EFFECT OF MINDFULNESS BASED RELAPSE PREVENTION ON DEVELOPMENTAL TRENDS, STRESS, AND SUBSTANCE USE AMONG YOUNG ADULTS IN RESIDENTIAL SUBSTANCE USE TREATMENT: A RANDOMIZED CONTROLLED TRIAL

BY

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DISSERTATION

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ABSTRACT

Substance use, stress, and early childhood trauma are among the most detrimental catalysts for chronic psychological, behavioral and health related problems. The Institute of Medicine recently released a report on the health and well-being of emerging adults, calling for a more comprehensive investigation of the risks, health, safety, and development of marginalized emerging adults. In a recent meta-analysis on mindfulness based interventions for substance use disorders only one study utilized an emerging adult population – however this study recruited college attending emerging adults. While important, no study has assessed the efficacy of mindfulness based relapse prevention (MBRP) with a sample of emerging adults recruited from a not for profit treatment facility. The current study used a randomized controlled design to assign individuals (N = 79) to receive MBRP or treatment as usual (TAU). Participants were followed for six months with assessments occurring on a bi-monthly basis (two week intervals). At each time point we measured substance use, craving, and stress. Results indicated significant decreases in substance use, stress, and craving for individuals assigned to MBRP versus TAU. Further, mediation models revealed a significant indirect effect for reductions in stress during the treatment phase and both substance use and craving during the post-treatment phase. This study provides further support for the use of mindfulness based interventions and is the first to investigate its utility among a sample of marginalized emerging adults. Further, this study provides support for reductions in perceived stress to act as a mechanism between reductions in both substance use and craving.

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Chapter 1: Introduction

Substance use, stress, and early childhood trauma are among the most detrimental catalysts for chronic psychological, behavioral and health related problems (Andersen & Teicher, 2009; Horgan, Skwara, & Strickler, 2001; Lupien, McEwen, Gunnar, & Heim, 2009; Shonkoff, Boyce, & McEwen, 2009; Shonkoff & Garner, 2012; Teicher et al., 2003). The American Psychological Association defines substance use disorders as the recurrent use of alcohol or other drugs that causes significant impaired control, social impairment, risky behaviors and health related risks (American Psychiatric Association, 2013). In 2013 over 22 million people needed treatment for alcohol or drug use problems; however, only 4.1 million people actually received treatment (SAMHSA (NSDUH), 2014). Among treatment admissions, 22% of individuals received some form of residential care, and a large proportion (34%) of these individuals receiving treatment were emerging adults (ages 18-29; SAMHSA, 2013). In 2000 Jeffry Arnett laid the groundwork for developing the theory of emerging adulthood, which he argued is a distinct and separate developmental period from adolescence and adulthood. Specifically, emerging adulthood is the developmental period between the ages of 18 and 29 in which individuals begin to separate from their parents and experience autonomy. One of the most common activities of emerging adults is drug and alcohol use. As a matter of fact, emerging adults have the highest rates of drug and alcohol use compared to adolescents and older adults (SAMHSA (NSDUH), 2014). Unfortunately, few studies exist, in comparison to the college literature, on interventions for non-college attending emerging adults (Davis, Smith, & Briley, 2017).

The Institute of Medicine recently released a report on the health and well-being of emerging adults, (IOM & National Research Council, 2014) calling for a more comprehensive investigation of the risks, health, safety, and development of marginalized emerging adults, in particular. Marginalized emerging adults – those who have been involved in the child welfare system, criminal justice system, or have not attended some form of higher education – have high risk for mental and physical health problems, as well as substance use problems (McNiel, Binder, & Robinson, 2014; Traube, James, Zhang, & Landsverk, 2012; Walters et al., 2014; White, Labouvie, & Papadaratsakis, 2005). Epidemiological studies have found that during this developmental period alcohol use increases nearly fourfold, with binge drinking increasing fivefold (SAMHSA (NSDUH), 2014). Non-college-attending emerging adults also exhibit significantly higher levels of drug use than their college-attending counterparts (White et al., 2005). In a recent meta-analysis investigating the effect of substance use treatment in non-college settings for emerging adults Davis and colleagues (in press) found larger treatment effects for studies that contained a higher proportion of participants currently in college or university. Results from this study indicate a need to understand, more fully, treatment effects among emerging adults outside of the college or university system.

While numerous risk factors for substance use have been identified, stress remains one of the most important contributors (Sinha, 2001; Sinha, 2008). Chronic exposure to stress such as adverse childhood events (ACEs; e.g. childhood neglect, abuse, emotional abuse) has been associated with increased prevalence of alcohol use, depression, drug use (Bierhaus et al., 2003; Edwards, Holden, Felitti, & Anda, 2003; Felitti et al., 1998; Shonkoff & Garner, 2012; Sinha, 2008), a variety of physical health issues such as cardiovascular disease (Cohen, Janicki-Deverts, & Miller, 2007; Miller, Cohen, & Ritchey, 2002) and inflammation-related diseases (Cohen et

al., 2012). Specifically, emerging adults experiencing chronic stress compounded from multiple ACEs are more likely to use substances and have problems related to substance use such as dependence diagnoses, associations with deviant peers, and problems with the law (Andersen & Teicher, 2009; Dembo et al., 2000; Paternoster, McGloin, Nguyen, & Thomas, 2013; Schilling, Aseltine, & Gore, 2007; Shonkoff & Garner, 2012; Sinha, 2008). In a recent review on the effect of stress on long term health outcomes, Thoits (2012) suggests that the top two priorities moving forward should be focusing on implementing interventions that effectively buffer the effects of stress and focusing on populations that are most at "risk for risk." This anecdote can easily be understood in the context of studying populations such as marginalized emerging adults in residential substance use treatment.

Unfortunately, there is a lack of research on emerging adults in substance use treatment outside of college settings compared to college samples despite being the larger subgroup of the population of substance users. For example, Davis and colleagues (2017) meta-analyzed 50 studies over the past 30 years, compared to over 100 studies investigating effects of brief alcohol interventions for college students (Borsari & Carey, 2003; Carey, Scott-Sheldon, Carey, & DeMartini, 2007; Carey, Scott-Sheldon, Elliott, Bolles, & Carey, 2009). Further, the majority (> 50%) of studies in the Davis meta-analysis comprised of brief motivational interviewing or cognitive behavioral (CBT) interventions. Results indicated strong effects for CBT and MI across studies and effect sizes were, in general, similar to other meta-analyses on college drinking interventions (e.g., Carey et al., 2014). That is, CBT tends to be effective in reducing drug and alcohol use across emerging adult populations.

While CBT has proven to be efficacious, more nuanced treatments such as mindfulness based interventions also have become widely used. Mindfulness is rooted in Buddhist traditions

and is commonly defined as the "state of being attentive to and aware of what is taking place in the present" (Brown & Ryan, 2003). Specifically, mindfulness treatments have significant advantages over traditional treatments (Brewer et al., 2013) given this approach helps patients stay in touch with their present experiences (Chiesa, Anselmi, & Serretti, 2014). In a recent meta-analysis on the effect of mindfulness interventions for substance misuse only one (out of 42) studies in were focused on emerging adults, unfortunately this study was a convenience sample of college students. Of the remaining studies, only three studies assessed the effect of Mindfulness Based Relapse Prevention (MBRP; Bowen & Chawla, 2011; Witkiewitz, Bowen, Douglas, & Hsu, 2013). Mindfulness based interventions such as Mindfulness Based Relapse Prevention (MBRP) have been integrated with variations of CBT and have been shown to reduce depressive symptoms (Zgierska et al., 2008), perceived stress (Brewer, Bowen, Smith, Marlatt, & Potenza, 2010) and days of substance use (Bowen & Chawla, 2011; Brewer, Elwafi, & Davis, 2013). Specific to substance use, MBRP has been shown to improve recovery rates (Marcus & Zgierska, 2009; Zgierska et al., 2008) and, simultaneously, reduce physiological and perceived stress levels (Matousek, Dobkin, & Pruessner, 2010). While several studies have shown promising results of MBRP with adults (e.g. Bowen & Chawla, 2011; Li, Howard, Garland, McGovern, & Lazar, 2017; Witkiewitz, Marlatt, & Walker, 2005) little is known regarding how MRBP may work for a sample of marginalized emerging adults or the mechanisms though which MBRP works.

The purpose of this study was to investigate the effectiveness of MBRP with emerging adults entering residential substance use treatment. Specifically, this study used a randomized controlled design to test the effects of MBRP versus treatment as usual (TAU) among a sample of marginalized emerging adults. Further, this study investigated mechanisms through which

MBRP may work. In particular, we investigated change in perceived stress as a mechanism through with MBRP may aid in reducing risk of relapse, days of substance use, and craving during the treatment phase as well as the follow-up phase. As a subsidiary analysis, we also collected physiological data (hair samples) to assess the effect of MBRP on physiological markers of stress. Finally, we explored the potential mitigating effect of ACEs on treatment outcomes. Research into the efficacy of treatments for emerging adults is in its infancy – this is the first study to investigate the effect of MBRP on a high risk sample of emerging adults and one of the few studies to investigate mechanisms of change related to stress response.

Background

Prevalence of Substance use among Emerging Adults

Emerging adulthood is marked as a time of increased risk for psychopathology and substance use (SAMHSA, 2014a; SAMHSA (NSDUH), 2014). Specifically, emerging adulthood is a period of life when individuals are most prone to develop one or more substance use disorders or addictions (Sussman & Arnett, 2014). Overall, emerging adults exhibit the highest rates of cannabis use (19%), alcohol use (59.6%), binge drinking (37.9%), and illicit drug use (21.5%) compared to adolescents and older adults (SAMHSA (NSDUH), 2014). Trends in overall alcohol use (~60%), binge drinking (~40%; consuming more than 5 drinks) and heavy episodic drinking (~13%; having multiple binge episodes in one month) have not changed for emerging adults over the past decade – remaining both steady and higher than adolescent and older adult rates (Park, Scott, Adams, Brindis, & Irwin, 2014). Similar results were found for cannabis use (~19%), with past decade trends remaining flat (e.g. no change) among emerging adults. The rate of substance dependence and abuse disorders (18.9%) is also highest among emerging adults compared to adolescents and older adults (SAMHSA (NSDUH), 2014).

Prevalence rates of substance use among emerging adults is alarming- yet there remain vast differences in use among subgroups of emerging adults. In particular it is important to acknowledge differences in use among emerging adults in college versus their peers who do not attend college.

Prevalence Rates by Specific Demographic variables

Education. Of the 59.4 million emerging adults in the United States the majority (60%) are not enrolled in college or university and, of those that do attend college or university only 28% finish by the age of 25 (Fouad & Bynner, 2008; U.S. Department of Education, NCES, 2013). Several studies have assessed variation in drug and alcohol use across college attending and their non-college attending peers. In 2013 the National Survey on Drug use and Health reported illicit drug use to be higher among individuals who did not complete high school (11.8%) than those who had graduated high school (9.9%), had some college education (10.8%), and those who had graduated from college (6.7%). Alcohol use, on the other hand, shows very different results. Overall alcohol use is shown to increase as number of years of education increases. For example, among individuals who do not have a high school degree only 36.5% were current drinkers compared to the 69.2% of college graduates who were current drinkers. Further, individuals who are in college were more likely to report current binge drinking (Courtney & Polich, 2009; Gmel, Kuntsche, & Rehm, 2011; Wechsler & Nelson, 2001) and heavy episodic drinking (Courtney & Polich, 2009; Gmel et al., 2011) compared to their non-college peers. However, when one considers high risk behavior such as daily drinking, college and non-college attending emerging adults have the same prevalence rates (4%). Drug use disorder prevalence is also higher among non-college attending emerging adults compared to their college attending peers (Blanco et al., 2008). Finally, non-college attending emerging adults

had a higher risk of ongoing drug and alcohol use and problems related to drug and alcohol consumption compared to their college bound peers (Thompson, Stockwell, Leadbeater, & Homel, 2014; White et al., 2005). When we look at who is entering treatment at publically funded facilities – only .06% are referred from school/universities (SAMHSA, 2014) indicating emerging adults in public treatment facilities are more likely to present with more severe problems. Sahker, Acion, and Arndt, (2014) found college students were more likely to list alcohol as their primary problem substance, less likely to have early onset substance use (e.g. before age 14), less likely to list illicit drugs as their primary problem, and, most importantly, more likely to successfully complete treatment than non-students (56% versus 42%, respectively).

While we have a vast knowledge on how treatments work on college campus settings and with college students – however we do not know how well treatments may work outside of the college setting. Using data from above, we can see that treatment completion rates are lower for non-college attending emerging adults and many of the referrals to treatment centers in non-college settings are from criminal justice settings. There is clearly a gap between college and non-college attending emerging adults, and this gap is paramount for emerging adults entering residential substance use treatment. Finally, if we look back at the Institute of Medicines definition of *marginalized* it is clear that emerging adults entering treatment would fit this definition. More research is needed to explore this gap in the literature, especially given the large number of emerging adults who are not in college or university.

Theoretical Orientation: Understanding Emerging Adult and Stress Related Theories

Theory of emerging Adulthood. Early developmental theory postulated that individuals moved from adolescence, the period lasting from puberty through the mid-teens, to young

adulthood, which lasted from late teens to about age 40 (Erikson, 1950). While this theory set the stage for understanding the life course, as individuals started developing changing attitudes toward what was expected of them such as pursuing higher education, and viewing the late teen and early 20's as a time of transition – developmental theory was beckoned to change. In 2000, Jeffrey Arnett proposed the theory of emerging adulthood to describe the developmental transition between adolescence and young adulthood. Specifically, this period was demarked to include individuals between the ages of 18 and 25 (although more recently this has been proposed to extend to age 29; Arnett, 2000; Arnett, 2005; Arnett & Tanner, 2006; Côté, 2006) in which individuals are delaying traditional adult roles (e.g. marriage, buying a home, settling down", having children) and are now engaging in more identity exploration (Arnett, 2001; Côté, 2006; Goldscheider & Goldscheider, 1999; Mulder, 2009). Emerging adulthood is also a period of instability and individuals are posited to engage in more experimentation (e.g. relationships, drugs, alcohol; Sussman & Arnett, 2014). With these developmental transitions in mind, it has also been noted that individuals who are characterized as having more identity exploration, increased instability and experimentation, and are free from parental monitoring (typically characterized in adolescence), and are not burdened with the responsibilities of full-fledged adulthood (Sussman & Arnett, 2014) are at increased risk for substance use and psychopathology (Schulenberg & Zarrett, 2006; Schulenberg & Maggs, 2002). Taken together, Arnett proposed emerging adulthood is a completely separate and distinct developmental period and included five dimensions: the *age of identity exploration*, the *age of instability*, the *self-focused age*, the *age of feeling in-between,* and the *age of possibilities* (Arnett, 2014). The dimensions may help explain why substance use and psychopathology rise during emerging adulthood.

Theories of self-regulation and stress. Briefly, there are two theories that aid our understanding of how early exposure to stress may alter self-regulatory processes (thus influencing substance use) and long-term dysfunction. The first is the *self-control strength model*, which posits that self-control is a finite resource and, once depleted, leads to impaired self-control (Baumeister & Vohs, 2003; Muraven & Baumeister, 2000). It may be that excessive stress stemming from early childhood adversity may lead to a depletion of self-regulation, which may in turn affect an individual's behavior (e.g., increased substance use). The second is the *toxic stress or allostatic load* model (McEwen, 2012; Shonkoff et al., 2009), which posits that the amount of stress an individual experiences over time contributes to pathogenic outcomes (Juster et al., 2011).

Briefly, self-control is the ability to override competing urges or desires and is otherwise used to maximize the long-term best interests of an individual (Agnew et al., 2011). The self-control strength model balances on the tenet that each time an individual self-regulates, they are drawing on a resource that, once depleted, results in reduced capacity to regulate emotions or impulses (Hagger, Wood, Stiff, & Chatzisarantis, 2010). Thus, when an individual exerts repetitive energy to self-regulate behavior, attempts thereafter should, in theory, fail indicating a lapse in time when decision making and impulsivity may play a larger role in problematic behaviors. Others have tested this model on alcohol consumption finding that exerting self-control (prior to alcohol consumption) resulted in higher levels of alcohol use (Muraven, Collins, & Neinhaus, 2002). Thus, it follows that emerging adults who are exposed to heightened stress may be exerting more self-control than those not experiencing stress and, subsequently, may have dysregulated self-regulation processes which may be linked to neurological dysfunction (e.g., prefrontal cortex, impulsivity) and increased substance use.

The toxic stress or allostatic load model underscores the importance of long-term, frequent, and prolonged exposure to stressful life experiences and the body's repeated neuroendocrine response (e.g., the way our body responds to stressors). The allostatic load model represents this 'wear and tear' (Juster et al., 2011; McEwen & Stellar, 1993) on the body and highlights the over-activation of the autonomic nervous system (e.g., sympathetic-adrenal-medullary (SAM) and the hypothalamic pituitary adrenal (HPA) axis) (Korte, Koolhaas, Wingfield, & McEwen, 2005; Sapolsky, Alberts, & Altmann, 1997). Prior studies have found that among low income youth, chronic exposure to stress mediates the association between poverty and allostatic load in young adulthood (Evans & Kim, 2012). This chronic exposure can result in dysregulation of multiple physiological systems which predict deleterious outcomes including cognitive functioning, cardiovascular disease, mortality, self-regulation problems, and substance use (Romeo & McEwen, 2006). Recently, Evans and Kim (2012) explained that chronic exposure to stressors during childhood and adolescence (specifically among low income youth) can lead to disruption in self-regulatory processes that aid in coping with external and acute stressors later in life. Several studies have echoed these findings such that youth tend to have higher concentrations of cortisol (HPA axis) when exposed to stressors (Gunnar et al., 2009).

In addition to the stress response system (e.g., HPA axis), exposure to chronic stress, absolute levels of stress, and history of stress also influence the prefrontal cortex, which serves as the area of the brain responsible for self-regulation (Pechtel & Pizzagalli, 2011). Prior studies have found prefrontal cortex dysfunction to be a phenotype important for the neural basis of addiction and is associated with impulsivity which increases risk of alcohol neurotoxicity (Reynolds, 2006). For example, studies of adolescents with alcohol use disorder show smaller

white and grey matter in the prefrontal cortex compared to adolescents without alcohol use disorder (De Bellis et al., 2005). Exposure to trauma, especially during adolescence when the brain in maturing and developing (Steinberg & Morris, 2001), can lead to a cascade of negative events (McEwen, 2003). As a matter of fact, most theories of addiction posit that acute and chronic stress play a large role in motivation to use substances (Koob & Le Moal, 2001; Koob & Le Moal, 2005; Koob & Le Moal, 1997; Leventhal & Cleary, 1980; Marlatt & Gordon, 1985; Russell & Mehrabian, 1975; Shiffman, 1982; Tomkins, 1966; Wills & Shiffman, 1985). For example, Marlatt & Gordon (1985) proposed the relapse prevention model and postulated that, in addition to bio-psychosocial risk factors such as deviant peers, parental substance use, and positive expectancies of substance use, individuals with poor coping strategies are at increased risk of substance use.

Among one of the more popular theories, the self-medication theory, Khantzian (1985) proposed that people use drugs and alcohol to enhance their experiences and mood in an attempt to temporally relieve emotional distress. Taking a more biological approach, Koob and Le Moal (1997) posited that stress leads to state-related changes in the brain's neurological circuitry – thus resulting in greater sensitivity to the reinforcing properties of substance use and increasing motivation and impulsivity to use substances to relieve distress. This may be especially true for emerging adults involved in the substance use treatment as they have experienced more trauma than community samples (Gordon, 2002), and the biological adaptation that occurs (e.g., impairment of HPA axis and prefrontal cortex) may make them more prone to impulsive decision making, heightened emotional reactions, and disorganized coping styles (Ford & Blaustein, 2013; Ford, Hartman, Hawke, & Chapman, 2008).

Substance Use Treatment Outcomes among Emerging Adults

In 2013 over 22 million people needed treatment for alcohol or drug use problems; however, only 4.1 million people actually received treatment (SAMHSA (NSDUH), 2014). Among treatment admissions, 22% of individuals received some form of residential care, and a large proportion (34%) of these individuals receiving treatment were emerging adults (SAMHSA, 2013). Until recently, many treatments that were developed for adults have been implemented with emerging adult populations without modification (Dennis et al., 2003; Muck et al., 2001). This is unfortunate, as evidence suggests that emerging adulthood is a period in which individuals experience unique aspects development compared to adolescence and in young or older adulthood (Arnett, 2000; Arnett, 2005). This is important to consider given how little is known regarding how well emerging adults respond to treatment compared to their younger (adolescents) and older (older adult) counterparts. Among the studies that have investigated these comparisons, all have found that emerging adults have lower treatment motivation, report higher substance use and more psychopathology at treatment intake, and have worse treatment outcomes. For example, Dennis, White, & Ives, (2009) used data from over 100 treatment programs across the United States to compare adolescents (n = 13,625) and emerging adults (n = 1,149). At intake emerging adults, compared to adolescents, reported higher risky environments (e.g. friends and family members who use substances), more substance use treatment episodes, perceived their substance use to be more problematic, had earlier age of onset, reported more victimization, and had more involvement in the criminal justice system. In another study that compared individuals from adolescence through adulthood – emerging adults were most vulnerable to co-occurring psychological and substance use problems compared to any other age group (Chan, Dennis, & Funk, 2008). Other studies have found that emerging adults have lower motivation for treatment compared to their older adult counter parts

(DiClemente, Doyle, & Donovan, 2009; Mason & Luckey, 2003; Satre, Mertens, Areán, & Weisner, 2003), indicating that not only are emerging adults worse coming in to treatment but they are less motivated which will impact treatment success. In terms of treatment outcomes two studies have investigated differences between older adults and emerging adults. Satre et al., (2003) showed that emerging adults, compared to their older adult counterparts, had higher rates of drug dependence and psychiatric symptoms, were less likely to have abstinence as a goal, and had lower post treatment (6 months) abstinence rates. Further, Satre, Mertens, Arean, & Weisner, (2004) found that emerging adults, compared to older adults, had less treatment retention, had more friends who encouraged drug and alcohol use, and were less likely to report abstinence. Smith, Godley, Godley, & Dennis, (2011) compared adolescents and emerging adults who were receiving the same treatment, Adolescent Community Reinforcement Approach (ACRA). Results indicated emerging adults were less likely to be abstinent at follow up and had more days of alcohol use compared to adolescents. Finally, Davis et al., (2016) compared emerging adults to older adults in Project Match (Project MATCH Research Group, 1993) across three treatments: Cognitive Behavioral Therapy, Motivational Enhancement Therapy, and Twelve-Step facilitation. Results indicated emerging adults showing significantly worse drinking outcomes during the treatment phase (e.g. first 3 months of study). However, these differences were no longer present during the year follow up, suggesting that emerging adults may have difficulty during the initial treatment phase and 'catch up' to older adults after treatment completion.

In general, emerging adults have worse profiles coming in to and out of substance use treatment compared to adolescents and older adults. With the low prevalence rate of treatment initiation among emerging adults and low treatment motivation it is imperative research continue

to develop ways to encourage treatment engagement. Further, results from these studies indicate a true need to both view emerging adults as a separate and distinct developmental period and to begin to understand what treatments work best for emerging adults. To do this, it is crucial practitioners and researchers understand why this developmental period is so unique and what aspects of this period are most predictive of substance use. This study will further the literature on emerging adulthood and how individuals respond to MBRP. Specifically, this will be the first study to investigate the impact of MBRP on an emerging adulthood population – thus furthering our knowledge base on the effect of mindfulness based interventions and on the developmental period of emerging adulthood.

Mindfulness Based Treatments for Substance Use Disorders

Studies of clinical populations have shown that clients entering substance use treatment report heightened levels of stress and an inability to adaptively cope with acute stressors (See Sinha, 2007 for review). This correlation between stress and increased substance use has led to the wide spread use of behavioral interventions (e.g. cognitive behavioral therapy (CBT)) in the treatment of addictions (Marlatt & Donovan, 2005; Monti et al., 1999). Though CBT has proven to be efficacious, more nuanced treatments such as Mindfulness Based Relapse Prevention (MBRP; Bowen et al., 2009; Witkiewitz et al., 2005) have been integrated with cognitive based therapies and shown to reduce depressive symptoms (Zgierska et al., 2008), perceived stress (Brewer et al., 2010), and days of substance use (Bowen & Chawla, 2011; Brewer et al., 2013).

Mindfulness is rooted in Buddhist traditions and is commonly defined as the "state of being attentive to and aware of what is taking place in the present" (Brown & Ryan, 2003). Some researchers have suggested that mindfulness based treatments may have significant advantages over traditional treatments (Brewer, Elwafi, & Davis, 2012) given this approach fosters the

patients' ability to stay in touch with their experiences rather than avoid or remove negative stimuli (Chiesa et al., 2014). In a recent review of the literature, mindfulness based interventions reduced consumption of alcohol, marijuana and opiates as well as reduced cravings compared to waitlist controls and support groups (Chiesa & Serretti, 2014). Mindfulness based treatments have been associated with structural changes in the brain (Hölzel, Lazar et al., 2011), changes in self-perception of stress (Holzel et al., 2010), and reduce cortisol levels thus establishing a direct link from mindfulness based treatments and indicators of stress physiology (Brand, Holsboer-Trachsler, Naranjo, & Schmidtl, 2012; Esch , Duckstein, Welke, & Braum, 2007).

Efficacy of Mindfulness Based Relapse Prevention

Recent studies have shown mindfulness based treatments to have medium effect sizes on relevant outcomes (d = 0.5; Grossman, Niemann, Schmidt, & Walach, 2004). These studies also show promising results in reducing both perceived and physiological stress, improving substance use treatment outcomes, reducing craving, and increasing trait (or state) mindfulness (Bowen & Chawla, 2011; Zoogman, Goldberg, Hoyt, & Miller, 2015). In a recent meta-analysis Li and colleagues (2017) found an overall effect of mindfulness based treatments of d = -.33 for any substance use. Specific to illicit drug use, results were replicated with a Cohen's d of -.51 for opiate use. One of the strongest effects of mindfulness based interventions was on stress with an overall effect size of d = -1.21. Thus, the efficacy for mindfulness based interventions is strong, yet little is known in regards to how well mindfulness based treatments, specifically MBRP, work for emerging adults.

Specifically, MBRP was developed to target negative thought processes such as rumination and craving which both play significant roles in substance use relapse (Witkiewitz et al., 2013). Staying true to the principals of mindfulness based practices, MBRP aims to increase

a patient's ability to tolerate problematic cognitive, as well as physiological experiences by helping patients to remain present focused which is typically achieved through meditative practice (Bowen et al., 2009). This means during treatment participants are taught to "respond" to situations that may trigger use or rumination through present-moment focus rather than acting or reacting in a habitual manner (Witkiewitz & Bowen, 2010). MBRP adds an interesting aspect to mindfulness-based treatments in that the intention is to enhance awareness of their internal and external triggers (Bowen, Witkiewitz, Chawla, & Grow, 2011). That is, MBRP adds an element of traditional cognitive behavioral exercises that aid in identifying high risk situations while creating alternative responses and coping strategies to respond to those triggers (Witkiewitz & Bowen, 2010). These skills are vitally important to master as both impulsivity and rumination are significant hindrances to post-treatment success. However, to date no study has investigated the relationship between receipt of MBRP, changes in perceived (or physiological) stress levels, and substance use outcomes (days of use and craving).

In an early MBRP trial Zgierska et al., (2008) examined the feasibility of implementing MBRP with 15 adult outpatients in treatment for alcohol dependence. A large percentage of individuals (53%) reported meditating 4 or more days per week in the 2 months following treatment. Alcohol outcomes indicated individuals reported fewer heavy drinking days 1 month after treatment and significant reductions in stress, depression and anxiety 2 months following treatment. These findings spurred two other smaller trials that pulled from various aspects of mindfulness based treatments. First, Vieten, Astin, Buscemi, & Galloway (2010) tested an 8-week manualized coping and relapse prevention program (using aspects of MBRP and other mindfulness based interventions) for 23 adults with alcohol use disorders. Individuals reported significant decreases in craving, negative affect, emotional reactivity, and perceived stress

immediately following completion of the 8-week intervention. However, this study did not find significant reductions in drinking. Second, Garland, Gaylord, Boettiger, & Howard (2010) randomly assigned individuals (*n* = 53) with alcohol dependence to a 10-session mindfulness based treatment or support group. The researchers were interested in investigating reductions in perceived stress, craving, psychiatric symptoms and thought suppression as well as increases in heart rate variability. Those assigned to the mindfulness based treatment significantly reduced their stress and thought suppression, and increased their physiological recovery from alcohol cues (heart rate variability). However, this study did not investigate the impact of reduced perceived stress and heart rate variability and subsequent alcohol use outcomes. The proposed study will address this gap in the literature by measuring perceived stress as a potential mechanism through which individuals remain abstinent (or have less days of use) post treatment and craving after receipt of MBRP.

Later, Bowen et al. (2009) randomly assigned participants (*n* = 168) to MBRP versus standard care. Individuals assigned to MBRP had significantly fewer days of alcohol and drug use two months following the intervention. However, these group differences were no longer significant at four months. Further, individuals assigned to MBRP showed significant reductions in craving and acceptance and a large majority (58%) reported continued practice 4 months after completion of treatment.

In the first evaluation of MBRP as a stand-alone treatment Brewer et al. (2009) randomly assigned participants (*n* = 36) who had alcohol or cocaine use disorders to MBRP or group cognitive behavioral therapy. At follow-up, no significant group differences were found for substance use outcomes, but those assigned to mindfulness training had significantly better reductions in physiological and psychological stress reactivity following a stress provocation lab

task. Again, while Brewer and colleagues have shown reductions in stress, this was done by assessing stress *reactivity* within a lab setting. The proposed study will investigate perceived stress levels while individuals are both in residential treatment as well as living in the community. This level of analysis will add a more comprehensive and "true to life" aspect given individuals are likely to experience stressful life experiences once discharged from treatment.

Most recently, Witkiewitz et al. (2014) investigated the effect of MBRP versus relapse prevention among women offenders in residential substance use treatment. Participants (N = 105) were randomly assigned to receive 8-sessions of MBRP (n = 55) or RP (n = 50). Results indicated at 15-week follow up individuals assigned to MBRP showed significantly fewer days of drug and alcohol use (d = .36 - .45), and significantly fewer legal problems (d = 1.18) compared to individuals assigned to relapse prevention. Bowen et al. (2014) randomly assigned adults assigned to MBRP (n = 103), relapse prevention (n = 88), and treatment as usual (TAU; n = 95). Compared to TAU, individuals assigned to MBRP and relapse prevention showed a 54% decreased risk of relapse for drug use and a 59% decrease risk of relapse to heavy drinking. Compared to the relapse prevention group, individuals assigned to MBRP showed a 21% increase in risk in relapse for drug use. No significant differences were found between MBRP and relapse prevention on any alcohol outcomes. At 6 month follow up individuals in MBRP or relapse prevention reported 31% fewer days of heavy drinking and a lower probability of relapse compared to TAU participants. No significant differences were found between relapse prevention and MBRP at 6-month follow up. Finally, at 12 months individuals assigned to MBRP reported 31% fewer drug use days and a significantly higher probability of no heavy drinking days compared to relapse prevention participants.

Overall, MBRP appears to be effective in reducing substance use, physiological stress, perceived stress, negative affect, and cravings. While understanding the main effects of MBRP is important for implementation and validation – previous large scale studies (e.g. Project MATCH, UKATT) that have sought to find the "best treatment" have found, on average, treatments work about the same (Heather et al., 2008; Project MATCH Research Group, 1998). One way to understand *why* treatments work is to investigate mechanisms of change. That is, investigating what factors, if any, mediate and moderate the association between group assignment and outcomes.

Among the studies that have used MBRP none have investigated its effects among an emerging adult population. This is important for two reasons. First, we know that emerging adults have worse treatment outcomes compared to older adults and adolescents. Therefore, it may be that, among the trials investigating the impact of MBRP, results will not translate to an emerging adult sample. For example, in the most recent study by Bowen and colleagues (2014) and Witkeiwitz and Bowen (2014) the average age was 38 and 40 years old, respectively. As discussed earlier emerging adults have much lower treatment motivation and a lower percent of treatment completion. It may be that MBRP is an appropriate treatment for older adults, but may have different effects for emerging adults. That is, treatment may work through "mechanisms" in different ways for emerging adults versus older adults given this period of life is a time of transition and identity development. Table 1 is an excerpt from Davis and colleagues (2016) investigating the differences between emerging adults and older adults assigned to CBT, Motivational Enhancement Therapy, and Twelve Step Facilitation from Project MATCH (Allen et al., 1997). As emerging adults enter treatment they are coming in with more risky social environments (e.g. more support for consumption), less support for abstinence, higher days of

substance use, and report more days of traumatic stress/victimization (Davis, Bergman, Smith, & Kelly, 2016; Dennis et al., 2009; Smith et al., 2011). With these higher risk profiles it is imperative that researchers develop, test, and fully understand which treatments 1) work for emerging adults and 2) are developmentally appropriate. Finally, while MBRP has been validated as an effective treatment for older adults it is important to determine its effectiveness for emerging adults given the large differences that exists between older adults and emerging adults. For example, among the studies that have found MBRP reduces both physiological and psychological stress, these have been with older adult populations who potentially have more salient coping mechanisms. With the amount of transitions and instability that exist during emerging adulthood, especially in a population of emerging adults entering residential substance use treatment (large percentage are criminal justice referred), reductions in perceived and physiological stress may have differential effects – especially for individuals who have experienced a large proportion of ACEs.

Table 1. Baseline differences between Emerging Adults and Older Adults M(SD) or n(%)

	EA N = 267	OA N = 1459	t/χ^2	*p*
DDD*	14.7 (8.05)	17.0 (11.0)	4.00	<.001
PDA*	0.40 (0.31)	0.29 (0.30)	-5.49	<.001
Psych Severity	0.23 (0.21)	0.20 (0.19)	-1.56	.119
BDI	10.1 (8.37)	10.2 (8.22)	0.16	.875
URICA	10.7 (1.73)	10.8 (1.66)	1.03	.302
DrlnC Total	52.2 (23.0)	51.7 (23.4)	-0.30	.762
DrlnC Interpersonal	11.8 (6.92)	12.3 (6.99)	0.94	.349
DrlnC physical*	8.37 (4.80)	9.68 (4.94)	3.97	<.001
DrlnC social*	8.46 (4.56)	7.31 (4.72)	-3.65	<.001
Social functioning	0.47 (0.18)	0.48 (.017)	1.10	.270
Self-efficacy – confidence	3.12 (.798)	3.04 (0.93)	-1.11	.269
Self-efficacy – temptation	-.120 (1.34)	-.134 (1.56)	0.63	.527
SOCRATES *	11.4 (4.53)	12.0 (4.01)	2.00	.045
Social support family	4.05 (2.47)	4.20 (2.44)	0.91	.365

Table 1 (cont.)

Social support friends	3.99 (2.24)	3.95 (2.20)	0.01	.989
Support for abstinence	21.3 (3.72)	21.7 (3.85)	1.61	.108
Support for consumption *	22.3 (7.98)	19.5 (7.63)	-4.63	<.001
Illicit drug use n (%)*	167 (62.5)	495 (33.9)	78.2	<.001

EA = emerging adult; OA = older adult; DDD = drinks per dinking day;
PDA = percent days abstinent; BDI = Becks depression inventory;
DrlnC = Drinker Inventory of Consequences; SOCRATES = Stages
Of change Readiness and Treatment Eagerness Scale.
* $p < .05$,

Empirical Evidence of the Stress and Substance Use Relationship

Early researchers believed that when an organism is stressed the body uses physiological signals (e.g. cortisol) to respond to the stressor and eventually return to a homeostatic state (Selye, 1982). However, Selye posited that when an organism is exposed to prolonged stressors an adaptation takes place and the organism will eventually 'submit' to the disease. Though this theory was developed nearly 70 years ago, researchers have uncovered a vast array of information regarding the neurobiological and psychological aspects of stress.

For the past 50 years, stress has been associated with negative health outcomes including psychological distress, lower reports of well-being, lower life-satisfaction, and physical health problems (Thoits, 2010). Researchers interested in the stress response system have primarily focused on four major aspects of stress: 1) the events that cause stress (e.g. stressful life events); 2) the cognitive processes that evaluate the stressor (e.g. appraisal); 3) physiological responses to stress; and 4) behavioral responses to the stressor (e.g. coping; Sinha, 2001). In general when an individual experiences a stressful event the response is usually one or more conditioned (or unconditioned) emotional reactions such as anger, fear, sadness, excitement, or pleasure. Regardless of what emotion arises, the reaction is reliant on the appraisal of the event, availability of appropriate coping mechanisms, and the prior emotional state of the individual (Sinha, 2001). Taken together, all of these "steps" in the stress response system vary within each individual based on their prior experiences (e.g. early life stress) and their ability to appropriately

appraise the stressor. The variation in these responses is what allows researchers to develop a better understanding of how certain individuals respond to treatments and what factors may mitigate those responses.

Early life stress and substance use in non-human studies. In both clinical, population, and animal studies chronic stressors such as childhood physical, sexual, and emotional abuse have been shown to lead to alcohol or drug use (Andersen & Teicher, 2009; Dembo et al., 2000; Gordon, 2002; Sinha, 2008; Weiss et al., 1997). For example, early animal research has shown that rhesus monkeys raised by their peers, compared to rhesus monkeys raised by their mothers, consumed significantly more alcohol as adults (Higley, Hasert, Suomi, & Linnoila, 1991). Interestingly, when stress was induced through social separation, mother-reared monkeys' alcohol intake increased and peer-reared monkeys remained the same, indicating that early life stress (e.g. isolation, separation, parental bonding) increases self-administration of alcohol. Other results indicate when monkeys are exposed to early life stress they show increased levels of corticotrophin releasing factors (CRF) which is linked to chronic distress (Arborelius, Owens, Plotsky, & Nemeroff, 1999; Coplan et al., 1996), hypercortisolism (typically found in individuals with chronic depression; (Sapolsky, Alberts, & Altmann, 1997), and long-lasting changes in the HPA response system, indicating increased sensitivity to behavioral stress response leading to increased alcohol intake later in life (Fahlke et al., 2000; Higley et al., 1991; Schneider, Moore, Kraemer, Roberts, & DeJesus, 2002).

Early life stress and substance use in human studies. Studies investigating the impact of early life stress in humans have found, in general, individuals who experience ACEs are at risk of increased drug and alcohol use (Andersen & Teicher, 2009; Dembo et al., 1988; Dembo et al., 2000; Gordon, 2002; Harrison, Fulkerson, & Beebe, 1997; Teicher et al., 2003). Early

stress also enhances our stress response system (e.g. reward pathways), such as HPA axis, to increase risk of drug use and dependence (see Andersen & Teicher, 2009). In particular, chronic exposure to stress has been associated with increased prevalence of alcohol use, depression, and drug use (Cohen et al., 2007; Miller et al., 2002). Further, ACEs have also been linked to: 1) permanent changes in the HPA axis (Enoch, 2011), 2) altered brain development that negatively impacts executive decision-making regarding substance use and other deficits in impulse control/disinhibition (Shonkoff & Garner, 2012) , and 3) increased risk of early (< 14 years old) alcohol or drug use (Andersen & Teicher, 2009; Dembo et al., 2000; Gordon, 2002; Sinha, 2008; Weiss et al., 1997). Individuals who have experienced ACEs may also possess altered stress response systems (i.e. altered cortisol secretion, elevated or blunted cortisol) and be at heightened risk of substance use relative to those who have not experienced ACEs (Coplan et al., 1996; Raposa et al., 2014; Shonkoff & Garner, 2012; Sinha, 2008). For example, Tykra et al. (2012) found, individuals under a lab stress test, who had experienced more ACEs showed increased methylation of genes associated with increased cortisol patterns (Tyrka, Price, Marsit, Walters, & Carpenter, 2012). These results suggest that ACEs may lead to modifications in the glucocorticoid receptor gene (associated with the HPA axis) which has implications for alterations to the stress response system and, more importantly, risk for psychopathology and substance use.

It is clear that ACEs are an important factor to consider when investigating both stress and substance use. As a matter of fact, in a recent review on the impact of stress on long term health outcomes, Thoits (2012) suggests that the top two priorities moving forward should be focusing on implementing interventions that effectively buffer the effects of stress and focusing on populations that are at the highest risk of developing long term dysfunction. The proposed

study will utilize a measure of childhood trauma and parental bonding to create a latent construct for assessing adverse childhood events. To assess stress, we will use both a perceived stress measure as well as a proxy for chronic physiological stress (see next section below). Given mindfulness based interventions have been shown to have a profound impact on stress (d = -1.3) we will assess the acute (treatment phase) and long term (duration of study) effects of MRBP on perceives stress and self-regulation (e.g., impulsivity).

Overall, the literature on the associations between both current and chronic stress (e.g. ACEs) and substance use is vast. As a matter of fact, these associations go back nearly 50 years. Our understanding of this association has led to advances in research such as understanding various ways to measure stress subjectively (e.g. perceived stress) and objectively (e.g. cortisol, HPA axis dysfunction). Interestingly, these two distinct ways of measuring stress have been shown to have high correlations such that those who report increased stress also report dysfunctional stress response systems. However, one aspect of the literature that has been ignored is the role stress (or change in stress) plays as a mechanism of change during intervention. Specifically, investigating how interventions that are designed to reduce stress impact both perceived and physiological stress patterns can aid our understanding of the process through which desired outcomes are achieved. One type of intervention that has received a lot of attention in the past several years is mindfulness based treatments.

Mindfulness, mechanisms of change, and stress

Mindfulness based treatments are cited as one of the only treatments to significantly lower cortisol levels (acute stress) at post-test compared to control groups, (Brand, Holsboer-Trachsler, Naranjo, & Schmidt, 2012; Matousek et al., 2010) and completing mindfulness based treatments results in reduced perceived and physiological stress patterns (Creswell, Pacilio,

Lindsay, & Brown, 2014; Davidson et al., 2003; Matousek et al., 2010). At the epicenter of mindfulness based practices is the potential for physiological, psychological and neurobiological stress reduction (Jung et al., 2010; Marchand, 2012; Mohan, Sharma, & Bijlani, 2011; Stefano, Benson, Fricchione, & Esch, 2005; Stefano, Fricchione, & Esch, 2006). For example, researchers have shown that when someone enters a meditative state there is a potential to elicit a "relaxation response" (Some researchers have posited that measuring salivary alpha amylase is a proxy for the relaxation response; Benson, 2000) which is thought to be an antagonist of the 'stress response' (Esch, 2014). In general, when under stress our body activates an automatic or "auto pilot" response typically in the form of rumination, negative thoughts, assumptions about what will happen, and impulsivity (Esch, 2014). In a recent review, researchers found that mindfulness may enhance positive emotional regulation strategies, self-compassion, increase trait (or state) mindfulness, and decrease rumination and experiential avoidance (Chiesa et al., 2014). Most importantly, these mechanisms were found to improve several clinical outcomes including depression levels, positive emotions and stress levels.

From a neurocognitivepoint of view, there have been two proposed pathways to aid in explaining the association between mindfulness, drug craving, and stress. The first pathway is through a "top down" approach in which individuals exhibit executive control over craving and the second, a "bottom up" approach, in which individuals change their subjective experience of craving (Westbrook et al., 2013; Witkiewitz et al., 2013). In a secondary analysis Witkiewitz & Bowen (2010) sought to test moderated mediation pathways between negative affect, craving, and post-treatment substance use outcomes. Results indicated that MBRP attenuated the associations between self-reported negative affect scores and craving, with craving significantly mediating the relation between treatment assignment and days of drug and alcohol use at follow

up. Interestingly, the relationship between negative affect and post-treatment substance use was mediated by craving among the TAU group and not MBRP participants. Further analyses revealed that the differences in craving between MBRP and TAU groups were partially explained by greater mindful acceptance, awareness and nonjudgement among individuals assigned to MBRP (Witkiewitz et al., 2013). These results support the purpose and use of mindfulness based treatments such that MBRP is designed to help clients experience a challenge or difficult situation and not react in an "automatic" way. That is, by actively controlling ("Top down") reactivity individuals are able to effectively alter their conditioned response to craving in the presence of negative affective states. Further, results from this study could indicate that MBRP (i.e. treatment condition) moderated the mediated pathway from negative affect to substance use through craving response, thus it may be that MBRP had a positive impact on managing craving.

