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ORIGINAL ARTICLE

How do Mindfulness-Based Programs Improve Depression Symptoms: Selflessness, Valence, or Valenced Self?

Ana L. Alejandre-Lara[1] · Nicholas K. Canby[1] · Kristen D. Wesbecher[1] · Kristina Eichel[1] · Willoughby B. Britton[1] · Jared R. Lindahl[2]

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Abstract
The current study investigated purported mechanisms by which mindfulness-based programs (MBP) improve depression symptoms, specifically, whether mindfulness-related changes in the processing of self-referential and/or emotionally valenced information are associated with improvements in depression symptoms. Four domains of the Self-Reference Task (SRT)—valence bias, self-bias, negative self-bias and positive self-bias in memory recall—were assessed before and after an 8-week MBP in 95 individuals with mild-severe depression symptoms. Associations between pre-post intervention changes in SRT biases and improvements in mindfulness skill acquisition and depression symptoms were examined. Intervention-related changes in SRT biases were also examined as a function of treatment response. Mindfulness skill acquisition from baseline to week eight was significantly associated with decreased self-bias and decreased negative self-bias. Improvement in depression symptom severity from baseline to week 20 was significantly associated with pre-to-post intervention decreases in negative valence bias and increases in positive self bias, but not changes in self-bias or negative self bias. Changes in valence bias significantly interacted with treatment response, while self biases did not. These findings suggest that MBPs decrease depression symptoms through changes in valence and valenced self rather than a global reduction in self-referential processing.
Trial registration clinicaltrials.gov NCT01831362

Keywords Mindfulness · Depression · Mechanism · Self-related processing · Emotional valence

Introduction

While mindfulness-based programs (MBPs) have been shown to be a potentially viable treatment for clinical and subclinical symptoms of depression (Goldberg et al., 2019; Hofmann et al., 2010; Khoury et al., 2013), the mechanism(s) by which MBPs exert their therapeutic effects are not well understood (Alsubaie et al., 2017; Armstrong & Rimes, 2016; van der Velden et al., 2015). Reduction in rumination—or negatively valenced self-referential processing (SRP)—is one of the best supported mechanisms for how MBPs reduce depression symptoms (Gu et al., 2015; van der Velden et al., 2015). However, rumination is comprised of both a bias toward negatively valenced information (valence bias) and a bias toward self-referential information (self-bias). Do MBPs lead to improvements in depression symptoms through changes in self-bias, valence bias, or some combination of the two (i.e., valenced self)? Current research supports all three possibilities.

Valence-Bias, Self-Bias, and Depression Symptoms

Cognitive theories of depression and dysphoric mood propose that negative valence bias, defined as a preferential attendance to or processing of negatively valenced information, is central to the onset, maintenance, and recurrence of depression symptoms (Beck, 2008; Mathews & MacLeod, 2005; Segal et al., 2006). Compared to never-depressed or euthymic controls, individuals with depression, remitted depression or subclinical levels of depressive symptoms (dysphoria) display both an attentional bias and a memory bias for negative information (i.e.,

✉ Willoughby B. Britton
willoughby_britton@brown.edu

[1] Department of Psychiatry and Human Behavior, Warren Alpert Medical School at Brown University, Biomed 232, 171 Meeting St, Providence, RI 02912, USA

[2] Department of Religious Studies, Brown University, Providence, RI, USA

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more robust encoding, storage, and retrieval) (De Raedt & Koster, 2010; Everaert et al., 2014; Gotlib & Joormann, 2010; Kellough et al., 2008; LeMoult & Gotlib, 2019).

Other theories have emphasized the absence of a positive valence bias—a factor independent of and separate from a negative bias—as causing and maintaining depressive symptoms. Not only do depressed, remitted and dysphoric individuals attend to and remember fewer positive stimuli, they also experience difficulty activating or maintaining positive emotions (Clark & Watson, 1991; Reidy, 2004; Rodriguez et al., 2010). In contrast, healthy, never-depressed controls typically display a positive valence bias (Gotlib et al., 2004), which is associated with increased well-being (Marsh et al., 2018). Taken together, both positive and negative valence bias appear to impact an individual's affective state independent of each other and may relate to the onset and maintenance of depressive symptoms (LeMoult & Gotlib, 2019).

In addition to emotional information processing biases, there is also an extensive literature linking elevated depressive symptoms and negative mood states to increased self-referential processing (SRP), excessive self-focus, self-preoccupation or "self-bias." Depressed individuals reliably show increased activation of brain areas involved in SRP (Sheline et al., 2009). Multiple meta-analyses have found positive correlations between trait self-consciousness, frequency of first-person pronoun use ("I", "me"), experimentally induced self-focus (looking at oneself in the mirror) and increased depression symptoms. Importantly, these meta-analyses also reported that few of the studies controlled for valence (Brockmeyer et al., 2015; Mor & Winquist, 2002; Tackman et al., 2019).

A substantial literature suggests that self-bias and valence bias may interact synergistically. Self-referential information "experienced as strongly related to one's own person" (Northoff et al., 2006, p. 441) is preferentially attended to and more strongly encoded, producing a well-documented self-bias in memory called the "self-reference effect" (Durbin et al., 2017; Sui & Humphreys, 2015; Symons & Johnson, 1997). On account of this effect, valence bias is amplified if the valenced information is self-referential (D'Argembeau et al., 2005). Thus, in healthy individuals, the self-reference effect amplifies a pre-existing positive valence bias and positive self-bias (Durbin et al., 2017). In contrast, in depressed individuals, the self-reference effect amplifies a pre-existing negative valence bias and negative self-bias (LeMoult & Gotlib, 2019; Williams & Moulds, 2010). This cycle results in a negatively valenced self-concept, which has become one of the most robust cognitive signatures and risk factors for not only clinical depression, but transdiagnostically across many clinically relevant presentations and diagnostic categories with dysphoric mood states (Disner et al., 2017; Mennin & Fresco, 2013; Phillips et al., 2010).

Negative self-concepts and negative mood states are thought to be caused and maintained by rumination, or repetitive negative thoughts about self and symptoms. Rumination exacerbates negative mood, increases risk for future dysphoric symptoms, and interferes with the efficacy of both psychological and pharmacological treatments (Watkins, 2015). Rumination is also linked to reduced optimistic or self-enhancing cognitive biases in individuals who are depressed or dysphoric compared to those who are not (Kuster et al., 2012; Orth & Robins, 2013). Reductions in rumination have been found to mediate improvement in depression symptoms in multiple treatments, including cognitive therapy, cognitive bias modification, and mindfulness-based treatments (van der Velden et al., 2015; Watkins, 2015). Although negative self-concept and its maintenance through rumination is a therapeutic target for many depression and anxiety treatments, some treatments target valence and some target SRP. Most treatments target some aspect of valence. For example, cognitive therapy and cognitive bias modification (CBM) target valence alone and/or the valence of the self-concept, shifting both from less negative to more positive. By contrast, mindfulness-based programs purportedly target the self-referential dimension rather than shifting valence (Hofmann et al., 2013; Watkins, 2015).

