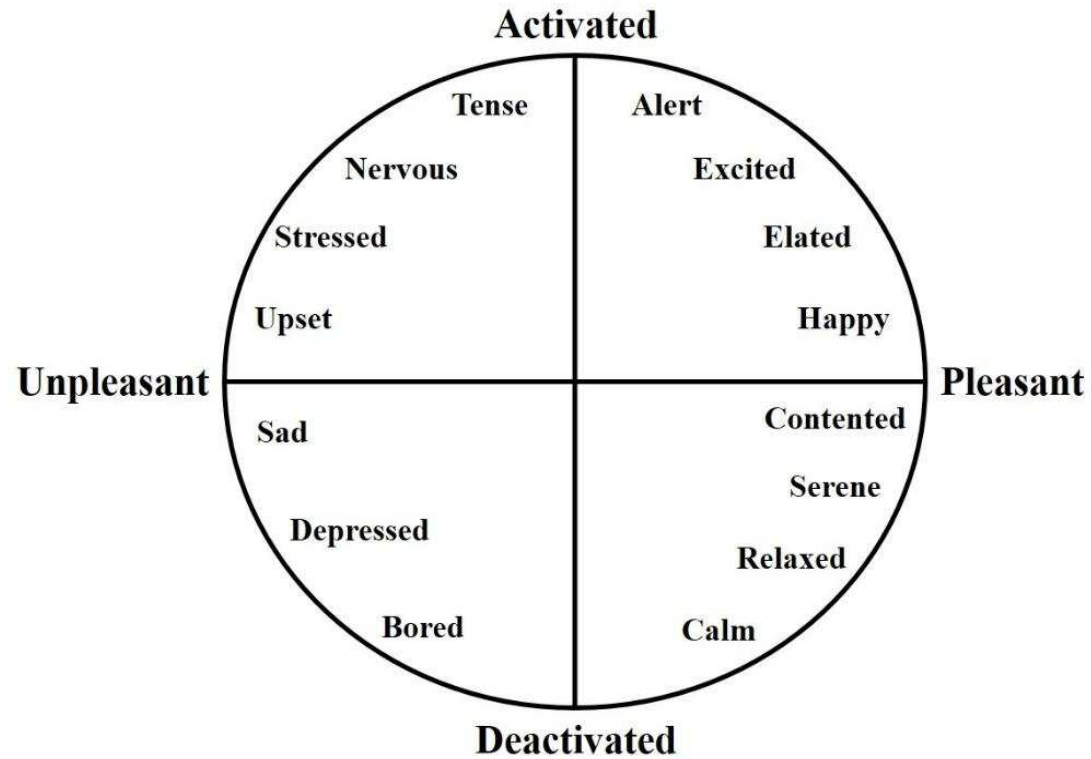
.05. **$p < .01$.