Similar pathways have been proposed for stress experience and exposure. For example, Sinha (2001) proposed a model in which maladaptive stress response (e.g. higher or lower reactivity/sensitivity to stress followed by slow recovery to baseline stress levels) mediate the increased frequency and chronic drug use among vulnerable individuals after exposure to a stressful situation. That is, when an individual experiences an acute stressor and they have a dysfunctional stress response system – that maladaptation may mediate the relationship between treatment and subsequent substance use outcomes. Further, Sinha also proposed neuroadaptions in the brain's stress and reward circuits as a moderator that promotes the maladaptive stress responses leading to chronic and continued substance use.

Both of these proposed models indicate various ways in which the stress response system can be activated and regulated. These findings indicate that mindfulness, and specifically MBRP,

may impact outcomes through reducing subjective experiences of craving, teaching individuals to practice acceptance (accepting their current craving as just craving), being nonjudgmental (noncritical of themselves and craving), changing the way they react to negative stimuli, changes in key areas of the brain (Cingulate cortex, changes in white – and – gray matter), and through stress response systems (both perceived and, potentially, physiological). One of the clear connections between these models and other theoretical models of stress response is the idea that stress regulation (e.g. changes in stress response patterns) can alter long term substance use outcomes. Despite efforts at reducing drug and alcohol use, high rates of relapse among emerging adults (60% with prior treatment episodes) have not declined. One potential way to address this is investigating how treatment may impact changes in our stress response system, thus impacting treatment outcomes. That is, investigating how MBRP may impact both perceived and physiological stress could impact how individuals respond to treatment. Witkiewitz et al., (2013) hypothesized that long-term effects of MBRP may be observable through physiological processes (e.g. alterations in stress response systems such as HPA axis) and perceived stress levels and it is important we understand the mechanisms through which MBRP improves treatment outcomes. To date only one study has attempted to assess this model through changes in hair cortisol concentrations (measure of chronic stress) for cigarette smoking (Goldberg et al., 2014). Results showed HCC was associated with decreases in cigarette smoking behavior and negative affect after mindfulness training, indicating that HCC may be a key player in understanding changes in other substance use behaviors.

In this sense, MBRP may work through reduction in both perceived and chronic stress patterns to improve substance use outcomes. Based on previous research we have seen that MBRP lends a direct link to reductions in both substance use and craving as well as changes in

perceived stress (and on occasion lab tested physiological stress patterns). However, no study has tested these potential mechanisms through which MBRP may work. Understanding mechanisms of behavior change takes research one step further by asking the question *"how does this work"* versus simply *"does this work*." It may be that MBRP is a successful treatment in aiding reductions in craving and days of substance use, however this may work primarily through how we appraise stress or how our body reacts to stress.

Summary and Hypotheses

The primary goal of the proposed study was to examine the effect of MBRP on perceived stress, craving and substance use. Further, this study sought to understand how changes in both perceived and chronic stress influence days of substance use and craving over six months following treatment discharge. The main analysis will investigate perceived stress as the mechanism of change. Emerging adults entering residential substance use treatment were randomized to treatment as usual plus MBRP (MBRP) or Treatment as Usual (TAU) plus additional self-help recovery meetings. The experimental group received treatment as usual along with eight sessions of MBRP, while individuals assigned to TAU received treatment as usual and attend additional Alcoholics or Narcotics Anonymous meetings. As a secondary goal we investigated how changes in stress patterns and subsequent days of substance use were moderated by ACEs. This study has 4 hypotheses outlined below.

Aim 1: Test the effect of MBRP on days of use and craving. This study investigated the effect of MBRP vs TAU among high risk emerging adults – a developmental span known to have the highest rate of substance use and relapse

Figure 1. Hypothesized model for H1 through H2.

(SAMHSA, 2014b). Specifically, we hypothesize (H1) that (random) assignment to MBRP (vs. TAU) will be associated with fewer days of use during the post-treatment phase, and (H2) lower craving during the treatment and post-treatment phase (Figure 1).

Aim 2: Test the effect of MBRP on measures of stress. The third hypothesis (H3) is that assignment to MBRP (vs. TAU) will result in greater decreases in stress during the treatment phase and post-treatment phase (Figure 2).

Figure 2. Hypothesized model for H1 through H2.

Aim 3: Evaluate the extent to which chronic stress mediates the effect of MBRP on substance use outcomes and the attenuating effect of ACEs. A full model will be employed to test the potential mediating effects of reductions in stress during the treatment phase on substance use during the post-treatment phase. Thus, the fourth hypothesis (H4) is that changes in stress during the treatment phase will mediate the effects of treatment assignment (MBRP vs TAU) on substance use during the follow up phase. Specifically, those assigned to MBRP will have greater reductions in stress during the treatment phase (compared to TAU) and these reductions will act as a mechanism in reduced substance use during the post-treatment phase. Finally, the attenuating effect of ACEs (H5) will be assessed as a potential moderator for main effects (e.g.,

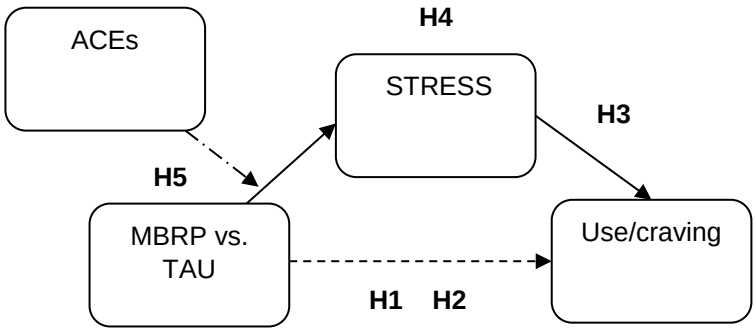


Figure 3. Hypothesized model for H3-H5

main effects on stress, craving, and substance use) as well as a moderator in our moderated mediation model (Figure 3). Specifically, ACEs will influence stress, craving, and substance use for the TAU group only – indicating that those assigned to MBRP will see reductions in all three constructs regardless of ACEs experience.

Chapter 2: Methods

Participants

This study has been approved, and held up, by the University of Illinois Internal Review Board (IRB # 15434) and was supported by a Campus Research Board grant (RB15247 – PI: Dr. Brent Roberts), a National Institute on Drug Abuse R36 grant (1R36DA041538 – 01- PI: Jordan Davis), and the Fahs-Beck Fund for Research and Experimentation (PI: Jordan Davis). All participants provided informed consent prior to participating. The study was conducted at one site, the Prairie Center Residential Substance Use Treatment Center in Champaign Illinois, a nonprofit public treatment facility. All participants (N = 79) had at least one diagnosed substance use disorder. All participants had a wide range of involvement in illegal activities such as drug use, drug possession, drug manufacturing, burglary, prostitution, and vandalism. The most common substances were heroin (n = 26, 32.5%), methamphetamine (n = 21, 26.3%), cannabis (n = 12, 15%), alcohol (n = 8, 10%), crack/cocaine (n = 6, 7.5%), and other drugs (e.g., bath salts, synthetic cannabis; n = 7, 7.5%). For participants to be admitted to the treatment facility each participant took and passed a drug screening through urine analysis. Participants were allowed to be positive for cannabis and barbiturates as these substances have a long half-life. Given this aspect of admittance into the facility participants had very few substance using days in the two weeks prior to entering treatment.

Design and Procedure

Recruitment for the study began on September 1st, 2015 and ended on November 15th 2016. Inclusion criteria for the study were residency at the treatment center**,** between the ages of 18 and 29, proficiency in the English language, and clear cognitive ability to understand and provide consent.

Recruitment and consenting. During the standardized intake procedure that each participant underwent as a new patient at Prairie Center, individuals who were within the 18-29 year old age range were given a study flyer and a demographics and interest sheet (See Appendix A). Research team members were notified of incoming emerging adults a week prior to their arrival. The project manager and Co-PI (Jordan Davis) retrieved demographic and interest sheets each day at the Prairie Center and set up a time for the following day to meet with interested participants. Prior to entering the study, each participant met with a member of the research staff to discuss the purpose of the study, what role they would play, the difference between experimental and control groups, intake and follow up procedures, and expectations during the 6-month study period. If participants agreed to enter the study, they completed an informed written consent (See Appendix B) prior to commencing the study. Each participant was read the informed consent documents and was given a copy of the signed consent. All participants who consented to participate in the study did not accrue any costs.

Following consenting procedures all participants underwent an initial baseline assessment. The baseline assessment took, on average, between 40 and 60 minutes to complete. Assessment procedures included gathering Locator Information from each participant. Locator information was used to track participants once they were discharged (or in the case that participants were excused from the Prairie Center for disciplinary reasons). We asked participants to provide us with the contact information for close family members, friends, relatives, or spouses/partners. We asked, specifically, for participants to provide both phone numbers, addresses, and e-mail addresses for their locators. When communicating with participants (by e-mail or telephone) we referred to the trial as a "the stress study" and did not reveal that the trial involved interventions to treat substance use disorders. Similar procedures

were used when contacting a close friend or family member from the "*Locator Form*." When communicating with individuals listed by a participant we began by stating "*We are attempting to get in contact with (NAME). He/she is involved in a study with the University of Illinois on stress, and they are due for a follow up assessment*." At no time was any information be relayed to individuals listed by participants as their locator contact regarding substance use treatment or services they had received from the University of Illinois or Prairie Center. Immediately following data collection on locators, research assistants began the baseline assessment using the online platform Qualtrics. All measures (see "*measures*" section below) were uploaded to Qualtrics for online assessments. Qualtrics LLC., our main outcome instrument, is an online survey instrument that may be accessed via e-mail or mobile technology. While there exists the potential for a breach of confidentiality, Qualtrics LLC has put security measures in place to safeguard against these. First, the Qualtrics system complies with HIPAA security requirements for secure web transmission of data. All data stored on their servers are firewall protected, with vulnerability scans and backups performed nightly. Second, Qualtrics uses Transport Layer Security encryption when data is being transferred via the web. All complete survey data are encrypted and hosted by a third-party data center which is SSAE-16 SOC II certified. More information on Qualtrics security and system can be found at www.qualtrics.com.

After consenting participants were randomized to receive MBRP or TAU. Treatment allocation was performed randomly by an online "Clinical trial randomizer" (www.randomization.com; Suresh, 2011) to assign individuals into their respective groups. Therapists were not blind to treatment allocation, however research assistants aiding in the follow-up assessments were blind to treatment allocation.

Assessments. During the treatment phase (approximately 4-6 weeks post baseline assessment) participants, regardless of treatment allocation, completed follow-up assessments (see "*Instruments and Measures*" section below for list of measures used in follow up and Table 2 for trial procedures) every two weeks.

Table 2. Time Line for Trial Procedures

	1st Year					2nd Year
	Intake	Residential Stay	Discharge	Bi-Monthly follow-up	Quarterly follow -up	
Randomization	X					
Tx		X				
Assessments	X	X	X	X		
Cortisol (Hair)	X		X		X	
Data Analysis						X

That is, if an individual remained in treatment at the Prairie Center for 30 days, they completed the baseline assessment and two follow up assessments. Follow-up assessments were shorter, taking approximately 20 - 30 minutes to complete. All follow-up assessments collected data on substance use, perceived stress, craving, coping, mindfulness, and emerging adult development. Once participants were discharged from the Prairie Center, we continued to contact individuals for follow-up assessments every two weeks for the remaining time in the 6-month study period. One of the major differences between this study and other studies was our approach to assessment. Our approach used assessments on a bi-monthly basis, as opposed to traditional methods that assess on a quarterly basis (e.g. 3, 6, 9 month follow-up). The major advantage of this approach is that we could assess nuanced changes in behavioral measures, thus allowing us to determine more precisely when individuals were at most risk for relapse, which in turn will contribute to the field's understanding of how to time and structure post-discharge treatments. In

total, if a participant were to complete each assessment (including baseline) we had 15 data points over a 6-month period.

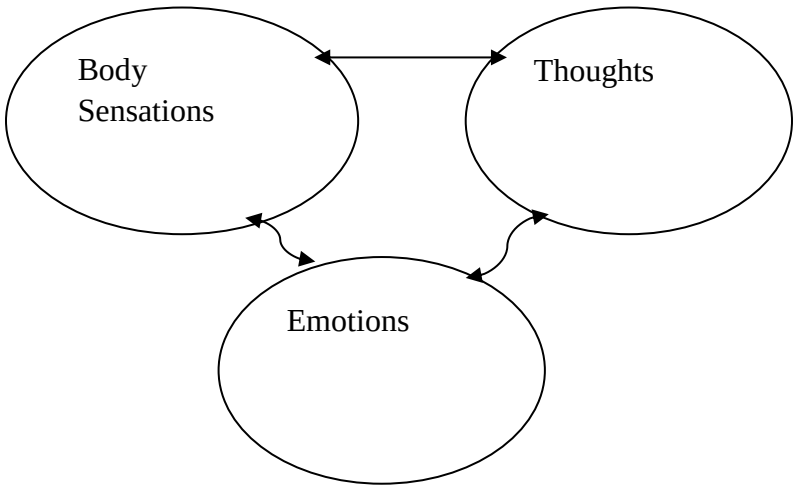
Remuneration. Each participant received $10.00 for each assessment they completed. If an individual completed all of the assessments over the 6-month period they earned a total of $150.00. Further, we also provided a bonus drawing twice during the follow-up period. For each completed assessment the individual was entered into a drawing for a $150.00 dollar gift card. If an individual completed 5 assessments over the 6 months they had 5 chances (versus 1) to win the gift card drawing.

Treatment Protocols

MBRP. Individuals assigned to the experimental group received the treatment normally provided by the Prairie Center as well as eight 1.5-hour group sessions of MBRP. Sessions occurred twice weekly given the average residential stay is one month. This allowed us to deliver all 8 sessions, which are typically delivered over an 8-week period. MBRP treatment was delivered at the Prairie Center Inpatient Unit by the PI, Jordan Davis, and by an advanced mindfulness instructor, Ellen Ritter, MA. Jordan Davis' mindfulness instructor training included completion of the required participation in an 8-week MBCT class in April 2015, personal daily practice, and successful completion of the UIUC Psychology Department's Mindfulness Instructor Training Practicum (Psychology 546). The Instructor Training Practicum began in the summer of 2015 with completion of "teachbacks" of the MBCT/MBRP guided mindfulness practices. The weekly practicum continued through the 2015/2016 academic year and included discussions of mindfulness research articles and dharma articles/talks; engagement with solo and interpersonal mindfulness practices; and clinical supervision provided by Dr. Chris Menard. Jordan met with Dr. Menard for weekly supervision during the mindfulness practicum and then

as needed in the summer and fall of 2016. Therapists abided by the principles and methodology established in *Mindfulness-Based Relapse Prevention for Addictive Behavior: A Clinician's Guide* (Bowen & Chawla, 2011). One important difference in our delivery of MBRP compared to the standard version is the use of rolling groups. We developed a protocol which allowed us to enroll individuals as they enter treatment at the Prairie Center, rather than employ the standard 8-week cohort based protocol. To do this we implemented a "common" start to each session which included a short discussion (5 – minutes) on the triangle of awareness (see Figure 4), and a short (5-10 minutes) meditation incorporating the triangle of awareness streaming into the SOBER breathing space meditation. This common beginning also included distributing handouts to any new participants which included a "*what is mindfulness*" handout, a "*understanding the triangle of awareness*" handout, and instructions on how to do the SOBER breathing space (See appendix C).

Figure 4. Triangle of Awareness



Session Content. Each session targeted a specific theme such as awareness of personal triggers, present focus, allowing/letting be, responding to emotional and physical experiences in skillful ways, intrusive thought recognition, or kindness in action. Table 3 displays each of the 8

sessions, theme, goals, and what meditations are taught. For example, two of the more prominent techniques are the SOBER breathing space and "Urge Surfing" in which participants were taken through steps to remove themselves from what is known as "automatic pilot" mode and bring their awareness to the present moment. Individuals were encouraged to make each of the exercises their own such that each person used their present experience as the catalyst for mindful practice. Participants were be trained on how to utilize mindfulness practices and given homework of 20-30 minutes per day. Homework assignments included guided mindfulness meditations that corresponded to the prior session as well as some light paper-based homework. Participants were also provided materials (e.g. recordings) with which to practice meditation during their stay in treatment as well as after discharge. Participants were asked to report how many times they practiced mindfulness meditation, how long, and which guided practices they used during the treatment phase and at all follow-ups. Individuals in the MBRP group were also asked about Alcoholics and Narcotics Anonymous attendance.

TAU. Those assigned to the control group (TAU) received treatment normally provided by the Prairie Center and were asked to attend up to eight extra social support groups (Alcoholics and Narcotics Anonymous) during the residential stay. This approach was taken to mitigate the possibility that treatment effects were solely due to the experimental group receiving "extra" attention. Attendance at extra support group meetings were equated to the number of hours the experimental group received additional MBRP sessions. The basic treatment practice employed at the Prairie Center was a mix of cognitive behavioral treatment and 12-step approach to recovery. Individuals were asked to report how many Alcoholics and Narcotics Anonymous meetings they attended during the treatment phase and at all follow-ups. Like the experimental group, individuals in the TAU group were also asked about mindfulness practices.

Table 3. Mindfulness Based Relapse Prevention Session Content

Session	Theme	Skills acquired	Meditations
Session 1 "Stepping out of Autopilot and Anchoring in the Present Moment"	When we experience cravings and urges to use alcohol or drugs, we often engage in reactive behaviors, acting on them without full awareness of what is occurring and what the consequences will be. On automatic pilot, it is easy to drift unaware into "doing" mode and the ruminative thought patterns that can tip us back into relapse. Habitual doing mode also robs us of our potential for living life more fully. We can transform our experience by intentionally paying attention to it in particular ways.	• Mindful of daily activity • Understanding of Auto-pilot	• SOBER breathing space • Mindful eating • Anchoring in the breath
Session 2 "Using Mindfulness to Cope with Triggers and Craving"	This session focused on recognizing triggers and introduces the practice of experiencing them without automatically reacting. We begin by learning to identify triggers and observe how they often lead to a chain of sensations, thoughts, emotions, and behaviors. Mindfulness can bring this process into awareness, disrupting automatic reactive behaviors and allowing greater flexibility and choice.	• Noticing triggers and how to deal successfully with them • Disruption of the automatic process	• Urge Surfing • Mountain Meditation

Table 3. (cont.)

Session 3 "Mindfulness in Daily Life"	Mindfulness meditation can increase our awareness and subsequently help us make better choices in our daily lives. Because breathing is always a present-moment experience, pausing and paying attention to the breath is a way to return to the present moment and bring awareness back to the body. With this presence and awareness, we are often less reactive and can make decisions from a strong, clearer place. The SOBER breathing space is a practice that can extend this quality of mindfulness from formal sitting or lying-down meditations into the daily situations and challenges we encounter.	• Integrating SOBER breathing space into daily life • Bring awareness to daily activities	• Awareness of Hearing • Breath meditation
Session 4 "Mindfulness in High Risk Situations"	In this session, we focus on staying present in challenging situations that have previously been associate with substance use or other reactive behavior. We learn how to relate differently to pressures or urges to use substances and practice responding to highly evocative stimuli with awareness rather than reacting automatically or out of habit.	• Remaining present focused in challenging situations • Working with craving and high risk situations	• Sitting meditation: Sound, breath, sensation, thought • SOBER breathing space in a challenging situation

Table 3. (cont.)

Session 5 "Acceptance and Skillful Action"	It is important to find the balance between accepting whatever arises while also encouraging healthy or positive action in our lives. When we fight against these things, however, we tend to feel frustrated, angry, or defeated, which can be triggers for substance use. When we accept the present as it is, we are not being passive. We are allowing what already is without struggle or resistance. This is often a necessary first step toward change. The same is true of self-acceptance; it often requires a complete acceptance of ourselves just as we are before real change can occur	• Acceptance practice	• Sitting meditation: sound, breath, sensation, thought, emotion • Sober breathing space in a difficult situation
Session 6 "Seeing Thoughts as Thoughts"	We have practiced noticing our minds wandering and labeling what is going on in our minds as "thinking." We have practiced gently returning the focus of attention to the breath or body. Now we want to turn our focus to thoughts, and begin to experience thoughts as just words or images in the mind that we may or may not choose to believe. We will discuss the role of thoughts and belief in thoughts in the relapse cycle	• Understanding thoughts as thoughts • Working through relapse cycle and how/when we can use SOBER breathing space to break that cycle	• Sitting meditation: thoughts

Table 3. (Cont.)

Session 7 "Self-Care and Lifestyle Balance"	We have spent some time paying close attention to the specific situations, thoughts, and emotions that put us at risk for relapse. In this session, we take a look at the broader picture of our lives, and identify those aspects that support a healthier, more vital life and those that put us at greater risk. Taking care of oneself and engaging in nourishing activities are an essential part of recovery.	• Nourishing and depleting activities • Where does relapse begin and how can meditation aid in reducing risk	• LovingKindness
Session 8 "Social Support and Continuing Practice"	Recovery and mindfulness practice are both lifelong journeys that require commitment and diligence. This is not an easy voyage. In fact, it can feel at times like swimming upstream. Hopefully, this group has provided you (or will provide you) with a sense of community and support. Having a support network is crucial to continuing along the path of practice and recovery. Having a recovery support network can help us recognize signs of relapse and provide support when we feel we are at risk. Having support around our meditation practice can help us sustain our practice and choose to show up for our lives in a mindful, intentional, and compassionate way.	• Understanding the importance of a social support network • Practice outside of group and its benefits	• Body scan • Walking meditation

Treatment fidelity. To prevent bias, therapists were not involved in follow-up assessments with the experimental group and were blind to participant responses on all outcomes during the treatment and follow up phase. To assess treatment fidelity, the clinical advisor, Dr. Chris Menard, attended 16 random sessions throughout the study period. Dr. Menard observed each of the 16 sessions in their entirety and rated both therapists using the MBRP Adherence and Competence Scale (MBRP-AC) to rate each therapist on style/approach, delivery, attitude, inquiry, and adherence to the manual (See Appendix D; Chawla et al., 2010). Dr. Menard acted as the clinical supervisor for the entirety of the project. Both therapists met with Dr. Menard weekly for supervision.

In general treatment adherence refers to the extent to which an intervention is prescribed through a treatment manual, is actually delivered to the participants (Waltz, Addis, Koerner, & Jacobson, 1993). Competence, however, refers to the actual ability (or skill) of the therapist to deliver the treatment (Waltz et al., 1993). The ability to track and assess these treatment integrity constructs is essential to the external and internal validity of a study protocol and its findings (Bellg et al., 2004). Accounting for the differential adherence, or skill, of therapists aids in reducing unaccounted variability and helps determine, to a certain extent, how the treatment itself is explains study outcomes (Bellg et al., 2004).

The MBRP-AC contains two main sections, *Adherence* and *Competence*, of which both have two subscales. The adherence subscales are: MBRP Treatment Components and Discussion of Key Concepts. The Adherence to MBRP Treatment Components is assessed using a "check list" of the major topics that are covered in each section to ensure both therapists delivered these components. The Adherence to MBRP Treatment Components contains 10-items. The original MBRP-AC guide has 10 items for the first session and 7 thereafter. Because we utilized a rolling

admissions framework, we incorporated all 10 items for each session as the three additional items relate to newcomer or 'new participant' material. Example of these check list items are "discussion of group format and structure," "what is mindfulness discussion," and "discussion group structure and format." The Discussion of Key Concepts subscale assesses the ability of the therapists to incorporate the main, or key, concepts from MBRP into the in-session exercises and when responding to clients. This subscale, unlike the Adherence to MBRP Treatment Components, contains 4 items which are rated using behavioral counts (e.g. tally) of instances of each behavior. Example items for the Adherence to MBRP Key Concepts include "Noticing/Awareness of Current Experience," "Acceptance of Current Experience," and "Acceptance versus Aversion."

The Competence section also retains two subscales including Therapist Style and Approach and Overall Therapist Performance. The Therapist Style and Approach subscale consists of 4-items that are rated on a 5 point Likert scale where 1 = *low ability* and 5 = *high ability*. Therapists are rated on their general competence (e.g. therapists to respond to inquiry with open questions, without judgment, and with an open curiosity) as well as mindfulness therapist competence (e.g. ability to describe and explain misconceptions of mindfulness based practices). Example items include "Inquiry: therapists ability to elicit and respond to both verbal and non-verbal feedback)" and "Attitude: therapists ability to model and embody the spirit of mindfulness (respond to participants in a way that is curious, focused in the present moment, and non-judgmental/accepting of whatever participants bring up." The Overall Therapist Competence subscale intends to capture therapist's global competence of treatment delivery such as maintaining on topic, not striving, working as a team during group sessions. This subscale consists of 4-items that are rated on a 5 point Likert scale in which 1 = *not satisfactory* and 5 =

excellent. Example items include "How would you rate the overall quality of therapy in this session?", "How would you rate the ability of the therapists to work as a team?" and "Please rate the overall quality of delivery of the meditation exercise." The MBRP-AC has high internal consistency with Chronbach α's ranging from 0.82 to 0.86 (Chawla et al., 2010). Further, adherence to the MBRP manual, as rated by the MBRP-AC has been shown to be positively associated with post-treatment mindfulness development among participants during the intervention (Chawla et al., 2010).

Measures

We used the web-based assessment tool Qualtrics LLC for all assessments. Time Line Follow Back (Sobell & Sobell, 1992) was used to assesses participants' recent (past 2 weeks) which has been shown to have excellent reliability and validity (Carey, 1997). Copies of instruments are in Appendix D.

Measures of substance use. The *Substance Frequency Scale* (M. L. Dennis, Funk, Godley, Godley, & Waldron, 2004) was used to assess a count of the number of days each participant has used a variety of drugs and alcohol. The SFS is the average percent of alcohol, heavy alcohol, cannabis, illicit drug, and problems associated with substance use. Higher scores on this scale represent increasing frequency of substance use days. Example items include "*in the past 2 weeks… how many days have you used any kind of alcohol*?", "…*used any marijuana*?" The SFS also asks about *binge drinking*, which refers to the number of days each individual has drank 5 or more drinks (4 or more for females) in one sitting. The SFS has shown good reliability with both adolescent and emerging adult samples (Buchan, Dennis, Tims, & Diamond, 2002; Dennis et al., 2002; Lennox, Dennis, Scott, & Funk, 2006) (α =.85; test-retest rho=.94; self-reported days of use across a variety of substances).

Craving scale. The items on the craving scale correspond to new DSM V criteria for craving. Composite scores were used as one of our primary outcome variables. The Craving

Scale includes 14 items has been retained from the GAIN assessment tool (M. L. Dennis, Titus, White, Unsicker, & Hodgkins, 2003). Example items include "*If I were using alcohol or other drugs, I would feel less nervous*", "*Using alcohol or other drugs would make things seem just perfect*", and "*All I want to do is use alcohol or other drugs*." Each item is answered using "yes" (coded 1) or "no" and scores will be summed across the 12 items. Reliability for this scale was α =.80 for this sample. This measure was administered at baseline and all follow-ups.

Childhood trauma questionnaire short form (CTQ-S). The CTQ-S (Bernstein et al., 2003) is a 25-item measure developed from the original 70 item measure. The CTQ-S was used to assess trauma experienced before the age of 16. Participants are primed to answer each item with the anchor "Prior to the age of 16…" Example items include "*I didn't have enough to eat*", "*people in my family called me "stupid", "lazy", or "ugly*"", "*people in my family looked out for each other*", and "*I believe I was physically abuse*." Each item is rated on a 5-point Likert scale ranging from 1 = *Never True* to 5 = *Very Often True*. This measure, administered at baseline only, has been validated in emerging adulthood samples. Initial studies with the original CTQ with adult substance users has shown excellent test-retest reliability as well as convergent and discriminant validity (Bernstein et al., 1994; Foote & Lovejoy, 1995). The CTQ-S has 5 distinct subscales including "emotional abuse" (α = .90), "Physical abuse" (α = .92), "Sexual abuse" (α = .95), "emotional neglect" (α = .92), and "physical neglect" (α = .79) (Bernstein et al., 2003). The overall reliability of the CTQ-S was high (α = .92). The CTQ-S has high convergent and discriminate validity when tested against therapist ratings of abuse and neglect among 4 psychiatrically referred groups (r = .28 - .51; e.g. mental health patients and substance use patients).

Stress. To measure stress the *Perceived Stress Scale* (PSS; Cohen, Kamarck, & Mermelstein, 1983) was used. Assessing objective measures of stress implies that the events are the precipitating cause of behavior, whereas utilizing a measures of perceived stress allows for the appraisal of stressful life events from the perspective of the participant (Cohen et al., 1983). An important theoretical aspect of understanding perceived stress is the causal event is the cognitive emotional response to an event, and not necessarily the event itself (Lazarus, 1974). This, then, inherently suggests that the response is not based only on the event occurring but also the contextual and personal factors associated with the event. The perceived stress scale is 14 items and had good reliability in this sample (α =.83). The PSS has also been validated in studies with adolescents, emerging adults, and older adults. Items from the PSS are answered on a 5-point Likert scale ranging from 0 = *Never* to 4 = *Very Often*. Participants are primed with the anchor "*in the past two weeks*…" Example items include "*How often have you been upset because of something that has happened unexpectedly*?", "*How often have you felt that things were going your way*?", and "*How often have you been angered because of things that happened that were outside of your control*?"

Mindful Attention Awareness Scale (MAAS). The MAAS (Brown & Ryan, 2003; MacKillop & Anderson, 2007) was used to assess trait (and state) mindfulness. Specifically, the MAAS measures a conceptualization of mindfulness as "attention to, and awareness of, what is occurring in the present moment" (Brown & Ryan, 2003), p. 824). The MAAS has been shown to have discriminate validity by differentiating between general public and Zen Buddhist practitioners (Brown & Ryan, 2003). The MAAS has shown high reliability (α = .82-.87) and has been used to assess changes in well-being, depression and anxiety symptoms (Zvolensky et al., 2006), and substance use disorders (Leigh, Bowen, & Marlatt, 2005). In this sample the MAAS

had good reliability α = .85. Participants were asked a series of questions relating to daily experiences and how frequently they have each experience. All questions were rated on a 6-point Likert scale ranging from 1 = *Almost Always* to 6 = *Almost Never*. Example items include "*I could be experiencing some emotion and not be conscious of it until sometime later*", "*I forget a person's name almost as soon as I've been told it for the first time*", "*I do jobs or tasks automatically, without being aware of what I'm doing*", and "*I find myself listening to someone with one ear, doing something else at the same time*." The MAAS was administered at baseline and all follow-up assessments.

Data Analytic Plan

Baseline differences. The first step in the data analysis plan is to assess group differences on a variety of baseline measures. To do this a series of *t*-test and chi-square tests were conducted using treatment assignment (MBRP = 1, TAU = 0) as the classification variable.

Change in stress, craving and substance use. To assess change across the three variables of interest (stress, craving, and substance use) a series of multi-level growth models (MLM), structural equation models (SEM) and Cox proportional hazard regression models (a form of multilevel modeling) were run. In general, growth models (regardless of framework) allow for a specific within-person trajectory such that rates of change are constant within-people but are allowed to vary between people. Typically in latent growth modeling two latent variables are created: latent intercept and latent slope. The latent intercept represents the level (or mean) differences between people at the baseline assessment. The latent slope represents the rate of change over the observation period. The advantage of using growth modeling is both the latent intercept and latent slope are allowed to vary across people and co-vary with each other.

To assess change across the three variables of interest (stress, craving, and substance use) a series of models were run. Specifically, for each variable of interest, both an SEM and MLM model were tested to ensure effects were robust across methods. Across all three variables several models were tested: 1) general linear growth independent of treatment assignment, 2) general bilinear spline growth model, independent of treatment assignment, 3) effect of treatment assignment on both linear and bilinear spline growth models, and 4) multi-group latent growth and bilinear spline modeling. In addition to running an SEM and MLM model for substance use a survival model was used to assess time to relapse across groups. For example, when assessing stress, a taxonomy of models was run for the general trend of stress across the study period (e.g., growth of stress regardless of treatment assignment), general trend of stress during the study period and follow up period (e.g., bilinear spline growth model regardless of treatment assignment), a time-invariant predictor model of both linear and bilinear spline functions (e.g., the effects of treatment assignment on stress), and finally testing invariance across groups (e.g., treatment assignment) on trajectories of stress. Below, a general description of multi-level modeling, structural equation modeling, multi-group analysis, and survival analysis is discussed and how each method was used to address specific research questions.

Multilevel modeling framework

To assess treatment assignment on main effects of stress, craving, and substance use we first explored these associations in a multi-level modeling framework. Multilevel models allow us to address within and between person questions about change, simultaneously. The way this is done is by specifying a level-1 model (or how each person changes over time) and a level-2 model (how changes differ across people). The level-1 model represents how each individual is

expected to change during the study period (also known as the individual growth model). A representative level-1 model (*EQ* 1) in which change is a linear function of time is:

$$Y_{ij} = [\pi_{0i} + \pi_{1i}(TIMEij)] + [\varepsilon_{ij}] \qquad (EQ\ 1)$$

Here, Y_{ij} represents the repeated measured variable (e.g., stress, craving, substance use) at for individual *i* at time *j*, π_{0i} represents the random intercept or the predicted score for individual *i* when time equals zero. This represents the 'true' score at baseline. π_{1i} is the random slope or linear rate of change for individual *i* for a one unit change in time. This is the most important aspect of the individual level model because it represents change over time. Because our time variable is in two week intervals, π_{1i} represents individual *i*'s true rate of change over a two-week span. Finally, the stochastic part of the level-1 model ε_{ij} represents random error. This is also sometimes referred to as level-1 residuals, as each residual can represent the part of individual *i*'s value of, say stress, that is not predicted by time. Assumptions of level-1 residuals is normally distributed $\varepsilon_{ij} \sim N(0, \sigma_{\varepsilon}^2)$. The level-2 model allows the exploration of interindividual differences across change trajectories (level -1) and associations with time-invariant predictors. The level-2 model accounts for basic patterns for the repeated measured variable (e.g., this is the between-group difference across intercepts and slopes) as well as heterogeneity of between-person patterns within groups. Each level-2 sub model must: 1) accommodate each part of the level-1 growth parameters (intercept, slope, random effects), 2) each part of the level -2 model must specific a relationship between time invariant predictors (e.g., treatment assignment) and individual growth parameters, and 3) allow for stochastic variation across individual growth trajectories. Thus, the level-2 sub model (*EQ 2*) would be:

$$\pi_{0i} = \gamma_{00} + \gamma_{01} MBRP_i + \xi_{0i} \qquad (EQ\ 2)$$

$$\pi_{1i} = \gamma_{10} + \gamma_{11} MBRP_i + \xi_{1i}$$

Here, γ_{00}, γ_{01}, γ_{10}, and γ_{11} are all the *fixed effects* in the multilevel model. These parameters are able to capture systematic between-person differences in change trajectories based on values of the level-2 time invariant predictors (treatment assignment). The stochastic part of the level-2 sub model represent the portion of the level-2 outcomes (i.e. ,random between-person variation in the lavel-1 parameters) that remain unexplained by any predictor in the level-2 model (in this case, treatment assignment). However, given we have a level-2 predictor and because these parameters describe the 'unexplained' variance around the intercepts and slopes, these are typically referred to as conditional residual variances. These variance parameters allow us to explore how much heterogeneity in change remains after accounting for the effect of treatment assignment on the outcome of interest. Just like with the level-1 residuals, there are assumptions that underlie the distribution of the level-2 conditional residual variances. Specifically, level-2 residual variances (*EQ* 3) are assumed to be bivariate normal with a mean of 0 and unknown variance:

$$\begin{bmatrix} \xi_{0i} \\ \xi_{1i} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_0^2 & \sigma_{01} \\ \sigma_{10} & \sigma_1^2 \end{bmatrix} \right) \qquad (EQ\ 3)$$

Thus, using the framework a taxonomy of models was run across the three variables of interest. Specifically a random intercept model (Model 1), an unconditional growth model (Model 2), an uncontrolled effects of MRBP on outcome (Model 3), and a controlled effects of MRBP on outcomes (Model 4; controlling for time spent in facility). In addition to testing main effects and variation in rates of change across MBRP and TAU participants multilevel modeling was also used to assess the mitigating effects of childhood trauma on initial levels and rates of change across stress, craving, and substance use.

Latent growth modeling

Linear growth model. In addition to assessing our research questions in a multilevel modeling framework each question will also be assessed using structural equation modeling (SEM) as a latent growth model. Latent growth models differ from multilevel models such that each are fit using restricted common factor models with the intercept and slope being represented by latent variables. The most basic growth model (*EQ* 4) with restricted factors is written as follows:

$$Y_i = \Lambda\eta_i + \mu_i \qquad (EQ\ 4)$$

Where Y_i represents a vector of repeated measures of an observed score for individual i, Λ is a vector matrix of factor loadings that define the growth function (e.g., latent factors for intercept and slope), η_i represents a vector of factor scores for each individual i, and μ_i is a vector of residual variances. Factor scores for η_i are expressed as a vector of factor means and residual variance $\eta_i = \alpha + \xi_i$. Similar to the multilevel modeling framework, residuals in a latent growth of SEM framework follow certain assumptions. Specifically, the means (μ) and covariance's (Σ)for a simple latent growth model are assumed to be homogeneous (although this can be relaxed and tested) such that:

$$\mu = \Lambda\alpha \qquad (EQ\ 5)$$

$$\Sigma = \Lambda\Psi\Lambda' + \Theta \qquad (EQ\ 6)$$

An illustration of a basic latent growth model with a latent intercept and slope is represented in Figure 5.

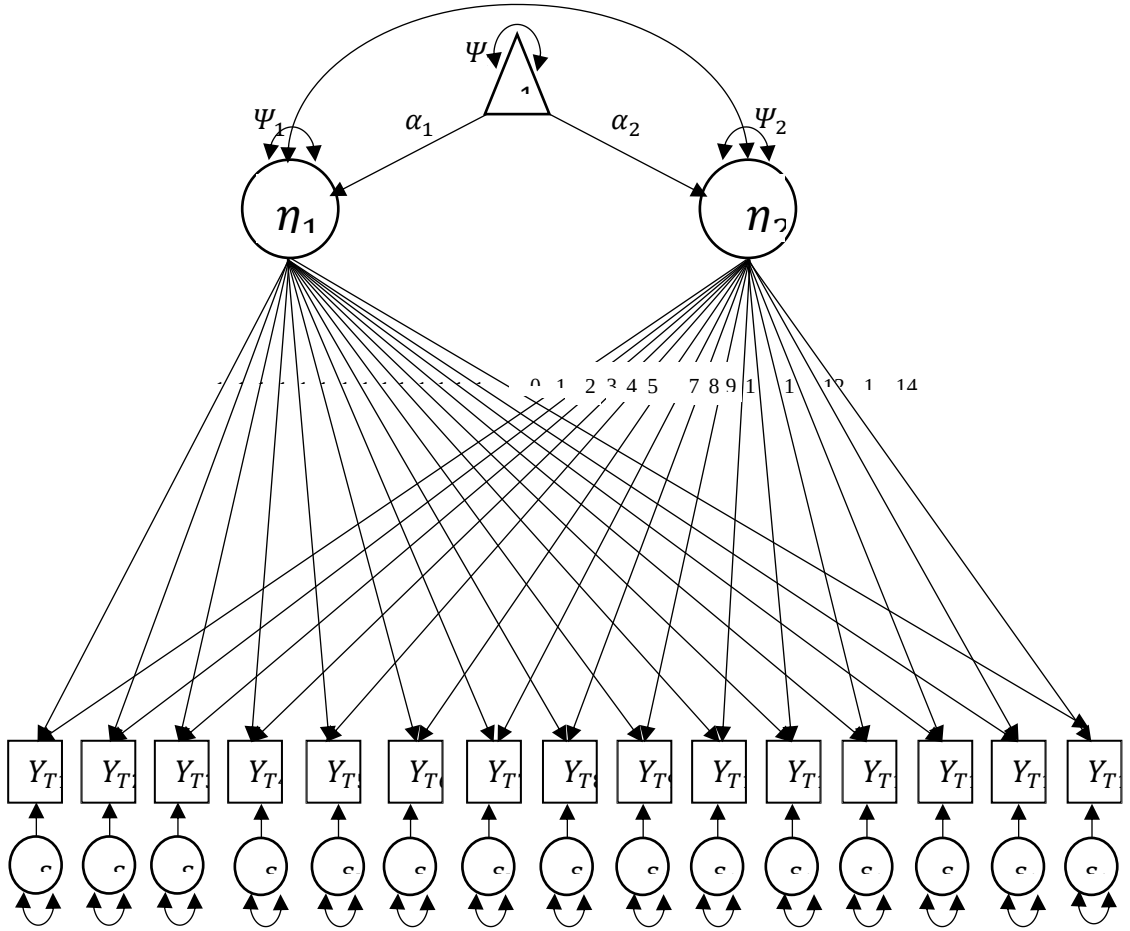


Figure 5. Squares represent manifest or observed variables, circles represent latent factors, one headed arrows represent a directional relationship, and two headed arrows represent non directional relationships such as variance and covariance. This latent growth model represents all time points for the current study (15 total per participant). η_1 = latent intercept, η_2 = latent slope, Ψ = *variance and covariance of the latent intercept and slope,* α *= mean intercept and slope,* θ *= residual variance.*

Using this basic linear growth model framework a series of models were fit for each of the three variables of interest. Specifically, a general trend across the entire sample (e.g., in the absence of treatment assignment) was estimated where model testing was used to assess the variance associated with random linear and quadratic slopes as well as constrained versus free residual variances. Negative two log likelihood (-2LL) ratio tests (LRT) were conducted to assess the addition of random latent slopes into the general growth modeling framework. For example, a model with constrained linear growth to zero is tested using LRT to a model where linear growth is allowed to vary freely. Significant reductions in -2LL using a LRT test (χ^2 distribution) using $\Delta - 2LL \; and \; \Delta \; degrees \; of \; freedom$ indicate significant increased model fit with the addition of a random linear slope.

Bilinear spline (or piecewise) growth models. In addition to fitting linear growth models, piece wise growth models were estimated. Bilinear spline models were used to assess the effects of treatment assignment (MBRP vs TAU) during the treatment phase and post-treatment phase. Bilinear spline models are useful when there are reasons to separate time into discrete phases. The usefulness of bilinear spline models is it allows growth (time) to be split into discrete phases which can be used to aid in explaining observed rates of change within each phase. Each discrete phase is usually a simple growth model and the segments that connect the growth models are called *knot* points or sometimes referred to as *transition points*. In the current study we expect different growth trajectories to emerge during the treatment phase and post-treatment phase for both stress and craving (substance use is only measured during the post-treatment phase due to no variability during treatment since each participant was in a residential facility). While a quadratic function can be estimated after a knot point, for simplicity we estimated a bilinear spline model with the distinct phases being treatment phase (slope 1) and

post-treatment (slope 2). An example of a bilinear spline model with 6 equally spaced time intervals is displayed in Figure 6. Only 6 time points are shown as an example of this type of model as placing all 15 time points into each theoretical model is difficult to discern.

