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How does mindfulness-based cognitive therapy work?☆

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ABSTRACT

Mindfulness-based cognitive therapy (MBCT) is an efficacious psychosocial intervention for recurrent depression (Kuyken et al., 2008; Ma & Teasdale, 2004; Teasdale et al., 2000). To date, no compelling research addresses MBCT's mechanisms of change. This study determines whether MBCT's treatment effects are mediated by enhancement of mindfulness and self-compassion across treatment, and/or by alterations in post-treatment cognitive reactivity. The study was embedded in a randomized controlled trial comparing MBCT with maintenance antidepressants (mADM) with 15-month follow-up (Kuyken et al., 2008). Mindfulness and self-compassion were assessed before and after MBCT treatment (or at equivalent time points in the mADM group). Post-treatment reactivity was assessed one month after the MBCT group sessions or at the equivalent time point in the mADM group. One hundred and twenty-three patients with ≥3 prior depressive episodes, and successfully treated with antidepressants, were randomized either to mADM or MBCT. The MBCT arm involved participation in MBCT, a group-based psychosocial intervention that teaches mindfulness skills, and discontinuation of ADM. The mADM arm involved maintenance on a therapeutic ADM dose for the duration of follow-up. Interviewer-administered outcome measures assessed depressive symptoms and relapse/recurrence across 15-month follow-up. Mindfulness and self-compassion were measured using self-report questionnaire. Cognitive reactivity was operationalized as change in depressive thinking during a laboratory mood induction.

MBCT's effects were mediated by enhancement of mindfulness and self-compassion across treatment. MBCT also changed the nature of the relationship between post-treatment cognitive reactivity and outcome. Greater reactivity predicted worse outcome for mADM participants but this relationship was not evident in the MBCT group.

MBCT's treatment effects are mediated by augmented self-compassion and mindfulness, along with a decoupling of the relationship between reactivity of depressive thinking and poor outcome. This decoupling is associated with the cultivation of self-compassion across treatment.

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Without ongoing treatment people suffering recurrent depression experience relapse/recurrence at rates as high as 80%, even after successful acute treatment (Kupfer et al., 1992). The majority of the burden attributable to depression could be offset through interventions aimed at the prevention of relapse/recurrence (Vos et al., 2004). Mindfulness-based Cognitive Therapy (MBCT) is a promising psychosocial group-based relapse prevention program (Segal, Williams, & Teasdale, 2002). Two randomized controlled trials suggest that MBCT produces superior outcomes compared with usual care typically comprising routine monitoring in primary care (Ma & Teasdale, 2004; Teasdale et al., 2000). A more recent study suggests MBCT produces comparable outcomes to maintenance antidepressant medication (mADM) (Kuyken et al., 2008).

☆ This paper was written by Willem Kuyken and Tim Dalgleish on behalf of the Exeter MBCT Trial team. Sarah Byford, Rod Taylor & Ed Watkins were co-investigators, Emily Holden and Kat White were research staff, Alison Evans was a trial therapist, Sholto Radford completed his MSc on archival data and John Teasdale advised on the design, conduct and analysis of this study.

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Even though MBCT was developed from translational research into mechanisms of depressive relapse/recurrence (Segal et al., 2002), there are as yet no compelling studies of how it works.

MBCT's theoretical premise is that depressive relapse is associated with the reinstatement of negative modes of thinking and feeling that contribute to depressive relapse and recurrence (Segal et al., 2002). This 'reactivated' network of negative thoughts and feelings can perpetuate into a depressive episode. Laboratory studies support this model by showing that recovered depressed patients revert to a depressive information processing style following a sad mood induction (for a review see Lau et al., 2004). Following successful treatment for depression, those patients showing greater reactivation of dysfunctional thinking styles in response to a sad mood provocation are at the highest risk of relapse over an 18 month period (Segal et al., 2006). Moreover, patients who recovered with cognitive behavior therapy (CBT) showed significantly less cognitive reactivation than those recovered with ADM. Attenuating the reactivation of dysfunctional thinking styles may therefore represent one mechanism by which CBT helps prevent depressive relapse.

MBCT targets cognitive reactivation (Segal et al., 2002). Mindfulness skills are taught as a means to note distressing thoughts and feelings, hold such experiences in awareness, and cultivate acceptance and self-compassion so as to break up associative networks and offset the risk of relapse (Segal et al., 2002). This dimension of mindfulness that involves meeting distressing thoughts and feelings with kindness, empathy, equanimity and patience is woven into mindfulness-based applications and is thought to be crucial to the change process (Feldman & Kuyken, in press). Intentional attention is learned in the first three MBCT sessions using a range of core mindfulness practices (the body scan, mindful movement and mindfulness of the breath). As well as developing attention, these early sessions highlight habitual patterns of reactivity that arise during meditation (e.g., intrusive negative thoughts) and the associated aversion and judgments (e.g., "I am no good at this, I am just more aware of how badly I feel"). As the person learns mindfulness skills, s/he learns to give less authority to self-judgment and blame – the fuel for depressive thinking – and to respond to these states with compassion; in short to step out of habitual unhelpful patterns of thinking (Feldman & Kuyken, in press). Elucidating these putative mechanisms of MBCT action will improve theoretical understanding of how this relatively new treatment works and provide the opportunity to enhance efficacy via emphasis of these mechanisms.