Self-Bias and Valence Bias in MBPs

While MBPs draw their mechanistic understandings from multiple sources including clinical psychology and neuroscience, the creators of MBSR and MBCT consider Buddhist philosophical underpinnings as among the essential and defining features of MBPs (Crane et al., 2017). Thus, to the extent that MBPs rely on Buddhist philosophy and practices to inform mechanisms, MBPs are hypothesized to exert their beneficial effects by reducing self-bias, without shifting valence bias from negative to positive (Holzel et al., 2011; Kabat-Zinn, 2011). In line with Buddhist principles, seeking positive experiences (craving, attachment) or trying to decrease or avoid negative ones (aversion) is viewed as a primary source of suffering, an idea which has been applied in MBPs to extend also to depression symptoms and a wide range of dysphoric mood states (Kabat-Zinn, 1990; Segal et al., 2002). Instead of trying to shift the valence bias of experiences, emotions, thoughts or self-concepts from negative to positive, mindfulness training promotes cultivating an altered *relationship* to thoughts and feelings: a stance of non-judgmental acceptance, non-reactivity, and equanimity that is impartial to either positive or negative valence bias (Desbordes et al., 2014).

The shift from suffering to equanimity and well-being is theorized to be achieved through a reduction in self-related processing (Dahl et al., 2015; Hadash et al., 2016; Kabat-Zinn, 2019; Ryan & Rigby, 2015), which is based

on the Buddhist theory and practice of "no self" or "not-self" (*anatta*). Creators of MBSR and MBCT, respectively, Jon Kabat-Zinn and John Teasdale invoke Buddhist not-self teachings, "nothing should be grasped at or clung to as 'me' or "mine"' (Buddhadasa, 1989, p. 138) as a central mechanism for MBP efficacy (Kabat-Zinn, 2010; Teasdale & Chaskalson, 2011a, 2011b).

Within MBPs, the principle of not-self is instilled several ways. During mindfulness meditation, participants are instructed to cultivate a detached, decentered, and disidentified witness or observer perspective in which thoughts and emotions of all valences are viewed as transient, impersonal mental events rather than as valid reflections of reality or traits of an enduring self (Bernstein et al., 2015; Ryan & Rigby, 2015; Williams, 2010). In addition, use of personal pronouns (I/me/my/mine or you/your/yours) that imply a self are discouraged. One MBCT teacher explains "In MBCT, the embodiment of not-self is supported by the guidance of the mindfulness-based meditation practices (for example, the way a teacher refers to '*the* body' versus '*your* body')" (Woods et al., 2019, p. 105). Similarly, participants are encouraged to reframe their experience from "I am angry" to "there is anger" to promote disidentification (Dahl et al., 2015; Kabat-Zinn, 1990; Ryan & Rigby, 2015; Wolf & Serpa, 2015).

MBPs differ from other treatments by prioritizing disidentification and reduction in *all* forms of SRP, positive as well as negative. *The Handbook of Mindfulness* explains (Ryan & Rigby, 2015):

> Perhaps fundamental to the effects of MT on positive functioning is the disidentification from these phenomena that an individual normally takes to be "me." In what has been called cognitive defusion (Hayes et al., 2012), decentering (Fresco, Moore, et al., 2007; Fresco, Segal, et al., 2007), deautomatization (Deikman, 1983), metacognitive awareness (Bishop et al., 2004), and related terms, the mindfulness trainee can sooner or later learn to recognize and disidentify *not just from maladaptive thoughts*, emotions, and sensations, which psychotherapy also promotes, *but from all such experiences*; with a capacity for sustained observation of internal experience is theorized to come a deep sense of calm and equanimity (Walsh & Shapiro, 2006). (p. 318, emphasis added)

Different terms have been used to refer to the pervasive and global reduction in SRP that purportedly underlies the efficacy of MBPs, including both "hypo-egoic" and "selfless" processing (Brown & Leary, 2016; Hadash et al., 2016). Hadash et al., (2016) define selfless processing as "no sense of the self as an immediate subject of experience, devoid of a sense of identification, ownership, agency or self-referential evaluation of experience" and as "a key mechanism through which mindfulness may alleviate suffering" and promote well-being (p. 857–858).

Additional support for a selfless processing mechanism is drawn from several separate lines of research: Depression symptoms and dysphoric mood states are associated with negative self-referential processing (rumination), and both are characterized by increased activation of the default mode network (DMN) and cortical midline structures (CMS) like the medial pre-frontal cortex (MPFC) (Cooney et al., 2010; Nejad et al., 2013; Sheline et al., 2009). Mindfulness meditation training has been associated with both decreased rumination (van der Velden et al., 2015) and attenuated CMS/DMN (Brewer et al., 2011; Farb et al., 2007; Garrison et al., 2013, 2015; Taylor et al., 2013).

Self-referential processing (SRP) and selfless processing (SLP) research in mindfulness meditation remains limited in several ways. While reductions in CMS/DMN activations have been found in meditators compared to non-meditators in cross-sectional studies, there is little evidence that meditation-induced reductions in CMS/DMN translate to reductions in depression symptoms in longitudinal clinical trials (Lin et al., 2018; Vignaud et al., 2018). Crucially, neither self-report nor neuroimaging-based mindfulness and SRP research has differentiated the self-referential dimensions from the negative valence dimension of rumination. Thus, it remains unknown whether self, valence, or a combination are associated with improvements in depression symptoms that result from mindfulness training.

The purpose of the current study was to test the validity of the SLP model by investigating the differential and/or combined contributions of self-referential and emotion-related processing to MBP-related improvements in depression symptoms. The current study used the Self-Reference Task (SRT), an objective measure of valenced SRP, which is able to differentiate implicit processing of emotional valence versus self-referential information. Specifically, the current study investigated whether pre- to post-treatment changes in SRT valence bias, self-bias, and/or their combination (valenced self) were associated with improvements in depression symptoms from baseline to week 20 (3-month follow-up). To the extent that the mechanism of MBPs are congruent with Buddhist not-self or SLP models, we would hypothesize that mindfulness-related decreases in self-bias will be associated with improvements in depression symptoms. Specifically, we hypothesize that: (1a) self-bias will decrease from baseline to week eight of mindfulness training, (1b) decreases in self-bias will be associated with increases in mindfulness skill acquisition, and (2) decreases in self-bias will be associated with improvements in depression symptoms and clinically significant treatment responses from baseline to week 20. SLP models would also predict that reductions in self-bias will be more important than shifts in valence, or that mindfulness training will have stronger

effects on self-bias than valence bias, and reduced self-bias will be associated with improvement in depression symptoms to a greater extent than changes in valence bias. While we expect reduction in negative self-bias—consistent with rumination findings—any effects on valenced self would be driven by reductions in self-bias rather than shifts in valence. Hence, the SLP model would also predict that both positive and negative self-bias should decrease.

