Mindfulness (2022) 14:113–127
https://doi.org/10.1007/s12671-022-02032-0

ORIGINAL PAPER

Increases in External Sensory Observing Cross-Sectionally Mediate the Repair of Positive Affect Following Mindfulness-Based Cognitive Therapy in Individuals with Residual Depression Symptoms

Barnaby D. Dunn[1] · Hanna Wiedemann[2] · Merle Kock[3] · Frenk Peeters[4,5] · Marieke Wichers[6] · Rachel Hayes[7] · Willem Kuyken[8] · Nicole Geschwind[9]

Accepted: 19 November 2022 / Published online: 26 December 2022
© The Author(s) 2022, corrected publication 2023

Abstract

Objectives Mindfulness-Based Cognitive Therapy for Depression (MBCT-D) has been shown to be effective at repairing positive affect deficits in depressed individuals, but the mechanism of action underpinning these changes has not been empirically examined. To address this issue, secondary analyses of two randomised controlled trials in individuals with residual depression were conducted.

Method Study 1 was a cross-sectional mediation analysis of a trial reporting superior effects of MBCT-D to a waitlist control in bolstering momentary positive affect in individuals with residual depression symptoms ($n = 130$). Study 2 replicated this analysis in the subset of individuals with residual depression symptoms ($n = 117$) from a second, larger trial comparing MBCT-D to maintenance antidepressants (M-ADM) to prevent depressive relapse that also included a positive affect outcome.

Results In Study 1, an increase in external sensory observing uniquely mediated the superiority of MBCT-D over the control in repairing momentary positive affect. Replicating these findings, in Study 2, MBCT-D was superior to M-ADM at repairing positive affect and this was cross-sectionally mediated by changes in external sensory observing.

Conclusions These findings suggest that one way in which MBCT-D enhances positive affect in individuals with residual depression may be by training the capacity to attend to external sensory experience.

Keywords Mindfulness · Anhedonia · Positive affect · Depression · Experiential processing

✉ Barnaby D. Dunn
b.d.dunn@exeter.ac.uk

1 Mood Disorders Centre, University of Exeter, Exeter, UK

2 Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, Netherlands

3 Centre for the Psychology of Learning and Experimental Psychopathology, KU Leuven, Louvain, Belgium

4 Department of Psychiatry and Psychology, University Hospital Maastricht, Maastricht, Netherlands

5 School for Mental Health and Neuroscience, Faculty of Health, Medicine and Life Sciences, Maastricht University, Maastricht, Netherlands

6 Medical Center Groningen (UMCG), University of Groningen, Groningen, Netherlands

7 Medical School, University of Exeter, Exeter University, Exeter, UK

8 Department of Psychiatry, University of Oxford, Oxford, UK

9 Department of Clinical Psychological Science, Maastricht University, Maastricht, Netherlands

Anhedonia, a deficit in the positive affect (PA) system whereby individuals experience reduced pleasure and interest when engaging with rewarding activities, is a prognostically important but clinically neglected feature of major depressive disorder. It is one of the two cardinal symptoms required for a diagnosis of a major depressive episode (American Psychiatric Association, 2013), yet is not currently targeted in current psychological treatments as explicitly as are elevations in negative affect (NA; see Dunn, 2012, 2019; Dunn & Roberts, 2016). This is potentially a missed opportunity to improve currently sub-optimal acute and relapse prevention outcomes in depression, given increasing evidence that anhedonia predicts first onset of depression (Bress et al., 2013; Morgan et al., 2013), mixed response to current depression treatments (McMakin et al., 2012; Wichers et al., 2009), and a poor long-term depression course (Shankman et al., 2010; Spijker et al., 2001). Moreover, anhedonia tends to persist as a residual symptom outside of full-blown depressive episodes and it is also

what clients report they would most like treatment to target (Demyttenaere et al., 2015).

There is increasing interest in the possibility that mindfulness practices may be one way to help individuals with a history of depression to reconnect to positive emotional experience. For example, Mindfulness-Based Cognitive Therapy for Depression (MBCT-D; Segal et al., 2012) provides systematic training in meditation practice ("paying attention in a particular way: on purpose, in the present moment, and non-judgmentally" [Kabat-Zinn, 1994, p. 4]) over an 8-week programme to help individuals build a new way of relating to internal and external experience. While the predominant emphasis in the MBCT-D programme is to help prevent reactivation of unhelpful depressogenic patterns of mind when experiencing negative mood, some components of the course do nevertheless focus on increasing reward reactivity. In Week 2, individuals are encouraged to engage in everyday activities in a mindful fashion (potentially leading to enhanced pleasure experience) and a pleasant events calendar is set as homework. In the following session, participants are invited to deconstruct their experience during these pleasant events (noticing the situation, bodily sensations, mood, thoughts, and appraisal of recall). Recent conceptual accounts have proposed that MBCT-D may repair anhedonia by countering the pervasive habitual tendency in depression to engage in experiential avoidance (Kuyken & Dunn, 2022). Instead, individuals are helped to cultivate an experiential processing mode (direct, sensory experience of the world as it unfolds moment to moment) that can be accessed to savour everyday simple pleasures (Kuyken & Dunn, 2022).

Extending earlier laboratory and experience sampling work showing that brief mindfulness exercises build positive emotional reactivity (e.g. Easterlin & Cardeña, 1998; Erisman & Roemer, 2010), the benefits of MBCT-D on enhancing PA have now been empirically demonstrated. A recent randomised controlled trial allocated 130 individuals with residual depression symptoms but not currently in episode either to receive MBCT-D or to a waitlist control condition (Geschwind et al., 2011). At baseline and post-treatment at around 9 weeks (when those in the MBCT-D condition had completed the course), individuals underwent the experience sampling method (ESM) to assess their everyday experience of positive and negative emotions (10 mood ratings taken per day at semi-random intervals over 6 days). ESM assesses participants in their daily life, thus providing ecologically valid, repeated in-the-moment assessments of affect that are highly reliable and less prone to retrospective memory biases than standardly administered questionnaires (Csikszentmihalyi & Larson, 1987; Peeters et al., 2003). MBCT-D led to increases in PA, increased ratings of how pleasurable activities were, and stronger boosts in PA when engaging in pleasurable activities (reward experience), relative to the control condition (Geschwind et al., 2011).

However, there has been very limited empirical examination to test the claim that these improvements in PA come about through the cultivation of an experiential processing mode (cf., Kuyken & Dunn, 2022). Laboratory studies show that bolstering experiential awareness through the use of attentional and imagery manipulations increases positive-affective experience (Gadeikis et al., 2017; Holmes et al., 2006, 2009). However, these studies do not directly test if and how mindfulness practice modulates these mechanisms. Another way to explore this issue is to examine the relationships between dispositional mindfulness and positive affect. Dispositional mindfulness is increasingly acknowledged as a multi-faceted construct, and a variety of questionnaire measures have been developed to measure these components. For example, the Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004) measures four key elements of mindfulness: observing (noticing your current bodily, sensory, and emotional experience; akin to experiential processing), describing (finding words to describe how you feel), acting with awareness (staying focused and aware of present-moment experience), and accepting (allowing reality to be as it is, without judging, avoiding, changing, or escaping it). More recently, the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) has become the most frequently utilised measure in the literature. This replicates the four primary factors of the KIMS and in addition incorporates a factor measuring non-reactivity to inner experience (perceiving thoughts and feelings without having to react to them).

A handful of studies examining the relationship between dispositional mindfulness and PA at a single point in time have revealed inconsistent findings. In adults seeking treatment for anxiety and depression, significant positive associations were found at intake assessment between greater anhedonia severity and lower scores on all facets of mindfulness on the FFMQ, *except* observing (Desrosiers et al., 2013). The non-judging and non-reacting associations held even when covarying for the other FFMQ facets. In a secondary analysis of this dataset, greater observing did predict lower anhedonia but only in those individuals high in non-reacting (Desrosiers et al., 2014). Analyses of other samples have not fully replicated these findings. For example, in two unselected undergraduate samples of 284 and 228 individuals, only greater acting with awareness was consistently linked to lower anhedonia (Raphiphatthana et al., 2016).

There are a number of limitations with these studies. Neither used formally defined depressed samples on the basis of diagnostic interviews, so how well these results generalise to clinical depression remains unclear. Moreover, the failure to find any links between observing and positive affect experience may reflect that observing is not a unitary construct. Recent factor analytic studies

(Rudkin et al., 2018) suggest that observing can be meaningfully fractionated into external sensory observing (e.g. "I notice the smells and aromas of things"), internal bodily observing (e.g. "I notice changes in my body, such as whether my breathing slows down or speeds up"), and internal emotional observing (e.g. "I am aware of my emotions when talking to others"). It is conceivable that these different components of observing may be differentially related to positive affect, but this possibility has not been tested. Even if these studies are replicated in clinically depressed samples and when looking at the sub-components of observing, this would still prove a poor test of mechanism of how mindfulness-based interventions work. Just because an association is observed between anhedonia and a given component of dispositional mindfulness, it does not necessarily logically follow that manipulating this component during a mindfulness intervention will be associated with changes in anhedonia.

