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Mindfulness-Based Interventions as a Mechanism for Improving Medical Regimen Adherence

Predictors of Formal Mindfulness Meditation Adherence During and After a Mindfulness Intervention

and

Self-Related Targets Engaged by Mindfulness-Based Interventions: A Systematic Review and Evidence Map

By

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Thesis

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VITA

Sarah I. Peters was born January 5, 1994 in Boston, Massachusetts to Dr. Edward Peters and Dr. Frannie Kronenberg. Sarah attended Brown University in Providence, Rhode Island. At Brown, Sarah was an active participant in the Rhode Island food system through the Swearer Center's TRI-Lab on healthy food access, through her work with Rhode Island Public Health Institute's mobile market, Food on The Move, and through courses, research, and activities. She founded the Brown University chapter of Project Sunshine at Hasbro Hospital, and became a certified group fitness instructor. Sarah graduated from Brown University in May 2016 with honors for her thesis, Fruit and Vegetable Intake and Perceived Barriers by Different Measures of Acculturation among Hispanics Participating in the Live Well Viva Bien Study in Rhode Island, for which she won an award for Excellence in Public Health Honors. While completing her Master's in Public Health, Sarah worked part-time at the Rhode Island Department of Health as a Program Assistant in the Physical Activity and Nutrition division. She also worked as a research assistant and was funded by Grant Number UH2AT009145 from the National Center for Complementary and Integrative Health (NCCIH) and the Office of Behavioral and Social Sciences Research (OBSSR). Sarah plans to continue her work focused on improving food access, physical activity, and the built environment so that everybody has an equal opportunity to lead a healthy life.

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PART I: PREDICTORS OF FORMAL MINDFULNESS MEDITATION ADHERENCE DURING AND AFTER A MINDFULNESS INTERVENTION

ABSTRACT

Background: Nonadherence to medical regimens is one of the major causes of healthcare spending in America. Meanwhile, mindfulness meditation interventions have gained popularity as effective treatments in both clinical and non-clinical populations.

Objective: This study aims to identify which baseline variables are associated with meditation adherence during and after a mindfulness-based intervention; which variables can be changed through the mindfulness intervention; and, of these changed variables, which are able to predict adherence to meditation post-intervention.

Methods: This study uses Pearson correlations and linear regressions to identify the relationships between six self-regulation (personality, executive function, emotion regulation, psychopathology, social support, and spiritual factors) assessment variables and meditation adherence during and after an eight-week mindfulness intervention.

Results: Baseline levels of conscientiousness, openness, and depression were found to significantly predict adherence during the intervention. Further, baseline levels of conscientiousness and depression, and week-eight measures of socializing skills, imitative behaviors, and existential factors significantly predicted adherence during follow-up. Almost all putative variables changed significantly during the intervention, yet only changes in mindfulness and depression were found to significantly predict adherence during follow-up.

Conclusion: This study observed that baseline levels of personality and psychopathology can predict meditation adherence during the intervention. It was also observed that measures of personality, psychopathology, and social support predicted post-intervention adherence to meditation. Future research is needed to replicate these findings and more fully understand the relationship between spirituality, social factors, and medical adherence.

INTRODUCTION

Medical regimen adherence (MRA) refers to the degree to which a patient correctly follows, or complies with, medical advice (Martin, Williams, Haskard, & Dimatteo, 2005). MRA is a key factor in determining effective healthcare and enabling the best possible health outcomes. Numerous studies have reported that MRA is essential for both preventing and curing disease (Martin et al., 2005; Ruff & Mackenzie, 2009). However, even though patient adherence is key to well-being, research indicates that nonadherence rates are as high as 70% (Martin et al., 2005). Medical treatment nonadherence is a major public health problem, which not only affects health outcomes, but it also adds an unnecessary cost burden to healthcare: an estimated $100 billion each year in the U.S. (M. H. Becker & Maiman, 1975; Cameron, 1996; Martin et al., 2005; Simoni, Frick, & Huang, 2006; Vermeire, Hearnshaw, Van Royen, & Denekens, 2001). In contrast, various preventive health approaches have been effective in reducing healthcare costs. Mind-body interventions, such as mindfulness meditation, represent one such modality that has been particularly beneficial (Ruff & Mackenzie, 2009).

Mindfulness meditation can be utilized for numerous circumstances, both clinical and nonclinical, as well as for treating and preventing disease. Today, research suggests that mindfulness training may be an effective strategy for treating many types of psychological disorders and physical conditions, such as mood disorders, depression, anxiety, diabetes, cancer, hypertension, chronic pain, workplace burnout, substance abuse, eating disorders, and traumatic brain injury (de Vibe et al., 2015; Geary & Rosenthal, 2011; Giluk, 2009; Hawley et al., 2014; Vettese, Toneatto, Stea, Nguyen, & Wang, 2009).

Mindfulness is characterized by an attentive non-judgmental focus on present moment experiences (Bishop et al., 2006). The practice of mindfulness evolved as part of the Buddhist practice; many of the recent mindfulness interventions draw upon the Buddhist traditions for inspiration and guidance. In the past two decades, research has focused on how mindfulness operates in the body and in the mind to actually create change (Cullen, 2011; Goyal, Singh, Sibinga, Gould, Rowland-Seymour, Sharma, Berger, KF, et al., 2014). In contemporary psychology, mindfulness has been viewed as a method for improving attention and awareness and for developing skills to reduce emotional and cognitive suffering (Bishop et al., 2006).

Mindfulness meditation has been thought to be able to create change through increased executive control and self-regulation (Teper & Inzlicht, 2013). Mindfulness meditation has been connected to self-regulation, which involves both initiating and maintaining behavior change, because it involves emotional, motivational, and cognitive processes (Bishop, Lau, Carlson, Anderson, & Speca, 2004). Frequently paying attention to the present moment is believed to improve self-regulation (Bishop et al., 2004). Furthermore, the nonjudgmental attitude that is developed through mindfulness leads to increased self-observation and the ability to better differentiate cognitive and affective experiences (Bishop et al., 2006; Teper & Inzlicht, 2013). Additionally, mindfulness meditation can be used to help people stay away from harmful behavioral responses to stress (Ruff & Mackenzie, 2009).

Most mindfulness meditation treatments include meditation home practice for participants to do in between class sessions. This practice is thought to be a crucial part of the intervention as it reinforces what is learned in class and gives participants an

opportunity to apply what they have learned in their own life (Crane et al., 2014; Kazantzis et al., 2016). Thus, home meditation practice adherence is an important element in measuring the effectiveness and the impact of mindfulness-based interventions. However, relatively few studies focus on meditation home practice adherence or on what can predict this adherence (Crane et al., 2014).

In order to improve MRA, including meditation home practice, it is necessary to understand what drives or predicts adherence in the first place. Adherence is affected by individual characteristics such as personality, attentional control, psychopathology, and spirituality as well as other factors, such as the degree of social support and the strength of the provider-patient relationship (Marshall H. Becker, 1985; de Vibe et al., 2015; Martin et al., 2005; Simoni et al., 2006).

PERSONALITY

Personality is often associated with health behaviors, and, as such, it is believed to be one of the major components that can affect MRA. Personality is typically defined using the five factor, or Big Five, model: this is the principal conceptual personality framework used in psychology today (Giluk, 2009; Latzman & Masuda, 2013; Sirois & Purc-Stephenson, 2008). This model is comprised by five factors: agreeableness, conscientiousness, openness, neuroticism, and extraversion. These five factors are used to categorize different aspects of human behavior, and together, in varying degrees, they can be used to describe a given individual. The factors that are commonly found to be more associated with health behaviors are conscientiousness, agreeableness, and neuroticism (Giluk, 2009; Sesker, Súilleabháin, Howard, & Hughes, 2016; Sirois & Purc-Stephenson, 2008). Previous research has discovered that high levels of conscientiousness and agreeableness are related to habits of more positive health behaviors and fewer negative

health behaviors (Sirois & Purc-Stephenson, 2008). Furthermore, research suggests that the facets of conscientiousness – achievement striving, orderliness, self-control, and deliberation – support the upkeep of positive behaviors and improved performance (Sesker et al., 2016). Conscientiousness and openness have also been associated with those who practice mindfulness meditation (de Vibe et al., 2015; Giluk, 2009; Honda & Jacobson, 2005; Latzman & Masuda, 2013; Sesker et al., 2016).

EXECUTIVE FUNCTION

Cognitive factors, such as attentional control and level of mindfulness, are believed to play a role in treatment adherence. Attentional control can inhibit or facilitate adherence. A patient's ability to pay attention to and remember information can greatly affect adherence, such as conscientious people are more likely to adhere to regimens due to their high levels of self-discipline and organization (Javaras et al., 2012). Additionally, attitudes and motivations relate to MRA as a person's thoughts and feelings can greatly impact their behaviors; the intention to adhere is necessary before carrying out the behavior (Martin et al., 2005). Moreover, levels of trait mindfulness can facilitate treatment adherence. Many studies suggest that mindfulness meditation engages the cognitive functions related to processes connected to attention and, thus, MRA (Chan & Woollacott, 2007; Tang et al., 2007; Teper & Inzlicht, 2013).

PSYCHOPATHOLOGY

The relationship between depression and adherence is well documented (DiMatteo et al., 2000). People with depression are more likely to be non-adherent to treatment regimens than those who do not have depression (Grenard et al., 2011). Furthermore, people with depression may be more motivated to meditate, yet their symptoms may interfere with their ability to practice (Crane & Williams, 2010; DiMatteo

et al., 2000). Research also demonstrates the potential of mindfulness-based interventions to improve levels of depression (Crane et al., 2014; Miller, Fletcher, & Kabat-Zinn, 1995). Depression has been conceptualized as disorder of self-regulation and as such, it was hypothesized that depression would be negatively correlated with measures of adherence (Brinkmann & Franzen, 2015; Strauman, 2002).

Additionally, poor emotion regulation hinders self-regulation and consequently MRA (Gross, 1998; Magai, Consedine, Neugut, & Hershman, 2007; Wing et al., 2008).

SPIRITUALITY

An individual's beliefs can affect health behaviors such as MRA. Spirituality has been conceptualized as the pursuit for understanding answers to ultimate questions about life, meaning, and relationships to the sacred or transcendent (Greeson et al., 2011). Research demonstrates that spirituality and spiritual beliefs are associated with better health behaviors, or medical adherence (Carmody, Reed, Kristeller, & Merriam, 2008; Greeson et al., 2011; Simoni et al., 2006). Furthermore, mindfulness-based interventions have demonstrated the ability to increase spirituality (Greeson et al., 2011). It was hypothesized that total spirituality would be associated with adherence since spirituality has been associated with lower levels of psychological distress and medical symptoms and has been associated with improved levels of health behaviors (Carmody et al., 2008).

SOCIAL SUPPORT

However, individual characteristics are not the only ones that matter when assessing drivers of MRA. Previous research strongly supports the relationship between social support and MRA (M. H. Becker & Maiman, 1975; Cameron, 1996; DiMatteo & Robin, 2004; Honda & Jacobson, 2005; Langenberg et al., 2000; Simoni et al., 2006; Steptoe, Perkins-Porras, Rink, Hilton, & Cappuccio, 2004). Social support includes the

relationships with family and friends as well as the patient-provider relationship. A social network, made up of family and friends, can offer assistance and encouragement to an individual. Social support is suggested to increase treatment adherence through improving self-efficacy, confidence, mood, and cognitive functioning while reducing conflict, distress, and social isolation (DiMatteo & Robin, 2004; Simoni et al., 2006). However, research also shows that simply the presence of a supportive social network alone is not sufficient to result in these beneficial health behaviors, but that the quality of the social support matters as well. Furthermore, a non-supportive social network may have deleterious effects on adherence by adding stress to an individual's life, rather than supporting or reducing it (DiMatteo & Robin, 2004).

The patient-provider relationship is found to be an important dimension of adherence. In order to recommend appropriate treatment, providers need to understand all aspects of their patient, such as personality traits, level of education, health literacy, as well as social and cultural drivers. And in order to properly comprehend and comply with a treatment plan, patients need to feel comfortable discussing the plan with the provider. Research suggests that openness and collaboration between providers and patients would result in greater likelihood of patient adherence (Cameron, 1996; Martin et al., 2005).

STUDY PURPOSE

The purpose of this current study was to examine possible predictors of mindfulness meditation adherence during and after an eight-week mindfulness intervention. Previous research has examined factors related to general medical treatment adherence, but very few papers have explored which variables may be responsible for adherence specifically with mindfulness-based interventions. This study has two main objectives:

1) to identify pre-existing trait-level factors that predict:

 a) meditation adherence during the treatment

 b) meditation goals set at week eight

 c) meditation adherence at three-month follow-up

2) to identify which pre-existing factors can be altered through treatment and

3) which of these treatment-related changes is associated with b) and c) above.

The putative self-regulation variables are: personality, executive function, emotional and psychopathology measures, spiritual, and social factors.

METHODS

PARTICIPANTS

Inclusion Criteria

In order to have a sample representative of American meditators, the present study included both clinical and non-clinical expressions of affective disorders (Barnes, Bloom, & Nahin, 2008). Included participants were English-speaking individuals between the ages of 18 and 65 years old. Individuals had to exhibit mild to severe levels of depression and high levels of negative affect. Depression was assessed using the Inventory of Depressive Symptomatology – Clinician Rated (IDS-C$_{30}$) (AJ Rush et al., 1986). Participants had to score between 10 and 48 in order to be considered for the trial. Negative affect was assessed using the Positive and Negative Affect Schedule – Expanded Form (PANAS-X); a well-validated scale that assesses dimensions of emotional experience (Watson & Anna Clark, 1999). A score of 18 or greater in the past month on the negative affect (NA) subscale was needed in order to participate in the study.

Exclusion Criteria

Participants were excluded if they had, at the time of screening or within the past month, extremely severe depression (IDS > 48); active suicidal ideation (IDS-18 > 2); presence of an DSM-IV defined Axis I personality disorder; panic disorder; post-traumatic stress disorder; eating disorder; substance abuse or dependence; inability to read or write in English; current psychotherapy; or a change in antidepressant medication type or dosage within the last 8 weeks. Participants were also excluded if they had a lifetime history of bipolar disorder; psychotic disorders (e.g. cyclothymia, schizophrenia, schizoaffective disorder); persistent antisocial behavior; repeated self-harm; borderline personality disorder; organic brain damage; or regular meditation practice. These conditions were considered as exclusion criteria because they may lead to behavior, which would disrupt group participation; require additional or specialized treatments; are outside the range of meditation uses and as such are not representative of typical meditators, or; they may confound the study results.