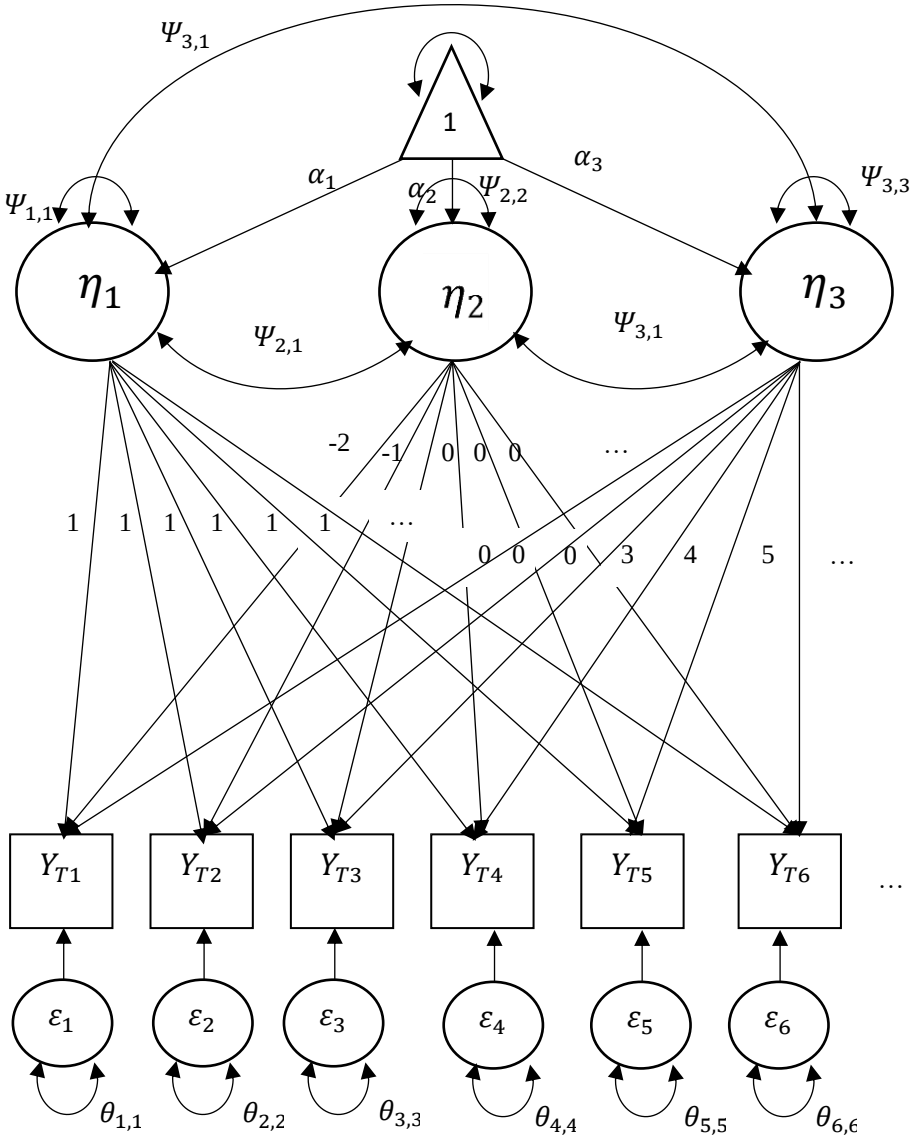


Figure 6. Diagram of a bilinear spline model with six equally spaced time interval. η_1 = latent intercept, η_2 = latent slope for treatment phase, η_3 = latent slope for post-treatment phase, Ψ = variance and covariance of the latent intercept and slope, α = mean intercept and slope, θ = residual variance.

A bilinear spline model can easily be fit by adjusting the elements of the $\boldsymbol{\Lambda}$ matrix that follow the function of time that is needed (e.g., linear, quadratic, centering the intercept at a certain time point). For example, if we use Figure 6 as our model the new $\boldsymbol{\Lambda}$ matrix (*EQ* 6) for a bilinear spline model would be:

$$\boldsymbol{\Lambda} = \begin{bmatrix} 1 & min\left(\frac{1-k_1}{k_2}, 0\right) & max\left(\frac{1-k_1}{k_2}, 0\right) \\ 1 & min\left(\frac{2-k_1}{k_2}, 0\right) & max\left(\frac{2-k_1}{k_2}, 0\right) \\ 1 & min\left(\frac{3-k_1}{k_2}, 0\right) & max\left(\frac{3-k_1}{k_2}, 0\right) \\ 1 & min\left(\frac{4-k_1}{k_2}, 0\right) & max\left(\frac{4-k_1}{k_2}, 0\right) \\ 1 & min\left(\frac{5-k_1}{k_2}, 0\right) & max\left(\frac{5-k_1}{k_2}, 0\right) \\ 1 & min\left(\frac{6-k_1}{k_2}, 0\right) & max\left(\frac{6-k_1}{k_2}, 0\right) \end{bmatrix} \qquad (EQ\ 6)$$

Here the first column of the matrix represents the intercept (loadings of 1 to identify), the second column is the slope before the *knot point* (in the current study this would be the treatment phase) and the third column represents the slope after the *knot point* (in the current study this would be the post-treatment phase). Thus, if we look at the $\boldsymbol{\Lambda}$ matrix in terms of factor loadings (*EQ* 7) we would have:

$$\boldsymbol{\Lambda} = \begin{bmatrix} 1 & -2 & 0 \\ 1 & -1 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 0 & 2 \\ 1 & 0 & 3 \end{bmatrix} \qquad (EQ\ 7)$$

In the current study a taxonomy of bilinear spline models was estimated. Using this bilinear spline growth model framework a series of models was fit for each of the three variables of

interest. Specifically, a general trend across the entire sample (e.g., in the absence of treatment assignment) was estimated where model testing was used to assess the variance associated with a bilinear spline growth factor and the functional form of the data. Negative two log likelihood (-2LL) ratio tests (LRT) were conducted to assess the addition of random latent slopes into the general growth modeling framework. Since bilinear spline models have two slopes a series of nested models were tested to see if random slopes were needed during the treatment phase and post-treatment phase. Significant reductions in -2LL using a LRT test (χ^2 distribution) using $\Delta -2LL \text{ and } \Delta \text{ degrees of freedom}$ indicate significant increased model fit with the addition of a random slope.

Linear and bilinear spline growth models with a time invariant predictor. To assess the effect of treatment assignment on growth of stress, craving and substance use a series of linear growth models (see "*Linear growth model***"** above) and bilinear spline models (see "*Bilinear spline (or piecewise) growth models***"** above) were estimated. When introducing a time-invariant covariate we can answer the question "*are between-person differences in the trajectories of change for stress, craving, and substance use related to treatment assignment*?" This is the first step in understanding if treatment assignment is associated with change in our variables of interest. This type of model was discussed above from a multi-level modeling framework. However, when assessing the effects of a time-invariant covariate within latent growth models, we use multiple-indicator multiple-cause (MIMIC) modeling (Jöreskog & Goldberger, 1975; McArdle & Epstein, 1987). Thus, the time-invariant covariate could be considered a causal predictor of the latent variables (e.g., intercept, slope, bilinear spline). Thus, when adding a time-invariant covariate a slight change in the foundation model for latent growth

(*EQ* 4) is made such that the latent factors (e.g., intercept and slope) are regressed on the time-invariant covariate.

$$Y_i = \boldsymbol{\Lambda}\eta_i + \mu_i \qquad (EQ\ 4)$$

$$\eta_i = \alpha + \boldsymbol{BX_i} + \boldsymbol{\xi_i} \qquad (EQ\ 8)$$

Where α represents a vector of latent intercepts, $\boldsymbol{B}$ is a matrix of regression coefficients, **X** is the matrix of time-invariant covariates (this can include any number of time-invariant covariates, however for the current study this would represent treatment assignment), and $\boldsymbol{\xi_i}$ represents a vector of residuals. Figure 7 is a diagram of a bilinear spline model with a time-invariant covariate. A similar model could be produced for a basic linear growth model by simply excluding the second slope (η_3) and all arrows, variances, and covariances associated with it. In this figure the time-invariant covariate has a mean (ω) and variance (ϕ) as well as effects on the intercept and slopes (β). For the current study both a latent linear growth model and a bilinear spline model were estimate with time-invariant covariates. Specifically, the best fitting model from the *overall* trend for the latent linear growth and bilinear spline models were used to estimate treatment effects using a time-invariant covariate latent growth model across stress, craving, and substance use. For the latent linear growth model the intercept, slope, and quadratic slope (if applicable) were regressed on the treatment assignment variable (1 = MBRP, 0 = TAU). For the bilinear spline model the treatment the intercept, treatment slope, and post-treatment slope were regressed on the treatment assignment variable. In addition to understanding the basic between group differences in the treatment effect the amount of variance explained by the treatment variable was calculated.

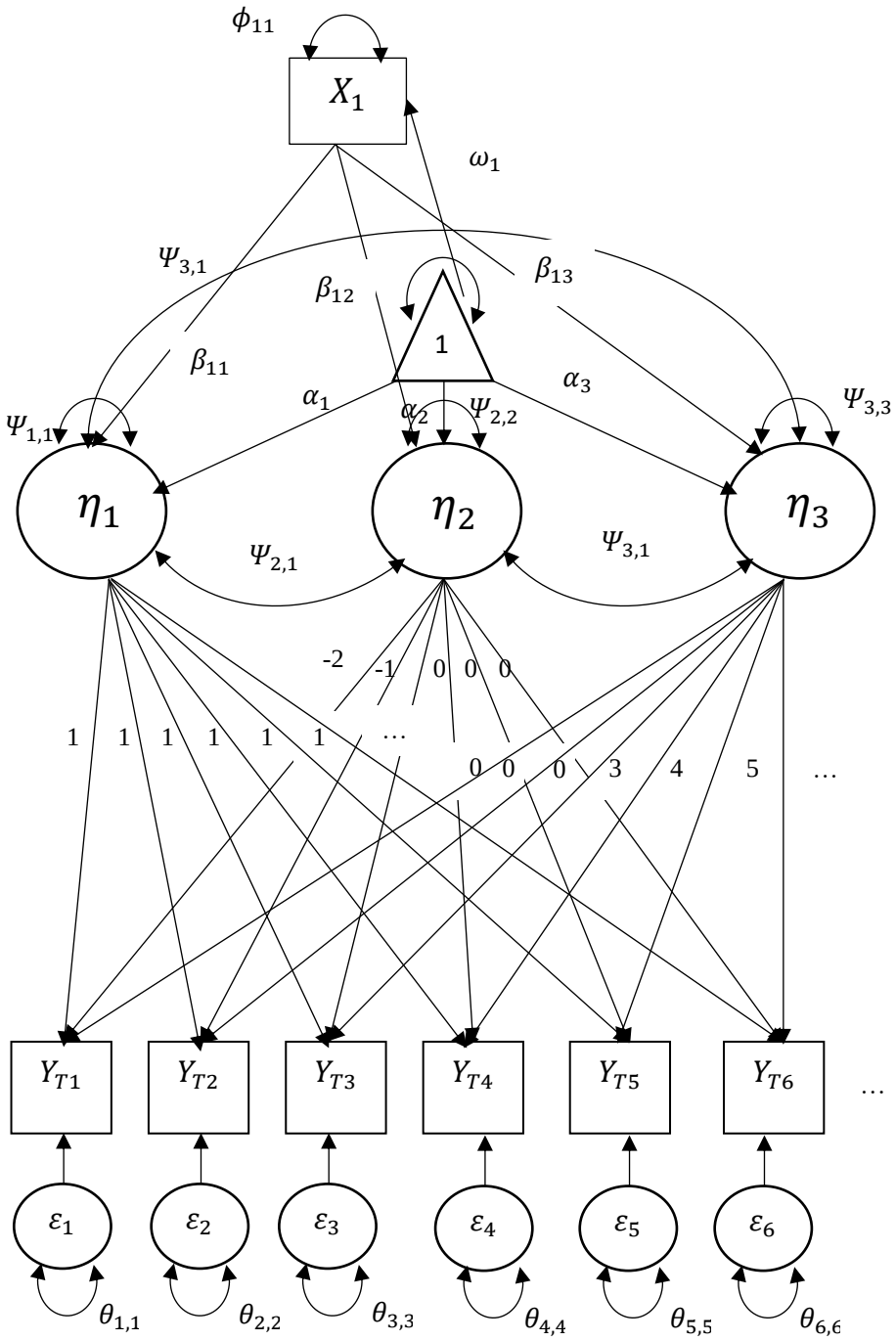


Figure 7. Bilinear spline model with a time invariant covariate. η_1 = latent intercept, η_2 = latent slope for treatment phase, η_3 = latent slope for post-treatment phase, Ψ = variance and covariance of the latent intercept and slope, α = mean intercept and slope, θ = residual variance.

Multi-group modeling. The multi-group growth modeling framework is an extension of the growth modeling with time-invariant covariates discussed in the previous section. Assessing the effects of treatment on latent growth (linear or bilinear spline) aid is understanding basic differences in average growth trajectories. Unfortunately, latent growth modeling is limited to only estimating between group differences thus are unable to examine differences of within-person change and the between-person differences in this process. Thus, these models are unable to examine differences in variance and covariance's within the growth factors (between-person differences) or the residual variability (within-person change). In general, multi-group modeling allows for growth models to be specified for each group and parameter labels are used to constrain certain parameters (e.g., variance, co-variance, residual variance) to be equal (or variant) across groups. This method allows for empirical testing of group differences in specific aspects of the growth model. Similar to the basic latent growth model the multi group model can be written with the same formula (*EQ* 9), but includes a group indicator:

$$Y_i^{(g)} = \Lambda\eta_i^{(g)} + \mu_i^{(g)} \qquad (EQ\ 9)$$

Further, the latent factors (*EQ10*) are written in the same fashion, however they are written as deviations from the group-specific means

$$\eta_i^{(g)} = \alpha^{(g)} + \boldsymbol{\xi_i}^{(g)} \qquad (EQ\ 10)$$

And the mean (*EQ 11*) and covariance (*EQ* 12) matrices are also specified as being group specific

$$\mu^{(g)} = \Lambda\alpha^{(g)} \qquad (EQ\ 11)$$

$$\Sigma^{(g)} = \Lambda\Psi^{(g)}\Lambda' + \Theta^{(g)} \qquad (EQ\ 12)$$

Figure 8 represents a basic multi-group linear latent growth model for participants assigned to MBRP or TAU. Only 6 time points are represented for readability, however all 15 time points

were estimated. Further, Figure 9 represents a multi-group bilinear spline model for participants assigned to MBRP or TAU.

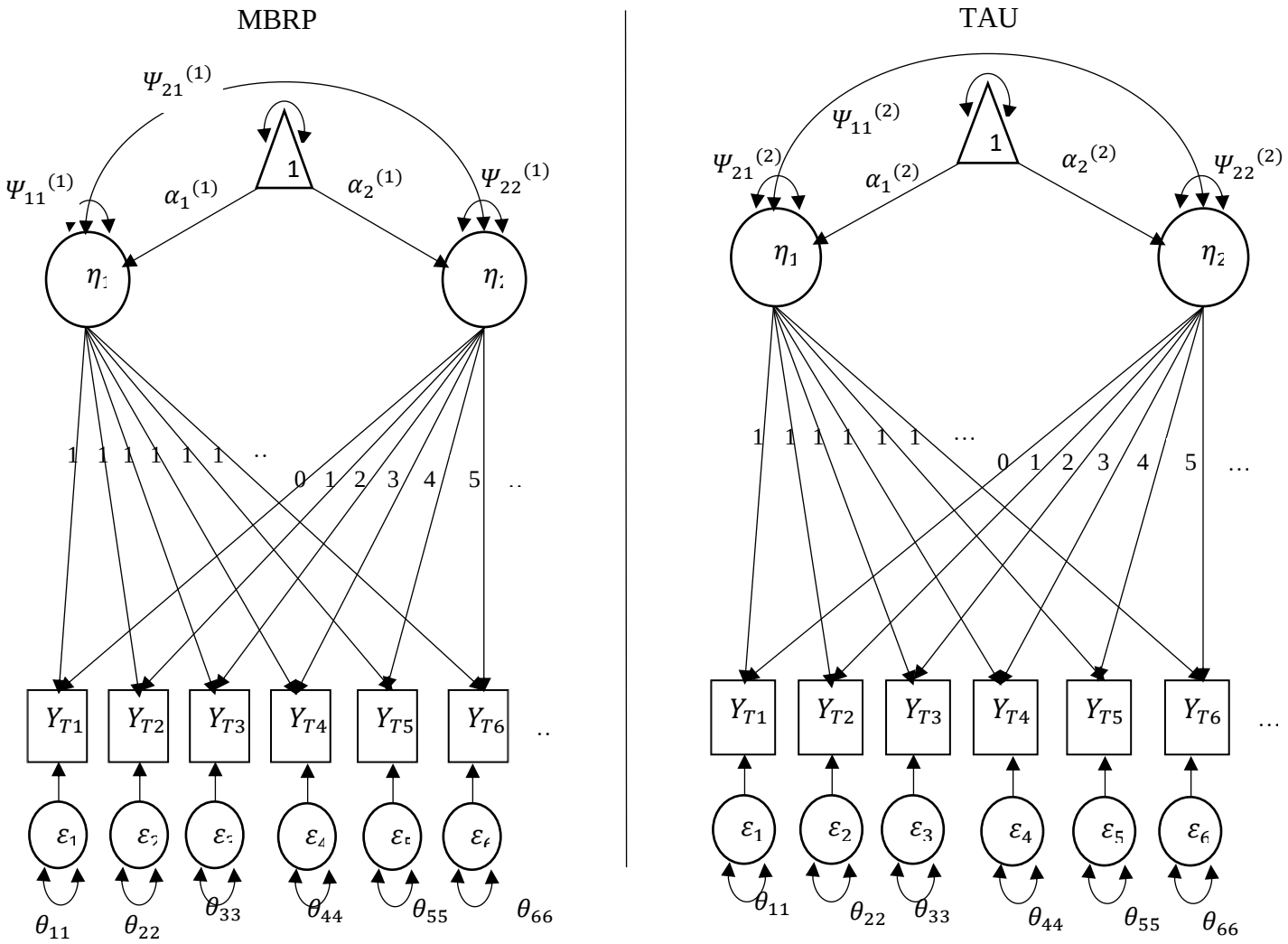


Figure 8. Multi-group linear growth model. Here, the latent means for the intercept and slope as well as the variances for the intercept and slope are group varying. η_1 = latent intercept, η_2 = latent slope for treatment phase, η_3 = latent slope for post-treatment phase, Ψ = variance and covariance of the latent intercept and slope, α = mean intercept and slope, θ = residual variance.

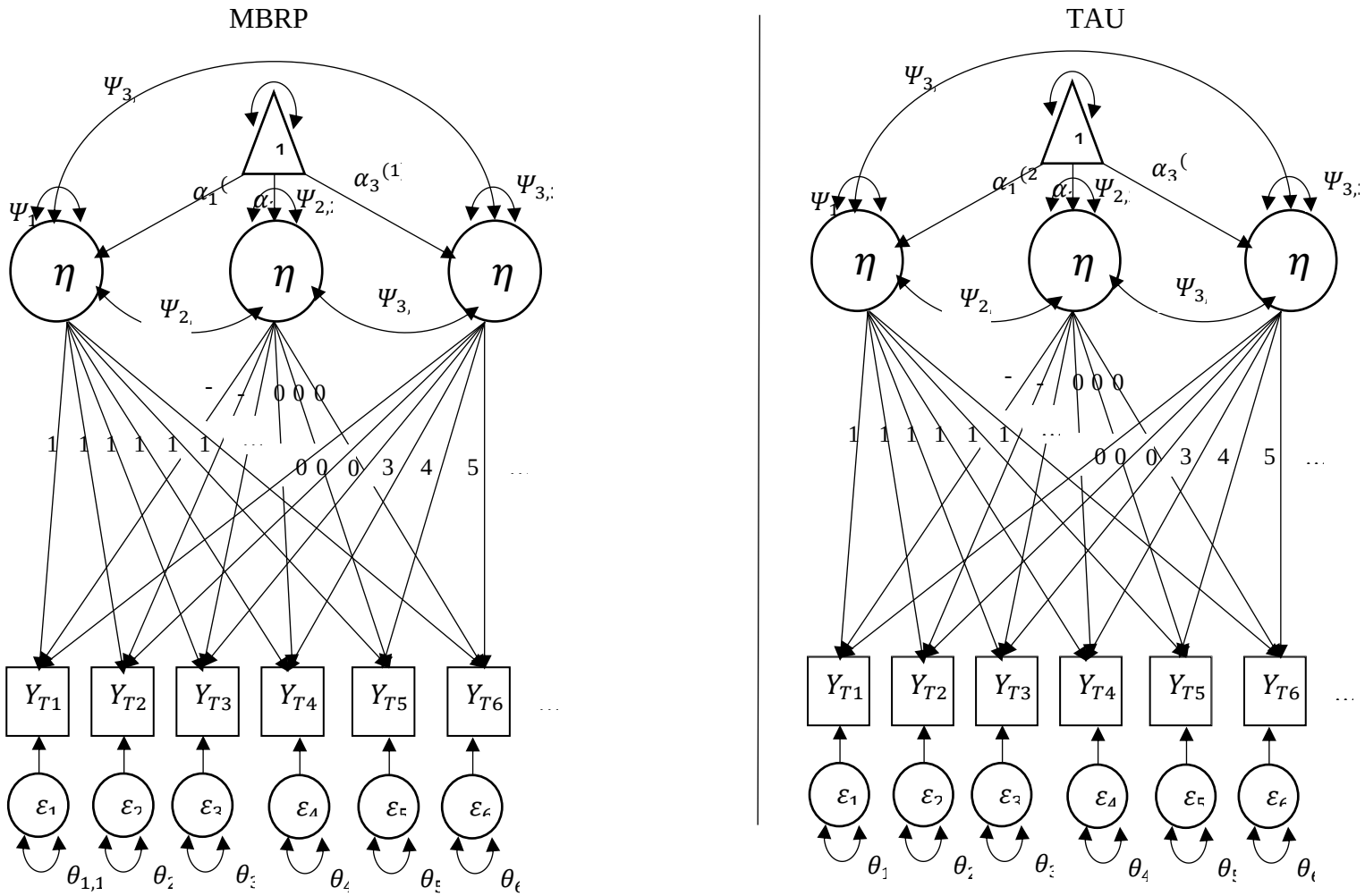


Figure 9. Multi-group bilinear spline model. Here, as an example, the latent means for the intercept and slope are group varying, represented by group codes (1) and (2). All other factors such as intercept and slope variances, covariances, and residual variances are constrained to be equal across groups (lack of group code). η_1 *= latent intercept,* η_2 *= latent slope for treatment phase,* η_3 *= latent slope for post-treatment phase,* Ψ *= variance and covariance of the latent intercept and slope,* α *= mean intercept and slope,* θ *= residual variance.*

To assess variation in between-person process as well as within-person differences the multi-group method typically yield four models. The first model is the *invariance* model where all parameters are invariant (the same) across the groups. This model should parallel results from the linear latent growth model and bilinear spline models without the grouping variable (e.g., not using the time-invariant covariate to predict intercepts and slopes). For example, the means of the intercept and slopes would be constrained to be the same between participants in the MBRP and TAU groups. The second model is called the *means* model where constraints are relaxed for the latent variable means (intercept and slopes) for each group. These are the only parameters that are allowed to be group varying and all other parameters (variances, covariance's, and residual variances) are constrained to be equal across groups. This model should be equivalent to the latent linear and bilinear spline models with the treatment (time-invariant) covariate model. Significantly better model fit based on a LRT test (model 1 vs. model 2) would reveal significant differences in average trajectories. Model 3 is the *means and covariance's* model which allows for the latent variable means, variances, and covariance's to vary across groups. Here parameter constraints remain on the residual variances only (e.g., residual variances are assumed to be homogeneous across groups). Significant difference's when comparing Model 3 to Model 2 using the LRT would indicate the magnitude of between-person variability and covariability of the growth parameters. Finally, the fourth model is the *means, covariances, and residual variances* model where all parameter constraints are relaxed across groups. By allowing the residual variances to vary across groups (e.g., constrained to be the same within group but vary between group) we can identify the magnitude of unexplained within-person variability over time. For the current study, all four of these models were run for stress, craving, and substance use and LRT tests were run to determine if constraints aided in significantly better model fit. A

5th model was estimated where the best fitting model was estimated based on LRT results across models 1 – 4.

Survival analysis. In addition to assessing group differences using latent growth modeling for substance use during the post-treatment phase a series of Cox Proportional Hazard Regression model were estimated. Cox proportional hazard models is used when time to an event (in this case relapse) is measured on a continuous scale (e.g., two week follow ups). One of the primary advantages of using a proportional hazard model is the strict assumptions that accompany traditional survival analyses (e.g., distribution of event occurrence) do not apply. A proportional hazard model requires two pieces of data: 1) an indicator if the event occurred by the end of the follow up period and 2) an indicator of how much time occurred up to the event (or non-event). The proportional hazard model assesses the hazard as the rate or 'risk' that an event will occur within an interval (e.g., time interval). Thus, the hazard function asks "*given a certain interval width, how often does the event time T occur between two ends of an interval, t and Δt, if the event has not occurred before that interval*?" (Newsom, 2015, p. 337) The hazard function (*EQ* 13) can be stated as

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t \leq T > t + \Delta t | T \geq t)}{\Delta t} \qquad (EQ\ 13)$$

Here the hazard rate $h(t)$ represents the risk of an event occurring in a certain time period. The Δt represents the time interval on a continuous scale that must decrease over time and this probability is conditional on the event having not already occurred in a prior interval ($|T \geq t$). The survival function (*EQ 14;* or the probability of still being at risk for event occurrence) is a simple transformation of the hazard function

$$S(t) = P(T > t) \qquad (EQ\ 14)$$

In the current study, proportional hazard regression was estimated assessing time to first relapse from the first follow up time point to the last (14 time points in total). Three separate cox regression models were run: 1) time to first use of alcohol or drugs, 2) time to first use of alcohol or heavy drinking episode, and 3) time to first use of any illicit drug (i.e., excluding alcohol use). Individuals who were lost to follow up or never experienced the event during the study period were censored. We used both time varying and time invariant predictors of the hazard function. Specifically, time to event occurrence was predicted using the treatment assignment variable (1 = MBRP, 0 = TAU). Two control variables were also used. A time varying covariate which assessed the maximum number of days each participant was not in the community (e.g., treatment facility, jail, hospital) was used to control for 'nonuse' due to the inability to access or utilize substances. The baseline value for past 14-day substance use was also used as a control variable. Three plots will be displayed: survival plot, log survival plot, and a hazard plot (kernel-smoothed hazard function). Hazard Ratios (HR) are reported as the standardized metric for cox proportional hazard regression.

Mediation. To assess if changes in stress mediated the association between treatment assignment and substance use and craving a series of structural equation models were estimated. Specifically, latent growth models were estimated for both stress and the outcome of interest (craving or substance use). To assess of changes in stress mediated the association between treatment assignment and craving or substance three regressions were estimated: slopes for stress change (treatment assignment predicting slopes in stress; a path), slope for change in craving or substance use (treatment assignment predicting craving or substance use, c path), and changes in stress predicting changes in craving or substance use (b path). Mediation was tested by assessing the indirect effect (e.g., a path * b path). In addition to the model based approach,

mediation was also tested using factor scores. That is, factor scores (FSCORES) were saved in *Mplus* when estimating the latent growth model for stress, craving, and substance use. These factor scores were then standardized and used in a bootstrapped (iterations = 10,000) indirect effect model. This was used as a robustness check and is akin to a Sobel test, however using bootstrapped methods are superior to basic Sobel tests (Preacher & Hayes, 2004).

Mediated Moderation. To assess the effect of early childhood trauma a mediated moderation model was estimated. Specifically, the latent growth indirect effect models for both substance use and craving were used. A latent variable for childhood trauma was created with the five subscales of the Childhood Trauma Questionnaire (sexual abuse, physical abuse, emotional abuse, physical neglect, and emotional neglect). The variance of the latent variable is set to 1 so it is standardized. To assess moderation a latent variable interaction was created using the XWITH command in *Mplus* between treatment assignment and the latent variable for childhood trauma. The main effect of the latent variable for childhood trauma as well as the latent interaction were then regressed on the mediating variables, changes in stress. Evidence of moderated mediation is assessed by a significant interaction term. If the interaction term is significant, the moderation is examined further by probing the interaction at reasonable values for the moderator. Typically, values corresponding to the mean, -1, and +1 standard deviations are used.

Missing data. One of the major advantages of using MLMs is how these models handle missing data. Specifically, MLMs make use of all the data available in the estimation model due to the flexible treatment of the time variable. To address attrition all models will be fit using the full information maximum likelihood (FIML) estimator in Mplus (Muthén & Muthén, 1998 - 2012), treating all observed predictors as single-item latent variables. That is, in each model

individuals will contribute whatever data they have to the likelihood function (i.e. both *X* and *Y* variables). For example, if an individual only has data at baseline will remain included in the analysis and contribute to the estimation model of parameters for baseline only. However, the validity of these methods lies under the assumption that missing data are "missing at random" (MAR) that is, the data are *conditionally* random after adjusting from the other variables included in the likelihood function—our estimates should by unbiased by missing data (Enders, 2011). One way to address the MAR assumption is to include covariates in the model that attribute to missingness. For example, if individuals were missing data due to being discharged from treatment early, this variable can be entered into the model to "retrieve" the missing pattern. Thus, given that prior values on X and Y variables are often reasonable predictors of missingness in longitudinal data, this lends support to the plausibility of this assumption.

Power Analysis. Although our sample size is small ($N = 79$), preliminary Monte Carlo simulations (Mplus(B. Muthén & Muthén, 1998 -2012)) suggested that it is quite reasonably powered (.81) to detect the small between-person effect sizes ($d = 0.3$) that are common in the relevant literature. Further, given the extensive number of longitudinal observations collected (i.e., substantial within-person variability), there is good reason assume that we have ample power to detect moderate within-person effects (Bolger & Laurenceau, 2013). Because the research questions utilize several complex analyses (e.g., mediation, moderated mediation), extant data with respect to plausible effect sizes is limited. However, prior work (Thoemmes, MacKinnon, & Reiser, 2010) has shown that 90 is needed to detect a modest mediated effect with a power of .80 with dichotomous treatment assignment. To address asymptotic assumptions of normality potentially challenged by both sample size and mediation parameters (i.e., product of the comprising pathway), all standard errors were bootstrapped (i.e. 5000 iterations).

Chapter 3: Results

Participants

Figure 10 displays the recruitment and follow up flow of the study. Due to the large number of follow-up assessments (15 per participant) the average retention rate is reported for specific time points throughout the study (e.g., 1 month, 3 month, 5 month). In total, 84 participants were eligible for participation in our study with 95% (N = 80) being successfully recruited. Currently, there are 1,050 time points across the 79 participants. Over the course of the study average retention rate was 83% (range 71% - 96%). The average number of days participants were at the treatment facility was 41.5 (SD = 26.3). No differences were found between MBRP and TAU groups in terms of days in residential treatment (t = -.67, df = 78, p = .50).

Table 4 displays means, standard deviations, and frequencies across a multitude of baseline variables. To assess if any baseline differences existed between individuals assigned to MBRP or TAU independent groups t-tests (continuous variables) and chi-square tests (categorical variables) were run for all items and measures in Table 4. On average, participants were 25 years old (SD = 2.7), primarily male (n = 52, 65%), and White (n = 73, 91.3%). The majority of participants were single (n= 48, 60%), not in college or university (n = 70, 87.5%) prior to entering the residential facility, on average participants had a high school degree (or equivalent; Mean years of education = 11.9 (SD = 1.6)), and were primarily unemployed (n = 52, 65%). When looking at salary (a crude measurement of socio-economic status) the median salary was 5,500 USD per year. However, because we ask participants about their income from legal and illegal (e.g., selling drugs) means the average salary was 16,807 USD per year. No

significant differences were found between MBRP or TAU groups across all demographic variables.

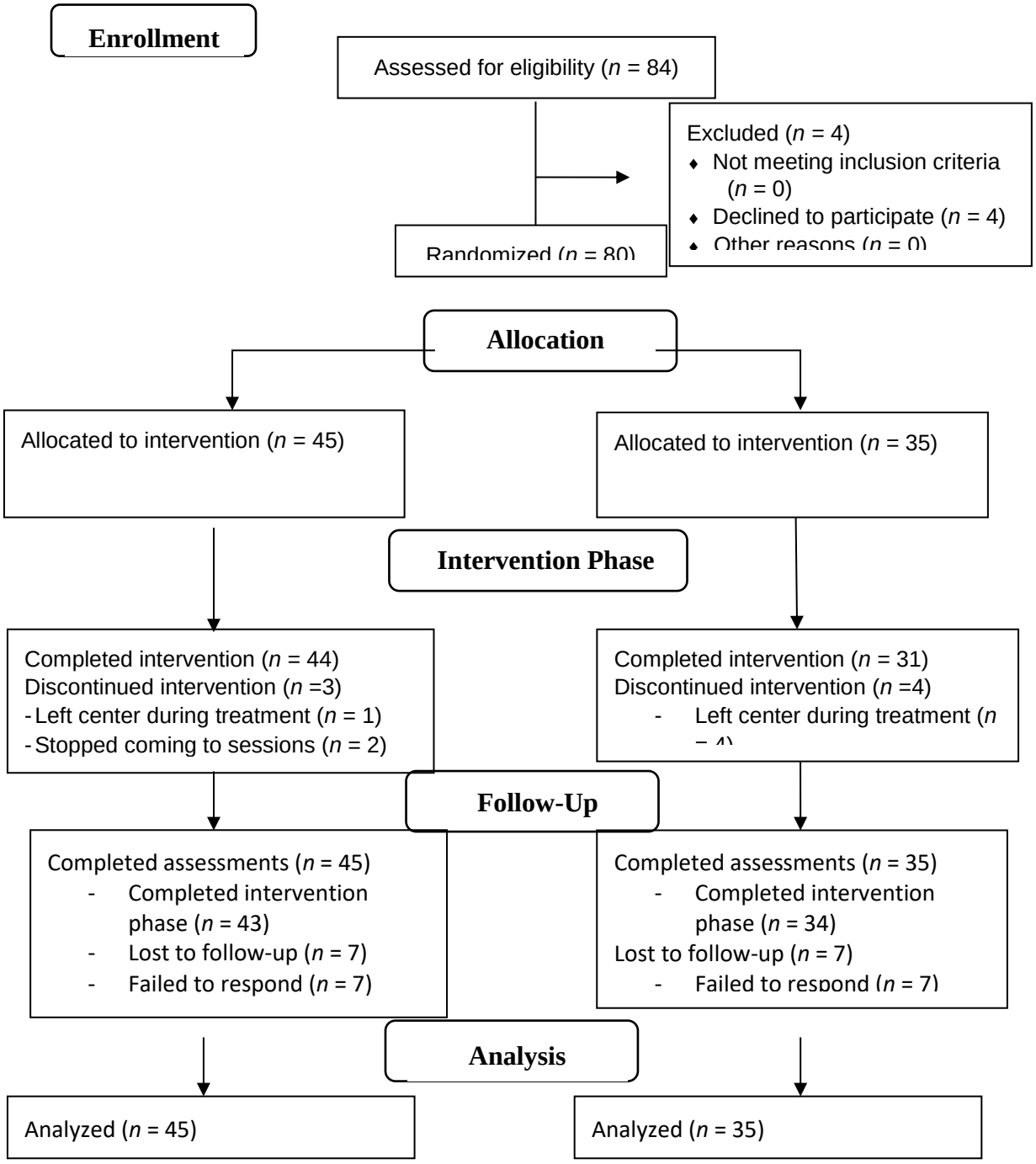


Figure 10. Consort flow diagram for recruitment, randomization, and analysis.

In terms of family characteristics most participants had parents with a high school degree or less (Mother: 66%, Father: 83%) and parents who abuse alcohol or other drugs (Mother: 73%, Father: 88%). We did find significant differences between MBRP and TAU group in terms of mother alcohol or drug use $\chi^2 = 4.87, df = 1, p = .03$), however if we use a Bonferroni adjustment for the number of tests (*t*-tests: 50, $p = .001$; $\chi^2 = 10, p = .005$) run in Table 4 differences between groups were no longer significant. Further, the items asking about parental substance use was rather broad and did not assess if their parent had a substance use disorder or had ever received treatment. Rather, it asked only if their mother or father used alcohol, thus it is difficult to determine if "use" in this case is clinically or substantively relevant.

Table 4. Baseline demographic characteristics between MBRP and TAU

	Total *M* (*SD*) or *n* (%)	MBRP *M* (*SD*) or *n* (%)	TAU *M* (*SD*) or *n* (%)	*t-test*	χ^2	*p*
Participant Characteristics						
Days in residential	41.6 (26.3)	43.3 (35.1)	39.3 (30.7)	-.670		.50
Age	25.3 (2.70)	25.3 (2.80)	25.3 (2.64)	.040		.97
Female *n* (%)	28 (35.0)	17 (37.8)	11 (31.4)		.350	.55
Race/Ethnicity *n* (%)						
White	73 (91.3)	42 (93.3)	31 (88.6)		2.13	.35
African-American	6 (7.5)	2 (4.44)	4 (11.3)			
Native American	1 (1.25)	1 (2.22)				
Children	1.10 (1.26)	1.31 (1.26)	.828 (1.22)	-1.71		.09
Relationship						
Single	48 (60.0)	25 (55.6)	23 (65.7)		1.61	.66
Divorced	8 (10.0)	6 (13.3)	2 (5.71)			
Serious relationship	16 (20.0)	9 (20.0)	7 (20.0)			
Married	8 (10.0)	5 (11.1)	3 (8.57)			
Education & Employment						
School *n* (%)						
Not in school	70 (87.5)	41 (91.1)	29 (82.9)		2.46	.29
Adult Education [a]	3 (3.75)	2 (4.44)	1 (2.86)			
2 year college	7 (8.75)	2 (4.44)	5 (14.29)			
Last grade completed	11.9 (1.63)	11.9 (1.75)	11.9 (1.48)	-.150		.88
Employment *n* (%)						
Full-time	23 (28.8)	14 (31.1)	9 (25.7)		1.74	.42
Part-time	5 (6.25)	4 (8.89)	1 (2.86)			
Unemployed	52 (65.0)	27 (60.0)	25 (71.43)			

Table 4. (cont.)

Salary (median)	5,500	6,000	5,000			
Salary (mean)	16,807 (36, 185)	18, 617 (31,337)	14, 479 (41, 971)	-.510		.62

Table 4 (cont.)

Delinquency						
Delinquency	12.8 (4.27)	12.7 (4.53)	13.0 (3.96)	.370		.71
Days in jail P90	41.3 (34.5)	37.1 (34.9)	46.7 (33.8)	1.23		.22
Family Characteristics						
Mother HS Education [b]	53 (66.3)	32 (71.1)	21 (60.0)		1.09	.30
Father HS Education	66 (82.5)	38 (84.4)	28 (80.0)		.269	.60
Mother AOD [c]	58 (72.5)	37 (82.2)	21 (60.0)		4.87	.03
Father AOD	70 (87.5)	41 (91.1)	29 (82.9)		1.22	.27
Substance use [d]						
Age first use	12.7 (2.77)	13.1 (2.51)	12.3 (3.04)	-1.21		.23
Alcohol P90	17.5 (21.8)	14.6 (21.8)	21.2 (24.5)	1.27		.21
Alcohol P14	2.51 (4.48)	2.51 (4.48)	4.02 (5.44)	1.37		.18
Alcohol P14ce	2.18 (4.29)	1.60 (3.60)	2.91 (5.01)	1.36		.18
Drunk P90	14.3 (21.4)	12.0 (20.3)	17.3 (22.8)	1.09		.28
Drunk P14	2.68 (4.79)	2.22 (4.04)	3.26 (5.24)	.960		.34
Drunk P14ce	1.73 (3.98)	1.36 (3.42)	2.20 (4.60)	.940		.35
Cannabis P90	27.4 (35.8)	26.3 (35.9)	28.8 (36.2)	.300		.76
Cannabis P14	4.36 (6.18)	4.00 (6.15)	4.83 (6.28)	.590		.56
Cannabis P14ce	2.40 (5.00)	2.13 (4.78)	2.74 (5.32)	.540		.59
Cocaine P90 [e]	7.19 (25.4)	2.31 (11.9)	13.5 (35.2)	1.79		.08
Cocaine P14	1.2 (4.15)	.156 (1.04)	2.54 (5.95)	2.34		.03
Cocaine P14ce	.156 (1.04)	.156 (1.04)	1.00 (2.95)	1.62		.11
Inhalants P90	.036 (.191)	.044 (.208)	.029 (.169)	-.370		.72
Inhalants P14	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-		-
Inhalants P14ce	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-		-
Heroin P90	14.3 (28.6)	10.9 (23.7)	18.7 (33.7)	1.22		.23
Heroin P14	1.92 (4.47)	1.24 (3.53)	2.8 (5.37)	1.48		.14
Heroin P14ce	.662 (2.41)	.867 (2.93)	.400 (1.50)	-.92		.36
Methadone P90	1.02 (4.59)	.689 (3.74)	1.43 (5.52)	.710		.48
Methadone P14	.150 (1.14)	0.00 (0.00)	.342 (1.71)	1.34		.18
MethadoneP14ce	.150 (1.14)	0.00 (0.00)	.343 (1.71)	1.18		.24
Pain killers P90	11.1 (20.1)	11.7 (23.2)	10.2 (15.5)	-.320		.75
Pain killers P14	1.07 (2.67)	.933 (2.47)	1.23 (2.94)	.490		.63
Pain killers P14ce	.838 (2.34)	.756 (2.22)	.943 (2.52)	.35		.73
PCP P90	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-		-
PCP P14	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-		-
PCP P14ce	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-		-
Hallucinogens P90	1.03 (6.74)	.267 (.963)	2.00 (10.1)	1.01		.32
Hallucinogens P14	.150 (1.03)	.067 (.330)	.257 (1.52)	.730		.47
Hallucinogens P14ce	.125 (1.01)	.022 (.149)	.257 (1.52)	.91		.37
Anti-anxiety drugs P90	5.94 (15.0)	3.56 (10.4)	9.00 (19.1)	1.52		.14
Anti-anxiety drugs P14	.950 (2.96)	.489 (2.17)	1.54 (3.70)	1.50		.14
Anti-anxiety drugs P14ce	.475 (1.81)	.178 (.683)	.857 (.259)	1.51		.14
Methamphetamine P90	19.1 (28.4)	17.5 (27.7)	21.2 (29.4)	.580		.56
Methamphetamine P14	2.90 (5.09)	2.82 (5.01)	3.00 (5.26)	.150		.89

Table 4 (cont.)

