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Mindfulness-Based Relapse Prevention for Substance Craving

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Abstract

Craving, defined as the subjective experience of an urge or desire to use substances, has been identified in clinical, laboratory, and preclinical studies as a significant predictor of substance use, substance use disorder, and relapse following treatment for a substance use disorder. Various models of craving have been proposed from biological, cognitive, and/or affective perspectives, and, collectively, these models of craving have informed the research and treatment of addictive behaviors. In this article we discuss craving from a mindfulness perspective, and specifically how mindfulness-based relapse prevention (MBRP) may be effective in reducing substance craving. We present secondary analyses of data from a randomized controlled trial that examined MBRP as an aftercare treatment for substance use disorders. In the primary analyses of the data from this trial, Bowen and colleagues (2009) found that individuals who received MBRP reported significantly lower levels of craving following treatment, in comparison to a treatment-as-usual control group, which mediated subsequent substance use outcomes. In the current study, we extend these findings to examine potential mechanisms by which MBRP might be associated with lower levels of craving. Results indicated that a latent factor representing scores on measures of acceptance, awareness, and nonjudgment significantly mediated the relation between receiving MBRP and self-reported levels of craving immediately following treatment. The mediation findings are consistent with the goals of MBRP and highlight the importance of interventions that increase acceptance and awareness, and help clients foster a nonjudgmental attitude toward their experience. Attending to these processes may target both the experience of and response to craving.

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Contributors: Katie Witkiewitz and Sarah Bowen designed the study and wrote the protocol. Sharon Hsu was integral to the execution of the study and the participant assessments. Haley Douglas and Sharon Hsu conducted literature searches and provided summaries of previous research studies. Katie Witkiewitz conducted the statistical analysis. Katie Witkiewitz and Sarah Bowen wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

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Keywords

craving; substance use disorder; mindfulness; relapse prevention; MBRP

1. Introduction¹

Over the past decade, substance use disorder has been conceptualized as a chronic relapsing condition (McLellan, 2002; McLellan, McKay, Forman, Cacciola, & Kemp, 2005), where relapse has been variously defined as either the return to problematic substance use following treatment or as a process of behavior change (Brownell, Marlatt, Lichtenstein, & Wilson, 1986; Maisto, Pollock, Cornelius, Lynch, & Martin, 2003; Witkiewitz & Marlatt, 2004). A substantial amount of research over the past 20 years has focused on identifying predictors of relapse and developing treatments (including pharmacological and psychological) that may help prevent relapse. One of the strongest predictors of relapse to emerge in both pre-clinical and clinical research studies is craving (Anton, 1999; Breese, Sinha, & Heilig, 2011; Drummond, 2001; Marlatt, 1978; Shadel et al., 2011; Sinha & O'Malley, 1999), and many of the promising pharmacotherapies and most effective psychotherapies for addiction have focused on reducing or managing substance craving. In the current paper, we review the efficacy of mindfulness-based relapse prevention as a treatment for substance use disorders and empirically examine mechanisms of action for reduction of substance craving.

1.1. Substance Craving

The concept of “craving” as an essential facet of substance use disorders is generally accepted by researchers, clinicians and patients, yet operational and conceptual definitions vary widely (Anton, 1999; Potgieter, Deckers, & Geerlings, 1999; Rosenberg, 2009; Skinner & Aubin, 2010; Tiffany, Carter, & Singleton, 2000). Skinner and Aubin (2010) reviewed 18 models of craving that have emerged over the past 60 years, and concluded that while collectively the models of craving have been indispensable in the research and treatment of addictive behaviors, none of the models independently provide a complete explanation of the craving construct. For the purposes of the current paper, we define craving as the subjective experience of an urge or desire to use substances. Consistent with numerous models of craving, we acknowledge that it can be experienced as intrusive thoughts and the elaboration of intrusive thoughts (Kavanagh et al., 2006), an impulsive drive or motivation (Cox & Klinger, 2002), substance wanting (Robinson & Berridge, 1993), an emotional state (Tiffany & Wray, 2009), a physical sensation (Paulus, 2007), a stress response (Sinha & Li, 2007), or any other manifestation that is salient for an individual who endorses experiencing “craving” or an “urge” to use substances.

The roots of craving can be attributed to biological, affective, or cognitive motivators. Within biological models of craving, addiction is viewed as a brain disease, and the etiology of substance craving and substance use are both born out of neurobiological and physiological states (Robinson & Berridge, 1993; Wise, 1988). Craving can be reflected in neural states, as suggested by studies linking neurotransmitters such as dopamine, serotonin, and gamma-aminobutyric acid (GABA) to drug use (Johnson, Seutin, & North, 1992; Wise, 1988) and/or alcohol use (Addolorato, Leggio, Abenavoli, & Gasbarrini, 2005; Verheul, van den Brink, & Geerlings, 1999). For example, dopamine in the dorsal striatum has been

¹Abbreviations. MBRP = mindfulness-based relapse prevention, TAU = treatment as usual, PACS = Penn Alcohol Craving Scale, AAQ = Acceptance and Action Questionnaire, FFMQ = Five Facet Mindfulness Questionnaire, ACT = Acting with Awareness subscale of the FFMQ, NONJ = Nonjudgmental awareness subscale of FFMQ, CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation, SE = standard error

associated with reported craving (Volkow et al., 2006), and GABA dysregulation has been associated with a craving drive described as a relief of tension (Addolorato, Abenavoli, Leggio, & Gasbarrini, 2005). Other biological models of craving focus on physiological withdrawal states, wherein craving can occur as interoceptive dysregulation (Goldstein et al., 2009; Paulus & Stein, 2006).