An important first step in establishing mechanisms of action is to identify mechanism variables that *mediate* the effects of a given treatment on outcome (Kazdin, 2007). In other words, those mechanisms that are (1) differentially altered by the treatment; and (2) that explain all or part of the effect of treatment on outcome. The present study sought to identify mediators of MBCT's effects in a randomized controlled trial (RCT) of MBCT versus mADM for the prevention of depressive relapse/recurrence (Kuyken et al., 2008).

The trial has been described in full previously (Kuyken et al., 2008), but in brief we recruited 123 people with a history of three or more episodes of depression, currently in full or partial remission. Participants were all on a therapeutic dose of mADM and were interested in learning a psychosocial approach to staying well and to discontinuing their medication. Following the baseline assessment, they were randomized to groups that involved (1) continuing their medication over 15 months (the control arm) or (2) taking part in an MBCT course and tapering their ADM medication (the experimental arm). From the baseline assessment participants were followed up at 3 monthly intervals for 15 months by researchers blind to treatment condition. The trial showed that MBCT was not significantly different from mADM in terms of relapse (47% versus 60%), but produced significantly better outcome in terms of self-reported and observer-rated depressive symptoms at 15-month follow-up (Kuyken et al., 2008).

Here, we asked three theoretically-driven questions: 1) Was better outcome in our trial mediated by greater improvement in mindfulness skills and self-compassion over the course of treatment? 2) Did MBCT, relative to mADM, attenuate the toxic relationship between reactivation of dysfunctional thinking (measured post-treatment) and later outcome (Segal et al., 2006)? 3) Was any such attenuation a function of improvement in mindfulness and self-compassion during the treatment? Prior to mediation analysis, we conducted exploratory moderation analyses for pre-randomization demographic and depression variables.

Method

Design

This mechanisms study was embedded in an RCT comparing MBCT (with discontinuation of ADM) to mADM (Kuyken et al., 2008). MBCT was delivered as a manualized, group-based training program designed to enable patients to learn mindfulness and other skills that prevent depression recurrence (Segal et al., 2002). The MBCT program involved a one-to-one orientation session with the therapist followed by eight weekly two hour sessions over approximately two months and four follow-up sessions spread out over approximately one year. MBCT therapists underwent an extensive training and supervision regime and high levels of competency and adherence were demonstrated by raters independent of the trial team (see Kuyken et al., 2008). MBCT participants were supported in discontinuing mADM by their primary care physician. The mADM arm involved patients remaining on a maintenance dose of ADM throughout the follow-up period, and generally this was the same ADM that they were on when they were recruited to the trial. Adherence was assessed at each follow-up point and if any adherence problems were picked up the primary care physician was alerted. Over the course of the follow-up, mADM adherence was shown to be high (see Kuyken et al., 2008).

To establish mediation requires attention to several key aspects of study design (Kazdin, 2007; Kraemer, Wilson, Fairburn, & Agras, 2002; Murphy, Cooper, Hollon, & Fairburn, 2009). First, ideally, MBCT must be compared with a treatment that works but not through the same mechanism of action, for example medication (Garratt, Ingram, Rand, & Sawalani, 2007; p. 227), thus allowing a test of effects specific to MBCT. Second, assessment of change in the hypothesized mediator must occur *during* MBCT and *before* the assessment of outcome. As MBCT targets relapse prevention, a design that tracks relapse after the end of MBCT is ideal. A robust marker for relapse is severity of depressive symptoms (Judd et al., 1999). Moreover, in the original trial MBCT produced greater change in depression severity at 15-month follow-up than did mADM (Kuyken et al., 2008). Therefore, severity of depressive symptoms and depressive relapse/recurrence over 15 months of follow-up were the dependent variables in our mediation/moderation analyses. Finally, the design requires that all those in the intervention arm received an adequate dose of the intervention to properly test the hypothesis that MBCT's impact on the hypothesized mechanisms (mindfulness, self-compassion and reactivity) mediates outcome.

Hypothesized moderators were assessed at baseline prior to randomization. Mediators were assessed as follows. Changes in self-compassion and in mindfulness skills were computed from Baseline to post-MBCT (i.e., 1 month after the end of MBCT or the equivalent time in the mADM arm). Mirroring the work of Segal and colleagues, cognitive reactivity was assessed only once, post-MBCT (Segal et al., 2006). Outcome in terms of relapse was assessed through the follow-up period up until 15 months after Baseline and

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outcome in terms of residual depressive symptoms was assessed 15 months after Baseline (1 year after the post-MBCT assessment).

Participants

In the trial, 123 patients with recurrent depression were randomized to either MBCT plus discontinuation of ADM ($n = 61$) or mADM ($n = 62$). Participants are described fully in the main outcome paper, where they were "characterized as a group of people with recurrent depression, treated pharmacologically in primary care, who following a referral from their primary care physician were interested in a psychological group-based approach that included tapering/discontinuing their maintenance anti-depressants" (Kuyken et al., 2008; p. 970). Inclusion criteria for the RCT were ≥3 previous DSM-IV depressive episodes; aged ≥18 years; on a therapeutic dose of ADM in line with the British National Formulary (British Medical Association & Royal Pharmaceutical Society of Great Britain, 2006) for ≥6 months; and in full/partial remission from depression. Exclusion criteria were: substance dependence; organic brain damage; current/past psychosis; bipolar disorder; persistent anti-social behavior; persistent self-injury requiring clinical management; inability to engage with MBCT for physical, practical or other reasons, and concurrent formal psychotherapy (Kuyken et al., 2008).