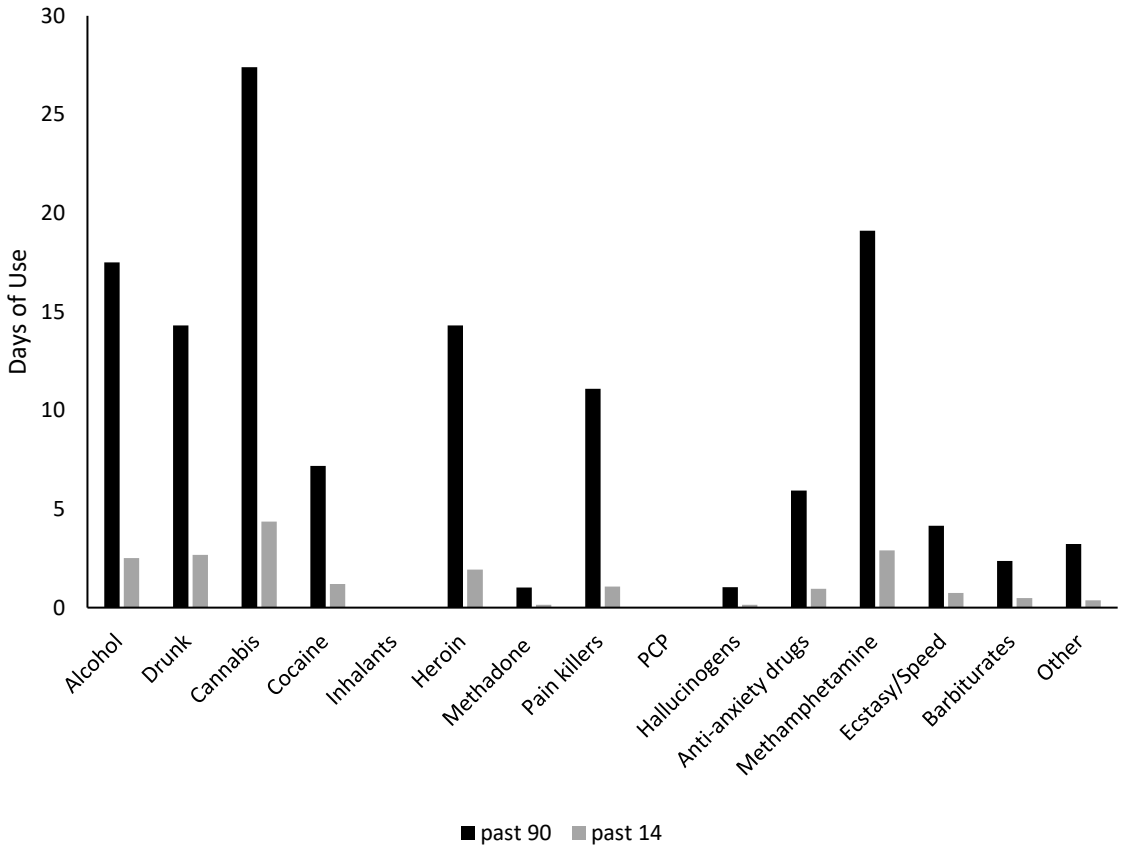
Methamphetamine Pce	1.13 (3.20)	.778 (2.44)	1.57 (3.96)	1.04	.30
Ecstasy/Speed P90	4.15 (14.5)	3.29 (14.0)	5.25 (15.3)	.600	.55
Ecstasy/Speed P14	.750 (2.88)	.778 (2.93)	.714 (2.86)	-.10	.92
Ecstasy/Speed P14ce	.538 (2.49)	.400 (2.11)	.714 (2.86)	.56	.57
Barbiturates P90	2.36 (11.1)	3.11 (14.0)	2.03 (5.65)	-.430	.67
Barbiturates P14	.487 (2.07)	.400 (2.15)	.300 (1.98)	.430	.67
Barbiturates P14ce	.488 (2.07)	.400 (2.18)	.600 (1.99)	.430	.67
Other P90 [f]	3.23 (11.9)	4.49 (15.0)	1.60 (5.78)	-1.19	.28
Other P14	.375 (2.20)	.644 (2.91)	.028 (.169)	-1.41	.16
Other P14ce	.188 (1.57)	.311 (2.09)	.029 (.169)	-.900	.37
SFS P90 [g]	16.1 (9.99)	14.8 (9.29)	17.7 (10.7)	1.29	.21
SFS P14	9.51 (9.73)	7.74 (8.63)	11.8 (10.7)	1.88	.07
SFS P14ce	8.65 (12.0)	7.39 (10.4)	10.3 (13.8)	1.03	.31
Self-help/social support					
Num. self-help [h]	1.87 (3.78)	2.06 (3.47)	1.62 (4.19)	-.510	.61
Craving					
Total Craving score	4.65 (2.78)	4.31 (2.89)	5.08 (2.59)	1.24	.22
Mental Health [i]					
Depression	19.4 (11.1)	19.6 (11.2)	19.0 (11.1)	-.24	.81
Anxiety	17.3 (10.5)	17.8 (9.63)	16.7 (11.6)	-.48	.63
Stress	22.6 (10.4)	22.4 (10.5)	22.8 (10.4)	.17	.87
Childhood Trauma					
Age first abused	6.63 (3.13)	6.87 (3.42)	6.34 (2.73)	-.74	.46
Total CTQ	50.3 (18.8)	48.1 (18.4)	53.0 (19.3)	1.17	.25
Emotional Abuse	12.2 (6.03)	11.6 (5.44)	13.1 (6.07)	1.07	.29
Physical Abuse	9.40 (5.43)	9.11 (5.39)	9.77 (5.54)	.540	.59
Sexual Abuse	8.53 (6.07)	8.31 (5.94)	8.28 (6.31)	.380	.71
Emotional Neglect	11.7 (5.46)	11.3 (5.14)	12.2 (5.90)	.740	.46
Physical Neglect	8.36 (4.07)	7.76 (3.56)	9.14 (4.57)	1.53	.13
Perceives Stress					
Total Stress	33.7 (7.96)	34.9 (7.11)	32.2 (8.81)	-1.49	.14
Mindfulness					
Total mindfulness	3.19 (.781)	3.19 (.689)	3.17 (.894)	-.07	.95
Practice mindfulness	5.76 (13.9)	3.96 (9.70)	8.09 (17.9)	1.32	.19

Note: MBRP = Mindfulness Based Relapse Prevention; TAU = Treatment as Usual (control condition). Items or measures followed by a P90 or P14 refer to past 90 days (P90) or past 2 weeks (P14). a. Adult education includes GED classes. b. Both mother and father education were dichotomized such that high school or less was the reference group. c. Mother AOD and Father AOD are dichotomous indicators if their mother or father abused alcohol or other drugs. d. Substance use was measured in two ways. The first is represented by the first two values (P90 and P14). These values are for both the current recall period or if the participant had been in jail, prison, or other facility prior to entering treatment the recall period is the 90 days and 14 days *prior* to entering a facility. The values labeled P14ce is adjusted for the *current* past 14 days such that if a participant was in a facility for the entire 14 days prior to entering treatment they will have a value of 0 for days of substance use. If a participant reported being in a facility, for example, for 10 out of the prior 14 days the original value for each substance was used minus the number of days reported in a facility. e. cocaine included the sum of both cocaine, crack, and other forms of cocaine. f. Other includes bath salts and K2 (synthetic marijuana). g. SFS is a variable created to contain information on all substances and three substance problem items. The scale calculates the proportion of days each individual uses all 15 substances or experiences problems. These values are averaged and multiplied by 100. h. Participants were asked how many days they attend any 12-step, self-help, or other social support group in the past 2 weeks. i. Subscales from the DASS-21 were multiplied by 2 to correspond to the larger scale, norms, and cut off scores.

In terms of substance use, most participants (over 90%) were polysubstance users. On average participants were 12.7 (*SD* 2.8) years old when they first used any substance. Table 4 also shows means for 15 different drugs for past 90 days and past 2 weeks. Substance use is displayed in two different ways. First, participants were asked on how many days they used each substance in the recall period (e.g., past 90 days, past 14 days) and if the participant reported being in jail, prison, or other facility where they could not use they were asked to refer to the 90 days and 14 days prior to entering a facility. The second way substance use is presented (represented by a "*ce*" after each substance) is the controlled environment adjusted estimates – such that each participant was asked to report on how many days in the past 2 weeks (regardless of being in a facility) how often they used each substance. Values for each substance were subtracted from the number of days in a controlled environment. The most used substances were alcohol (past 90-day *Mean* = 17.5 days), getting drunk (past 90 day *Mean* = 14.3 days), cannabis (past 90 day *Mean* = 27.4 days), methamphetamine (past 90 day *Mean* = 19.1 days), and heroin (past 90 day *Mean* = 14.3 days). For controlled environment adjusted similar results were found such that alcohol use, getting drunk, cannabis use, opiate use (both heroin and pain killers), and methamphetamine were the most used drugs prior to entering the treatment facility. Figure 11 displays overall means for past 90 days and past 14 days across the entire sample and Figures 12 and 13 display means separated by treatment assignment. Across all substances one showed significant differences between MRBP and TAU groups (Crack/cocaine use, $p = .03$). Two variables (crack, cocaine) were averaged to obtain a single use variable for the two similar substances. However, this difference was no longer significant when assessing the controlled environment adjusted means ($p = .11$). The substance frequency scale was used to assess use of all substances and problems associated with substance use. No differences existed across the

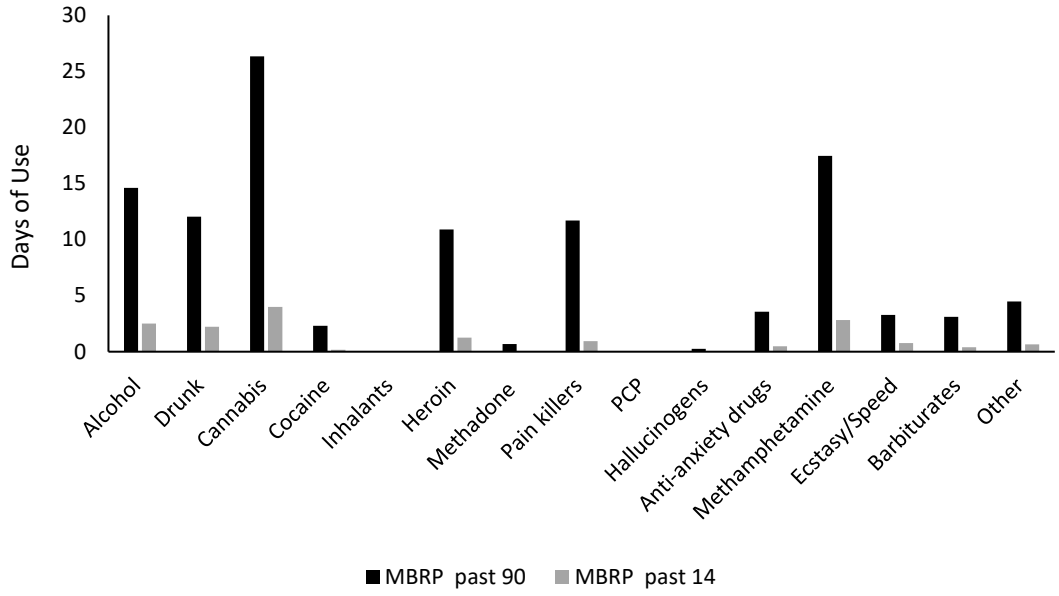
substance frequency scale when comparing MBRP and TAU participants for the unadjusted and adjusted means. On average participants attended approximately 2 self-help or social support recovery meetings in the 30 days prior to entering treatment.

Figure 11. Mean days of substance use for overall sample at baseline



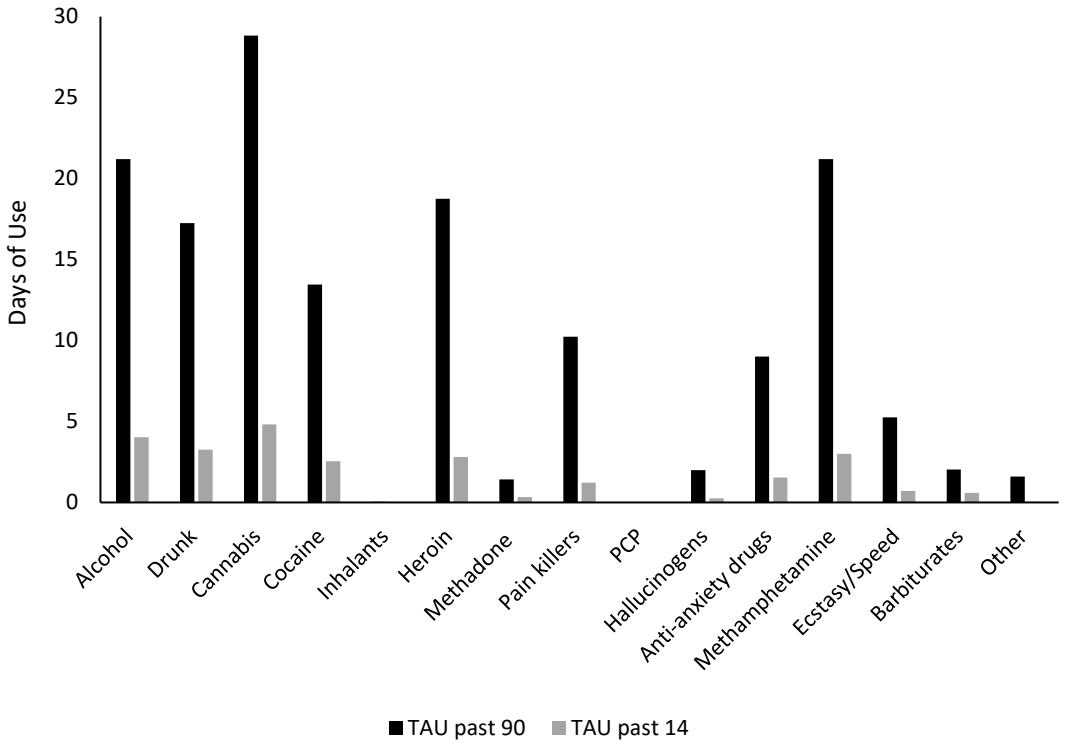
Note: Black bars represents past 90 day use and grey bars represents past 14 day use.

Figure 12. Mean days of substance use for participants assigned to MBRP at baseline



Note: Black bars represents past 90 day use and grey bars represents past 14 day use.

Figure 13. Mean days of substance use for participants assigned to TAU at baseline

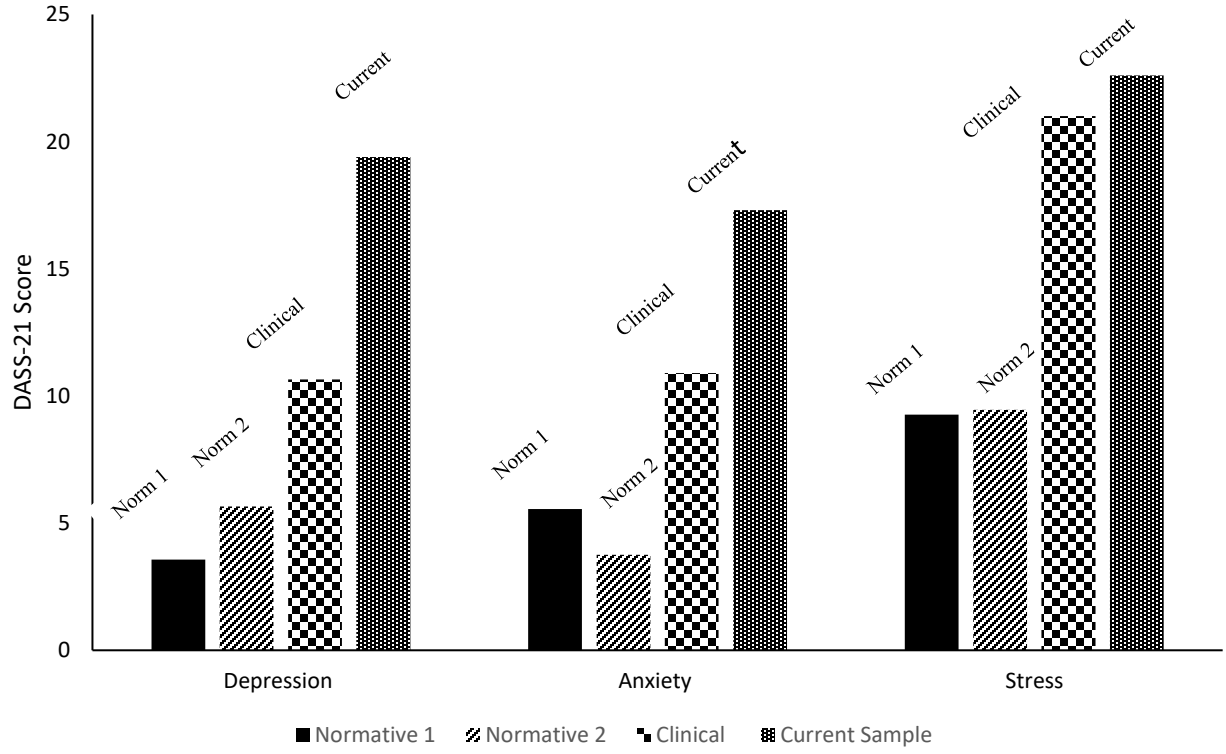


Note: Black bars represents past 90 day use and grey bars represents past 14 day use.

In terms of mental health the DASS-21 was used to assess depression, anxiety, and stress. Participants, on average scored 19.4 for depression, 17.3 for anxiety, and 22.6 for stress. To place this in context, the DASS-21 provide cut off scores for (normal, mild, moderate, severe, extremely severe). For example, for depression: normal (0-9), mild (10-13), moderate (14-20), severe (21-27), extremely severe (28+); anxiety: normal (0-7), mild (8-9), moderate (10-14), severe (15-19), extremely severe (20+); stress: normal (0-14), mild (15-18), moderate (19-25), severe (26-33), extremely severe (34+). No significant differences existed between those assigned to MBRP or TAU. Figure 14 shows how the current sample compares two to normative samples and one clinical sample. Across all three comparison groups, the current

sample had higher scores on depression, anxiety, and stress. Specifically, if we compare the clinical sample to our current sample (both MBRP and TAU) depression scores have a standardized mean difference (Cohen's *d*) of *d* = .91, anxiety *d* = .75, and stress *d* = .15. Figures 15, 16, and 17 display DASS-21 counts by severity for the overall sample, MBRP, and TAU groups.

Figure 14. DASS-21 Comparison across multiple samples at baseline



Note: Normative 1 data are from Crawford & Henry (2003). Data were obtained from 1,771 adults in the UK. Normative 2 data are from Henry & Crawford (2005). Data were obtained from 1,794 general adult UK population at two time points. Clinical data are from Brown et al. (1997). Data were from 678 participants presenting for assessment and treatment for depression, phobia, and anxiety disorders.

Figure 15. Counts of DASS-21 depression scores by severity for overall sample, MBRP, and TAU at baseline

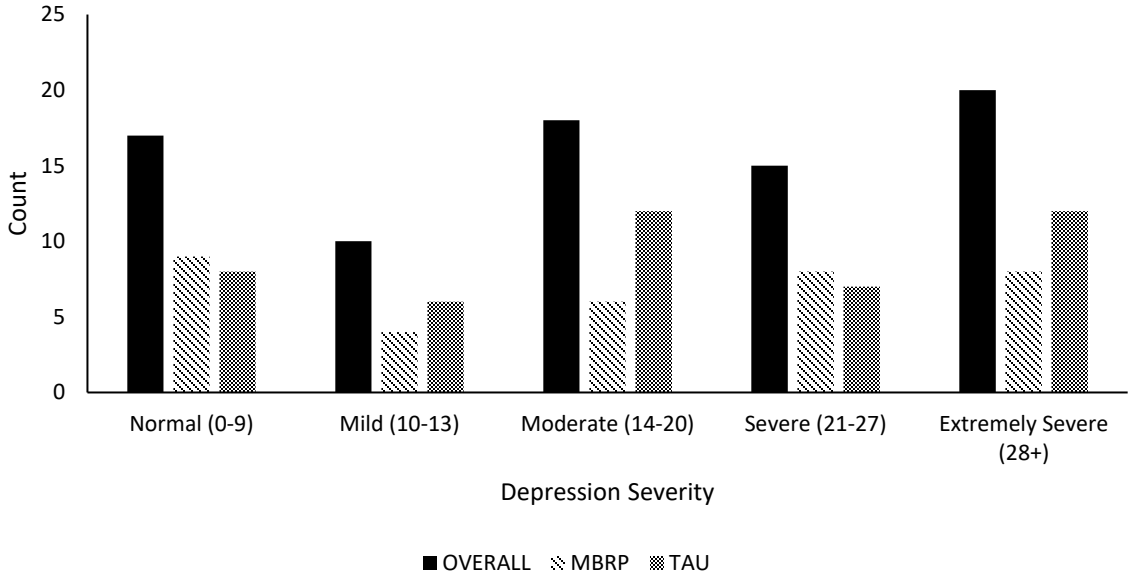


Figure 16. Counts of DASS-21 anxiety scores by severity for overall sample, MBRP, and TAU at baseline

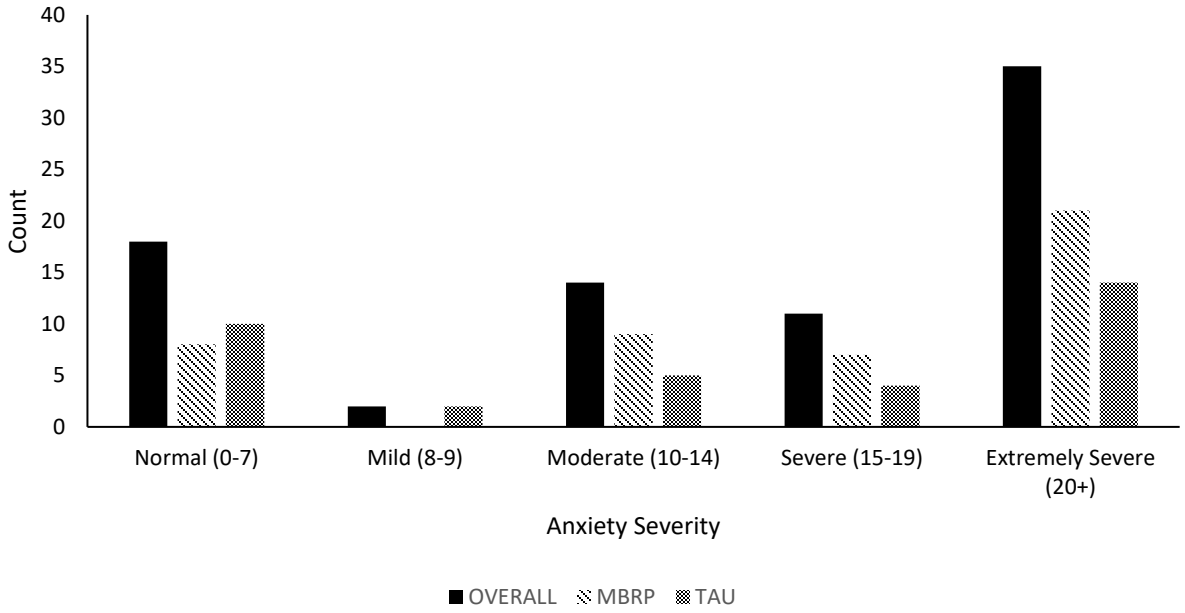
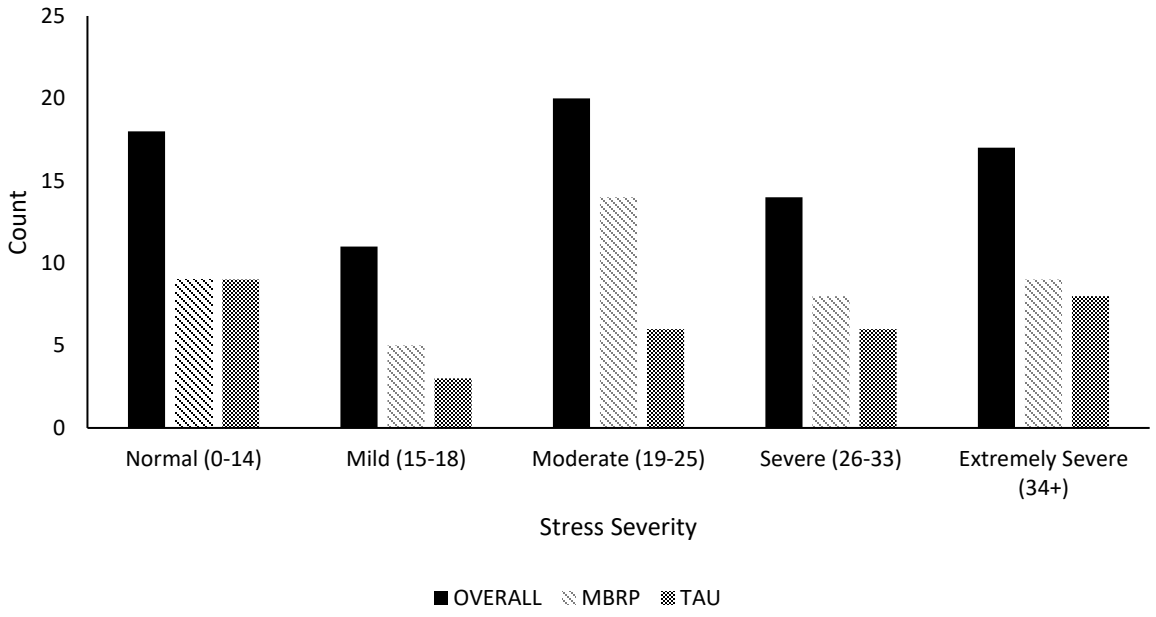
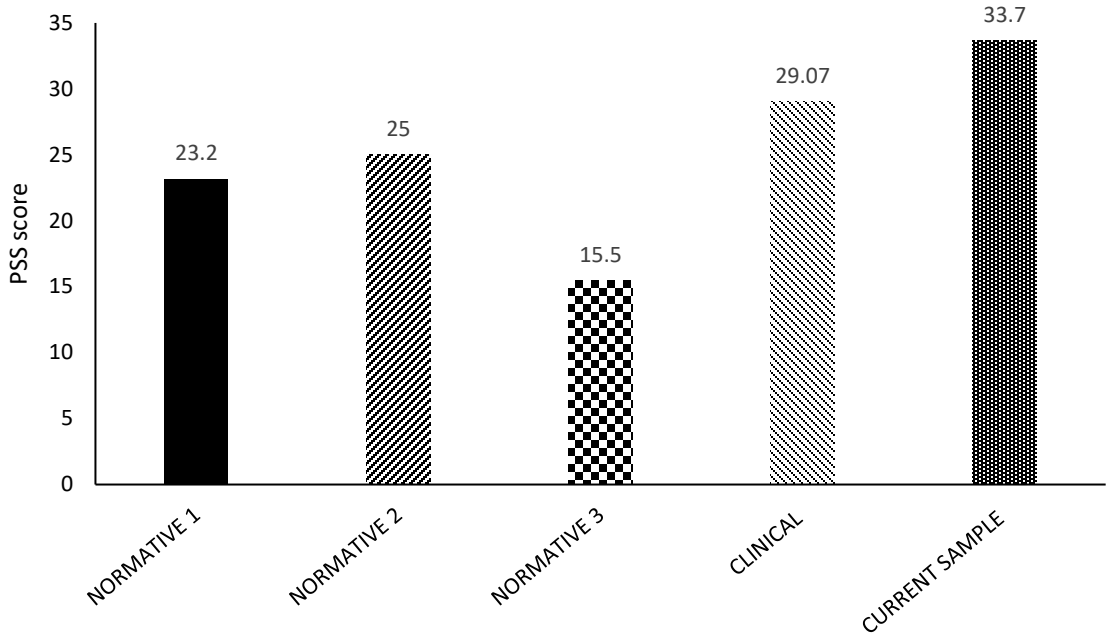


Figure 17. Counts of DASS-21 stress scores by severity for overall sample, MBRP, and TAU at baseline



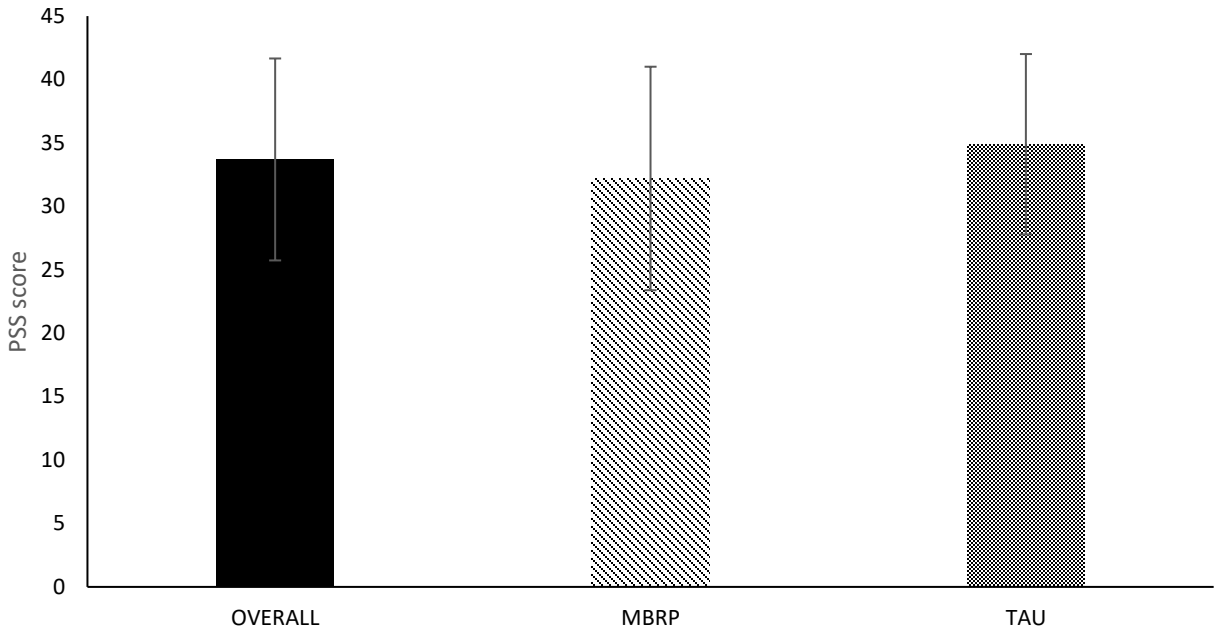
To further assess stress, participants were also administered the perceived stress scale. On average, participants scored 33.7 (*SD* = 7.96). No significant differences existed between individuals assigned to MBRP or TAU. Figure 18 compares perceives stress scores in the current sample to three normative samples and one clinical sample. Similar to our comparisons across the DASS-21 scores participants in the current study have higher stress scores than the three normative samples and the clinical sample. Standardized mean difference between the clinical comparison study and the current sample result in *d* = .55. Figure 19 displays the means perceived stress scores for the overall sample, MRBP, and TAU groups.

Figure 18. Normative and current sample scores on the Perceived Stress Scale at baseline



Note: *Normative 1 & 2 data are from Cohen et al. (1983). Data are for a college sample (N = 332; normative 1) and a community sample (N = 64; normative 2) of individuals participating in a smoking cessation program. Normative 3 data are from Cohen & Janicki-Deverts (2013). Data are for a large normative US sample (n = 2,000). The clinical data are from Hewitt et al. (1992). Data are from 96 psychiatric patients.*

Figure 19. Mean perceived stress scores for overall, MRBP, and TAU groups at baseline



Data were also collected on childhood trauma using the childhood trauma questionnaire. At baseline, participants reported, on average, a score of 50.3 (*SD* = 18.8) across all subscales. When looking at each of the 5 subscales, specifically, participants averages 12.2 (*SD* = 6.0) for emotional abuse, 9.40 (*SD* = 5.4) for physical abuse, 8.53 (*SD* = 6.1) for sexual abuse, 11.7 (*SD* = 5.5) for emotional neglect, and 8.36 (*SD* = 4.1) for physical neglect. No significant differences existed between individuals assigned to MBRP or TAU. Table 5 displays item level means for the current study sample compared to two large normative samples. In general, the current study sample has higher average scores across emotional abuse items, physical abuse items, and sexual abuse items. Comparison across emotional neglect and physical neglect are relatively comparable.

Table 5. Mean, Standard Deviations and Reliability of Measured Items for the CTQ. Comparison with Original Community Sample from Bernstein et al. (2003) and a larger Sample of emerging adults from Davis et al. (in press).

	Current Study Sample Mean (SD) *N* = 80	Davis, Dumas, & Roberts Mean (SD)[a] *N* = 832	Bernstein et al. Mean (SD)[b] *N* = 579
I. Emotional Abuse (α = .90)			
Called names by family	2.2 (1.4)	1.9 (1.2)	1.9 (1.2)
Parents wished was never born	1.9 (1.3)	1.6 (1.1)	1.4 (.90)
Felt hated by family	2.5 (1.6)	1.8 (1.2)	1.7 (1.1)
Family said hurtful things	2.7 (1.3)	2.1 (1.3)	2.1 (1.1)
Was emotionally abused	2.9 (1.6)	1.9 (1.4)	1.8 (1.3)
Mean Subscale	12.2 (6.0)	9.3 (5.3)	
II. Physical Abuse (α = .92)			
Hit hard enough to see doctor	1.6 (1.1)	1.3 (.72)	1.1 (.50)
Hit hard to leave bruises	1.8 (1.3)	1.5 (.96)	1.3 (.80)
Punished with hard object	2.7 (1.5)	1.9 (1.2)	2.2 (1.2)
Hit badly enough to be noticed	1.4 (1.1)	1.3 (.82)	1.1 (.50)
Was physically abused	1.9 (1.4)	1.5 (1.0)	1.4 (1.0)
Mean Subscale	9.4 (5.4)	7.4 (3.9)	
III. Sexual Abuse (α = .95)			
Was touched sexually	1.8 (1.4)	1.4 (.91)	1.6 (1.0)
Hurt if didn't do something sexual	1.4 (1.0)	1.2 (.76)	1.1 (.60)
Made me do sexual things	1.6 (1.2)	1.3 (.83)	1.4 (.90)
Was molested	1.8 (1.5)	1.3 (.90)	1.4 (1.0)
Was sexually abused	1.9 (1.5)	1.3 (.91)	1.4 (1.0)
Mean Subscale	8.5 (6.1)	6.6 (4.0)	
IV. Emotional Neglect (α = .92)			
Felt loved	2.0 (1.1)	2.0 (1.2)	1.8 (.90)
Made to feel important	2.0 (1.2)	2.2 (1.2)	2.0 (1.1)
Was looked out for	2.4 (1.3)	2.3 (1.2)	1.9 (1.0)
Family felt close	2.7 (1.3)	2.5 (1.3)	2.2 (1.1)
Family was source of strength	2.4 (1.4)	2.4 (1.3)	2.1 (1.1)
Mean Subscale	11.7 (5.5)	11.3 (5.4)	
V. Physical Neglect (α = .79)			
Not enough to eat	1.6 (1.0)	1.6 (.91)	1.2 (.60)
Got taken care of	1.9 (1.2)	1.9 (1.1)	1.7 (1.0)
Parents too drunk or high	2.0 (1.3)	1.4 (.91)	1.3 (.70)
Wore dirty clothes	1.4 (.93)	1.5 (.89)	1.2 (.50)

Table 5 (cont.)

Got taken to doctor	1.6 (1.0)	2.1 (1.5)	1.3 (.80)
Mean Subscale	8.4 (4.1)	8.4 (3.9)	

[a]Data are from Davis, Dumas, & Roberts (in press). Normative sample of emerging adults recruited from Amazon's MTurk.
[b]Data obtained from Bernstein et al. (2003) for sample of community members.
Range of all variables is 1 – 5 where 1 = *never true; 2 = rarely true; 3 = sometimes true; 4 = often true; 5 = very often true*.
Please note the original study (Bernstein et al., 2003) did not provide means for subscales.

Treatment Fidelity

To assess treatment fidelity Dr. Christopher Menard sat in on 16 sessions over the course of the study period. During each session, Dr. Menard coded each therapist using the Mindfulness Based Relapse Prevention Adherence and Competence (MBRP-AC) scale. There are two adherence constructs (treatment components and key concepts) and two competence constructs (therapist style/approach and therapist performance). The treatment components adherence scale is assessed using a checklist of major topics assessed within each session. To make each session comparable in terms of the number possible components (each session differs based on if there are new participants, meditation, and activities within each session) we made the treatment components have 10 possible items. The average across all 16 observed sessions was 7.0 (*SD* = 1.43) with a range of 4 to 9 components. Although we did not reach 100% in terms of adhering to treatment components this is likely due to sessions in which we did not have new participants (thus the component describing new participant orientation). The key components adherence scale is a count of behaviors used within each session that use the key concepts of MBRP to facilitate discussion and in-session exercises. Therapists averaged 20 (*SD* = 5.91) key concept behaviors per session (scores ranged from 8 to 30). In other words, therapists were able to administer 91% of the key components, on average, across each of the sessions. The therapist style/approach competence scale is assess overall ability to administer MBRP and mindfulness

based interventions (e.g., elicit feedback, clarifying expectations) and the overall therapist performance is the raters global impression of the sessions (e.g., therapists' ability to work as a team. Overall therapists averaged 4.78 (*SD* = .176) on the style/approach scale and 4.72 (*SD* = .264) on the overall performance scale. Overall, fidelity across the adherence constructs were good with therapists averaging over 90% in both of the adherence categories. In terms of the competence scales, considering the scores for these scales ranged from 1 (*low*) to 5 (*high*), the scores indicated therapists in this study reached excellent levels of competence on both therapist style/approach and overall therapist performance. As a comparison, Chawla and colleagues (2010) reported Therapist/approach mean rating of 3.95 (*SD* = .50) and overall therapist performance mean rating of 3.92 (*SD* = .42).

Treatment Completion and Mindfulness Practice

To assess treatment completion and engagement we tracked how many sessions each participant attended and how often they practiced mindfulness between each session. Session attendance ranged from 93% - 100% across the 8 sessions with 89% of participants receiving all 8 sessions. The primary reason for non-attendance was early termination at the residential facility due to behavioral issues. Mindfulness practice was tracked by asking each participant how many times they practiced mindfulness since the last session. Sessions were held bi-weekly thus counts of mindfulness practice refer to the time between each session (3 – 4 days between sessions). A "weekly" count of mindfulness practice can be obtained by summing two adjacent sessions (e.g., session 1 and session 2 will give you the average number of times each person practiced mindfulness in week 1). In general participants assigned to the MBRP were practicing mindfulness at least once per day in between sessions. As participants became more engaged in the treatment process the number of times practiced per day increased over the course of the 8

sessions. These results indicate that the majority of participants assigned to MBRP attended sessions and nearly 90% received all 8 MBRP sessions. Further, engagement in mindfulness practice is evident by the near daily practice in between each of the sessions.

Table 6. Participant treatment attendance and engagement in mindfulness practices

	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Session 7	Session 8
Attendance	100%	97.8%	95.6%	93.3%	93.3%	97.8%	93.3%	93.3%
Mindfulness Practice	3.8 (3.0)	3.8 (3.1)	5.0 (4.2)	6.3 (6.9)	6.4 (6.5)	6.5 (5.2)	6.7 (5.9)	6.5 (5.6)

Note: Sessions were held twice weekly, thus mindfulness practice refers to the Mean (SD) number of time participants practiced mindfulness between sessions (3-4 days between each session).

Attrition Analysis

On average total attrition across the study period was 18% ranging from 0% - 29%. Among the individuals recruited for the study 17% (n = 14) did not have any data following discharge from the residential facility or provided assessments following discharge but were lost to follow up at various times throughout the follow-up period. Further, 95% completed follow-up assessments during the 1 month period, 91% completed follow-up assessments during the 3 month period, and 75% completed follow-up assessments during the 5 month period. To assess if there are differences between individuals who were lost to follow up and those who completed the majority of follow up assessments an attrition analysis was conducted on the main variables of interest. There were no differences in terms of basic demographics such as age (t = 1.67, df = 78, p = .10), sex ($\chi^2 = 1.67, df = 1, p = .20$), or race ($\chi^2 = .346, df = 1, p = .55$). There were no differences across all 15 substances: alcohol (t = -.92, df = 78, p = .36); binge drinking (t = -.89, df = 78, p = .37); cannabis (t = -1.14, df = 78, p = .26); crack/cocaine (t = .21, df = 78, p = .83); heroin (t = -.13, df = 78, p = .89); methadone (t = .54, df = 78, p = .59); pain killers or other opiates (t = .87, df = 78, p = .39); hallucinogens (t = .60, df = 78, p = .55); anti-anxiety drugs (t

=.62, *df* = 78, *p* = .53); methamphetamine (*t* = .44, *df* = 78, *p* = .66); stimulants (*t* = 1.07, *df* = 78, *p* = .29); sedatives (*t* = .97, *df* = 78, *p* = .34); other drugs (*t* = .70, *df* = 78, *p* = .49); substance frequency scale past 90 days (*t* = .50, *df* = 78, *p* = .61); substance frequency scale past 14 days (*t* = -.07, *df* = 78, *p* = .94). Further, there were no differences when between those lost to follow-up versus those not lost to follow up in terms of childhood trauma scores: CTQ total (*t* = 1.77, *df* = 78, *p* = .08); physical abuse (*t* = 1.45, *df* = 78, *p* = .15); emotional neglect (*t* = 1.35, *df* = 78, *p* = .18); emotional abuse (*t* = 1.80, *df* = 78, *p* = .08); physical neglect (*t* = .73, *df* = 78, *p* = .47); sexual abuse (*t* = .65, *df* = 78, *p* = .51). No differences emerged when assessing craving scores (*t* = .12, *df* = 78, *p* = .91) or perceived stress (*t* = 1.08, *df* = 78, *p* = .28).

Stress: Basic Growth Models for Overall Sample

Table 7 displays fit statistics for a linear growth model for stress across the entire sample. Results indicate a model with random intercept, linear growth, quadratic growth fit the data best ($\Delta - 2ll = 11.4, df = 1, p < .001$). Table 8 displays parameter estimates and standard errors for all three models. Focusing on Model 3, we can see that there is an overall significant decrease in stress (linear slope *b* = -.158, *SE* = .29, *p* =.01; quadratic slope *b* = .061, *SE* = .02, *p* = .001). However, looking at Figure 20 which displays estimated and sample means for stress across the entire sample, we can see that the basic latent linear growth model does not capture the steep drop in stress during the first three time points (e.g., the treatment phase). To account for this a bilinear spline model was fit to the data. Table 9 displays fit statics for the bilinear spline model.

Table 7. Model fit statistics for overall stress linear latent growth model

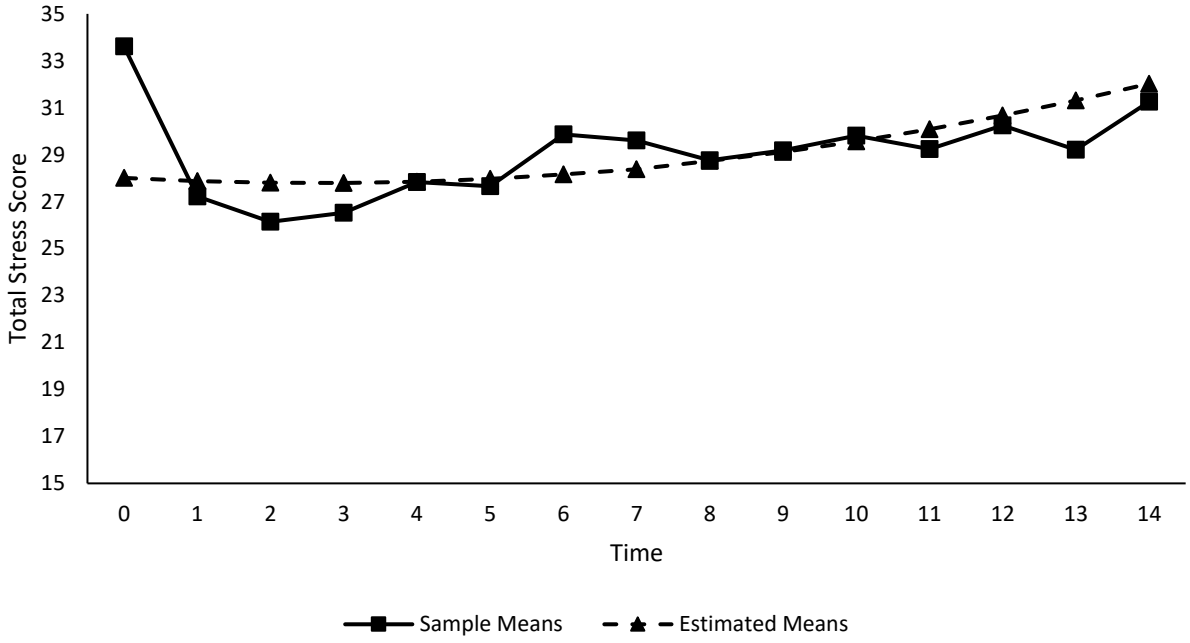
	Model 1	Model 2	Model 3
Parameters			
-2*LL*	6567.8	6497.3	6356.3
AIC	6557.8	6509.3	6466.7
BIC	6589.7	6523.6	6514.4
df	5	6	10
$\Delta Parameters$			
$\Delta - 2LL$		70.5	241
$\Delta\, df$		1	4
LRT		.000	.000

Note: Model 1 is a random intercept and fixed slope model with constrained residual variances
Model 2 is a random intercept, random linear slope and constrained residual variances
Model 3 random intercept, random linear slope, random quadratic slope, constrained residual variance

Table 8. Model parameters and standard errors for overall stress linear latent growth model

	Model 1	Model 2	Model 3
$Stress_{int}$	28.4 (.662)*	28.3 (.727)*	26.9 (.760)*
$Stress_{slp}$	.080 (.059)	.111 (.104)	-.671 (.260)*
$Stress_{qad}$			.061 (.019)*
Residual (co) variance			
$Stress_{int}$with $Stress_{slp}$	.656 (.188)*	-1.40 (.731)	-2.24 (.1.96)
$Stress_{int}$with $Stress_{qad}$			.062 (.131)
$Stress_{qad}$with $Stress_{slp}$			-.150 (.061)*
Variance			
$Stress_{int}$	20.5 (5.14)*	29.4 (6.63)*	25.6 (7.20)*
$Stress_{slp}$	.000 (.000)	.564 (.139)*	2.57 (.891)*
$Stress_{qad}$			.011 (.004)*

Figure 20. Estimates and sample means for stress across entire study sample.