Figure 1. An illustration of the affective circumplex (Russell, 1980; Posner et al., 2005). The horizontal axis represents the valence dimension, and the vertical axis represents the arousal dimension. Emotions are mapped onto the affective circumplex using blends of both dimensions.
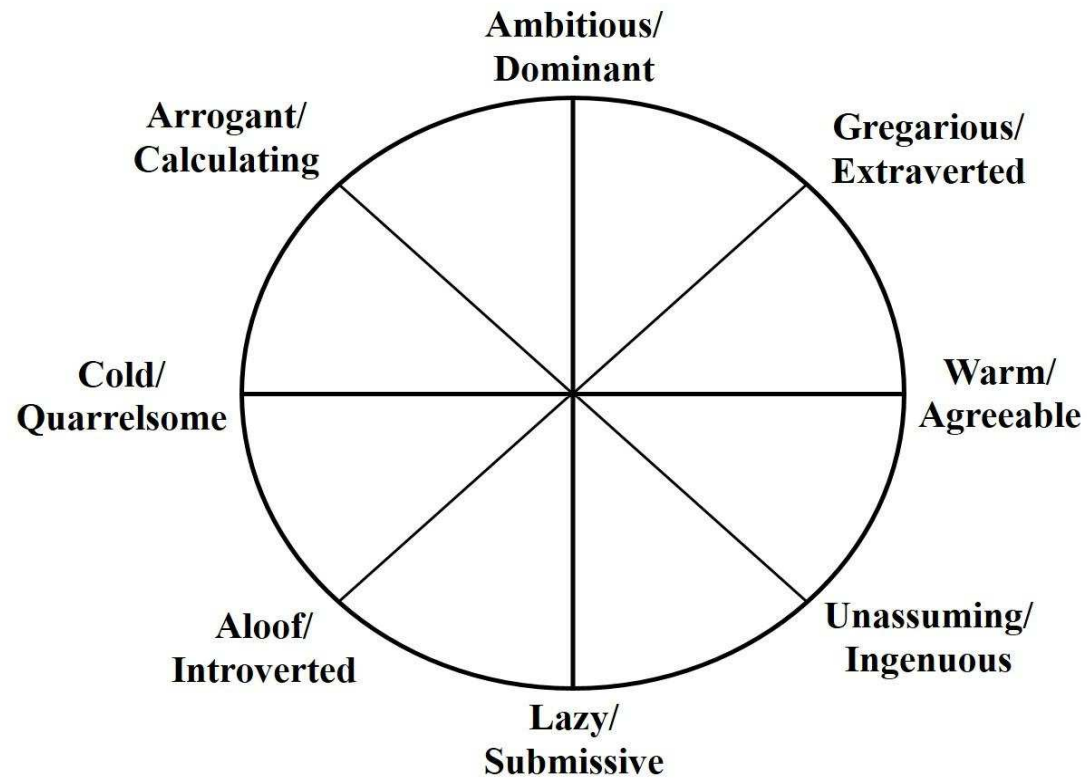
Figure 2. An illustration of the interpersonal circumplex (Leary, 1957; Gifford & O'Connor, 1987). The horizontal axis represents warmth, and the vertical axis represents dominance. Interpersonal behaviors are mapped onto the