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Differential effects of mindful breathing, progressive muscle relaxation, and loving-kindness meditation on decentering and negative reactions to repetitive thoughts

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ABSTRACT

Decentering has been proposed as a potential mechanism of mindfulness-based interventions but has received limited empirical examination to date in experimental studies comparing mindfulness meditation to active comparison conditions. In the present study, we compared the immediate effects of mindful breathing (MB) to two alternative stress-management techniques: progressive muscle relaxation (PMR) and loving-kindness meditation (LKM) to test whether decentering is unique to mindfulness meditation or common across approaches. Novice meditators (190 female undergraduates) were randomly assigned to complete one of three 15-min stress-management exercises (MB, PMR, or LKM) presented by audio recording. Immediately after the exercise, participants completed measures of decentering, frequency of repetitive thoughts during the exercise, and degree of negative reaction to thoughts. As predicted, participants in the MB condition reported greater decentering relative to the other two conditions. The association between frequency of repetitive thought and negative reactions to thoughts was relatively weaker in the MB condition than in the PMR and LKM conditions, in which these two variables were strongly and positively correlated. Consistent with the construct of decentering, the relative independence between these two variables in the MB condition suggests that mindful breathing may help to reduce reactivity to repetitive thoughts. Taken together, results help to provide further evidence of decentering as a potential mechanism that distinguishes mindfulness practice from other credible stress-management approaches.

During the past twenty years, a body of literature has emerged supporting the efficacy of mindfulness-based treatment approaches for both mental and physical illness (for reviews, see Baer, 2003; Bohlmeijer, Prenger, Taal, & Cuijpers, 2010; Greeson, 2009; Hofmann, Sawyer, Witt, & Oh, 2010). Given the promise of mindfulness as an intervention strategy, there has been a call to direct research towards understanding the mechanisms of mindfulness-based interventions (Roemer & Orsillo, 2003; Shapiro, Carlson, Astin, & Freedman, 2006; Williams, 2008). Decentering is emphasized as a mechanism of mindfulness-based cognitive therapy for depression (MBCT, Segal, Williams, & Teasdale, 2002), in which a patients learn to view thoughts as events in the mind rather than necessarily being reflections of reality or accurate self-view. Decentering involves viewing internal experience with increased objectivity; thus, the emphasis is on changing one's relationship to one's thoughts rather than trying to alter the content of the thoughts (Fresco et al., 2007; Safran & Segal, 1990).[1] In an integrative theory of the mechanisms of mindfulness, Shapiro et al. (2006) proposed that this ability to "reperceive" one's own thought processes may in turn facilitate a tendency to respond to internal and external experiences with less emotional reactivity (Shapiro et al., 2006).

Decentering may be especially relevant in explaining how mindfulness training may decrease depressive rumination. Depressive rumination involves recurrent, passive thoughts about one's distress and the circumstances contributing to it (Nolen-Hoeksema, 1991) and has been found to contribute to a range of clinical problems including depression, anxiety, binge eating, binge drinking, and self-harm (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Depressive rumination can be understood as an ineffective attempt to resolve discrepancies between current and desired states (Watkins, 2008; see also Treynor, Gonzalez, &

[1] Similarly, in Acceptance and Commitment Therapy (ACT, Hayes, Strosahl, & Wilson, 1999), a range of techniques including mindfulness meditation are used to help patients develop cognitive defusion, also referred to as the deliteralization of thoughts.

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Nolen-Hoeksema, 2003). In mindfulness-based cognitive therapy for depression (Segal et al., 2002), individuals with a history of depression are taught to recognize and disengage from unproductive discrepancy-based repetitive thoughts (e.g., self-criticism, regrets about past events) in order to reduce vulnerability for depression relapse (see also Crane et al., 2008; Williams, 2008).

The relationship between mindfulness and rumination has been a focus of increasing empirical study. In cross-sectional observational studies, both dispositional and state measures of mindfulness are inversely associated with dispositional measures of rumination and other constructs reflecting recurrent, discrepancy-based thought (Brown & Ryan, 2003; Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007; Lau et al., 2006). In clinical studies, participants who receive mindfulness training show significant decreases in rumination (Deyo, Wilson, Ong, & Koopman, 2009; Kumar, Feldman, & Hayes, 2008; Ramel, Goldin, Carmona, & McQuaid, 2004). The decrease in rumination among individuals receiving mindfulness training has been found to be greater than for those randomized to a control group (Jain et al., 2007). These clinical studies document that mindfulness training may ultimately reduce ruminative thinking but leaves open the question of how and why this occurs. For instance, it is unclear if this occurs due to participants changing their relationship to these ruminative thoughts, as suggested by the construct of decentering. This possibility is suggested by two non-controlled studies of patients enrolled in mindfulness-based stress reduction courses, which have found that decentering increased pre- to post-intervention when assessed as both a state (Lau et al., 2006, Study 2) and dispositional trait (Carmody, Baer, Lykins, & Olendzki, 2009).

Experimental laboratory studies can valuably complement the understanding of mechanisms of mindfulness gained from clinical studies of full mindfulness-based intervention approaches (Roemer & Orsillo, 2003; Williams, 2008). Initial experimental studies with novice meditators have compared brief mindful breathing exercises to other comparison conditions including rumination and distraction (Broderick, 2005) and worry and unfocused attention (Arch & Craske, 2006). Results suggest that mindfulness may aid in recovery from a dysphoric mood induction (Broderick, 2005). Furthermore, the Arch and Craske (2006) study found that mindfulness training facilitated less emotional reactivity and increased willingness to engage in an affectively distressing task. However, these studies did not explicitly examine whether mindfulness meditation resulted in decentering from internal experiences.

More recently, laboratory-based studies have begun to examine constructs related to decentering as an outcome. A study of an unselected student sample (Frewen, Evans, Maraj, Dozois, & Partridge, 2008) found that trait mindfulness was predictive of decreased frequency of negative automatic thoughts as well as higher perceived ability to disengage from (or "let-go" of) negative thoughts during a 15-min mindfulness exercise. That study made the contribution of examining both frequency and response to thoughts as separate constructs; however, it did not include a control group leaving open questions about the specific effect of mindfulness meditation on frequency of negative thoughts or reactions to them. In a related line of research, studies have examined predictors and correlates of decentering immediately after practice of mindfulness meditation (Lau et al., 2006, Study 1; Ortner, Kilner, & Zelazo, 2007, Study 1; Thompson & Waltz, 2007). In those studies, decentering was assessed by the Toronto Mindfulness Scale (TMS, Lau et al., 2006).[2] However, like the Frewen et al. (2008) study, those two studies did not include a control or comparison group. Recently, Erisman and Roemer (2010) found that brief mindful exercises including mindful breathing produced greater decentering on the TMS than a neutral control condition consisting of listening to educational recordings and completing mental puzzles.