Nested models were tested for the bilinear spline model to determine if a random slope was needed for the treatment phase and for the post-treatment phase. Results from likelihood ratio tests indicate a random slope is needed for both the treatment phase and the post-treatment phase (Table 9, Model 3). Table 10 displays parameter estimates and standard errors for the bilinear spline model. Focusing on model 3, there is a significant deceleration in stress during the treatment phase ($b = -3.48, SE = .883, p < .001$) and a slight slowing of the deceleration during the post-treatment phase ($b = .443, SE = .106, p < .001$). Significant variance existed across all parameters (intercept, treatment phase slope, and post-treatment phase slope). Figure 21 displays the estimated and sample means for stress across the entire sample using a bilinear spline model.

Table 9. Model fit statistics for overall stress using a bilinear spline model

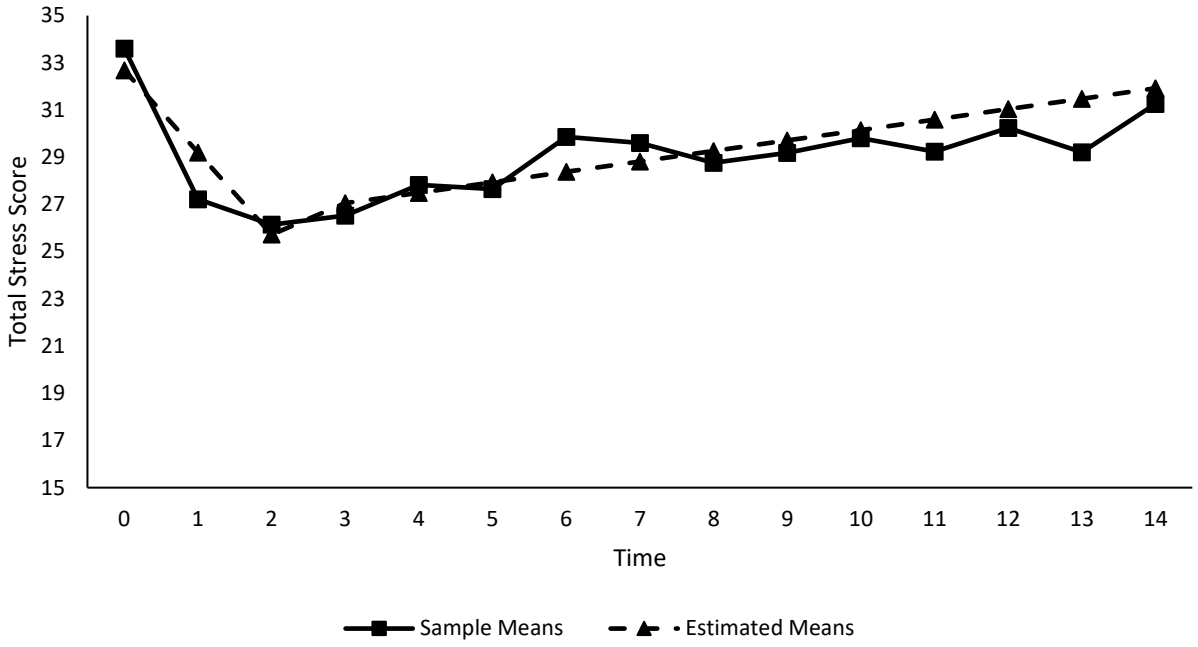
	Model 1	Model 2	Model 3
Parameters			
-2*LL*	6524.4	6470.6	6368.8
AIC	6534.4	6512.6	6416.8
BIC	6546.3	6562.6	6473.9
df	5	6	10
$\Delta Parameters$			
$\Delta - 2LL$		53.8	101.8
$\Delta\, df$		1	4
LRT		.000	.000

Note: Model 1 random intercept, fixed treatment slope, fixed follow up slope,
Model 2 random intercept, random treatment slope, fixed follow up slope,
Model 3 random intercept, random treatment slope, random follow up slope,

Table 10. Model parameters and standard errors for overall stress. Bilinear spine latent growth model

	Model 1	Model 2	Model 3
$Stress_{int}$	32.71 (.938)*	32.8 (.887)*	25.7 (.883)*
$Stress_{TXslp}$	-3.13 (.440)	-3.11 (.574)*	-3.48 (.532)*
$Stress_{FUslp}$	.368 (.070)*	.385 (.067)*	.443 (.106)*
Residual (co) variance			
$Stress_{int}$with $Stress_{TXslp}$	.000 (.000)	-4.00 (7.97)	14.5 (5.1)*
$Stress_{int}$with $Stress_{FUslp}$	.000 (.000)	.000 (.000)	-1.89 (.939)*
$Stress_{TXslp}$with $Stress_{FUslp}$	.000 (.000)	.000 (.000)	-.420 (.546)
Variance			
$Stress_{int}$	32.4 (5.99)*	15.26 (15.2)	44.7 (9.96)*
$Stress_{TXslp}$	.000 (.000)	10.2 (4.85)*	9.04 (3.69)*
$Stress_{FUslp}$	.000 (.000)		.525 (.137)*

Figure 21. Estimated and sample means for stress for overall sample using bilinear spline model



Stress: Treatment Effect on Stress Using Time Invariant Predictor Model

As an initial step in determining the effect of MBRP on stress over time, latent growth models with time a time invariant treatment predictor were estimated. Two sets of models were estimated: the first used a basic latent growth model with random linear and quadratic slopes, the second used a bilinear spline model with a random slope for the treatment phase and the post-treatment phase. Both sets of models controlled for the number of days each participant spent at the inpatient facility. Table 11 presents results from the basic latent linear growth model. Results indicate a significant treatment effect on the linear ($b = -2.05, SE = .470, p < .001$) and quadratic ($b = .096, SE = .036, p = .008$) slope for stress. Put differently individuals assigned to MBRP had significant decreases in stress over the study period compared to individuals assigned to TAU. Figure 22 displays mean stress scores for individuals assigned to MBRP and TAU.

Table 11. Treatment effects on latent stress trajectories.

	B	SE	P	95% CI
$Stress_{int}$	29.6	1.17	.000	27.3, 31.8
$Stress_{slp}$	.463	.358	.197	-.240, 1.17
$Stress_{qad}$	.008	.028	.764	-.046, .060
$Stress_{int}$ on MBRP	.547	1.54	.718	-2.46, 3.57
$Stress_{slp}$ on MBRP	-2.05	.470	.000	-2.97, -1.13
$Stress_{qad}$ on MBRP	.096	.036	.008	.025, .166
Residual (co) variance				
$Stress_{int}$with $Stress_{slp}$	-2.11	1.78	.236	-5.60, 1.38
$Stress_{int}$with $Stress_{qad}$	.050	.124	.689	-.194, .294
$Stress_{qad}$with $Stress_{slp}$	-.10	.050	.048	-.197, -.001
Variance				
$Stress_{int}$	25.9	7.24	.000	11.7, 4.1
$Stress_{slp}$	1.51	.688	.028	.168, 2.86
$Stress_{qad}$	.009	.004	.027	.001, .017
Fit Statistics				
-2LL	6315.5			
AIC	6341.5			
BIC	6372.3			
df	13			
CFI	.722			
TLI	.769			
RMSEA	.12			
χ^2	356.7			

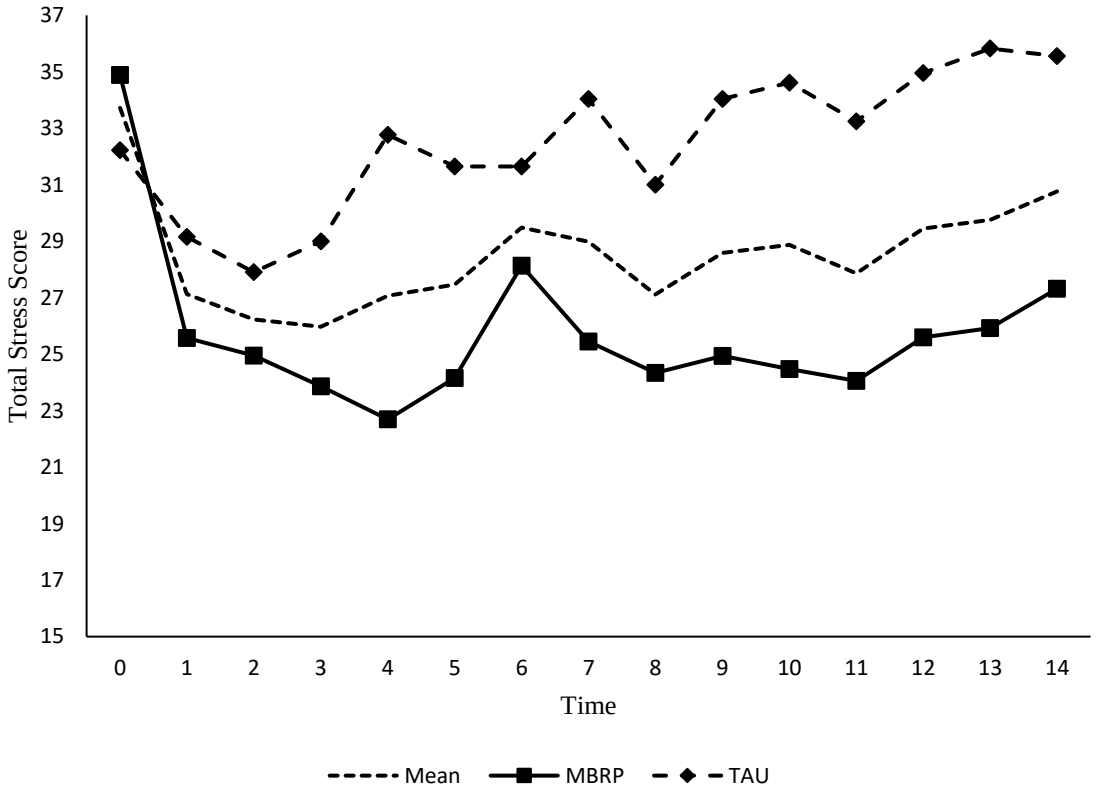


Figure 22. Mean stress scores for individuals assigned to MBRP, TAU, and the total mean scores.

To assess the treatment effect during the treatment phase and the post-treatment phase a model was estimated using a bilinear spline specification. Table 12 presents results for the bilinear spline growth model. Results indicate a significant treatment effect for stress during the treatment phase ($b = -3.70, SE = .947, p < .001$) and post treatment phase ($b = -.582, SE = .233, p = .013$). Put differently individuals assigned to MBRP had significant decreases in stress during both the treatment and post-treatment phases compared to individuals assigned to TAU.

Table 12. Treatment effects on latent stress trajectories for the bilinear spline model

	B	SE	P	95% CI
$Stress_{int}$	31.4	1.24	.000	30.0, 33.8
$Stress_{slp}$	-1.06	.718	.157	-2.42, .392
$Stress_{qad}$	.775	.180	.000	.423, 1.13
$Stress_{int}$ on MBRP	2.09	1.65	.205	-1.14, 5.31
$Stress_{tx\ slp}$ on MBRP	-3.70	.947	.000	-5.60, -1.85
$Stress_{ptx\ slp}$ on MBRP	-.582	.233	.013	-1.04, -.198
Residual (co) variance				
$Stress_{int}$with $Stress_{tx\ slp}$	-2.55	4.05	.529	-10.5, 5.38
$Stress_{int}$with $Stress_{ptx\ slp}$	-.963	.809	.234	-2.55, .623
$Stress_{tx\ slp}$with $Stress_{ptx\ slp}$	-.767	.545	.159	-2.17, .300
Variance				
$Stress_{int}$	22.3	2.86	.009	5.63, 38.9
$Stress_{slp}$	5.52	2.86	.054	-.094, 11.1
$Stress_{ptx\ slp}$	.615	.164	.000	.293, .937
Fit Statistics				
-2LL	6267.7			
AIC	6293.7			
BIC	6324.5			
df	13			
CFI	.714			
TLI	.770			
RMSEA	.13			
χ^2	308.9			

Stress: Treatment Effect on Stress Using Multi-Group Modeling

While the prior models (e.g., time invariant predictor) indicate a significant effect for individuals assigned to the experimental group, these models cannot determine if the slopes are actually different for experimental and control groups. To test differences in slopes across randomized groups, a series of multi-group models were estimated. In particular, a taxonomy of models were estimated for the overall trajectory (e.g., across both treatment and post-treatment phases) as well as for a bilinear spline model. Within both of these growth models five separate models (Model 1 – Model 5) were estimated to determine invariance across groups (e.g., invariance model, means model, means and co-variances model, means, co-variances, and residual variances, and the final model). Model fit was estimated using LRT test. The final model (Model 5) employs and constraints needed based on LRT tests across the first four models. The MODEL TEST command was used to assess differences in stress slopes across groups (MRBP and TAU). Table 13 displays results of the multi-group model for overall stress trajectories. There was significantly better model fit ($\Delta - 2LL = 39.4, \Delta\, df = 3, p = .001$) for Model 2 (means model) compared to Model 1 (invariance model) indicating are significant differences in average trajectories. The non-significant LRT results in Model 3 ($\Delta - 2LL = 8.4, \Delta\, df = 6, p = .212$) indicates limited between person variability and co-variability in the growth parameters. However, the significant LRT result in Model 4 ($\Delta - 2LL = 72.7, \Delta\, df = 1, p = .000$) indicates significant unexplained within person variability in stress over time. Model 5 represents the final model with variances and co-variances constrained to be equal across groups. Results from the LRT test indicate the model was not significantly worse fitting compared to Model 5, thus constraining variances and co-variances to be equal across groups does not result in a worse

fitting model. Results indicate a significant linear decrease in stress for individuals assigned to MRBP ($b = -.842, SE = .356, p = .018$) and a significant deceleration for the quadratic term ($b = .060, SE = .026, p = .018$). Conversely, there was a significant linear increase in stress for individuals assigned to TAU ($b = .921, SE = .402, p = .022$) and a non-significant quadratic effect ($b = -.027, SE = .029, p = .353$). Results from the Wald test of parameter constraints indicate a significant difference between groups for the linear slope ($Wald\ \chi^2 = 10.7\ , df = 1, p = .001$) and quadratic slope ($Wald\ \chi^2 = 10.7\ , df = 1, p = .001$). Figure 23 displays means and estimated trajectories for overall stress across individuals assigned to MRBP and TAU.

In addition to assessing differences in slopes (change), model testing was also assessed on mean differences at four distinct time points: 1) baseline, 2) treatment completion, 3) mid-point (3 months), and 4) end of study (6 months). To assess mean differences at these time points from a modeling perspective the intercept was set at each of the above mentioned time points. The MODEL TEST option was used to assess mean differences for the intercept at each phase of the study. For stress, no significant differences were found between individuals assigned to MRBP and TAU at baseline ($Wald\ \chi^2 = .367\ , df = 1, p = .545$). In terms of standardized mean differences (Cohen's *d*) results for baseline mean differences resulted in small, but non-significant, difference ($d = -.14, 95\% CI\ [-.58, .31]\ , df = 1, p = .545$). However, significant mean differences were found across groups at treatment completion ($Wald\ \chi^2 = 9.45\ , df = 1, p = .002; Cohen's\ d = -.70, 95\%\ CI[-1.16, -.25]$), mid-point ($Wald\ \chi^2 = 40.8\ , df = 1, p < .001;\ Cohen's\ d = -1.5, 95\%\ CI[-2.03, -1.02]$), and at study completion ($Wald\ \chi^2 = 12.5\ , df = 1, p < .001;\ Cohen's\ d = -.80, 95\%\ CI[-1.26, -.33]$).

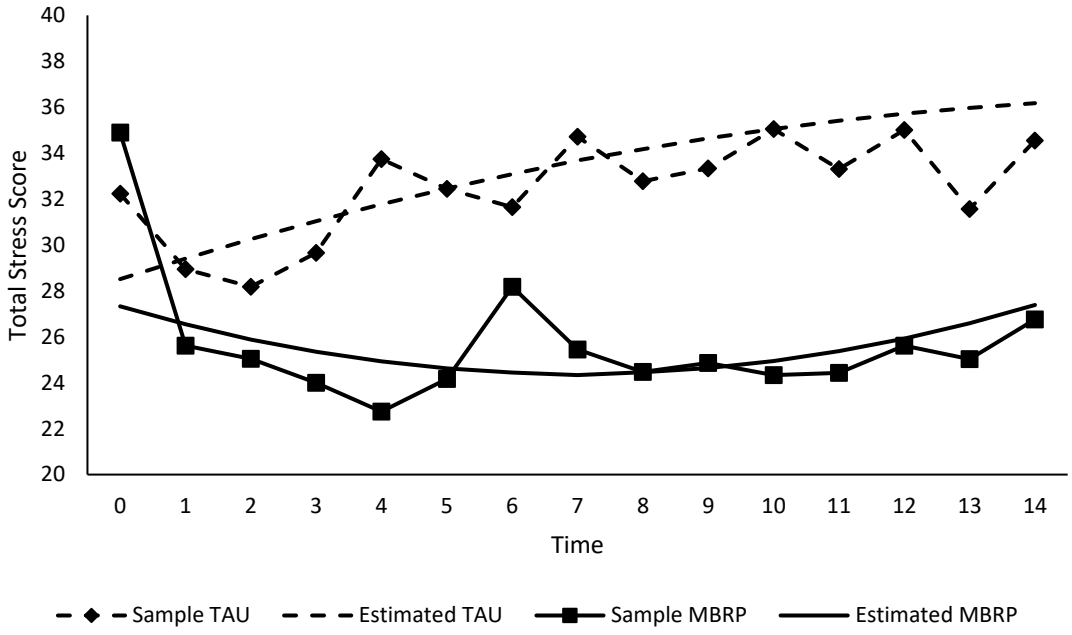


Figure 23. Means and estimated trajectories for multi-group growth modeling

Table 13. Multi-group model parameters and standard errors for stress trajectories by treatment assignment

	Model 1	Model 2	Model 3	Model 4	Model 5
MRBP					
$Stress_{int}$	29.9 (.757)*	30.1 (1.01)*	30.07 (.948)*	27.1 (1.26)*	27.3 (1.21)*
$Stress_{slp}$	-.672(.257)*	-1.57 (.303)*	-1.59 (.269)*	-.802 (.373)*	-.842 (.356)*
$Stress_{qad}$	.060 (.018)*	.103 (.023)*	.104 (.020)*	.059 (.027)*	.060 (.026)
Residual (co) variance					
$Stress_{int}$with $Stress_{slp}$	-.207 (1.96)	-2.10 (1.77)	-1.99 (2.06)	-6.28 (3.82)	-2.58 (2.35)
$Stress_{int}$with $Stress_{qad}$	.041 (.130)	.038 (.124)	.079 (.143)	.349 (.262)	.036 (.154)
$Stress_{qad}$with $Stress_{slp}$	-.144 (.061)*	-.094 (.049)*	-.036 (.047)	-.127 (.084)	-.086 (.054)
Variance					
$Stress_{int}$	25.5 (7.18)*	25.9 (7.24)*	20.6 (8.47)*	37.2 (14.1)*	31.1 (9.89)*
$Stress_{slp}$	2.46 (.875)*	1.46 (.676)*	.689 (.672)	2.03 (1.22)	1.41 (.786)
$Stress_{qad}$	.011 (.004)*	.008 (.004)*	.004 (.004)	.010 (.006)	.008 (.004)*
TAU					
$Stress_{int}$	29.9 (.757)*	27.7 (1.15)*	29.7 (1.24)*	28.5 (1.39)*	28.5 (1.43)*
$Stress_{slp}$	-.672 (.257)*	.430 (.352)	.507 (.405)	.939 (.388)*	.921 (.402)*
$Stress_{qad}$	.060 (.018)*	.006 (.027)	-.002 (.031)	-.028 (.027)	-.027 (.029)*
Residual (co) variance					
$Stress_{int}$with $Stress_{slp}$	-.207 (1.96)	-2.098 (1.77)	-2.64 (3.21)	-6.29 (3.80)	-2.58 (2.35)
$Stress_{int}$with $Stress_{qad}$	.041 (.130)	.038 (.124)	.014 (.226)	.349 (.262)	.036 (.154)
$Stress_{qad}$with $Stress_{slp}$	-.144 (.061)*	-.094 (.049)*	-.193 (.106)	-.127 (.084)	-.086 (.054)
Variance					
$Stress_{int}$	25.5 (7.18)*	25.9 (7.24)*	33.3 (12.7)*	37.3 (14.1)*	31.1 (9.89)*
$Stress_{slp}$	2.46 (.875)*	1.42 (.676)*	2.776 (1.41)*	2.03 (1.22)	1.41 (.786)
$Stress_{qad}$	.011 (.004)*	.008 (.004)*	.016 (.008)	.010 (.006)	.008 (.004)*
Fit Indices					

Table 13. (cont.)					
-2LL	6455.7	6416.296	6407.9	6335.2	6342.0
AIC	6475.7	6442.3	6445.9	6431.2	
BIC	6499.5	6473.3	6491.2	6545.6	
df	10	13	19	48	42
$\Delta Parameters$					
$\Delta - 2LL$		39.4	8.4	72.7	6.8
$\Delta\, df$		3	6	29	6
LRT		.001	.212	.000	.34

Note:
Model 5 is the final model with variances and co-variances constrained to be equal across groups (based on Results from LRT M3 versus M2) and group varying intercepts, slopes, and residuals. Results of the LRT Indicate a non-significant increase in -2LL, indicating model fit is not significantly worse than a model with Group varying variances and co-variances.

Table 14 displays results of the multi-group model for the bilinear spline model for stress trajectories. There was significantly better model fit ($\Delta - 2LL = 40.5, \Delta\, df = 3, p = .001$) for Model 2 (means model) compared to Model 1 (invariance model) indicating are significant differences in average trajectories. The non-significant LRT results in Model 3 ($\Delta - 2LL = 10.5, \Delta\, df = 6, p = .105$) indicates limited between person variability and co-variability in the growth parameters. However, the significant LRT result in Model 4 ($\Delta - 2LL = 5.5, \Delta\, df = 1, p = .019$) indicates significant unexplained within person variability in stress over time. Model 5 represents the final model with variances and co-variances constrained to be equal across groups. Results from the LRT test indicate the model was not significantly worse fitting compared to Model 5, thus constraining variances and co-variances to be equal across groups does not result in a worse fitting model. Results indicate a significant decrease in stress for individuals assigned to MRBP during the treatment phase ($b = -4.72, SE = .571, p < .001$) but a non-significant effect during the post-treatment phase ($b = .194, SE = .146, p = .186$). Conversely, there was a non-significant decrease in stress for individuals assigned to TAU during the treatment phase ($b = -1.02, SE = .733, p = .163$) and a significant increase in stress during the post-treatment phase ($b = .763, SE = .183, p < .001$). Results from the Wald test of parameter constraints indicate a significant difference between groups during the treatment phase ($Wald\ \chi^2 = 15.7\,, df = 1, p < .001$) and during the post-treatment phase ($Wald\ \chi^2 = 5.94\,, df = 1, p = .015$). Figure 24 displays means and estimated trajectories for overall stress across individuals assigned to MRBP and TAU.

Table 14. Multi-group model parameters and standard errors for bilinear spline stress trajectories by treatment assignment

	Model 1	Model 2	Model 3	Model 4	Model 5
MRBP					
$Stress_{int}$	32.68 (.819)*	33.5 (1.08)*	33.5 (.932)*	33.1 (1.03)*	33.5 (1.03)*
$Stress_{TXslp}$	-3.12 (.506)*	-4.72 (.614)*	-4.73 (.488)*	-4.51 (.556)*	-4.72 (.571)*
$Stress_{PTX\ slp}$	.455 (.120)*	.194 (.152)	.206 (.147)	.176 (.149)	.194 (.149)
Residual (co) variance					
$Stress_{int}$ with $Stress_{TXslp}$	-3.78 (4.40)	-2.245 (4.01)	3.73 (3.36)	12.8 (7.27)	-.866 (3.89)
$Stress_{int}$ with $Stress_{PTX\ slp}$	-1.46 (.861)	-1.17 (.827)	-.901 (.856)	-.899 (.853)	-1.19 (.798)
$Stress_{TX\ slp}$ with $Stress_{PTXslp}$	.091(.588)	-.696 (.545)	-.223 (.529)	-.419 (.536)	-.636 (.525)
Variance					
$Stress_{int}$	22.90 (8.62)*	22.2 (8.50)*	8.33 (8.42)	-9.24 (14.0)	19.9 (8.32)*
$Stress_{TXslp}$	8.43 (3.36)*	5.14 (2.82)*	-1.11 (2.36)	-4.83 (3.95)	4.03 (2.75)
$Stress_{PTX\ slp}$	.680 (.177)*	.648 (.170)*	.572 (.209)*	.629 (.211)*	.633 (.168)*
TAU					
$Stress_{int}$	32.68 (.819)*	31.7 (1.23)*	31.6 (1.42)*	31.8 (1.44)*	31.7 (1.26)*
$Stress_{TXslp}$	-3.12 (.506)*	-1.07 (.704)	-.989 (.853)	-1.05 (.874)	-1.08 (.722)
$Stress_{PTX\ slp}$	.455 (.120)*	.718 (.181)*	.689 (.190)*	.709 (.211)*	.703 (.184)*
Residual (co) variance					
$Stress_{int}$ with $Stress_{TXslp}$	-3.78 (4.40)	-2.245 (4.01)	-9.88 (8.42)	-6.08 (13.5)	-.866 (3.89)
$Stress_{int}$ with $Stress_{PTX\ slp}$	-1.46 (.861)	-1.17 (.827)	-1.48 (1.56)	-1.12 (1.70)	-1.19 (.798)
$Stress_{PTXslp}$ with $Stress_{TXslp}$	.091(.588)	-.696 (.545)	-1.33 (1.06)	-1.79 (1.16)	-.636 (.525)
Variance					
$Stress_{int}$	22.90 (8.62)*	22.2 (8.50)*	39.6 (16.8)*	29.81 (25.9)	19.9 (8.32)*
$Stress_{TXslp}$	8.43 (3.36)*	5.14 (2.82)*	13.1 (6.15)*	11.7 (8.35)	4.03 (2.75)
$Stress_{PTX\ slp}$	.680 (.177)*	.648 (.170)*	.720 (.278)*	.997 (.331)*	.633 (.168)*
Fit Indices					

Table 14. (cont.)					
-2LL	6409.6	6369.1	6358.6	6353.4	6362
AIC	6429.6	6395.1	6396.6	6395.4	6390.5
BIC	6453.4	6426.0	6441.8	6442.6	6423.9
df	10	13	19	20	14
$\Delta Parameters$					
$\Delta - 2LL$		40.5	10.5	5.5	9
$\Delta\, df$		3	6	1	6
LRT		.000	.105	.019	.174

Model 5 is the final model with variances and co-variances constrained to be equal across groups (based on Results from LRT M3 versus M2) and group varying intercepts, slopes, and residuals. Results of the LRT Indicate a non-significant increase in -2LL, indicating model fit is not significantly worse than a model with Group varying variances and co-variances.

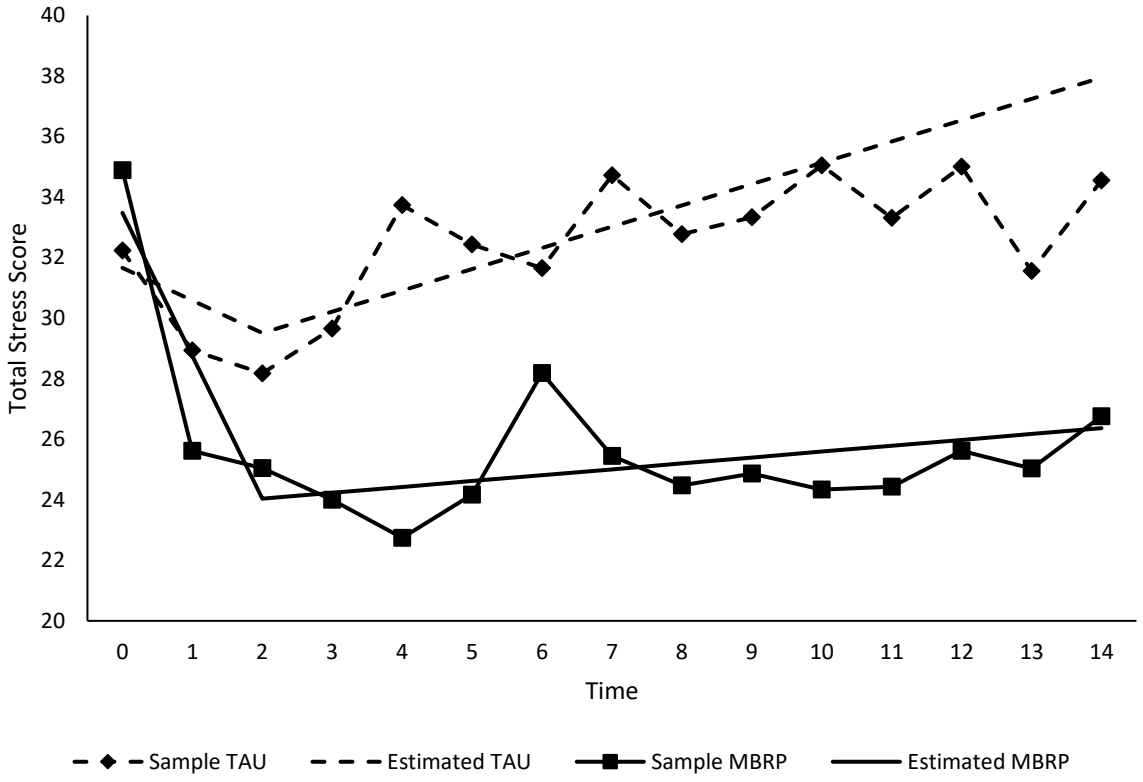


Figure 24. Stress means and estimated trajectories for the multi-group bilinear spline model

Stress: Multi-Level Modeling

As a robustness check the effect of treatment on stress was also assessed using a multi-level modeling framework. Unconditional growth models revealed an Intraclass Correlation of 36.0% indicating that 36% of the variance in stress is retained in the between-person level and 64% at the within-person level. An LRT test was conducted to determine if a random slope was needed. Results indicate a significant reduction in -2 log likelihood ($\Delta - 2LL = 605, \Delta\, df = 2, p < .001$), indicating a random slope fits the data better than a model with a fixed slope. In the final model, treatment assignment, days in residential facility, and days not in the community

were entered into the model. Results indicate a significant effect of treatment on the slope of stress ($b = -.907, SE = .140, p < .001$). This means individuals assigned to MBRP had significantly lower stress over the study period compared to individuals assigned to TAU.

Craving: Basic Growth Models for Overall Sample

Table 15 displays fit statistics for a linear growth model for craving across the entire sample. Results indicate a model with random intercept, linear growth, quadratic growth fit the data best ($\Delta - 2ll = 11.4, df = 1, p < .001$). Table 16 displays parameter estimates and standard errors for all three models. Focusing on Model 3, we can see that there is an overall significant decrease in craving (linear slope *b* = -.189, *SE* = .094, *p* =.045; quadratic slope *b* = .015, *SE* = .007, *p* = .034). However, looking at Figure 25 which displays estimated and sample means for craving across the entire sample, we can see that the basic latent linear growth model does not capture the steep drop in craving during the first three time points (e.g., the treatment phase). To account for this a bilinear spline model was fit to the data. Table 17 displays fit statics for the bilinear spline model.

Table 15. Model fit statistics for overall craving linear latent growth model

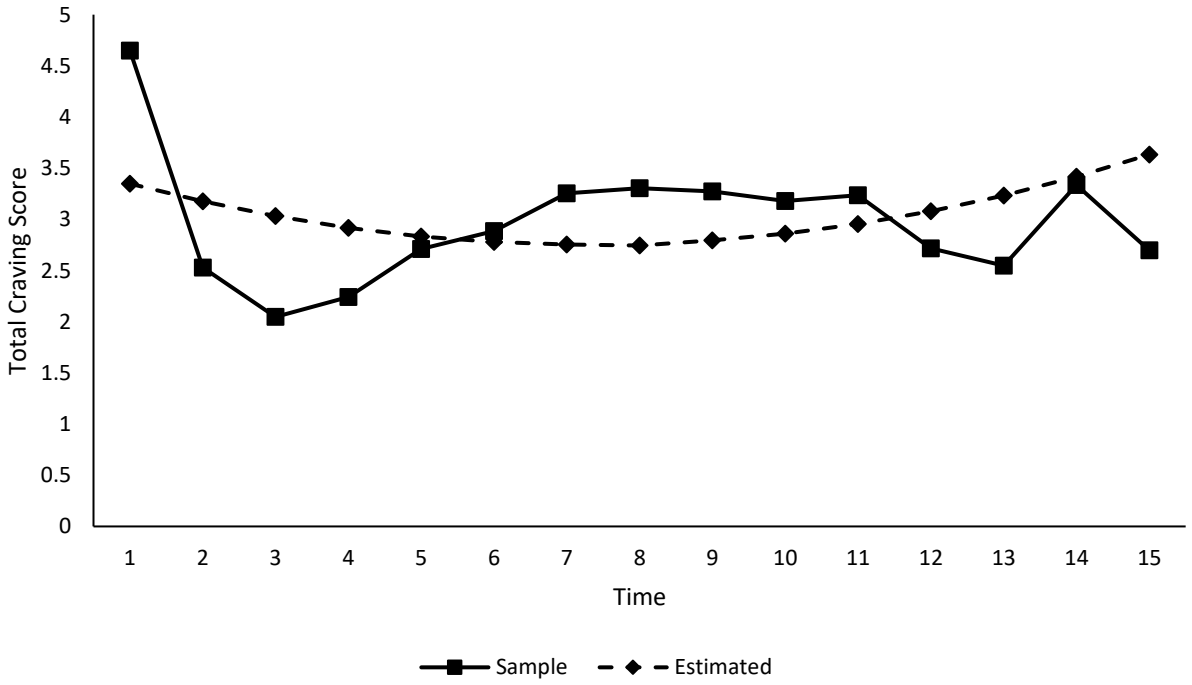
	Model 1	Model 2	Model 3
Parameters			
-2*LL*	4429.8	4357.8	4269.4
AIC	4439.8	4369.8	4289.4
BIC	4435.9	4365.2	4281.7
df	5	6	10
$\Delta Parameters$			
$\Delta - 2LL$		71.9	88.4
$\Delta\, df$		1	4
LRT		.000	.000

Note: Model 1 is a random intercept and fixed slope model with constrained residual variances
Model 2 is a random intercept, random linear slope and constrained residual variances
Model 3 random intercept, random linear slope, random quadratic slope, constrained residual variance

Table 16. Model parameters and standard errors for overall craving linear latent growth model

	Model 1	Model 2	Model 3
$Crav_{int}$	2.97 (.255)*	2.92(.267)*	3.35 (.241)*
$Crav_{slp}$	.007 (.019)	.016 (.035)	-.189 (.094)*
$Crav_{qad}$			.015 (.007)*
Residual (co) variance			
$Crav_{int}$with $Crav_{slp}$	.073 (.025)*	-,088 (.087)	-.023 (.209)
$Crav_{int}$with $Crav_{qad}$			-.009 (.015)
$Crav_{qad}$with $Crav_{slp}$			-.029 (.008)*
Variance			
$Crav_{int}$	23.74 (.802)*	4.45 (.915)*	2.78 (.743)*
$Crav_{slp}$	.000 (.000)	.063 (.016)*	.437 (.113)*
$Crav_{qad}$			.002 (.001)*

Figure 25. Estimates and sample means for craving across entire study sample.



Nested models were tested for the bilinear spline model to determine if a random slope was needed for the treatment phase and for the post-treatment phase. Results from likelihood ratio tests indicate a random slope is needed for both the treatment phase and the post-treatment phase (Table 17, Model 3). Table 18 displays parameter estimates and standard errors for the bilinear spline model. Focusing on model 3, there is a significant deceleration in craving during the treatment phase ($b = -1.15, SE = .172, p < .001$) and a slight slowing of the deceleration during the post-treatment phase($b = .124, SE = .038, p < .001$). Significant variance existed across all parameters (intercept, treatment phase slope, and post-treatment phase slope). Figure 26 displays the estimated and sample means for craving across the entire sample using a bilinear spline model.

Table 17. Model fit statistics for overall craving using a bilinear spline model

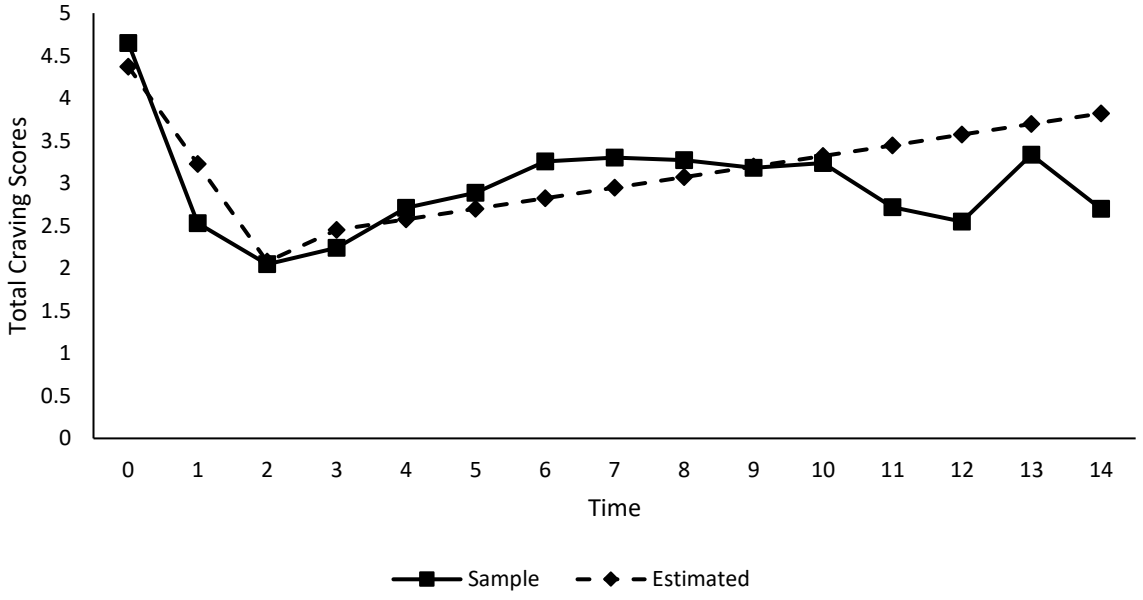
	Model 1	Model 2	Model 3
Parameters			
-2LL	4340.9	4336.6	4256.6
AIC	4356.9	4354.6	4276.6
BIC	4350.7	4347.6	4300.4
df	8	9	10
$\Delta Parameters$			
$\Delta - 2LL$		4.29	80.0
$\Delta\, df$		1	1
LRT		.038	.000

Note: Model 1 random intercept, fixed treatment slope, fixed follow up slope,
Model 2 random intercept, random treatment slope, fixed follow up slope,
Model 3 random intercept, random treatment slope, random follow up slope,

Table 18. Model parameters and standard errors for overall craving. Bilinear spine latent growth model

	Model 1	Model 2	Model 3
$Crave_{int}$	2.10 (.282)*	2.12 (.294)*	2.08 (.318)*
$Crave_{TXslp}$	-1.12 (.142)*	-1.11 (.163)*	-1.15 (.172)*
$Crave_{PTX\ slp}$	.099 (.020)*	.098 (.020)*	.124 (.038)*
Residual (co) variance			
$Crave_{int}$with $Crave_{TXslp}$	.597 (.245)*	-1.57 (.471)*	1.77 (.587)*
$Crave_{int}$with $Stress_{PTX\ slp}$	.078 (.028)*	.068 (.029)*	-.199 (.118)
$Crave_{TXslp}$with $Stress_{PTX\ slp}$	.056 (.013)*	.048 (.016)*	-.086 (.061)
Variance			
$Crave_{int}$	4.41 (.872)*	5.02 (1.05)*	6.41 (1.31)*
$Crave_{TXslp}$	.000 (.000)	.564 (.325)	1.07 (.378)
$Crave_{PTX\ slp}$	.000 (.000)	.000 (.000)	.077 (.019)*

Figure 26. Estimated and sample means for craving for overall sample using bilinear spline model



Craving: Treatment Effect on Craving Using Time Invariant Predictor Model

As an initial step in determining the effect of MBRP on craving over time, latent growth models with a time invariant treatment predictor were estimated. Two sets of models were estimated: the first used a basic latent growth model with random linear and quadratic slopes, the second used a bilinear spline model with a random slope for the treatment phase and the post-treatment phase. Both sets of models controlled for the number of days each participant spent at the inpatient facility. Table 19 presents results from the basic latent linear growth model. Results indicate a significant treatment effect on the linear ($b = -.778, SE = .169, p < .001$) and quadratic ($b = .048, SE = .013, p < .001$) slope for craving. Put differently, individuals assigned to MBRP had significant decreases in craving over the study period compared to individuals assigned to TAU. Figure 27 displays mean craving scores for individuals assigned to MBRP and TAU.

Table 19. Treatment effects on latent craving trajectories.

	B	SE	P	95% CI
$Crave_{int}$	3.56	.518	.000	27.3, 31.8
$Crave_{slp}$	.291	.177	.101	-.240, 1.17
$Crave_{qad}$	-.019	.014	.169	-.046, .060
$Crave_{int}$ on MBRP	-.425	.487	.383	-2.46, 3.57
$Crave_{slp}$ on MBRP	-.778	.013	.000	-2.97, -1.13
$Crave_{qad}$ on MBRP	.048	.013	.008	.025, .166
Residual (co) variance				
$Crave_{int}$with $Crave_{slp}$	-.080	.191	.676	-5.60, 1.38
$Crave_{int}$with $Crave_{qad}$	-.003	.014	.825	-.194, .294
$Crave_{qad}$with $Crave_{slp}$	-.020	.006	.001	-.197, -.001
Variance				
$Crave_{int}$	2.77	.743	.000	11.7, 4.1
$Crave_{slp}$	.290	.085	.001	.168, 2.86
$Crave_{qad}$	.002	.0001	.001	.001, .017
Fit Statistics				
-2LL	4237.5			
AIC	4269.5			
BIC	4307.6			
df	16			
CFI	.729			
TLI	.764			
RMSEA	.16			
χ^2	470.1			

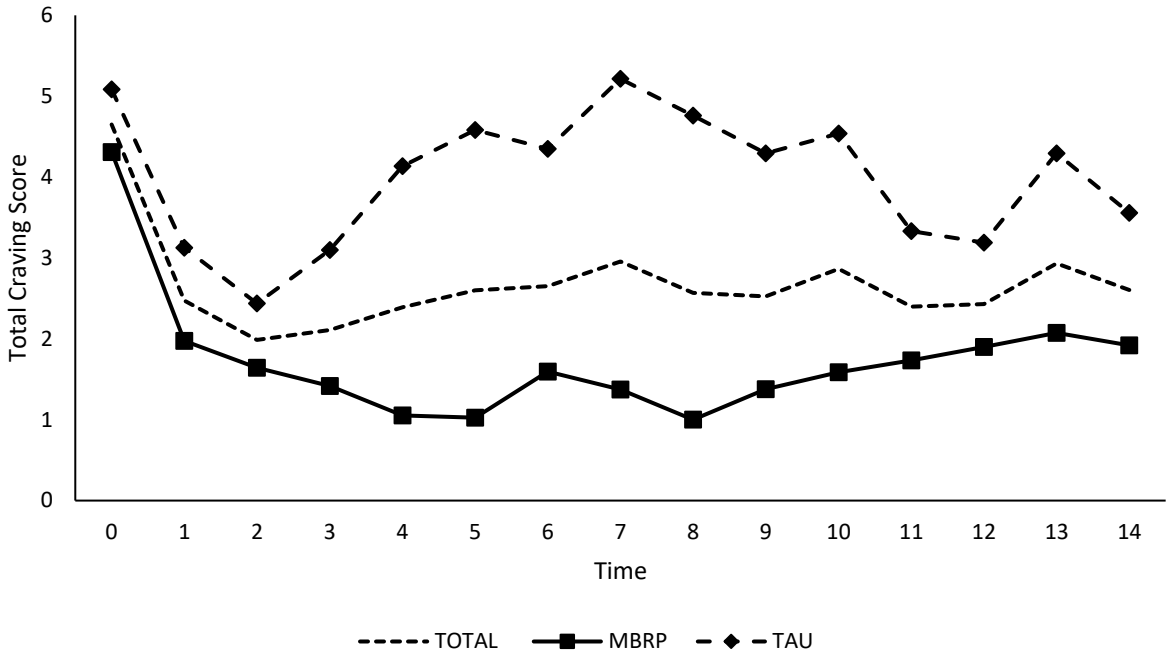


Figure 27. Mean craving scores for individuals assigned to MBRP, TAU, and the total mean scores.