Methods

Participants

The sample was intended to be representative of Americans seeking mindfulness meditation training, who typically exhibit clinical, sub-clinical and transdiagnostic expressions of affective disturbances, including anxiety, depression and stress (Morone et al., 2017). Participants were English-speaking adults between the ages of 18 and 65 who exhibited mild to severe levels of depression symptoms (Inventory of Depressive Symptomology; IDS-C; Rush et al., 1996; score of 10–48) and persistently high levels of negative affect (Positive and Negative Affect Schedule; PANAS; Watson et al., 1988; negative affect scale score > 18 in last month). Specific diagnostic criteria, although measured, were not required for inclusion, as such a categorical approach overlooks the significant contribution of subclinical symptoms to the persistent course of illness (Cuijpers & Smit, 2004; Krueger et al., 2003; Lovibond, 1998); functional impairment and quality of life (Cuijpers et al., 2004; Gotlib et al., 1995) and increased risk for developing physical health problems (Frasure-Smith et al., 1995; Nabi et al., 2008, 2009). Similarly, and relevant to the current paper, both clinical and subclinical symptoms of depression, as well as transdiagnostic dysphoric mood states have also been found to be linked to biases in valenced and self-related information processing (De Raedt & Koster, 2010; Everaert et al., 2014; Gotlib & Joormann, 2010; Kellough et al., 2008; LeMoult & Gotlib, 2019; Mennin & Fresco, 2013; Mor & Winquist, 2002) and are among the most reliably improved outcomes of mindfulness-based programs, especially MBCT (Hoge et al., 2021).

Exclusion criteria included extremely severe levels of depression symptoms (IDS > 48) or active suicidal ideation; history of psychotic or bipolar disorder, borderline or antisocial personality disorder, or organic brain damage; current obsessive–compulsive disorder, panic, PTSD, eating disorder, or substance abuse and/or dependence; inability to read and write in English; regular meditation practice; and current psychotherapy or change in antidepressant medication in the last 2 months for details, see Britton et al. (2018).

Procedure

Participants were recruited through community advertisements describing meditation for stress, anxiety, and depression. This study was carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki. All participants provided written, informed consent approved by the Brown University Institutional Review Board. Following screening, eligible participants were randomized to participate in one of three types of 8-week mindfulness-based programs. Participants completed the Self-Reference Task (SRT) before and after the 8-week mindfulness training program. Depression symptoms were assessed at baseline, eight weeks, and 20-week follow-up. Mindfulness was assessed at baseline, week three, week five, week seven, and week eight. All assessments and treatments were conducted between November 2012 and March 2016 at the Clinical and Affective Neuroscience Laboratory in the Department of Psychiatry and Human Behavior at Brown University.

Intervention

As reported in Britton et al. (2018), the treatment programs were three variants of Mindfulness-Based Cognitive Therapy (MBCT): open monitoring (OM), focused attention (FA), and standard MBCT, which took place in nine treatment groups (three groups for each treatment program). The OM treatment had participants bring unbiased and open attention to their experience without focusing on any single object. FA treatment, by contrast, had individuals select an anchor on which to focus during meditation. Standard MBCT combines components of cognitive behavioral therapy and Mindfulness-Based Stress Reduction (MBSR) using a group-based psychoeducational format (Segal et al., 2002) and employs a combination of both OM and FA meditation techniques. Each intervention lasted 8 weeks and included weekly 2.5-h classes and a daylong retreat during the 7th week. Homework consisted of 45 min per day of formal meditation practice. The first four weeks included practice instruction (FA, OM, or combination), while the latter half focused on applying the practices to manage acute negative affect. For detailed information about the treatment, including session by session content, transcripts of practices, structural equivalence, differential validity, adherence and fidelity, see Britton et al. (2018).

Measures

Baseline diagnostic status and exclusion criteria were established with the Structured Clinical Interview for DSM-IV

for Axis I (SCID-I) and Axis II (SCID-II) disorders (Frist, 1997). Recordings of SCID-I interviews were independently reviewed for current depressive disorder (MDD) and generalized anxiety disorder (GAD) diagnostic criteria by a second Ph.D.-level clinician (κs > 0.90).

Inventory of Depressive Symptomatology

The IDS (Rush et al., 1996) is a 30-item clinician-administered interview that assesses depressive symptomatology according to DSM-IV criteria in the last 7 days. The IDS measures multiple symptom domains including a wide range of dysphoric mood states and cognitions (anhedonia, sadness, irritability, anxiety, panic, reactivity; self-criticism and self-blame, suicidal ideation), and physical changes (energy, sleep, appetite, digestion, body pain, sex, psychomotor agitation or retardation). Each item is scored 0–3 and total scores of 0–13 indicate normal or non-depressed, 14–25 indicates mild, 26–38 indicates moderate, 39–48 indicates severe, and 49–84 indicates very severely depressed (Rush et al., 1996). The IDS was administered at baseline, post-intervention (week eight), and 20-week follow-up by graduate-level research assistants who were trained by and met high inter-rater reliability with PhD-level clinicians (baseline, week 8, week 20 αs = 0.89, 0.93, 0.94; κs = 0.64, 0.72, 0.83). While the IDS was originally created to measure symptoms of MDD, it is also has transdiagnostic utility in detecting and predicting MDD as well as several anxiety disorders (GAD, panic), which frequently co-occur with MDD (Wardenaar et al., 2012).

Self-Reference Task (SRT)

The SRT (Kelley et al., 2002) is an implicit measure of self-referential processing that assesses the temporally extended, linguistically-mediated "narrative," autobiographical self, or self-concept that is neurally substantiated by the MPFC (Farb et al., 2007; Macrae et al., 2004; Northoff et al., 2006). The SRT has been used to measure SRP in mindfulness meditation studies that assert an SLP model (Brewer et al., 2011; Farb et al., 2007; Garrison et al., 2015). Because there are multiple versions and outputs of the SRT, researchers must choose the version that fits their objective (Dainer-Best et al., 2018; Goldstein et al., 2015). In the current study, we used memory recall rather than reaction time in the task because biases in explicit memory (free recall) show more consistent associations with depression symptoms than biases in attention (Banos et al., 2001). In addition, recall (but not endorsement) of negative self-referential words is more reflective of rumination (Moulds et al., 2007); therefore, the self-reference effect (preferential memory for self-referential information; our central measure of SRP) is assessed via a memory-based measure (Cunningham & Turk, 2017). Studies examining the psychometrics of the SRT recall metric indicate that it has adequate test–retest reliability and is correlated with other behavioral and neurophysiological metrics of the SRT task (Auerbach et al., 2016). Further, findings indicate that biases in the recall of positively or negatively valenced words on the SRT task depend on depression symptoms, such that healthy individuals tend to exert a bias toward positive words, subclinically depressed individuals tend to exert no bias, and clinically depressed individuals tend to exert a bias toward negative words (see Matt et al., 1992 for a meta-analysis).