A better way to test which components of mindfulness drive change in PA is to examine how change in these dispositional mindfulness components relates to changes in anhedonia in the context of randomised controlled trials (RCTs) of MBCT-D relative to control conditions. Analytically, a mediation framework can be applied, examining the extent to which the relationship between the independent variable (X; whether individuals are allocated to mindfulness or a control condition) and the dependent variable (Y; extent of anhedonia/PA repair during treatment) is accounted for by change in putative mediator variables (M; changes in mindfulness components during treatment). Randomisation should minimise confounder effects. To provide some test of causality, the temporal precedence criteria should ideally be met (where change in the mediator occurs before change in the outcomes). Where change in the mediator and the outcome are measured concurrently, this cannot provide a test of causality, but this is nevertheless more powerful evidence of a mechanism than simple associations between measures taken at a single time point in a cross-sectional survey. We are not aware of any such mediation analyses having been published to date examining links between mindfulness interventions, changes in dispositional mindfulness, and anhedonia repair.

Therefore, to further explore the mechanisms through which mindfulness may bolster PA, Study 1 conducted a secondary analysis of the Geschwind et al. (2011) trial to evaluate to what extent change in dispositional mindfulness facets (including a more fine-grained fractionation of the observing facet into different components) mediated any observed improvement in PA during MBCT-D relative to waitlist control. As we had no strong rationale regarding which sub-components of observing might mediate the relationship between mindfulness and PA change and the analyses are post hoc and exploratory, we set no hypotheses for the relationships that might emerge between the various elements of dispositional mindfulness and PA repair.

Study 1

Method

Participants

The study recruited 130 Dutch adults with a previous history of at least one episode of major depressive disorder, who showed some residual symptoms but did not meet diagnostic criteria for a current episode. The cut-off used for residual symptoms was a score of 7 or greater on the 17-item Hamilton Depression Rating Scale (HDRS; Hamilton, 1960) during an intake assessment. Participants were excluded if they had schizophrenia, psychotic episodes in the past year, or changes in the past 4 weeks or coming weeks in ongoing psychological or pharmacological treatment.

Procedure

Participants completed a week of experience sampling and then a battery of questionnaires at baseline. If they had at least 20 valid ESM assessments (cf., Delespaul, 1995), participants were then randomised to either MBCT-D ($n = 64$) or waitlist control ($n = 66$) in a 1:1 fashion following a sealed envelope method. Randomisation was stratified by number of previous episodes (two or less episodes versus three or more episodes). Participants in the control condition were offered the chance to receive the MBCT-D course after the study had finished.

MBCT-D was delivered according to the protocol outlined by Segal et al. (2012), consisting of a manualised, group-based training programme aiming to allow patients to learn mindfulness and a range of other skills that prevent depression recurrence. Participants attended eight 150-min group sessions of guided mediation, experiential exercises, discussion, and psychoeducation. Participants were expected to complete daily homework exercises lasting 30–60 min per day for the duration of the course. MBCT-D was delivered by experienced trainers in a centre specialised in mindfulness trainings. All trainers were supervised by an experienced mental health care professional trained in MBCT-D by the protocol developers. All MBCT-D participants completed the assessment and ESM protocol again at the end of the MBCT-D course (9 to 10 weeks after baseline). Participants from the waitlist control group were assessed at the same time point. The study was approved by the Medical Ethics Committee of Maastricht University Medical Centre, and all participants gave written, informed consent. Participants received 50 Euros as compensation for taking part.

The sample was predominantly female (76%) and had a mean age of 44 years (SD = 9.60). Approximately 55% of the sample had experienced two or fewer previous depressive episodes, whereas the remaining 45% had experienced three or more previous depressive episodes. The mean score on the HDRS at baseline was 10.39 (SD = 3.58). Ethnicity data were not collected in this study (for full details of participant characteristics and the CONSORT diagram for the trial, see Geschwind et al., 2011).

Measures

PA was measured via experiencing sampling in everyday life. For the ESM, participants were loaned a digital wristwatch, which was programmed to emit beeps at unpredictable moments over 90-min blocks between 7:30 am and 10:30 pm (10 beeps per day over 6 consecutive days). At each beep, participants were instructed to rate their mood and what they were doing using a pen and paper ESM self-assessment form. All ESM assessments were made on 7-point Likert scales, ranging from 1 (*not at all*) to 7 (*very*). Participants were instructed to complete their reports immediately after the beep to minimise retrospective memory bias. Participants recorded the time at which they completed the form, and if this was more than 15 min after the beep had been scheduled, that rating was excluded (cf., Delespaul, 1995). PA at each beep was indexed by averaging ratings of the adjectives happy, satisfied, strong, enthusiastic, curious, animated, and inspired, reflecting the original analysis done by Geschwind et al. (2011) and as is standard when scoring adjective rating measures of this kind (e.g. the PANAS; Watson et al., 1988). Internal reliability across the adjectives was good ($\alpha = 0.89$). One individual was excluded who had fewer than 20 valid entries at baseline (from the MBCT-D condition). The remaining participants on average completed 49 (out of a possible maximum of 60) valid entries (SD = 7.6). Given that the putative moderators/mediators (KIMS facets) were measured at the individual level and not the beep level, we collapsed the original hierarchical structure of the PA data and simply computed mean PA ratings per individual (averaging across all beeps).

Mindfulness was indexed using the KIMS (Baer et al., 2004), a 39-item self-report inventory originally designed to cover four facets of mindfulness: observing (observing, noticing, and attending to internal and external phenomena), describing (describing, labelling, or noting of observed phenomena by applying words in a non-judgemental way), acting with awareness (being attentive and engaging fully in the current activity), and accepting (allowing what is there to be as it is, without judging, avoiding, changing, or escaping it). Items are rated from 1 (*never or very rarely true*) to 5 (*very often or always true*). Psychometric studies show this scale generally has satisfactory reliability and validity (Baer et al., 2004; Baum et al., 2010). The KIMS rather than the FFMQ was used as the study conception predated publication and widespread adoption of the FFMQ. Scale internal reliability was adequate for all factors in the present sample (pre-assessment $\alpha > 0.76$).

Data Analyses

ESM data were available for 129 participants (63 in MBCT-D, 66 in waitlist control) at baseline and for 119 participants (57 in MBCT-D, 62 in waitlist control) at post-treatment. KIMS data were available for 128 participants (62 in MBCT-D, 66 in waitlist control) at baseline and for 126 participants (63 in MBCT-D, 63 in waitlist control) at post-treatment (the remaining participants missed the reverse side of the paper of the KIMS measure). In the mediation analysis, 116 participants (56 in MBCT-D, 60 in waitlist control) had complete ESM and KIMS data at intake and post-treatment.

Alpha was set at 0.05, and the results of two-tailed statistical tests are reported throughout. Data of participants with complete case data were used in all analyses. Confirmatory factor analysis was conducted to determine if the standard observing scale or the fractionated (sensory, bodily, emotional) observing was the best fit of the data. We selected the items from the KIMS that conceptually measured bodily observing (Items 1, 5, and 17), external perception (or sensory observing; Items 13, 21, 25, 29, and 33), and emotional awareness (Items 30, 37, and 39) in the Rudkin et al. (2018) study. Item 9 ("When I'm walking, I deliberately notice the sensations of my body moving") was excluded based on findings of cross-loadings on the sensory and bodily observe factor (Rudkin et al., 2018). Following recommendations from Kline (2015), model fit was examined in terms of χ^2, relative χ^2, root mean square error of approximation (RMSEA), the comparative fit index (CFI), standardised root mean square residuals (SRMR), and the Akaike information criterion (AIC). The model that had the best fit was selected to take forward into the subsequent mediation analyses.

To explore the extent to which the mindfulness facets were related to each other, zero-order correlations were run (using Pearson's correlation coefficients). To examine if groups were comparable at baseline, a series of analyses of covariance were run, with baseline ratings as the dependent variable and condition (MBCT-D, control) as the between-subjects factor. Number of previous depressive episodes (< 3 versus ≥ 3) was entered as an additional covariate, given that this was a stratification variable in the original trial (Geschwind et al., 2011). To examine the impact of condition on the ESM PA measures and the KIMS mindfulness components, a series of analyses of covariance were run, with post-measurement ratings as the dependent variable, condition (MBCT-D, control) as the

independent between-subjects factor, and baseline ratings and number of previous episodes (< 3 versus ≥ 3) as covariates.

Mediation analyses examined whether change in the independent variable (X: condition) altered a dependent variable (Y: ESM PA) through one or more potential intervening variables (M: KIMS factors). A variety of approaches have been used in the treatment trial literature to operationalise change scores, including simple subtraction methods, residual change, or covariate approaches. A consensus is emerging that, for the purposes of mediation analyses, the covariate approach is most robust when analysing randomised controlled trial designs (i.e. where Lord's paradox is not an issue; cf., Miller & Chapman, 2001). For example, a recent simulation study showed that the covariate approach performs best in two-wave designs typically used in treatment trials, as it is more robust in the face of violations in assumptions about the stability and cross-lagged relations of the outcome and mediator variables (Valente & MacKinnon, 2017; see also commentary by Hayes & Rockwood, 2017). Therefore, we adopted a covariate approach here.