In sum, laboratory studies of mindful breathing to date have either not examined decentering as an outcome, done so using observational designs, or used experimental designs with inactive control conditions or comparison conditions that would be expected to be distressing (e.g., worry, rumination). As such, it remains an open question whether mindful breathing would result in greater decentering than other credible relaxation or meditation exercises. This limitation is consistent with recent critiques of the mindfulness-based intervention literature which have highlighted the need to establish what processes and outcomes distinguish mindfulness training from other active treatments (Coelho, Canter, & Ernst, 2007; Toneatto & Nguyen, 2007), especially relaxation training (Roemer & Orsillo, 2003).

As such, the goal of the present study was to test the hypothesis that mindful breathing has a unique effect on decentering (especially from repetitive thoughts) compared to two other popular stress-management approaches. Specifically, we compared the immediate effects of mindful breathing (MB) to two alternative stress-management techniques, progressive muscle relaxation (PMR) and loving-kindness meditation (LKM), in a non-clinical sample of novice meditators. We selected these two comparison conditions because like MB, both PMR and LKM have been incorporated into multi-week clinical interventions (e.g., Bernstein & Borkovec, 1973; Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008) but also lend themselves to stand-alone experimental manipulations that can be presented in a single session (e.g., Avants, Margolin, & Salovey, 1990; Hutcherson, Seppala, & Gross, 2008). All three would be expected to produce feelings of relaxation and could be conceptualized as stress-management exercises. However, the essential goal of MB differs from PMR and LKM. Whereas the objective of PMR is to increase sensations of physical relaxation and LKM is designed to increase feelings of social connection and compassion for one's self and others, MB is not designed to actively change physical or emotional states, but instead to observe and accept current internal experiences as they are while maintaining a primary focus on the breath sensations.

We assessed frequency of different forms of repetitive thoughts that occurred during the meditation and relaxation exercises (henceforth referred to as simply 'exercises'). Repetitive thought (RT) is a broad construct reflecting the "process of thinking attentively, repetitively, or frequently about one's self and one's world" (Segerstrom, Stanton, Alden, & Shortridge, 2003, p. 909) with the goal of reducing discrepancy between current and desired states (Watkins, 2008, see also Martin & Tesser, 1996). In this study, we chose to examine a range of RT including aspects of depressive rumination (e.g., self-criticism, regrets over past experience), but also constructs such as worry, planning, and problem-solving given that this may be more relevant in a non-clinical sample than restricting responses to depressed mood specifically as articulated in the Response Style Theory (RST, Nolen-Hoeksema, 1991).[3] Repetitive thoughts about negatively-valenced content tend to be associated with poorer outcomes (e.g., distress); however, this may be moderated by the ways in which individuals approach their thoughts (Watkins, 2008). This is highly consistent with mindfulness training (Kabat-Zinn, 1990) in which RT processes are viewed

[2] The Thompson and Waltz (2007) and Ortner et al. (2007) studies used an earlier version of the TMS that was scored as a single total score. As such, it did not specifically examine the construct of decentering; however, the items used to calculate the total score included many of the items that later were used to create the decentering subscale.

[3] Furthermore, measures of specific aspects of RT tend to be highly intercorrelated, suggesting that it may be valuable to apply this broader conceptualization (Watkins, 2008).

as normal and at times essential activities of the mind. During mindfulness meditation, individuals are encouraged to accept these thoughts regardless of their content, but to also be intentional in deciding when to attend to or disengage from them if they are not helpful or necessary at that moment.

In addition to assessing the frequency of RT occurring during the exercises, we also assessed the degree to which participants experienced negative reaction to the thoughts such as annoyance, distress, or distraction. The construct of decentering suggests that mindfulness training would facilitate greater awareness of repetitive thought but less negative reactivity to it. We predicted that participants in the MB condition would report greater frequency of RT (suggesting greater awareness) and less negative reaction to it than those in the PMR and LKM conditions. We also predicted that MB would result in greater decentering as measured by the TMS (Lau et al., 2006) than PMR and LKM. In a second approach to capture this construct, we operationalized decentering as an "unlinking" or weak correlation between frequency of RT and negative reaction to RT, suggesting relative independence between having RT and having a negative reaction to them. This approach is informed by past research which finds that CBT produces an "unlinking" of negative cognitions from mood and somatic symptoms of depression, as indexed by a weaker correlation between these two variables among individuals who receive CBT relative to those receiving non-CBT interventions (Beevers & Miller, 2005). We predicted a statistically-significant interaction such that frequency of RT and negative reaction to them would be positively and significantly correlated in the PMR and LKM conditions, but show a relatively weaker correlation in the MB condition. We also predicted that this relationship would be independent of decreases in negative affect (NA). Thus, we hypothesized that this interaction would remain significant after controlling for changes in NA.

Methods

Participants were 190 undergraduate students attending a small private women's college. As such all participants were female (age: $M = 19.83$, $SD = 1.34$). In terms of ethnicity, 72.6% identified as Caucasian/White, 10.0% as Asian or Pacific Islander, 3.7% as Black or African-American, 12.1% circled two or more ethnicities or circled "other," and 1.6% left this item blank. 91.6% identified as non-Hispanic, 4.2% identified as Hispanic, and 4.2% left this item blank. Students participated in exchange for credit applied towards a psychology course in which they were enrolled. Although we did not expect a large proportion of the sample to be experienced meditators, we assessed frequency of meditation practice given that past studies with student samples have shown that meditation experience may impact responses to meditation exercises (Thompson & Waltz, 2007) or scores on measures of traits related to mindfulness (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). Consistent with these studies, we assessed meditation experience by asking frequency of current meditation with four response options ("I meditate at least once a day," "I meditate at least once a week," "I meditate once per month," "I do not meditate regularly"). As part of the question, we also presented a definition of meditation to reduce false positives through participants applying idiosyncratic interpretations of the term ("*Meditation can be defined as a practice that focuses on training attention and awareness with the goal of producing emotional calm, mental clarity, self-awareness, and/or concentration*"). The majority of participants reported no regular meditation ($n = 148$, 78.7%) with the remaining sample reporting meditating at least once a day ($n = 9$, 4.8%), once a week ($n = 21$, 11.2%), or once a month ($n = 10$, 5.3%).