Affective models suggest that craving is an emotion that can be elicited by affective expectancies, negative affect or stress (Baker, Morse, & Sherman, 1986; Wikler, 1948). In terms of positive expectancy, craving for drug use is elicited with positive associations with the effects of drug use. With negative affect, craving is suggested to be a state elicited by the avoidance of negative affect or stress associated with withdrawal such that craving can be both the result and cause of stress (Sinha & Li, 2007). Thus, the core motivation to avoid negative affective states is the cause of craving (Baker, Piper, Fiore, McCarthy, & Majeskie, 2004). In support, stress- and negative-affect-induced states have been shown to increase craving in the laboratory (Sinha & O'Malley, 1999). Further, negative affect is one of the most frequently endorsed reasons for relapse (Brownell et al., 1986; Marlatt & Gordon, 1985). Within an affective model of craving, affective states can elicit craving or prevent individuals from inhibiting craving.

From a cognitive perspective, it is suggested that craving is rooted in cognitive processes (e.g., memory, expectancies) that reflect higher-order information processing (Tiffany, 1999) that evolve into automatic processes of use (Tiffany, 1990). For example, Marlatt posits that craving is a result of cognitive expectancies for drug use (Marlatt, 1978; Marlatt & Gordon, 1985). Stress-induced craving is an example of how cognitive interpretations of an event can trigger craving, even in a laboratory setting (Sinha & Li, 2007). Additional evidence suggests that self-efficacy is a critical factor in the relation between craving and substance use (Marlatt & Witkiewitz, 2005). Hence, cognitive models of craving clearly outline craving as a psychological process, separate from drug use, whereby craving can occur without substance use, and substance use can occur without craving (Skinner & Aubin, 2010).

While these perspectives provide unique explanations of the causes of craving, many specific models of craving are a complex amalgam of biological, affective and cognitive constructs. For example, the withdrawal model (Wikler, 1948) describes craving, or the drive to use, as a result of both a biological conditioned response to drug related stimuli, and an attempt to escape negative affective states. Additionally, the theory of neural opponent motivation identifies craving as a biological deviation from the homeostatic regulation of neurotransmitters that can be elicited by change in affective states (Koob & Le Moal, 2001, 2008).

Different perspectives on craving imply unique implications for treatment. A cognitive perspective of craving treatment might target working memory (Houben, Wiers, & Jansen, 2011) or re-training attention to push substance cues away (Wiers, Rinck, Kordts, Houben, & Strack, 2010). An affective process perspective might focus on disrupting the association between negative affective states and the desire to use. A neurobiological perspective would be interested in directly targeting neurobiological dysfunction to impact craving (Volkow et al., 2006).

1.2. A Mindfulness Perspective on Craving

A fourth perspective on craving, of particular interest to the present study, comes from the mindfulness literature, and the use of mindfulness-based treatments to reduce and cope with craving. Such a perspective has the potential to advance the conceptualization and the treatment of neurobiological, cognitive, and affective aspects of craving.

Mindfulness has been described as, “the awareness that emerges through paying attention, on purpose, in the present moment, and nonjudgmentally to the unfolding of experience” (pg. 145; Kabat-Zinn, 2003). While secularized in most Western treatment contexts, mindfulness meditation has roots in the Buddhist tradition. From a Buddhist perspective, craving is considered a core component of human existence, and craving and attachment are viewed as the root cause of human suffering (Bodhi, 2005). From a mindfulness perspective, we might view addiction as an effort to either hold on to or avoid cognitive, affective or physical experiences. In an effort to avoid suffering, an individual either clings onto positive states (e.g., craving the next high) or avoids negative states (e.g., seeking an escape from sadness). Mindfulness practice includes observing craving, which is considered to be a transient cognitive and affective phenomenon, just like any other experience. Thus, the intention of the practice is to bring awareness to the experience of craving and to learn to observe it without reacting and without judgment.

Another intention of mindfulness practice is to increase acceptance of one's experience, allowing one to experience his or her current physical and affective state as impermanent. In recognizing that neither positive nor negative states are enduring, an individual realizes that the effort exerted to achieve or cling to a particular state of being is not only futile, but causes suffering. The practice of accepting physical and affective states as they are in the present moment is counter to the clinging quality of craving (Breslin, Zack, & McMain, 2002). Finally, the practice of mindfulness meditation has been shown to reduce neural aspects of craving (Westbrook et al., 2011). Specifically, Westbrook and colleagues (2011) found that the brain regions that are typically activated during craving (including the subgenual anterior cingulate cortex) showed reduced activity during mindful attention of smoking images, as compared to looking at the smoking images without mindful attention. Furthermore, during mindful attention, there was significantly reduced functional connectivity between the subgenual anterior cingulate cortex and other regions associated with craving, including the ventral striatum and the bilateral insula. Taken together, there is evidence to suggest that mindfulness-based treatment has the potential in addressing neurobiological, cognitive, and affective aspects of craving.

1.3. Mindfulness-Based Relapse Prevention

Drawing from the Buddhist tradition, Marlatt (2002) recognized that craving and addiction could be targeted by mindfulness meditation, but that many individuals might need additional cognitive and behavioral skills for coping with high risk situations for relapse. In response to the need for integrating mindfulness meditation with cognitive-behavioral skills training for addiction, Mindfulness-Based Relapse Prevention (MBRP; Bowen, Chawla, & Marlatt, 2010; Witkiewitz, Marlatt, & Walker, 2005), was developed as an aftercare treatment program that was designed to reduce the risk and severity of relapse following intensive substance abuse treatment.

1.3.1. The Mindfulness-Based Relapse Prevention Program—The MBRP program consists of eight 2-hour sessions, each including formal mindfulness practices, as well as exercises and skills designed to bring these practices into daily life, specifically into situations in which an individual is at high risk for relapse. The first three sessions focus on raising awareness of environmental triggers, and the physical, affective and cognitive reactions that follow, bringing awareness to the progression of reactions that occur in response to such cues. Clients learn “informal” mindfulness practices based on the foundational meditation practice they have built thus far to step out of the habitual cognitive and behavioral patterns and choose a more skillful response. As early as session two, clients engage in exercises specifically focused on coping with craving. Through in-session exercises designed to elicit craving, clients practice bringing awareness to the multiple

components of their experience while slowly increasing exposure and intensity to the craving response. They practice approaching the reactions with a gentle curiosity, and are given instructions to guide them through “staying with” the experience without exacerbating it, giving into it, or attempting to suppress it. The exercise allows clients to practice imaginal exposure and nonreactivity to substance use triggers. They learn skills to stay in contact with the internal reactions to external triggers (i.e., craving in response to substance use cues) that put them at high risk for relapse. Additionally, they learn an alternative, competing response to craving by approaching the experience with curious awareness, deescalating the process by not engaging in habitual cognitive or behavioral patterns that tend to intensify the craving reaction.