interpersonal circumplex using blends of both dimensions.
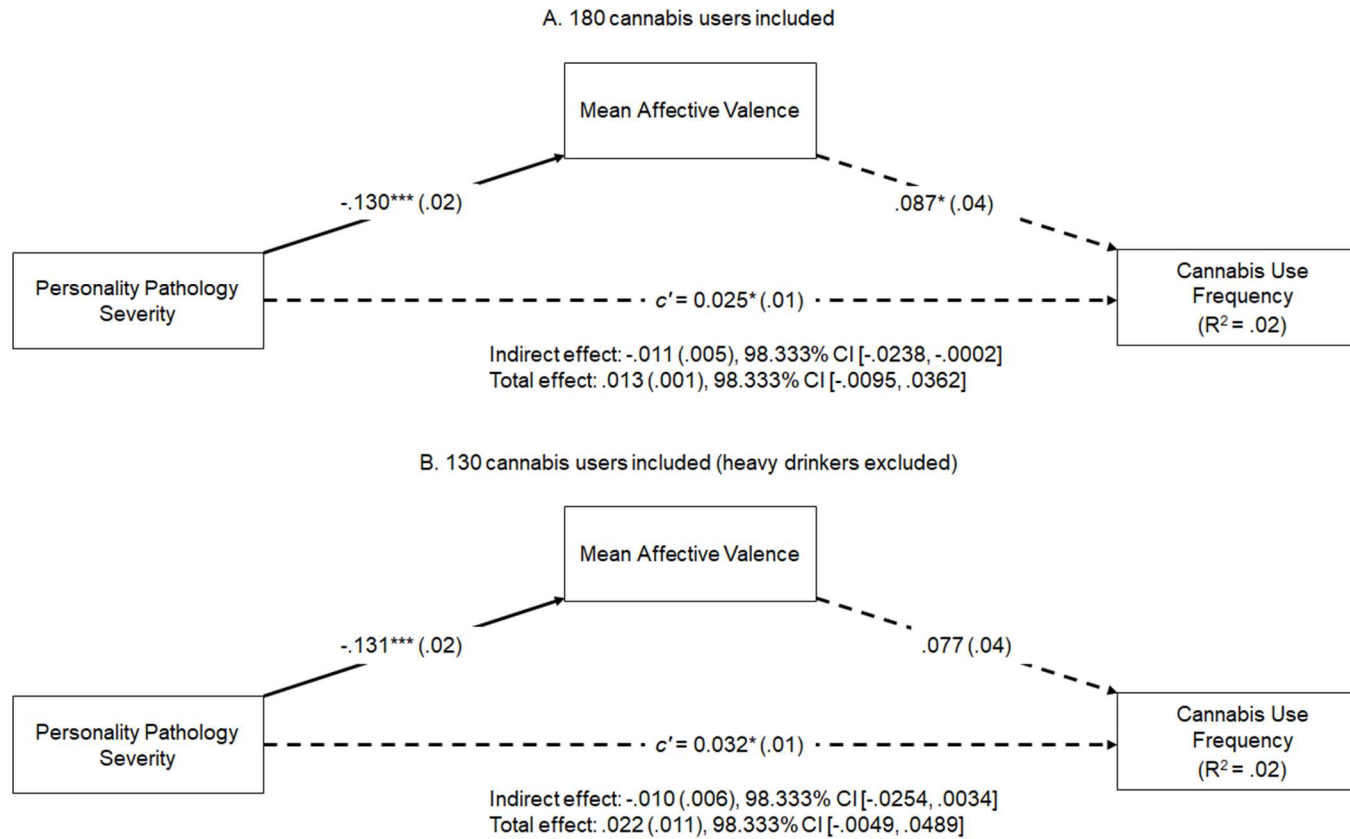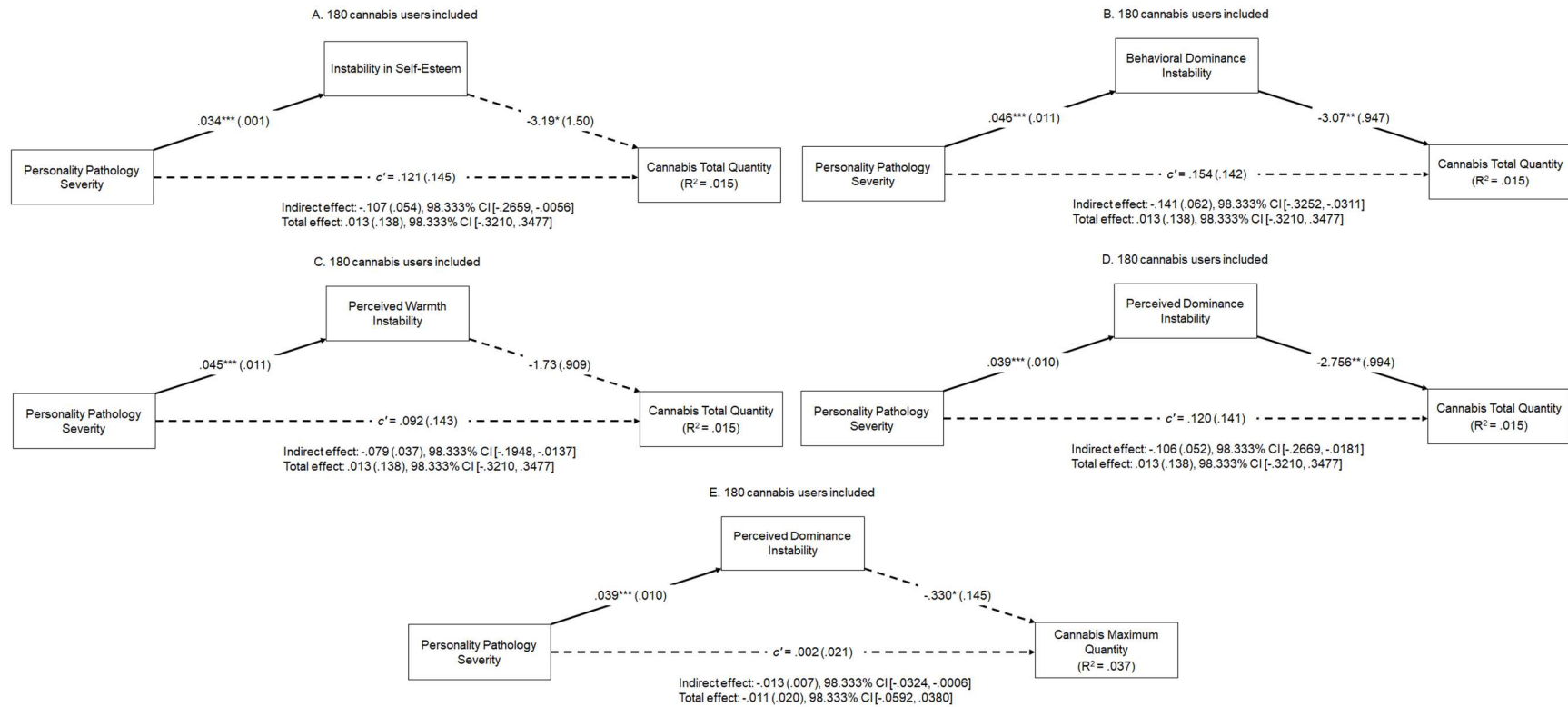
Figure 3. Unstandardized specific indirect, total indirect, total, and direct effects (and unstandardized standard errors in parantheses)