Measures

Repetitive thought

Repetitive thought (RT) during the exercises was assessed with a measure created for the present study given the limited availability of measures of this construct that are state- rather than trait-oriented and that cover a range of forms of discrepancy-based RT. Items were modeled on existing measures of RT as a state (Moberly & Watkins, 2008) and dispositional tendency (McIntosh & Martin, 1992; Meyer, Miller, Metzger, & Borkovec, 1990; Nolen-Hoeksema & Morrow, 1991). Participants were given the following prompt to answer with reference to their experience during the exercise. "During the exercise, how often did you experience each of the following types of thoughts described below?" and were provided with a 5 point scale with 0 = Never, 1 = Rarely, 2 = Sometimes, 3 = Often, and 4 = Almost constantly. The items used to measure RT were "Thoughts about one or more problems in your life," "Worries about something in the future," "Thoughts about a recent situation that you wish had gone differently," "A mental to-do list," and "Criticisms of yourself." The frequency of RT measure was derived by summing these five items, which demonstrated high internal consistency ($\alpha = .85$). Participants were also asked, "To what degree were you *upset* by the thoughts you experienced during the exercise?" and were provided with a 5 point scale with 0 = Very slightly or not at all, 1 = A little, 2 = Moderately, 3 = Quite a bit, and 4 = Extremely. Participants then answered two additional questions identical to the first question however the words "annoyed" and "distracted" were substituted for "upset." The negative reaction to RT measure was created by summing these three items, which demonstrated acceptable internal consistency ($\alpha = .70$). The possible range of scores is 0–20 for frequency of RT and 0–12 for negative reaction to RT.

Decentering

Decentering was assessed with a subscale of Toronto Mindfulness Scale (TMS, Lau et al., 2006), which is designed to be administered after a person meditates. Participants are asked to respond to items in reference to their experiences while meditating. The 7 items measuring decentering emphasize the participant's perception of being able to experience one's self as separate from one's thoughts and feelings (e.g., "I experienced my thoughts more as events in my mind than as a necessarily accurate reflection of the way things really are.") and the ability to observe thoughts and feelings without analyzing or attempting to alter them ("I was more concerned with being open to my experiences than controlling or changing them"). The possible range of scores for this scale is 7–35. Past research has shown that change in this variable predicted change in distress following an 8-week mindfulness-based stress-management program (Lau et al., 2006) and that novice participants completing brief mindfulness exercises score higher on this measure than participants in an inactive control group (Erisman & Roemer, 2010). Past research in samples of experienced meditators offer further evidence of construct validity in that individuals with greater meditation experience tend to score higher on the TMS than those with less experience (Lau et al., 2006; Ortner et al., 2007). Furthermore, higher TMS scores are associated with reduced emotional interference on a cognitive task (Ortner et al., 2007).

Negative affect

The Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988) was used to assess negative affect before and after the exercises. Participants rated 10 items measuring negative affect (NA) in terms of the degree to which they describe how they are feeling "right now." NA items assess subjective distress, anger,

contempt, guilt, shame, fear, and nervousness. Possible scores on the PANAS range from 10 to 50. This variable was included as a manipulation check rather than a primary dependent variable. The primary goal of this study was to compare MB to other credible stress-management interventions. Given that all three stress-management exercises were expected to be relaxing, a significant reduction in NA was expected in all groups however no one group was predicted to experience greater reduction in NA. This equivalence was important to demonstrate to ensure that any potential differences in decentering across conditions was not due to one activity simply being more effective at lowering NA. As noted in the hypotheses, we also assessed change in negative affect for use as a covariate to ensure that the effect of frequency of RT on perceived negativity of RT was not better accounted for by change in negative mood state. NA scores were not examined as a dependent variable because, unlike prior studies (Arch & Craske, 2006, Broderick, 2005; Erisman & Roemer, 2010) where NA scores have been used as a dependent variable, the present study did not include emotional provocation (e.g., mood induction, exposure to emotional stimuli), thus NA scores following a stress-management exercise would be expected to exhibit a potential floor effect in a non-clinical sample.

Clarity of and compliance with instructions

Given some concerns that meditation exercises may seem esoteric or inaccessible to non-experienced meditators, we asked two question to examine potential differences across conditions as to clarity of instructions ("To what extent did you feel that the taped instructions were clear enough for you to understand what you were being asked to do") and compliance with instructions ("To what extent did you follow the taped instructions?"). Both items were rated on a 7 point scale (1 = "Not at All," 3 = "Very Little," 5 = "Somewhat," and 7 = "To a Great Extent"). In general, participants agreed that they found the instructions clear ($M = 6.29$, $SD = .87$) and that they complied with the instructions ($M = 5.50$, $SD = 1.09$).

Procedure

The study was approved by the Simmons College Institutional Review Board before data collection commenced. Participants completed written informed consent procedures before participating. Participants were tested in group testing sessions ranging in size from 1 to 8 participants ($M = 5.26$, $SD = 2.14$) at a range of times during the day (Median = 12:00 pm). Testing groups were randomly assigned to one of three conditions (mindfulness of the breath, progressive muscle relaxation, and loving-kindness meditation). Group assignments were made on the morning of each day of testing based on the number of participants who had signed up for each session with the goal of achieving comparable numbers of participants in each condition at the conclusion of data collection. Running enrollment totals from prior testing days were also factored into assignment decisions to account for participants who were assigned to a condition but were absent from the testing session for which they had signed up. Furthermore, the number of participants signed up for a session (i.e., size of group) and time of day of sessions were also factored into condition assignment to ensure that no condition was disproportionally administered in groups of a small/large size or early/late in the day.