The PROCESS macro for SPSS (version 4.0) developed by Hayes (2013) was deployed to examine mediation, which indexes whether the indirect effect (the effect of X on Y through path M) is significantly different from 0. Given that the sampling distribution of the indirect effect often does not exhibit a standard normal distribution, we used bootstrapping (a nonparametric resampling procedure) to construct a confidence interval around the indirect effect. We ran 10,000 resamples during bootstrapping. Because the bootstrapping method is based on random sampling from the data, there are slightly different results each time PROCESS is run. For replication purposes, we seeded the random number generator to a value of 1,270,918,299 (a random number between 1 and 2,000,000,000) prior to running PROCESS.

Mediation was examined for each mindfulness factor separately as well as when entering all mindfulness factors into the same model (multiple mediation; Hayes & Rockwood, 2017; Preacher & Hayes, 2008). The strongest evidence of mediation is where a facet is a significant mediator in both individual and combined analyses (i.e. it is associated with change in anhedonia on its own and when covarying for all other components of mindfulness). As dispositional mindfulness and PA were only examined at pre- and post-MBCT-D, the mediation analyses were concurrent only. In the absence of the temporal precedence criterion being met, strong conclusions cannot be reached about a causal path from changes in mindfulness to changes in PA. Nevertheless, these analyses will provide preliminary examination of changes in dispositional mindfulness as a potential mechanism of anhedonia repair in MBCT-D.

As in previous analyses, the number of previous episodes (< 3 versus ≥ 3) was entered as a covariate in all mediation analyses. Analyses report the point estimate of the indirect effect, the standard error of the estimate of the indirect effect, and the bootstrapped 95% confidence interval around the point estimate for the total mediation model and each KIMS factor separately within the model. If 0 does not fall in the 95% confidence interval, this indicates the indirect effect is significant.

Results

Confirmatory factor analysis supported the fractionation of observe into sub-components. Model fit was better for the fractionated model than the original model (a lower AIC score and generally superior model fit indices; see Supplementary Online Materials [SOM] Table S1). Overall fit of the fractionated model was good (Wheaton's relative $\chi^2 < 2$; root mean square error of approximation < 0.05 and comparative fit index > 0.95), and all individual items had satisfactory loadings on their respective factors (> 0.4; see SOM Table S2). In contrast, the original model had poor model fit indices and individual item loadings were lower and not consistently > 0.4. As the fractionated observe model was superior to the single factor model, all subsequent analyses looked at sensory observing, emotional observing, and bodily observing separately. Internal reliability of the sensory observing subscale was good ($\alpha = 0.81$), adequate for the emotional observing subscale ($\alpha = 0.68$), but only borderline adequate for the bodily observing subscale ($\alpha = 0.58$) in the present sample.

As anticipated, the KIMS factors were positively and in the main significantly associated with one another (Table 1). The correlations were of a medium effect size

Table 1 Pearson's *r* correlation coefficients between Kentucky Inventory of Mindfulness Skills (KIMS) factors in Study 1

KIMS factors	1	2	3	4	5	6
Sensory observing (1)	1					
Bodily observing (2)	0.43***	1				
Emotional observing (3)	0.30**	0.38***	1			
Acting with awareness (4)	0.17	0.14	0.30**	1		
Describing (5)	0.27**	0.26**	0.39***	0.13	1	
Accepting (6)	0.01	-0.09	-0.12	0.30***	0.04	1

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

magnitude or smaller (r-values ranging from 0.01 to 0.43), suggesting the factors are at least partly dissociable from one another and supporting their inclusion as separate predictors in subsequent mediation models.

Table 2 reports baseline and post levels for ESM PA and the KIMS facets and presents results of ANCOVAs contrasting the groups at baseline and at post-treatment (with baseline levels and number of previous episodes entered as a covariate). As intended, the groups did not differ at baseline on any of the mindfulness factors or outcome variables, ANCOVA $F \leq 2.33, p \geq 0.128$. Levels of all the KIMS factors were greater at post-treatment (covarying for baseline levels) in the MBCT-D relative to the waitlist control group, ANCOVA $F \geq 5.17$, $p \leq 0.026$ (the XM path for mediation analyses). As reported in Geschwind et al. (2011), there were significantly greater levels of PA at post-treatment (covarying for baseline levels) in the MBCT-D relative to the control group, ANCOVA $F = 14.10$, $p < 0.001$ (the XY path for mediation analyses).

Next, we conducted mediation analyses to test our central hypothesis that change in KIMS facets would account for differences in change in PA between the MBCT-D and the control condition using PROCESS. Greater increases in sensory observing and accepting partially mediated the superiority of MBCT-D over the waitlist control in repairing momentary PA (zero not included in the 95% confidence interval of the indirect test) in the individual mediation models (top left panel of Table 3). In other words, a greater increase in sensory observing and accepting was associated with the superiority of MBCT-D over the waitlist control in increasing PA. The describing, acting with awareness, emotional observing, and bodily observing subscale associations were not significant (as 0 fell in the 95% confidence intervals). In the multiple mediation model (bottom left, panel of Table 3), the mediation effect was only significant for sensory observing.

The Geschwind et al. (2011) trial also included the Temporal Experience of Pleasure Scale (TEPS; Gard et al., 2006) as an additional self-report measure of anticipatory and consummatory pleasure experience at intake and post-treatment. For the sake of completeness, we conducted secondary analyses on this measure (see SOM). MBCT-D resulted in significantly lower TEPS anticipatory pleasure post-treatment, but there was no significant difference in TEPS consummatory pleasure (see SOM Table S3). A difference between MBCT-D and control at repairing TEPS consummatory pleasure was individually and uniquely cross-sectionally mediated by sensory

Table 3 Study 1 Kentucky Inventory of Mindfulness Skills (KIMS) mediation analyses

KIMS factor	ESM PA	
	Mean (*SE*)	95% CI [LL, UL]
Individual mediation		
Sensory observing	0.15 (0.07)	[0.04, 0.30]*
Emotional observing	0.05 (0.04)	[−0.01, 0.14]
Bodily observing	0.01 (0.03)	[−0.04, 0.08]
Acting with awareness	0.07 (0.05)	[−0.02, 0.16]
Describing	0.04 (0.03)	[−0.00, 0.12]
Accepting	0.07 (0.04)	[0.01, 0.16]*
Multiple mediation		
Total	0.20 (0.08)	[0.06, 0.37]*
Sensory observing	0.12 (0.07)	[0.00, 0.27]*
Emotional observing	0.03 (0.03)	[−0.04, 0.10]
Bodily observing	−0.03 (0.03)	[−0.11, 0.02]
Acting with awareness	0.03 (0.06)	[−0.09, 0.16]
Describing	0.01 (0.04)	[−0.06, 0.09]
Accepting	0.05 (0.04)	[−0.02, 0.14]

Number of bootstrap samples was set to 10,000. Seed value was set to 12,709,182. Number of previous depression episodes included as covariate

CI confidence interval, *LL* lower limit, *UL* upper limit

*Zero not included in the confidence interval, meaning a significant mediation ($p < .05$)

Table 2 Mindfulness and affective experience at baseline and post-treatment in each condition and the results of tests comparing conditions in Study 1

Measure	Control		MBCT-D		Baseline ANCOVA	Baseline post-ANCOVA
	Baseline	Post	Baseline	Post		
Sensory observing	20.77 (4.50)	20.75 (4.81)	19.64(4.67)	22.84 (3.82)	$F < 1$	$F(1,121) = 22.52, p < 0.001, \eta_p^2 = .16$
Bodily observing	9.48 (2.65)	9.43(2.56)	9.68(2.36)	10.34 (1.73)	$F < 1$	$F(1,121) = 7.46, p < 0.01, \eta_p^2 = .06$
Emotional observing	10.47 (2.30)	10.42 (1.97)	10.36 (2.21)	11.18 (1.74)	$F < 1$	$F(1,121) = 7.47, p < 0.01, \eta_p^2 = .06$
Acting with awareness	26.38 (5.99)	26.96 (5.62)	26.96 (5.62)	30.71 (5.06)	$F < 1$	$F(1,121) = 22.87, p < 0.001, \eta_p^2 = .16$
Describing	27.15 (6.30)	27.72 (6.28)	27.00 (6.53)	29.08 (5.96)	$F < 1$	$F(1,121) = 5.17, p = 0.025, \eta_p^2 = .04$
Accepting	32.65 (8.34)	34.63 8.15)	29.70 (8.59)	34.99 (8.39)	$F = 2.33, p = 0.129$	$F(1,121) = 5.32, p = 0.023, \eta_p^2 = .04$
ESM PA	3.95 (0.80)	3.85 (0.92)	3.77 (0.81)	4.17 (0.91)	$F = 2.03, p = 0.157$	$F(1,115) = 14.10, p < 0.001, \eta_p^2 = .11$

Data are mean (standard deviation) values

ESM PA positive affect average during experience sampling

observing only, similar to results reported for the ESM PA. In contrast, the superiority of MBCT-D over the control in repairing TEPS anticipatory pleasure was uniquely mediated by reduced levels of acting with awareness.