SRT Procedure Participants were presented with a set of adjectives that were either negative or positive, but not neutral (i.e., "kind," "SAD," "witty," and "SELFISH") on a computer screen and asked to make one of two judgments. One judgment is cued by the word "self" and asks the participant to decide "Does this word describe you?" The other judgment is cued by the word "case" and asks the participant to indicate, "Is this adjective printed in uppercase letters?" Participants indicate their "yes" or "no" responses via left- or right-handed key presses. Each trial consisted of a fixation cross (500 ms) followed by the cue word indicating the condition of the judgment above the fixation cross and an adjective below the fixation cross (3000 ms). Two lists of 120 adjectives each were counterbalanced for word length and valence, with equal numbers of words for the self and case conditions (Anderson, 1968). Lists were alternatively presented at baseline or post-intervention according to participants' ID numbers. Participants underwent a practice round after instructions, and the researcher checked to make sure that they understood and were engaging with the task correctly before they were allowed to proceed with the task.

After completing the SRT, participants were asked to write down any words that they remembered from the task in any order without a time limit. The total number of correct positive, negative, self, case, positive self, and negative self words recalled was calculated. Ratios were used (% of total words) to account for individual differences in overall memory (Goldstein et al., 2015). SRT recall patterns were reported in four indices: self-bias, valence bias, positive self-bias and negative self-bias.

Self-Bias Self-bias is represented by fraction of words recalled that were presented as 'self' words over the number of total accurate words recalled. This self-bias measure represents the self-reference effect.

Valence Bias Valence bias reflects the extent to which the valence of the word (positive or negative) influences its likelihood of being recalled, independent of whether it was encoded as self-relevant. Valence bias is represented by the

fraction of negative words recalled over the total number of accurate words recalled. Because all words were presented as either negative or positive, negative bias would be the inverse of positive bias (number of positive words recalled over the total number of accurate words). We use negative bias for consistency.

Negative Self-Bias Negative self-bias is a measure of negatively valenced self-concept and is measured as the ratio of negative words that were presented as "self" words recalled over the total number of accurate words recalled.

Positive Self-Bias Positive self-bias is a measure of positively valenced self-concept and is measured as the ratio of positive words that were presented as "self" words recalled over the total number of accurate words recalled. Unlike negative and positive bias, negative self-bias and positive self-bias are not inverses of each other, because words that were not negative self words may have been positive or negative case words.

The Five Facet Mindfulness Questionnaire

The FFMQ (Baer et al., 2006) is a 39-item self-report questionnaire that measures five dimensions of mindfulness: observing, describing, acting with awareness, non-judging and emotional non-reactivity. Each item is a rated on a five-point scale from "never or rarely true" to "very often or always true." The FFMQ total score change from baseline to post-intervention has been shown to successfully differentiate MBPs from control conditions better than any facet alone (Baer et al., 2019) and was therefore used to measure mindfulness skill acquisition (baseline and week eight, $\alpha = 0.91, 0.93$).

Preliminary Analysis

Analyses were conducted with SPSS 26 and R 4.0.3 and included only participants who completed the intervention. All variables were examined for normality, outliers, and missing values. Growth curve models using a multilevel modeling approach were constructed for depression symptoms, mindfulness skills, and SRT biases. This approach creates a model for each individual's change trajectory over time on the dependent variable, allowing for modeling of nested data and prediction of participant changes in the dependent variable across more than two time points (see Singer & Willett, 2003). Models were constructed using the nlme R package with maximum likelihood estimation. Assumptions were investigated for each model.

Multilevel models were constructed in stages in order to address each study hypothesis. First, models accounted for the nested structure of the data by adding random intercepts to nest time (level one) within each participant (level two), participants within the nine intervention groups (level three) and groups within the three treatment types (level four). Random effects that accounted for no variance were not retained in the models.

In order to test for changes over time in the dependent variable, time in weeks was added to each model as a fixed effect. The model for depression scores included IDS measured at three timepoints (week 0, week 8, and week 20), the model for mindfulness skills included FFMQ measured at five timepoints (week 0, week 3, week 5, week 7, and week 8), and the SRT models included time at two timepoints (week 0 and week 8). Establishing significant change in mindfulness and depression symptoms was a prerequisite for the primary analyses, which examined predictors of change. The time variable was coded such that post-course (week 8) was set to zero in all models. Lastly, error and variance structures were fit to each model using deviance statistics to determine the best fit. Deviance statistics were used to compare models and determine if additional parameters significantly improved model fit. For analyses comparing pre-post means and standard deviations, effect sizes were reported as Cohen's d, small = 0.20, medium = 0.50 and large = 0.80 (Cohen, 2013).

Primary Analysis

Mindfulness-Related Changes in SRT Biases

Two methods were used to assess whether mindfulness training influenced SRT biases. First, as mentioned in the previous section, pre-to-post intervention changes in SRT biases were assessed by adding time as a fixed effect into models predicting SRT biases. Second, SRT change scores were entered into the mindfulness growth model to predict the slope of change in mindfulness over time. This was assessed through SRT change score by time interaction effects (see Singer & Willett, 2003). The effect of SRT change scores on the model intercept was tested before the interaction effect was added to the model in order to control for intercept effects when testing for slope effects. Note that when the interaction effect is part of the model, the intercept coefficient is reinterpreted to refer to prediction of the intercept zero-point, which was set to the post-course timepoint. Three-month-follow-up FFMQ scores were not included in the mindfulness growth model due to a correlational (non-directional) hypothesis for the relationship between SRT bias change and change in mindfulness. Thus, changes in both variables occurred in the same span of time. Akaike information criteria (AIC) statistics were used to compare models with different predictors, such that lower AIC values indicate better model fit.

SRT Bias Change Impact on Depression Symptom Severity

The impact of SRT bias change on changes in depression symptom severity was similarly assessed, as described above for the mindfulness growth model, by entering SRT change scores into the depression growth model to predict the slope of depression symptoms over time. Since depression symptoms were considered an outcome of the intervention, three-month follow-up measures of depression symptoms were considered to be relevant for intervention efficacy and were thus included in the growth model for depression. Models with different predictors were compared using AIC statistics.

SRT Bias Change Impact on Treatment Response

Following recent recommendations to report findings in terms of clinical significance in addition to statistical significance (Guidi et al., 2018; IOM, 2008), changes in SRT biases were assessed as a function of positive treatment response vs non-response. Positive treatment response was defined as a $\geq 50\%$ reduction in depression symptoms from baseline to 20 weeks (Rush et al., 2006). An interaction term between positive treatment response (a dichotomous variable) and time was added to the SRT bias models to assess whether positive treatment response differentially impacted changes in SRT bias over time.

Results

Preliminary Analysis

Sample and Treatment Characteristics

Table 1 describes sample and treatment characteristics, including demographics, diagnoses, attendance and attrition, meditation homework compliance, and instructor treatment fidelity. Of the 104 participants enrolled in the present study (FA = 36, MBCT = 32, OM = 36), 96 completed the intervention and all follow-up assessments (FA = 35, MBCT = 32, OM = 31). Participants were typical of mindfulness meditators in the U.S. (Morone et al., 2017): predominantly female (73.1%), white, educated, middle-aged with mild-severe depression (mean IDS = 23.2 ± 7.3, range 11–39). Approximately forty percent of the sample met DSM criteria for current depression, exactly half met criteria for GAD, and a third were taking antidepressant medication at enrollment.