Participants were seated around a conference room table. After providing informed consent, they were asked to complete the PANAS to assess negative affect before listening to the exercise instructions. Once this measure was completed, subjects were asked to turn their chairs 180 degrees and face the wall during the exercise to reduce distractions during the exercise. This procedure is consistent with past studies (Lau et al., 2006; Thompson & Waltz, 2007). Participants then listened to the recorded instructions presented by audio recording played over computer speakers.

All three recordings were a total of 15 min in duration with 12 min of guided instruction in the technique followed by a 3-min period of silence before which participants were instructed to continue with self-guided practice. All three recordings began with instructions for participants to settle into a comfortable sitting position, sit with their back straight against the back of the chair with legs uncrossed, feet flat on the floor, and hands in their lap. All three recordings were narrated by the second author of the study, a licensed clinical psychologist with extensive experience in teaching mindfulness meditation and other forms of stress management. A summary of the specific instructions contained in each of the three recordings are presented below.

Mindful breathing (MB)

This exercise was based on a script used in MBCT (Segal et al., 2002) and in a laboratory study by Arch and Craske (2006). Participants are guided to become aware of physical sensations—especially those associated with the process of breathing—and to observe them without the intention of altering them. Participants are asked to notice in an accepting, non-judgmental manner when their minds wander to something other than the exercise and to gently return focus to the sensations of breathing when this occurs. This basic meditation exercise embodies the central features of mindfulness practice: intentionally paying attention to moment-by-moment experience with an attitude of acceptance (Kabat-Zinn, 1994; Shapiro et al., 2006). However, to reduce potential demand characteristics in self-reporting of decentering, instructions did not include language or techniques applied in MBCT (Segal et al., 2002) and other interventions that explicitly addressed viewing specific thoughts from an objective, decentered perspective. Such techniques include the use of metaphors (i.e., imagining thoughts are images projected on a movie screen), labeling thoughts (i.e., encouraging participants to label thoughts as worries, self-criticisms, etc.), or explicitly describing the idea of decentering (e.g., encouraging participants to view thoughts as "just thoughts" and not objective reality or a reflection of one's true self). In contrast to these approaches, the primary focus of this exercise was on the direct perception of breathing rather than thoughts themselves. During the 3 min of silence, participants were encouraged to continue with this practice.

Passive progressive muscle relaxation

This exercise was based on adaptations by Bernstein and Borkovec (1973) and Antoni (2003) of procedures originally described by Jacobson (1938). The exercise first began with guided instructions for slow, paced breathing. Participants are then guided to notice sensations of tension in their right and left hands and arms and then allow these muscles to relax completely. Participants were then guided to repeat this with three other muscle groups (the face and neck; the chest, shoulders, upper back, and abdomen; and the right and left upper legs, calves, and feet.) During the 3 min of silent practice, participants were asked to count slowly from 1 through 10 and continue to mentally move through the four muscle groups, to notice them becoming deeply relaxed, and to repeat this process until they were instructed to stop. Although some versions of PMR involve active tensing and relaxing of muscles, we decided to use a passive PMR exercise in which individuals are instructed to relax muscle groups without tensing as described in Bernstein and Borkovec (1973) and Antoni (2003). This was done to eliminate the potential confound of physical movement that would be absent in the MB and LKM conditions.

Loving-kindness meditation

This exercise was adapted from scripts developed by Salzberg and Goldstein (2001) based upon ancient Buddhist meditation practices. The purpose of the exercise is to create feelings of social connection and compassion for oneself and others. First, participants are guided to mentally repeat the phrase "May I live in safety. May I be happy. May I be healthy. May I live with ease." Participants are then guided to visualize a good friend and mentally direct a similar wish for wellness to them using a variant of the phrase used previously. Next, participants are guided through visualizing a series of people ("someone you know who's having a difficult time," "a person in your life that you don't know very well," and "a person who is mildly difficult or irritating") and asked to wish them wellness using a similar series of phrases. Finally, the participant is asked to imagine sending similar wishes of wellness to "all beings everywhere." During the 3 min of silent practice, the participant is asked to repeat the series of visualizations and wishes for wellness to each of the individuals until they are instructed to stop.

Following the exercise, participants were asked to turn their chairs 180 degrees in order to sit at the conference table and complete a packet of questionnaires including the PANAS to assess post-exercise mood; the TMS; the brief measures of RT, clarity of exercise instructions, and compliance with instructions; and a demographics questionnaire.

Analysis plan

Before conducting formal analyses, we examined descriptive statistics for all variables of interest. To test the hypotheses that the MB group would differ from the other two conditions (PMR and LKM) on decentering, frequency of RT, and reaction to RT (but not changes in NA), we conducted one-way ANOVAs with planned contrasts. To test the hypothesis that the MB group would experience greater unlinking of frequency of RT and negative reactions to RT than the other two conditions, hierarchical multiple regression analyses were conducted to examine the interaction of condition and frequency of RT in predicting negative reaction to RT. This analysis was repeated controlling for change in NA.

Results

Preliminary analyses

As shown in Table 1, scores on the PANAS, TMS, and RT measure were within an expected range with significant variability. All variables were normally distributed. Randomization to exercise was successful in ensuring that groups were comparable: The three groups not differ on pre-exercise NA [$F(2,183) = .57$, $p = .56$], or current meditation experience when this variable was treated as a continuous variable [$F(2,185) = .46$, $p = .63$] or a dichotomized variable [χ^2 (2) = .1.43, $p = .49$] with participants indicating meditating at least once a day or week being categorized as current meditators ($n = 30$). Size of group, time of day, and meditation experience were not significantly correlated with any of the variables of interest in the study (all $r < |.10|$; all $p > |.19|$). No group differences emerged in terms of participants perception of the clarity of the instructions [$F(2,175) = 1.57$, $p = .21$] or their compliance with the instructions [$F(2,118) = .16$, $p = .85$]. NA reduced significantly from pre- to post-exercise in the full sample (pre-exercise: $M = 14.50$, SD = 4.92; post-exercise: $M = 11.69$, SD = 2.90; $t(180) = 9.61$, $p < .001$); however, a one-way ANOVA with planned contrasts revealed that participants assigned to practice MB did not differ in the degree of change in NA relative to the two comparison conditions (Contrast = −1.26, SE = 1.22, $t = -1.03$, df = 178, $p = .30$, $d = .16$). Mean pre-exercise scores were consistent with prior studies of college students (Watson et al., 1988) and post-exercise scores approached the minimum score of 10.