Analyses for this study that address moderation and mediation of *treatment specific* effects require an adequate treatment dose (Kazdin, 2007). Consistent with trials to date (Kuyken et al., 2008; Ma & Teasdale, 2004; Teasdale et al., 2000), an adequate dose of MBCT was defined as participation in ≥4 of 8 MBCT sessions. Examining typical MBCT attendance rates suggests first that >85% of people attend all or almost all the sessions, and where people do drop out they tend to drop out between the orientation session and first group session, or otherwise within the first few sessions. In short, a skewed attendance distribution means that the cut-off of ≥4 of 8 MBCT sessions captures well those people who engaged with the MBCT program. The full treatment-adherent sample comprised 114 participants (MBCT = 52; mADM = 62). It is important to note however that we did repeat all analyses reported below on the available ITT sample and the pattern of findings was unaltered.

For analyses with relapse as the outcome it is also necessary that participants had not relapsed prior to the post-MBCT assessment point. This reduced the treatment-adherent sample for relapse analyses to 94 (MBCT = 49; mADM = 45).

For the mood induction and reactivity task, following the protocol of Segal and colleagues (Segal, Gemar, & Williams, 1999; Segal et al., 2006), we further excluded participants who scored >10 on the Hamilton Rating Scale for Depression (HRSD) ($n = 8$) at the post-MBCT assessment as it was theoretically important to assess reactivity in the euthymic state (Segal et al., 2006). A further 5 participants either did not attend for ($n = 4$) or consent to ($n = 1$) this task, leaving 80 participants (MBCT = 43; mADM = 37) for the reactivity analyses. This is comparable to the sample size with complete data in the Segal et al. reactivity study ($n = 78$) (Segal et al., 2006).

The treatment adherent and cognitive reactivity sub-samples were not significantly different from the ITT sample on demographic or psychiatric variables at Baseline, $ps > .1$, with the exception of lower depression severity in the reactivity sub-sample, $F(1,122) = 8.92$, $p < .01$, as a result of excluding people who scored >10 on the HRSD.

Outcome measures

To assess severity of depressive symptoms at 15 months we used the observer-rated 17-item *Hamilton Rating Scale for Depression* (HRSD; Williams, 1988). Time to depressive relapse/recurrence up to the 15-month follow-up was assessed using the depression module of the Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1995). Relapse was defined as meeting DSM-IV criteria for depression.

Mechanisms measures

To assess mindfulness we used the *Kentucky Inventory of Mindfulness Skills* (KIMS: Baer, Smith, & Allen, 2004), a 39-item self-report inventory covering four facets of mindfulness: observing, describing, acting with awareness, and accepting without judgment. Items are rated from 1 (*never or very rarely true*) to 5 (*very often or always true*). Findings suggest good reliability and validity (Baer et al., 2004; Baum et al., 2010). To assess the global dimension of mindfulness and to keep our analysis strategy as parsimonious as possible we used only the total score in line with evidence from confirmatory factor analyses (Baer et al., 2004).

To assess self-compassion we used the *Self-Compassion Scale* (SCS: Neff, 2003), a 26-item self-report instrument. Sample items include "*I try to be loving towards myself when I'm feeling emotional pain*" and "*When times are really difficult, I tend to be tough on myself.*" Confirmatory factor analysis suggests a single higher-order factor. The SCS has good reliability and validity, including high associations with mental health outcomes (Neff, 2003). The SCS includes dimensions (awareness, self-kindness, self-judgment and common humanity) thought to be important to the change process in MBCT (Feldman & Kuyken, in press).

To assess cognitive reactivity we employed the laboratory paradigm used by Segal et al. (1999, 2006) which measures reinstatement of depressive thinking styles following induction of a transient sad mood. To induce sad mood participants listened to sad music (Prokofiev's "*Russia under the Mongolian Yoke*" re-mastered at half speed) for 8 min while rehearsing a sad memory. Sad mood was assessed pre- and post-mood induction using a visual analogue scale from 0 (*I do not feel this way at all*) to 100 (*I feel this way very much or extremely*). Depressive thinking style before and after the mood induction was assessed with the *Dysfunctional Attitude Scale, Versions A and B* (DAS: Weissman & Beck, 1978), with the order counterbalanced. The DAS is a 40-item measure of beliefs, assumptions and rules thought to be dysfunctional. Participants endorsed items on a Likert scale from 1 *totally disagree* to 7 *totally agree*. Psychometric properties of the scale are adequate (Beck, Brown, Steer, & Weissman, 1991; Power et al., 1994). Cognitive reactivity was the residual change in DAS scores from pre- to post-mood induction (Segal et al., 2006).

Procedure

The approach to recruitment and CONSORT diagram are described in full elsewhere (Kuyken et al., 2008; White, Holden, Byng, Mullan, & Kuyken, 2007). Participants were assessed at the University or in primary care settings, by research staff blind to treatment allocation. The study was approved by a UK National Health Service Research Ethics Committee and work was conducted in line with relevant ethical guidelines. After complete description of the study to the subjects, written informed consent was obtained.

Statistical analysis

We used the mediation and moderation analytic framework recommended by Kraemer et al. (2002) for RCTs. This comprises a regression approach in which treatment group (T), the mediator or moderator (M), and the treatment by moderator/mediator interaction term (T × M) are the independent variables. We examined the outcome of depressive symptoms (HRSD15m) using linear

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regression and the outcome of relapse using Cox proportional hazards regression (Cox, 1972). Within these regressions, for M to be a moderator of treatment, M must be a pre-randomization (Baseline) variable that has an interactive effect with treatment on the outcome; i.e. the T × M term in the regression must be significant. For M to be a mediator of treatment, M must be an event occurring during or after treatment that is significantly altered by treatment and temporally precedes the outcome. M must also then show a main and/or interactive effect with treatment on outcome; i.e. the M and/or T × M terms in the regression should be significant. Treatment need not have a significant overall or main effect on outcome (Kraemer et al., 2002).