In order to increase ability to tolerate the discomfort often associated with craving and other reactions to triggers clients maintain an ongoing practice of both formal meditation and of exercises designed to increase awareness of triggers and reactions. They begin to increase their ability to endure the affective and physical discomfort without reacting in ways that may temporarily relieve distress, but lead to problematic longer-term outcomes. The final two sessions of the course focus on social and environmental factors that either support or detract from the maintenance of treatment gains and an ongoing mindfulness practice.

1.3.2. Pilot Randomized Trial of Mindfulness-Based Relapse Prevention—A randomized pilot trial was conducted to assess feasibility and establish initial efficacy of the MBRP treatment protocol (Bowen et al., 2009). Participants (N = 168) were clients from a private, nonprofit treatment agency providing a continuum of care to adults with alcohol or other drug use disorders. To be eligible for the study, individuals had to have completed either inpatient or intensive outpatient treatment, and be medically stable to progress into aftercare. As such, all participants had completed initial treatment immediately prior to entering the trial, and were thus in early stages of abstinence. Clients with psychotic disorders or acute suicidality were excluded from participating.

Following a web-based baseline battery of assessments, participants were randomized to either MBRP or to treatment as usual (TAU) as delivered by the agency, which consisted primarily of 12-step treatment and psychoeducational programming. Analyses in the parent study (Bowen et al., 2009) revealed a difference in racial distribution between groups at baseline, with a higher percentage of White participants in MBRP (63%) than TAU (45%). This difference was not a systematic effect of randomization; thus, race was used as a covariate in all analyses in the parent study (Bowen et al., 2009). There were no other baseline differences between groups in demographic or main outcome variables. Overall, this indicates that randomization was successful.

Following the 8-week treatment period, participants randomized to the MBRP condition returned to their regular agency aftercare programs. As described in more detail in Section 2, assessments were given at baseline, immediately following the 8-week treatment period, and 2 and 4 months following the treatment. Individual characteristics, psychosocial factors and substance use in the 60day period prior to entering initial inpatient or intensive outpatient treatment were assessed. MBRP and TAU participants reported using substances on 27 (SD = 24) and 28.9 (SD = 24.8) days, respectively (Bowen et al., 2009). This difference was not statistically significant.

With respect to substance use outcomes, participants in both groups had a low base rate of substance use during and following treatment, with average days of use over the follow-up of 9.33 days for TAU (SD = 20.80) and 5.62 days for MBRP (SD = 14.33). Across both groups, fewer than 30% of participants (29.1% in TAU, 28.6% in MBRP) had any days of use. Of those who used, 28.6% and 33.3% of TAU and MBRP participants, respectively,

only used substances on one day during the follow-up period. A curvilinear effect of treatment on substance use outcomes suggested that treatment gains made by MBRP participants, compared to TAU participants, decayed by 4 months post-treatment. Analyses of craving showed a significantly greater decrease over the 4-month follow-up period in MBRP participants as compared to those in TAU. Additionally, there were significant increases in acceptance, as measured by the Acceptance and Action Questionnaire (Hayes et al., 2004), in MBRP versus TAU participants. Secondary analyses of data from the study by Bowen and colleagues (2009) found individuals who received MBRP were less likely to experience craving in response to depressed mood and the attenuated reactivity to depressed mood and reduced craving also predicted fewer days of substance use for those who received MBRP (Witkiewitz & Bowen, 2010). Based on these findings, we hypothesized that MBRP may extinguish the habitual response of subjective craving during periods of negative mood. Yet, previous studies have not examined mechanisms by which MBRP might reduce craving or alter the response of craving during negative mood states.

Given the basic tenets of MBRP, we propose numerous factors may predict levels of self-reported craving and changes in craving over time following MBRP. As noted above, one of the primary goals of MBRP is to target both the experience of and response to craving. Through several exercises and practices, clients increase their awareness of triggers that elicit craving and of the “automatic” craving reaction in response to these triggers. They practice acceptance of the discomfort often associated with triggers that may have, in the past, led to craving for escape relief, such as a desire for a substance to decrease the intensity of the negative affective, cognitive, or physical state. Finally, clients practice relating to their experiences and reactions with a nonjudgmental attitude, decreasing the distress often associated with self-judgment, frustration or shame in relation to craving or use.

We hypothesize that awareness, acceptance and nonjudgment function as necessary and interdependent processes, each supporting one another, and each an essential factor in the mitigation of the craving response. For example, awareness is a necessary condition for acceptance, i.e., an individual cannot truly accept something of which he or she is not aware. However, an individual may be aware of his or her experience but unwilling or unable to accept it. This individual may be more likely to attempt to deny or suppress the experience of craving, which may in turn result in even greater craving (Berry, May, Andrade, & Kavanagh, 2010). Finally, an individual may be aware of an experience, such as an affective response to a substance use trigger, but may experience self-judgment or shame about the reaction, increasing levels of negative affect and thus putting the individual at greater risk of increased craving. Thus, we hypothesized that a latent factor indicated by acceptance of experience, acting with awareness, and a non-judgmental attitude toward inner experience, would predict lower levels of craving and would mediate the association between receiving MBRP and changes in craving over time.

1.4. Current Study

The goal of the current study was to follow-up on the significant effect of MBRP on post-treatment craving scores reported by Bowen and colleagues (2009) by examining theoretically driven mechanisms of change. The first goal of the current study was to examine the effect of MBRP on levels of craving and changes in craving over time in a latent growth modeling framework to estimate the between-person and within-person variability in craving scores over time. The second goal was to build upon the study by Bowen and colleagues (2009) by examining whether changes in acting with awareness, acceptance, and nonjudgment mediated the association between participation in MBRP and self-reported changes in craving during and following MBRP.