Discussion

A secondary analysis of the Geschwind et al. (2011) trial was conducted to examine whether change in individual mindfulness facets was associated with the superiority of MBCT-D over a waitlist control condition in building momentary PA. Replicating Rudkin et al. (2018), a confirmatory factor analysis of the KIMS mindfulness scale revealed that the observing facet could be divided into sensory, bodily, and emotional components. Therefore, all subsequent mediation analyses used the revised six-factor solution (describing, accepting, awareness, bodily observing, sensory observing, and emotional observing).

Individuals in the MBCT-D group showed comparable levels of PA at baseline and superior levels of PA at post-treatment, compared to the waitlist control condition (cf., Geschwind et al., 2011). As expected, MBCT-D led to a significant increase in KIMS score on all six factors, relative to the waitlist control condition. In the individual mediation analyses, the superiority of MBCT-D over waitlist control in increasing momentary PA was concurrently mediated by a significantly greater increase in sensory observing and accepting. In the more stringent multiple mediation analyses looking at the unique mediating relationship of each factor over and above the other factors (as recommended by Hayes & Rockwood, 2017), only sensory observing was a significant mediator.

Overall, these findings indicate improvements in daily PA during MBCT-D are uniquely associated with increases in sensory observing. However, these findings should be viewed as tentative and preliminary as they emerged from an exploratory post hoc analysis. Is it important to establish if these findings will be replicated in other RCTs. Study 2 therefore conducted a secondary analysis of a trial comparing the relapse prevention effects of MBCT-D in 424 individuals with a history of recurrent depression who were not currently in episode (Kuyken et al., 2015). This trial also included a self-report questionnaire of PA (various subscales of the Dispositional Positive Emotion Scale; Shiota et al., 2006) as a secondary outcome and the FFMQ as a measure of dispositional mindfulness, making it possible to replicate the Study 1 analyses. To ensure this was as close a replication as possible, we focused solely on the subgroup of clients in trial with residual symptoms of depression (using the same HDRS cut-off as reported by Geschwind et al., 2011).

On the basis of the findings from Geschwind et al. (2011), we predicted that MBCT-D would be superior to treatment as usual in building PA in the subgroup of individuals with residual depression symptoms. On the basis of the results observed in Study 1, we hypothesised that only sensory observing will uniquely mediate the superiority of MBCT-D in repairing PA compared to the control group.

Study 2

Method

Participants

The PREVENT trial recruited 424 UK adults with a previous history of at least three episodes of depression who did not currently meet criteria for a major depressive episode but were currently taking a therapeutic dose of maintenance antidepressants.

We focus here in the subgroup of individuals with residual depression symptoms scoring 7 or higher on the GRID-HDRS to align the current sample with participants recruited in Geschwind et al. (2011). Fifty-nine participants in the M-ADM arm and 58 participants in the MBCT-D group met this criterion. In this subset, the sample was predominantly female (81%) and entirely of White ethnic origin and had a mean age of 51 (SD = 11.43), a mean depression score on the GRID-HDRS of 10.52 (SD = 3.23), and a mean depression score on the Beck Depression Inventory Revised (BDI-II; Beck et al., 1996) of 19.97 (SD = 9.80).

Procedure

Participants were randomised in a 1:1 ratio to maintenance antidepressant treatment (M-ADM) or to an 8-week course of MBCT-D. MBCT-D followed the treatment protocol described by Segal et al. (2012). In addition, participants were given support by their MBCT-D therapist and GP about how to taper or discontinue medication (following best-practice guidelines about discontinuation regimes and possible withdrawal effects). Those in the M-ADM group were supported via their general practitioners to maintain a therapeutic dose of antidepressants over the 2-year follow-up period. Participants were assessed at baseline (prior to randomisation), post-treatment (1 month after the end of the MBCT-D programme or the equivalent time in the M-ADM group; varying between 12 and 24 weeks post-randomisation), and at 9, 12, 18, and 24 months post-randomisation. Independent assessors were blind to allocation status for the duration of the follow-up. The trial was pre-registered and approved by the UK National Health Service South West Research Ethics Committee (09/H0206/43), and all participants gave written informed consent to take part. For a full summary of inclusion and exclusion criteria, sample characteristics,

treatment conditions, and fidelity assessments, see Kuyken et al. (2010) and Kuyken et al. (2015).

Measures

The measure of PA was a composite of subscales from the Dispositional Positive Emotions Scale (DPES; Shiota et al., 2006), which ask participants to rate to what extent they agree with a variety of statements about experience of positive emotions. We chose to focus on the joy subscale (six items; e.g. "On a typical day, many events make me happy") and the contentment subscale (five items; e.g. "I am generally a contented person"), as these correspond to high and low arousal PA respectively. Each item was rated on a scale from 1 (strongly disagree) to 5 (strongly agree). This a minor modification to the original DPES validation papers (Shiota et al., 2006), where each item was rated on a scale from 1 (strongly disagree) to 7 (strongly agree), meaning the current data cannot be directly benchmarked against existing normative data on the DPES. We set aside the love subscale (six items; e.g. "I can depend on people when I need help") and compassion scales (five items; e.g. "When I see someone in hurt or need, I feel a powerful urge to take care of them") as these are measures of positive social emotions and moves beyond how anhedonia is conceptualised in depression. We also set aside the awe subscale (six items, e.g. "I see beauty all around me") which measures the tendency to feel awe toward the world in general. While this aligns to some extent with high arousal PA, it also has significant conceptual overlap with the sensory observing subscale. Scale internal reliability for the combined DPES joy and contentment scale (subsequently referred to as "DPES PA") was good in the current sample (intake $\alpha = 0.90$).

The 39-item FFMQ (Baer et al., 2006) was used to assess dispositional mindfulness at each assessment point. Items measure the same underlying subscales as the KIMS, with the modification that the acceptance factor is labelled "non-judging" and it incorporates one additional non-reacting factor (for example, "I perceive my feelings and emotions without having to react to them"). Each item is rated on a 5-point Likert-type scale indicating to what extent it is generally true of them, ranging from 1 (*never or very rarely true*) to 5 (*very often or always true*), and items on each subscale are reversed where appropriate and then summed (with higher scores indicating greater dispositional mindfulness). Internal reliability was at least adequate for all five facets in the current sample (intake $\alpha \geq 0.76$).

Data Analyses

DPES data were available on 111 participants (54 in M-ADM, 57 in MBCT-D) at intake and 96 participants (46 in ADM, 50 in MBCT-D) at post-treatment. FFMQ data were available on 110 participants (54 in M-ADM, 56 in MBCT-D) at intake and 96 participants (46 in M-ADM, 50 in MBCT-D) at post-treatment. In the mediation analysis, 93 participants (43 in M-ADM, 50 in MBCT-D) had complete FFMQ and DPES data at intake and post-treatment.

Analysis largely mirrored Study 1. First, we conducted a confirmatory factor analysis on the observe subscale of the FFMQ to establish if the original factor structure or a modified structure was a better fit. The FFMQ observe scale has a smaller number of items than the KIMS (five items measuring sensory observing but only two items measuring bodily observing and one item cross-loading on both). It is possible, but relatively unlikely, that a stable factor could emerge from the two bodily observing items. Therefore, we compared three models: the original FFMQ observe scale of eight items; a two-factor model of separate sensory-observing (five items) and bodily-observing (two items) components; and a five-item sensory-observing subscale model only. Second, Pearson's correlation coefficients were used to explore the zero-order relationships between all FFMQ factors at baseline. Third, ANCOVAs examined if the groups differed on key variables at intake, covarying for recruitment site given that this was the stratification variable in the original trial. ANCOVAs also explored if groups differed at post-treatment, additionally covarying for intake levels on each dependent variable. The PROCESS macro was used to examine if changes in the mindfulness facets concurrently mediated improvements in DPES PA, both when considered individually and when entered into multiple mediation models.

Results

Confirmatory factor analysis on the FFMQ observing scale supported the use of the five-item sensory observing scale. The model fit was better for the model using the five-item scale compared to both the model using the standard eight-item single factor or the model incorporating separate bodily and sensory observing subscales. In particular, the five-item sensory observing model had a lower RMSEA and higher CFI value than the other models (see SOM Table S5). Moreover, the five-item single factor model was the only model that met criteria for adequate overall model fit (RMSEA = 0.07 and CFI = 0.98) and for which all individual item factor loadings were adequate (> 0.60; see SOM Table S6). The five-item scale also had adequate internal reliability ($\alpha = 0.78$). Therefore, we replaced the standard FFMQ observing scale with the five-item sensory observing scale in all subsequent analyses. The individual items on the sensory observing subscale are identical to the one derived from the KIMS in Study 1.

Table 4 reports associations between the FFMQ factors. The strength of these associations varied from negligible to medium effect sizes (r-values ranging from 0.07 to 0.38), consistent with the view that they are sufficiently distinct constructs to be entered as independent mediators in subsequent analyses.