To assess the treatment effect during the treatment phase and the post-treatment phase a model was estimated using a bilinear spline specification. Table 20 presents results for the bilinear spline growth model. Results indicate a significant treatment effect for craving during the treatment phase ($b = -.802, SE = .325, p = .014$) but a non-significant effect during the post treatment phase($b = -.150, SE = .087, p = .085$). Put differently individuals assigned to MBRP had significant decreases in craving during the treatment phase compared to individual assigned to TAU, however a non-significant effect during the post-treatment phase indicates that although individual assigned to MBRP had lower craving scores, these slopes were not significantly different from each other.

Table 20. Treatment effects on latent craving trajectories for the bilinear spline model

	B	SE	P	95% CI
$Stress_{int}$	4.64	.697	.000	3.45, 5.83
$Stress_{slp}$	-.446	.347	.199	-1.27, .235
$Stress_{qad}$	.136	.091	.133	-.042, .314
$Stress_{int}$ on MBRP	-.676	.571	.237	-1.80, .446
$Stress_{tx\ slp}$ on MBRP	-.802	.325	.014	-1.4, -.165
$Stress_{ptx\ slp}$ on MBRP	-.150	.087	.085	-.320, .020
Residual (co) variance				
$Stress_{int}$with $Stress_{tx\ slp}$	-.552	.474	.244	-1.48, .377
$Stress_{int}$with $Stress_{ptx\ slp}$	-.077	.150	.465	-.282, .129
$Stress_{tx\ slp}$with $Stress_{ptx\ slp}$	-.097	.064	.129	-.223, .028
Variance				
$Stress_{int}$	3.54	1.04	.001	1.51, 5.57
$Stress_{slp}$	.943	.330	.004	.295, 1.59
$Stress_{ptx\ slp}$	.098	.024	.000	.050, .145
Fit Statistics				
-2LL	4223.0			
AIC	4255.0			
BIC	4293.1			
df	16			
CFI	.746			
TLI	.779			
RMSEA	.16			
χ^2	455.6			

Craving: Treatment Effect on Craving Using Multi-Group Modeling

While the prior models (e.g., time invariant predictor) indicate a significant effect for individuals assigned to the experimental group, these models cannot determine if the slopes are actually different for experimental and control groups. To test differences in slopes across randomized groups, a series of multi-group models were estimated. In particular, a taxonomy of models were estimated for the overall trajectory (e.g., across both treatment and post-treatment phases) as well as for a bilinear spline model. Within both of these growth models five separate models (Model 1 – Model 5) were estimated to determine invariance across groups (e.g., invariance model, means model, means and co-variances model, means, co-variances, and residual variances, and the final model). Model fit was estimated using LRT test. The final model (Model 5) employs and constraints needed based on LRT tests across the first four models. The MODEL TEST command was used to assess differences in craving slopes across groups (MRBP and TAU). Table 21 displays results of the multi-group model for overall craving trajectories. There was significantly better model fit ($\Delta - 2LL = 30.8, \Delta\, df = 3, p < .001$) for Model 2 (means model) compared to Model 1 (invariance model) indicating significant differences in average trajectories. The significant LRT results in Model 3 ($\Delta - 2LL = 34.0, \Delta\, df = 6, p < .001$) indicates significant between person variability and co-variability in the growth parameters. Finally, the significant LRT result in Model 4 ($\Delta - 2LL = 65.5, \Delta\, df = 1, p < .001$) indicates significant unexplained within person variability in craving over time. Model 5 represents the final model, which is simply replicated from model 4 as all parameters were allowed to be freely estimated. Results indicate a significant linear decrease in craving for individuals assigned to MRBP ($b = -.556, SE = .087, p < .001$) and a significant

deceleration for the quadratic term ($b = .038, SE = .007, p < .001$). Conversely, there was a non-significant linear slope in craving for individuals assigned to TAU ($b = .231, SE = .148, p = .119$) and a non-significant quadratic effect ($b = -.010, SE = .011, p = .377$). Results from the Wald test of parameter constraints indicate a significant difference between groups for the linear slope ($Wald\ \chi^2 = 20.9\ , df = 1, p < .001$) and quadratic slope ($Wald\ \chi^2 = 13.3\ , df = 1, p < .001$). Figure 28 displays means and estimated trajectories for overall craving across individuals assigned to MRBP and TAU.

Mean differences across the four time points (baseline, treatment completion, mid-point (3 months), and study completion (6-months) were also assessed. For craving, no significant differences were found between individuals assigned to MRBP and TAU at baseline ($Wald\ \chi^2 = .734\ , df = 1, p = .392; Cohen's\ d = -.06, 95\%\ CI\ [-.50, .39]$). However, significant mean differences were found across groups at treatment completion ($Wald\ \chi^2 = 15.1\ , df = 1, p < .001;\ Cohen's\ d = -.94, 95\%\ CI\ [-1.40, -.47]$), mid-point ($Wald\ \chi^2 = 32.7\ , df = 1, p < .001;\ Cohen's\ d = -1.52, 95\%\ CI\ [-2.02, -1.01]$), and at study completion ($Wald\ \chi^2 = 4.41\ , df = 1, p = .036;\ Cohen's\ d = -.50, 95\%\ CI\ [-950, -.05]$).

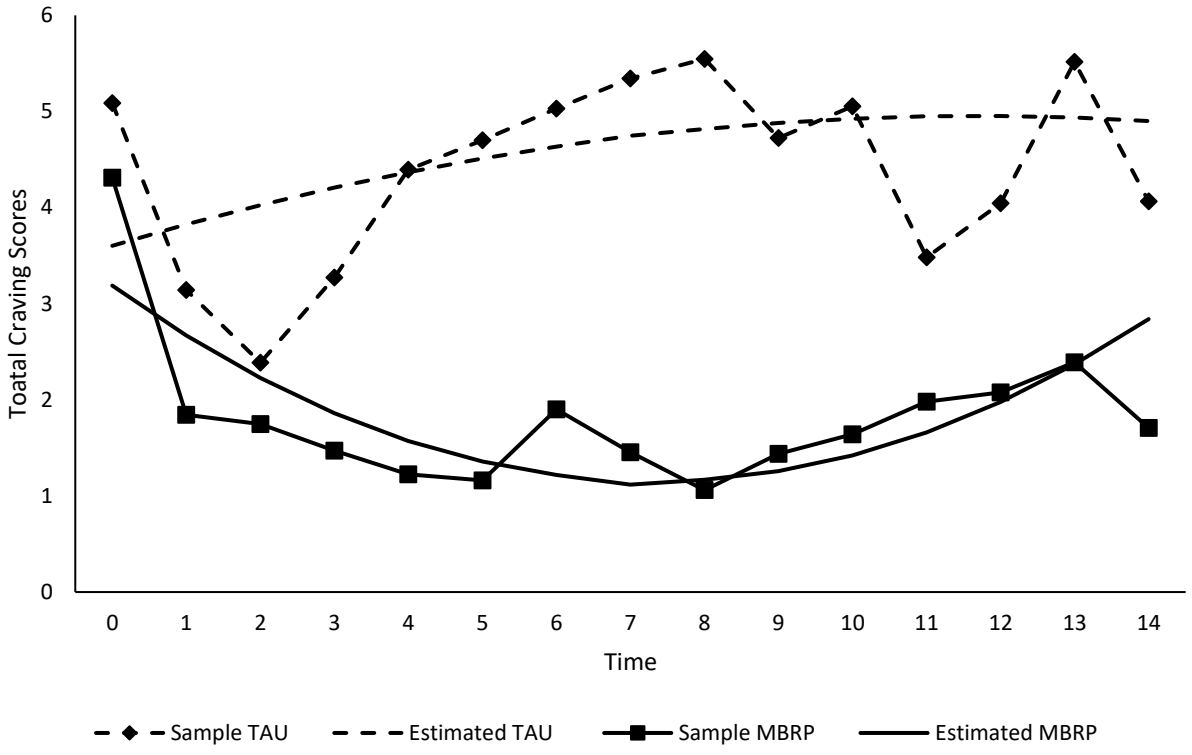


Figure 28. Craving means and estimated trajectories for multi-group growth modeling

Table 21. Multi-group model parameters and standard errors for craving trajectories by treatment assignment

	Model 1	Model 2	Model 3	Model 4	Model 5
MRBP					
$Crave_{int}$	3.35 (.241)*	3.18 (.320)*	3.18 (.336)*	3.19 (.333)*	3.19 (.333)*
$Crave_{slp}$	-.189 (.094)*	-.541 (.110)*	-.557 (.090)*	-.556 (.087)*	-.556 (.087)*
$Crave_{qad}$	.015 (.007)*	.037 (.008)*	.038 (.007)*	.038 (.007)*	.038 (.007)*
Residual (co) variance					
$Crave_{int}$with $Crave_{slp}$	.023 (.209)	-.082 (.192)	-.513 (.257)*	-.619 (.244)*	-.619 (.244)*
$Crave_{int}$with $Stress_{qad}$	-.009 (.015)	-.003 (.014)	.034 (.019)	.039 (.018)*	.039 (.018)*
$Crave_{qad}$with $Stress_{slp}$	-.029 (.008)*	-.020 (.006)*	-.009 (.005)	-.013 (.005)*	-.013 (.005)*
Variance					
$Crave_{int}$	2.77 (.743)*	2.77 (.743)*	3.62 (1.07)*	3.79 (1.05)*	3.79 (1.05)*
$Crave_{slp}$	.437 (.113)*	.291 (.086)*	.129 (.074)	.181 (.069)*	.181 (.069)*
$Crave_{qad}$	.002 (.001)*	.002 (.001)*	.002 (.001)*	.001 (.0001)*	.001 (.0001)*
TAU					
$Crave_{int}$	3.35 (.241)*	3.60 (.365)*	3.61 (.353)*	3.60 (.350)*	3.60 (.350)*
$Crave_{slp}$	-.189 (.094)*	.244 (.127)	.235 (.148)	.231 (.148)	.231 (.148)
$Crave_{qad}$	.015 (.007)*	-.012 (.010)	-.010 (.011)	-.010 (.011)	-.010 (.011)
Residual (co) variance					
$Crave_{int}$with $Crave_{slp}$	.023 (.209)	-.082 (.192)	.328 (.308)	.587 (.307)	.587 (.307)
$Crave_{int}$with $Crave_{qad}$	-.009 (.015)	-.003 (.014)	-.043 (.023)	-.057 (.022)*	-.057 (.022)*
$Crave_{qad}$with $Crave_{slp}$	-.029 (.008)*	-.020 (.006)*	-.031 (.013)*	-.023 (.013)	-.023 (.013)
Variance					
$Crave_{int}$	2.77 (.743)*	2.77 (.743)*	2.54 (1.06)*	1.44 (1.06)	1.44 (1.06)
$Crave_{slp}$	.437 (.113)*	.291 (.086)*	.481 (.179)*	.369 (.178)*	.369 (.178)*
$Crave_{qad}$	.002 (.001)*	.002 (.001)*	.002 (.012)*	.002 (.001)*	.002 (.001)*
Fit Indices					

Table 21. (cont.)					
-2LL	4269.4	4269.4	4204.7	4139.3	4139.3
AIC	4289.4	4264.7	4242.7	4179.3	4179.3
BIC	4313.3	4295.6	4288.0	4226.9	4226.9
df	10	13	19	20	20
$\Delta Parameters$					
$\Delta - 2LL$		30.8	34.0	65.5	6.8
$\Delta\, df$		3	6	1	6
LRT		.000	.000	.000	.34

Note:
Model 5 is the final model with variances and co-variances constrained to be equal across groups (based on Results from LRT M3 versus M2) and group varying intercepts, slopes, and residuals. Results of the LRT Indicate a non-significant increase in -2LL, indicating model fit is not significantly worse than a model with Group varying variances and co-variances.

Table 22 displays results of the multi-group model for the bilinear spline model for craving trajectories. There was significantly better model fit ($\Delta - 2LL = 27.9, \Delta\, df = 3, p = .001$) for Model 2 (means model) compared to Model 1 (invariance model) indicating significant differences in average trajectories. The non-significant LRT results in Model 3 ($\Delta - 2LL = 38.4, \Delta\, df = 6, p = .000$) indicates limited between person variability and co-variability in the growth parameters. However, the significant LRT result in Model 4 ($\Delta - 2LL = 63.0, \Delta\, df = 1, p = .019$) indicates significant unexplained within person variability in craving over time. Model 5 represents the final model which is a replication of Model 4 as all parameters were allowed to vary freely across groups. Results indicate a significant decrease in craving for individuals assigned to MRBP during the treatment phase ($b = -1.42, SE = .178, p < .001$) but a non-significant (slowing of the deceleration) effect during the post-treatment phase ($b = .065, SE = .041, p = .114$). Conversely, there was a significant decrease in craving for individuals assigned to TAU during the treatment phase ($b = -.585, SE = .288, p = .042$) and a significant increase in craving during the post-treatment phase ($b = .212, SE = .087, p < .014$). Results from the Wald test of parameter constraints indicate a significant difference between groups during the treatment phase ($Wald\ \chi^2 = 6.14\,, df = 1, p = .013$) however a non-significant difference during the post-treatment phase ($Wald\ \chi^2 = 2.34\,, df = 1, p = .127$). Figure 29 displays means and estimated trajectories for overall craving across individuals assigned to MRBP and TAU.

Table 22. Multi-group model parameters and standard errors for bilinear spline craving trajectories by treatment assignment

	Model 1	Model 2	Model 3	Model 4	Model 5
MRBP					
$Crave_{int}$	4.34 (.285)*	4.05 (.377)*	4.05 (.394)*	4.05 (.395)*	4.05 (.395)*
$Crave_{TXslp}$	-1.04 (.167)*	-1.40 (.214)*	-1.45 (.177)*	-1.42 (.178)*	-1.42 (.178)*
$Crave_{PTX\ slp}$	.132 (.044)*	.062 (.056)	.071 (.041)	.065 (.041)	.065 (.041)
Residual (co) variance					
$Crave_{int}$ with $Crave_{TXslp}$	-.421 (.484)	-.555 (.474)	-1.08 (.607)	-1.56 (.604)*	-1.56 (.604)*
$Crave_{int}$ with $Crave_{PTX\ slp}$	-.042 (.108)	-.075 (.10)	-.013 (.103)	-.018 (.105)	-.018 (.105)
$Crave_{TX\ slp}$ with $Crave_{PTXslp}$	-.068 (.067)	-.098 (.065)	.002 (.046)	-.029 (.048)	-.029 (.048)
Variance					
$Crave_{int}$	3.64 (1.05)*	3.54 (1.04)*	4.15 (1.49)*	5.17 (1.49)*	5.17 (1.49)*
$Crave_{TXslp}$	1.11 (.357)*	.940 (.331)*	.315 (.293)	.760 (.298)*	.760 (.298)*
$Crave_{PTX\ slp}$	.103 (.026)*	.099 (.024)*	.038 (.015)*	.048 (.016)*	.048 (.016)*
TAU					
$Crave_{int}$	4.34 (.285)*	4.74 (.428)*	4.72 (.406)*	4.71 (.403)*	4.71 (.403)*
$Crave_{TXslp}$	-1.04 (.167)*	-.585 (.245)*	-.606 (.288)*	-.585 (.288)*	-.585 (.288)*
$Crave_{PTX\ slp}$	.132 (.044)*	.204 (.067)*	.240 (.092)*	.212 (.087)*	.212 (.087)*
Residual (co) variance					
$Crave_{int}$ with $Crave_{TXslp}$	-.421 (.484)	-.555 (.474)	-.018 (.744)	-.787 (.759)	-.787 (.759)
$Crave_{int}$ with $Crave_{PTX\ slp}$	-.042 (.108)	-.075 (.10)	-.150(.216)	-.155 (.199)	-.155 (.199)
$Crave_{PTXslp}$ with $Crave_{TXslp}$	-.068 (.067)	-.098 (.065)	-.242 (.164)	-.176 (.152)	-.176 (.152)
Variance					
$Crave_{int}$	3.64 (1.05)*	3.54 (1.04)*	2.89 (1.40)*	1.32 (1.43)	1.32 (1.43)
$Crave_{TXslp}$	1.11 (.357)*	.940 (.331)*	1.74 (.695)*	1.14 (.699)	1.14 (.699)
$Crave_{PTX\ slp}$	.103 (.026)*	.099 (.024)*	.226 (.075)*	.169 (.065)*	.169 (.065)*
Fit Indices					

Table 22. (cont.)					
-2LL	4252.1	4224.2	4185.8	4122.8	4122.8
AIC	4272.1	4250.2	4223.8	4162.8	4162.8
BIC	4295.9	4281.2	4269.0	4210.4	4210.4
df	10	13	19	20	20
$\Delta Parameters$					
$\Delta - 2LL$		27.9	38.4	63.0	
$\Delta\, df$		3	6	1	
LRT		.000	.000	.000	

Model 5 is the final model with variances and co-variances constrained to be equal across groups (based on Results from LRT M3 versus M2) and group varying intercepts, slopes, and residuals. Results of the LRT Indicate a non-significant increase in -2LL, indicating model fit is not significantly worse than a model with Group varying variances and co-variances.

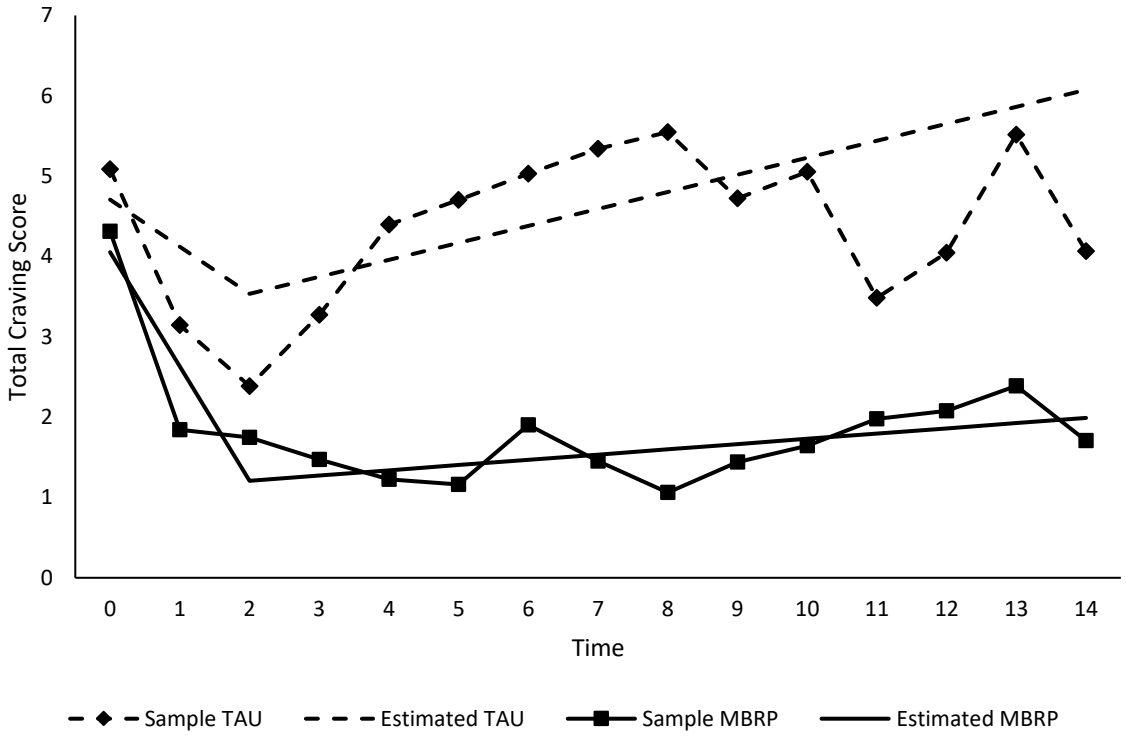


Figure 29. Craving means and estimated trajectories for the multi-group bilinear spline model

Craving: Multi-Level Modeling

As a robustness check the effect of treatment on craving was also assessed using a multi-level modeling framework. Unconditional growth models revealed an Inter Class Correlation of .488 indicating that 49% of the variance in craving is retained in the between-person level and 51% at the within-person level. An LRT test was conducted to determine if a random slope was needed. Results indicate a significant reduction in -2 log likelihood ($\Delta - 2LL = 78.5, \Delta\, df = 2, p < .001$), indicating a random slope fits the data better than a model with a fixed slope. In the final model, treatment assignment, days in residential facility, and days not in the community

were entered into the model. Results indicate a significant effect of treatment on the slope of craving ($b = -.277, SE = .064, p < .001$). This means individuals assigned to MBRP had significantly lower craving over the study period compared to individuals assigned to TAU, thus replicating our latent growth model results.

Substance Use

Because participants were in a controlled facility during the first four weeks of the study (treatment phase) it was assumed there would be little to no variance in the substance use variables. While some participants did report substance use within these time points (n = 3), our assumption was confirmed when attempting to model substance use using the first two time points following the baseline assessment. Specifically, an error indicating a zero variance was displayed for both time points 1 and 2. Thus, our analyses for substance use when using latent growth modeling assessed post-treatment substance use only. However, when assessing substance use using a survival function, all time points after the initial baseline assessment were used. Each model in the latent growth and survival models controlled for the number of days each participant spent in the residential facility as well as number of days not in the community over time. No bilinear spline models were run for substance use given data from post-treatment are being analyzed.

Substance use: Basic Growth Models for Overall Sample

Table 23 displays fit statistics for a linear growth model for substance use across the entire sample. Results indicate a model with random intercept, linear growth, quadratic growth fit the data best ($\Delta - 2ll = 66.2, df = 4, p < .001$). Table 24 displays parameter estimates and standard errors for all three models. Focusing on Model 3, we can see that there is an overall

significant increase in substance use (linear slope b = 2.09, SE = .436, p < .000) and a significant slowing of the acceleration (quadratic slope b = -.130, SE = .043, p = .002).

Table 23. Model fit statistics for overall substance use linear latent growth model

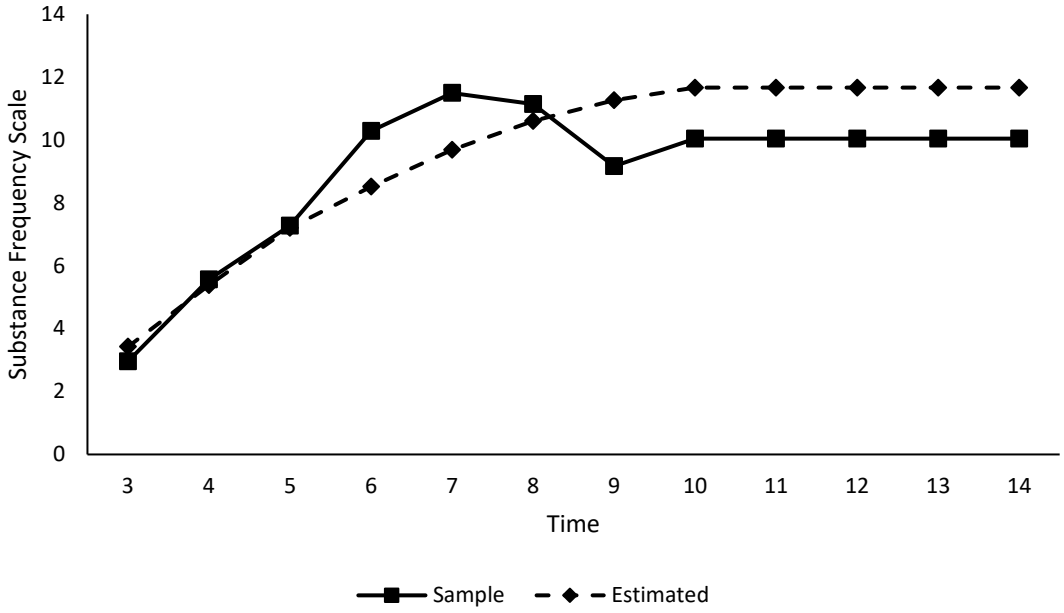
	Model 1	Model 2	Model 3
Parameters			
-2LL	5066.0	4977.8	4911.6
AIC	5076.0	4989.8	4931.6
BIC	5087.8	5003.9	4955.1
df	5	6	10
$\Delta Parameters$			
$\Delta - 2LL$		88.3	66.2
$\Delta\, df$		1	4
LRT		.000	.000

Note: Model 1 is a random intercept and fixed slope model with constrained residual variances
Model 2 is a random intercept, random linear slope and constrained residual variances
Model 3 random intercept, random linear slope, random quadratic slope, constrained residual variance

Table 24. Model parameters and standard errors for overall substance use linear latent growth model

	Model 1	Model 2	Model 3
$SubUse_{int}$	5.45 (1.07)*	4.99 (1.07)*	3.42 (.919)*
$SubUse_{slp}$	.721 (.091)*	.903 (.182)*	2.09 (.436)*
$SubUse_{qad}$			-.130 (.043)*
Residual (co) variance			
$SubUse_{int}$with $SubUse_{slp}$	1.26 (.491)*	-1.20 (1.86)	7.45 (3.76)*
$SubUse_{int}$with $SubUse_{qad}$			-.973 (.362)*
$SubUse_{qad}$with $SubUse_{slp}$			-.757 (.243)*
Variance			
$SubUse_{int}$	68.3 (14.5)*	71.8 (14.8)*	40.8 (11.2)*
$SubUse_{slp}$	.000 (.000)	1.68 (.438)*	8.63 (2.52)*
$SubUse_{qad}$			.079 (.025)*

Figure 30. Estimates and sample means for substance use across entire study sample.



Substance use: Treatment Effect on Substance use Using Time Invariant Predictor Model

As an initial step in determining the effect of MBRP on substance use over time, latent growth models with a time invariant treatment predictor were estimated. This model controlled for the number of days each participant spent at the inpatient facility, baseline substance use scores, and no community time. Table 25 presents results from the basic latent linear growth model for the effect of treatment on substance use during the post-treatment phase. Results indicate a significant treatment effect on the linear ($b = -3.28, SE = .768, p < .001$) and quadratic ($b = .257, SE = .080, p < .001$) slope for substance use. Put differently, individuals assigned to MBRP had significant decreases in substance use over the study period compared to individuals assigned to TAU. Figure 31 displays mean substance use scores for individuals assigned to MBRP and TAU.

Table 25. Treatment effects on latent substance use trajectories.

	B	SE	P	95% CI
$SubUse_{int}$	10.4	2.26	.000	5.98, 14.8
$SubUse_{slp}$	3.08	.984	.002	1.15, 5.00
$SubUse_{qad}$	-.255	.101	.011	-.452, -.057
$SubUse_{int}$ on MBRP	-6.34	1.73	.000	-9.72, -2.98
$SubUse_{slp}$ on MBRP	-3.28	.768	.000	-4.79, -1.78
$SubUse_{qad}$ on MBRP	.257	.080	.001	.101, .414
Residual (co) variance				
$SubUse_{int}$with $SubUse_{slp}$	.717	3.10	.817	-5.35, 6.79
$SubUse_{int}$with $SubUse_{qad}$	-.437	.301	.147	-1.03, .154
$SubUse_{qad}$with $SubUse_{slp}$	-.462	.172	.007	-.799, -.125
Variance				
$SubUse_{int}$	28.8	9.01	.001	11.2, 46.5
$SubUse_{slp}$	4.94	1.71	.005	1.50, 8.19
$SubUse_{qad}$	.056	.019	.003	.018, .093
Fit Statistics				
-2LL	4838.4			
AIC	4882.4			
BIC	4864.8			
df	22			
CFI	.747			
TLI	.751			
RMSEA	.14			
χ^2	290.8			

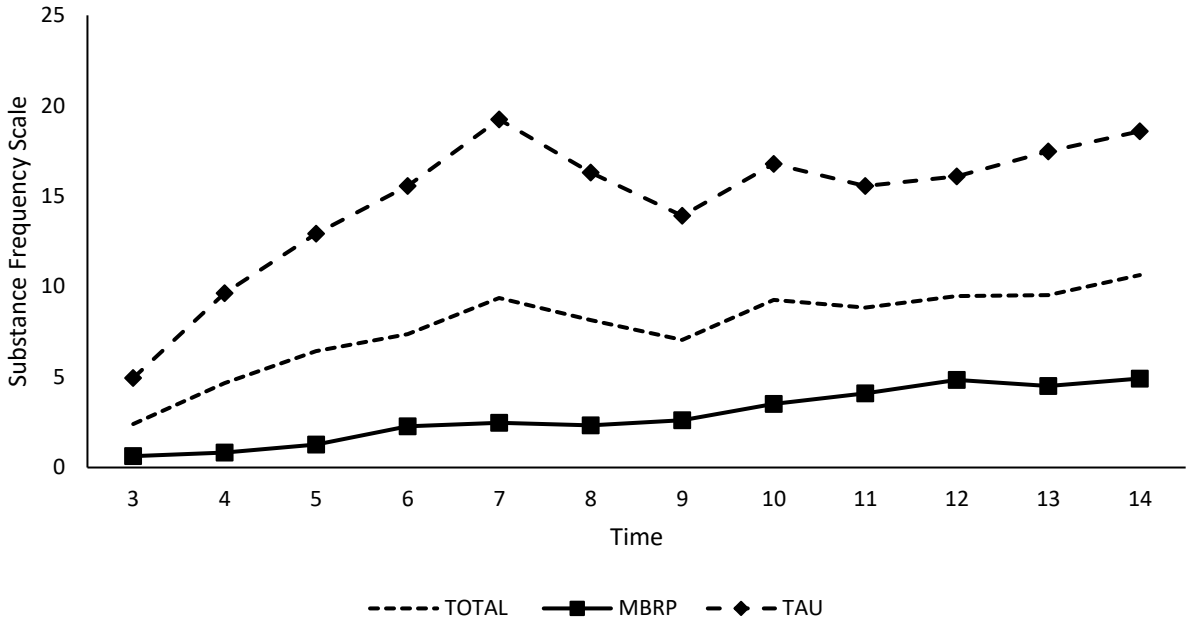


Figure 31. Mean substance use scores for individuals assigned to MBRP, TAU, and the total mean scores.

Substance use: Treatment Effect on Substance use Using Multi-Group Modeling

While the prior models (e.g., time invariant predictor) indicate a significant effect for individuals assigned to the experimental group, these models cannot determine if the slopes are actually different for experimental and control groups. To test differences in slopes across randomized groups, a series of multi-group models were estimated. In particular, a taxonomy of models was estimated for the overall trajectory (e.g., post-treatment phases). Five separate models (Model 1 – Model 5) were estimated to determine invariance across groups (e.g., invariance model, means model, means and co-variances model, means, co-variances, and residual variances, and the final model). Model fit was estimated using LRT test. The final model (Model 5) employs any constraints needed based on LRT tests across the first four models. The MODEL TEST command was used to assess differences in substance use slopes across groups

(MRBP and TAU). Table 26 displays results of the multi-group model for substance use trajectories. There was significantly better model fit ($\Delta - 2LL = 60.4, \Delta\, df = 3, p < .001$) for Model 2 (means model) compared to Model 1 (invariance model) indicating are significant differences in average trajectories. The significant LRT results in Model 3 ($\Delta - 2LL = 103.9, \Delta\, df = 6, p < .001$) indicates significant between person variability and co-variability in the growth parameters. Finally, the significant LRT result in Model 4 ($\Delta - 2LL = 90.,8, \Delta\, df = 1, p < .001$) indicates significant unexplained within person variability in substance use over time. Model 5 represents the final model, which is simply replicated from model 4 as all parameters were allowed to be freely estimated. Results indicate a non-significant linear increase in substance use for individuals assigned to MRBP ($b = .406, SE = .388, p = .295$) and a non-significant acceleration for the quadratic term ($b = .003, SE = .042, p = .945$). Conversely, there was a significant linear increase in substance use for individuals assigned to TAU ($b = 4.10, SE = .784, p < .001$) and a significant deceleration in substance use from the quadratic effect ($b = -.292, SE = .078, p < .001$). Results from the Wald test of parameter constraints indicate a significant difference between groups for the linear slope ($Wald\ \chi^2 = 17.8\,, df = 1, p < .001$) and quadratic slope ($Wald\ \chi^2 = 11.0\,, df = 1, p < .001$). Figure 32 displays means and estimated trajectories for substance use across individuals assigned to MRBP and TAU during the post-treatment phase.

Mean differences across the three of the four selected time points (treatment completion, mid-point (3 months), and study completion (6-months)) were also assessed. Baseline was not assessed as it is used as a control variable in the growth models given the first two time points have zero variance and cannot be modeled. For substance use, significant mean differences were found across groups at treatment completion ($Wald\ \chi^2 = 11.3\,, df = 1, p <$

.001; $Cohen's\ d = -.81, 95\%\ CI\ [-1.28, -.35]$), mid-point ($Wald\ \chi^2 = 11.2\ , df = 1, p =$ .001; $Cohen's\ d = -2.1, 95\%\ CI\ [-2.7, -1.59]$), and at study completion ($Wald\ \chi^2 = 11.5\ , df = 1, p =$ .001; $Cohen's\ d = -1.80, 95\%\ CI\ [-2.3, 1.27]$).

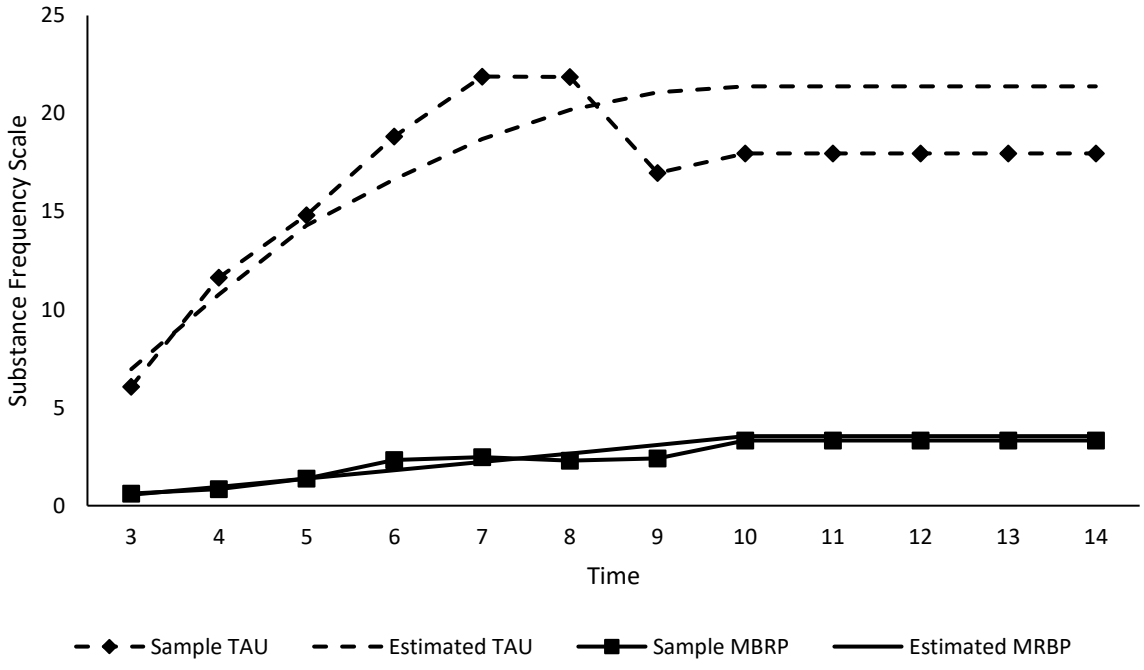


Figure 32. Substance use means and estimated trajectories for multi-group growth modeling

Table 26. Multi-group model parameters and standard errors for substance use trajectories by treatment assignment

	Model 1	Model 2	Model 3	Model 4	Model 5
MRBP					
$SubUse_{int}$	3.42 (.919)*	.604 (1.11)	.538 (.667)	.557 (.512)	.557 (.512)
$SubUse_{slp}$	2.09 (.436)*	.426 (.489)	.357 (.502)	.406 (.388)	.406 (.388)
$SubUse_{qad}$	-.130 (.043)*	-.002 (.050)	.012 (.054)	.003 (.042)	.003 (.042)
Residual (co) variance					
$SubUse_{int}$with $SubUse_{slp}$	7.45 (3.76)*	1.20 (3.21)	-5.85 (1.81)*	-2.72 (1.07)*	-2.72 (1.07)*
$SubUse_{int}$with $SubUse_{qad}$	-.973 (.362)*	-.529 (.313)	.786 (.228)*	.368 (.133)*	.368 (.133)*
$SubUse_{qad}$with $SubUse_{slp}$	-.757 (.243)*	-.502 (184)*	-.721 (.255)*	-.428 (.042)*	-.428 (.042)*
Variance					
$SubUse_{int}$	40.8 (11.2)*	31.3 (9.46)*	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
$SubUse_{slp}$	8.63 (2.52)*	5.27 (1.83)*	6.49 (2.33)*	3.87 (1.32)*	3.87 (1.32)*
$SubUse_{qad}$	.079 (025)*	.061 (.020)*	.081 (.029)*	.050 (.017)*	.050 (.017)*
TAU					
$SubUse_{int}$	3.42 (.919)*	7.03 (1.32)*	6.85 (.1.98)*	6.96 (1.98)*	6.96 (1.98)*
$SubUse_{slp}$	2.09 (.436)*	4.08 (.598)*	4.33 (.828)*	.4.10 (784)*	.4.10 (784)*
$SubUse_{qad}$	-.130 (.043)*	-.295 (.063)*	-.319 (.084)*	-.292 (078)*	-.292 (078)*
Residual (co) variance					
$SubUse_{int}$with $SubUse_{slp}$	7.45 (3.76)*	1.20 (3.21)	5.50 (10.3)	.548 (9.94)	.548 (9.94)
$SubUse_{int}$with $SubUse_{qad}$	-.973 (.362)*	-.529 (.313)	-.908 (.964)	-1.25 (.905)	-1.25 (.905)
$SubUse_{qad}$with $SubUse_{slp}$	-.757 (.243)*	-.502 (184)*	1.34 (.588)*	-.791 (.475)	-.791 (.475)
Variance					
$SubUse_{int}$	40.8 (11.2)*	31.3 (9.46)*	102.9 (32.2)*	85.3 (32.8)*	85.3 (32.8)*
$SubUse_{slp}$	8.63 (2.52)*	5.27 (1.83)*	15.4 (5.84)*	9.60 (5.00)	9.60 (5.00)
$SubUse$	.079 (025)*	.061 (.020)*	.147 (.065)*	.091 (.051)	.091 (.051)
Fit Indices					

Table 26. (cont.)				
-2LL	4911.6	4851.1	4747.2	4656.4
AIC	4931.6	4877.1	4783.2	4696.4
BIC	4955.1	4907.8	4825.6	4680.5
df	10	13	18	20
$\Delta Parameters$				
$\Delta - 2LL$		60.4	103.9	90.8
$\Delta\, df$		3	5	2
LRT		.000	.000	.000

Substance use: Multi-Level Modeling

As a robustness check the effect of treatment on substance use was also assessed using a multi-level modeling framework. Unconditional growth models revealed an Intraclass Correlation of .561 indicating that 56% of the variance in substance use is retained in the between-person level and 44% at the within-person level. An LRT test was conducted to determine if a random slope was needed. Results indicate a significant reduction in -2 log likelihood ($\Delta - 2LL = 94.6, \Delta\, df = 2, p < .001$), indicating a random slope fits the data better than a model with a fixed slope. In the final model, treatment assignment, days in residential facility, and days not in the community were entered into the model. Results indicate a significant effect of treatment on the slope of substance use ($b = -1.85, SE = .365, p < .001$). This means individuals assigned to MBRP had significantly lower substance use over the study period compared to individuals assigned to TAU, thus replicating our latent growth model results.

Substance Use: Survival Analysis

To assess relapse (e.g., time to first use after entering treatment) a survival model was estimated. Specifically, data were set up to assess time to first use following baseline assessment using a continuous time survival analysis. Three separate models were estimated: 1) time to use across all substances, 2) time to first alcohol or heavy drinking episode, and 3) time to first illicit drug use. The model controlled for baseline levels of use, number of days spent in the inpatient facility, and number of days each participant was not residing in the community. Figure 33 displays the failure curves for time to first use across all substances, Figure 34 for alcohol or heavy/binge drinking, and Figure 35 illicit drug use. While both groups have increasing rates of

relapse over time, those assigned to TAU (compared to MRBP) have a much steeper incline in risk of relapse following baseline assessment. For example, failure trends were significantly different between those assigned to MRBP versus TAU based on the log-rank chi-square statistic for any substance use ($log-rank\ \chi^2 = 23.9, df = 1, p < .001$), alcohol or heavy/binge drinking ($log-rank\ \chi^2 = 31.5, df = 1, p < .001$), and illicit drug use ($log-rank\ \chi^2 = 27.6, df = 1, p < .001$). This trend was replicated in the multivariate Cox proportional hazard regression model. In particular, individuals assigned to MBRP had a 64% (*Hazard Ratio* = .351, 95% CI[.190, .645]) decrease in the risk of relapse to drug or alcohol use, 54% (*Hazard Ratio* = .456, 95% CI[.235, .687]) decrease in the risk of relapse to alcohol or heavy (binge) drinking, and a 56% (*Hazard Ratio* = .436, 95% CI[.238, .797]) decrease in the risk of relapse to illicit drug use compared to individuals assigned to TAU.