Settings

All assessments and treatments took place between November 2012 and March 2016 at the Clinical and Affective Neuroscience Laboratory in the Department of Psychiatry and Human Behavior at Brown University Medical School in Providence, RI. Participants were recruited by community flyers for a mindfulness program for people with anxiety, stress, or depression. Efforts were made to recruit racial and ethnic minorities by advertising in areas with high representation of these demographics.

Procedures

A total of 506 people were screened over the phone for eligibility based on the inclusion and exclusion criteria. After passing the phone screening, participants were

invited to the lab where they received clinical administration of the Structured Clinical Interview for DSM-IV (SCID), an instrument, which assesses the presence of DSM-IV Axis-I and Axis-II diagnoses that would exclude subjects from participating in the study. Participants were given the IDS-C$_{30}$ and the PANAS-X to determine that they had sufficient levels of depression and negative affect to participate in the trial. After screening was complete, 104 eligible people were invited to participate in the study. Participants underwent a baseline assessment to estimate baseline levels of neuropsychological and behavioral measures before beginning treatment. These assessments were repeated after participants completed the eight-week mindfulness training and again at a three-month follow-up interview. Individuals were randomly assigned to one of three intervention arms Mindfulness-Based Cognitive Therapy (MBCT), Focused Attention (FA) training, or Open Monitoring (OM) training based on a random sequence generated by an independent statistician using R (R Core Team, 2013). Since all three interventions were described as "mindfulness training," participants were unaware of which treatment type they actually received. Only the therapists knew the identifications of each treatment, and the post-treatment assessors were blind to treatment allocation.

INTERVENTIONS

Mindfulness-Based Cognitive Therapy (MBCT) was originally designed to help prevent relapse of depression, especially in people with major depressive disorder (MDD) (Williams & Teasdale, 2007). Additionally, MBCT has a published manual with standardized handouts and published treatment fidelity guidelines (Segal, Teasdale, Williams, & Gemar, 2002; Segal, Williams, & Teasdale, 2002). The MBCT arm adhered to the standardized MBCT manual, which focuses on both Focused Attention (FA) and

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Open Monitoring (OM). These components of MBCT – FA and OM – were also assigned as separate, concurrent eight-week interventions. All three interventions were matched for duration, format, and content. Each class contained an average of 11.5 participants with a range of 10-13 participants per class. Classes met for three hours once a week for eight weeks with a full day silent retreat offered during week six or seven. Meditation homework was assigned as 45 minutes/day of formal meditation practice six days a week.

The FA intervention trained participants on focused awareness techniques, which require sustained attention on a selected object or "anchor" while forgoing attention to surrounding objects or events. The FA process involves continuous attention on a chosen object, identifying distractions without becoming unfocused, dismissing the distraction, and refocusing on the anchor (Lutz, Slagter, Dunne, & Davidson, 2008).

The OM intervention trained participants to bring a balanced awareness to the present moment, including both internal and external events, without focusing directly on any object. OM meditation involves staying in a non-reactive monitoring state where stimuli are neither treated as distractors nor focused upon (Lutz et al., 2008).

MEASURES

Attendance: classes attended (%), retreat

Participant adherence during the intervention was tracked through attendance at the in-person intervention classes. Attendance was recorded at every class. Percent of classes attended was calculated by dividing the number of classes a participant attended by the total of eight classes. Participation at the day-long retreat was also recorded in order to later assess adherence with the treatment.

Intervention Treatment Adherence: Formal meditation minutes

Intervention treatment adherence was monitored through weekly logs that participants kept on Survey Monkey. Each week, participants recorded information about home formal meditation (FM) practice, such as the type of meditation (e.g. body scan, breath awareness); the number of minutes practiced; whether they fell asleep during practice; the use of a CD or tape during practice; and any informal practice (e.g. walking, mindful activities). Practice types were classified as either FM practice or informal meditation practice. FM types were the practices that involved a formal sit. This present study reports data concerning only FM practices. Weekly FM totals were calculated for each participant by multiplying the duration of meditation practice with the frequency of meditation practice.

Total FM minutes over the eight-week trial for each participant were subsequently calculated. Means of FM minutes practiced per week were calculated by averaging each of the weekly total FM minutes over the eight-week intervention.

Percent Adherence during Treatment

Percent adherence during the intervention program was calculated by taking the total number of FM minutes practiced during the eight-week intervention and dividing by 2160, the total number of homework minutes prescribed during the intervention, and multiplying by 100.

Follow-Up Practice Goals (FUG)

At the end of the intervention, participants were asked to set frequency and duration goals for each type of meditation they would practice following the eight-week therapy. This was done to have participants create a meditation plan for themselves; participants were asked to anticipate and report their practice goals on a weekly basis,

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including frequency and duration of each practice. We multiplied the frequency of FM per month with the duration-per-session of formal practice in order to calculate total FM practiced per month per participant. We then divided these values by four in order to get the total FM minutes per week that participants set at as goals for themselves at the end of the eight-week intervention.

Follow-Up Treatment Adherence: Formal Meditation Minutes

Follow-up evaluations took place three months after the eight-week interventions ended. At this time, participants were interviewed about their meditation practice during the past three months. Participants completed the same forms as they did at week eight, except this time in regards to meditation they had done over the past three months. Total FM minutes per week were calculated in the same manner as was done for the goals set at week eight.

Percent Adherence with Self Goals (ASG)

At five months, adherence was measured in reference to participants' own goals, Adherence with Self Goals (ASG). This was calculated by taking the number of FM minutes practiced per week reported at three-month follow-up and dividing it by the amount the participant predicted as FM practice per week at week eight, which was then multiplied by 100.

Percent Adherence with Program Goals (APG)

Adherence was also measured at five months in reference to the program's standard recommended amount of 45 minutes per day (270 minutes per week) as Adherence to Program Goals (APG). APG was calculated by taking the actual number of FM minutes per week reported at three-month follow-up and dividing it by 270 and then multiplying that by 100.

Personality

Big Five Inventory (BFI)

The Big Five Inventory (BFI) is a 44-item inventory that assesses an individual on five dimensions of personality (Big Five Factors) (John, Donahue, & Kentle, 1991; John, Naumann, & Soto, 2008). Participants indicate their level of agreement with statements concerning perceptions about themselves on a scale of 1 = strongly disagree, 2 = disagree a little, 3 = neither agree nor disagree, 4 = agree a little, and 5 = strongly agree. The Big Five dimensions are extraversion vs. introversion, agreeableness vs. antagonism, conscientiousness vs. lack of direction, neuroticism vs. emotional stability, and openness vs. closed to experience. Each of these dimensions forms a subscale of the test. The extraversion scale is made up of the following facets: gregariousness, assertiveness, activity, excitement seeking, positive emotions, and warmth mindedness (pre α = 0.88, eight-week α = 0.87, three-month α = 0.89). A sample statement from the extraversion subscale is, "- is full of energy." The agreeableness subscale consists of the facets of trust, straightforwardness, altruism, adherence, modesty, and tender-mindedness (pre α = 0.79, eight-week α = 0.76, three-month α = 0.76). A sample statement from this subscale is "- is helpful and unselfish with others." The conscientiousness subscale involves the facets of competence, order, dutifulness, achievement striving, self-discipline, and deliberation mindedness (pre α = 0.84, eight-week α = 0.82, three-month α = 0.86). A sample statement from the conscientiousness subscale is, "- makes plans and follows through with them." The neuroticism subscale consists of anxiety, angry hostility, depression, self-consciousness, impulsiveness, and vulnerability mindedness (pre α = 0.71, eight-week α = 0.84, three-month α = 0.84). A sample statement from this subscale is, "- gets nervous easily." And the openness subscale consists of the facets of ideas,

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fantasy, aesthetics, actions, feelings, and values mindedness (pre α = 0.79, eight-week α = 0.77, three-month α = 0.82). A sample statement from the openness subscale is, "- is original, comes up with new ideas" (John et al., 2008). The mean of each subscale is calculated to get a score for each subscale. We predicted that conscientiousness and openness would be positively correlated with adherence and that neuroticism would be negatively correlated with adherence.

Executive Function

Attention Control Scale (ACS)

The Attention Control Scale (ACS) is a 20-item scale that measures the ability to sustain attention or to concentrate and direct attention at will. These two abilities are associated with improvements in self-control and emotion regulation (Derryberry & Reed, 2002; Judah, Grant, Mills, & Lechner, 2014). The Cronbach's alphas for the Total ACS at pre-test, eight-week assessment, and three-month follow-up were 0.84, 0.88, and 0.88, respectively. Participants rate the likelihood of items using a four-point Likert scale ranging from "almost never" to "always," This scale is comprised of a nine-item subscale of attentional focusing and an 11-item subscale of attentional shifting. These subscales correlate with cognitive tasks using the respective attentional control. The Focus subscale assesses the ability to intentionally focus on desired tasks in a sustained way (pre α = 0.73, eight-week α = 0.77, three-month α = 0.79). A sample item is, "When I am working hard on something, I still get distracted by events around me." The Shift subscale assesses the ability to intentionally shift the attention to desired tasks (pre α = 0.76, eight-week α = 0.81, three-month α = 0.81). A sample item is, "I can quickly switch from one task to another."

Five Facet Mindfulness Questionnaire (FFMQ)

The Five Facet Mindfulness Questionnaire (FFMQ) is a 39-item questionnaire based on a factor analytic study of five independently created mindfulness questionnaires. These five factors, which represent elements of mindfulness, are observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. The questionnaire provides a total value along with values for each of the five subscales made up by the five factors of mindfulness (Baer, Hopkins, Krietemeyer, Smith, & Toney, 2006). Participants rate how true statements are for themselves on a five-level Likert scale with 1 = never or very rarely true, 2 = rarely true, 3 = sometimes true, 4 = often true, and 5 = very often or always true. Total FFMQ scores will be used to measure level of mindfulness before and after the intervention.

Psychopathology

Inventory of Depressive Symptomatology (IDS)

The Inventory of Depressive Symptomatology (IDS) is a well-validated interviewer-rated measure that is similar to the Hamilton Depression Rating Scale (HAMD), yet directly corresponds to the DSM-IV major depression criteria (A. John Rush, Carmody, & Reimitz, 2000; A J Rush et al., 1986; A J Rush, Gullion, Basco, Jarrett, & Trivedi, 1996). Total scores on the IDS indicate severity of depression with 0-13 implying normal, 14-25 implying mild, 26-38 implying moderate, 39-48 implying severe, and 49-84 implying very severe depression.

Difficulties in Emotion Regulation Scale (DERS)

The Difficulties in Emotion Regulation Scale (DERS) is a 36-item multidimensional questionnaire designed to comprehensively assess aspects of emotion dysregulation. The scale was created to reflect difficulties in the emotion regulation

dimensions of awareness and understanding of emotions; acceptance of emotions; the ability to engage in goal-directed behavior and refrain from impulsive behavior when experiencing negative emotions; and access to emotion regulation strategies perceived as effective. Participants respond to a series of statements about emotion regulation using options that range from 1 = almost never (0-10%), 2 = sometimes (11-35%), 3 = about half the time (36-65%), 4 = most of the time (66-90%), and 5 = almost always (91-100%). The questionnaire provides a total score in addition to six subscale scores. The subscales of the DERS are: nonacceptance of emotional responses; difficulties engaging in goal directed behavior; impulse control difficulties; lack of emotional awareness; limited access to emotion regulation strategies; and lack of emotional clarity (Gratz & Roemer, 2004). A sample statement from the goal-directed behavior subscale is, "When I'm upset, I have difficulty getting work done." Cronbach's alphas for the DERS-Goals subscale at pre-test, eight-week assessment, and three-month follow-up were 0.85, 0.83, and 0.84, respectively. The DERS has been reported to have high internal consistency and good test-retest reliability and predictive validity (Gratz & Roemer, 2004). We predicted that the DERS-Goals subscale would be negatively correlated with adherence since self-regulation inherently involves pursuing and attaining goals (Gratz & Roemer, 2004; Mann, De Ridder, & Fujita, 2013).

Spirituality

Spiritual Perspectives Scale (SPS)

The Spiritual Perspectives Scale (SPS) is a 10-item comprehensive instrument that measures a person's perception of their spirituality and how they engage with their spirituality. This scale is unique in that it does not rely on any references to a "God" or a "Higher Power." Research suggests that spirituality is associated with positive mood and

health outcomes (Runquist & Reed, 2007). This scale separates responses into spiritual behaviors and spiritual beliefs. The spiritual behaviors subscale contains items about frequency of personal prayer (pre $\alpha = 0.85$, eight-week $\alpha = 0.89$, three-month $\alpha = 0.88$). The spiritual beliefs subscale contains items related to the importance of spirituality such as "My spirituality is a significant part of my life" or "My spiritual views have had an influence upon my life" (pre $\alpha = 0.93$, eight-week $\alpha = 0.93$, three-month $\alpha = 0.94$). Items are rated from 1 = strongly disagree to 6 = strongly agree. The Cronbach's alpha for the SPS total at pre assessment, eight-week assessment, and three-month follow-up were 0.95, 0.95, and 0.96, respectively.

Social Support

Therapeutic Factors Inventory (TFI)

The Therapeutic Factors Inventory (TFI) is a 99-item scale, which measures the presence or absence of 11 therapeutic factors that facilitate group therapy. These 11 therapeutic factors were based on Yalom's theory of group therapy (Yalom & Leszcz, 2005). The factors included in this scale are altruism, catharsis, cohesiveness, existential factors, hope, imitative behavior, imparting information, interpersonal learning, recapitulation of family system, socializing techniques, and universality (Lese & MacNair-Semands, 2000; Yalom & Leszcz, 2008). This instrument is useful for therapists and researchers in order to assess group member perceptions of the degree to which therapeutic factors are present within a given group. The Cronbach's alpha for Total TFI was 0.98. Participants are asked to respond to statements on a seven-level Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. The present study focuses on the subscales of cohesion, interpersonal, socialize, and existential due to the relation of these subscales to spirituality and social support, two areas of interest with mindfulness meditation and

MRA. Some sample items from the existential factors subscale are: "In group I have learned that I am responsible for my own improvement," "This group has freed me to take action in my life," and "The closeness in our group helps us take more responsibility for ourselves" (Lese & MacNair-Semands, 2000). The Cronbach's alpha for the existential subscale was 0.91. Existentialism is commonly linked to spirituality (Crowell, 2016; Fehl, 2012; Wachs, 2011). Similarly as the SPS, it was anticipated that the existential factors subscale would be positively associated with adherence. Furthermore, social support and group environment has been shown to affect adherence, and we predicted that the some subscales of the TFI which directly suggest social support (Cohesion, Interpersonal) would be positively correlated with adherence (Abraído-Lanza, Chao, & Flórez, 2005; DiMatteo & Robin, 2004; Simoni et al., 2006).