Table 4 Pearson's correlation coefficients between Five Facet Mindfulness Questionnaire (FFMQ) factors in Study 2

FFMQ factor	1	2	3	4	5
Sensory observing (1)	1				
Acting with awareness (2)	−0.04	1			
Describing (3)	0.23*	0.10	1		
Non-judging (4)	−0.05	0.32***	0.12	1	
Non-reacting (5)	0.38***	0.07	0.21*	0.17	1

***$p<0.001$; **$p<0.01$; *$p<0.05$

Table 5 reports baseline and post-treatment levels of all variables and the results of analyses comparing them. As intended, the groups did not differ at baseline on any of the mindfulness facets or the DPES PA outcome, ANCOVA $F \leq 2.69$, $p \geq 0.10$. Levels of the FFMQ factors sensory observing, non-reacting, and non-judging FFMQ factors were greater at post-treatment in the MBCT-D relative to the M-ADM group, ANCOVA $F \geq 6.83$, $p \leq 0.01$ (the XM path in the mediation analyses). There were no group differences for the acting with awareness and describing FFMQ factors at post-treatment ($F \leq 2.12$ $p \geq 0.15$). There were significantly higher DPES PA scores in the MBCT-D group compared to the M-ADM group at post-treatment, ANCOVA $F=4.90$, $p=0.03$ (the XY path in the mediation analyses).

We then conducted mediation analyses to test our central hypothesis that change in FFMQ factors would account for differences in change in DPES PA from pre- to post-treatment between the MBCT-D and the M-ADM group. In the individual mediation models (top panel of Table 6), the indirect effect was significant for the sensory observing, non-reacting, and non-judging FFMQ factors (zero not included in 95% confidence interval of the indirect test) but not for describing and acting with awareness FFMQ factors (as zero fell in the 95% confidence intervals). In the more conservative multiple mediation model (bottom panel of Table 6), the unique indirect effect was significant only for sensory observing. In other words, the superiority of MCBT-D over M-ADM in building PA was associated with a greater enhancement of sensory observing.

Table 6 Study 2 Five Facet Mindfulness Questionnaire (FFMQ) mediation analysis

FFMQ factor	Mean (*SE*)	95% CI [LL, UL]
Individual mediation		
Sensory observing	1.21 (0.56)	[0.23, 2.43]*
Acting with awareness	0.78 (0.65)	[−0.40, 2.16]
Describing	0.77 (0.64)	[−0.40, 2.12]
Non-reacting	1.31 (0.54)	[0.31, 2.46]*
Non-judging	1.52 (0.60)	[0.43, 2.78]*
Multiple mediation		
Total	2.56 (1.05)	[0.72, 4.80]*
Sensory observing	0.75 (0.45)	[0.04, 1.78]*
Acting with awareness	0.40 (0.45)	[−0.22, 1.53]
Describing	0.30 (0.37)	[−0.24, 1.18]
Non-reacting	0.46 (0.49)	[−0.54, 1.47]
Non-judging	0.66 (0.52)	[−0.14, 1.90]

Number of bootstrap samples was set to 10,000. Seed value was set to 12,709,182

CI confidence interval, *LL* lower limit, *UL* upper limit

*Zero not included in the confidence interval, meaning a significant mediation ($p<0.05$)

Discussion

Study 2 replicated the findings of Study 1 in a different sample. Individuals with residual depression symptoms in the MBCT-D group showed superior DPES PA levels at post-treatment compared to the M-ADM group. The superiority of MBCT-D in increasing PA was uniquely mediated by increases in sensory observing only.

Table 5 Mindfulness and affective experience at baseline and post-treatment in each condition and the results of tests comparing conditions in Study 2

Measure	M-ADM		MBCT-D		Baseline ANCOVA	Baseline post-ANCOVA
	Baseline	Post	Baseline	Post		
Sensory observing	16.11 (3.81)	16.75 (4.05)	16.34 (4.41)	18.32 (3.71)	$F<1$	$F=7.78$, $p=0.006$, $\eta_p^2=0.08$
Acting with awareness	21.98 (4.01)	22.41 (4.49)	22.90 (4.56)	24.00 (4.46)	$F<1$	$F=2.12$, $p=0.149$, $\eta_p^2=0.03$
Describing	22.34 (6.91)	23.64 (6.92)	24.10 (6.57)	26.20 (7.48)	$F=1.55$, $p=0.216$	$F=1.55$, $p=0.217$, $\eta_p^2=0.02$
Non-judging	23.07 (5.95)	22.89 (5.99)	23.14 (6.47)	26.18 (6.31)	$F<1$	$F=6.83$, $p=0.011$, $\eta_p^2=0.07$
Non-reacting	18.68 (4.42)	19.77 (4.16)	18.64 (4.85)	21.82 (4.19)	$F<1$	$F=7.58$, $p=0.007$, $\eta_p^2=0.08$
DPES PA	28.69 (6.37)	28.23 (7.99)	30.15 (6.71)	32.06 (8.18)	$F=2.69$, $p=0.104$	$F=4.90$, $p=0.029$, $\eta_p^2=0.05$

Data are mean (standard deviation) values

DPES PA positive affect assessed using the Dispositional Positive Emotions Scale

General Discussion

In two secondary analyses, it was examined if the superiority of MBCT-D over a control group in repairing PA is associated with increases in specific mindfulness facets. In Study 1 (secondary analysis on Geschwind et al., 2011), MBCT-D was compared to a waitlist control group in individuals with residual depression using ESM to assess PA and the KIMS to assess dispositional mindfulness levels (i.e. describing, accepting, acting with awareness, observing) before and after the intervention. In Study 2 (secondary analysis of Kuyken et al., 2015), MBCT-D was compared to M-ADM in individuals with residual depression using the joy and contentment DPES subscales to assess PA and the FFMQ to assess mindfulness level (i.e. describing, acting with awareness, non-reacting, non-judging, observing) before and after the intervention.

In Study 1, MBCT-D was more effective at bolstering PA than the waitlist control group (cf., Geschwind et al., 2011). In line with Study 1 and Geschwind et al. (2011), Study 2 demonstrated that MBCT-D increased PA relative to the M-ADM group immediately post-treatment. MBCT-D led to significant increases in all KIMS mindfulness facets (Study 1) and in the sensory observing, non-judging, and non-reacting FFMQ mindfulness facets (Study 2). In both studies, cross-sectional mediation analyses using PROCESS revealed that increases in PA were uniquely positively mediated by sensory observing only. The analysis in Study 1 was exploratory and post hoc so should be interpreted tentatively. However, the fact that this effect was replicated in Study 2 (where an a priori hypothesis was set that sensory observing would mediate PA outcomes on the basis of Study 1) increases conviction in this result and suggests it is unlikely to be a false-positive effect. Moreover, the fact the same pattern emerged in different samples using different measures of PA and mindfulness indicates that this result is likely to generalise across samples and is unlikely to be an artefact of the particular measures chosen.

That MBCT-D increased positive emotionality in two separate RCTs further supports claims that mindfulness practices can be helpful to repair anhedonia in depression. However, in neither sample was positive affect fully optimised for all individuals. The MBCT-D curriculum still has a predominant focus on reducing unhelpful reactivity to negative mood, and only a handful of sessions explicitly target reward processing. There is scope to further refine the MBCT-D curriculum to more systematically target anhedonia in depression, for example, via integrating elements from the Mindfulness-Based Cognitive Therapy for Life curriculum that help develop the capacity to savour (Strauss et al., 2021).

The fact that increases in sensory observing uniquely mediate increases in PA is consistent with basic science findings that increasing experiential processing bolsters positive-affective experience during a range of positive mood inductions in the laboratory (Gadeikis et al., 2017; Nelis et al., 2015). In both studies, the mediation analyses were cross-sectional, meaning that temporal precedence was not established and the findings are associations only. This precludes any strong inferences being made regarding the direction and causality of the relationship observed. Nevertheless, the current findings are consistent with the possibility that one causal pathway through which mindfulness enhances PA is via increases in sensory observing.

The present findings clearly indicate that a general mindfulness observe facet can be fractionated into distinctive subfactors, replicating findings of Rudkin et al. (2018). Results of confirmatory factor analyses on the KIMS and FFMQ support the use of a three-factor observe structure in the KIMS (sensory, bodily, and emotional observing) and a replacement of the standard observe factor by a better fitting sensory observe factor in the FFMQ. This underlines the need for mindfulness scales to distinguish between different types of observing that may relate differently to measures of psychopathology and wellbeing. That previous studies have focused on a global observing scale rather than these distinct components may explain why inconsistent relationships have been found between levels of dispositional observing and clinical outcomes in previous association research (e.g. Baer et al., 2006, 2008; Barnhofer et al., 2011; Brown et al., 2015; Cash & Whittingham, 2010; Curtiss & Klemanski, 2014; Desrosiers et al., 2013). Based on our results, sensory observing seems to be the most validated subscale of a general observing factor as it could be robustly extracted from the KIMS as well as from the FFMQ, whereas the other two observing factors had only very few or no items in both scales. We recommend future studies to use the extended pool of observing items reported in Rudkin et al. (2018) to reliably assess all three facets of observing.