Main effects of condition

One-way ANOVAs with planned contrasts revealed that participants assigned to practice MB reported a higher frequency of RT (Contrast = −3.09, SE = 1.56, $t = -1.98$, df = 182, $p = .049$, $d = .31$) and greater decentering (Contrast = −3.60, 1.53, $t = -2.36$, df = 182, $p = .019$. $d = .36$) than the other two conditions (PMR and LKM). Further contrasts further revealed non-significant group differences for negative reaction to thoughts (Contrast = .29, SE = .74, $t = .39$, df = 186, $p = .69$, $d = -.03$). Applying Cohen's (1988) interpretation of d (i.e., small [$d > .2$], moderate [$d > .5$], and large effect sizes [$d > .8$]), the effect of MB on frequency of repetitive thoughts and decentering would be considered small to moderate in size; whereas the effect of MB on negative reaction to thoughts would be less than small.

Interaction of condition and frequency of RT in predicting negative reaction to RT

A multiple regression analysis was conducted to predict negative reaction to RT during the exercise using guidelines described by West, Aiken, Wu, and Taylor (2007) for testing interactions between continuous and categorical variables. Frequency of RT was entered in Step 1 after being centered. Group assignment was dummy coded with MB as the reference group and entered in Step 2. The interaction of frequency of thoughts and group assignment was entered in Step 3. A summary of the predictive model along with the unstandardized regression coefficients are presented in Table 2. Two significant interactions were found suggesting that for the relationship between frequency of RT and negative reaction to RT, the slopes were significantly different between the MB and PMR ($p = .001$) groups, as well as between MB and LKM ($p = .014$) groups. Cohen's (1988) guidelines were used for interpreting the effect size of R^2 in multiple regression analyses with both a single independent variable (.01 = small, .06 = medium, and .14 = large) and multiple independent variables (.02–.12 = small, .13–.25 = medium, .26 and greater = large). In Step 1, frequency of RT accounted for 22% of the variance in negative reaction to RT,

Table 1
Descriptive statistics.

	Total sample ($N = 190$)		MB ($n = 68$)		PMR ($n = 63$)		LKM ($n = 59$)	
	M	SD	*M*	SD	*M*	SD	*M*	SD
Frequency of repetitive thoughts	8.31	5.12	9.32	5.12	7.15	5.13	8.40	4.94
Neg. reaction to repetitive thoughts	3.18	2.41	3.09	2.07	3.08	2.68	3.40	2.50
Decentering	20.72	5.07	21.88	4.78	20.32	4.79	19.85	5.48
Change in NA	−2.81	3.94	−2.40	4.23	−3.38	4.14	−2.68	3.30

Note. MB = mindfulness of the breath, PMR = progressive muscle relaxation, LKM = loving-kindness mediation, NA = negative affect.

Table 2
Final multiple regression model of predictors of negative reactions to repetitive thoughts.

Block	Variable entered	Final *B* (SE)	R^2	ΔR^2
1	Frequency of repetitive thoughts	.09 (.05)	.22	.22***
2	PMR	.54 (.38)	.23	.01
	LKM	.36 (.38)		
3	Frequency × PMR	.24 (2.52)**	.28	.05**
	Frequency × LKM	.19 (.08)*		
	(Constant)	3.00 (.27)		

*$p < .05$, **$p < .01$ ***$p < .001$.
Note. PMR = progressive muscle relaxation, LKM = loving-kindness mediation. PMR and LKM variables are dummy coded with MB (mindful breathing) condition as the reference group.

suggesting a large effect. In Step 2, group assignment accounted for an additional 1% of variance suggesting a small effect. In Step 3, the addition of the interaction terms in Step 3 accounted for an additional 5% of the variance in negative reaction to thoughts, suggesting a small magnitude effect. The total model accounted for a relatively large proportion (28%) of the variance in negative reaction to repetitive thoughts.

To aid in interpreting the regression equation, the interaction between group and negative reaction to RT was graphed using the procedures described by Aiken and West (1991). Consistent with predictions, as shown in Fig. 1 frequency of RT was more strongly associated with negative reaction to thoughts in the PMR and LKM conditions than in the MB condition consistent with the predicted unlinking effect. Separate Pearson's correlation coefficients were calculated for each group. Using Cohen's (1988) guidelines for interpreting the magnitude of correlations, there was a moderate positive correlation between the effect of RT and negative reaction to RT when the groups were collapsed ($r = .47$, $p < .001$, $n = 185$). When the groups are analyzed separately, in the MB condition, frequency of RT and negative reaction to RT exhibited a small positive correlation that was not statistically significant ($r = .23$, $p = .068$, $n = 65$). In contrast, frequency of RT and negative reaction to RT exhibited a large positive correlation in the PMR ($r = .63$, $p < .001$, $n = 61$) and LKM ($r = .56$, $p < .001$, $n = 59$) conditions.

We re-ran the multiple regression analyses controlling for change in negative mood to examine whether the observed unlinking effect was independent of reduction in negative affect, another widely-studied outcome in research on mindfulness and other stress-management interventions. When this variable was entered as a covariate in Step 1, it was not a significant predictor of negative reaction to thoughts ($B = -.01$, SE = .05, $p = .85$). Furthermore, controlling for this variable did not alter the regression equation appreciably and both interaction terms remained significant.

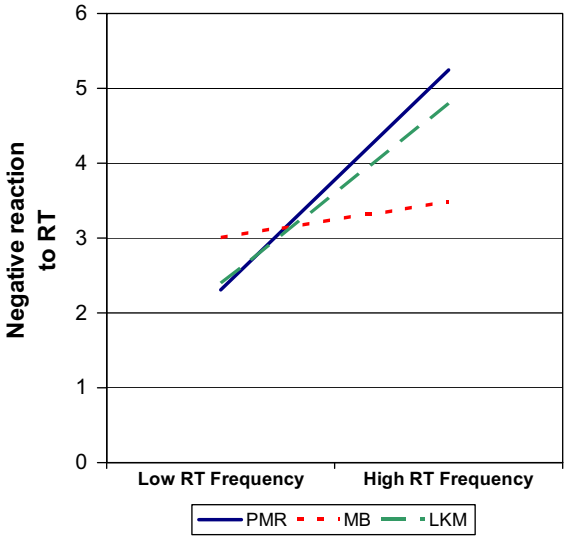

Fig. 1. The effect of frequency of repetitive thought (RT) on negative reaction to RT during progressive muscle relaxation (PMR), mindful breathing (MB), and loving-kindness meditation (LKM).