DATA ANALYSIS

All statistical analyses were performed using SPSS 24.0 (IBM, 2016). Participants who did not complete the full eight-week intervention were not included in analyses. Pearson correlations were estimated across all baseline treatment measures to quantify the degree to which variables predict intervention treatment adherence and amount; goals set at week eight; as well as three-month follow-up amount and adherence. One-sample T tests were used for variables with significant correlations with adherence during treatment to test if there was a significant change in scores from pre- to post-treatment. Furthermore, Pearson correlations were estimated between differences of measures from pre- to post-treatment and three-month follow-up amount, adherence with goals set by self, and adherence with goals set by the program. Linear regression analyses were performed with variables with significant correlations ($p < .05$) with treatment adherence

during the intervention as well as with adherence with program goals during three-month follow-up.

RESULTS

PARTICIPANT DEMOGRAPHICS

A total of 104 individuals were enrolled in the study and randomized into the three variants of mindfulness-based interventions. Eight participants dropped out over the course of the eight-week intervention leaving 96 participants to be included in analysis. Table 1 reports the demographic information for the 96 participants who completed the trial. Mean (SD) baseline scores for scales of interest are also shown in Table 1.

As displayed in Table 1, women comprised a majority of the study population (72.9%). The mean age of the population was 40.4 (SD = 12.9), and mean years of education were 17.1 (SD = 2.69). Furthermore, one third (33.3%) of the population was taking psychotropic medication. During treatment, the mean percentage of classes attended was 90.2% (SD = 11.4), and the mean amount of formal meditation practice at home during treatment was 202.6 minutes (SD = 73.7). The mean goal amount of formal meditation set for follow-up was 210.4 minutes (SD = 161.3). Lastly, the mean amount of formal meditation reported during follow-up was 100.5 minutes (SD = 100.9)

INTERVENTION MEDITATION, PRACTICE GOALS, AND FOLLOW-UP

Table 2 presents correlations between retreat attendance, percent class attendance, number of classes attended, and measures of FM during the eight-week intervention. Attending class and the retreat has a significant positive correlation with the amount of FM practiced during the intervention ($r = .252, p = .01; r = .219, p = .03$). This finding indicates that those who attended more classes were also more likely to do their

meditation homework. Additionally, the correlation between these two forms of adherence suggests convergent validity.

Table 3 reports correlations between measures of FM during the intervention and FUG set at week eight with FM reported at follow-up and percent ASG and percent APG. The amount of meditation performed during the intervention had a significant positive correlation with amount of follow-up meditation ($r = .384$, $p < .001$), FM amount during the intervention was also significantly associated with adherence with the amount of meditation encouraged by MBCT ($r = .384$, $p < .001$).

Furthermore, FUG had a significant positive correlation with the amount of FM reported at follow-up ($r = .253$, $p = .01$). However, FUG had significant negative correlation with actual adherence with these goals ($r = -.285$, $p = .006$). FUG had a significant positive correlation with percent APG (270 minutes/week) ($r = .253$, $p = .01$).

ADHERENCE DURING TREATMENT

Correlation

Significant correlations were observed with percent attendance during the intervention and the personality dimensions of conscientiousness ($r = .313$, $p = .002$) and extraversion $(r = .252$, $p = .014)$ as displayed in Table 5. Furthermore, DERS-Goals exhibited a significant negative correlation with percent attendance with the intervention ($r = -.226$, $p = .028$). Some factors of the TFI, which is measured post-intervention at week eight, demonstrated significant associations with percent attendance: cohesion ($r = .316$, $p = .002$); universality ($r = .263$, $p = .010$); altruism ($r = .344$, $p = .001$); catharsis ($r = .314$, $p = .002$); and, total TFI score ($r = .215$, $p = .036$) (Table 5).

Baselines levels of personality, as measured by the BFI, that exhibited a significant positive correlation with mean FM minutes per week during treatment were

conscientiousness ($r = .352$, $p < .001$) and openness ($r = .250$, $p =. 015$) as displayed in Table 5. Additionally, attentional control, as measured by total ACS at baseline showed a significant positive correlation with mean FM minutes per week during the intervention ($r = .222$, $p = .031$). Baseline levels of depression as measured by the IDS-C30 ($r = .203$, $p = .048$) and baseline DERS-Goals ($r = -.226$, $p = .028$) were also significantly correlated with FM minutes per week during the intervention.

No significant correlations were observed with neuroticism, agreeableness, extraversion, total FFMQ score, or spirituality as measured by the SPS.

Regression

To predict adherence during treatment, a linear regression model was estimated including those variables that were significantly correlated with mean FM minutes per week during treatment (conscientiousness, openness, ACS total, IDS, and DERS-Goals). Using a backward stepwise selection method with the criterion of probability of F-to-remove $\geq .100$ a significant regression model was identified of R = .471, F(3, 91) = .865, $p < .0001$ which predicts 22.2% of the variability. In this model, baseline levels of conscientiousness ($\beta = .358$, $p < .0001$), openness ($\beta = .235, p = .013$), and depression ($\beta = .186$, $p = .048$) emerged as significant predictors of adherence during treatment as measured by mean FM minutes per week of homework practice as reported in Table 7. Adherence during treatment increased by 3.99 (95% CI = 1.94, 6.04, $p < .0001$) units for each unit increase in conscientiousness as measured by the BFI given that all else was held constant. Furthermore, adherence during treatment increased by 2.77 (95% CI = .594, 4.95, $p = .013$) for each unit increase of personality openness as measured by the BFI given that all else was held constant. This regression model also predicted that

adherence during treatment increased by 1.95 (95% CI = .013, 3.88, p = .048) units for each unit increase on the IDS-C$_{30}$ if everything else was held constant.

CHANGES DURING INTERVENTION

Table 2 reports pre-intervention and post-intervention means (SD) as well as the mean change for all self-regulation variables of interest. All variables except for agreeableness (p = .060) and SPS-Beliefs (p = .063) changed significantly during the eight-week intervention. The personality dimensions of conscientiousness (M = 1.6, p < .001, Cohen's d = .48), openness (M = 1.4, p < .001, Cohen's d = .40), neuroticism (M = -3.25, p < .001, Cohen's d = .66), and extraversion (M = 1.06, p = .0014, Cohen's d = .34) all changed significantly during the intervention. Further, significant improvements were observed in total attentional control as measured by the ACS (M = 4.9, p < .001, Cohen's d = .84) as well as total mindfulness scores as measured by the FFMQ (M = 28.3, p < .001, Cohen's d = 1.04) during the intervention (Table 2). Scores on the IDS (M = -11.8, p < .001, Cohen's d = 1.52) and DERS-Goals (M = -3.1, p < .001, Cohen's d = .84) decreased significantly during the intervention indicating improved levels of depression and engaging in goal related behavior at the end of the intervention. Total spirituality increased significantly (M = 1.4, p = .04, Cohen's d = .22), yet change in spiritual beliefs as measured by the SPS was almost significant with a mean increase of 1.0, p = .06, Cohen's d = .20.

ADHERENCE DURING FOLLOW-UP

Correlation

Conscientious was the only baseline measure to demonstrate a significant (p < .05) correlation with ASG (r = .247, p = .019) as displayed in Table 5. Additionally, baseline levels of conscientiousness (r = .210, p = .041), openness (r = .209, p = .042),

and IDS (r = .238, p = .020) displayed significant correlations with APG as reported in Table 5. No other baseline variables had significant correlations with adherence during follow-up (p > .05).

Additionally, even though almost every self-regulation variable of interest changed significantly (p < .05) during the intervention, with the exception of BFI-Agreeableness and SPS-Beliefs, none of these change scores demonstrated any statistically significant correlations with any measure of treatment adherence during follow-up as reported in Table 6 (p > .05). While SPS-Beliefs did not change significantly (p = .063) during the intervention, the change did significantly correlate with FM minutes per week at follow-up and APG (r = .214, p = .040)

Some factors of the TFI, which was only assessed at week eight, displayed significant correlations with adherence during follow-up: existentialism (r = .238, p = .020), socializing (r = .225, p = .028), and interpersonal (r = .207, p = .043) as reported in Table 6.

Regression

To predict adherence during follow-up, linear regressions were calculated with: all baseline variables with significant correlations with APG and all variables with significant pre-post change scores. All factors of the TFI were included in both regressions since these measures were only assessed at week eight of treatment. For examining which baseline variables predict adherence during follow-up, the significant variables of conscientiousness, openness, IDS and all TFI facets were included. Using a backward stepwise selection method with a criterion of probability of F-to-remove ≥ .100, a significant regression equation was fitted with R = .437, $F(4, 90)$ = 5.32, p = .001, which predicts 19.1% of the variability of the model. Baseline levels of conscientiousness

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(β = .234, p = .018), IDS (β = .240, p = .014) and week eight measures of TFI-Socializing (β = .350, p = .005) and TFI-Imitate (β = -.284, p = .024) emerged as significant predictors of adherence during follow-up (Table 8).

To understand the relationship between change scores and adherence during follow-up, a linear regression was predicted using the backward method with the criterion of probability of F-to-remove $\geq$ .100. A significant regression equation was found of R = .367, $F(3, 88)$ = 4.58, p = .005, which predicts 13.5% of the variability of the model. Of all the significant change variables included (conscientiousness, openness, neuroticism, extraversion, ACS-Total, FFMQ-Total, IDS, DERS-Goals, SPS-Total) and all of the TFI variables (existential, socialize, interpersonal, cohesion, hope, universality, information, imitate, altruism, family, catharsis, and total), only the variables of FFMQ-Total (β = -.225, p = .032), IDS (β = -.233, p = .023), and TFI-Existential (β = .283, p = .007) emerged as significant predictors of adherence during follow-up (APG) as reported in Table 9. Percent adherence to treatment meditation goals decreases by -.388 (95% CI = -.743, -.034, p = .032) for each unit increase in FFMQ-Total change scores, where a positive number indicates improvement in mindfulness, demonstrating that as mindfulness scores increase, percent adherence decreases during follow-up. Additionally, percent adherence during follow-up decreases by -1.09 (95% CI = -2.02, -1.55, p = .023) for each unit increase in IDS change score, where a positive number indicates a worsening of depression, which suggests that increased levels of depression predict poorer adherence levels during follow-up. Lastly, APG increased by .989 (95% CI = .280, 1.70, p = .007) for each one unit increase in existentialism as evaluated by the TFI (Table 9).

This study sought to identify which variables predicted adherence during and after a mindfulness meditation intervention. Previous research has examined predictors of medical regimen adherence (MRA); however, adherence with meditation practice has not been examined as closely. Through the analysis of multiple variables, including personality, cognitive control, emotional and psychopathology measures, and spiritual and social factors, we found that baseline levels of conscientiousness, openness, and depression can predict meditation adherence during the intervention, and that baseline levels of conscientiousness, depression, and week eight measures of socializing and imitation can predict meditation adherence during follow-up.

We also sought to distinguish which variables might be increased during a mindfulness meditation treatment, and then which of these changes predicted post-treatment meditation adherence. While we observed that measures of personality, cognitive control, emotion regulation, psychopathology, and spirituality increased significantly during treatment, only mindfulness changes, depression changes, and existential factors predicted post-intervention adherence to meditation.

PERSONALITY

In our study, baseline levels of conscientiousness were observed to have a significant linear relationship with meditation practice adherence during the eight-week intervention as well as during follow-up. This is consistent with previous research that has demonstrated the important role that personality plays in MRA, such as meditation home practice adherence (Barkan et al., 2016; Christensen & Smith, 1995; de Vibe et al., 2015; Delmonte, 1988; Giluk, 2009; Latzman & Masuda, 2013; Sesker et al., 2016; Sirois & Purc-Stephenson, 2008; Thomson, Jones, Browne, & Leslie, 2014; van den Hurk et al.,

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2011). Likewise, prior research strongly supports that levels of conscientiousness play a role in adherence to medical treatment (de Vibe et al., 2015; Giluk, 2009; Javaras et al., 2012; Latzman & Masuda, 2013). Conscientiousness is characterized by self-discipline, self-regulation, thoughtfulness, deliberation, competence, and achievement-striving (de Vibe et al., 2015; Giluk, 2009; Javaras et al., 2012; Sesker et al., 2016). These facets help explain the positive relationship between conscientiousness and adherence: individuals who strive to achieve and are self-disciplined are more likely to engage in positive health behaviors (Sesker et al., 2016). Sesker et al. (2016) also claim that individuals with higher levels of conscientiousness are more likely to set higher personal goals.

Openness to experiences is another dimension of personality that has been observed to associate with MRA. One of the components of openness is curiosity, which might explain why higher levels of openness are associated with higher utilization of mindfulness (Barkan et al., 2016; van den Hurk et al., 2011). The present study supports that baseline levels of openness have a significant linear relationship with adherence to meditation practice during the intervention.

Even though conscientiousness and openness are dimensions of personality, they changed significantly during the meditation training intervention. While personality was once considered as a fixed concept, recent research suggests that life experiences and environmental factors can alter personality. Since inclusion in a group-intervention and mindfulness meditation, itself, involves a substantial change in a person's point of view and thinking, this has been thought to be able to modify personality (van den Hurk et al., 2011).

EXECUTIVE FUNCTION

Baseline levels of mindfulness, as measured by the FFMQ-Total, had no

significant association with adherence during or after the intervention. Moreover, mindfulness levels increased significantly during the intervention, and this change was found to have a significant converse linear relationship with adherence during follow-up. This finding suggests that as mindfulness levels increase, adherence to meditation practice during follow-up decreases. This finding suggests that, contrary to predictions, overall mindfulness does not improve adherence to meditation after the conclusion of a mindfulness intervention. Mindfulness has been found to be associated with greater levels of executive function, attention control, emotion regulation, self-regulation, and improved health outcomes (Bishop et al., 2004; Ruff & Mackenzie, 2009; Teper & Inzlicht, 2013). However, individuals may be aware of their improvements in mindfulness and might feel as though they have already benefited from meditation and, thus, do not need to adhere to it as often.

Furthermore, difficulties with engaging in goal-directed behavior and self-reported attention control improved as well during the intervention. However, these changes did not appear to have any significant relationships with practice adherence during the intervention or during follow-up. It appears that participants reported psychological changes from the intervention, yet these reports did not translate into long-term behavior change. This finding suggests that perhaps changed levels or improvements in factors examined in the present study do not play a significant role in adherence. All of the factors considered in the present study were assessed through self-report questionnaires, which can introduce the possibility of self-report bias (Arnold & Feldman, 1981; Hebert, Clemow, Pbert, Ockene, & Ockene, 1995). There is also a potential risk of bias in this study because of social desirability. This would manifest if

participants expect that they should experience changes during the eight-week mindfulness intervention, and, in turn, this may have influenced their responses in the post-treatment assessments. Many other studies have found that self-report measures show larger changes than objective measures of the same construct (W. B. Britton, Haynes, Fridel, & Bootzin, 2010). Future research should attempt to objectively measure as many factors as possible to limit opportunities for bias.