Subsequent replication of these findings in designs that do meet temporal precedence criteria would have a number of clinical implications. First, if the goal in a particular mindfulness practice is to help individuals reconnect to PA, it may be beneficial to use external sensory experience (rather than internal bodily or emotional experience) as the anchor for meditation practice. Examples are exercises that promote awareness of sights, sounds, tastes, and smells (Park et al., 2011). There is potential to integrate these exercises into everyday life, for example, mindful awareness of the senses during positive activity scheduling like a pleasant walk (cf., Gotink et al., 2016). Mindful awareness of everyday activities is already part of the MBCT-D programme in week two (Segal et al., 2012), but then, the predominate focus moves to internal bodily awareness during practice in subsequent sessions. To better bolster PA, external sensory awareness could be a focus throughout the course and could be specifically directed at activities that are likely to be pleasurable. This point is also consistent with the emphasis

on connecting individuals to sensory experience in a range of other therapeutic approaches, including sensory-perceptual sharpening exercises in the savouring literature (Bryant & Veroff, 2007).

While caution should be exercised when interpreting null findings, especially given the modest sample sizes in the present studies, it is nevertheless noteworthy no other dispositional mindfulness factors apart from sensory observing significantly uniquely individually mediated improvements in PA during MBCT. The present study focused solely on the subset of individuals receiving MBCT who have residual depression symptoms. Further research is warranted to examine if similar null findings emerge when looking at larger sample sizes of individuals receiving MBCT (irrespective of residual symptom status) to see if these findings replicate.

It is also important to acknowledge that mindfulness programmes like MBCT are just one of a number of emerging interventions that may be effective at building PA in clinical populations. For example, there is emerging evidence that a range of individual and group therapies can also to some extent repair PA, including behavioural activation (Alsayednasser et al., 2022; Carl et al., 2016; Nagy et al., 2020), CBT (Dunn et al., 2020; Alsayednasser et al., 2022), mindfulness-oriented recovery enhancement (Garland et al., 2021), positive affect treatment (Craske et al., 2019), positive CBT (Geschwind et al., 2019), augmented depression therapy (Dunn et al., 2019), and group positive CBT (Chaves et al., 2017). Many of these interventions include elements that focus on positive affect. It is important that mechanisms research clearly articulates theorised mechanisms of change, and which components of the treatment might target these mechanisms, and then design studies that can test these hypothesised mechanisms of action. The present findings suggest that changes in experiential processing are one candidate mechanism of change in these treatments that is worthy of further investigation.

Limitations and Future Research

A series of limitations needs to be evaluated when interpreting the present results. Most importantly, the mediations are cross-sectional and therefore cannot robustly test a causal mechanistic pathway. What is now needed is further research that does meet temporal precedence criteria (Alsubaie et al., 2017; Kraemer et al., 2002). This research should ideally deploy methods that can capture a dynamic process of change where mechanism and outcome influence each other reciprocally over time (e.g. cross-lagged mediation analyses when outcome and mechanism are measured intensively over time (Garland et al., 2015; Shoham et al., 2017). In addition, other methods should also be used to test if changes in sensory observing causally change PA. This includes use of manipulation designs in laboratory and real-world settings that deploy pure manipulations of sensory observing, rather than sensory observing being one component of a multifaceted intervention (cf., Dunn, 2017).

A second limitation is that in both analyses we focus solely on individuals with residual depression symptoms with a history of major depression but not currently in episode. It needs to be established if similar findings emerge when looking at individuals who currently meet criteria for clinical depression. Third, the studies had better coverage of sensory observing than emotional and bodily observing. While in Study 1 all three factors could be extracted, the KIMS bodily and emotional observing subscales (each three items) had only lower reliability than the five-item sensory observing subscales (likely driven by the difference in number of items). It cannot be ruled out that the null results in mediation analyses for the bodily and emotional subscales are an artefact of this lower reliability. In Study 2, only sensory observing could be extracted. It therefore remains unclear if and how changes in bodily and emotional observing relate to anhedonia.

A fourth limitation is the studies were not optimally powered to test subtler mediation effects. It is plausible that some of the other dispositional mindfulness factors would also be shown to be significant mediators if a larger sample size had been studied. Inspection of the confidence intervals suggests the KIMS accepting factor (95% CI [−0.02, 0.14]) was not far off from significance for the ESM PA multiple mediation model in Study 1. Intriguingly, the KIMS bodily observing factor was not far from significance for ESM PA in the reverse direction (95% CI [−0.11, 0.02]). In other words, a greater increase in bodily observing in MBCT-D relative to waitlist control may actually lead to a lowering of PA in the active treatment condition. Similarly, low sample size and power may explain why in Study 2 MBCT-D did not significantly increase levels of FFMQ describing and acting with awareness. Fifth, the present work exclusively focuses on changes in underlying components of trait mindfulness. It does not, however, shed any light on which particular mindfulness practices about these changes (for example, use of mindfulness of everyday activities or a positive events calendar).

Sixth, we have focused solely on PA experience. It would be useful for future work to consider eudemonic wellbeing as well as hedonic wellbeing. Seventh, the MBCT-D arm in Study 2 also invited participants to taper from antidepressant medication. There was not sufficient power to examine whether the decision to taper or not changed the nature of the associations observed. Eighth, the present studies use two different measures of mindfulness (the KIMS in Study 1 and the FFMQ in Study 2) in two different languages (Dutch in Study 1, English in Study 2). On the one hand, it is a strength of the present findings that they generalise across

measures and languages. On the other hand, it is conceivable that the use of different scales in different languages means that the various mindfulness facets represent slightly different conceptual constructs. Ninth, in Study 1, we collapsed data across beeps and days to create a composite measure of positive affect. This has the advantage of being easier to interpret and also aligns with the approach taken in Study 2, but is at risk of ignoring within-individual variability in PA across time. Tenth, ethnicity data was only available in Study 2, and indicated the sample all reported their ethnic origin as White. It therefore remains unclear if these findings generalise to other ethnicities. It is conceivable that sensory observing may have a different relationship to affective experience in groups of individuals exposed to macro- and micro-aggressions on the basis of minority ethnic status, as elevations in observing could instead reflect increased vigilance to external threat. Similarly, the samples were predominantly of female gender. Whether or not individual differences in demographics moderate the extent to which experiential processing mediates improvements in PA during mindfulness interventions should be further examined in future research. Finally, the present studies have concentrated solely on how MBCT-D repairs PA in depression and it would be useful to also examine other mindfulness programmes in future research (e.g. loving-kindness practices; Hofmann et al., 2015).

In summary, the present study demonstrates that the capacity of MBCT-D to enhance positive emotion experience in those with residual depression symptoms is associated with the extent to which individuals learn to pay greater attention to their external sensory experience. This resonates with a broader theoretical and empirical literature emphasising that experiential processing builds positive mood. Findings are consistent with the hypothesis that MBCT-D may help individuals to "stop and smell the roses", and it is this that may increase their capacity to experience pleasure in everyday life. What is now needed is further research using mediation designs that meet temporal precedence criteria to test this hypothesis more robustly.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12671-022-02032-0.

Acknowledgements The views expressed in this article are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care.

Author Contribution BD designed and executed the secondary analyses, co-performed the analyses, and co-wrote the original and revised manuscripts; MK and HW co-performed the analyses and co-wrote the original and revised manuscripts; RH and WK designed and executed the trial that was analysed in Study 2, and commented on the original and revised manuscripts. FP, MW, and NG collaborated in the secondary analysis design, designed and executed the trial that was analysed in Study 1, and commented on the original and revised manuscripts.

Funding This secondary analysis was not funded. The original trial analysed in Study 1 was supported by the Dutch Research Council (VENI grant nr 916.76.147 to MW). The original trial analysed in Study 2 was funded by a UK National Institute for Health Research (NIHR) Health Technology Assessment (HTA) programme (HTS 08/56/01; MBCT 2009) and via the NIHR Collaboration for Leadership in Applied Research and Care South West. Merle Kock is supported by an FWO PhD fellowship (11I1622N).

Data Availability Access to the dataset for Study 1 can be requested from NG (Nicole.geschwind@maastrichtuniversity.nl). Access to the dataset for Study 2 can be requested from WK (willem.kuyken@psych.ox.ac.uk).

Declarations

Ethical Approval Ethical approval for Study 1 was given by the Medical Ethics Committee of Maastricht University Medical Centre (NL17751.068.07 / MEC 07–3-060). Ethical approval for Study 2 was given by the UK National Health Service South West Research Ethics Committee (09/H0206/43), and research governance approval was given by local primary care trusts or health boards.

Informed Consent All participants in both studies gave written informed consent.