A *main* (but not interactive) effect of mediation is therefore where treatment significantly changes the mediator but the effect of the mediator on outcome does not significantly differ across treatment types. For example, in the present study if MBCT differentially improves mindfulness skills and/or self-compassion and any such improvement translates into better outcome, but the relationship between improvement and outcome does not differ across MBCT versus mADM, this would be a main, but not interactive, effect of mediation.

In contrast, an *interactive* effect of mediation is where treatment not only significantly changes the mediator but also changes the relationship between the mediator and outcome such that it is significantly different for the alternative treatments. For example, in the present study if treatment significantly affects the degree of cognitive reactivity following the mood induction, but the relationship between cognitive reactivity and worse outcome is then significantly different in the mADM versus MBCT group, this would be an interactive effect of mediation.

To ensure that any moderation/mediation effects found in the current study were present over and above the influence of levels of depression, our regression models included depression severity on the HRSD at baseline (for moderation) or change in depression severity on the HRSD from baseline to post-MBCT (for mediation), on the first step. We also covaried the number of previous depressive episodes as this was a significant independent predictor of both HRSD15m and relapse, unlike the other demographic and depression history variables. For analyses involving mediation of treatment effects by cognitive reactivity we also covaried affective reactivity in the form of VAS mood change following the mood-induction protocol. It is important to note however that the pattern of findings was unaltered without these covariates included.

Potential mediators were computed as change over time. That is, baseline to post-MBCT for self-compassion (SCS) and mindfulness (KIMS), and pre- to post-mood induction for cognitive reactivity (DAS). In line the approach of Segal and colleagues, we calculated standardized residualized change scores for the mediating variables using a simple linear regression model in which Time 1 scores predicted Time 2 scores (Mackinnon, 2008; Segal et al., 2006). The standardized residuals were then used in the mediation analyses. We report raw score equivalents where appropriate for ease of comprehension.

Results

For the treatment-adherent sample ($N = 114$) and cognitive reactivity sub-sample ($n = 80$), descriptive information at baseline is in Table 1, and outcomes at post-treatment and 15-month follow-up are in Table 2. These outcome profiles were comparable to the ITT sample (Kuyken et al., 2008).

Table 1
Baseline characteristics of treatment-adherent sample and cognitive reactivity sub-sample.

Variable	Treatment-adherent sample ($n = 114$)		Cognitive reactivity sub-sample ($n = 80$)	
	MBCT ($n = 52$)	mADM ($n = 62$)	MBCT ($n = 43$)	mADM ($n = 37$)
Gender, women: *n* (%)	41 (79)	47 (76)	36 (84)	29 (78)
Age (in years): *M* (*SD*)	50 (10.64)	49 (11.84)	48.35 (10.68)	49.27 (11.53)
Marital status: *n* (%)				
Single	3 (6)	9 (15)	3 (7)	5 (14)
Married or cohabiting	37 (71)	40 (65)	30 (70)	28 (76)
Separated, divorced, or widowed	12 (23)	13 (21)	10 (23)	4 (11)
Religion, Christian: *n* (%)[a]	39 (75)	47 (76)	32 (74)	28 (76)
Level of education: *n* (%)				
No educational qualification	8 (15)	17 (27)	7 (16)	9 (24)
Some school qualification	12 (23)	16 (26)	10 (23)	10 (27)
High school and/or vocational qualification	21 (40)	13 (21)	18 (42)	9 (24)
University degree/professional qualification	11 (21)	14 (23)	8 (19)	9 (24)
Social class: *n* (%)[b]				
Class 1	20 (38)	23(38)	16 (37)	15 (41)
Class 2	13 (25)	12 (20)	12 (28)	8 (22)
Class 3	5 (10)	7 (11)	5 (12)	5 (14)
Class 4	5 (10)	2 (3)	3 (7)	0
Class 5	9 (17)	17 (28)	7 (16)	9 (24)
Depression diagnosis at intake *n* (%)				
In full remission	38 (73)	41 (66)	33 (77)	26 (70)
In partial remission	14 (27)	21 (34)	10 (23)	11 (30)
With co-morbid DSM-IV psychiatric diagnoses *n* (%)	25 (48)	38 (61)	21 (49)	23 (62)
Previous episodes of depression *M* (*SD*)	6.35 (3.04)	6.55 (2.83)	6.16 (2.97)	6.03 (2.69)
Age (in years) at first depression onset *M* (*SD*)	26.78 (12.5)	26.11 (12.65)	27.98 (12.91)	25.72 (11.47)
HRSD score: *M* (*SD*)[c]	5.23 (4.19)	5.76 (4.69)	5.09 (4.21)	4.54 (3.86)

Note. MBCT = mindfulness-based cognitive therapy; mADM = maintenance antidepressant medication; HRSD = Hamilton Rating Scale for Depression; *DSM-IV* = *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.).

[a] There was 1 Muslim in the mADM group and 1 Bahai, 1 Buddhist and 1 Spiritualist in the MBCT group. The remaining participants endorsed no religion.

[b] Social class was according to UK National Office of National Statistics, and the range was from professional and managerial occupations (Class 1) to semi-routine and routine occupations (Class 5). Data were missing for 1 mADM participant in the treatment-adherent sample.

[c] Complete data set for $n = 111$ (MBCT = 52 group; mADM = 59) in the treatment-adherent sample.