PSYCHOPATHOLOGY

Baseline levels of depression, as measured by the IDS-C$_{30}$, were found to have a significant linear relationship with adherence during the intervention. Moreover, changes in depression were observed to have a significant converse linear association with adherence during follow-up. Individuals with higher levels of depression at baseline were more likely to meditate during the treatment. This finding suggests that individuals with depression may have motivation to adhere to meditation practice as a method to improve their depression. Further, baseline levels of depression also demonstrated a significant linear relationship with APG suggesting that higher levels of baseline depression predict high adherence during follow-up

However, as depression change scores increase, which indicates that depression is worsening, participants are less likely to adhere to meditation practice during follow-up. So as depression improves, participants are more likely to have a higher APG. This finding may suggest that participants who feel they are benefiting from meditation practice decide to adhere with meditation as an effective treatment option for them.

SPIRITUALITY

Spirituality is another factor that has been associated with practicing mindfulness meditation (Carmody et al., 2008; Geary & Rosenthal, 2011; Greeson et al., 2011; Simoni

et al., 2006; Thomson et al., 2014; Vettese et al., 2009). Previous research has identified relationships between increased levels of spirituality and increased levels of trait and state mindfulness, decreased levels of psychological distress, and decreased medical symptoms (Carmody et al., 2008; Greeson et al., 2011).

However, in the present study, baseline levels of spirituality, as assessed by the SPS, did not predict meditation practice adherence during or after the intervention. Instead, the mindfulness intervention was able to change levels of spirituality, which is supported by previous research (Carmody et al., 2008; Geary & Rosenthal, 2011; Greeson et al., 2011). Carmody et al. (2008) observed that increases in levels of both state and trait mindfulness were associated with increases in levels of spirituality. It is possible that mindfulness practice facilitated awareness of what spirituality means for each participant. Everyday spiritual experiences are characterized by an awareness and a relationship with the transcendent; this increased awareness is similar to what is cultivated during mindfulness meditation (Greeson et al., 2011). Furthermore, the change in spirituality beliefs during the intervention was found to be significantly correlated to meditation amount at follow-up. Since this adherence relationship did not exist at baseline, it appears that change in spiritual beliefs might play an important role in meditation adherence in the long-term. Additional research is needed to understand the relationship between spirituality and treatment adherence more fully.

SOCIAL SUPPORT

Another important influence in medical treatment adherence is social support (M. H. Becker & Maiman, 1975; Cameron, 1996; DiMatteo & Robin, 2004; Dunn, Morrison, & Bentall, 2006; Honda & Jacobson, 2005; Langenberg et al., 2000; Simoni et al., 2006; Steptoe et al., 2004). Previous research by Dunn et al. (2006) observed that high quality

therapeutic relationships were associated with higher ratings of treatment homework adherence. Since therapeutic factors were only assessed at week eight, it is hard to draw conclusions about these components of social support and adherence during the intervention. However, the therapeutic factors of socializing techniques, imitative behaviors, and existential factors were observed to have significant linear relationships with percent adherence with program goals during follow-up. It is possible that the fostering of relationships, social support, and self-efficacy skills learned from the group atmosphere helped participants better adhere to their practice. Previous research indicates that a group therapy setting may be more efficacious for behavior change than an individual setting (Renjilian et al., 2001). Additionally, the group aspect of MBIs presents an excellent opportunity to foster social support and improve health behaviors and self-regulation. Future studies looking at factors associated with mindfulness adherence should include additional measures of social support across time in the intervention as well as outside of the intervention setting.

STRENGTHS AND LIMITATIONS

The present study is important in that it identifies not only what factors can predict meditation practice adherence, but also what factors can be increased by the treatment to maximize adherence. Research exists on general MRA; however, very few studies look at adherence with mindfulness-based interventions. Furthermore, this study assesses adherence not only during the intervention, but also with goals set by the participant and the program as well as during follow-up. This study is also strong in that there appears to be reliability in the measures used to assess quantity of FM during the intervention since these measures are correlated with actual class attendance. Since assessments were completed before and after the intervention, this study is also able to

assess differences in adherence before and after the intervention. This study was exploratory with multiple correlational and regression analyses, so it was not limited to one domain and, instead, included a wide range of variables for consideration with adherence. Another strength of this study is that it includes a sample size of almost 100 participants.

However, this study is limited by the reliance of subjective self-report questionnaires. Self-report questionnaires may introduce response bias, which should be taken into account with these results. Moreover, social desirability and expectations of change from the intervention may have influenced participants' responses during post-assessments. Future research should focus on utilizing as many objective measures as possible in order to limit these potential biases. Further, participants were responsible for reporting all meditation practice amounts. During the intervention, participants used an online diary every week. But the follow-up measures we calculated were based on participants' abilities to recall their meditation practice over the previous three months. This format introduces recall bias into the study. Since mindfulness-based interventions aim to change a person's life, it is important to consider how long the benefits gained from these interventions persist through a participant's life. For this reason, future research should include a longer follow-up time.

IMPLICATIONS AND FUTURE RESEARCH

Mindfulness meditation has been used as a treatment in the medical community for a few decades now; however, very few studies have examined possible predictors of treatment adherence. To improve MRA, and mindfulness meditation adherence, it is necessary to understand what causes people to engage with mindfulness meditation and what keeps people practicing mindfulness meditation. The current study challenged

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current hypotheses that increases in executive function and emotion regulation are the mechanisms by which mindfulness interventions impact behavior changes. Instead, personality, depression, and social factors predicted behavior adherence. Renewed emphasis and research on these less-studied dimensions of mindfulness-based interventions may be an avenue to maximize treatment effects.

TABLE 1: SAMPLE CHARACTERISTICS

Characteristic	Total (N = 96)
Female N (%)	70 (72.9)
Mean age (SD)	40.4 (12.9)
Mean years of education (SD)	17.1 (2.69)
Psychotropic medication N (%)	32 (33.3)
Mean percent of classes attended (SD)	90.2 (11.4)
Mean # min per week meditation during Tx (SD)	202.6 (73.7)
Mean # min per week goals (SD)	210.4 (161.3)
Mean # min per week at follow-up (SD)	100.5 (100.9)

TABLE 2: BASELINE AND POST-INTERVENTION MEANS (SD) AND EFFECT SIZES

Predictor	Pre Mean (SD)	Post Mean (SD)	Mean Change	p	Cohen's d
BFI-Conscientiousness	32.8 (6.64)	34.3 (6.28)	2.6	<.001	0.48
BFI-Openness	39.9 (6.27)	41.3 (5.44)	1.4	<.001	0.40
BFI-Neuroticism	29.2 (5.28)	25.8 (6.11)	-3.25	<.001	0.66
BFI-Agreeableness	34.2 (5.98)	34.9 (5.36)	.70	.060	0.20
BFI-Extraversion	25.4 (6.99)	26.6 (6.92)	1.06	.0014	0.34
ACS-Total	50.0 (8.16)	54.72 (8.43)	4.9	<.001	0.84
FFMQ-Total	122.8 (18.9)	144.1 (18.6)	28.3	<.001	1.04
DERS-Goals	16.3 (4.26)	13.3 (3.52)	-3.1	<.001	0.84
IDS-Total	23.0 (7.03)	11.2 (6.19)	-11.8	<.001	1.52
SPS-Total	30.0 (12.8)	31.4 (13.9)	1.4	.039	0.22
SPS-Beliefs	18.1 (8.00)	19.0 (8.68)	1.0	.063	0.20

TABLE 3: CORRELATIONS BETWEEN TREATMENT ATTENDANCE AND MEDITATION HOME PRACTICE DURING THE INTERVENTION

Predictor	Mean Formal Meditation (FM) min/week during Intervention
Attended retreat	.219*
Percent attendance	.252*
Number of classes attended	.252*

*p < 0.05; **p < 0.001

TABLE 4: CORRELATIONS BETWEEN MEDITATION ADHERENCE DURING INTERVENTION AND MEDITATION ADHERENCE AT FOLLOW-UP

Predictor	FM min/week at Follow-Up	ASG	APG
Mean FM minutes per week during intervention	.384**	.200	.384**
FUG	.253*	-.285**	.253*

*$p < 0.05$; **$p < 0.001$; FM = Formal meditation; ASG = Adherence with Self-set Goals; APG = Adherence to Program-set Goals; FUG = Follow-Up Goals

TABLE 5: CORRELATIONS OF BASELINE LEVELS WITH MEDITATION ADHERENCE DURING INTERVENTION AND AT FOLLOW-UP

	Percent Attendance	Mean FM min/week during Treatment	ASG	APG
PERSONALITY				
BFI-Conscientiousness[1]	.313**	.352**	.247*	.210*
BFI-Openness[1]	.041	.250*	.117	.209*
BFI-Neuroticism[1]	-.078	.003	.014	.045
BFI-Agreeableness	.064	.078	.044	.101
BFI-Extraversion[1]	.252*	.080	-.067	.034
COGNITIVE				
ACS-Total[1]	.145	.222*	.076	.089
FFMQ-Total[1]	.081	.216	.140	.198
EMOTION				
IDS[1]	.048	.203*	.170	.238*
DERS-Goals[1]	-.226*	-.226*	-.140	-.148
SPIRITUAL				
SPS-Total[1]	-.070	-.066	.128	.078
SPS-Beliefs	-.072	-.009	.120	.095
SOCIAL				
TFI-Existential	.136	.199	.226*	.238*
TFI-Socialize	.111	.208*	-.109	.225*
TFI-Interpersonal	.116	.135	-.056	.207*
TFI-Cohesion	.316**	.194	-.011	.100
TFI-Hope	.090	.174	.071	.200
TFI-Universality	.263**	.195	-.110	.088
TFI-Information	.084	.159	-.052	.113
TFI-Imitate	.180	.166	-.071	-.022
TFI-Altruism	.344**	.268**	-.005	.182
TFI-Family	.047	.286**	-.033	.166
TFI-Catharsis	.314**	.117	-.068	.138
TFI-Total	.215*	.235*	-.052	.188

*$p < 0.05$; **$p < 0.01$; 1, values changed significantly during intervention; FM = Formal meditation; ASG = Adherence with Self-set Goals; APG = Adherence to Program-set Goals

TABLE 6: CORRELATIONS OF PRE-POST CHANGE LEVELS AND MEDITATION ADHERENCE AT

THREE-MONTH FOLLOW-UP

	FUG	FM min/week at FU	ASG	APG
PERSONALITY				
BFI-Conscientiousness[1]	.147	-.014	-.084	-.014
BFI-Openness[1]	-.197	-.088	.078	-.088
BFI-Neuroticism[1]	-.088	-.046	.008	-.046
BFI-Agreeableness	.033	-.050	-.127	-.050
BFI-Extraversion[1]	.059	-.014	.069	-.014
COGNITIVE				
ACS-Total[1]	.075	.089	.014	.089
FFMQ-Total[1]	.064	-.137	-.122	-.137
EMOTION				
IDS[1]	-.035	-.180	-.071	-.180
DERS-Goals[1]	-.055	.095	.104	.095
SPIRITUAL				
SPS-Total[1]	.179	.180	.120	.180
SPS-Beliefs	.189	.214*	.129	.214*
SOCIAL				
TFI-Existential	.172	.238*	.226*	.238*
TFI-Socialize	.234*	.225*	-.109	.225*
TFI-Interpersonal	.222*	.207*	-.056	.207*
TFI-Cohesion	.154	.100	-.011	.100
TFI-Hope	.084	.200	.071	.200
TFI-Universality	.233*	.088	-.110	.088
TFI-Information	.080	.113	-.052	.113
TFI-Imitate	.041	-.022	-.071	-.022
TFI-Altruism	.067	.182	-.005	.182
TFI-Family	.087	.166	-.033	.166
TFI-Catharsis	.200	.138	-.068	.138
TFI-Total	.175	.188	-.052	.188

*$p < 0.05$; **$p < 0.001$; 1, values changed significantly during intervention; FM = Formal meditation; ASG = Adherence with Self-set Goals; APG = Adherence to Program-set Goals; FUG = Follow-Up Goals

TABLE 7: REGRESSION COEFFICIENTS FOR SIGNIFICANT BASELINE CORRELATIONS WITH

ADHERENCE DURING INTERVENTION

Predictor	Unstandardized β (95% CI)	p	Standardized β
BFI-Conscientiousness	3.99 (1.94, 6.04)	<.0001	.358
BFI-Openness	2.77 (.594, 4.95)	.013	.235
IDS	1.95 (.013, 3.88)	.048	.186

TABLE 8: REGRESSION COEFFICIENTS FOR SIGNIFICANT BASELINE CORRELATIONS WITH

ADHERENCE DURING FOLLOW-UP

Predictor	Unstandardized β (95% CI)	p	Standardized β
BFI-Conscientiousness	1.29 (.226, 2.35)	.018	.234
IDS	1.24 (.261, 2.22)	.014	.240
TFI-Socializing	1.30 (.405, 2.20)	.005	.350
TFI-Imitate	-1.05 (-1.96, -.143)	.024	-.284

TABLE 9: REGRESSION COEFFICIENTS FOR SIGNIFICANT CHANGE VARIABLES WITH ADHERENCE

DURING FOLLOW-UP

Predictor	Unstandardized β (95% CI)	p	Standardized β
FFMQ-Total	-.388 (-.743, -.034)	.032	-.225
IDS	-1.09 (-2.02, -.155)	.023	-.233
TFI-Existentialism	.989 (.280, 1.70)	.007	.283

ACS = Attention Control Scale; APG = Adherence to Program Goals; ASG = Adherence to Self-Goals; BFI = Big Five Inventory; DERS = Difficulty in Emotion Regulation Scale; IDS = Inventory of Depressive Symptomatology; FFMQ = Five Facet Mindfulness Questionnaire; SPS = Spiritual Perspectives Scale; TFI = Therapeutic Factors Inventory

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PART II: SELF-RELATED TARGETS ENGAGED BY MINDFULNESS-BASED

INTERVENTIONS: A SYSTEMATIC REVIEW AND EVIDENCE MAP

STRUCTURED SUMMARY

Background: Medical regimen adherence is a crucial component in managing chronic health conditions. This adherence is frequently limited by a person's ability for self-regulation. Self-regulation consists of managing cognitive processing, emotion regulation, and self-related processes. Research suggests that mindfulness-based interventions (MBI), such as Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT), are promising methods for improving self-regulation.

Objective: This study examines what constructs and assays of self-related processes are used in randomized controlled trials of MBSR or MBCT. The present study also provides a description of the state of evidence supporting that MBIs are effective for improving self-related processes.