for the mediating relationship between personality pathology severity and cannabis use through mean affective valence after

controlling for age, sex, and race. Dotted lines reflect specific indirect and direct effects that were not statistically significant after

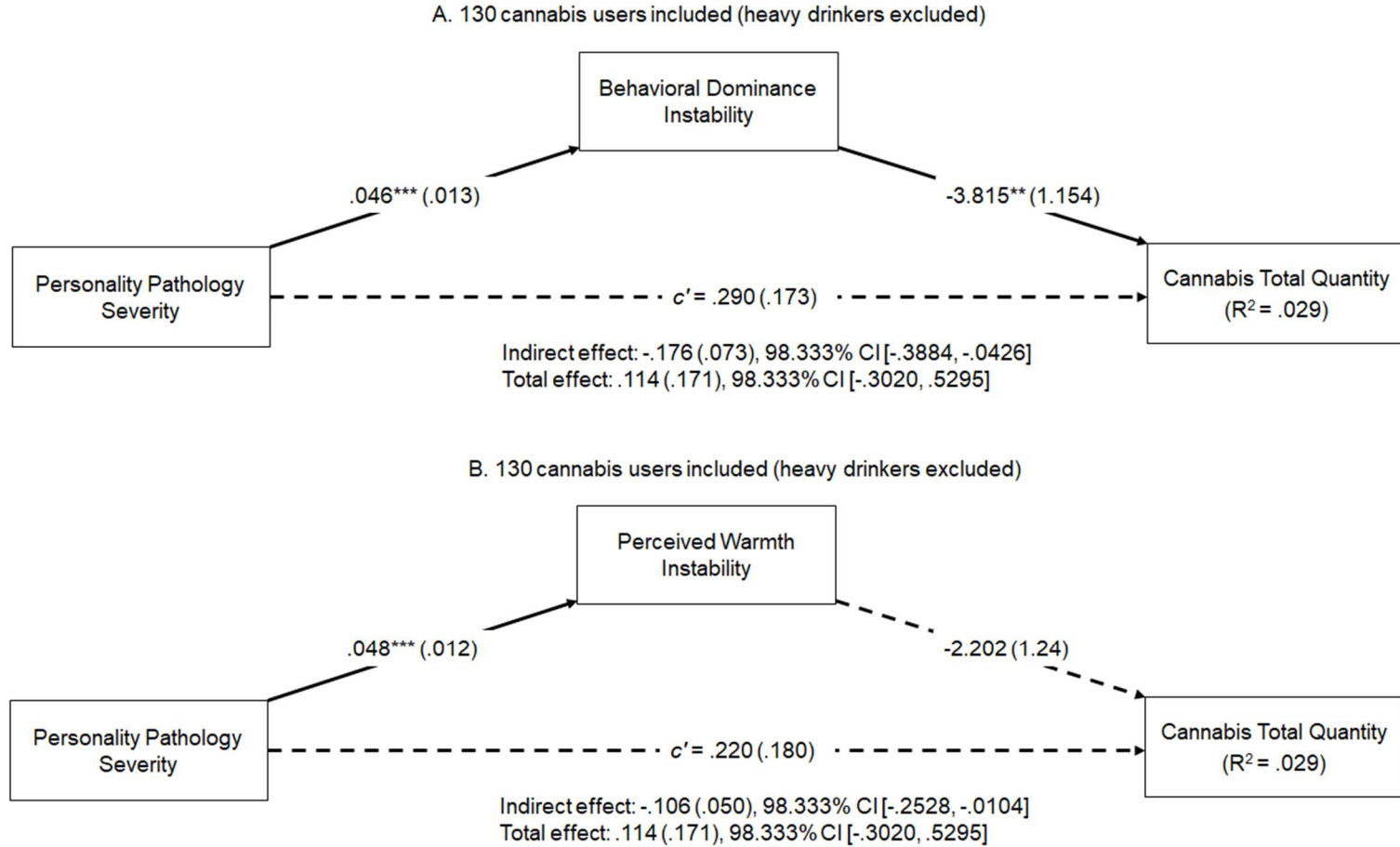Bonferonni corrections ($\alpha = .01667$). $*p < .05$. $**p < .01667$. $***p < .001$.