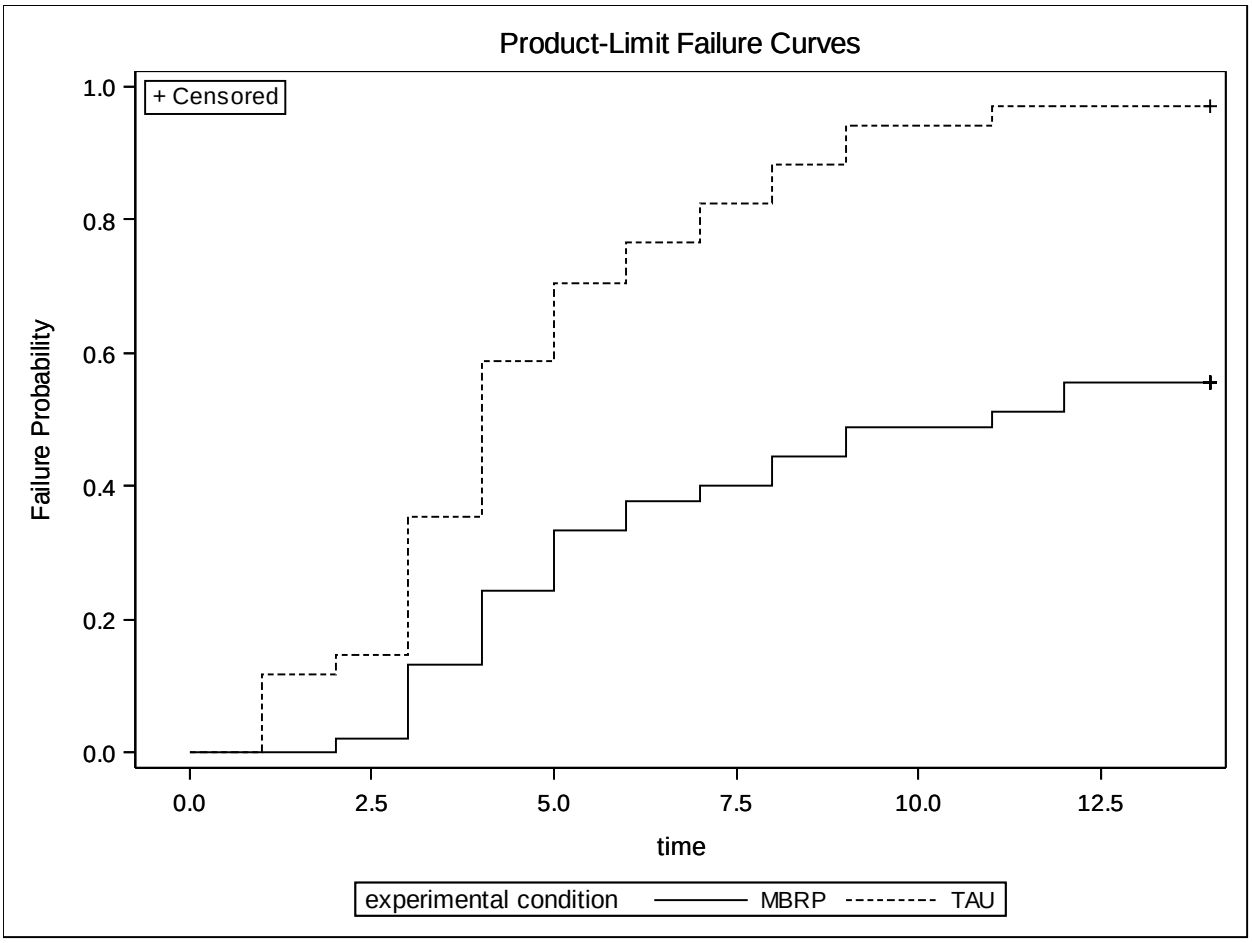


Figure 33. Failure curves from survival analysis across all substances. MBRP = mindfulness based relapse prevention. TAU = treatment as usual

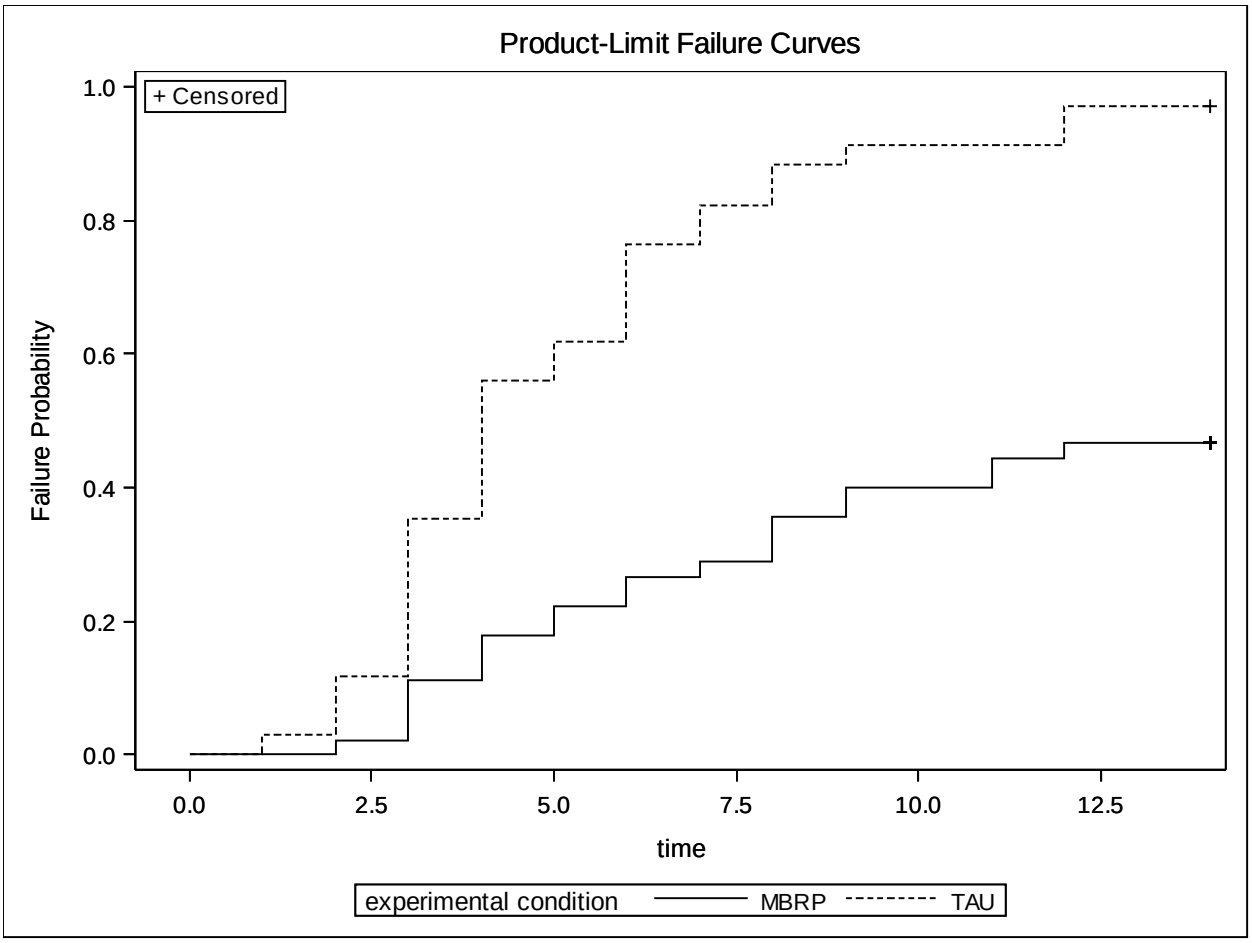


Figure 34. Failure curves from survival analysis for alcohol or binge drinking episode.

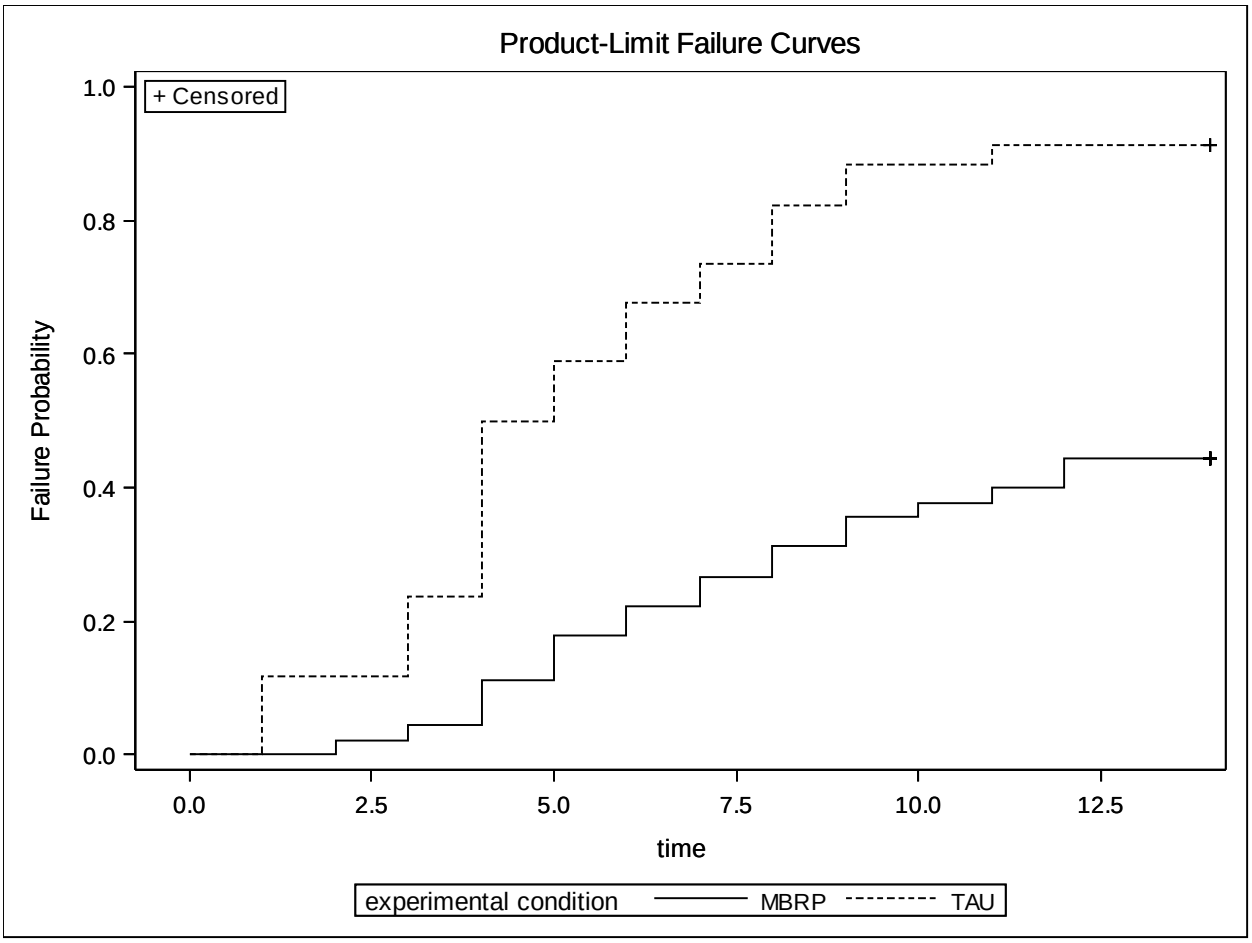


Figure 35. Failure curves for survival analysis for illicit drug use.

Mediation Models

To assess if reductions in stress mediated the association between treatment assignment (MBRP vs. TAU) and craving or substance use a series of models were estimated. First, a model based approach was used where the slopes for both stress and substance use or craving were estimated using latent growth models. Specifically, the exogenous variable for treatment assignment was regression both stress (a path) and substance use and craving (c path). Further, the stress slope was regressed on the slope for substance use and craving (b path). All intercepts were allowed to covary. The MODEL INDIRECT function was used to assess if there was a significant indirect effect from treatment assignment to the outcome of interest (e.g., substance

use or craving) through changes in stress. Second, latent growth models were estimated for stress, substance use, and craving. Using the SAVEDATA command, the factor scores were saved and used in a bootstrapped mediation model (Preacher & Hayes, 2004). This method is parallel to a Sobel test (Hayes, 2009), but has the advantage of using bootstrapped confidence intervals. Models were estimated using standardized factor scores.

Table 27 presents results for the model based latent growth mediation model for craving and substance use. Results for craving indicate a significant indirect effect for stress between treatment assignment and craving ($indirect\ effect = -.126, SE = .065, 95\%\ CI\ [-.254, -.001]$). Using the standardized results ($standarized\ indirect\ effect = -.288, SE = .146, 95\%\ CI\ [-.537, -.003]$) we can conclude that craving is expected to decrease by .28 standard deviations for individuals assigned to MBRP (compared to TAU) via decreases in stress. Figure 36 depicts the model based indirect effect for craving.

Table 27. Model based approach for mediation

	Model 1 Craving			Model 2 Substance Use		
	Parameter (SE)	*p-value*	*95% CI*	Parameter (SE)	*p-value*	*95% CI*
A path	-.422 (.193)	.022	-.820, -.064	-.608 (.180)	.001	-.961, -.256
B path	.285 (.103)	.006	.082, .487	1.28 (.409)	.002	.480, 2.09
C' path	-.053 (.081)	.510	-.212, .105	.314 (.338)	.353	-.348, .967
Total effect	-.179 (.066)	.007	-.309, -.050	-.467 (.398)	.241	-1.24, .313
Indirect effect	-.126 (.065)	.050	-.254, .001	-.780 (.340)	.022	-1.45, -.114

Results were replicated in the bootstrapped approach using extracted factor scores. Table 28 displays parameter estimates and 95% confidence intervals for the bootstrapped approach. For craving, a significant indirect effect was found ($indirect\ effect = -.560, SE =$

$.143, 95\%\ CI\ [-.892, -.316]$) indicating craving is expected to decrease by .56 standard deviations for individuals assigned to MBRP (versus TAU) via decreases in perceived stress. Figure 37 displays the bootstrapped mediation model. Results for substance use revealed a

Table 28. Bootstrapped factor score approach for mediation

	Model 1 Craving			Model 2 Substance Use		
	Parameter (SE)	*p-value*	*95% CI*	Parameter (SE)	*p-value*	*95% CI*
A path	-1.07 (.189)	.000	-1.43, -.717	-1.07 (.189)	.000	-.143, -.717
B path	.523 (.097)	.000	.351, .740	.011 (.132)	.933	-.239, .280
C' path	-.187 (.229)	.415	-.621, .286	-.484 (.265)	.067	-.994, .037
Total effect	-.746 (.223)	.001	-1.14, -.299	-.496 (.227)	.029	-.943, -.064
Indirect effect	-.560 (.143)	.000	-.892, -.316	-.012 (.143)	.933	-.343, .229

Significant indirect effect ($indirect\ effect = -.780, SE = .340, 95\%\ CI\ [-1.45, -.113]$). Using the standardized parameters ($indirect\ effect = -.449, SE = .173, 95\%\ CI\ [-.788, -.110]$) this indicates that substance use is expected to decrease by .45 standard deviations for individuals assigned to MRBP (versus TAU) via decreases in perceived stress (see Figure 38). These results were not replicated in the bootstrapped model (see Figure 39) such that a non-significant indirect effect was found ($indirect\ effect = -.012, SE = .143, 95\%\ CI\ [-.343,\ .229]$).

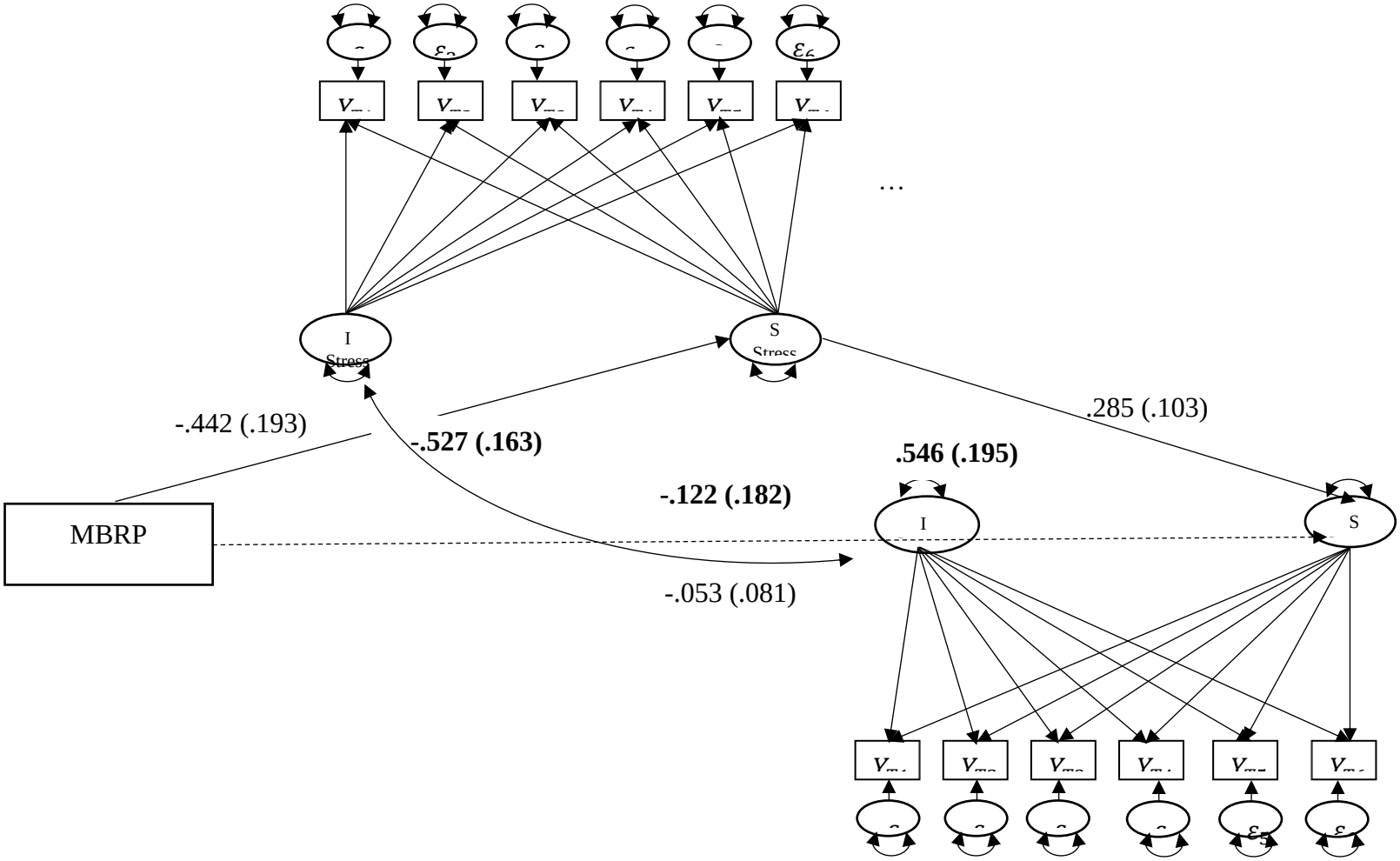


Figure 36. Model based latent growth mediation model for craving. Solid lines indicate significant path, dashed lines indicate non-significant path. Parameter (Standard Error) estimates that are not bold are unstandardized, bold parameter estimates (Standard Error) are in standardized units. Not all time points are displayed for ease of reading – all 15 time points were estimated in the model.

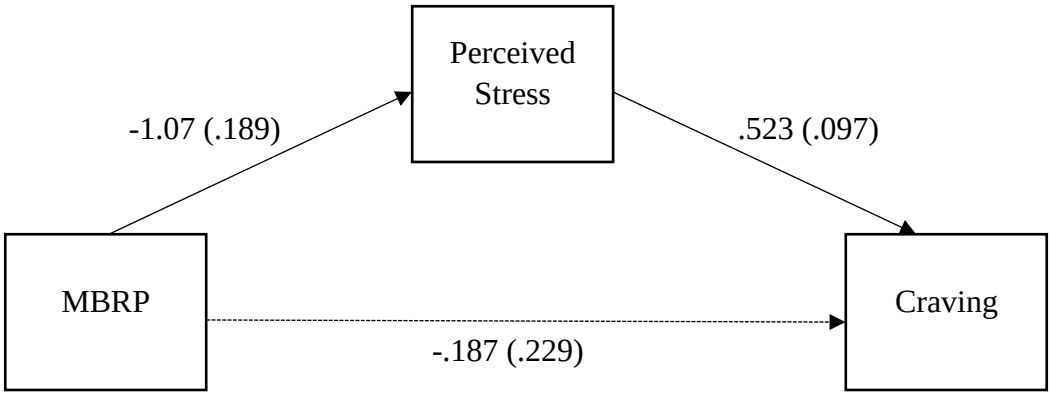


Figure 37. Factor score bootstrapped mediation model for craving. Solid lines indicate significant path, dashed lines indicate non-significant path. Parameter (Standard Error) estimates are in standardized units are factor scores were standardized prior to model estimation.

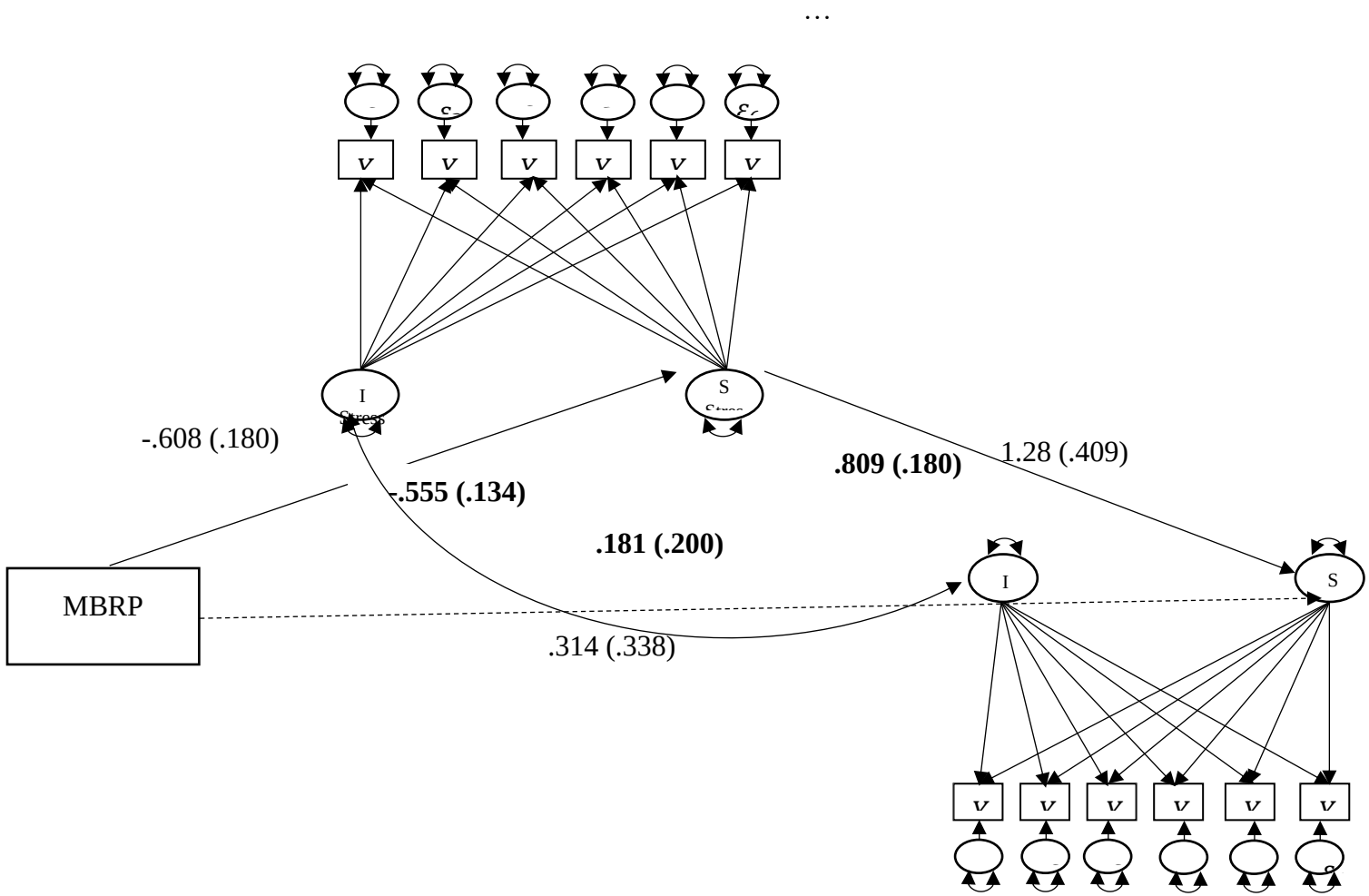


Figure 38. Model based latent growth mediation model for substance. Solid lines indicate significant path, dashed lines indicate non-significant path. Parameter (Standard Error) estimates that are not bold are unstandardized, bold parameter estimates (Standard Error) are in standardized units. Not all time points are displayed for ease of reading – all 15 time points were estimated in the model.

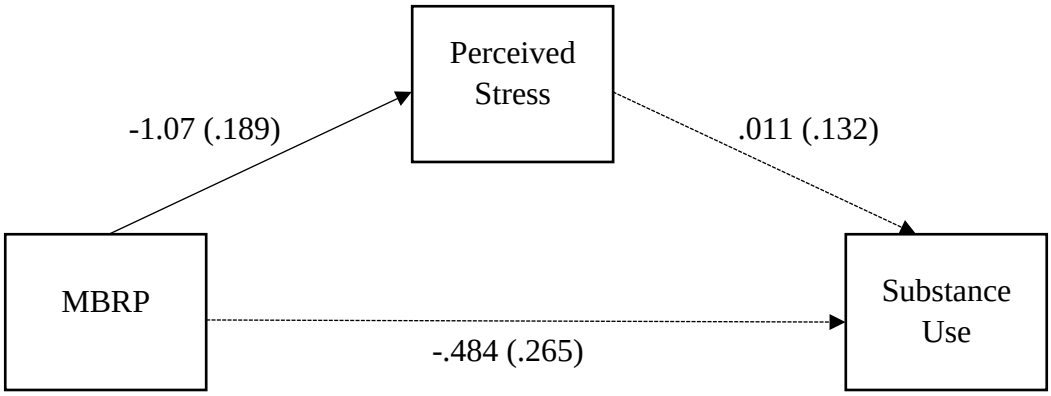


Figure 39. Factor score bootstrapped mediation model for substance use. Solid lines indicate significant path, dashed lines indicate non-significant path. Parameter (Standard Error) estimates are in standardized units are factor scores were standardized prior to model estimation. .

Given the preliminary results found above, that changes in stress act as a mechanism between treatment assignment and changes in substance use, several robustness checks were run. This was done because the mediation tested above ignores temporal order. That is, the measurement of stress, substance use, and craving are simultaneous making it difficult to determine if stress is actually a mechanism of change. Thus, additional models were run to assess the stability of stress as a mechanism.

First, the mediator and outcome variables were switched such that changes in substance use and craving were the acting mechanisms and changes in stress the outcome. Second, the centering point was moved for stress as the mechanism to the end of treatment and the mid-point of the study. Third, a bilinear spline approach was taken such that stress was split into change during

the treatment phase and change during the post treatment phase. The knot point remains at the end of treatment (same modeling approach as the bilinear spline models above). The indirect effects of interest are the effect of treatment on changes in stress during the treatment phase (*a* path) and the effect of changes in stress during the treatment phase on changes in both substance use and craving during the post-treatment phase (*b* path).

Results for models where the mediator and outcome were switched can be found in Table 29. When placing change in craving as the mediating construct, no evidence was found for an indirect effect between treatment assignment and changes in stress ($indirect\ effect = -.163, SE = .093, 95\%\ CI\ [-.345,\ .020]$). Similar results were found in the second model where changes in substance use was the mediating construct. That is, no indirect effect was found for substance use as the mechanism between treatment assignment and changes in stress ($indirect\ effect = -.012, SE = .143, 95\%\ CI\ [-.343,\ .229]$).

Table 29. Model based approach for mediation with substance use and craving as mediator

	Model 1 Craving Mediator			Model 2 Substance Use Mediator		
	Parameter (SE)	*p-value*	*95% CI*	Parameter (SE)	*p-value*	*95% CI*
A path	-.179 (.060)	.003	-.296, -.062	-.467 (.398)	.241	-1.25, .331
B path	.908 (.436)	.038	.052, 1.76	.381 (.109)	.000	.167, .595
C' path	-.279 (.145)	.054	-.563, .005	-.431 (.197)	.029	-.817, -.044
Total effect	-.442 (.144)	.002	-.725, -.160	-.608 (.180)	.001	-.817, -.293
Indirect effect	-.163 (.093)	.080	-.345, .020	-.178 (.172)	.302	-.458, .134

As a second check, stress was placed as the mediating construct but the centering point (the zero point) was placed at the end of treatment and the mid-point of the study. Results from the indirect effect models can be found in Table 30. When stress was centered at the mid-point, evidence of an indirect effect between treatment assignment and substance use via stress

remained ($indirect\ effect = -.529, SE = .270\ 95\%\ CI\ [1.066, -.008]$). Looking at the standardized indirect effect ($Standarized\ indirect\ effect = -.219$) individuals assigned to MBRP (versus TAU) are expected to reduce their substance use by .22 standard deviations via decreases in stress. When stress was centered at the end of treatment results were replicated such there was a significant indirect effect between treatment assignment and substance use via stress ($indirect\ effect = -.998, SE = .355, 95\%\ CI\ [-1.69, -.302]$). Looking at the standardized indirect effect ($Standarized\ indirect\ effect = -.359$) substance use is expected to decrease by .36 standard deviations via decreases in stress during the treatment phase for individuals assigned to MBRP versus TAU.

Table 30. Indirect effects for variations in centering slope of stress for substance use outcome

	Model 1 End of treatment			Model 2 Mid-point of study		
	Parameter (SE)	*p-value*	*95% CI*	Parameter (SE)	*p-value*	*95% CI*
A path	-.947 (.187)	.000	-1.31, -.581	-.832 (.185)	.000	-1.19, -.465
B path	1.05 (.304)	.001	.459 1.65	.636 (.291)	.029	.065, 1.20
C' path	-.509 (.393)	.195	-1.28, .261	-.758 (.368)	.039	-1.48, -.037
Total effect	-1.51 (.336)	.000	-.725, -.160	1.29 (.306)	.000	-1.89, -.688
Indirect effect	-.998 (.355)	.005	-.345, .020	-.529 (.270)	.049	-1.07, -.008

Results were consistent for craving when assessing variations in the centering point for stress. Table 31 displays results for craving. When stress was centered at the mid-point, there remained evidence of an indirect effect between treatment assignment and craving use via stress ($indirect\ effect = -.166, SE = .051\ 95\%\ CI\ [-.267, -.066]$). Looking at the standardized indirect effect ($Standarized\ indirect\ effect = -.540$) individuals assigned to MBRP (versus TAU) are expected to reduce their craving use by .54 standard deviations via decreases in stress. When stress was centered at the end of treatment results were replicated such there was a

significant indirect effect between treatment assignment and substance use via stress ($indirect\ effect = -.151, SE = .060\ 95\%\ CI\ [-.268, -.064]$). Looking at the standardized indirect effect ($Standarized\ indirect\ effect = -.511$) substance use is expected to decrease by .51 standard deviations via decreases in stress during the treatment phase for individuals assigned to MBRP versus TAU.

Table 31. Indirect effects for variations in centering slope of stress for craving outcome

	Model 1 End of treatment			Model 2 Mid-point of study		
	Parameter (SE)	*p-value*	*95% CI*	Parameter (SE)	*p-value*	*95% CI*
A path	-.868 (.168)	.000	-1.20, -.539	-.830 (.186)	.000	-1.20, -.464
B path	.174 (.061)	.004	.055, .292	.200 (.043)	.000	.117, .284
C' path	.092 (.067)	.195	-.038, .223	.074 (.052)	.159	-.029, .177
Total effect	-.058 (.050)	.224	-.156, -.040	-.092 (.049)	.059	-.188, .003
Indirect effect	-.151 (.060)	.0012	-.268, -.034	-.166 (.051)	.001	-.267, -.066

Results from the bilinear spline model, again, replicated prior mediation results. For substance use, there was a significant indirect effect for treatment assignment and changes in substance use. That is, for those assigned to MBRP changes in stress during the treatment phase fully mediated the association between treatment assignment and changes in substance use during the post-treatment phase ($indirect\ effect = 1.35, SE = .585\ 95\%\ CI\ [.206, 2.50]$). For craving, there was a significant indirect effect for treatment assignment and changes in craving. That is, for those assigned to MBRP changes in stress during the treatment phase fully mediated the association between treatment assignment and changes in craving during the post-treatment phase ($indirect\ effect = .676, SE = .344\ 95\%\ CI\ [.002, 1.35]$).

Mediated Moderation by Early Childhood Trauma

There was no support for the fifth hypothesis (H5) across both substance use and craving. That is, no evidence was found for a moderated mediation by childhood trauma. Given the two models tested above assessed latent change over the course of the study, secondary set of models were estimated using the bilinear spline modeling approach. Similar to the additional models run for the mediation results, the same models were used here with the addition of the latent variable and latent variable interaction for childhood trauma. In both of the bilinear spline models, again, no evidence for moderated mediation existed for substance use ($B_{latent\ interaction} = .597, SE = .600, 95\%\ CI\ [-1.77, .578]$) or craving ($B_{latent\ interaction} = -.406, SE = .557, 95\%\ CI\ [-1.50, .685]$).

Chapter 4: Discussion

Emerging adults represent about 10% (30,474,600) of the population in the United States (U.S. Census Bureau, 2016). While only comprising a small subset of individuals in the United States, emerging adults have the highest prevalence rate of alcohol use (58.3%), binge drinking (39%), and illicit drug use (22.3%) compared to adolescents and young adults (NSDUH, 2015). Naturally, this high prevalence rate also corresponds to high treatment admissions (10.5%) for substance use disorders (NSDUH, 2016). Not surprisingly, trajectories of lifetime use and misuse peak in emerging adulthood, to 49% among 19 – and 20- year-olds and 72% by age 27 (Johnston, O'Malley, Bachman, & Schulenberg, 2013; SAMHSA, 2015). Prior research has identified a myriad of risk factors associated with substance use and substance problems. For example, Stone and colleagues (2012) found that most of the risk factors in the adolescent substance use literature also pertain to emerging adulthood. Other researchers have assessed predictors of treatment entry across adolescence and young adulthood. For example, Davis and colleagues (2016) found youth with a diagnosis of PTSD had a 67% increase in the risk of entering treatment across adolescence and emerging adulthood. Over the past several decades stress has been posited to be one of the most prominent risk factors for substance use. Given emerging adulthood is a period of life riddled with change, transitions, and decision making – it is primed to be one of the most stressful periods of life. This may be particularly true for emerging adults who have experienced early life traumas such as childhood physical abuse, neglect, and emotional abuse.

Until recently, while emerging adults maintain the highest prevalence rate of substance use and substance related problems, few studies have focused on treatment outcomes among emerging adults (Davis, Smith, & Briley, 2017). This is particularly true for mindfulness based

interventions. In a recent meta-analysis investigating mindfulness interventions, only one study used an emerging adult population (Li et al., 2017), however this sample was comprised of college students. This is unfortunate as mindfulness based interventions have shown relatively strong effects for individuals with substance use disorders (Li et al., 2017). Further, mindfulness based interventions have been shown to influence both physiological and psychological stress (Li et al., 2017).

This randomized controlled trial represents the first study to investigate the effect of MBRP among a sample of emerging adults in residential substance use disorder treatment. Specifically, this study investigated the effect of MBRP on substance use, stress, and craving over a six month period. In line with recommendations from the Institute of Medicine, this trial also investigated treatment effects among at risk, or marginalized, emerging adults. For example, the median yearly salary among individuals in this study was $5,500 with the majority of participants reporting being unemployed (65%) and spending, on average, 40 days (out of the past 90) in jail prior to entering treatment. In addition to low income, participants in this sample also reported relatively high childhood trauma (average childhood trauma questionnaire score ~50) and an average age of 6.5 when the abuse/trauma began. Needless to say, our sample clearly fits the definition of being marginalized and meets several criteria outlined by the IOM.

Over the course of the study we found support for several of the proposed hypotheses. In particular, we found that assignment to MBRP (compared to TAU) was associated with lower rates of substance use (H1) during the post-treatment phase. Further, partial support was found for the second hypothesis (H2) such that individuals assigned to MBRP had significantly lower craving scores during the treatment phase, however no group differences were found during the

post-treatment phase (e.g., change trajectories) but significant differences were found at the level (e.g., mean differences across time at post treatment, midpoint of follow up, and end of follow up). In regards to the third hypothesis (H3) individuals assigned to MRBP had significantly lower stress trajectories during the treatment phase and post-treatment phase compared to individuals assigned to TAU. We found full support for our mediation hypotheses (H4) such that reductions in stress mediated the association between treatment assignment and both craving and substance use. Finally, no significant results were found for a moderated mediation (H5) by childhood trauma.

Substance Use and Craving Main Effects

This is the first study to assess the effect of MBRP on substance use and craving outcomes in a high-risk sample of emerging adults. In line with the first hypothesis (H1) results from this study found evidence for significant reductions in substance use for individuals assigned to MBRP. In particular, emerging adults assigned to MBRP had significant decreases in substance use during the post-treatment phase. However, individuals assigned to TAU did show a significant slowing of acceleration in substance use (significant quadratic effect) indicating that given enough time (e.g., measuring substance use over a year) the two groups may become more similar in substance use outcomes. These results echo findings from a recent meta-analysis that found small effects (d = -.28) for mindfulness interventions on substance use [when compared to control conditions (e.g., TAU)] (Li et al., 2017). More importantly, given our sample was primarily illicit drug users (e.g., heroin and methamphetamine) our results also echo findings from Li and colleague's (2016) which found a Cohen's d of -.51 for mindfulness interventions in reducing opiate abuse. While results from the current study cannot be directly compared to prior

studies in terms of sample (e.g., marginalized emerging adults), results from the current study are parallel to previous studies investigating the effect of MBRP on substance use outcomes with adult populations. Taking results from the current study's survival analysis, individuals assigned to MBRP had a 64% decrease in the risk for relapse across both alcohol and drug use (results also showed a 54% decrease in risk for relapse to alcohol or heavy alcohol use and 56% decrease in risk of relapse for illicit drug use). Bowen and colleagues (2014) found that, compared to individuals assigned to TAU, adults assigned to MBRP or Relapse Prevention had a 54% decrease in risk for relapse to drug use and a 59% decrease in risk for relapse to heavy alcohol use. However, when comparing individuals assigned to MRBP or Relapse Prevention, adults assigned to MRBP had a 21% *increase* in the risk for relapse to drug use. Participants from the Bowen and colleagues (2014) sample were primarily older adults (average age 38 years old) with an average of high school education. Further, participants in the Bowen study were primarily poly substance users (average 82.3%). Thus, while the current study investigated a younger population compared to Bowen and colleagues, from a demographic perspective the samples were relatively comparable. Witkiewitz and colleagues (2014) assessed MBRP versus Relapse Prevention among a sample of female offenders in a residential treatment facility. While the Witkiewitz's sample was all female offenders results indicated a 96% decrease in the risk for relapse for individuals assigned to MBRP compared to individuals assigned to Relapse Prevention. This estimate is much larger than the effect found in the current study (55% decrease). However, it was noted that a small proportion of participants actually relapsed during the follow up period (10%), thus these results may be biased due to a high frequency of abstainers. Further, Witkiewitz and colleagues were unable to track vital information regarding MBRP implementation such as number of sessions attended and participants were allowed to

switch treatment groups, making the study design relatively weak, compared to a randomized controlled trial.

The current study results also follow prior studies investigating the relative efficacy of 12-step/self-help meetings on substance use among emerging adults. For example, Davis and colleagues (2016) found that emerging adults in Project MATCH assigned to 12-step/self-help had significantly worse drinking and drug outcomes compared to emerging adults (and older adults) assigned to either Motivational Enhancement Therapy or Cognitive Behavioral Therapy. Given individuals in the current study that were assigned to TAU received 8 -12 additional hours of 12-step/self-help (e.g., alcoholics anonymous), our results are in line with conclusions drawn by Davis and colleagues (2014) that only receiving 12-step based help as a treatment may not be effective in reducing substance use among emerging adults.

In line with our second hypothesis (H2), individuals assigned to MBRP had significantly lower craving scores during the treatment phase. However, while individuals assigned to MBRP still had lower craving scores during the post-treatment phase the group differences were no longer significant during the post-treatment phase. That is, simple slopes were not significantly different from each other, however when assessing mean differences across time differences did emerge at three critical time points: post-treatment, mid-follow up, and end of follow-up. Our results follow suit with prior studies investigating the effect of mindfulness based interventions on craving across a variety of samples. For example, Garland and colleagues (2016) found that individuals assigned to Mindfulness Oriented Recovery Enhancement (MORE) had significantly lower craving scores 10 weeks post-treatment compared to individuals assigned to Cognitive Behavioral Therapy. Further, Witkiewitz and colleagues (2010) reported significant effects on

craving for female offenders in residential substance use disorder treatment assigned to MBRP compared to female offenders assigned to Relapse Prevention only. Our results extend the literature in several ways. First, this is the first study to find effects of MBRP on long term craving scores for a sample of at-risk emerging adults. Second, our study assessed craving scores over a 6-month period of time every two weeks – thus we were better able to assess nuanced change in craving during the treatment phase and post-treatment phase. Third, our results also maintain clinical significance. For example, in the multi-group bilinear spline model significant within-person variability was found for craving over time. This translated to an overall decrease in craving for both groups (though significantly different for those assigned to MBRP) during the treatment phase and a significant increase in craving for individuals assigned to TAU and a relatively flat slope for craving for individuals assigned to MBRP during the post treatment phase. However, when assessing mean differences across the study (e.g., end of treatment, middle of post-treatment phase, and end of study) significant differences were found at all three time points, indicating MBRP is associated with mean decreases in craving during the post-treatment phase. When looking at the standardized results assignment to MRBP was associated with a 38% decrease in craving during the treatment phase and a 23% decrease during the post-treatment phase. These results are in line with a recent meta-analysis that found a significant effect (d = -.65) of mindfulness on craving outcomes across 42 studies.

MBRP provides several modules throughout the 8 session curriculum to aid in dealing with craving or coping with craving symptomology. For example, participants are instructed to deconstruct their experience of craving (or negative thoughts) into both a cognitive and affective component. When their experience becomes too overwhelming (e.g., craving and negative thoughts become rumination) participants are instructed to return to the sensory experience of

noticing the breath. Mindfulness has been posited to be an effective way for individuals with substance use disorders to deal with craving (Brewer, Elwafi, & Davis, 2013). It is thought that when individuals experience craving, the automatic reaction is to rid themselves of the sensations (e.g., emotional, physiological, psychological) associated with craving. However, mindfulness teaches individuals to sit with the uncomfortable feelings (both physical and psychological) associated with craving. The ability to sit with this uncomfortable sensation has been posited to do two things: first, it teaching individuals that cravings are physical sensations that happen within the body and not necessarily a moral imperative that must be acted upon immediately. Second, it allows individuals to experience, first hand, the impermanent nature of the sensation of craving. That is, the feelings and sensations will not last forever. This experience is directly replicated in session 2 of the MBRP curriculum in which participants are asked to sit with a difficult experience or memory and taught (during the meditation portion) that they are able to sit with uncomfortable and unpleasant experiences without reacting in a typical (e.g., using) way.

Stress Main Effects

In line with the third hypothesis (H3) individuals assigned to MBRP had significantly lower stress scores during both the treatment phase and the post-treatment phase. In particular, when looking at the standardized effects individuals assigned to MBRP had a 62% decrease in stress during the treatment phase and a 35% decrease in stress during the post-treatment phase. Li and colleagues (2017) reported that reductions in stress had the largest effect size across all studies assessing effectiveness of mindfulness interventions for substance use disorders. Specifically, they found a Cohen's *d* of -1.12 for stress indicating a large effect of mindfulness based interventions on stress.

It is well known that prolonged or repeated exposure to stress can increase one's health risks (Cohen et al., 2002; Cohen, Janicki-Deverts, & Miller, 2007; Flier, Underhill, & McEwen, 1998). Given stress is one of the most well-known contributors to initiation and continuation of substance use (Sinha, 2008; Shonkoff & garner, 2012) – assessing how a treatment, mindfulness, that targets reduction in stress is vital for understanding recovery processes. The stress response system consists of two major components: 1) physiological stress response and 2) psychological stress response. From a physiological perspective stress response has been associated with a variety of neuroendocrine responses (e.g., cortisol production) and activation of neurological pathways associated with increased risk for drug use (Gordon, 2002). For example, in nonhuman primate studies high stress environments are associated with heightened corticotropin releasing factor (CRF) concentrations and lower cerebrospinal fluid (CSF) cortisol indicating a lack of feedback inhibition for the release of the stress hormone cortisol (see Andersen & Teicher, 2009 for review). Similar results have been found in human studies which has been extensively reviewed by Sinha (2008), Shonkoff & Garner (2012) and Holzel and colleagues (2011).

While the stress response system remains an important aspect in understanding addiction, stress is also a common denominator for psychological stress – which can make an individual more vulnerable to drug or alcohol use. Stress is typically consequent from events or environmental conditions and manifested by acute psychological reactions where individuals seek a mollifying escape from the event which is typically achieved through psychoactive substances. However, mindfulness has been posited to alleviate some of this psychological strain and aid in reductions in stress. For example, Creswell and colleagues (2014) found that exposure to a brief mindfulness intervention (compared to cognitive training) resulted in buffered self-reported psychological stress reactivity and increased cortisol reactivity in a lab based stress test.