Methods: For this systematic review, the databases of PubMed, CINAHL, PsychInfo, and ERIC were searched for terms relevant to mindfulness meditation and self-related processes. Studies were limited to English-only, human-only randomized controlled trials with all participants over the age of 18 years old as well as a minimum of ten participants in the MBI group.

Results: The final search yielded 10,595 studies. These were doubled-screened by a six person review team and narrowed down to 1,771 studies. These full-text publications were further screened for inclusion, and the data from 87 studies were extracted. Twelve studies reported an outcome directly related to a construct in the self-related processes domain and were included in this present study.

Conclusions: The primary areas of self-related processes assessed by studies of MBSR and MBCT are prosocial behaviors, self-compassion, and self-related rumination. The results of this study also demonstrate the need for further research on the impact of MBIs on self-related processes.

Medical regimen adherence (MRA) refers to the degree to which a patient correctly follows, or complies with, medical advice (Martin et al., 2005). MRA is critical in preventing and curing disease as well as keeping healthcare costs low (Martin et al., 2005; Ruff & Mackenzie, 2009; Vermeire et al., 2001). However, even though patient adherence is key to well-being, research indicates that nonadherence rates are as high as 70% (Martin et al., 2005). An essential component of adherence is self-regulation, which involves both creating and maintaining behavior change. Self-regulation involves managing emotional, cognitive, and self-relevant resources to align mental states and behavior with goals (Vohs & Baumeister, 2010). Together, these three domains, emotion regulation, cognitive regulation, and self-related processes, work together internally to coordinate behaviors, thoughts, and actions to meet and sustain intended goals. Mind-body interventions, such as mindfulness meditation, have been suggested as an effective method for improving self-regulation through the mechanisms of regulating affective, cognitive, and self-related processes. Mindfulness-based interventions (MBI) integrate these domains into one comprehensive therapy.

OVERVIEW OF MBIS

Mindfulness meditation has been utilized for a number of circumstances, both clinical and nonclinical, as well as for preventing and treating disease. Today, research suggests that mindfulness meditation may be useful for treating many types of psychological and physical disorders, such as mood disorders, stress, depression, anxiety, diabetes, cancer, hypertension, chronic pain, workplace burnout, substance abuse, eating disorders, and traumatic brain injury (de Vibe et al., 2015; Geary & Rosenthal, 2011;

Giluk, 2009; Goyal, Singh, Sibinga, Gould, Rowland-Seymour, Sharma, Berger, Sleicher, et al., 2014; Hawley et al., 2014; Vettese et al., 2009).

Mindfulness, a practice that evolved as part of the Buddhist practice, has been defined in various ways. Today, it is generally characterized by maintaining attention in the present moment with a curious, accepting, and non-judgmental focus (Bishop et al., 2004; Farb, Anderson, & Segal, 2012; Holzel et al., 2011; Kabat-Zinn, 2013). Interest in mindfulness meditation has grown in the past two decades with the creation of mindfulness-based interventions (MBI) (Cullen, 2011; Williams & Teasdale, 2007). Current research is focused on discovering how mindfulness operates in the body and mind to change behavior (Cullen, 2011; Goyal, Singh, Sibinga, Gould, Rowland-Seymour, Sharma, Berger, Sleicher, et al., 2014). Mindfulness has been viewed as a method for improving attention and awareness and for developing skills to reduce emotional and cognitive suffering (Bishop et al., 2004).

Two of the most commonly used MBIs are Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Training (MBCT). MBSR focuses on stress reduction and has been utilized as a strategy for treating both physical and psychological disorders while MBCT was created specifically with the focus of preventing relapse in people with depression (Segal, Teasdale, & Williams, 2004; Williams & Teasdale, 2007). Both interventions involve eight-weeks of mindfulness meditation training classes. In these classes, participants learn a variety of types of meditation practices and learn to acknowledge that automatic reactions release detrimental ones (Gotink et al., 2015).

MINDFULNESS AND SELF-REGULATION

Mindfulness is purported to improve well-being by enhancing self-regulation and executive control (Brown & Ryan, 2003; Howell & Buro, 2010). Self-regulation, or the

ability to attend to one's goals and act in accordance with them, is a crucial developmental skill (Howell & Buro, 2010). Characteristics of mindfulness include attention regulation, an internal focus, emotion regulation, cognitive control, and a flexible sense of self (Holzel et al., 2011). Mindfulness strengthens self-regulation through improvements in sustaining and controlling attention. The non-judgmental perspective developed through mindfulness also contributes to increased self-observation and the ability to better differentiate cognitive and affective experiences (Bishop et al., 2006; Teper & Inzlicht, 2013).

SELF-RELATED PROCESSES AND MINDFULNESS

Self-referential processing refers to the process of associating "exteroceptive stimuli, interoceptive stimuli, and mental events with one's self" (Northoff et al., 2006). Self-referential processes (SRP) involve those functions that turn our experiences from independent events to ones related to the self (Hadash, Plonsker, Vago, & Bernstein, 2016). Some aspects of SRP include self-reflection, decentering, identity, self-esteem, rumination, and social cognition (Goldin, Ramel, & Gross, 2009). Furthermore, research suggests that SRP is essential for reducing emotional reactivity, while improving cognitive regulation of emotion and interpersonal functioning (Goldin et al., 2009).

One way in which mindfulness meditation may influence self-regulation is by altering SRP. Mindfulness meditation promotes a non-judgmental awareness and this cultivation of an unprejudiced and accepting point of view can help inhibit negative self-rumination (Goldin et al., 2009; Hadash, Plonsker, Vago, & Bernstein, 2016). This attitude can also lead to a "decentering" of self as individuals learn to let thoughts and feelings come and go (Deyo, Wilson, Ong, & Koopman, 2009; Hadash et al., 2016). The inward focus and attention that mindfulness meditation fosters also has the ability to

increase self-awareness of thoughts, emotions, and feelings within the body (Goldin et al., 2009). This practice may be especially useful for those with depression and other mental disorders because as the ability to discern and understand thoughts and emotions grows so may the ability to tolerate them (Hadash et al., 2016).

Specific parts of the brain have been identified through research as being responsible for SRP. Cortical midline structures of the brain, such as the medial prefrontal cortex, posterior cingulate cortex, and inferior parietal lobe, are activated with tasks of SRP (Farb et al., 2007; Northoff et al., 2006). These areas have high activity during rest and mind wandering, so they are commonly referred to as the "default mode network" of the brain (Dahl, Lutz, & Davidson, 2015; Hadash et al., 2016; Holzel et al., 2011). While research involving neuroscientific findings and mindfulness is important for self-regulation, these findings will be discussed elsewhere. Some dimensions of SRP, such as decentering, are included in mindfulness questionnaires, including the FFMQ, the MAAS, the Toronto, Kentucky and Freiburg mindfulness scales, and the Experiences Scale (Fresco et al., 2007). However, the literature has previously validated and examined mindfulness scales in excellent reviews and meta-analyses, so these will not be repeated here (Park, Reilly-Spong, & Gross, 2013; Visted, Vollestad, Nielsen, & GH, 2014).

STUDY PURPOSE

This review is part of a larger project set to determine the extent to which various measures of self-regulation assess separate or intersecting mechanisms used in behavior change. The purpose of this study is to systematically review studies involving MBIs with at least one outcome related to SRP and to draw conclusions about the most common mechanisms of SRP that may be altered by mindfulness meditation in order to improve self-regulation. The effectiveness of MBIs has been demonstrated for several

conditions related to self-regulation, yet the understanding of which mechanisms engage self-regulatory processes is not well understood. For MBIs to effectively enhance self-regulation and create behavior change, it is important to understand which factors have the most impact on health behaviors and change. In this article, we want to identify which mechanisms in the SRP domain of mindfulness are the most promising for improving self-regulation and medical treatment adherence as well as which assays of SRP measurement are widely used in MBSR and MBCT research to date.

METHODS

A systematic review of the published MBI scientific literature was conducted to provide an overview of the current literature on MBCT and MBSR in regards to self-related processes. This review provides a comprehensive assessment of what is known and not known and about the impacts of MBCT and MBSR on SRP. Established methodologies as outlined in the Cochrane Handbook of Systematic Reviews and the Agency for Healthcare Research and Quality's Methods Guide for Comparative Effectiveness Reviews were used to conduct this review (Agency for Healthcare Research and Quality, 2014). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed for the reporting of this systematic review (Liberati et al., 2009).

PROTOCOL

A review protocol for this systematic review was submitted to the PROSPERO review registration on December 9, 2016. Confirmation was received on December 16, 2016 that all necessary documentation has been processed. The registration number is CRD42016051765 (W. Britton et al., 2016). The review protocol can be accessed on the

Web   at:

https://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016051765.

ELIGIBILITY CRITERIA

Inclusion was restricted to English-language randomized controlled trials with a control group. Included studies were required to have a sample size of at least 10 participants in the mindfulness intervention arm, all over the age of 18. Studies were included if they involved a mindfulness-based component: Integrative Body-Mind Training (IBMT), Mindfulness-Based Intervention (MBI), Mindfulness-Based Cognitive Training (MBCT), Mindfulness-Based Stress Reduction (MBSR), Vipassana, or Zen. Studies that focused on a meditative practice other than mindfulness were excluded: ACT; DBT; metta compassion training; mantra meditation; relaxation response; clinically standardized meditation; yoga; tai chi; qigong; visualization; prana(yama); controlled/diaphragmatic breathing; energy; qi; chi; kundalini; scripture-based meditation; prayer.

For the purposes of the present study, the focus was only on the standardized mindfulness interventions of MBCT and MBSR. Thus, any interventions that delivered a modified or adapted version of MBCT or MBSR were excluded. A standard intervention of MBSR or MBCT required the intervention content to follow the appropriate manual, to be delivered in person, in a group setting, and over the course of eight weeks. Further, the interventions were comprised of weekly two-and-a-half hour-long classes with an accompanying all-day retreat (usually around seven hours).

The present study used the electronic databases of CINAHL, ERIC, PsychInfo, and PubMed. Searches involved studies focusing on mindfulness meditation interventions from inception to March 25, 2016.

The search was designed with the help of a research librarian at the Center for Evidence Synthesis in Health at Brown University. The AND operator was used to connect terms designed to find mindfulness studies to 118 terms related to the three domains of self-regulation (see Appendix for full search term). The Medical Subject Heading (MeSH) terms of Mindfulness and Meditation were also used. Terms were truncated with an asterisk (*) to capture all possible endings for the designated root of the specified word. The search was limited to English-language randomized control trials, with at least one control arm, comprised of human-only participants over the age of 18.

Relevant SRP-related constructs or processes were generated by 12 PhD-level mindfulness experts who served as Co-Investigators on the project. After initial generation, the experts then voted on the inclusion or exclusion of each term. The final search terms of self-related processes were: (life-span) development, agency, body awareness, decentering, disidentification, default mode network, ego, embodiment, empathy, experiential self, identity/identification, interoception, meta-awareness, narrative self, observing self, perceived control, perspective taking, prosocial, reperceiving, self awareness, self-compassion, self-criticism, self-distancing, self-efficacy, self-esteem, self-loathing, self-monitoring, self-praise, self-referential processing, self-regulation, self-related rumination, self-worth, social cognition, sense of agency, sense of control, sense of ownership, and theory of mind.

The review team for this systematic review consisted of four graduate-level public health students and two bachelor's level research assistants, advised by 11 PhD-level researchers including two with systematic review expertise, a reference librarian specializing in systematic reviews, and directly supervised by three PhD-level researchers. The Center for Evidence Synthesis in Health (CESH) at the Brown University School of Public Health, which specializes in systematic reviews and meta-analyses, was consulted as needed for extraction processes.

De-duplication of citations yielded in the search was first completed using EndNote library and then manually by two of the Master's level reviewers. Titles and abstracts were double screened by reviewers using the Abstrackr program (Wallace, Small, Brodley, Lau, & Trikalinos, 2012). Reviewers rated each title and abstract as "yes" meaning include, "no" meaning exclude, or "maybe" meaning the PhD-level researchers' opinion was needed. Each citation for which two randomly-allocated reviewers did not unanimously agree on the inclusion or exclusion status was later determined to be included or excluded by discussion among three graduate students. The final decision on inclusion or exclusion status among these studies was made by the principal investigator (Britton). Citations presented in Abstrackr with only a title yet no abstract were included for full text review.

All citations included after the title and abstract screening were reviewed further in detail to make sure they fit the inclusion criteria. Microsoft Excel was used to organize this data.

DATA COLLECTION

The Systematic Review Data Repository (SRDR) online system (http://srdr.ahrq.gov) was used to create forms, which were designed to capture all elements relevant to the key review questions, and each study was entered into this system. SRDR is publically available with the capacity to read, download, and comment on data. The 13-member review team completed a training in using SRDR before any full-text articles were extracted. Several practice extractions were completed and reviewed in weekly meetings until familiarity and agreement in the process were met. Thorough extraction instructions for each data field of the SRDR form was created in order to minimize disagreements in coding. Weekly meetings were held during the early extraction phase in order to review any points of confusion. Each study included in this review was extracted by one member of the review team. Upon completion of this extraction, the entry was assessed for completion and errors by a graduate-level reviewer. Corrections were made as needed by the initial reviewer and then reassessed by the graduate-level reviewer. Any disagreements were resolved by discussion among the team, with the principal investigator making the final decision.

DATA ITEMS

The basic elements and design of the SRDR form included elements that address population characteristics; descriptions of the interventions, exposures, and comparators analyzed; outcome definitions; effect modifiers; enrolled and analyzed sample sizes; study design features; funding source; results; and risk of bias questions. Specific MBI-related questions included the duration of class sessions; number of class sessions; number of hours for the all-day retreat; assigned home practice; reported home practice amount; instructor training; and program fidelity.

The methodological quality of each study was assessed based on predefined criteria, using the Cochrane risk of bias tool (http://handbook.cochrane.org/chapter_8/table_8_5_d_criteria_for_judging_risk_of_bias _in_the_risk_of.htm) (Higgins & Green, 2011). This tool asks about risk of selection bias, performance bias, detection bias, attrition bias, reporting bias, and other potential biases. We also assessed methodological quality with MBCT/MBSR specific quality indices, which include teacher training and qualifications, class attendance, treatment fidelity, and adverse effect monitoring. General trends were reported for each of the Cochrane risk of bias questions.

SUMMARY MEASURES

As an exploratory, sweeping review, no specific summary measures were predetermined before data collection. Hazard ratios for clinical diagnoses were not recorded, however means, standard deviations, F-statistics, medians, ranges, confidence intervals, *p*-values, and effect sizes such as Cohen's *d* were extracted for qualitative analysis.