2. Materials and Methods

2.1. Participants

Participants ($N = 168$) were recruited from a private, nonprofit agency providing a continuum of care for alcohol and drug use disorders, serving approximately 126 clients per month in both inpatient and outpatient settings. Approximately 57% of the agency's outpatient and 2% of inpatient clients are legally mandated to substance abuse treatment, and 19% of outpatient and 75% of inpatient clients are homeless. Roughly 55% of clients complete treatment as recommended. Eligible participants were between the ages of 18 and 70, fluent in English, had completed intensive outpatient or inpatient treatment in the previous 2 weeks, and were medically cleared for participation. Exclusion criteria included psychosis, dementia, imminent suicide risk, significant withdrawal risk, need for more intensive treatment, or not completing inpatient or intensive outpatient treatment. Out of 260 individuals screened, 29% ($n = 73$) failed to meet eligibility criteria, with primary exclusions being not completing the treatment program prior to the study enrollment ($n = 58$), active psychosis ($n = 10$), scheduling conflicts ($n = 4$), and active suicidality ($n = 1$). Of those eligible to participate ($n = 187$), eighteen declined participation or failed to attend the baseline appointment and one individual refused to be randomized. In anticipation of higher attrition in a novel treatment, we oversampled for the MBRP condition by 10%. Randomization was conducted using a web-based random number sequencer (<http://www.randomizer.org>). For the final total sample size of 168, of which 93 (55%) were randomized to MBRP and 75 (45%) were randomized to TAU, reflecting the oversampling for the MBRP treatment group.

The majority of participants (63.7%) were male, with an average age of 40.5 (10.3) years. Approximately half identified as Caucasian (51.8%), followed by African American (28.6%), Multiracial (15.3%), and Native American (7.7%). Approximately 41.3% reported being unemployed, with 32.9% receiving some form of public assistance, and 62.3% earning less than \$4999 per year. Approximately 45.2% of the sample reported alcohol as their primary substance of abuse, followed by cocaine/crack (36.2%), methamphetamines (13.7%), opiates/heroin (7.1%), marijuana (5.4%), and other (1.9%). Approximately 19.1% reported polysubstance use. Over 40% of the sample was in treatment for legal reasons (e.g., treatment was court ordered) and for many individuals substance use was prohibited during and following treatment.

2.2. Procedures

All study procedures were approved by the University of Washington Institutional Review Board. No side effects of treatment or adverse events during the course of the study were detected or reported. Participants were recruited near the end of their inpatient or outpatient treatment through flyers and referrals from agency or research staff. Potential participants contacted research staff by telephone, provided verbal consent for screening, and completed a 30–45 minute telephone eligibility screen. Following informed consent procedures, eligible participants completed a web-based baseline assessment in a private room at the treatment agency, with research staff available to assist or answer participants' questions. Each participant was assigned a unique study ID number, which also serves as the ID number for accessing the subsequent follow-up web-based assessments, which participants were free to complete at a location of their choosing. Following completion of the assessment, participants were randomly assigned (using a computerized random number generator) to either 8-weeks of MBRP or continuation of their existing treatment (treatment as usual, TAU). Participants randomized to MBRP agreed to discontinue TAU for the 8-weeks of the course, and to resume TAU following completion of MBRP. MBRP participants were scheduled to complete a web-based follow-up assessment immediately

following the 8-week course, and 2-months and 4-months following the intervention. TAU participants followed the same schedule. Reminder calls for follow-up assessments were made to each cohort according to assessment schedule. Given that the assessment was web-based, participants were given the option to complete the assessment on their own or schedule an appointment at the treatment agency. Participants who did not complete their scheduled follow-up assessments were contacted via telephone to document their substance use. All participants received \$45 gift cards for completion of baseline and post-intervention assessments, and a \$50 gift card for completion of 2- and 4-month assessments. All participants, regardless of assignment, were encouraged to continue attending any additional community 12-step or other self-help meetings as recommended by the treatment agency.

MBRP was delivered by two therapists to groups of 6–10 participants. Sessions were conducted in the group therapy room at the treatment agency. Closed cohorts met weekly for eight two-hour sessions. Sessions included guided meditations, experiential exercises, and discussion. Participants were assigned daily exercises to practice between sessions, and were given CDs for daily meditation practice. Relapse prevention practices (Daley & Marlatt, 1992) were integrated into the mindfulness-based skills. MBRP therapists held master's degrees in psychology or social work, and all had a background in cognitive-behavioral interventions and mindfulness meditation practice. All sessions were audio recorded, and treatment fidelity was assessed by a team of coders who were trained to identify key content- and style-related components of MBRP, using The Mindfulness-Based Relapse Prevention Adherence and Competence Scale (Chawla et al., 2010).

Participants in the TAU condition continued in their standard, rolling admission outpatient aftercare, which included work in the 12-step model, process-oriented groups, and psychoeducation. Relapse prevention skills, based on the disease model of addiction (Gorski, 1990), were included in some of the groups. Therapists facilitating the TAU groups were licensed Chemical Dependency Counselors, with diverse clinical training and experience.

2.3. Measures

All measures were self-report, and were administered via a web-based assessment program with staff available to assist participants in using the assessment interface. Research has found no significant differences between paper-and-pencil and web administration of commonly utilized measures (Miller et al., 2002). The measures used in the current analyses are described below and interested readers are referred to prior publications from this study for more information about other measures (Bowen et al., 2009).

2.3.1. Alcohol and Drug Craving—The Penn Alcohol Craving Scale (PACS; Flannery, Volpicelli, & Pettinati, 1999), a five-item self-report measure, was adapted to include craving for both alcohol and other drugs. The PACS measures frequency, intensity, and duration of craving, as well as an overall rating of craving for the previous week. The PACS has shown excellent internal consistency and predictive validity for alcohol relapse. The internal consistency of the PACS in the current sample was 0.87.