Correspondence between measures of decentering

In this study, we assessed decentering in two ways: one direct and established (i.e., self-report measure of decentering as assessed by the TMS) and one indirect and novel (i.e., degree of correlation between frequency and negative reaction to thoughts). We performed a series of analyses to assess the degree of correspondence between these two measurement strategies.

First, we performed correlations between decentering and the two components of the indirect measure (the frequency of thoughts and negative reactions to thoughts scales) in the full sample and then within groups (see Table 3). Decentering was not significantly correlated with frequency of thoughts in either the full sample or within any conditions. Decentering was significantly, negatively correlated with negative reaction to thoughts in the MB condition, but not in the full sample or the PMR and LKM conditions. Then, we performed partial correlations examining the association of decentering with each RT variables controlling for the other (see Table 3). The pattern of findings was similar to the univariate analyses in that decentering was not significantly associated with frequency of repetitive thoughts after accounting for negative reaction to thoughts. However, decentering was significantly, negatively correlated with negative reaction to thoughts in both the full sample and the MB condition (but not in the PMR or LKM) conditions, after accounting for frequency of negative thoughts. In sum, these findings suggest that decentering is relatively independent from frequency of thoughts. However, decentering was related to less negative reactions to thoughts, primarily in the MB condition. This suggests some correspondence between the measures, but one that is context-dependant.

As such, we tested a three-way interaction examining whether the previously observed interaction between frequency of thoughts and condition in predicting negative reaction to thoughts was further moderated by decentering. Using a multiple regression analysis (see Table 4), we first entered in Step 1 the variables

Table 3
Intercorrelation of decentering, frequency of RT, and negative reaction to RT in the full sample and within each condition.

		Correlation with frequency of RT (*r*)	Correlation with neg. reaction to RT (*r*)
Decentering	Full sample	.06	−.10
	MB	−.01	−.30*
	PMR	.15	.03
	LKM	−.01	−.07
		Partial correlation with frequency of RT controlling for neg. reaction to RT (*pr*)	**Partial correlation with neg. reaction to RT controlling for frequency of RT (*pr*)**
Decentering	Full sample	.13	−.17*
	MB	.07	−.30*
	PMR	.19	−.12
	LKM	.04	−.08

*$p < .05$.
Note. RT = repetitive thought, MB = mindful breathing, PMR = progressive muscle relaxation, LKM = loving-kindness mediation.

Table 4
Final multiple regression model examining the interaction of frequency of repetitive thoughts, decentering, and condition assignment in predicting negative reactions to repetitive thoughts.

Block	Variable entered	Final *B* (SE)	R^2	ΔR^2
1	Frequency of repetitive thoughts	.31 (.04)***	.24	.24***
	Decentering	−.04 (.04)		
2	MB	−.28 (.33)	.25	.01
3	Frequency × MB	−.17 (.07)*	.30	.06**
	Decentering × MB	−.09 (.06)		
	Frequency × decentering	.01 (.01)		
4	Frequency × decentering × MB	−.03 (.01)[a]	.32	.01[a]
	(Constant)	3.41 (.19)		

Note. MB = mindful breathing. MB variable is dummy coded with the two comparison conditions collapsed into a single reference group.
[a] $p = .058$, *$p < .05$, **$p < .01$, ***$p < .001$.

decentering and frequency of RT (both variables centered). In Step 2, we entered a dummy-coded variable to represent experimental condition in which mindfulness was coded as 1. Given that the contrast between the mindfulness group and the comparison groups was of primary interest, we collapsed the two comparison conditions into a single reference group (coded as 0) to allow for a more parsimonious and readily interpretable model. In Step 3, we entered the three two-way interaction terms (decentering × condition, frequency of RT × condition, decentering × frequency of RT). In Step 4, we added the three-way interaction term (decentering × frequency of RT × condition). The results of the regression analyses are presented in Table 4. Notably, the three-way interaction term was marginally-significant ($p = .058$). When graphed (see Fig. 2), results suggest that in the two comparison conditions, higher frequency of thoughts was associated with greater negative reaction to thoughts regardless of decentering—consistent with prior moderation analysis. However, among participants in the MB condition, this association appeared to depend upon decentering scores. Those who were assigned to the mindful breathing condition but who experienced low decentering showed a similar pattern of correlation between thought frequency and negative reaction to thoughts as those in the comparison conditions. However, those who practiced mindful breathing and experienced high decentering showed the pattern consistent with unlinking (i.e., greater relative independence between thoughts and reactions).

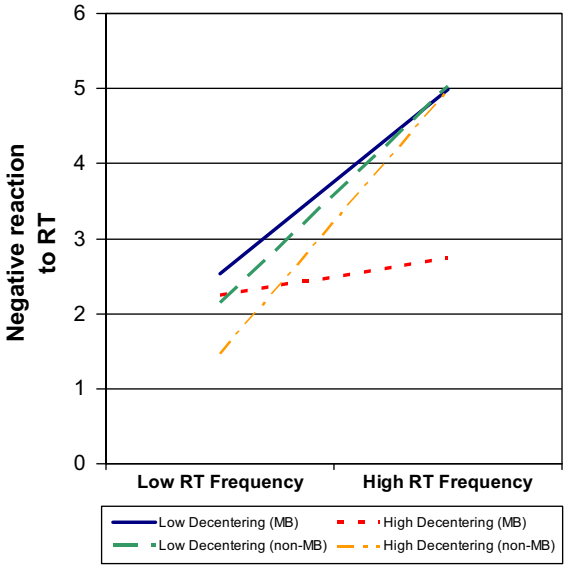

Fig. 2. The effect of frequency of repetitive thought (RT) on negative reaction to RT as a function of high and low decentering during mindful breathing (MB) and comparison conditions (non-MB).