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Table 2
Outcome data for the treatment-adherent sample ($n = 114$) and cognitive reactivity sub-sample ($n = 80$)

Outcome	Post-MBCT		15-Month follow-up	
	MBCT	mADM	MBCT	mADM
Treatment-adherent sample[a]				
HRSD: *M* (*SD*)	5.23 (4.77)	7.75 (6.65)	7.12 (6.07)	8.69 (7.34)
Relapse: *n* (%)	–	–	21 (43)	23 (51)
Reactivity sub-sample[b]				
HRSD: *M* (*SD*)	3.53 (2.71)	3.86 (3.03)	5.72 (4.24)	7.43 (7.35)
Relapse: *n* (%)	–	–	16 (37)	18 (49)

Note. MBCT = mindfulness-based cognitive therapy; mADM = maintenance antidepressant medication; post-MBCT = assessment point 1 month after the end of MBCT treatment in the MBCT arm and at the equivalent time point in the mADM arm; HRSD = Hamilton Rating Scale for Depression.
Treatment-adherent sample: MBCT − $n = 52$; mADM − $n = 62$.
Cognitive reactivity sub-sample: MBCT − $n = 43$; mADM − $n = 37$.
[a] At post-MBCT there was a significant overall effect of treatment on HRSD scores in the treatment-adherent sample, $B = -2.52$, $beta = -.21$, $t = 2.26$, $p = .03$, though this did not reach significance at 15-month follow-up, $B = -1.58$, $beta = -.12$, $t = 1.23$, $p = .22$. There was no significant overall effect of treatment on relapse at 15 months, $Wald = .36$, $p = .55$, hazard ratio = .83.
[b] For the cognitive reactivity sub-sample there was no significant overall effect of treatment at 15-month follow-up on either HRSD scores, $B = -1.81$, $beta = -.15$, $t = 1.36$, $p = .18$, or relapse, $Wald = .99$, $p = .32$, hazard ratio = .71.

Moderation

Treatment outcome was not significantly moderated by the Baseline demographic or psychiatric variables listed in Table 1, with the exception of gender: HRSD15m scores − $B = 6.82$, $beta = .30$, $t = 2.36$, $p < .03$; relapse, $Wald = 5.56$, $p < .03$, hazard ratio = 8.29. Within MBCT, females fared significantly better than males on HRSD15 scores, $B = 4.30$, $beta = .29$, $t = 2.21$, $p < .03$, with a similar weak trend in terms of relapse, $Wald = 3.13$, $p = .08$, hazard ratio = 2.75, while for mADM, gender effects were non-significant, $ps > .09$. These findings need to be interpreted with caution however as, firstly, the number of males in each treatment group was small (e.g., $n = 11$ in the MBCT group) and, secondly, analyses of archival data obtained (Williams, 2009) from the two previous trials of MBCT versus usual care (Ma & Teasdale, 2004; Teasdale et al., 2000) found no support for a moderating effect of gender. Nevertheless, due to the consistency of the gender effect across both outcome variables in the present study we covaried gender in our mediation analyses.

Mediation

Mediation during treatment

Baseline and post-MBCT data for the treatment-adherent sample on self-compassion (SCS) and mindfulness (KIMS) are presented in Table 3. The first criterion of mediation is whether treatment significantly changes the mediator (Kraemer et al., 2002). This criterion was met for both measures. MBCT was associated with significantly greater improvement on both the SCS, $F(1,106) = 6.73$, $p < .02$, Cohen's $d = .50$, and KIMS, $F(1,106) = 12.44$, $p < .001$, $d = .68$, relative to mADM.

We included these potential mediators in separate regression analyses. Main effect (M) and interaction (T × M) terms for these mediation analyses are presented in Table 4. As can be seen, with HRSD15m as the outcome, changes on both the KIMS and SCS showed a significant main effect of mediation indicating that, independent of changes in depression severity, increase in mindfulness and self-compassion during MBCT (or the equivalent time period during mADM), across all participants, accounted for less severe later depressive symptoms at 15 months. These effects did not extend to prediction of relapse in the smaller sample who had not relapsed prior to the end of treatment ($n = 94$). There were no significant interactive mediation effects.

Mediation by cognitive reactivity

Mood induction and reactivity data for the reactivity sub-sample ($n = 80$) are in Table 3. Analyses followed the approach of Segal et al. (2006). Mirroring their results, the mood provocation protocol successfully produced significant changes in VAS sadness across treatment groups, $t(79) = 14.48$, $p < .001$, and the groups did not significantly differ in the magnitude of this response, $F(1,78) = 1.62$, ns, $d = .28$.

To validate the reactivity task we first sought to replicate the previous findings (Segal et al., 2006). Segal and colleagues showed that for both ADM and CBT groups in their study, higher reactivity predicted greater relapse, with no difference across groups. While there is no CBT group in the present study, the two trials do have an ADM group in common. To replicate the relevant results from Segal and colleagues we therefore tested whether cognitive reactivity predicted relapse and HRSD15m scores in the current mADM group alone. For the current mADM group, higher cognitive reactivity significantly independently predicted both higher HRSD15m scores, $B = 2.81$, $beta = .38$, $t = 2.46$, $p = .02$, and greater hazard of relapse, $Wald = 4.74$, $p = .04$, hazard ratio = 1.83, replicating the previous results (Segal et al., 2006) and testifying to the validity of the task.