2.3.2. Awareness—The “acting with awareness” and “non-judgment” subscales of the Five Factor Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) were used as measures of awareness and nonjudgment in the current study. The FFMQ consists of 39 items and five subscales (1) “observe,” (notice or attend to internal and external phenomena); (2) “describe,” (label observed phenomena such as thoughts and emotions); (3) “acting with awareness,” (engage with full awareness in current experience or activity); (4) “non-judgment,” (nonjudgmental awareness of current

experience without evaluation); and (5) “non-reactivity,” (notice internal phenomena without reacting). Internal consistency of the FFMQ in the current study was .91, with subscale alphas ranging from .80–.87.

Sample items from the acting with awareness subscale include: “I find it difficult to stay focused on what’s happening in the present” and, “It seems I am “running on automatic” without much awareness of what I’m doing.” Sample items from the non-judgment subscale include: “I criticize myself for having irrational or inappropriate emotions” and, “When I have distressing thoughts or images, I judge myself as good or bad, depending on what the thought/image is about.” Items are rated on a 5-point Likert-type scale (always true to never true) with higher scores indicating greater awareness and non-judgment.

2.3.3. Acceptance—Acceptance was measured using the Acceptance and Action Questionnaire (AAQ; Hayes et al., 2004). The AAQ is a 9-item instrument that assesses acceptance versus avoidance and control of negative private experiences. Internal consistency of this measure in the current study was .68. Sample items include, “When I evaluate something negatively, I usually recognize that this is just a reaction, not an objective fact” and, “If I could magically remove all the painful experiences I’ve had in my life, I would do so” (reverse coded). Items are rated on a 7-point Likert-type scale with higher scores indicating greater acceptance.

2.4. Statistical Analyses

To examine the hypotheses outlined above, a series of latent variable growth models were estimated using Mplus version 6.11 (Muthén & Muthén, 2010). First, unconditional models of self-reported craving were estimated separately without covariates using a systematic process of model testing whereby an intercept-only model was compared to increasingly complex functional forms (e.g., linear slope, linear + quadratic slope, nonlinear slope). Model fit of all models was evaluated by χ^2 values, the Root Mean Square Error of Approximation (RMSEA) (Browne & Cudeck, 1993), and the Comparative Fit Index (CFI) (Bentler, 1990). Models with non-significant χ^2 , RMSEA less than 0.06, and CFI greater than 0.95 were considered a good fit to the observed data (Hu & Bentler, 1999).

After establishing the unconditional model of craving, we examined the association between treatment group and craving changes over time by including treatment condition (dummy coded as “treatment as usual = 0” and “MBRP = 1”) as a covariate predictor of the craving growth factors. Race and treatment hours (total hours of treatment received including MBRP groups as recorded in agency records), which have been shown to influence outcomes in the current sample (Bowen et al., 2009; Witkiewitz & Bowen, 2010), were also included as covariate predictors of the craving growth factors in all analyses.

Next, we examined whether a latent factor indicated by acceptance, nonjudgmental awareness, and acting with awareness provided a reasonable fit to the data using a longitudinal confirmatory factor analysis of each indicator assessed at baseline and the end of treatment. Finally, we examined whether the end of treatment latent acceptance, nonjudgmental awareness, and acting with awareness factor mediated the association between treatment condition and changes in craving over time using the product of coefficients method (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). The product of coefficients method provides an estimate of the mediated (i.e., indirect) effect by multiplying regression coefficients for the regression of the mediator (i.e., acceptance, nonjudgmental awareness, and acting with awareness latent factor) on the independent variable (i.e., treatment condition) and for the regression of the outcome (i.e., craving) on the mediator with the independent variable and baseline measures of the mediator and outcome included in the model (Mackinnon & Fairchild, 2009). The mediated effect was

estimated in Mplus using 1000 bootstrap draws to obtain confidence intervals for the indirect effect.

All models were estimated using full information maximum likelihood, which provides estimates of the variance-covariance matrix for all available data, including those individuals who have incomplete data on some measures. Maximum likelihood estimation is considered to be superior to other methods of handling missing data (e.g., listwise deletion), when the reason for the missing data is completely random or if the variables that explain the missing data are included in the model (i.e., the data are “missing at random;” Schafer & Graham, 2002). Analyses indicated that individuals with missing craving assessments at 2- and 4-months following treatment had significantly higher craving at posttreatment ($t = -3.22, p = 0.002$), thus one of the reasons for missing data was known and we assumed that data were missing at random with posttreatment craving included in the model.

3. Results

3.1. Preliminary Analyses

Descriptive statistics for craving scores and covariates for the total sample and by treatment groups are included in Table 1. First, it is important to note that the MBRP group had significantly greater treatment exposure (as measured by total number of treatment hours), on average. Craving scores had a possible range of 0 (no thoughts of craving) to 6 (constant thoughts of craving). Individuals who were assigned to MBRP had lower craving scores during and following treatment, with significantly lower craving scores during treatment (midtreatment; $t(125) = 2.43, p = 0.02$) and immediately following treatment (posttreatment; $t(101) = 2.37, p = 0.02$). Treatment groups also significantly differed on average scores on the AAQ and on the nonjudgmental awareness subscale of the FFMQ immediately following treatment, with the MBRP group scoring higher on each scale indicating a tendency toward greater acceptance ($t(94) = -2.00, p = 0.04$) and less judgment ($t(95) = -2.19, p = 0.03$).

3.2. Changes in Craving

The unconditional latent growth model of craving (without covariates) which included the intercept set at baseline, a linear slope, and a quadratic slope, provided an excellent fit to the observed data ($\chi^2(7) = 7.19, p = 0.41, CFI = 0.99$, and $RMSEA = 0.01$ (90% CI: 0.00 – 0.09)). The average intercept was 1.61 (SE = 0.10), the average linear slope was -0.12 (SE = 0.07), and the average quadratic slope was 0.009 (SE = 0.01), indicating that scores on the PACS were low at baseline (range = 0.00 to 5.60) and decreased over time before leveling out at the 2- to 4-month follow-ups. The average variances of all growth factors were significant, indicating significant individual variation around the mean growth trajectory of self-reported craving.