Table 1 Sample and treatment characteristics

Female, *n* (%)	76 (73.1%)
Age, *M* (*SD*)	40.3 (12.8)
Race, *n* (%)	101 (99.0%)
White	
Ethnicity, *n* (%)	
Hispanic/Latino	96 (93.2%)
Highest level of education, *n* (%)	
High school	3 (2.9%)
College	56 (53.8%)
Graduate	45 (43.2%)
Axis I Diagnoses, *n* (%)	
Current clinical MDD	41 (39.4%)
Current clinical GAD	52 (50.0%)
IDS, *M* (SD)	23.2 (7.3)
AD meds, *n* (%)	35 (33.7%)
Participant adherence	
Total enrolled, *n*	104
Dropped out of treatment, *n* (%)[a]	6 (5.9%)
Completed all assessments, *n* (%)[b]	96 (94.1%)
Classes attended, *M* (*SD*)[b]	7.8 (1.6)
Meditation Homework Compliance	
8 week formal min/wk, *M* (*SD*)[b]	202.6 (73.7)
3 month formal min/wk, *M* (*SD*)[b]	100.7 (99.2)
Treatment Fidelity	93.3%

Sample and treatment characteristics are presented as raw totals and percentages

MDD Major depressive disorder, *GAD* Generalized anxiety disorder, *AD* Antidepressants

Missing Data

One missing datapoint on the SRT task was caused by the participant failing to correctly recall any words. The number of words correctly recalled on the SRT task was found to be unrelated ($p > 0.05$) to depression, mindfulness, or diagnostic status at any timepoint, indicating that this missing datapoint was missing completely at random. This participant was excluded from analysis, resulting in complete data for 95 participants. FFMQ scores across all five timepoints contained 3.6% missing data. Missingness on the FFMQ was not correlated with any other variables and was handled with the maximum likelihood procedure in the multilevel models. All other variables contained no missing data.

SRT Bias Descriptive Statistics

Descriptive statistics of valence bias at baseline indicated that 62% of the sample recalled more positive words than negative words (positivity bias), 21% recalled more

negative words than positive words (negativity bias) and 17% showed no valence bias. With regards to self-bias, 95% of the sample recalled more self than case words, indicating a robust self-reference effect. The remaining participants either recalled more case words or recalled the same number of words presented with self and case judgment. With regards to positive and negative self biases, 31% of the sample recalled more negative self words than positive self words, while 47% of the sample recalled more positive self words than negative self words.

Outliers and Model Assumptions

Numerous outliers (three of them extreme outliers) were identified on SRT change scores. In order to reduce the impact of outliers on the statistical models, the four SRT change score variables were winsorized by substituting values outside of the 95th percentile range with the minimum or maximum score within that range. See Supplementary Table S1 for the correlation coefficients between SRT change scores. Examination of model residuals for the growth model predicting depression symptoms revealed a violation of the homoscedasticity assumption due to non-normally distributed depression symptom scores across all three time points (skew = 0.61, kurtosis = −0.43). A Box Cox power transformation using maximum likelihood estimation was used to find an optimal power transformation to normality for this variable (Pek et al., 2018). The transformation estimate was exactly 0.50, resulting in a square root transformation for the depression symptom score variable. All other model assumptions were adequately met.

Nested Data Structure

Across all time points for depression symptoms, mindfulness skills, and all four SRT biases (self bias, valence bias, positive self bias, negative self bias) random intercepts at the levels of the three treatment types and nine intervention groups explained very close to zero variance (ICC < 0.001), indicating that there were no treatment or group differences in depression symptoms, mindfulness skills, or SRT biases across time points. As a result, these random intercepts were not retained in the models. Random intercepts at the participant level explained 1.49% of depression symptom variance, 49.94% of mindfulness skills variance, 31% of self bias variance, 10% of valence bias variance, 13% of positive self bias variance, and < 1% of negative self bias variance.

Intervention-Related Changes in Mindfulness and Depression

For depression symptoms, the addition of the linear time slope as a fixed effect into the model significantly improved model fit, $\chi^2(1) = 100.90$, $p < 0.0001$. The addition of a random slope for the effects of time at the participant level resulted in the model not converging, indicating that there was very little slope variance across participants. An autocorrelated error structure significantly improved model fit, $\chi^2(1) = 4.96$, $p = 0.026$. The final model for depression symptoms had a significant fixed effect for the effect of time on depression symptoms ($b = -0.08$, $SE = 0.01$, $p < 0.0001$), indicating a significant main effect of time on depression symptoms from baseline to three-month-follow-up measurements. Effect size calculation indicated that depression symptom scores decreased with a large effect size from baseline to three-month-follow-up ($d = 1.48$).

For mindfulness skills, including time as a fixed effect also significantly improved the model, $\chi^2(1) = 173.95$, $p < 0.0001$. Allowing the time slope to vary across participants further improved the model, $\chi^2(2) = 45.33$, $p < 0.0001$. Finally, an autocorrelated error structure significantly improved model fit, $\chi^2(1) = 4.44$, $p = 0.035$. The final model for mindfulness skills had a significant fixed effect for the effect of time on mindfulness skills ($b = 2.58$, $SE = 0.26$, $p < 0.0001$), indicating that mindfulness skills significantly changed from baseline to post-course measurements. Effect size calculation revealed that mindfulness skills increased with a large effect size from baseline to post-course ($d = 1.04$). See Supplementary Table S2 for depression and mindfulness model parameters.

Primary Analyses

Intervention-Related Changes in SRT Biases

Contrary to our hypotheses, when time was added as a fixed effect into models for the four types of SRT biases (valence bias, self bias, positive self bias, negative self bias) it was not significant for any model, indicating that SRT biases did not change significantly from baseline to post-intervention. See Table 2 for descriptive statistics for SRT bias at each time point and *t* statistics for the time coefficients in each model. Random slopes and error structures were also added to each model and did not significantly improve model fit for any of the models.