Discussion

Decentering from internal experiences has been identified as a potential mechanism of mindfulness (Segal et al., 2002; Shapiro et al., 2006). The present study compared the effects of brief practice of mindful breathing (MB), progressive muscle relaxation (PMR), and loving-kindness meditation (LKM) on decentering assessed by two methods. First, MB was found to produce higher scores on the decentering scale of the Toronto Mindfulness Scale (Lau et al., 2006) than PMR and LKM. Second, we also operationalized decentering as a relatively weak correlation between frequency of repetitive thought (RT) and negative reactions to RT, suggesting an unlinking of repetitive thoughts and emotional reactivity to them. Consistent with predictions, there was a stronger association between frequency of RT and negative emotional reactions to them in the PMR and LKM conditions than in the MB condition. Decentering has been found to increase pre- to post-intervention in non-controlled clinical studies of mindfulness-based stress reduction (Carmody et al., 2009; Lau et al., 2006, Study 2). The present study complements and extends these studies with the inclusion of two active comparison conditions allowing the direct test of the effectiveness of mindful breathing to facilitating decentering relative to other stress-management strategies.

The hypotheses regarding the effects of MB on frequency of RT and negative reaction to RT were partially supported in that participants in the MB condition reported greater frequency of RT but no difference in negative reaction to RT relative to participants in the PMR and LKM conditions. Each of these results is considered in turn.

One interpretation of the greater reported frequency of RT in the MB condition is that this exercise heightened awareness of repetitive thoughts relative to the other two conditions given that MB explicitly asks participants to notice when thoughts wander from breathing sensations. Nonetheless, this finding may appear to run counter to findings from clinical interventions that rumination tends to reduce following participation in multi-week mindfulness training interventions (Jain et al., 2007; Kumar et al., 2008; Ramel et al., 2004). Taken together, however, these findings raise the intriguing possibility that reduction in ruminative thought processes during mindfulness training could be non-linear. Objectively attending to internal experience in mindfulness practice (i.e., "bare" attention) may initially heighten awareness of unpleasant repetitive thought but, consistent with the principles of exposure therapy, ultimately facilitate its decrease through habituation, distress tolerance, and emotional processing (see Baer, 2003; Hayes & Feldman, 2004; Linehan, 1993; Shapiro et al., 2006). Testing for the presence of such effects is beyond the design of the present study. Although such phenomena may not be apparent immediately following a single session of meditation; it may not necessarily require a full clinical intervention to be detectable. In a recent experiment (Low, Stanton, & Bower, 2008), participants' heart rate was monitored while completing a stressful writing task. Participants were randomly assigned to one of three conditions: evaluating the appropriateness of emotions, attending to emotions in a non-judgmental and accepting way (analogous to mindfulness- and acceptance-based interventions), or a control group. No group differences were observed in the initial session. However, the acceptance group showed less cardiovascular reactivity and more rapid recovery than the evaluative group when the task was repeated in a second testing session one-week later.

The lack of effect of MB on negative reaction to RT needs to be considered in the context of the significant interaction between frequency of RT and condition in predicting RT. These results suggest that for individuals experiencing relatively lower levels of RT during the exercise, differences in negative reaction to RT are not evident. However, among individuals experiencing relatively higher levels of RT, group differences are evident. As such, the effect of condition on negative reaction to RT appears to be most pronounced among individuals who experienced greater frequency of intrusive thoughts, which may speak to the question of which individuals are most likely to benefit from mindful breathing relative to other stress-management interventions. This finding may also have reflected the different objectives of the three stress-management exercises. In the PMR and LKM conditions, participants followed specific instructions to release muscle tension and visualize individuals to wish them wellness, respectively. Therefore, participants in the PMR and LKM groups who experienced repetitive thoughts during the exercise may have been more likely to perceive them as annoying distractions because they were interrupting another intentional activity. In contrast, participants who practiced MB were encouraged to view thoughts with an attitude of non-judgment and gently return focus to observing breathing sensations, which may have allowed these individuals to be more accepting of RT when they arose. This possibility is bolstered by the result that MB resulted in greater self-reported decentering than the PMR and LKM conditions.

The present study helps contribute to a growing body of laboratory studies on mindfulness meditation by examining decentering as an outcome in a study with an experimental design and the use of two comparison groups consisting of credible stress-management activities. Indeed, all three interventions reduced emotional arousal to a comparable degree as assessed by measures of change in negative affect. Such a finding helps to establish that mindfulness practice has benefits that cannot be attributed solely to relaxation effects common to other stress-management procedures (Roemer & Orsillo, 2003). Furthermore, the differential association of frequency and emotional reaction to RT remained significant when change in negative affect was statistically controlled, which helps to further rule-out this alternative explanation.

The findings on the role of decentering is consistent with evidence emerging from clinical studies suggesting that mindfulness- and acceptance-based interventions can facilitate an ability to experience repetitive thoughts and emotions without becoming emotionally distressed by them. For instance, Bach and Hayes (2002) compared a 4-session Acceptance and Commitment Therapy (ACT) intervention with treatment as usual (TAU) in a sample of inpatients with psychotic symptoms. At a 4 month follow-up assessment, relative to the TAU group, patients in the ACT group reported that their hallucinations and delusions were less believable and distressing and were less likely to be rehospitalized. The latter finding is especially striking given that the ACT group actually reported greater frequency of hallucinations and delusions at the follow-up assessment than the TAU group—a finding consistent with the increased RT found in the present study. Findings from other treatment studies suggest that interventions that include mindfulness training may weaken (i.e., unlink) the association between depression symptoms and alcohol cravings among individuals with substance use disorders (Bowen & Witkiewitz, 2009) and facilitate patients with treatment resistant depression learning to attend to emotions without becoming overwhelmed by them (Feldman, Harley, Kerrigan, Jacobo, & Fava, 2009). Taken together, these clinical studies suggest that interventions designed to cultivate mindfulness and acceptance may alter the way that individuals respond to negative thoughts and emotions, and potentially render them less upsetting.

The present study examined both an established, direct method of assessing decentering (decentering scale of the TMS) and a novel, indirect strategy (as captured by the "unlinking" of frequency and negative reaction to thoughts). Results suggested some convergence across methodologies in that decentering and negative reaction to thoughts were negatively correlated among participants in the MB condition. When frequency of repetitive thoughts was held constant, decentering was negatively and significantly correlated with negative reaction to thoughts in both the full sample and the MB condition. Furthermore, a marginally-significant 3-way interaction integrating both assessment strategies suggested a synergistic association in that decentering (TMS) appears to further moderate the effect of exercise type on the relationship between frequency of RT and negative reaction to RT. Results suggest that the "unlinking" of frequency of thoughts and negative reactions to them may be specific to individuals who both practiced MB and who experienced higher levels of decentering. Based on this finding, a fruitful area for future research would be to see whether the clinical effectiveness of mindfulness meditation may be better explained by a combination of contextual factors, including practice type and practice quality as identified in this study, in addition to practice frequency and duration as identified in previous work (for review see Vettese, Toneatto, Stea, Nguyen, & Wang, 2009).