The latent growth model of craving with growth factors regressed on treatment, race, and treatment hours also provided a reasonable fit to the data ($\chi^2(13) = 19.95, p = 0.10; CFI = 0.98; RMSEA = 0.06$ (90% CI: 0.00 – 0.10)). The intercept of craving was significantly associated with race ($\beta = 0.43; B(SE) = 0.94(0.18), p < 0.005$), such that non-Hispanic white participants had higher initial craving. Treatment condition was significantly associated with both the linear slope ($\beta = -0.38; B(SE) = -0.42(0.16), p = 0.01$) and the quadratic slope ($\beta = 0.39; B(SE) = 0.06(0.03), p = 0.01$) of craving scores. The significant difference between treatment conditions in the changes in craving over time was further examined using a multiple groups design whereby treatment condition was used as a grouping variable with the means and the variances of the growth factors freed to vary across treatment conditions. As seen in Figure 1, individuals assigned to MBRP had a

greater decrease in craving scores during treatment, and their craving scores leveled out following treatment, whereas individuals in TAU reported a slight increase in craving scores during treatment.

3.3. Confirmatory Latent Factor Model of Acceptance and Nonjudgmental Awareness

A longitudinal confirmatory latent factor model of the Acceptance and Action Questionnaire (AAQ) total score and the total scores from the Acting with Awareness (ACT) and Nonjudgmental Awareness (NONJ) of the Five Facet Mindfulness Questionnaire was estimated with AAQ, ACT, and NONJ at baseline and posttreatment included as indicators of latent variables at baseline and posttreatment. Sequential model testing indicated that a longitudinal confirmatory factor model with time-invariant factor loadings and residual variances, and time-varying item intercepts and factor means provided the best fit to the data ($\chi^2(8) = 4.69, p = 0.79; CFI = 1.00; RMSEA = 0.00$ (90% CI: 0.00 – 0.06). Standardized factor loadings were greater than 0.7 for all indicators (AAQ: $\beta = 0.72$; ACT: $\beta = 0.78$; NONJ: $\beta = 0.77$) and the post-treatment latent factor was significantly associated with the baseline latent factor ($B(SE) = 0.64(0.11), p < 0.001$). For sake of brevity we will refer to this latent factor as “mindfulness” throughout the remainder of this paper, however it is important to note we do not imply that we have identified a mindfulness construct that is distinct from previous conceptualizations of mindfulness (Baer et al., 2006). “Mindfulness” is merely a descriptive label for the latent factor.

3.4. Predictors of Craving following MBRP

Next, we estimated a latent growth model of craving scores with the intercept centered at the end of treatment so that we could examine the predictors of the level of craving immediately following treatment, as well as the change in craving over time (i.e., slope). Treatment hours, treatment condition, race and the mindfulness latent factor were included as predictors of the craving growth factors.

The latent growth model with main effects of the covariate predictors and the interaction between the covariates and treatment condition provided an adequate fit to the observed data ($\chi^2(64) = 84.35, p = 0.05; CFI = 0.97; RMSEA = 0.044$ (90% CI: 0.00 – 0.07). As seen in Table 2, there was a significant main effect of treatment group, the mindfulness latent factor, and race in predicting the craving intercept. Random assignment to MBRP, higher scores on the latent factor (indicating greater acceptance, awareness, and nonjudgment), and being a minority were significantly associated with lower levels of craving. There were also significant main effects of treatment hours and race in predicting linear slope, such that more treatment hours and being non-Hispanic white were associated with a greater linear decrease in craving over time.

3.5. Mediators of the Association between MBRP and Changes in Craving

In the final set of analyses, we examined whether the mindfulness latent factor mediated the association between receiving MBRP and changes in craving over time while controlling for baseline levels of all measures. The mediation model provided an excellent fit to the data ($\chi^2(63) = 78.64, p = 0.09; CFI = 0.98; RMSEA = 0.039$ (90% CI: 0.00 – 0.06). As seen in Figure 2, results indicated that treatment was significantly associated with the mindfulness latent factor ($\beta = 0.23; B(SE) = 2.21(0.89), p = 0.01$) and the mindfulness latent factor predicted the level of craving at the end of treatment ($\beta = -0.43; B(SE) = -0.09(0.03), p = 0.001$). Mediation testing indicated that the mindfulness latent factor significantly mediated the association between treatment and the level of craving at the end of treatment ($B(SE) = -.19(.10), p = 0.04; 95\% CI: -0.38, -0.004$). The mindfulness latent factor did not significantly mediate the association between treatment and the linear slope ($p = 0.68$) or quadratic slope ($p = 0.72$) of craving.

Follow-up mediation analyses were conducted with each indicator of the mindfulness latent factor incorporated into the model as an observed mediator of the association between treatment group and the craving growth factors. These mediation analyses, which were conducted separately for each indicator of the mindfulness latent factor (AAQ, ACT, NONJ), provided a test of whether the mediating effect of acceptance, awareness, and nonjudgment in the association between treatment and the craving growth factors was specific to one of the three indicators of the latent factor. Results indicated no significant mediating effects of any of the individual observed indicators (AAQ indirect: $B (SE) = -0.18 (0.10)$, $p = 0.07$; ACT indirect: $B (SE) = -0.10 (0.06)$, $p = 0.10$; NONJ indirect: $B (SE) = -0.04 (0.05)$, $p = 0.39$).

4. Discussion

In line with our previously reported results (Bowen et al., 2009), the current analyses support that participating in MBRP was associated with significant reductions in self-reported craving during and following treatment. Race and treatment hours were significantly associated with the level of craving following treatment and changes in craving over time, such that being non-Hispanic white was associated with higher levels of craving and a greater decrease in craving over time. Treatment hours were also associated with a greater decrease in craving.

Extending our prior research, the results from the mediation analyses supported the hypothesis that a latent factor representing interdependent processes of acceptance, awareness and nonjudgment would significantly mediate the relation between receiving MBRP and self-reported levels of craving immediately following the intervention. Thus, higher levels of this factor could be a potential mechanism by which MBRP may influence craving. Importantly, acceptance, awareness, or nonjudgment did not independently mediate the association between MBRP and the level of craving following treatment, suggesting that the combination of the processes is necessary to predict changes in craving.