In general, when under stress our body activates an automatic or "auto pilot" response typically in the form of rumination, negative thoughts, assumptions about what will happen, and impulsivity (Esch, 2014). The MBRP curriculum has a strong focus on acknowledging when we enter 'auto pilot' and attempts to offer alternatives to remaining in this state. For example, one way MRBP may mitigate effects of stress is through the practice of reducing rumination and enhancing emotional regulation. Through practices such as the "SOBER breathing space" and allowing "thoughts to be thoughts" MBRP teaching individuals *not* to push negative thought processes aside (which can activate a stress response via neglecting internal emotionality), but to sit with the negative thoughts in a safe space. Prior research has shown mindfulness to enhance positive emotional regulation strategies, self-compassion, increase trait (or state) mindfulness, and decrease rumination and experiential avoidance (Chiesa et al., 2014). The current study provides further support for the effects of mindfulness based interventions on psychological stress.

Mechanisms of Behavior Change

In the past five years researchers have become interested in the potential mechanisms (both behavioral and physiological) that may aid in explaining the effect of mindfulness based interventions on substance use problems and related behaviors (e.g., craving; Witkiewitz et al., (2013)). Mindfulness based interventions have been associated with changes in brain structure and brain functioning. Recent studies have found individuals assigned to mindfulness based interventions (compared to control) show significant increases in gray-matter in brain regions associated with learning and memory, emotional regulation, perspective taking, and impulsivity (Hölzel, Carmody et al., 2011), similar areas which drug and alcohol use inhibit. There seems to

be evidence that mindfulness works through neoplastic changes in brain areas (e.g. anterior cingulate cortex, insula, temporo-parietal junction, fronto-limbic network) associated with establishing a more enhanced self-regulation system (Hölzel et al., 2011). Because of this recent evidence, Witkiewitz et al. (2013) outlined several mechanisms though which MBRP may work, one being stress response systems such as the HPA axis (e.g., stress response system), in relation to craving and subsequent substance use. Two pathways have been proposed: 1) a "top down" approach in which individuals exhibit executive control over craving and stressful experiences (e.g., rumination from stress) and 2) a "bottom up" approach in which individuals actually change their subjective experiences of stress and craving (Westbrook et al., 2013; Witkiewitz et al., 2013). Prior research has found that greater mindful acceptance and nonjudgement partially explained differences in craving and negative affect affecting substance use for individuals assigned to MBRP versus Relapse Prevention (Witkiewitz & Bowen, 2010). Thus, prior research has shown support for the utility of mindfulness based interventions (specifically MBRP) to aid participants in reducing initial reactivity to negative or stressful experiences (e.g., thoughts, direct experience) - indicating a potential "top down" conditioned response. Results from the current study provide further support for this top down hypothesis. Specifically, we found full support for the fourth hypothesis (H4) such that reductions in stress mediated the association between treatment assignment and craving and substance use. These results support the notion that reducing one's stress can act as an important mechanism in the recovery loop.

Similar pathways have been proposed for stress experience and exposure. Sinha (2001) proposed a model in which maladaptive stress response (e.g. higher or lower reactivity/sensitivity to stress followed by slow recovery to baseline stress levels) mediate the increased frequency and chronic drug use among vulnerable individuals after exposure to a

stressful situation. For example, in a review by Sinha (2008) several have found that lab based stress induction is associated with increased craving (or desire to use; Chaplin, Hong, Bergquist, & Sinha, 2008; Fox, Bergquist, Hong, & Sinha, 2007; Hyman, Fox, Hong, Doebrick, & Sinha, 2007; Sinha, Easton, Renee-Aubin, & Carroll, 2003), salivary cortisol, and heart rate variability (both are known proxy's for stress; Sinha, 2003). Others have found that among recently abstinent drug users, brief exposure to stress and drug cures activated the HPA axis (increases in ACTH, cortisol and prolactin levels) – and interestingly, little evidence of return to baseline stress levels nearly 2 hours after the brief (5 min) stress exposure (Sinha, 2003). When comparing stress response and craving across treatment-engaged participants and a matched social drinking group – treatment-engaged participants had higher levels of emotional distress and physiological arousal (e.g., drug craving and stress) compared to controls (Fox, Hong, Siedlarz, & Sinha, 2008). In essence, one of the key constructs for individuals in substance use disorder treatment is the ability to appropriately assess stressful events or negative emotion states. That is, when an individual experiences an acute stressor and they have a dysfunctional stress response system – that maladaptation may mediate the relationship between treatment and subsequent substance use outcomes. By attempting to reduce stress among individuals in substance use disorder treatment we have shown this process can be reversed and actually lead to reduced long-term problem behaviors.

Both of these proposed models indicate various ways in which the stress response system can be activated and regulated. Findings from the current study indicate that mindfulness, specifically MBRP, significantly reduced the stress response which ultimately led to reduced craving and days of alcohol and drug use over a six month period.

MBRP teaches individuals to practice acceptance (accepting their current craving as just craving), being nonjudgmental (noncritical of themselves and craving), and changing the way they react to negative stimuli. While the current study is unable to determine any physiological effects– it is possible that reduced perceived stress is associated with changes in the stress response system. That is, it may be that the skills learned in MBRP influence neurological (HPA axis) aspects of the stress response systems which aid in reduced craving and return to use. Sinha and colleagues (2006) found that stress-induced cocaine craving during laboratory tests (e.g., prior to treatment entry) was predictive of shorter time to relapse after inpatient treatment. It may be that individuals assigned to MBRP have successfully mitigated the effects of dysregulated stress response systems thus leading to decreased desire (craving) and substance use. This falls in line with Witkiewitz et al., (2013) who hypothesized that long-term effects of MBRP may be observable through changes in physiological processes (e.g. alterations in stress response systems such as HPA axis) and perceived stress which may improve long-term treatment outcomes.

Clinical Implications

Results from this study have specific clinical implications. In a recent meta-analysis Davis and colleagues (2017) reported an average treatment effect of $d = .17$ for emerging adults in substance use disorder treatment in non-college settings. While this effect is in line with prior studies investigating the meta-analytic effects of interventions for college students, Davis and colleagues called for more research on emerging adults treated in non-college settings, especially among ‘at risk’ or marginalized emerging adults. The current study fills this gap in the literature and provides evidence for long-term treatment effects using MBRP among a sample of marginalized emerging adults. In the current study treatment fidelity was

high and the clinicians had extensive training in mindfulness based interventions. Thus, clinicians wishing to implement MRBP or similar protocol may need extensive training to see similar results. While this may appear to be a limitation – it implies that with correct training and implementation clinicians may see similar results. This would, however, include extensive supervision and, again, opens the door to future research on implementation and dissemination of MBRP in the context of treatment centers.

One of the more meaningful clinical implications from this study is the effect MBRP has on stress. Results indicate that by reducing stress, clinicians can expect significant decreases in craving and substance use. Given the extensive literature on the negative effects of chronic stress on both behavioral and physiological outcomes – results from the current study are promising and provides a potential 'entry point' to reducing participants' substance use and craving. This is important as many studies (including large scale intervention studies such as Project MATCH) have found treatments, in general, work to reduce substance use. Results from the current study indicate that by simply reducing one's stress acts as a mechanism between reductions in craving and substance use. Extrapolating these results open future research to explore dynamic processes involved within the treatment phase (e.g, does reductions in stress lead to reductions in craving during treatment) which may have implications for longer-term processes (e.g., substance use during the post-treatment phase).

Further, while the MBRP curriculum does not directly address trauma or trauma symptoms, the current study provides marginal support for utilizing MBRP among samples with relatively high rates of past trauma. That is, we did not find evidence of a moderated mediated indirect effect for early childhood trauma, likely due to low power. Probing that interaction, it did show that for individuals in MBRP (compared to TAU) with high. Future research may wish

to investigate the effects of a trauma-informed MBRP to specifically address trauma, however it appears the current curriculum may be useful for emerging adults with or without a history of trauma. Prior research has found that a diagnosis of Post-traumatic stress disorder increases the risk of substance use disorder treatment entry by 67% (Davis et al., 2016). Earlier reviews have noted rates of victimization of 50% - 100% among individuals entering inpatient substance use disorder treatment (Najavits, Weiss, & Shaw, 1997). Others have noted that among individuals entering substance use disorder treatment nearly 25%-50% meet criteria for Post-traumatic stress disorder (Ellason, Ross, & Fuchs, 1996). While the current study did not asses post-traumatic stress disorder symptoms it is likely that these prevalence rates are similar in the current sample of emerging adults.

In addition to being useful for trauma exposed clients, clinicians may also note that the current study found moderate to large treatment effects among a sample of polysubstance users. Specifically, 33% of participants were in treatment for heroin use and 25% for methamphetamine. The current study provides further evidence for clinicians treating emerging adults for illicit drug use. Unfortunately, the prevalence rate of co-occurring mental health diagnoses was not available given the treatment facility does not conduct mental health diagnostic interviews. However, future research and clinicians may wish to investigate the efficacy of MBRP among a sample of co-morbid emerging adults. Prior research has found mindfulness based interventions (MORE) to be effective in treating adults with co-morbid substance use and post-traumatic stress (Garland et al., 2016). However, more research is needed for samples of emerging adults.

Limitations and Strengths

Numerous limitations to the study warrant caution when interpreting results. First, the small sample size and attrition rates may have influenced the power to detect effects of interest. For example, while mean differences for craving existed at various time points across the post-treatment phase, no significant differences in the slopes were found. Further, results for the moderated mediation were not powered to find an effect. Thus, with a larger sample size a more accurate estimate of how early childhood trauma influences treatment effects (e.g., stress, craving, substance use) may have been possible. Second, the present study was limited by a lack of biochemical measures of abstinence. While it would have been ideal to assess the effects of the intervention on drug and alcohol use using biochemical verification, this was not possible due to the population being studied. That is, biochemical analyses were conducted at random when individuals were at the residential facility (100% corroboration with self-report), however over 75% of the participants returned home after discharge to different communities than where the treatment facility was located. Prior studies have found that self-reported substance use is highly correlated with biochemical results and a reliable way to assess treatment effects (Chan, 2009; Digiusto, Seres, Bibby, & Batey, 1996; Jain, 2004). Third, with respect to the study design the treatment facility provided ample opportunity for participants to share their treatment experience across conditions. While the program at the residential facility did provide some mindfulness based activities within the treatment program (e.g., yoga, mindfulness session separate from MBRP curriculum) we did ask each participant at each time point to indicate how often they practiced mindfulness in the past two weeks. Individuals assigned to MBRP reported significantly higher number of times practicing mindfulness during the treatment phase ($t(51.3) = -2.31$, $p = .023$). Further, participants assigned to MBRP were given explicit instructions not to share the material being learned in the MBRP sessions with their peers. No participant could

switch treatment assignments after randomization was completed. Related to this is our adaptation to the original manualized MBRP workbook. The original format is a closed group and 8, 2 hour sessions. We used a rolling admissions framework and only 1.5 hours per session. While the classes were shorter (given time constraints at the residential facility) no aspect of the curriculum was not completed. However, to address the different time constraints several of the modules were shortened (e.g., some meditations were shortened). Fourth, the examination of mediation may not lend itself to an actual temporal effect. For example, the indirect effect was assessing changes in stress and changes in substance use that were measures simultaneously (over time). While our post-hoc models did show consistent results with the mediation effect of stress, temporal order can only be established using lagged effects. Future research may wish to examine temporal lags (e.g., autoregressive latent trajectory (ALT) models, or latent change models). This would also allow researchers to examine within-person change process. The current study only assessed between person differences. Assessing within-person changes across treatment groups would allow for a better understanding of the cross lagged relationship between, say, stress and substance use over the study period.

Finally, the current study may not be generalizable to other populations. The current sample consisted of emerging adults only entering a public not-for-profit residential substance use disorder treatment facility. The majority of participants were referred by the criminal justice system, had low education attainment, and high prevalence rate of early childhood trauma. Thus, results found here may only be generalizable to a similar sample of emerging adults and may not extend to adolescents or older adults.

While the current study had a number of limitations, it also had numerous strengths. First, this is the first randomized controlled trial investigating the effect of MBRP on multiple

outcomes among a sample of marginalized emerging adults. Successful recruitment of 79 emerging adults entering residential care indicates that studying this population may not only be a possibility, but within the reach of most researchers. Further, retention rates were relatively high for this type of sample (average 82% retention). Given the transient nature of this population and the frequency of contact with the criminal justice system, retaining the large majority of participants throughout the 6-month study period is a major strength. Further, the current study controlled for a variety of factors that may influence treatment outcomes such as number of days participants stayed in the residential facility as well as how many days (at each time point) each participant was in jail or other facility. Finally, the current study used a continuous measurement approach to assess changes in stress, craving, and substance use over the study period. The current study assessed each participant 15 times over the study period with a total of 1,185 time points across the 79 participants. This is a strength as many researchers assess participants quarterly (3 month intervals) and potentially missing important changes in stress, craving, or other constructs that change based on experiencing an event.

Chapter 5: Conclusion

This is the first study to provide evidence and support for the use of MBRP among high risk, marginalized emerging adults in residential substance use disorder treatment. The current study showed modest, yet statistically significant therapeutic effects on factors that are integral to reducing relapse among a sample of individuals with low abstinence rates. Further, this study provided further support that MBRP can be used as an active treatment, and not just as an aftercare protocol. This is also the second study to investigate the use of MBRP using a rolling group admission processes (Witkiewitz et al., 2010) which is more likely to be disseminated in community based settings compared to the closed group format. This study also showed that MBRP is effective in reducing perceived stress during the treatment phase and – more importantly maintaining lower stress throughout the post-treatment phase. This study is the first to provide support for changes in stress as an active mechanism contributing to lower craving and substance use. Overall, this study suggests that MBRP is an appropriate and integrative therapy designed to reduce stress, negative emotion, and substance use among a sample of marginalized young adults.

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Appendix A: Study Materials

Are you:

RESEARCH STUDY

- 18-29 years old?
- Interested in psychology?
  - Personality
  - Stress
  - Coping with stress
  - Mindfulness
- Willing to be in a longitudinal Study?
- Want to earn money by answering questions about personality, stress, and mindfulness?

If you answered yes to all of these questions, you may be eligible to participate in a research project through the University of Illinois.

Participants in this project will participate in a yearlong study and receive compensation for each follow-up.

For more information or to enroll, please contact:

Research Team

(217) 333-4187

jdavis37@illinois.edu

Demographics and Interest Sheet

Thank you for expressing interest in our study! We are very excited about this research and are ready to answer any questions you might have. First, we want to get a little information about you. This information will be used to get to know you a little and keep in contact with you after you leave the Prairie Center. We will not share this information with anyone, the only people who will see it are our research staff. Simply place this filled out sheet into the locked cabinet labeled "University of Illinois", and one of our research staff will meet with you in the next one to two days. Thanks again, we look forward to meeting you!

Name: _____

First Last

Address: _____

_____

E-mail address: _____

Home Phone number: _____

Cell Phone Number: _____

Any medications? ☐ **Yes** **No** ☐

If yes, what medications are you taking? _____

_____

Appendix B: IRB Letter

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

DEPT. OF PSYCHOLOGY

Informed Consent

Study Name: Impact of Mindfulness Based Relapse Prevention on Stress and Developmental Trends among Emerging Adults in Residential Substance Use Treatment

Principle Investigator: Brent Roberts, PhD, Professor, Psychology

Other Investigators: Jordan Davis, MSW

WHAT IS THE PURPOSE OF THIS STUDY?

You are eligible to be in a research study about developmental changes among people your age entering residential substance use treatment. That is, we want to find out what life is like for people your age after leaving treatment, including: whether personality changes, how stress changes over time, and how you feel you are progressing in adulthood. Whether or not you participate is entirely up to you, and the purpose of this consent is to help you make a decision about whether or not to participate. If you decide to participate, we will give you a copy of this form so you can go back to it later.

HOW LONG WILL I BE IN THIS STUDY?

If you agree to participate in this study, you will receive an initial assessment that will last approximately 1 hour. In addition, we will meet with you or call you 2-3 times per month for much shorter (20-25 min) assessments for about one year. Your participation in this study is voluntary and you can decide to drop out at any time.

WHAT WILL HAPPEN DURING THIS STUDY?

If you decide to participate, we will ask you to do an initial assessment and several follow up assessments. The initial assessment will take place in person at the Prairie Center. All follow up assessments will take place in person or over the phone. If we are able to schedule a follow-up

assessment in person we will work with you to determine a safe, quiet, and private location. Typically locations such as our University office/lab or local libraries are used for in person follow-up assessments. In both cases, quiet and private rooms will be available for assessments to ensure confidentiality is not breeched. We expect each of the follow up assessments to take approximately 20-25 minutes each. During these assessments, we will ask you questions about your behaviors, including: your use of alcohol and drugs, your mental and physical health, your use of services for mental health or substance use problems, and illegal behaviors (i.e., substance use, money earned from illegal behaviors). We will also ask you about your family and friends' use of alcohol or drugs, personality, stress, ways of dealing with stress, and what stressful life events you have had. A table has been provided for you at the end of this document that explains what will happen at each of the assessments/time points.

We will help you to remember your follow up appointments by giving you reminder calls between each assessment. We will also ask you to give us the names of up to three people and your consent to contact them in case we lose touch with you during the follow up period.

We will audiotape your initial assessment to help us supervise our research team and make sure we have recorded your answers correctly. Willingness to be audio recorded is not a requirement for participating in this study.

It should be noted that you will be asked to sign separate consents for the collection of hair and blood samples (bottom of this document).

If you are placed in a prison or jail setting we will still attempt to get follow up data on you. This will require a research staff member coordinating with prison or jail staff a safe and quiet place to conduct the assessment. You will still be compensated for your time at the regular rate of $5 per follow up.

It should be noted that you are able to remove yourself from the study at any time and your choice to remove yourself will not impact the treatment or services you will receive from the Prairie Center or any other agency.

BLOOD AND HAIR SAMPLING

As part of our study we would like to collect hair and blood samples. The hair and blood that you provide us will allow our research team to investigate how stress impacts your life. Further, the blood samples will allow our research team to investigate genetic changes that occur as a result of stress. It should be noted participation in this study is completely voluntary and declining to give blood samples will not have an impact on the treatment you receive or your participation eligibility in our study.

WHAT ARE THE BENEFITS OF THIS STUDY?

Although we cannot be sure, you may benefit from participating in this study gaining a better understanding of psychological processes that are important to persons leaving substance use treatment. Also, you may gain a better understanding of your drug and alcohol use, stressors, and

ways you cope with stress. Further, this study may help researchers improve treatments for young adults with alcohol and drug problems, which might make you feel good.

WHAT ARE THE RISKS OF THIS STUDY?

There may be some risks from participation, including:

- **Discomfort.** You may feel uncomfortable at times as you talk about sensitive topics in the treatment sessions, as well as during your follow up appointments. Discomfort may also occur during the collection of hair and blood samples.

- **Physical risks.** You may experience physical risk during the collection of hair and blood. These risks are minimal and are not more than one would experience during a routine doctor visit.

- **Mandatory reporting/Duty to warn.** If you share information with us about child abuse or neglect, we must report this to proper authorities. We are also required to report someone who may seriously injure themselves or others.

- **Confidentiality.** Although very unlikely, there is a chance that information that you provide in confidence will be shared with others or will allow you to be identified, or that others may attempt to access data or audio recording files that are transferred via the internet between treatment staff and research staff.

HOW WILL WE MINIMIZE THESE RISKS?

It is important that you not disclose information from this study to other people in order to protect your privacy and your friend's privacy.

Identifying information like your name, contact information and birth date will not be attached to the information gathered. We are committed to keeping your participation in this study both safe and confidential. However, it is possible that other people may become aware of your participation in this study. To keep this risk low we will keep your signed consent form and any other materials with your name on them in a locked file cabinet away from the forms with your answers to our questions (i.e., data collection forms). Instead of putting your name on the data collection forms, we will put a made up number (i.e. code number) that allows only the researchers to identify your responses. All audio recordings and answers to questions will be stored by your code number only, and they will be stored in a password protected computer network. Please remember that we will not tell your counselor, other members of the Prairie Center staff, or other residents any of your answers to the questions we ask you. Finally, all of your biological material (e.g. blood and hair samples) will be given the same unique ID. All samples of blood will be stored in a locked deep freezer in the Psychology building. All hair samples will be stored in a locked cabinet in at the University of Illinois.

We do not anticipate that you will experience any physical injuries as a result of participation in this study. However, during the course of hair and blood sampling you may become injured. Risks of hair and blood collection include potential cut (hair extraction), soreness or bruising

(blood collection). When taking hair and blood samples we do not believe this is any more risk than would be expected form a routine medical visit. Prairie Center staff are trained and equipped to deal with any issues that arise during the collection of hair and blood samples such as feeling uncomfortable or agitated from the act of giving blood or hair and involuntary triggering of drug use from the blood drawing. The University of Illinois does not provide medical or hospitalization insurance coverage for participants in this research study, nor will the University of Illinois provide compensation for any injury sustained as a result of participation in this research study, except as required by law.

All information gathered in this study will be kept confidential. We will not disclose your answers, blood, or hair test results to treatment providers, law enforcement agencies, or any others not listed on this sheet. Furthermore, if we write a report on this study's findings, the readers will not be able to identify you or your individual responses. There are, however, two exceptions to confidentiality. Researchers will voluntarily disclose your identity under the following situations: in the case of child abuse or if you are contemplating seriously injuring another individual or yourself (i.e., murder, suicide, serious attack). The only time your data will be used is to help researchers understand problems faced by persons your age. In order to further protect the confidentiality of your information research staff and anyone authorized to use the combined data set or review audio recordings must sign an agreement to respect your confidentiality by:

a) agreeing never to try to figure out who you are
b) not to report any information on you as an individual, and
c) to abide by federal regulations that protect the privacy of your treatment records and their use in program evaluation and research (42 C.F.R., Part 2, HIPAA).

IS BEING IN THIS STUDY VOLUNTARY?

Taking part in this study is completely voluntary. If you decide not to participate in this developmental study, you may stop participating at any time and you won't be penalized or lose any benefits for which you otherwise qualify. You may decline to answer any question that you do not want to answer, and you may request that we turn off the tape recorder if there is something you would like to say without being taped.

WHAT IF I HAVE QUESTIONS?

Please contact Jordan Davis at (217) 333-4187 or jdavis37@illinois.edu with any questions or concerns about the research. You may also call Jordan Davis if you feel you have been injured or harmed by this research. If you have any questions about your rights as a participant in this study or any concerns or complaints, please contact the University of Illinois Institutional Review Board at (217) 333-2670 or via email at irb@illinois.edu.

WILL IT COST ME ANYTHING TO BE IN THIS STUDY?

It will not cost you anything to participate in this study.

WILL I BE PAID FOR PARTICIPATING?

If you choose to participate in this study, you will receive compensation. You will receive $5 for completing the initial assessment. You will also receive $10 per month if you complete both (2) monthly assessments. Finally, for every month you complete both assessments you will have an added chance of winning a lottery to be drawn every 6 months for a $100 gift card. The total cash compensation possible per person is $144. With the additional 2 lotteries the total cash compensation possible (if you win both lotteries) is $344. The approximate odds of winning are 1/35 for the first six months of the study, 1/70 for the second six months. Your odds, however, will go up or down based on how many assessments you complete.

Information in this study will be presented at professional conferences and submitted for publication in scientific journals. We may assign your quotation a fake name so people will not know it is you. Again, your individual responses will not be identifiable. Further, the audio recordings of your sessions will not be shared with anyone outside of the research team.

GENERAL CONSENT

Your signature below indicates:

- I am 18 years of age or older.
- I have read and understand the above consent form and voluntarily agree to participate in this study.
- I understand my assessment will be audio recorded for quality assurance purposes.
- I understand that I will be given a copy of this consent form for my records.

_____ _____

Participant Signature Date

BLOOD CONSENT

By signing this document:

a) You will have given members of our research team permission draw blood samples
b) You will give members of our research team permission to analyze blood samples
c) You will give permission to use your blood samples in future analyses if funding is acquired.
d) You understand that you may rescind consent to analyze your blood samples at any time.

__ I hereby allow the research team to use blood samples for genetic testing and stress testing

__ I do not allow the research team to use blood samples for genetic testing and stress testing

_____

Participant Signature Date

HAIR CONSENT

By signing this document:

a) You will have given members of our research team permission collect hair samples.
b) You will give members of our research team permission to analyze hair samples.
c) You understand that you may rescind consent to analyze your hair samples at any time.

__ I hereby allow the research team to use hair samples for stress testing

__ I do not allow the research team to use hair samples for stress testing

_____

Participant Signature Date

Process and Procedures of Study Follow Ups

	Intake	Residential Stay	Discharge	Monthly Follow-up	3,6,12 Month Follow-Up
Procedures	**Assessments:** Initial assessment	**Assessments:** Maximum of 1 follow-up assessment per week	**Assessments:** Final follow up assessment.	**Assessments:** 2-3 assessments per month via telephone or in person	**Assessments:** Same shorter follow up assessment plus hair samples collected
	Time: Approximately 1-1.5 hours	**Time:** Approximately 20-25 min	**Time:** Approximately 20-30 min	**Time:** Approximately 20-25 min	**Time:** Approximately 20-30 min
	Measures: All	**Measures:** Shorter subset	**Measures:** Shorter subset	**Measures:** Shorter subset	**Measures:** Shorter subset
	Biological Material Collection: Hair and Blood	**Biological Material Collection:** None	**Biological Material Collection:** Hair and Blood	**Biological Material Collection:** See next panel	**Biological Material Collection:** Hair samples

Appendix C: Class handouts

Introduction to Mindfulness Handout

What is mindfulness?
Mindfulness is the ability to bring full awareness to the present moment. It means to be attentive and conscious about what's happening both around us and inside of us.

What are mindfulness practices/exercises?
Mindfulness practices involve different ways of practicing mindfulness and paying attention to what is happening in the present moment. Some practices are focused on noticing particular aspects of our experience such as inner experience (body sensations, thoughts, emotions) or things around us (sounds, sights, smells).

Do I have to stop my thoughts?
No, but that is a common misconception. People often think that meditating correctly means clearing all thought from the mind. We are not trying to stop or control our thoughts, we're simply noticing them.

Where should I practice mindfulness?
You can practice mindfulness almost anywhere. One option is to set aside time to practice. It is ideal to create a supportive environment for practice, one that is comfortable, quiet and uncluttered. Another option is to practice throughout the day and do brief "on-the-go" practices.

Is mindfulness a religion?
No, mindfulness is not a system of beliefs. It is a practice that brings full awareness to the present moment.

What position or posture should I be in when I practice mindfulness?
Choose the position that works best for you. In choosing a position, it is important to think about what position will help you feel both comfortable and alert at the same time. Here are some common positions for meditation:

Sitting in a chair: You can sit at the edge of the seat with your feet flat on the floor and with a straight, upright posture. You can also sit back in the chair to support your lower back with the option of placing a cushion or pillow behind your lower back.

Lying on your back on the floor or on a cushioned surface: You can lie on your back with your feet flat on the floor and knees pointing towards the ceiling. Or you can lie on your back with the legs fully extended with the option of placing a pillow or cushion under your knees relieve any strain in the lower back.

Sitting cross-legged on the floor: You can sit cross-legged on the floor with a rolled up blanket or towel or one or more cushions or pillows under your butt. Placing support under your butt lifts your hips above your knees and

support your upright sitting posture. If your knees are lifted high off the ground while sitting cross-legged, you can also place cushions under your knees to support them, so you can sit more comfortably.

Kneeling on the floor: Another option for sitting on the floor is to sit on your knees with a pillow or cushion placed under your butt. Your feet can be on either side of the cushion. In a kneeling position, it is often helpful to have a soft surface under your knees for comfort.

Standing: You can also meditate in an upright standing position with both feet firmly placed on the floor about hip's width apart.

Mindful Check-In Handout

The Mindful Check-In Practice involves setting aside a brief amount of time to check-in with yourself and notice what you are experiencing in that moment. The amount of time you take is up to you. For example you can take 1-2 minutes to do the practice or you can take 5-10 minutes, or more if you like. You can close your eyes, you can have your eyes half open and softly gaze at something in front of you, or you can have you eyes open. Whatever works for you. Here are the basic steps for doing the practice:

Step 1: Check-in/notice what's happening with your body

- Notice sensations in your body in the present moment
- You can notice where your body is touching the chair or cushion.
- You can feel the weight of your body.
- You can scan your body starting from the top of your head and slowly moving down noticing sensations in different parts of your body.

Step 2: Check-in/notice thoughts

- Notice thoughts you are having from moment to moment.
- You can notice what's going on in your mind. Is it busy with thoughts? Are your thoughts fast or slow or somewhere in between.
- No need to do anything special with your thoughts but just stepping back and noticing your own thoughts, almost like you are watching your own mind.

Step 3: Check-in/notice emotions

- Notice any emotions you may be experiencing or your overall mood.
- Just acknowledging what you are feeling allowing any emotions to be present.

Step 4: Anchoring attention on the breath

- Gather your attention and shift your focus to your breathing.
- Use your breath as an anchor for your attention.
- Allow your attention to settle on the breath and simply notice sensations of the breath from moment to moment.

SOBER Breathing Space Handout

This is an exercise that you can do almost anywhere, anytime because it is very brief and quite simple. It can be used in the midst of stressful situation, if you are upset about something, or when you are experiencing urges or impulses to engage in unwanted behavior. It can help you step out of "automatic pilot", becoming less reactive, and more aware and mindful in your response.

A way to help remember these steps is the acronym SOBER.

- **S – Stop.** When you are in a stressful or risky situation, or even just random times throughout the day, remember to stop and do this exercise. This is the first step in stepping out of automatic pilot.
- **O– Observe**. Observe the sensations that are happening in your body. Also observe any emotions, moods or thoughts you are having. Just notice as much as you can about your experience.
- **B – Breath.** Allow your attention to settle on your breath.
- **E – Expand.** Expand your awareness to include the rest of your body, to your experience, and to the situation, seeing if you can gently hold it all in awareness.
- **R – Respond.** Respond (versus react) mindfully, with awareness of what is truly needed in the situation and how you can best take care of yourself.

MINDFULNESS BASED RELAPSE PREVENTION ADHERENCE AND COMPETENCE SCALE

Adherence: MBRP Treatment Components	
Session One	Check if Completed
1. Introductions	
2. Expectations for group and rules for confidentiality and privacy	
3. Discussion of group structure and format	
4. Raisin exercise/discussion of automatic pilot	
5. What is mindfulness?	
6. Body scan practice	
7. Home practice for the week	

Adherence: Discussion of Key Concepts	
Key Concept	Behavior Counts
1. Noticing/awareness of current experience: *To what extent do therapists encourage noticing and being aware of present-moment experience?* This includes pointing out and validating client behaviors, if the client is already paying attention to his/her experience (e.g., ‘‘So you noticed the thought that. . .’’; ‘‘So you noticed a judging thought’’; ‘‘So you noticed your mind wandering’’; ‘‘Seems like you were aware of the craving’’), as well as encouraging client to pay attention to his/her	_____

experience (e.g., ‘‘What would happen if you just tried to notice that as a thought?’’; ‘‘Could you pay attention to the sensation?’’).	
2. Acceptance of current experience: *To what extent do therapists encourage bringing curiosity and a nonjudgmental attitude to whatever arises in the present moment, regardless of whether it is pleasant, unpleasant, or neutral?* For example, paying attention to the experience of sleepiness, restlessness, peacefulness, calm, anger, an itch, etc., with curiosity and nonjudgment: ‘‘Can you just notice what the experience of anger is like?’’; ‘‘What does an itch really feel like*Is it burning, is it hot, pulsing, throbbing?’’	_____
3. Acceptance versus aversion: *To what extent do therapists introduce the differences between relating to one’s experiences from a standpoint of acceptance as opposed to aversion?* For example, allowing and being with difficult emotional and physical states instead of trying to get rid of them, fight them, fix them, or manipulate one’s experience in some way: ‘‘Can you just stay with the itch for a moment and get to know it before scratching it, or immediately getting rid of it and having to make it go away?’’	_____
4. Acceptance and action: *To what extent do therapists discuss the importance of stepping out of auto-pilot (pausing, taking a breathing space, evaluating one’s choices etc.) as a means of engaging in mindful action (responding vs. reacting, making*	_____

choices that are in one's best interest), and/or to what extent do therapists describe the relationship between acceptance and skillful/mindful action?	

Competence: Therapist Style/Approach		
Inquiry	Therapists' ability to elicit and respond to both verbal and nonverbal feedback (this may be demonstrated through eliciting reactions to exercises, asking open questions, validating the clients' experience and summarizing/making reflections).	1 2 3 4 5 Low High
Attitude	Therapists' ability to model and embody the spirit of mindfulness (respond to participants in a way that is curious, focused in the present moment, and nonjudgmental/accepting of whatever participants bring up).	1 2 3 4 5 Low High
Use of Key Questions	The overall extent to which the therapists used key questions in eliciting discussion about exercises and home practice. (1) Highlighting the participant's raw experience in the moment: What did you experience in this exercise? What body sensations did you experience during the exercise? Making a distinction between thoughts, feelings, and body sensations. (2) Distinguishing from typical way of experiencing things: How is this different from how you usually experience things? (3) Relationship to purpose of program: How does it relate to relapse?	1 2 3 4 5 Low High
Clarifying Expectations	The extent to which the therapist addresses and clarifies ideas and misconceptions about mindfulness meditation (e.g., ''I'm not doing it right'';'' I'm just in a different zone when I practice''; ''This practice is great because it makes me feel so relaxed and blissful'').	1 2 3 4 5 Low High

Competence: Overall Therapist Performance				
1. How would you rate the overall quality of the therapy in this session?				
1	2	3	4	5
Not Satisfactory	Mediocre	Satisfactory	Good	Excellent
2. How would you rate the ability of the therapists to work as a team?				
1	2	3	4	5
Not Satisfactory	Mediocre	Satisfactory	Good	Excellent
3. How would you rate the ability of the therapists to keep the session focused and on topic?				
1	2	3	4	5
Not Satisfactory	Mediocre	Satisfactory	Good	Excellent
4. Please rate the overall quality of delivery of the meditation exercises.				
1	2	3	4	5
Not Satisfactory	Mediocre	Satisfactory	Good	Excellent
*These items vary based of the content of each of the eight sessions.				

Appendix D: Measures

DEMOGRAPHICS

1. Enter participant ID _____

2. What is today's date? (MM/DD/YYYY) _____

3. What is the Assessment Number? _____

4. What Is your gender?

    a. Male
    b. Female
    c. Transgender (male to female)
    d. Transgender (female to male)

5. What is your date of birth? (MM/DD/YYY) _____

6. How old are you today? _____

7. Which race, ethnicities, nationalities or tribes best describe you?

    a. Alaskan native
    b. Asian
    c. African American/black
    d. Caucasian/white
    e. Hispanic, Latino, Chicano
    f. Native American
    g. Native Hawaiian
    h. Pacific islander
    i. Some other group _____

8. Which of the following best describes your current relationship status?
    a. Single
    b. Married
    c. Divorced
    d. In a serious relationship (boyfriend/girlfriend)

9. How many children, if any, do you have? _____

10. Which of the following best describes your present school situation?
    a. IN a 4 year university full time?
    b. In a 4 year university part time
    c. In a 2 year college full time
    d. In a 2 year college part time
    e. Adult education (e.g. GED classes)
    f. Not in college /university

11. What was the last grad you completed in school? (NOTE: use 12 for high school, 16 for BA/BS, and 17+ for graduate school years)

    _____

12. What is your current job status?
    a. Employed full time, 35 hours per week
    b. Employed part time, less than 35 hours per week
    c. Unemployed

13. How much do you earn per year from your job? _____

Substance Frequency

The next questions deal with problems associated with drug and alcohol use.

In the past 2 weeks how often have you experienced the following problems associated with alcohol and drug use?

Substance	90 days	2 weeks
Used any kind of alcohol		
Gotten drunk or had 5 or more drinks?		
Used marijuana, hashish, blunts, THC		
Used crack, smoked crack		
Used other forms of cocaine		
Used inhalants or huffed		
Used heroin (alone or mixed)		
Used nonprescription or street methadone?		
Used pain killers, opiates, or other analgesics?		
Uses PCP or angel dust		
Used acid, LSD, ketamine, mushrooms, or other hallucinogens		
Used anti-anxiety drugs or tranquilizers		
Used methamphetamine, crystal, ice glass, or other forms		
Used speed, uppers, amphetamines, ecstasy, MDMA, or other stimulant		
Used downers, sleeping pills, barbiturates or other sedatives		

Used any other drug?		

Substance Problems Scale

The next questions deal with problems associated with drug and alcohol use.

In the past 2 weeks how often have you experienced the following problems associated with alcohol and drug use?

1	2	3	4
Never	Once	Twice	Multiple Times

1. Get hurt of injured? _____
2. Argue with friends and family? _____
3. Get into a physical fight? _____
4. Become physically sick or unable to take care of yourself? _____
5. Not used protection when you had sex? _____
6. Forget where you were or what you did? _____

CRS. Craving Scale

(Mazza, 2011)

The next questions are about the extent to which you currently crave alcohol or other drugs.

Please answer the next questions using yes or no.

	Yes	No
CRS1. If I were using alcohol or other drugs, I would feel less nervous.....	1	0
CRS2. I have an urge for alcohol or other drugs.....	1	0
CRS3. I crave alcohol or other drugs right now.....	1	0
CRS4. Using alcohol or other drugs would make things seem just perfect.....	1	0
CRS5. I would not be able to control how much alcohol or other drugs I used if I had some.....	1	0
CRS6. Nothing would be better than using alcohol or other drugs right now.....	1	0
CRS7. My desire for alcohol or other drugs seems overwhelming.	1	0
CRS8. I want to use alcohol or other drugs so badly that I can't think of anything else.....	1	0
CRS9. Right now, I want to use alcohol or other drugs so badly I can almost taste it.....	1	0
CRS10.All I want to do is use alcohol or other drugs.....	1	0
CRS11.I would do almost anything to use alcohol or other drugs.....	1	0
CRS12.I am going to use alcohol or other drugs as soon as I possibly can.....	1	0
CRS13.It has been uncomfortable for me to answer these questions.	1	0

CRS14.Which substance were you thinking of **most** when you answered these questions? v. _____

	Never True	Rarely True	Sometimes True	Often True	Very Often True
1. I didn't have enough to eat.	1	2	3	4	5
2. I knew there was someone to take care of me and protect me (R).	1	2	3	4	5
3. People in my family called me "stupid," "lazy," or "ugly."	1	2	3	4	5
4. My parents were too drunk or high to take care of the family.	1	2	3	4	5
5. Someone in my family helped me feel important or special. (R)	1	2	3	4	5
6. I had to wear dirty clothes	1	2	3	4	5
7. I felt loved. (R)	1	2	3	4	5
8. I thought that my parents wished I had never been born.	1	2	3	4	5
9. Got hit so hard that I had to see a doctor or go to the hospital.	1	2	3	4	5
10. Family hit me so hard that it left me with bruises or marks.	1	2	3	4	5
11. I was punished with a belt/board/cord/other hard object	1	2	3	4	5
12. People in my family looked out for each other. (R)	1	2	3	4	5
13. People in my family said hurtful or insulting things to me	1	2	3	4	5
14. I believe that I was physically abused	1	2	3	4	5
15. Beaten so badly it was noticed by a Teacher/neighbor/doctor.	1	2	3	4	5
16. I felt that someone in my family hated me	1	2	3	4	5
17. People in my family felt close to each other. (R)	1	2	3	4	5
18. Someone tried to touch me in a sexual way/ Made me touch them.	1	2	3	4	5
19. Someone threatened me unless I did something sexual.	1	2	3	4	5
20. Someone tried to make me do/watch sexual things	1	2	3	4	5

21. Someone Molested me	1	2	3	4	5
22. I believe that I was emotionally abused	1	2	3	4	5
23. There was someone to take me to the doctor if I needed it. (R).	1	2	3	4	5
24. I believe I was sexually abused	1	2	3	4	5
25. My family was a source of strength and support. (R)	1	2	3	4	5

Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate how often you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

For each question choose from the following alternatives.

0	1	2	3	4
Never	Almost Never	Sometimes	Fairly Often	Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly? _____

2. In the last month, how often have you felt that you were unable to control the_____ important things in your life?

3. In the last month, how often have you felt nervous and "stressed"? _____

4.[a] In the last month, how often have you dealt successfully with irritating life hassles? _____

5.[a] In the last month, how often have you felt that you were effectively coping with _____ important changes that were occurring in your life?

6.[a] In the last month, how often have you felt confident about your ability to handle your personal problems _____

7.[a] In the last month, how often have you felt that things were going your way? _____

8. In the last month, how often have you found that you could not cope with all the _____ things that you had to do?

9.[a] In the last month, how often have you been able to control irritations in your life? _____

10.[a] In the last month, how often have you felt that you were on top of things _____

11. In the last month, how often have you been angered because of things that _____ happened that were outside of your control?

12. In the last month, how often have you found yourself thinking about things that you have to accomplish? _____

13.[a] In the last month, how often have you been able to control the way you spend your time? _____

14. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? _____

Brief COPE

These items deal with ways you've been coping with the stress in your life since you found out you were going to have to have this operation. There are many ways to try to deal with problems. These items ask what you've been doing to cope with this one. Obviously, different people deal with things in different ways, but I'm interested in how you've tried to deal with it. Each item says something about a particular way of coping. I want to know to what extent you've been doing what the item says. How much or how frequently. Don't answer on the basis of whether it seems to be working or not—just whether or not you're doing it. Use these response choices. Try to rate each item separately in your mind from the others. Make your answers as true FOR YOU as you can.

1 = I haven't been doing this at all
2 = I've been doing this a little bit
3 = I've been doing this a medium amount
4 = I've been doing this a lot

1. I've been turning to work or other activities to take my mind off things. _____
2. I've been concentrating my efforts on doing something about the situation I'm in. _____
3. I've been saying to myself "this isn't real.". _____
4. I've been using alcohol or other drugs to make myself feel better. _____
5. I've been getting emotional support from others. _____
6. I've been giving up trying to deal with it. _____
7. I've been taking action to try to make the situation better. _____
8. I've been refusing to believe that it has happened. _____
9. I've been saying things to let my unpleasant feelings escape. _____
10. I've been getting help and advice from other people. _____
11. I've been using alcohol or other drugs to help me get through it. _____
12. I've been trying to see it in a different light, to make it seem more positive. _____
13. I've been criticizing myself. _____
14. I've been trying to come up with a strategy about what to do. _____
15. I've been getting comfort and understanding from someone. _____
16. I've been giving up the attempt to cope. _____
17. I've been looking for something good in what is happening. _____
18. I've been making jokes about it. _____
19. I've been doing something to think about it less, such as going to movies, watching TV, reading, daydreaming, sleeping, or shopping. _____ 20. I've been accepting the reality of the fact that it has happened.

21. I've been expressing my negative feelings. _____
22. I've been trying to find comfort in my religion or spiritual beliefs. _____
23. I've been trying to get advice or help from other people about what to do. _____
24. I've been learning to live with it. _____
25. I've been thinking hard about what steps to take. _____
26. I've been blaming myself for things that happened. _____
27. I've been praying or meditating. _____
28. I've been making fun of the situation. _____

MAAS

Instructions: Below is a collection of statements about your everyday experience. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.

1	2	3	4	5	6
Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never

I could be experiencing some emotion and not be conscious of it until some time later.	1	2	3	4	5	6
I break or spill things because of carelessness, not paying attention, or thinking of something else.	1	2	3	4	5	6
I find it difficult to stay focused on what's happening in the present.	1	2	3	4	5	6
I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.	1	2	3	4	5	6
I tend not to notice feelings of physical tension or discomfort until they really grab my attention.	1	2	3	4	5	6

I forget a person's name almost as soon as I've been told it for the first time.	1	2	3	4	5	6
It seems I am "running on automatic," without much awareness of what I'm doing.	1	2	3	4	5	6
I rush through activities without being really attentive to them.	1	2	3	4	5	6
I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.	1	2	3	4	5	6
I do jobs or tasks automatically, without being aware of what I'm doing.	1	2	3	4	5	6
I find myself listening to someone with one ear, doing something else at the same time.	1	2	3	4	5	6
I drive places on 'automatic pilot' and then wonder why I went there.	1	2	3	4	5	6
I find myself preoccupied with the future or the past.	1	2	3	4	5	6
I find myself doing things without paying attention.	1	2	3	4	5	6
I snack without being aware that I'm eating.	1	2	3	4	5	6

In the past 2 weeks how many times have you practiced any type of mindfulness activity?

Enter number of times here _____