We next included the MBCT group in the analyses. Segal and colleagues reported that patients receiving CBT evidenced significantly *lower* cognitive reactivity than patients receiving ADM (Segal et al., 2006). In the present study however (Table 3), the MBCT patients showed *higher* cognitive reactivity than the mADM group, $F(1,78) = 4.36$, $p = .04$, $d = .47$.

We now examined whether post-treatment cognitive reactivity mediated the relationship between treatment and outcome (Kraemer et al., 2002). The main effect and interaction terms are again shown in Table 4. For HRSD15m there was a significant

Table 3
Mean (*SD*) data for the potential mediator variables.

Variable	Baseline		Post-MBCT	
	MBCT	mADM	MBCT	mADM
KIMS[a]	108.10 (13.50)	105.88 (18.12)	120.96 (15.70)	109.00 (15.67)
SCS[a]	15.11 (2.79)	14.36 (2.75)	16.93 (3.50)	14.69 (3.65)
Sad mood pre-induction[b]	–	–	19.70 (18.56)	22.19 (20.35)
Sad mood post-induction[b]	–	–	63.70 (19.14)	60.14 (23.87)
DAS pre-induction[b]	–	–	123.93 (33.91)	131.70 (34.36)
DAS post-induction[b]	–	–	143.63 (43.88)	140.14 (40.00)

Note. MBCT = mindfulness-based cognitive therapy; mADM = maintenance antidepressant medication; post-MBCT = assessment point 1 month after the end of MBCT treatment in the MBCT arm and at the equivalent time point in the mADM arm. KIMS = Kentucky Inventory of Mindfulness Skills; SCS = Self-Compassion Scale; DAS = Dysfunctional Attitudes Scale.
[a] Data for the treatment-adherent sample. Full data available for $n = 108$: MBCT = 51; mADM = 57.
[b] Data for the cognitive reactivity sub-sample ($n = 80$): MBCT = 43; mADM = 37.

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Table 4
Main effects of treatment and main and interactive effects of potential mediators in the prediction of depressive symptoms (HRSD15m) and relapse at 15-month follow-up.

Depression severity (HRSD15m) as the outcome				
Variable	*B*	*Beta*	*t*	*p*
Treatment[a, b]	−.66	−.05	.77	.44
ΔKIMS[a, b]	−1.97	−.29	2.88	.005
ΔKIMS × Treatment[a, b]	.36	.04	.26	.79
ΔSCS[a, b]	−1.73	−.25	2.59	.01
ΔSCS × Treatment[a, b]	.65	.07	.49	.62
Treatment[c]	−2.00	−.17	1.58	.12
Cognitive reactivity[c]	1.39	.23	2.07	.04
Cognitive reactivity × Treatment[c]	−2.72	−.33	2.09	.04

Depressive relapse as the outcome			
Variable	*Wald*	*p*	Hazard ratio
Treatment[b, d]	.39	.53	.82
ΔKIMS[b, d]	.74	.79	.96
ΔKIMS × Treatment[b, d]	2.35	.13	1.68
ΔSCS[b, d]	.02	.88	.98
ΔSCS × Treatment[b, d]	.17	.68	1.14
Treatment[c]	3.23	.07	.51
Cognitive reactivity[c]	1.07	.30	1.20
Cognitive reactivity × Treatment[c]	3.55	.058	.51

Note. KIMS = Kentucky Inventory of Mindfulness Skills; SCS = Self-Compassion Scale; HRSD15m = Hamilton Rating Scale for Depression scores at 15-month follow-up; Treatment = mindfulness-based cognitive therapy (MBCT) versus maintenance antidepressant medication (mADM).
Δ = standardized residualized change in process variable from baseline to post-MBCT (the assessment point 1 month after the end of MBCT treatment in the MBCT arm and at the equivalent time point in the mADM arm).
Cognitive reactivity measured by standardized residualized change scores on the Dysfunctional Attitudes Scale from pre- to post-mood induction (Segal et al., 2006).
[a] Analyses involved the treatment-adherent sample for whom full data were available ($n = 108$; MBCT = 51, mADM = 57).
[b] Analyses control for change in HRSD scores from baseline to post-MBCT, number of previous episodes of depression, and gender.
[c] Analyses involved the cognitive reactivity sub-sample ($n = 80$; MBCT = 43, mADM = 37). Analyses control for HRSD scores at post-MBCT, affective reactivity in response to the mood induction, number of previous episodes of depression, and gender.
[d] Analyses involved the treatment-adherent sample who had not relapsed prior to the post-MBCT assessment ($n = 94$; MBCT = 49, mADM = 45).

interaction between cognitive reactivity and treatment group in the prediction of outcome, which qualified a significant main effect of cognitive reactivity. There was a similar marginally significant interaction in the prediction of relapse. As noted earlier, these interactive mediation effects indicate that treatment changes the nature of the relationship between cognitive reactivity and outcome differentially for the two treatment groups.

To understand how reactivity was related to outcome differentially for the MBCT versus mADM participants, we deconstructed these interactions. As reported above in the task validation analysis, in the mADM group, for both the relapse and HRSD15m outcome variables, greater reactivity related to worse outcome. However, for the MBCT group this toxic association was absent with greater reactivity not significantly relating to outcome for either HRSD15m scores, $B = .00$, $beta = .00$, $t = .01$, $p = 1.00$, or relapse $Wald = .01$, $p = .91$, hazard ratio = .97. This interactive mediation relationship is illustrated in Fig. 1 for HRSD15m scores where, following recommended convention, we have modelled the reactivity data for the mean score, and for scores 1 *SD* above and below the mean (Preacher & Hayes, 2008; Preacher, Curran, & Bauer, 2006).