SYNTHESIS OF RESULTS

Unique trials were used as the unit of analysis; for studies using the same participant pool but reporting different outcomes in sequential publications, the results of publications beyond the primary, first published, study were entered in the SRDR form for the primary study. Only supplementary outcomes not present in the primary study were added to the extraction form. Repeated outcomes of interest therefore were not entered again to avoid double-counting outcomes. If the studies reported unique

outcomes from the same trial, but used different participants, these studies were kept separate in their SRDR forms and marked as linked publications.

The compiled results from the SRDR extraction form were exported into Microsoft Excel. These results were used for the qualitative analysis presented in this review. The full text of the article was reviewed for any additional clarifications needed. Study characteristics and descriptive information for each included article are summarized in this review, including study duration, sample size, mean age, and race, education, and gender distributions. Further, the type of intervention, description of control group, specific assays of interest, and summaries of major study findings with effect sizes were reported when available.

RISK OF BIAS ACROSS STUDIES

Data were independently extracted and entered by six individuals. Three graduate students reviewed all extracted and entered data, including reviewing each other's extracted data. At the end of extraction, an inter-rater reliability score was calculated.

RESULTS

STUDY SELECTION

The total search results identified 13,084 titles through March 2016. After automatic and manual de-duplication took place, 10,595 studies remained. Of these titles, 1,771 were included after abstract screening. During the full text retrieval and data extraction process, another 1,684 titles were excluded: 1) not a RCT [n = 750]; 2) not standard MBSR/MBCT [n = 548]; 3) meditation other than mindfulness [n = 159]; 4) results not available [n = 49]; 5) excluded publication type [n = 43]; 6) data not relevant [n = 42]; 7) intervention arm n<10 [n = 33]; 8) participants <18 years old [n = 25]; 9) associated publication [n = 34]; 10) neuroimaging study [n = 12]; 11) duplicate study n =

62

2]. A total of 87 titles remained (Figure 1). Out of these publications, 12 were identified as assessing constructs self-related processes and mindfulness.

STUDY CHARACTERISTICS

Methods

Study characteristics are summarized in Table 1. All included studies were randomly controlled trials (RCT) published in English. All studies were published after 2007, with the most recent study published in 2016. The most common type of control group was a passive control wait list, which was used by seven (58.3%) of the included studies. The average duration of follow-up time was 17 weeks with a range from eight weeks to 60 weeks.

Participants

The included studies involved 1,110 participants. Study sample sizes ranged from 30 to 205 participants. Eight studies (66.7%) involved a clinical population, six of which focused on depression (Table 1) (Bondolfi et al., 2010; Crane et al., 2008; Eisendrath et al., 2016; Geschwind, Peeters, Drukker, van Os, & Wichers, 2011; Michalak, Schultze, Heidenreich, & Schramm, 2015; van Aalderen et al., 2012) and two of which focused on social anxiety disorder (Jazaieri, Goldin, Werner, Ziv, & Gross, 2012; Koszycki, Benger, Shlik, & Bradwejn, 2007). The main inclusion criteria consisted of having no previous formal meditation practice, psychotropic medication stable for a time period before the trial, no substance abuse, no current suicide risk, and not having any psychosis disorder that would interfere with being able to participate in a group setting.

All participants in the included studies were 18 years or older. Mean age of participants for each study arm was reported by all studies except for one (Shapiro et al., 2011). MBCT intervention arm mean ages ranged from 44.6-49.75 years, and mean age

range for control groups in MBCT studies was 40.44-54 years. MBSR intervention arm mean ages ranged from 32.9-64.35 years, and the mean age range for control groups in MBSR studies was 32.9-65.16 years.

Seven (58.3%) of the included studies reported race or ethnicity. Of these, only four reported race or ethnicity information by study arm. Only one of these studies that reported race by arm was a MBCT intervention. The remaining three studies that reported race by arm were MBSR trials. Intervention arms were largely made up of individuals who identified as Caucasian (65.0%, 80.7%, 41.9%, 95.0%). Control arms were also largely made up of individuals who identified as Caucasian (65.0%, 79.5%, 40.0%, 86.0%) (Table 1).

Education information was reported by nine (75.0%) of the included studies. However, the manner in which education information was reported varied greatly across the studies. Six (50.0%) of the included studies reported education information by intervention arm, yet the reported levels and groups of education differed greatly. Two of these studies only included median or mean years of education by arm.

Gender information was reported by ten (83.3%) of the included studies. Only one of these did not report information by intervention arm. Study populations were mostly comprised of women. Both MBSR (85.0%, 61.3%, 61.5%, and 90.0%) and MBCT (74.0%, 75.9%, 79.0%, 58.3%, 70.0%) intervention arms were largely comprised of women. Additionally, control arms were also mostly female (40.0%-76.7%) (Table 1).

Intervention

Seven studies used a standard intervention of MBSR (Anderson, Lau, Segal, & Bishop, 2007; Creswell et al., 2012; Jazaieri et al., 2012; Koszycki et al., 2007; Robins, Keng, Ekblad, & Brantley, 2012; Shapiro, Brown, Thoresen, & Plante, 2011). Seven of

the included thirteen studies took place in North America with the remaining five studies taking place in Europe.

Outcomes

All included studies involved outcomes related to mechanisms of self-related processing (SRP). Construct outcomes were distributed as the following: (life-span) development (n = 1); prosocial (n = 4); self-awareness (n = 1); self-compassion (n = 4); self-esteem (n = 1); self-related rumination (n = 7); and social cognition (n = 1) (Figure 2).

RISK OF BIAS WITHIN STUDIES

Risk of bias and quality assessment for each study is presented in Table 3. All studies except for two (Koszycki et al., 2007 and Robins et al., 2011) used and reported adequate randomization methods. Both Koszycki et al., 2007 and Robins et al., 2011 did not provide information about how they randomized their participants. Allocation was properly concealed before assignment in 11 studies except for Robins et al., 2011, which did not provide enough information about their allocation procedure. Due to the nature of MBIs and the controls used, participant blinding was not applicable for eight of the studies as participants were able to know if they were in a MBI course or on a waitlist or receiving TAU. One study, in which participant blinding was possible due to the nature of the active control group, did not provide enough information about the nature of participant blinding. And two studies, where participant blinding was possible due to the nature of the active control group, did adequately blind their participants. Additionally, outcome assessors were suitably blinded in seven of the included studies, yet four of the included studies did not report enough information about the blinding of their outcome assessors. Only one study did not properly blind their outcome assessors.

Three of the included studies introduced bias through incomplete outcome data due to the amount, nature, or the handling of incomplete data. However, no studies had any evidence of selective outcome reporting bias. Further, only two studies had incomplete intervention compliance across groups (a difference of attrition rates between arms greater than 20.0%). And two studies did not provide enough data to determine if attrition rates differed between arms. Three studies reported a significant difference between groups at baseline, and three studies did not use intention-to-treat analysis.

RESULTS OF INDIVIDUAL STUDIES

Results of individual studies are presented in Table 2. Out of all of the assessed papers, none included assays that directly assessed outcomes related to agency, body awareness, decentering, disidentification, default mode network, ego, embodiment, empathy, experiential self, identity, interoception, meta-awareness, narrative self, observing self, perceived control, perspective taking, reperceiving, self-criticism, self-distancing, self-efficacy, self-loathing, self-monitoring, self-praise, self-worth, sense of agency, sense of control, sense of ownership, or theory of mind.

Lifespan development

Lifespan development provides a framework for understanding aging and is conceptualized as the physical and cognitive changes that occur during a person's life (Boyd & Bee, 2009). One of the included studies observed the effects of a mindfulness-based intervention on lifespan development as conceptualized with the Self-Description Questionnaire, which has participants describe different self-concepts of their ought and ideal selves (Crane et al., 2008). Crane et al. (2008) delivered an eight-week MBCT intervention for individuals in recovery from a history of affective disorder that included suicidal ideation and behavior. In the MBCT group, self-description or self-discrepancy

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measures improved or remained the same during the eight-week intervention. Further, participants in the MBCT group demonstrated a nonsignificant decrease in discrepancy from baseline to follow-up (Mi – j = 1.58, SE = 1.05, *p* = .14). However, in the waitlist control group, self-discrepancy measures increased from baseline to follow-up (Mi – j = - 1.65, SE = .96, *p* = .09). For ratings of likelihood of attaining ideal self-guides in the future, participants in the MBCT group showed no significant change from baseline to follow-up, yet those on the waitlist decreased (Mi – j = -1.61, SE = .67, *p* = .02). There were no significant changes on the measure of similarity to ought self-guides or the measure of change in ought self-likelihood.

When looking at comparisons across intervention arms, changes of ratings of similarity to ideal self-guides showed a significant time by group interaction (F(1, 40) = 5.15, *p* = .03, Cohen's *d* = .70). It was observed that at follow-up after an eight-week MBCT intervention, participants in the MBCT group reported significantly less disagreement from ideal self-guides than those in the wait list control group (Mi – j = 2.26, SE = 1.02, *p* = .03). There was also a significant time by group interaction for ratings of likelihood of attaining ideal self-guides in the future (F(1, 40) = 4.46, *p* = .04, Cohen's *d* = .67). Participants in the MBCT arm and the waitlist arm did not differ significantly at follow-up though. There were no significant time, group, or time by group interactions on the measures of similarity to ought self-guides or change in ought self-likelihood. Additionally, participants in the MBCT group showed no significant change in their perceived probability of reaching their ideal self-guide while those in the waitlist control group showed a significant reduction.

Prosocial

Prosocial behaviors are those related to helping and benefiting the rights, feelings, and actions of other people (Batson, Powell, Batson, & Powell, 2003). Three studies assessed prosocial outcomes before and after a MBSR intervention. Koszycki et al. (2007) assessed prosocial behavior using the Social Interaction Scale (SIAS) and the Social Phobia Scale (SPS). This study conducted an intervention with individuals with DSM-IV diagnosed Social Anxiety Disorder (SAD) randomized to an eight-week course of MBSR or a 12-week course of Cognitive-Behavioral Group Therapy (CBGT). MBSR participants improved significantly on both the SIAS (Cohen's d = .81) and the SPS (Cohen's d = .61) Participants in the CBGT group also improved significantly on both the SIAS (Cohen's d =1.61) and the SPS (Cohen's d =1.68).

However, when compared to the control group of CBGT, participants in the MBSR group had significantly higher scores on the SIAS ($F(1, 53)$ = 3.81, p = .057, Cohen's d =.30) and the SPS ($F(1, 53)$ = 8.28, p = .006, Cohen's d = .68) at post-treatment.

Both Creswell et al. (2012) and Jazaieri et al. (2012) used the UCLA-R Loneliness Scale to assess prosocial behavior. In both studies, participants in the MBSR group had significant decreases or improvements in loneliness scores from baseline to post-treatment. Jazaieri et al. (2012) reported a significant time interaction in the MBSR arm (F = 9.60, p = .008, Cohen's d = 1.67).

Further, both studies indicated that levels of loneliness improved significantly more in the MBSR group than in one comparison group. Creswell et al. (2012) reported a significant group by time interaction with MBSR participants' levels of loneliness being significantly different from those in the wait list control group ($F(1, 35)$ = 7.86, p = .008)

at post-treatment. Jazaieri et al. (2012) compared participants in a MBSR treatment to those in an aerobic exercise (AE) active control group and to a control group of untreated SAD individuals. The study observed a significant time effect between the MBSR and AE groups of (F(1, 25) = 11.55, $p < .01$, Cohen's $d = 1.31$). Additionally, when compared to the untreated SAD controls, those in the MBSR group had greater improvement on the loneliness scores (t (30) = 2.25, $p < .03$, Cohen's $d = .81$).

Self-Awareness

Self-awareness involves accurately understanding one's attitudes, preferences, strengths, weaknesses, and abilities and the implications they have on one's behaviors (Furnham, 2015). One of the included studies assessed self-awareness with the Social Adaptation Self-Evaluation Scale (SASS) (Michalak et al., 2015). This study compared an eight-week MBCT intervention group to a Cognitive Behavioral Analysis System of Psychotherapy (CBASP) plus treatment as usual (TAU) group to a TAU group for individuals with a current DSM-IV diagnosed major depressive episode with persistent depressive symptoms for more than two years.

Additionally, Michalak et al. (2015) observed that participants in the MBCT group had significantly different changes in scores on the SASS than those in the TAU group ($p < .05$, Cohen's $d = .57$) at post-treatment. Yet the participants in the CBASP group did not present changed levels of self-awareness at post-intervention.

Self-Compassion

Self-compassion refers to acting towards oneself with the same compassion one would show a friend even when dealing with a difficult time, failure, or something unappealing about oneself. There are three core elements of self-compassion: self-kindness, common humanity, and mindfulness (K. Neff, 2017). Four of the included

studies assessed self-compassion using the Self-Compassion Scale (SCS). Three out of the four studies observed significantly increased levels of self-compassion among participants in the active MBI arm from pre- to post-treatment (Eisendrath et al., 2016; Jazaieri et al., 2012; Robins et al., 2012).

However, out of these three studies, only one found that the MBI arm had significantly greater SCS score increases than in the wait list arm ($B = .36$, $\Delta R^2 = .11$, $p = .006$, $f^2 = .24$) (Robins et al., 2012). Further, Shapiro et al. (2011) observed no significant group by time effects for MBSR participants at either two-month or 12-month follow-up (12 month Cohen's $d = .36$). Jazaieri et al. (2012) only observed main time effects for MBSR compared to the aerobic exercise active control group (F(1, 20) = 16.56, $p < .001$, Cohen's $d = 1.77$) from baseline to post-intervention as well as from baseline to three-month follow-up (F(1, 17) = 13.60, $p < .002$, Cohen's $d = 1.74$).

Self-Esteem

Self-esteem refers to a person's sense of overall sense of self-worth or personal value. One of the included studies assessed self-esteem using the Rosenberg Self-Esteem Scale (RSES) (Jazaieri et al., 2012). Participants in the MBCT arm improved significantly on measures of self-esteem during the intervention (F(1, 30) = 15.18, $p < .001$, Cohen's $d = 2.00$).

Significant time effects were observed between the MBCT and AE groups from baseline to post-intervention (F(1, 30) = 17.11, $p < .001$, Cohen's $d = 1.50$) as well as from baseline to three-month follow-up (F(1, 22) = 9.06, $p < .006$, Cohen's $d = 1.25$) (Jazaieri et al., 2012). There were no significant differences between the MBCT and untreated SAD control group on the self-esteem measure.

Self-Related Rumination

Self-related rumination involves repetitive thinking of the causes, consequences, and symptoms of one's negative affect (Smith & Alloy, 2009). Self-related rumination was assessed by seven of the included studies (Anderson et al., 2007; Bondolfi et al., 2010; Eisendrath et al., 2016; Geschwind et al., 2011; Robins et al., 2012; Shapiro et al., 2011; van Aalderen et al., 2012). Self-related rumination was evaluated by four different scales: Anger Rumination Scale, Rumination Response Scale (RRS), Rumination on Sadness Scale (RSS), and the Rumination-Reflection Questionnaire (RRQ).