Table 2 Self-reference task bias changes from baseline to post-intervention (8-weeks)

Measure	Baseline			Post-Intervention			Effect of time			
	% Bias	Mean	SD	% Bias	Mean	SD	*t*	*p*	Cohen's *d*	95% CI for Cohen's *d*
Negative Valence	21%	0.42	0.16	22%	0.44	0.15	−0.66	0.510	−0.07	[−0.27, .13]
Self	95%	0.81	0.15	92%	0.78	0.16	1.36	0.176	0.14	[−0.06, .34]
Negative self	31%	0.37	0.17	33%	0.37	0.15	0.07	0.947	0.01	[−0.19, .21]
Positive self	47%	0.43	0.18	45%	0.41	0.16	1.05	0.299	0.11	[−0.10, .31]

N = 95. Means are expressed as decimals and represent the percentage of words of the specified type correctly recalled over the total number of words correctly recalled. The effect of time was assessed by adding time as a fixed predictor into mixed effect models predicting each SRT bias. Note that this is statistically equivalent to a paired-sample *t* test. All tests were two-tailed

Associations Between Changes in SRT Biases and Changes in Mindfulness

In order to control for the effects of SRT bias change scores on the mindfulness model intercept, SRT bias change scores were first added to the mindfulness growth model as predictors of the intercept (assessing the main effect). This did not significantly improve model fit for any of the models: negative valence bias change, $\chi^2(1) = 0.02$, p = 0.900; self bias change, $\chi^2(1) = 1.81$, p = 0.180; positive self bias change, $\chi^2(1) = 0.19$, p = 0.662; negative self bias change, $\chi^2(1) = 0.34$, p = 0.562. Next, interaction terms between SRT bias change scores and time were added to these models to predict the slope of mindfulness skills over time. Decreases in self bias and negative self bias were both significantly associated with increases in the mindfulness slope. There was a trend-level relationship between a decrease in (negative) valence bias and an increase in mindfulness, while changes in positive self bias were not significantly related to the mindfulness slope. See Table 3 for the results of these models and Fig. 1 for a graphical representation of the interaction effects. Model comparisons using AIC statistics revealed that change in self bias provided the best fit to the data (AIC = 3682.77), followed by change in negative self bias (AIC = 3683.35). Change in negative valence bias (AIC = 3686.82) and positive self bias (AIC = 3689.18)

Table 3 Associations between changes in SRT biases and changes in depression symptoms and mindfulness scores

Predictors:	Depression symptoms (IDS)				Mindfulness scores (FFMQ)			
	AIC	Deviance (df)	*b*	*SE*	AIC	Deviance (df)	*b*	*SE*
Δ in % of negative valence words recalled	795.45	4.97* (1)			3686.82	3.19 ~ (1)		
Intercept at post-course			0.15	0.36			−8.55	9.66
Time slope			0.06*	0.03			−2.31 ~	1.29
Δ in % of self words recalled	799.63	0.74 (1)			3682.77	5.45* (1)		
Intercept at post-course			−0.24	0.40			−25.28*	10.42
Time Slope			−0.03	0.04			−3.32*	1.41
Δ in % of positive self words recalled	792.44	6.60* (1)			3689.18	0.66 (1)		
Intercept at post-course			−0.37	0.34			0.84	9.19
Time slope			−0.07*	0.03			1.00	1.24
Δ in % of negative self words recalled	798.53	2.25 (1)			3683.35	6.34* (1)		
Intercept at post-course			0.03	0.35			−15.34 ~	8.19
Time slope			0.04	0.03			−2.78*	1.09

~ p < .10

*p < .05

**p < .01

*** p < .001

Predictors were entered as fixed effects into growth models for Depression Symptoms and Mindfulness Scores. Interaction terms with Time represented prediction of model slope, while predictors not in interaction represented prediction of the intercept at the post-course timepoint (the zero point of the time variable). Deviance statistics refer to the likelihood ratio of each model when compared to the same model without the interaction term (main effect only). The IDS is the Inventory of Depressive Symptomology. The FFMQ is the Five Facet Mindfulness Questionnaire. SRT is the self reference task

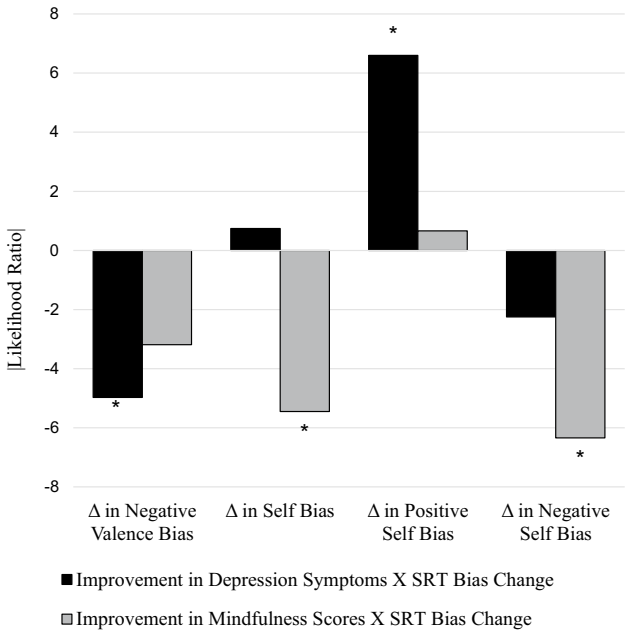

Fig. 1 Associations between changes in SRT biases and improvements in depression symptoms and mindfulness scores. Note. Likelihood ratios were calculated by comparing the model with the SRT bias change score by time interaction term with the same model without the interaction term. They are used to provide a standardized effect size for the interactions between SRT bias change score and time. In order to illustrate the direction of the effects, the likelihood ratios of inverse relationships were multiplied by − 1. Therefore, positive values can be interpreted as relationships in which increases in SRT bias relate to improvements in depression symptoms and mindfulness, while negative values can be interpreted as relationships in which decreases in SRT bias relate to improvements in depression symptoms and mindfulness. *$p < .05$

provided a worse fit to the data than the model without SRT bias predictors (AIC = 3686.03).

Associations Between Changes in SRT Biases and Changes in Depression Symptoms

First, SRT bias change scores were entered into the growth model for depression symptoms as predictors of the model intercept (assessing the main effect). None of them significantly improved model fit: negative valence bias change: $\chi^2(1) = 0.41$, p = 0.521, self bias change: $\chi^2(1) = 0.47$, p = 0.494, positive self bias change: $\chi^2(1) = 1.80$, p = 0.180, negative self bias change: $\chi^2(1) = 0.05$, p = 0.822. Next, interaction terms between time and SRT bias change scores were added to the models. Decreases in valence bias were significantly associated with decreases in the depression symptom slope (see Table 3). Change in self bias was not significantly associated with the depression symptom slope; however, contrary to expectations, the direction of the relationship was negative such that increases in self-bias corresponded with decreases in depression symptoms. Increases in positive self bias were significantly associated with decreases in the depression symptom slope. Change in negative self bias was not significantly associated with the depression symptom slope. See Table 3 and Fig. 1 for the results of these models.

Model comparisons using AIC statistics indicated that compared to the growth model for depression symptoms without SRT bias change scores (AIC = 796.84), the model with change in positive self bias provided the best fit to the data (AIC = 792.44), followed by the model with change in valence bias (AIC = 795.45). The models with change in self bias (AIC = 799.63) and change in negative self bias (AIC = 798.53) provided a worse fit to the data than the model without SRT predictors.