The indirect method of assessing decentering introduced here may help to address some limitations inherent in a more explicit measure of decentering like the TMS. First, given that decentering is a higher-order meta-cognitive skill, it is possible that people's perceived ability to separate themselves from their thoughts does not reflect their actual abilities or that some individuals may possess this ability but have limited self-awareness to report on it accurately. In contrast, the components of the indirect measure (frequency and negative reaction to repetitive thoughts) may be somewhat more accessible constructs for individuals to self-report. Second, an explicit measure of decentering like the TMS is likely to include language that may overlap with meditation instructions. This is challenging to avoid given that both meditation instructions and the self-report measure are attempting to articulate the somewhat elusive construct of mindfulness in a manner that is meaningful to individuals with little or no prior exposure to the construct. Nonetheless, such overlap may artificially inflate the effects of mindfulness practice on self-reported decentering. In contrast, there is virtually no content overlap between the MB instructions used in the present study and the items assessing frequency and reaction to RT, which helps to rule-out content overlap as a confound.

As noted in the methods section, care was taken in selecting and developing a script for the present study that included minimal explicit discussion of decentering from thoughts to reduce potential demand characteristics. Nonetheless, it is important to address whether the results of the present study are tautological given that the MB instructions are intended to facilitate decentering through increasing awareness and acceptance of internal experience. We would argue the results were not a foregone conclusion given that different patterns of results would have been plausible. First, as noted previously, the effects of MB on decentering have not been examined in a study employing comparison groups that would be intended to be relaxing. Thus, it might have been possible that any activity that reduces arousal would produce comparable levels of decentering. Furthermore, although changes in self-reported decentering have been observed following full-length mindfulness-based interventions (Lau et al., 2006), it is not clear if group differences would be detectable following brief practice in a sample of novice meditators.

In considering the generalizability of these results, it is important to note that the types of repetitive thought assessed in the

present study are primarily negatively valenced (e.g., thoughts about life problems, self-criticisms). Such negatively-valenced repetitive thoughts may be especially important to study given their relatively stronger link to negative emotional states (Watkins, 2008). However, the present study is limited in terms of understanding how MB or other stress-management exercises impact positively- or neutrally-valanced repetitive thoughts.

Another question that is unexplored in this study is whether the repetitive thoughts were perceived as helpful or unhelpful. Assessment of this dimension of repetitive thoughts would allow testing of whether MB helps to shift the style of repetitive thought such that it became more constructive. Past research has shown that repetitive thought that is concrete and solution-focused rather than abstract and evaluative tends to be associated with better outcomes (Watkins, 2008). It is possible that the experiential, non-evaluative, non-elaborative nature of the MB instructions facilitated such a shift in the present study and this could help to explain why participants in the MB condition who experienced more frequent thoughts found them to be relatively less upsetting. This idea would be consistent with the model of Shapiro et al. (2006) that suggests that reperceiving (a concept analogous to decentering) facilitates more intentional and effective choices in self-regulation, which could include use of concrete, specific thoughts when problem-solving. As noted previously, this model also posits that reperceiving facilitates exposure to upsetting internal sensations, rendering them less upsetting over time. Future research on mechanisms of mindfulness could help to clarify the direct and indirect effects of decentering, self-regulatory repetitive thought, and exposure in facilitating less negative reactions to thoughts and other mental health benefits of mindfulness practice. The present study is limited in its ability to tease apart such relationships given its focus on the immediate effects of mindfulness practice. Future studies using repeated assessment of these constructs especially with longitudinal follow-up assessments would be better suited to address this question.

Another area of concern is the self-report assessment of decentering and repetitive thoughts. Future studies would benefit from the use of more objective measures of these constructs through information-processing, "think aloud," or psychophysiological assessment. In addition, it is worth noting that decentering and repetitive thought were not assessed prior to practice of the exercises (e.g., during period of silence without instruction). As such, it is possible that observed differences in decentering and repetitive thought post-practice were a function of baseline differences in groups not equalized through random-assignment. This possibility was unlikely, however, given that the three randomized experimental groups did not differ at baseline on any of the measured variables on which they were compared (meditation experience and NA), suggesting that the randomization procedure was successful in creating equivalent groups. Nonetheless, future experiments that include an examination of the relationship between frequency of RT and negative reactions to RT prior to a meditation practice would allow for examination of within-subject changes in decentering and repetitive thought as a function of mindful breathing.

A final limitation worth considering is the use of a sample of convenience. There are some advantages to studying mindfulness in non-clinical samples of novice meditators. Some have suggested that the potential mental and physical health benefits of mindfulness can be studied meaningfully in a range of populations given that mindfulness is a universal capacity (Brown, Ryan, & Creswell, 2007). Similarly, mindfulness training is being increasingly applied as a form of stress-management for students in higher education settings (Shapiro, Brown, & Astin, 2008) and has been found to be effective in non-clinical samples (Chiesa & Serretti, 2009). Nonetheless, it remains to be seen if the present results generalize to individuals with psychological disorders characterized by more severe and entrenched patterns of repetitive thoughts or experienced meditators with more practice observing thoughts from a decentered perspective. Furthermore, potential floor effects in the measure of negative affect in this non-clinical sample preclude meaningful examination of the effects of decentering on mood changes following practice of MB.

Despite these limitations, the present study helps to provide further evidence of decentering as potential mechanism that distinguishes mindfulness practice from other stress-management exercises. The present study adds to the clinical literature by examining the immediate effect of a specific mindfulness meditation practice on decentering. This is valuable given that mindfulness- and acceptance-based intervention approaches contain many components and experimental studies can isolate the effects of a specific practice or skill building exercise (Roemer & Orsillo, 2003). The present study helps to establish that mindfulness of the breath may offer psychological benefits above and beyond other credible brief stress-management exercises.

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