Importantly, there was not a significant effect of MBRP or the mindfulness latent factor on the linear or quadratic rate of change in craving over time; subsequently the mindfulness latent factor was not a significant mediator of the association between MBRP and craving changes. As seen in Figure 1, the greatest changes in craving for the MBRP group emerged between the baseline and midtreatment assessment, after which the rate of change in craving was similar across the MBRP and TAU groups. The first assessment of acceptance, awareness, and nonjudgment after treatment initiation also occurred at midtreatment. We did find a significant association between the mindfulness latent factor and observed craving scores at midtreatment ($\beta = -0.37$), after controlling for baseline levels, however we did not have temporal precedence to test whether initial changes in the mindfulness latent factor mediated the initial changes in craving observed between baseline and the midtreatment assessment.

The finding that the mindfulness latent factor, but not the independent subscales of acceptance, awareness, or nonjudgment mediated the association between MBRP and self-reported craving is intriguing. On one hand, this might reflect enhanced reliability and reduced measurement error in latent variable models. Although, as noted above in Section 1.3, this finding is also consistent with the goals of MBRP to specifically target both the experience of and response to internal stimuli by increasing acceptance and awareness, while maintaining a nonjudgmental attitude. Heightened acceptance, without true awareness, could be referred to as “naïve acceptance” and could result in an individual being blindsided by triggers that were not in conscious awareness (Andrade, May, & Kavanagh, 2009; Ingjaldsson, Thayer, & Laberg, 2003). Improved awareness without acceptance might lead

to attempts to avoid or suppress the experience of craving, which may actually increase the experience of craving (Berry et al., 2010). Finally, greater acceptance and awareness with a judgmental attitude could also be counterproductive in that an individual may be highly aware and accepting of his or her craving, while also judging him or herself and experiencing shame (Luoma, Kohlenberg, Hayes, & Fletcher, 2011). Small sample sizes in the current study prevented us from directly examining these speculations. For example, none of the MBRP participants and only two of the TAU participants were more than one standard deviation above the mean on awareness and more than one standard deviation below the mean on acceptance.

4.1. Limitations

The current study had numerous limitations and future work is needed to replicate and extend the analyses conducted in the current study. The most significant limitation was the subjective, self-reported measurement of craving, acceptance, awareness, and nonjudgment. Numerous authors have questioned self-reported craving measures (Drummond, Litten, Lowman, & Hunt, 2000) and, in general, there is not an agreed upon operational definition of craving (Skinner & Aubin, 2010). Similar measurement issues have been raised in the study of mindfulness and mindfulness-based treatments (Diclemente, 2010; Grossman, 2011). Furthermore, the measures of acceptance, awareness, and nonjudgment used in the current study were not designed to assess the types of responses and experiences targeted in MBRP, and a more specifically tailored assessment measure (e.g., a behavioral task) might more accurately reflect the true underlying mechanisms.

Other major design limitations included the brevity of the follow-up window, the lack of a no-treatment or waitlist control group, and the amount of missing data. Finally, as noted in prior analyses of these data (Bowen et al., 2009; Witkiewitz & Bowen, 2010), there were also noteworthy differences between the treatment as usual and MBRP groups, with respect to therapist training, group composition (closed cohort vs. rolling admission), and group content (primarily educational versus highly interactive), that could also explain the current findings.

4.2. Clinical Implications and Future Directions

Differing perspectives on causes of craving may point to different processes by which to treat clients in early abstinence for substance use disorders. While previous studies and treatments suggest treating the contributing biological, cognitive and affective symptoms, a mindfulness perspective focuses on increasing awareness, acceptance, and fostering a compassionate, nonjudgmental relationship to these experiences. The current findings suggest that a combination of these three components may be necessary for decreasing craving. It may therefore be critical for providers of mindfulness-based treatments for substance use disorders to maintain emphasis on all three processes.

Future research should attempt to replicate and extend the current findings by including a longer follow-up following treatment, and adding additional and possibly multimodal assessments of acceptance, awareness, nonjudgment and craving during treatment. Ideally, future studies would include implicit, physiological and/or neurobiological measures of craving, as well as behavioral, objective measures of acceptance, awareness, and nonjudgment. Having individuals complete a behavioral task in which they practice acceptance and awareness without judgment during a cue reactivity task could provide further information about whether MBRP is truly changing the experiences of and responses to substance use triggers (Westbrook et al., 2011). Furthermore, it would be useful to combine all of the constructs identified in the current study into a single self-report questionnaire that could measure acceptance, awareness and nonjudgment of craving

experiences. Finally, it will be important to determine whether MBRP is more or less beneficial for individuals with specific types of craving (e.g., aversion-driven vs. reward-driven; Gardner, 2011) and whether specific components of MBRP are more or less associated with changes in awareness, acceptance, non-judgment, and craving.

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Highlights

- MBRP was designed to change the response to and experience of substance craving.
- MBRP has been shown to reduce substance craving and use following treatment.
- We examine potential mediators of the association between MBRP and craving changes.
- Acceptance, awareness, & nonjudgment were used to create a mindfulness factor.
- The mindfulness latent factor mediated the association between MBRP and craving.

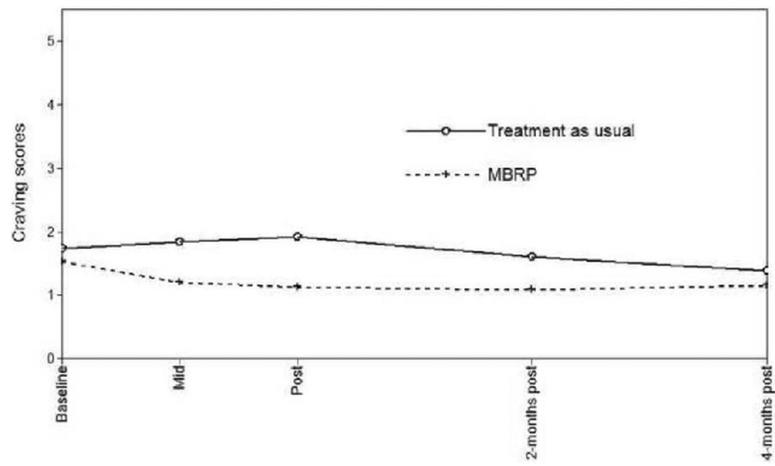


Figure 1. Changes in self-reported craving scores over time by treatment group. MBRP = mindfulness-based relapse prevention.