Self-related rumination improved in all MBI arms in all seven studies. This improvement was clearly reported as significant in four studies (Bondolfi et al., 2010; Eisendrath et al., 2016; Geschwind et al., 2011; Shapiro et al., 2011), but the other three studies did not provide enough information about within arm changes in self-related rumination (Anderson et al., 2007; Robins et al., 2011; van Aalderen et al., 2012).

When compared to controls, the pre-post change in rumination was observed to be significantly greater in the MBI arms in on three (ARS, RSS, RRQ) assays in three out of seven studies (Anderson et al., 2007; Geschwind et al., 2011; van Aalderen et al., 2012).

Eisendrath et al. (2016) and Robins et al. (2012) both used the Rumination Response Scale (RRS), a self-report scale on ruminative coping to evaluate self-related rumination. Both studies observed reduced levels of rumination among participants in the MBI arm.

However, both studies observed no significant differences between the MBI and the control groups in these decreased levels of rumination at post-intervention (Eisendrath et al., 2016; Robins et al., 2012). Eisendrath et al. (2016) observed that while both arms continued to improve significantly on levels of rumination for the yearlong

follow-up, there were no significant differences between the groups. Robins et al. (2012) observed a nonsignificant ($p = .06$) greater decrease in levels of rumination in the MBSR group.

The Anger Rumination Scale was used by Anderson et al. (2007) to measure self-related rumination. Anger rumination is a type of rumination that arises specifically with feelings of anger and is conceptualized as involuntary and repetitive thinking that arises during and after an episode of anger (Sukhodolsky, Golub, & Cromwell, 2001). Anderson et al. (2007) observed that scores on the Anger Rumination Scale decreased for both the wait list control group and the MBSR group from baseline to post-intervention.

Further, analyses demonstrated that these changes in rumination were greater in the MBSR group at post-test compared to the control group ($p < .02$) (Anderson et al., 2007).

Two studies used the Rumination on Sadness Scale (RSS) (Geschwind et al., 2011; van Aalderen et al., 2012) to assess the effects of MBCT on self-related rumination. This scale assesses rumination specifically relating to feelings and circumstances of sadness, yet this concept still involves unintentional and repetitive thinking (Smith & Alloy, 2009). Both studies found that participants in the MBCT arm had significantly reduced levels of rumination at post-treatment compared to baseline scores. Geschwind et al. (2011) randomized individuals with a lifetime history of depression and current residual depressive symptoms to MBCT or a wait list control group. The researchers found that from baseline to post-intervention, participants in the MBCT group had significantly reduced levels of rumination ($p < .05$). van Aalderen et al. (2012) did not report within arm changes for the MBCT arm on the RRS.

Both studies reported that the MBCT arm had significantly lower levels of rumination at post-treatment when compared to the control group. Geschwind et al. (2011) observed that MBCT group was associated with significant reductions in rumination compared to the control group. Further, Van Aalderen et al. (2012) observed, in their study of MBCT plus TAU compared to TAU alone, that participants in the MBCT plus TAU group had significantly less reported levels of rumination at post-intervention than those participants only receiving TAU (F(1, 44) = 13.4, $p <$ .01, Cohen's d = .50).

Three studies used the Rumination Reflection Questionnaire (RRQ) (Anderson et al., 2007; Bondolfi et al., 2010; Shapiro et al., 2011) to measure self-related rumination. This scale focuses on inward-focused thinking that is motivated by negative events as well as self-interest (Trapnell & Campbell, 1999). During the intervention, levels of rumination on the RRQ decreased significantly in the MBI arm in one of the three studies (Bondolfi et al., 2010). Anderson et al. (2007) did not provide enough within arm information about the changes on the RRQ during the intervention. Further, Shapiro et al. (2011) reported that changes in scores on the RRQ were not significant in the MBI arm with two month Cohen's d = .17 and 12 month Cohen's d = .22.

Moreover, pre-post changes on RRQ were observed to be significantly greater in the MBI arm in only one out of the three studies (Anderson et al., 2007). Anderson et al. (2007) found that the MBSR group had greater decreased rumination levels from pre-test to post-intervention than the wait list control group did ($p <$ .02). However, Bondolfi et al. (2010) observed that the TAU participants had lower rumination levels than their MBCT plus TAU participants did at each time point. The researchers also found

significant time (F(2, 68) = 4.53 p = .01, Cohen's d = .74) and group (F(1, 34) = 4.88 p = .03, Cohen's d = .77) interactions between the MBCT plus TAU group and the TAU only group (Bondolfi et al., 2010). However, no significant group by time interactions were observed (F(2, 68) = .66, p = .52, Cohen's d = .29). Additionally, Shapiro et al., (2011) reported no significant group by time interactions (p > .12).

Social cognition

Social cognition involves the cognitive processes related to social interactions, being part of a social group, and information processing in a social setting (Frith, 2008). Koszycki et al. (2007) evaluated social cognition by using the Interpersonal Sensitivity Measure (IPSM). This study conducted an intervention with individuals with DSM-IV diagnosed Social Anxiety Disorder (SAD) randomized to an eight-week course of MBSR or a 12-week course of Cognitive-Behavioral Group Therapy (CBGT). Participants in both the MBSR (Cohen's d = .66) and CBGT (Cohen's d = .99) groups had significantly improved scores on the IPSM at post-treatment compared to at baseline.

In the intent-to-treat analysis, post-treatment scores were not significantly different between groups on the IPSM (F(1, 53) = 1.56, p = .22, Cohen's d = .28). However, in completer analyses, participants in the CBGT group had significantly lower post-treatment scores than those in the MBSR group (F(1, 39) = 4.63, p = .038, Cohen's d = .76) (Koszycki et al., 2007).

SYNTHESIS OF RESULTS

Of the 87 studies available for this systematic review, only 12 of them included scales that directly assessed aspects SRP. Information about the quality of the included studies is reported in Table 3. Figure 2 presents an evidence map of the included studies.

To ensure inter-rater reliability, 13 pairs of extractors-reviewers were created so that all reviewers were able to edit each extractor's data entry. Differences between extractors and reviewers were resolved by consensus. Mean extractor-reviewer agreement was 94.3% (range = 86.4%-100%). Overall inter-rater agreement was very high (kappa = .933; range = .851-.990).

DISCUSSION

SUMMARY OF EVIDENCE

The aim of this study was to systematically review the current evidence on MBSR and MBCT interventions that involve assessing mechanisms of self-related processing (SRP). This review suggests that further research on mindfulness meditation's effect on mechanisms of SRP is needed. Our search resulted in 12 studies involving either MBSR or MBCT and an outcome of a mechanism of SRP. The 12 included studies assessed seven out of the 37 SRP mechanisms of interest. The most frequently assessed self-related processes or constructs were prosocial, self-compassion, and self-related rumination. This review suggests that these mechanisms may be avenues to pursue in order to further understand how mindfulness meditation improves self-regulation.

Three different scales were used to assess the SRP construct of prosocial processes: the Social Interaction Scale, the Social Phobia Scale, and the UCLA-R Loneliness Scale. Only studies with MBSR intervention evaluated prosocial behavior. Overall, it was observed that scores on these assays in all three studies decreased during the MBSR intervention demonstrating improvements on prosocial behavior (Creswell et al., 2012; Jazaieri et al., 2012; Koszycki et al., 2007). Further, all three studies observed greater changes in scores on three prosocial scales from pre-intervention to post-

intervention in the MBSR arm than in the control arm (Creswell et al., 2012; Jazaieri et al., 2012; Koszycki et al., 2007).

One scale was used to assess the SRP construct of self-compassion. The Self-Compassion Scale (K. D. Neff, 2003) was used in four studies (Eisendrath et al., 2016; Jazaieri et al., 2012; Robins, Keng, Ekblad, & Brantley, 2012; Shapiro, Brown, Thoresen, & Plante, 2011). Three of these studies found that the scores on the Self-Compassion Scale improved significantly after the MBI (Eisendrath et al., 2016; Jazaieri et al., 2012; Robins et al., 2012). Additionally, one of these three studies found that the improvements in self-compassion were greater in the MBI arm than in the control arm (Robins et al., 2012).

Self-related rumination was evaluated by four different scales: the Anger Rumination Scale, the Rumination Response Scale, the Rumination on Sadness Scale, and the Rumination Reflection Questionnaire. All of the seven studies that assessed self-related rumination observed that levels of rumination were lower at post-intervention than at pre-intervention. However, due to lack of within-arm results, it is difficult to understand the significance of these changes. Three of these studies observed that the reductions in rumination were greater in the MBI arm than in the control arm (Anderson, Lau, Segal, & Bishop, 2007; Geschwind et al., 2011; van Aalderen et al., 2012). While self-related rumination improvements appear to be significant within the MBI arm, these benefits do not always remain when compared to control groups.

Many of the constructs of SRP that were included in our initial search and generated by an expert panel were not represented in our results: agency, body awareness, decentering, disidentification, default mode network, ego, embodiment,

empathy, experiential self, identity, interoception, meta-awareness, narrative self, observing self, perceived control, perspective taking, reperceiving, self-criticism, self-distancing, self-efficacy, self-loathing, self-monitoring, self-praise, self-worth, sense of agency, sense of control, sense of ownership, or theory of mind. However, the lack of evidence of these constructs in this review does not mean they should be abandoned altogether. Some of the constructs of SRP that were not directly assessed may be represented in other domains not included in this review: the SRP construct of sense of control may be evaluated through assays of cognitive control; the SRP construct of perspective taking could be gauged in measures of quality of life. Measures of quality of life and wellbeing were not included in this review due to the intricate nature of these outcomes with the affective domain. Measures of decentering, disidentification, meta-awareness, observing self, reperceiving, and sense of ownership are also included in many of the mindfulness scales that were excluded because several reviews of mindfulness scales have been published recently (Baer et al., 2006; Bergomi, Tschacher, & Kupper, 2013; Brown & Ryan, 2006; Park et al., 2013; Siegling & Petrides, 2016; Visted et al., 2014).

Furthermore, this review only includes studies with the standard versions of MBSR or MBCT. Non-standard versions of MBSR or MBCT and other types of mindfulness-based interventions may include outcomes of SRP that are not represented in this current review. This review also only includes studies with the design of a randomized controlled trial. Other types of trials may lend support for additional constructs of SRP with mindfulness meditation.

All of the SRP assays from the included studies in this review were subjective self-report scales. Due to SRP being related to the self, it can be a difficult concept to assess objectively. However, subjective measures can introduce response bias into a study. Studies utilizing neuroscientific tools would be able to provide a more objective understanding of the mechanisms of SRP involved with mindfulness meditation. Yet, this review does not include any studies with neuroscience findings. Evidence suggests a strong neural relationship with mindfulness and SRP (Farb et al., 2007; Goldin et al., 2009; Holzel et al., 2011; Northoff et al., 2006). Future research that includes neuroscientific findings may expose additional SRP constructs to focus on for self-regulation.

The methodological quality of the studies included in this review suggests that the studies provided an overall low risk of bias. The smallest sample size was 30 participants, which provided 15 participants in each arm of the trial. Furthermore, all of the included studies were RCT with nine (69.0%) using a passive model of a control group with either a waitlist or treatment as usual. The remaining four studies utilized an active control condition. Three of these controls were matched comparators to MBSR or MBCT (HEP, CBT, CBASP), and one of the studies used aerobic exercise as an active control; this control was matched to the duration of the MBI interventions but the content was essentially different. Additionally, the content and format of MBSR and MBCT limit the ability to blind participants throughout the treatment. However, participants were usually kept blind of their study allocation until after baseline assessments were completed. Individuals with mental health disorders were the population of interest for 8 (62.0%) of the included studies. MBIs have been shown to be a possibly effective treatment for a

variety of mental health disorders, such as depression and social anxiety disorder (Ma &
Teasdale, 2004; Mars et al., 2010; Segal, Williams, et al., 2002; Teasdale et al., 2000;
Williams & Teasdale, 2007). Yet by focusing on these clinical populations, the studies
included in this review are not generalizable to a broader population. Additionally, many
of the included trials did not specify whether participants were allowed to have had prior
mind-body intervention experience, such as previous cognitive behavioral therapy
experience or a regular meditation or yoga practice. Previous meditation experience may
alter the effects of a MBI treatment and thus influence the evaluation of mechanisms of
SRP as amount of meditation experience has been associated with brain matter changes
(Lazar et al., 2005).

STRENGTHS AND LIMITATIONS

This is the first systematic review to focus specifically on mindfulness meditation
and SRP outcomes. Furthermore, the inclusion criteria used in this review aims to gather
studies of high methodological quality. We chose to focus on the rigorous study design of
randomized controlled trials to try to eliminate any population bias in the results.
Additionally, all of the interventions included were either standard MBSR or MBCT,
which are manualized and lend the results to share a degree of commonality. Moreover,
the inter-rater reliability for the extraction of outcomes in this review demonstrates a
substantial level of agreement between the reviews.

However, the strict inclusion criteria used in this review also makes it vulnerable
to selection bias. The lack of objective outcome measures suggests the possibility of
response bias in the included studies. Additionally, the exploratory nature of the review
where we were interested in all outcomes related to SRP and mindfulness meditation may
introduce outcome reporting bias into the review. Since the field of mindfulness is still

relatively new field, all included studies have been published in the past ten years; further research is needed. Additionally, this review is limited to English studies published in peer-reviewed journals and, as such, is susceptible to publication bias.

CONCLUSIONS

This study provides support for which mechanisms of SRP have and have not been assessed in MBI research thus far. Further, this review supports the need for future research on mindfulness meditation interventions and self-related processes. The assays for the constructs of SRP suggest mixed significance for the results. Additionally, the majority of studies focused on clinical populations, specifically with affective disorders, and this limits the generalizability of the findings. Future research should focus on other constructs of SRP and mindfulness meditation. Additionally, further research could expand on this review by including neuroscientific findings, grey literature, and other study designs other than RCTs.