Figure 4. Unstandardized specific indirect, total indirect, total, and direct effects (and unstandardized standard errors in parantheses) for the mediating relationship between personality pathology severity and cannabis use through indices of psychological instability after controlling for age, sex, and race. Dotted lines reflect specific indirect and direct effects that were not statistically significant after Bonferonni corrections (α = .01667). *p < .05. **p < .01667. ***p < .001.

A. 130 cannabis users included (heavy drinkers excluded)

Behavioral Dominance
Instability

.046*** (.013)   -3.815** (1.154)

Personality Pathology
Severity

c' = .290 (.173)

Cannabis Total Quantity
(R^2 = .029)

Indirect effect: -.176 (.073), 98.333% CI [-.3884, -.0426]
Total effect: .114 (.171), 98.333% CI [-.3020, .5295]

B. 130 cannabis users included (heavy drinkers excluded)

Perceived Warmth
Instability

.048*** (.012)   -2.202 (1.24)

Personality Pathology
Severity

c' = .220 (.180)

Cannabis Total Quantity
(R^2 = .029)

Indirect effect: -.106 (.050), 98.333% CI [-.2528, -.0104]
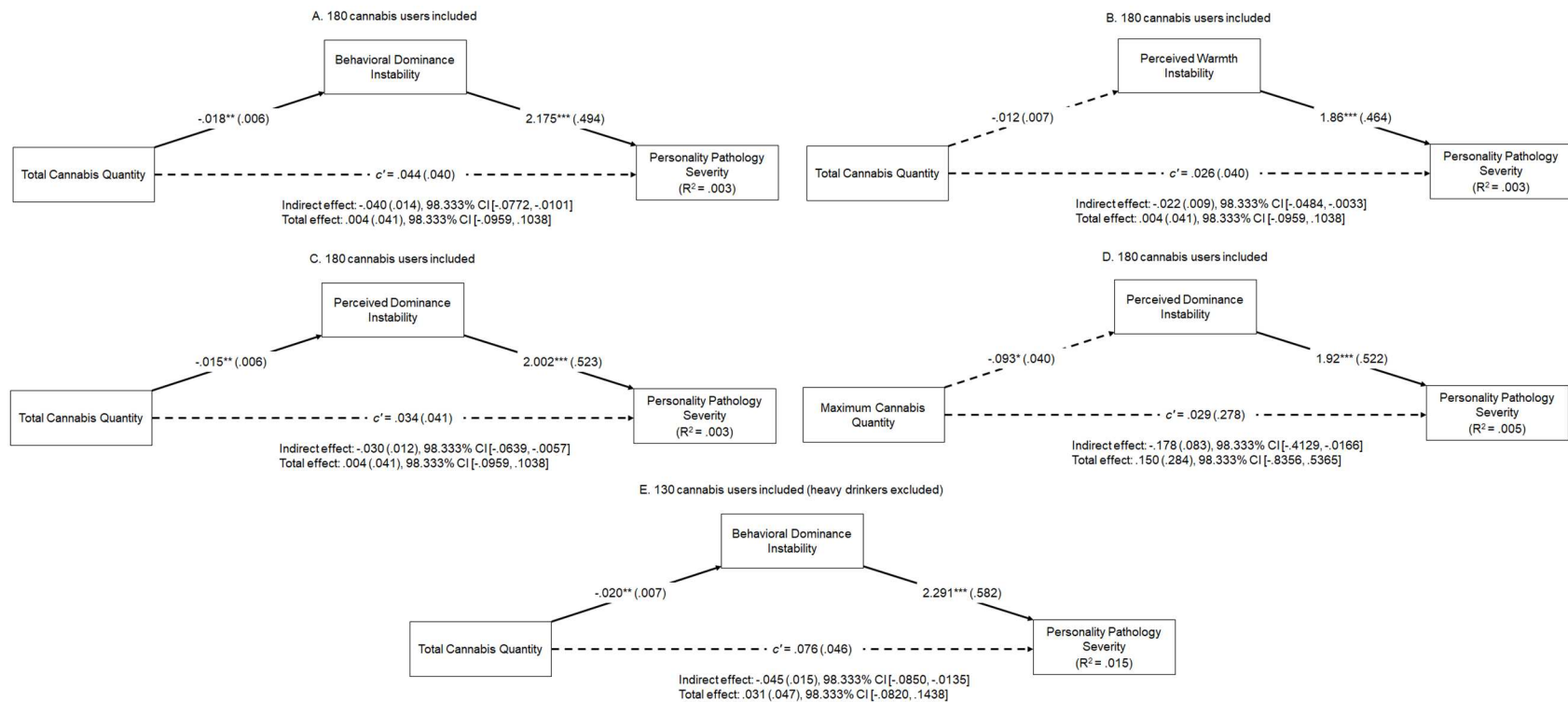Total effect: .114 (.171), 98.333% CI [-.3020, .5295]

Figure 5. Unstandardized specific indirect, total indirect, total, and direct effects (and unstandardized standard errors in parantheses) for the mediating relationship between personality pathology severity and cannabis use through indices of psychological instability after controlling for age, sex, and race. Dotted lines reflect specific indirect and direct effects that were not statistically significant after Bonferonni corrections (α = .01667). *p < .05. **p < .01667. ***p < .001.

Figure 6. Unstandardized specific indirect, total indirect, total, and direct effects (and unstandardized standard errors in parantheses) for the reversed mediating relationship between cannabis use and personality pathology severity through indices of psychological instability after controlling for age, sex, and race. Dotted lines reflect specific indirect and direct effects that were not statistically significant after Bonferonni corrections ($\alpha = .01667$). *$p < .05$. **$p < .01667$. ***$p < .001$.

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VITA

NAME OF AUTHOR: Nicole E. Ellerbeck

CONTACT INFORMATION:

430 Huntington Hall

Syracuse, NY 13244

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

Syracuse University, Syracuse, NY

University of Virginia, Charlottesville, NY

University of Michigan, Ann Arbor, MI

DEGREES AWARDED:

Bachelor of Arts in Psychology, *magna cum laude*, 2013, University of Virginia