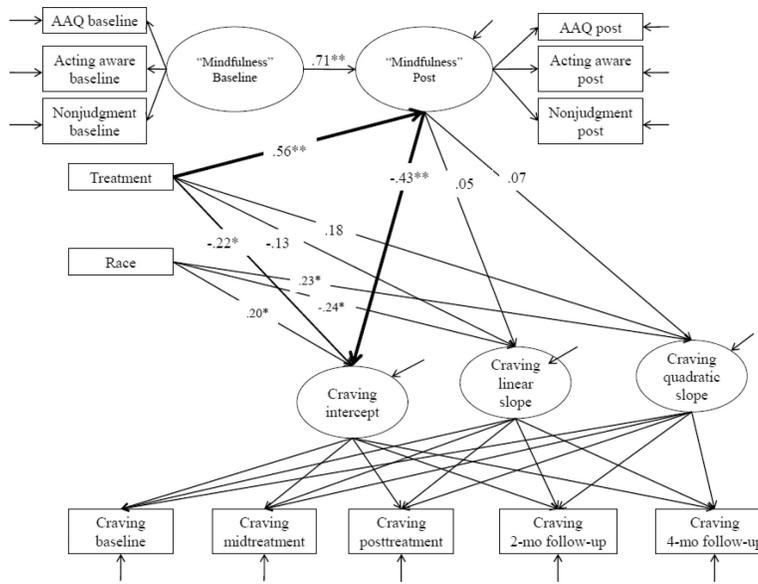


Figure 2. Model of the “mindfulness” latent factor mediating the association between treatment and the craving growth factors with thicker black lines marking the significant mediated effect. As described in section 3.4 the craving intercept was centered at posttreatment by setting the linear slope coefficients to -1 for baseline, -0.5 at midtreatment, 0 at posttreatment, 1 at the two-month follow-up, and 2 at the four-month follow-up. AAQ = Acceptance and Action Questionnaire. * $p < 0.05$, ** $p < 0.001$.

Table 1
 Descriptive Statistics (Means (Standard Deviations) for Total Sample and By Treatment Groups

Measure	Total sample		Treatment as usual		MBRP		d
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	
Treatment hours	167	11.44 (6.71)	74	9.75 (8.17)	93	12.79 (4.91)	.45*
Craving baseline	166	1.63 (1.26)	75	1.73 (1.42)	91	1.55 (1.13)	.14
Craving midtreatment	127	1.38 (1.06)	47	1.67 (1.26)	80	1.21 (0.89)	.45*
Craving posttreatment	103	1.35 (1.24)	41	1.70 (1.42)	62	1.12 (1.05)	.47*
Craving 2-months post	95	1.17 (1.24)	42	1.42 (1.49)	53	0.98 (0.98)	.36
Craving 4-months post	122	1.17 (1.37)	52	1.28 (1.50)	70	1.09 (1.26)	.14
Acceptance baseline	148	47.14 (8.52)	72	47.18 (9.55)	76	47.09 (7.47)	.01
Acceptance posttreatment	96	49.72 (8.91)	40	47.60 (10.03)	56	51.23 (7.76)	.41*
Nonjudgment baseline	148	26.27 (6.47)	68	26.99 (6.68)	80	25.66 (6.27)	.24
Nonjudgment posttreatment	97	27.18 (6.74)	38	25.34 (6.12)	59	28.36 (6.90)	.45*
Acting with awareness baseline	156	26.87 (6.50)	72	27.69 (6.85)	84	26.15 (6.23)	.24
Acting with awareness posttreatment	95	26.84 (7.04)	40	26.50 (7.21)	55	27.09 (6.97)	.09

Note. MBRP = mindfulness based relapse prevention d = Cohen's d measure of effect size calculated at each time point using the formula:

$$d = \frac{x_1 - x_2}{s_p^2}$$

* $p < 0.05$, differences between treatment groups based on independent samples t-test.

Table 2
Covariate Predictors of the Change in Craving Over Time (from Baseline to 4-Months Post-Treatment)

Model Predictor	Intercept		Linear Slope		Quadratic	
	B (SE)	β	B (SE)	β	B (SE)	β
Main Effects						
Treatment hours	-0.009 (0.01)	-0.06	-0.02 (0.01) *	-0.26	0.004 (0.01)	0.09
Race (1 = Non-Hispanic white)	0.41 (0.18) *	0.21	-0.27 (0.12) *	-0.24	0.14 (.08)	0.23
Treatment group (1 = MBRP)	-0.57 (0.17) **	-0.30	-0.06 (0.12)	-0.05	0.11 (.08)	0.18
Acceptance & awareness latent factor	-0.06 (0.02) **	-0.41	0.01 (0.01)	0.09	0.003 (0.01)	0.06
Mediation Model						
Treatment hours	-0.01 (0.01)	-0.08	-0.02 (0.01) *	-0.26	0.004 (0.01)	0.09
Race (1 = Non-Hispanic white)	0.38 (0.18) *	0.20	-0.27 (0.12) *	-0.24	0.14 (.07) *	0.23
Treatment group (1 = MBRP)	-0.46 (0.20) *	-0.24	-0.08 (0.13)	-0.07	0.11 (.09)	0.18
Acceptance & awareness latent factor	-0.09 (0.03) **	-0.43	0.01 (0.02)	0.08	0.004 (0.01)	0.06
Indirect effect	-0.19 (0.10) *	-0.20	0.02 (0.05)	0.04	0.009 (0.02)	0.03

etc.

* $p < 0.05$

** $p < 0.01$, B (SE) = unstandardized regression coefficient (standard error), β = standardized regression coefficient.