FUNDING

FIGURE 1: FLOW CHART OF STUDY INCLUSION

Records identified through PubMed search (n=8,312)

Records identified through PubMed search (n=8,312)

IDENTIFICATION

Duplicate studies removed (n=2,489)

SCREENING

Potentially relevant studies screened (n=10,595)

Records excluded due to not meeting inclusion criteria (n=8,824)

ELIGIBILITY

Full-text articles assessed for eligibility (n=1,771)

Full-text articles excluded (n=1,684)
- Not RCT (n=750)
- Not standard MBSR/MBCT (n=548)
- Meditation not mindfulness (n=159)
- Results not available (n=49)
- Excluded publication type (n=43)
- Data not relevant (n=42)
- Intervention arm n<10 (n=33)
- Participants <18 years old (n=25)
- Associated publication (n=34)
- Neuroimaging study (n=12)
- Duplicate study (n=2)

Studies included in all domains (n=87)
MBSR (n=59)
MBCT (n=28)

No self-related processing outcomes reported (n=75)

INCLUDED

Studies included in self-related processing domain (n=12)
MBSR (n=6)
MBCT (n=6)

Construct	Assay	MBSR	MBCT
(life-span) Development	Self-Description Questionnaire	0	1
Prosocial	Social Interaction Scale	1	0
	Social Phobia Scale	1	0
	Loneliness - The composite UCLA-R Loneliness Scale	2	0
Self-Awareness	Social Adaptation Self-Evaluation Scale (SASS)	0	1
Self-Compassion	Self-Compassion Scale (SCS)	3	1
Self-Esteem	Rosenberg Self-Esteem Scale (RSES)	1	0
Self-Related Rumination	Anger Rumination Scale	1	0
	Rumination Response Scale (RRS)	1	1
	Rumination on Sadness Scale (RSS)	0	2
	Rumination-Reflection Questionnaire	2	1
Social Cognition	Interpersonal Sensitivity Measure	1	0

TABLE 1: STUDY CHARACTERISTICS OF INCLUDED STUDIES

Author (year)	N	Follow-up Time (weeks)	Population	Age (mean)	Race	Percent Female
Anderson, et al. (2007)	72	8	Healthy individuals	MBSR: 37.0; Passive Control: 41.7	NR	NR
Bondolfi et al. (2010) (Jermann et al. (2013))	60	60	Individuals with ≥3 previous depressive episodes	MBCT: 46; TAU Control: 49	NR	MBCT: 74%; Control: 69%
Crane et al. (2008) (Williams et al. (2008); Hepburn et al. (2009))	68	8	History of affective disorder with suicidal ideation and behavior	MBCT: 49.75; Passive Control: 40.44	All: 68 (100%) Caucasian	NR
Creswell et al. (2012)	40	8	Healthy older adults	MBSR: 64.35; Passive Control: 65.16	MBSR: Caucasian N=65%, African American N=10%, Asian American N=10%, Latino(a) N=15%; Control: Caucasian N=65%, African American N=15%, Asian American N=5%, Latino(a) N=5%, Native American N=5%, Other N=5%	All: 32 (80%); MBSR N: 17; Control N: 15

Eisendrath et al. (2016)	173	8	Treatment-resistant depression	MBCT: 47.1; Active Control (HEP): 45.2	MBCT: 80.7% Caucasian, 4.8% Asian American, 8.4% African American, 6.1% Other; Control: 79.5% Caucasian, 6.4% Asian American, 7.7% African American, 5.3% Other	MBCT: 75.9%; Control: 76.7%
Geschwind et al. (2011) (Batnik et al. (2013); Collip et al. (2013); Forkmann et al. (2014); Garland et al. (2015); Geschwind et al. (2012))	129	8	Lifetime history of depression and current residual depressive symptoms	MBCT: 44.6; Passive Control: 43.2	All: 129 (100%) Caucasian	MBCT: 79%; Control: 73%
Jazaieri et al. (2012)	133	12	Patients with social anxiety disorder	MBSR: 32.9; Active Control (Aerobic Exercise): 32.9	MBSR: 13 (41.9%) Caucasian, 14 (45.2%) Asian American, 3 (9.7%) Hispanic, 1 (3.2%) Multiracial; AE: 10 (40%) Caucasian, 11 (44%) Asian American, 1 (4%) Hispanic, 3 (12%) Multiracial	MBSR: 19 (61.3%); AE: 10 (40%)
Koszycki et al. (2007)	53	8	Generalized social anxiety disorder	MBSR: 38.9; Active Control	NR	MBSR: 16 (61.5%); CBGT: 12

				(CBGT): 37.6		(44.4%)
Michalak et al. (2015)	106	8	Current DSM–IV defined major depressive episode and persistent depressive symptoms for more than 2 years	MBCT: 48.4; Active Control (CBASP): 50.2; TAU: 54	NR	MBCT: 21 (58.3%); CBASP: 22 (62.9%); TAU: 23 (65.7%)
Robins et al. (2011) (Keng et al. (2012))	41	16	Non-clinical adults	MBSR: 43.8; Passive Control: 46.5	MBSR: 19 (95%) Caucasian, 1 (5%) Hispanic; WL: 18 (86%) Caucasian, 2 (9.5%) African American, 1 (4.8%) Hispanic	MBSR: 18 (90%); WL: 16 (76.2%)
Shapiro et al. (2011)	30	52	Undergraduate students	All: 18.73	All: 25 (83.3%) Caucasian, 3 (10%) Hispanic, 2 (6.7%) Asian American	All: 26 (86.7%)
van Aalderen et al. (2012) (Van den Hurk et al. (2012))	205	8	Patients with ≥ 3 previous depressive episodes according to DSM-IV criteria	MBCT: 47.3, TAU: 47.7	NR	MBCT: 71 (70%); TAU: 74 (72%)

TABLE 2: RESULTS OF INCLUDED STUDIES

Construct	Assay	Time	Within-arm comparisons	Between-arm comparisons	First author, year	MBI Type	Control
(Lifespan) development	Self-description Questionnaire	8 weeks	MBCT: (Mi-j=1.58, SE=1.05, p=.14); Control: (Mi-j=-1.65, SE=.96, p=.09)	Similarity to ideal self-guides Time x Group: F(1, 40)=5.15, p=.03, d=.70; Likelihood of attaining ideal self-guides Time x Group: F(1, 40)=4.46, p=.04, d=.67	Crane et al., 2008	MBCT	Waitlist
Prosocial	Social Interaction Scale (SIAS)	12 weeks	MBSR: d=.81; Control: d=1.61	Group: F(1, 53)=3.81, p=.057, d=.30	Koszycki et al., 2007	MBSR	Cognitive-Behavioral Group Therapy (CBGT)
	Social Phobia Scale (SPS)	12 weeks	MBSR: d=.61; Control: d=1.68	Group: F(1, 53)=8.28, p=.006, d=.68	Koszycki et al., 2007	MBSR	Cognitive-Behavioral Group Therapy (CBGT)
	The Composite UCLA-R Loneliness Scale	0 weeks	MBSR: M=42.35, SD= 2.23; Control: M=38.40, SD=2.33	NR	Creswell et al., 2012	MBSR	Waitlist
	The Composite UCLA-R Loneliness Scale	8 weeks	MBSR: M=37.40, SD=2.51; Control: M=40.75, SD=2.30	Group x Time: F(1, 35)=7.86, p=.008	Creswell et al., 2012	MBSR	Waitlist
	The Composite UCLA-R Loneliness Scale	12 weeks	MBSR Time: F=9.60, p=.008, d=1.67); Control Time= NS	MBSR vs AE Time: F(1, 25)=11.55, p<.01, d=1.31; MBSR vs TAU: t(30)=2.25, p<.03, d=.81	Jazaieri et al., 2012	MBSR	Aerobic Exercise (AE); TAU SAD control
Self-Awareness	Social Adaptation Self-Evaluation Scale (SASS)	8 weeks	NR	MBCT vs CBASP: p<.05, d=.57	Michalak et al., 2015	MBCT	Cognitive Behavioral Analysis System of Psychotherapy (CBASP)

	Self-Compassion Scale (SCS)	0 weeks	MBCT: M=2.3, SD=.6; Control: M=2.3, SD=.6	NR	Eisendrath et al., 2016	MBCT	HEP
	SCS	8 weeks	MBCT: M=2.8, SD=.7; Control: M=2.7, SD=.7	NR	Eisendrath et al., 2016	MBCT	HEP
Self-Compassion		8 weeks	MBSR time: F=1.70, *p*=.23, *d*=1.00; AE time: F=22.71, *p*=.001, *d*=2.67	MBSR vs AE time: F(1, 20)=16.56, *p*=.001, *d*=1.77	Jazaieri et al., 2012	MBSR	Aerobic Exercise (AE); TAU SAD control
	SCS	12 weeks	MBSR time: F=4.37, *p*=.07, *d*=1.57; AE time: F=10.46, *p*=.008, *d*=1.96	MBSR vs AE time: F(1, 27)=13.60, *p*=.002, *d*=1.74; MBSR vs TAU Group x Time: *p*=.001, *d*=1.53	Jazaieri et al., 2012	MBSR	Aerobic Exercise (AE); TAU SAD control
	SCS	0 weeks	MBSR: M=73.2, SD=17.58; Control: M=76.95, SD=19.53	NR	Robins et al., 2011	MBSR	Waitlist
	SCS	8 weeks	MBSR: M=89.75, SD=15.38; Control: M=76.86, SD=20.6	MBSR vs control: Group *β=.36, p*=.006, *d*=.80	Robins et al., 2011	MBSR	Waitlist
	SCS	16 weeks	NR	MBSR vs control: *d*=.84	Robins et al., 2011	MBSR	Waitlist
	SCS	0 weeks	MBSR: M=.70, SD=.13; Control: M=.67, SD=.16	NR	Shapiro et al., 2011	MBSR	Waitlist
	SCS	16 weeks	MBSR: M=.79, SD=.19; Control:	MBSR vs control Group x Time: NS, *d*=.18	Shapiro et al., 2011	MBSR	Waitlist

			M=.73, SD=.15				
	SCS	52 weeks	MBSR: M=.78, SD=.17; Control: M=.72, SD=.16	MBSR vs control Group x Time: NS, d=.36	Shapiro et al., 2011	MBSR	Waitlist
Self-Esteem	Rosenberg Self-Esteem Scale (RSES)	8 weeks	MBSR time: F=15.18, p=.001, d=2.0; AE time: F=4.48, p=.05, d=1.09	MBSR vs AE time: F(1, 30)=17.11, p=.001, d=1.50	Jazaieri et al., 2012	MBSR	Aerobic Exercise (AE); TAU SAD control
	RSES	12 weeks	MBSR time: F=6.96, p=.02, d=1.53; AE time: F=3.34, p=.01, d=1.09	MBSR vs AE time: F(1, 22)=9.06, p=.006, d=1.25	Jazaieri et al., 2012	MBSR	Aerobic Exercise (AE); TAU SAD control
Self-Related Rumination	Anger Rumination Scale	8 weeks	MBSR: M=36.3, SD=11.8; Control: M=34.7, SD=10.0	MBSR vs control: p<.02	Anderson et al., 2007	MBSR	Waitlist
	Rumination Response Scale (RRS)	8 weeks	MBCT: M=49.3, SD=11.5; Control: M=49.9, SD=11.5	NR	Eisendrath et al., 2016	MBCT	HEP
	RRS	0 weeks	MBSR: M=49.9, SD=13.3; Control: M=9.62, SD=9.68	NR	Robins et al, 2012	MBSR	Waitlist
	RRS	8 weeks	MBSR: M=47.1, SD=11.1; Control: M=50.9, SD=11.1	MBSR vs control: Group β=-.18, p=.062, d=.18	Robins et al, 2012	MBSR	Waitlist
	Rumination on Sadness Scale (RSS)	8 weeks	MBSR: M_{diff}=-7.8, SD=8.5, p<.05; Control: M_{diff}=-2.7, SD=7.7, p>.05	MBCT vs Control Group x Time: F=.04, p=.49, d=.13	Geschwind et al., 2011	MBCT	Waitlist
	RSS	8 weeks	MBCT: M=22.0, SD=8.6;	MBCT vs TAU Group: F(1,	van Aalderen et al.,	MMBCT	TAU

			Control: M=27.3, SD=10.6	44)=13.4, $p<.05$, $d=.50$; $M_{diff}=-4.8$	2012		
	Rumination-Reflection Questionnaire (RRQ)	8 weeks	MBSR: M=47.2, SD=13.5; Control: M=45.1, SD=14.5	NR	Anderson et al., 2007	MBSR	Waitlist
	RRQ	60 weeks	MBCT: M=34.9, SD=7.7; Control: M=31.1, SD=8.7	MBCT vs Control Group x Time: $F_{(2, 68)}=.66$, $p=.52$, $d=.29$; Time: $F_{(2, 68)}=4.53$, $p=.01$, $d=.74$; Group: $F_{(1, 34)}=4.88$, $p=.03$, $d=.77$	Bondolfi et al., 2010	MBCT	TAU
	RRQ	16 weeks	MBSR Group x Time: $p=-.6$; Control Group x Time: $p=-.33$	MBSR vs Control Group x Time: $p>.05$, $d=.17$	Shapiro et al., 2011	MBSR	Waitlist
	RRQ	52 weeks	MBSR Group x Time: $p=-.52$; Control Group x Time: $p=-.36$	MBSR vs Control Group x Time: $p>.05$, $d=.22$	Shapiro et al., 2011	MBSR	Waitlist
Social Cognition	Interpersonal Sensitivity Measure	12 weeks	MBSR: M=102.5, SD=16.9, $d=.66$; Control: M=98.1, SD=14.6, $d=.99$	MBSR vs Control Group: $F_{(1, 53)}=1.56$, $p=.22$, $d=.28$	Koszycki et al., 2007	MBSR	Cognitive-Behavioral Group Therapy (CBGT)

TABLE 3: QUALITY RATINGS FOR INCLUDED STUDIES

Author, year	1	2	3	4	5	6	7	8	9
Anderson et al., 2007	+	+	NA	?	+	+	-	-	+
Bondolfi et al., 2010	+	+	NA	+	+	+	+	+	-
Crane et al., 2008	+	+	NA	+	+	+	+	+	?
Creswell et al., 2012	+	+	NA	+	-	+	+	+	+
Eisendrath et al., 2016	+	+	+	+	+	+	+	+	-
Geschwind et al., 2011	+	+	NA	-	+	+	+	+	+
Jazaieri et al., 2012	+	+	NA	?	+	+	+	-	+
Koszycki et al., 2007	?	+	?	+	+	+	+	+	+
Michalak et al., 2015	+	+	+	+	-	+	+	+	+
Robins et al., 2011	?	?	NA	?	-	+	-	-	+
Shapiro et al., 2011	+	+	NA	+	+	+	-	+	?
van Aalderen et al., 2012	+	+	NA	?	+	+	+	+	+

+ = Low risk of bias; - = high risk of bias; ? = incomplete data; NA = not applicable

1. Was the allocation sequence adequately generated
2. Was allocation adequately concealed (prior to assignment)
3. Were participants adequately blinded?
4. Were outcome assessors adequately blinded?
5. Incomplete outcome data due to amount, nature or handling of incomplete outcome data
6. Is there evidence of selective outcome reporting bias?
7. Was there intention to treat analysis?
8. Group similarity at baseline?
9. Was there incomplete compliance with interventions across groups?

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