Conflict of Interest The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

Alsayednasser, B., Widnall, E., O'Mahen, H., Wright, K., Warren, F., Ladwa, A., et al. (2022). How well do cognitive behavioural therapy (CBT) and behavioural activation (BA) for depression repair anhedonia: A secondary analysis of the COBRA randomised controlled trial. *Behaviour Research & Therapy, 159*, 104185. https://doi.org/10.1016/j.brat.2022.104185

Alsubaie, M., Abbot, R., Dunn, B., Dickens, C., Henley, W., & Kuyken, W. (2017). Mechanisms of action of mindfulness-based cognitive therapy (MBCT) and mindfulness-based stress reduction (MBSR) in people with physical and/or psychological conditions: A systematic review. *Clinical Psychology Review, 55*, 74–91. https://doi.org/10.1016/j.cpr.2017,04.008

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5)* (5th ed). American Psychiatric Publishing, Inc. https://doi.org/10.1176/appi.books.9780890425596

Baer, R. A., Smith, G. T., & Allen, K. B. (2004). Assessment of mindfulness by self-report. *Assessment, 11*(3), 191–206. https://doi.org/10.1177/1073191104268029

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*(1), 27–45. https://doi.org/10.1177/1073191105283504

Baer, R. A., Smith, G. T., Lykins, E., Button, D., Krietemeyer, J., Sauer, S., Walsh, E., Duggan, D., & Williams, J. M. G. (2008). Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment, 15*(3), 329–342. https://doi.org/10.1177/1073191107313003

Barnhofer, T., Duggan, D. S., & Griffith, J. W. (2011). Dispositional mindfulness moderates the relation between neuroticism and depressive symptoms. *Personality and Individual Differences, 51*(8), 958–962. https://doi.org/10.1016/j.paid.2011.07.032

Baum, C., Kuyken, W., Bohus, M., Heidenreich, T., Michalak, J., & Steil, R. (2010). The psychometric properties of the Kentucky Inventory of Mindfulness Skills in clinical populations. *Assessment, 17*(2), 220–229. https://doi.org/10.1177/1073191109356525

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck depression inventory-II* (2nd ed.). Psychological Corporation.

Bress, J. N., Foti, D., Kotov, R., Klein, D. N., & Hajcak, G. (2013). Blunted neural response to rewards prospectively predicts depression in adolescent girls. *Psychophysiology, 50*(1), 74–81. https://doi.org/10.1111/j.1469-8986.2012.01485.x

Brown, D. B., Bravo, A. J., Roos, C. R., & Pearson, M. R. (2015). Five facets of mindfulness and psychological health: Evaluating a psychological model of the mechanisms of mindfulness. *Mindfulness, 6*(5), 1021–1032. https://doi.org/10.1007/s12671-014-0349-4

Bryant, F. B., & Veroff, J. (2007). *Savoring: A new model of positive experience*. Lawrence Erlbaum Associates Publishers. https://doi.org/10.4324/9781315088426

Carl, H., Walsh, E., Eisenlohr-Maul, T., Minkel, J., Crowther, A., Moore, T., Gibbs, D., Petty, C., Bizzell, J., Dichter, G. S., & Smoski, M. J. (2016). Sustained anterior cingulate cortex activation during reward processing predicts response to psychotherapy in major depressive disorder. *Journal of Affective Disorders, 203*, 204–212. https://doi.org/10.1016/j.jad.2016.06.005

Cash, M., & Whittingham, K. (2010). What facets of mindfulness contribute to psychological well-being and depressive, anxious and stress-related symptomatology? *Mindfulness, 1*(3), 177–182. https://doi.org/10.1007/s12671-010-0023-4

Chaves, C., Lopez-Gomez, I., Hervas, G., & Vazquez, C. (2017). A comparative study on the efficacy of a positive psychology intervention and a cognitive behavioral therapy for clinical depression. *Cognitive Therapy and Research, 41*, 417–433. https://doi.org/10.1007/s10608-016-9778-9

Craske, M. G., Meuret, A. E., Ritz, T., Treanor, M., Dour, H., & Rosenfield, D. (2019). Positive affect treatment for depression and anxiety: A randomized clinical trial for a core feature of anhedonia. *Journal of Consulting and Clinical Psychology, 87*, 457–471. https://doi.org/10.1037/ccp0000396

Csikszentmihalyi, M., & Larson, R. (1987). The experience sampling method: Toward a systematic phenomenology. *Journal of Nervous and Mental Disease, 175*(9), 526–536.

Curtiss, J., & Klemanski, D. H. (2014). Factor analysis of the five facet mindfulness questionnaire in a heterogeneous clinical sample. *Journal of Psychopathology and Behavioral Assessment, 36*(4), 683–694. https://doi.org/10.1007/s10862-014-9429-y

Delespaul, P. (1995). *Assessing schizophrenia in daily life: The experience sampling method*. University of Maastricht.

Demyttenaere, K., Donneau, A. F., Albert, A., Ansseau, M., Constant, E., & van Heeringen, K. (2015). What is important in being cured from depression? Discordance between physicians and patients. *Journal of Affective Disorders, 174*, 390–396. https://doi.org/10.1016/j.jad.2014.12.004

Desrosiers, A., Klemanski, D. H., & Nolen-Hoeksema, S. (2013). Mapping mindfulness facets onto dimensions of anxiety and depression. *Behaviour Therapy, 44*(3), 373–384. https://doi.org/10.1016/j.beth.2013.02.001

Desrosiers, A., Vine, V., Curtiss, J., & Klemanski, D. H. (2014). Observing nonreactively: A conditional process model linking mindfulness facets, cognitive emotion regulation strategies, and depression and anxiety symptoms. *Journal of Affective Disorders, 165*, 31–37. https://doi.org/10.1016/j.jad.2014.04.024

Dunn, B. D. (2012). Helping depressed clients reconnect to positive emotion experience: Current insights and future directions. *Clinical Psychology & Psychotherapy, 19*(4), 326–340. https://doi.org/10.1002/cpp.1799

Dunn, B. D. (2017). Opportunities and challenges for the emerging field of positive emotion regulation: A commentary on the special edition on positive emotions in psychopathology. *Cognitive Therapy and Research, 41*(3), 469–478. https://doi.org/10.1007/s10608-017-9831-3

Dunn, B. D. (2019). Augmenting cognitive behavioral therapy to build positive mood in depression. In J. Gruber (Ed.), *The Oxford Handbook of Positive Emotion and Psychopathology* (pp. 539–560). Oxford University Press.

Dunn, B. D., & Roberts, H. (2016). Improving the capacity to treat depression using talking therapies: Setting a positive clinical psychology agenda. In A. Wood & J. Johnson (Eds.), *The Wiley handbook of positive clinical psychology* (pp. 183–204). https://doi.org/10.1002/9781118468197.ch13

Dunn, B. D., Widnall, E., Reed, N., Owens, C., Campbell, J., & Kuyken, W. (2019). Bringing light into darkness: A multiple baseline mixed methods case series evaluation of Augmented Depression Therapy (ADepT). *Behaviour Research and Therapy, 120*, 103418. https://doi.org/10.1016/j.brat.2019.103418

Dunn, B. D., German, R. E., Khazanov, G., Xu, C. L., Hollon, S. D., & DeRubeis, R. J. (2020). Changes in positive and negative affect during pharmacological treatment and cognitive therapy for major depressive disorder: A secondary analysis of two randomized controlled trials. *Clinical Psychological Science, 8*(1), 36–51. https://doi.org/10.1177/21677026198634

Easterlin, B. L., & Cardeña, E. (1998). Cognitive and emotional differences between short-and long-term Vipassana meditators. *Imagination, Cognition and Personality, 18*(1), 69–81. https://doi.org/10.2190/21GX-R4TD-XMD4-6P2W

Erisman, S. M., & Roemer, L. (2010). A preliminary investigation of the effects of experimentally induced mindfulness on emotional responding to film clips. *Emotion, 10*(1), 72–82. https://doi.org/10.3758/s13415-012-0092-z/10.1037/a0017162

Gadeikis, D., Bos, N., Schweizer, S., Murphy, F., & Dunn, B. D. (2017). Engaging in an experiential processing mode increases positive emotional response during recall of pleasant autobiographical memories. *Behaviour Research and Therapy, 92*, 68–76. https://doi.org/10.1016/j.brat.2017.02.005

Gard, D. E., Gard, M. G., Kring, A. M., & John, O. (2006). Anticipatory and consummatory components of the experiences of pleasure: A scale development study. *Journal of Research in Personality, 40*(6), 1086–1102. https://doi.org/10.1016/j.jrp.2005.11.001

Garland, E. L., Geschwind, N., Peeters, F., & Wichers, M. (2015). Mindfulness training promotes upward spirals of positive affect and cognition: Multilevel and autoregressive latent trajectory modeling analyses. *Frontiers in Psychology, 6*, 15. https://doi.org/10.3389/fpsyg.2015.00015

Garland, E., Fix, S. T., Hudak, J. P., Bernat, E. M., Nakamura, Y., Hanley, A. W., Donaldson, G. W., Marchand, W. R., & Froeliger, B. (2021). Mindfulness-oriented recovery enhancement remediates anhedonia in chronic opioid use by enhancing neurophysiological

responses during savoring of natural rewards. *Psychological Medicine*. https://doi.org/10.1017/S0033291721003834

Geschwind, N., Peeters, F., Drukker, M., van Os, J., & Wichers, M. (2011). Mindfulness training increases momentary positive emotions and reward experience in adults vulnerable to depression: A randomized controlled trial. *Journal of Consulting and Clinical Psychology, 79*(5), 618–628. https://doi.org/10.1037/a0024595

Geschwind, N., Arntz, A., Bannink, F., & Peeters, F. (2019). Positive cognitive behavior therapy in the treatment of depression: A randomized order within-subject comparison with traditional cognitive behavior therapy. *Behaviour Research and Therapy, 116*, 119–130. https://doi.org/10.1016/j.brat.2019.03.005

Gotink, R., Karlijn, H., Geschwind, N., De Nooij, R., De Groot, W., & Speckens, A. (2016). Mindfulness and mood stimulate each other in an upward spiral: A mindful walking intervention using experience sampling. *Mindfulness, 7*(5), 1114–1122. https://doi.org/10.1007/s12671-016-0550-8

Hamilton, M. (1960). A rating scale for depression. *Journal of Neurology, Neurosurgery, and Psychiatry, 23*(1), 56–62. https://doi.org/10.1136/jnnp.23.1.56

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. The Guilford Press.