SRT Bias Change and Treatment Response Interactions

First, the dichotomous treatment response variable was added to the mixed models predicting SRT biases to assess the main effect of treatment response on SRT biases. This was not significant in any of the models: negative valence bias model: $\chi^2(1) = 0.94$, $p = 0.333$, self bias model: $\chi^2(1) = 0.05$, $p = 0.819$, positive self bias model: $\chi^2(1) = 0.53$, $p = 0.468$, negative self bias model: $\chi^2(1) = 1.17$, $p = 0.279$. Next, interaction terms between the dichotomous treatment response variable and time were added to each model. This significantly improved model fit for the valence bias model, $\chi^2(1) = 4.14$, $p = 0.042$, but not for any of the other models: self bias, $\chi^2(1) = 0.07$, $p = 0.797$, positive self bias: $\chi^2(1) = 2.29$, $p = 0.130$, negative self bias model: $\chi^2(1) = 1.66$, $p = 0.197$. For the valence bias model, the interaction was significant ($b = -0.09$, $SE = 0.04$, $p = 0.045$), such that treatment non-responders significantly increased in negative valence bias pre-to-post-intervention ($b = 0.07$, $SE = 0.03$, $p = 0.049$) while responders non-significantly decreased in negative valence bias ($b = -0.02$, $SE = 0.03$, $p = 0.433$).

Discussion

The purpose of the current study was to test the validity of the SLP model by investigating the differential and/or combined contributions of self-referential and emotion-related processing to MBP-related improvements in depression symptoms. In line with SLP theories found both in Buddhism and in contemporary mindfulness research, we hypothesized that mindfulness training would cause decreases in self-bias and that decreases in self-bias would be associated with improvements in depression symptoms from baseline to week 20. Furthermore, we predicted that decreases in self-bias would be more important than changes in valence bias. Our hypotheses were partially confirmed, but mostly refuted. While mindfulness skill acquisition was associated with reductions in self-bias, self-bias reductions

were not associated with improvement in depression symptoms. Instead, changes in valence bias and positively valenced self-bias were associated with improvements in depression symptoms. Together, these data suggest that improvements in depression symptoms in MBPs are associated with changes in valence bias and increases in positively valenced self-bias but not with a decrease in self-referential processing. Each of these findings and their implications for mindfulness-based programs is discussed below.

Mindfulness Skill Acquisition and SRT Biases

Consistent with the SLP model, mindfulness skill acquisition was significantly associated with decreased self-bias and decreased negative self-bias, but not significantly associated with changes in valence bias or increases in positive self-bias. Furthermore, in line with predictions, the model estimating the relationship between self bias change and mindfulness skill acquisition had a greater fit to the data than the model estimating the relationship between valence bias and mindfulness skill acquisition, indicating that self-bias change had a stronger association with mindfulness skill acquisition than valence bias change.

Valence and Valenced Self as Potential Mechanisms of MBPs

In the current study, changes in valence bias and positive self bias were associated with improvements in depression symptom severity. Furthermore, only changes in valence bias differentiated treatment responders from non-responders: responders shifted toward more positively valenced recall, whereas non-responders shifted toward more negatively valenced recall. This echoes previous findings that biases in information processing toward negative information and/or away from positive information increase risk for current and future depression symptoms (LeMoult & Gotlib, 2019) and that modifying valence biases form the basis of many treatments such as cognitive bias modification (Hallion & Ruscio, 2011). Several studies of MBPs have found that changes in emotional memory biases were associated with improvements in depression symptoms (Roberts-Wolfe et al., 2012; van Vugt et al., 2012).

Similar to valence, the findings that changes in positive self-bias were associated with depression symptom improvements is consistent with the centrality of valenced self-concept in depression and its modification in depression treatments like cognitive therapy (Hofmann et al., 2013). MBPs are also capable of shifting the valence of self-concept from negative to more positive as measured by valenced self-constructs such as rumination, self-esteem, self-efficacy, and self-compassion (Britton et al., 2021; Goldin et al., 2009; Randal et al., 2016). While not all valenced self measures have been assessed as mediators of symptom improvements, of the ones that have, rumination and self-compassion have been found to mediate improvements in depression symptoms (Britton et al., 2021; van der Velden et al., 2015).

Increase in Positive Self-Bias: Some Implications

An increase in positive self-bias had the strongest association with improvements in depression symptoms. This finding is noteworthy for several reasons. First, this finding directly challenges SLP models that view all forms of SRP as maladaptive and require a generalized decrease in SRP to produce therapeutic effects. In the current study *increase*s in SRP were non-significantly associated with improvements in depression symptoms. However, when self-bias was further divided into positive self bias and negative self bias, the direction of the effects differed, such that significant increases in positive self bias and non-significant decreases in negative self bias were associated with improvements in depression symptoms. Thus, the present findings suggest that changes in SRP in the context of an MBI are associated with improvements in depression symptoms in a valence-dependent way. These data parallel findings that antidepressant medications decrease SRP to negative stimuli but *increase* SRP to positive stimuli (Di Simplicio et al., 2012; Komulainen et al., 2018; Norbury et al., 2008).

The second potential implication of these findings is that increases in positive valence may be as or possibly more important than reductions in negative valence, echoing other findings that increases in positive valence are important for the treatment of depression symptoms. In the present study, increases in positive self bias resulted in a stronger fitting model of depression symptom improvement than decreases in negative self-bias. This is in line with the findings from other studies, such as Geschwind et al. (2011a), who found that early improvements in positive but not negative affect predicted successful pharmacology treatment for depression symptoms. Similarly, studies of MBP mechanisms have indicated that increased positive affect may be more important for depression symptoms outcomes than decreased negative affect (Batink et al., 2013; Geschwind et al., 2011a, b). In addition, MBP-related changes in memory for positive (but not negative words) was associated with improvements in depression symptoms and well-being (Roberts-Wolfe et al., 2012).

Finally, increased positive self-bias had the strongest association with improvements in depression symptoms but was not associated with mindfulness skill acquisition. This could suggest that some dimension of MBPs other than mindfulness training may facilitate more positive self-concepts, such as affirming relationships with the teacher or other participants. Alternatively, it is possible that mindfulness skill acquisition *does* promote increases

in positive SRP, but that the mindfulness scale used in this study (FFMQ) failed to capture it. Indeed, other mindfulness scales include items about positive SRP (e.g., "I am able to appreciate myself") (Walach et al., 2006). Determining which dimensions of MBPs facilitate increased positive self-concept is important and could potentially increase their efficacy. Both depression researchers (Dunn et al., 2009) and mindfulness researchers (Batink et al., 2013; Garland et al., 2015; Geschwind et al., 2011a, b; Kiken et al., 2017; van der Velden et al., 2015) have begun to bring increased attention to the role of positive valence in cognition, self-concept, and affect.

Disambiguating Valence and Self

The current study disambiguates the roles of valence and self-referential processing, which have been conflated in mindfulness research. For example, while changes in mindfulness and rumination are often cited as evidence of the SLP model of MBPs beneficial effects, neither mindfulness nor rumination are pure measures of SRP; each has conflated valence and valenced-self. Mindfulness scales intended to measure reductions in SRP in the context of mindfulness practice (such as disidentification, decentering, or nondual awareness) also contain valenced-self items (e.g., "I am better able to accept myself as I am") (Fresco, Moore, et al., 2007; Fresco, Segal, et al., 2007) or references to positively valenced emotions (e.g., "I have experienced a perfectly peaceful state") (Hanley et al., 2018; Segal et al., 2019). These have the effect of conflating valence and SRP as distinct mechanisms and inflating the correlation with well-being and/or depression symptoms (Britton et al., 2021). The conflation of changes in sense of self—particularly attenuations or "selfless" states —with positive valence is a long-standing problem in psychological research that stems back to early research on mysticism (Taves, 2020).