Moderation of the relationship between cognitive reactivity and outcome

We next examined which facets of MBCT may have nullified the toxic effects of post-treatment cognitive reactivity in the MBCT group such that, despite cognitive reactivity being greater overall, it no longer significantly predicted outcome. To do this we assessed whether the significantly greater improvements in mindfulness and self-compassion with MBCT versus mADM that mediated outcome (see above and Table 4) were a factor. We thus examined whether either SCS change or KIMS change moderated the significant main effect relationship in the cognitive reactivity sub-sample ($n = 80$) between reactivity and outcome, using the same regression approach. There were no significant effects involving the KIMS, $ps > .45$. For the SCS however, there was a significant interaction between SCS change and cognitive reactivity in the prediction of HRSD15m scores indicative of moderation, $B = -1.27$, $beta = -.24$, $t = 2.06$, $p = .04$ (see Fig. 2; Preacher & Hayes, 2008; Preacher et al., 2006). As can be seen from the figure, post-treatment cognitive reactivity relates less strongly to outcome for participants who have shown greater improvements in self-compassion across the previous treatment period. The comparable analysis with relapse as the outcome was not significant, $p = .64$.

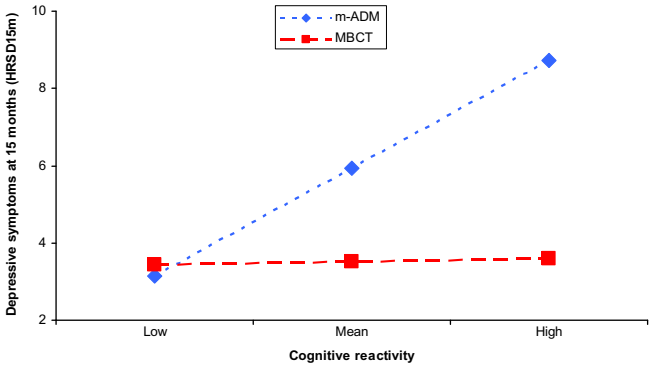


Fig. 1. Prediction of depressive symptoms at 15 months by levels of cognitive reactivity across treatment groups.
Note. HRSD15m = Hamilton Rating Scale for Depression scores at 15-month follow-up. MBCT = mindfulness-based cognitive therapy ($n = 43$); mADM = maintenance antidepressant medication ($n = 37$).
Cognitive reactivity measured by standardized residualized change scores on the Dysfunctional Attitudes Scale from pre- to post-mood induction (Segal et al., 2006) modelled for mean value, and values 1 *SD* above (high) and 1 *SD* below (low) the mean (Preacher & Hayes, 2008; Preacher et al., 2006).
Regression lines control for change in HRSD scores from baseline to post-MBCT (the assessment point 1 month after the end of MBCT treatment in the MBCT arm and at the equivalent time point in the mADM arm), number of previous episodes of depression, gender, and change in sad mood as a result of the induction protocol.

Discussion

This study provides the first evidence of what mediates MBCT's treatment effects. Consistent with MBCT's theoretical premise, increases in mindfulness and self-compassion across treatment mediated the effect of MBCT on depressive symptoms at 15-month follow-up. Furthermore, MBCT changed the relationship between post-treatment cognitive reactivity and depression outcome. In patients receiving mADM, greater reactivity predicted poorer outcome, replicating previous findings (Segal et al., 2006). However, following MBCT there was no support for this toxic relationship between reactivity and outcome, with an indication that enhancement of self-compassion had nullified this relationship.

These findings are consistent with a recent evidence synthesis arguing that MBCT works through a "retraining of awareness and non-reactivity, … allowing the individual to more consciously choose those thoughts, emotions, and sensations…, rather than habitually reacting to them" (Chambers, Gullone, & Allen, 2009; p. 569). The results are also in line with recent data using a self-report measure of cognitive reactivity showing that MBCT

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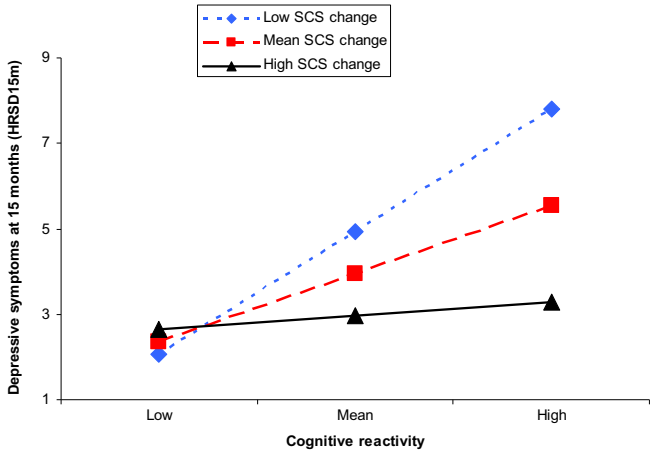


Fig. 2. Moderation of the relationship between cognitive reactivity and depressive symptoms at 15 months as a function of change in self-compassion during prior treatment.
Note. Cognitive reactivity measured by standardized residualized change scores on the Dysfunctional Attitudes Scale from pre- to post-mood induction (Segal et al., 2006).
SCS change = standardized residualized change scores on the Self-Compassion Scale from baseline to post-MBCT (the assessment point 1 month after the end of MBCT treatment in the MBCT arm and at the equivalent time point in the mADM arm).
Cognitive reactivity and SCS change modelled for mean value, and values 1 *SD* above (high) and 1 *SD* below (low) the mean (Preacher & Hayes, 2008; Preacher et al., 2006).
HRSD15m = Hamilton Rating Scale for Depression scores at 15-month follow-up.
MBCT = mindfulness-based cognitive therapy ($n = 43$); mADM = maintenance antidepressant medication ($n = 36$). One MBCT participant in the mood-induction sample did not complete the SCS.
Regression lines control for change in HRSD scores from baseline to post-MBCT, number of previous episodes of depression, and gender.