Hayes, A. F., & Rockwood, N. J. (2017). Regression-based statistical mediation and moderation analysis in clinical research: Observations, recommendations, and implementation. *Behaviour Research and Therapy, 98*, 39–57. https://doi.org/10.1016/j.brat.2016.11.001

Hofmann, S. G., Petrocchi, N., Steinberg, J., Lin, M., Arimitsu, K., Kind, S., Mendes, A., & Stangier, U. (2015). Loving-kindness meditation to target affect in mood disorders. A proof-of-concept study. *Evidence-Based Complementary and Alternative Medicine, 2015*. https://doi.org/10.1155/2015/269126

Holmes, E. A., Mathews, A., Dalgleish, T., & Mackintosh, B. (2006). Positive interpretation training: Effects of mental imagery versus verbal training on positive mood. *Behavior Therapy, 37*(3), 237–247. https://doi.org/10.1016/j.beth.2006.02.002

Holmes, E. A., Lang, T. J., & Shah, D. M. (2009). Developing interpretation bias modification as a "cognitive vaccine" for depressed mood: Imagining positive events makes you feel better than thinking about them verbally. *Journal of Abnormal Psychology, 118*(1), 76–88. https://doi.org/10.1037/a0012590

Kabat-Zinn, J. (1994). *Wherever you go, there you are: Mindfulness meditation in everyday life*. Hyperion.

Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4th ed.). The Guilford Press.

Kraemer, H. C., Wilson, G. T., Fairburn, C. G., & Agras, W. S. (2002). Mediators and moderators of treatment effects in randomised controlled trials. *Archives of General Psychiatry, 59*, 877–883. https://doi.org/10.1001/archpsyc.59.10.877

Kuyken, W., & Dunn, B. D. (2022). Case conceptualization in mindfulness-based cognitive therapy. In T. D. Eells (Ed.), *Handbook of psychotherapy case formulation* (3rd ed., pp. 353–379). Guilford Press.

Kuyken, W., Byford, S., Byng, R., Dalgleish, T., Lewis, G., Taylor, R., Watkins, E. R., Hayes, R., Lanham, P., Kessler, D., Morant, N., & Evans, A. (2010). Study protocol for a randomized controlled trial comparing mindfulness-based cognitive therapy with maintenance anti-depressant treatment in the prevention of depressive relapse/recurrence: The PREVENT trial. *Trials, 11*, 99. https://doi.org/10.1186/1745-6215-11-99

Kuyken, W., Hayes, R., Barrett, B., Byng, R., Dalgleish, T., Kessler, D., Lewis, G., Watkins, E., Brejcha, C., Cardy, J., Causley, A., Cowderoy, S., Evans, A., Gradinger, F., Kaur, S., Lanham, P., Morant, N., Richards, J., Shah, P., … Byford, S. (2015). Effectiveness and cost-effectiveness of mindfulness-based cognitive therapy compared with maintenance antidepressant treatment in the prevention of depressive relapse or recurrence (PREVENT): A randomised controlled trial. *The Lancet, 386*(9988), 63–73. https://doi.org/10.1016/S0140-6736(14)62222-4

McMakin, D. L., Olino, T. M., Porta, G., Dietz, L. J., Emslie, G., Clarke, G., Wagner, K. D., Asarnow, J. R., Ryan, N. D., Birmaher, B., & Shamseddeen, W. (2012). Anhedonia predicts poorer recovery among youth with selective serotonin reuptake inhibitor treatment–resistant depression. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*(4), 404–411. https://doi.org/10.1016/j.jaac.2012.01.011

Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology, 110*(1), 40–48. https://doi.org/10.1037//0021-843X.110.1.40

Morgan, J. K., Olino, T. M., McMakin, D. L., Ryan, N. D., & Forbes, E. E. (2013). Neural response to reward as a predictor of increases in depressive symptoms in adolescence. *Neurobiology of Disease, 52*, 66–74. https://doi.org/10.1016/j.nbd.2012.03.039

Nagy, G., Cernasov, P., Pisoni, A., Walsh, E., Dichter, G. S., & Smoski, M. J. (2020). Reward network modulation as a mechanism of change in behavioral activation. *Behavior Modification, 44*(2), 186–213. https://doi.org/10.1177/0145445518805682

Nelis, S., Holmes, E. A., Palmieri, R., Bellelli, G., Raes, F., & Jindal, R. D. (2015). Thinking back about a positive event: The impact of processing style on positive affect. *Frontiers in Psychiatry, 6*, 3. https://doi.org/10.3389/fpsyt.2015.00003

Park, R. J., Dunn, B. D., & Barnard, P. J. (2011). Schematic models and modes of mind in anorexia nervosa II: Implications for treatment and course. *International Journal of Cognitive Therapy, 5*, 86–98. https://doi.org/10.1521/ijct.2011.4.4.415

Peeters, F., Nicolson, N. A., Berkhof, J., Delespaul, P., & deVries, M. (2003). Effects of daily events on mood states in major depressive disorder. *Journal of Abnormal Psychology, 112*(2), 203–211. https://doi.org/10.1037/0021-843X.112.2.203

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879–891. https://doi.org/10.3758/BRM.40.3.879

Raphiphatthana, B., Jose, P. E., & Kielpikowski, M. (2016). How do the facets of mindfulness predict the constructs of depression and anxiety as seen through the lens of the tripartite theory? *Personality and Individual Differences, 93*, 104–111. https://doi.org/10.1016/j.paid.2015.08.005

Rudkin, E., Medvedev, O. N., & Siegert, R. J. (2018). The Five Facet Mindfulness Questionnaire: Why the observing subscale does not predict psychological symptoms. *Mindfulness, 9*(1), 230–242. https://doi.org/10.1007/s12671-017-0766-2

Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2012). *Mindfulness-based cognitive therapy for depression: A new approach to relapse prevention* (2nd ed.). The Guilford Press.

Shankman, S. A., Nelson, B. D., Harrow, M., & Faull, R. (2010). Does physical anhedonia play a role in depression? A 20-year longitudinal study. *Journal of Affective Disorders, 120*(1), 170–176. https://doi.org/10.1016/j.jad.2009.05.002

Shiota, M. N., Keltner, D., & John, O. P. (2006). Positive emotion dispositions differentially associated with Big Five personality and attachment style. *The Journal of Positive Psychology, 1*(2), 61–71. https://doi.org/10.1080/17439760500510833

Shoham, A., Goldstein, P., Oren, R., Spivak, D., & Bernstein, A. (2017). Decentering in the process of cultivating mindfulness: An experience-sampling study in time and context. *Journal of Consulting and Clinical Psychology, 85*(2), 123–134. https://doi.org/10.1037/ccp0000154

Spijker, J., Bijl, R., De Graaf, R., & Nolen, W. (2001). Determinants of poor 1-year outcome of DSM-III-R major depression in the general population: Results of the Netherlands Mental Health

Survey and Incidence Study (NEMESIS). *Acta Psychiatrica Scandinavica, 103*(2), 122–130. https://doi.org/10.1034/j.1600-0447.2001.103002122.x

Strauss, C., Gu, J., Montero-Marin, J., Whittington, A., Chapman, C., & Kuyken, W. (2021). Reducing stress and promoting well-being in healthcare workers using mindfulness-based cognitive therapy for life. *International Journal of Clinical and Health Psychology, 21*(2), 100227. https://doi.org/10.1016/j.ijchp.2021.100227

Valente, M. J., & MacKinnon, D. P. (2017). Comparing models of change to estimate the mediated effect in the pretest-posttest control group design. *Structural Equation Modelling, 24*(3), 428–450. https://doi.org/10.1080/10705511.2016.1274657

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070. https://doi.org/10.1037//0022-3514.54.6.1063

Wichers, M., Barge-Schaapveld, D., Nicolson, N., Peeters, F., De Vries, M., Mengelers, R., & Van Os, J. (2009). Reduced stress-sensitivity or increased reward experience: The psychological mechanism of response to antidepressant medication. *Neuropsychopharmacology, 34*(4), 923–931. https://doi.org/10.1038/npp.2008.66

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.