Conflation of SRP and valence can also be found in measures of rumination. As a result, van der Velden et al. (2015) described the empirical support for rumination as a mediator for the effects of MBCT on depression symptoms "questionable," as many studies have found non-significant effects. Closer examination of these studies found that the way rumination was measured may account for the discrepancy. Indeed, most rumination scales contain a negatively valenced self-evaluation dimension (brooding) and a neutral or non-valenced self-focus dimension (reflection). It is the negatively valenced dimension (brooding) and not reflection (non-valenced SRP) that is both reduced by MBPs and mediates reductions in depression symptoms (Armstrong & Rimes, 2016; Shahar et al., 2010). In contrast, MBP studies that combined the two scales often found no effect (Eisendrath et al., 2016; Robins et al., 2012). In other words, as the results of the current study also suggest, it is the valence and/or valenced self dimension of rumination and mindfulness rather than SRP alone that explains the beneficial effects of MBPs on depression symptoms.

Mindfulness and SRP

Although mindfulness skill acquisition was associated with decreased self-bias, reductions in self-bias did not translate into improvements in depression symptoms. On the contrary, reductions in self-bias were more strongly associated with *increases* in depression symptoms than improvements. This finding parallels neural measures of SRP. Mindfulness meditation is associated with decreased self-referential processing as assessed by brain activation (CMS/DMN) in cross-sectional studies, but there is very little evidence that these reductions in neural SRP mediate MBP-related improvements in well-being or clinical syndromes like depression (Britton et al., 2021; Lin et al., 2018; Vignaud et al., 2018). In contrast to promotion of well-being, global reductions in SRP—whether measured as CMS/DMN, the SRT self-bias, or self-reports—have also been associated with psychopathology and impaired functioning, including schizophrenia, dissociation, autism, and dementia (Burrows et al., 2017; Hahn et al., 2017; Harvey et al., 2011; Lebois et al., 2019; Lindahl & Britton, 2019; Sorg et al., 2007). Indeed, a recent study of challenging meditation-induced changes in sense of self found that more pervasive and global reductions in SRP were associated with a greater degree of functional impairment (Lindahl & Britton, 2019). Thus, while the SLP model upholds that the efficacy of MBPs requires global reductions in SRP (Giles, 2019; Hadash et al., 2016; Teasdale & Chaskalson, 2011a, 2011b) and advocates for a "drastic disidentification" (Holzel et al., 2011, p.547), "disidentifying from the entire play of inner experience," (Kabat-Zinn, 1990, p. 297), or a state of "selflessness" (Dor-Ziderman et al., 2013; Hadash et al., 2016), these recommendations are more reflective of certain Buddhist soteriological claims than of clinical evidence for mechanisms of eight-week MBIs (Britton et al., 2021).

From a clinical science perspective, maximizing MBP efficacy depends on how well the program engages evidence-based mechanistic targets that mediate therapeutic benefit for a given population (Dimidjian & Segal, 2015; Onken et al., 2014). Either MBPs can be modified to better engage evidence-based mechanistic targets, or new programs can be created that do. While it remains unknown exactly which aspects of MBPs (formal meditation practice, teacher, group dynamics, psychoeducation, etc.) engage which mechanistic targets (Alsubaie et al., 2017), a few studies have begun to address this problem. For example, Lumma et al. (2018) created three different contemplative training programs that target different skills and found that emotional self-concept (valenced self) was modified through training in

meta-cognitive and perspective-taking on self and other, but not through body-focused mindfulness training or compassion-based practices. Similarly, findings have demonstrated that increases in self-compassion may be a stronger predictor than mindfulness for the alleviation of depression symptoms (Van Dam et al., 2011). As a result, self-compassion programs that specifically target valenced self have been created (Germer & Neff, 2013, 2018).

Limitations and Future Directions

The current study has strengths and limitations. Strengths include the use of objective and clinician-rated measures and describing outcome in terms of both symptom reduction and clinically significant treatment response.

Limitations include trial design, possible ceiling effects, measurement parameters, sample characteristics, and generalizability. In terms of design, the lack of a no-treatment or no-meditation control group leaves the possibility that the effects could be a result of nonspecific effects (passage of time, expectancies, social support) rather than of specific mindfulness training. The self-report nature of the assessments mean the scores are not objective measures of mindfulness skills, but may instead be measuring participants' own perceptions of their mindfulness.

Mean SRT biases did not significantly change from baseline to post-intervention, which may be due to a ceiling effect that limited further change. At baseline, the majority of participants exhibited a positive bias characteristic of healthy samples, rather than the negative bias expected in depression. While the sample was selected for at least mild depression symptoms and 40% met criteria for MDD, a more depressed sample may have generated more consistent negative biases that could be modified by treatment. Alternatively, the choice of SRT measures may have impacted baseline SRT rates. For example, the use of free recall, compared to recognition, has been found to increase positive bias in recall (D'Argembeau et al., 2005). Similarly, while the current study used memory of trait adjectives, endorsements may be more predictive of or associated with depression symptoms (Dainer-Best et al., 2018). Future studies should investigate the effect of different SRT parameters.

Finally, the sample in the current study was primarily educated, non-Hispanic white, middle-aged adults with mild to severe depression symptoms, and therefore the results may not generalize to other populations, especially since self-referential processing and its relationship to well-being may differ as a function of culture (Chentsova-Dutton & Tsai, 2010; Zhu et al., 2007). Similarly, valence bias may not universalize, as ideal affect has also been shown to have cultural and religious variations (Tsai et al., 2006).

Conclusion

The current study tested the validity of a selfless processing (SLP) model as a mechanism of change in MBPs by investigating the differential and/or combined contributions of self-referential and emotion-related processing to MBP-related improvements in depression symptoms. Results challenge the SLP model and suggest that MBPs decrease depression symptoms through changes in valence and valenced self rather than through a generalized reduction in self-referential processing.

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Declarations

Conflict of interest W.B.B. and J.R.L receive payments for providing trainings and education in scientific literacy, meditation safety, and trauma-informed mindfulness. W.B.B. and J.R.L are nominally affiliated with the Mindfulness Center at Brown University which generates income by offering mindfulness classes to the public. W.B.B. is a MBSR and MBCT teacher and has received financial compensation for this role. W.B.B is the founder of Cheetah House, a RI nonprofit organization that provides information about meditation-related difficulties, individual consultations, and support groups, as well as educational trainings to meditation teachers, clinicians, educators and mindfulness providers. This interest has been disclosed to and is being managed by Brown University, in accordance with its Conflict of Interest and Conflict of Commitment policies.

Ethical Approval This study was carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki.

Informed Consent All participants provided written, informed consent approved by the Brown University Institutional Review Board.

Animal Rights No animal studies were carried out by the authors for this paper.

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