attenuates reactivity and its impact on depression (Raes, Dewulf, Van Heeringen, & Williams, 2009). This is reflected in distinct neural responses to sad mood in people who had undergone MBCT, suggesting a neural basis for these findings (Farb et al., 2010). The findings suggest that whereas negative mood may reactivate dysfunctional thinking patterns in people who have participated in an MBCT class, it is their response to these dysfunctional thoughts that is altering the impact at follow-up.

The suggestion of a key role for self-compassion is consistent with emerging theory (e.g. Gilbert, 2009) and data (e.g., Leary, Tate, Adams, Allen, & Hancock, 2007) that compassion in the face of negative thoughts and feelings is adaptive, validating it as a key skill learned in MBCT (Feldman & Kuyken, in press). Moreover, again there is preliminary data that the modulation of reactivity by self-compassion is mirrored at the neural level, at least in more experienced meditators (Lutz, Greischar, Perlman, & Davidson, 2009).

An intriguing aspect of the present findings is that MBCT was associated with *greater* post-treatment cognitive reactivity than mADM. This contrasts with the lowered reactivity associated with CBT relative to mADM in previous research (Segal et al., 2006) suggesting that these psychological interventions work through different mechanisms. MBCT teaches people to be more attuned to thoughts and feelings without explicitly trying to change them and this may partly account for the greater reactivity. Reactivity may have been further enhanced by many of the MBCT group having recently discontinued their mADM.

Strengths and limitations

This study builds on prior cross-sectional and qualitative research on mechanisms in MBCT (Allen, Bromley, Kuyken, & Sonnenberg, 2009; Raes et al., 2009), but attends to the temporal sequencing of the putative mediator and outcome variables to investigate moderation and mediation effects, thus providing key information about mechanisms of change (Kraemer et al., 2002; Laurenceau, Hayes, & Feldman, 2007). Further strengths were the integrated use of experimental, self-report, and interviewer-administered measures/methods and the examination of clear theoretically-driven questions.

This initial study indicates that the cultivation of self-compassion and mindfulness in MBCT plays an important role in symptom change. However, there is now a need for more nuanced assessment of these variables (Grossman, 2008). Moreover, we need to investigate other potential mechanisms and the specificity of any effects to MBCT. For example, commentators (Brown, Ryan, & Creswell, 2007; Chambers et al., 2009) and our qualitative (Allen et al., 2009) and psychometric work (Baum et al., 2010) suggest that mindfulness is multi-dimensional and future studies should thus evaluate different dimensions of mindfulness such as attentional control, observing and de-centering. The present study also relied on self-report questionnaires to assess mindfulness, self-compassion and dysfunctional thinking. Future investigations would be enhanced by triangulation with behavioral and neuroscience measures.

Establishing that a variable is a mediator of change does not, of course, definitively establish it as a mechanism of change (Kazdin, 2007; Murphy et al., 2009). A mediator could yet prove to be a marker of an alternative change mechanism. This is especially so for cognitive reactivity, which we could only assess in those with appropriate levels of depression (i.e., low symptoms) and only at one time-point post-treatment. It is possible that reactivity is a marker for some other effect that is causal. However, identifying mediators of change is a significant milestone in establishing how MBCT works because it narrows down the search by identifying "necessary, sufficient and facilitative ingredients for treatment to achieve change" (Kazdin, 2007; p. 11). A next step is to use alternative research designs to further unpack these initial findings; for instance, experimental manipulations, individual differences designs, experience sampling methods, or randomized controlled trials that 'dismantle' the components of MBCT (Murphy et al., 2009), so that each mediator can be examined in turn.

The sample in this study comprised a group with recurrent depression currently in remission, treated with ADM, and willing to try a group-based psychosocial intervention. Generalizability beyond this sample will require examination of moderators and mediators with different populations for whom MBCT is being adapted (e.g., Bertschy et al., 2008; Eisendrath et al., 2008; Kenny & Williams, 2007; Williams et al., 2008). The significant moderating effect of gender in the present data requires further examination in future larger trials.

Finally, while the interactive mediational effects involving cognitive reactivity emerged significantly for severity of depressive symptoms and near-significantly for relapse ($p = .058$), over 15-month follow-up, the results involving changes in self-compassion and mindfulness were only present for the depression symptoms outcome variable. It may be that the effects of self-compassion and mindfulness change are more subtle and that the smaller sample size and binary outcome in the relapse analyses did not provide enough power to detect them. Thus, although severity of depressive symptoms is an excellent marker for risk of later relapse (Judd et al., 1999), it will be important for future studies to be adequately powered to test our findings in terms of depressive relapse itself over meaningful follow-up periods.

Consistent with theory, in an RCT of MBCT versus mADM, MBCT's treatment effects were mediated by augmented self-compassion and mindfulness during treatment, along with a decoupling of the relationship between post-treatment reactivity of depressive thinking and poor outcome. This decoupling appears linked to the cultivation of self-compassion across treatment.

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Future research can build on these findings to test specific hypotheses about MBCT's mechanisms of change.

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