



Mindfulness and Affect During Mindfulness-Based Cognitive Therapy for Recurrent Depression: an Autoregressive Latent Trajectory Analysis

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Abstract

Objectives Gaining knowledge of dynamic processes of mechanisms underlying mindfulness-based cognitive therapy (MBCT) for recurrent depression could help to improve treatment efficacy. The current study examined the overall course and week-to-week associations of mindfulness and positive/negative affect during MBCT for recurrent depression.

Methods Using data from the MOMENT study, 235 patients with recurrent depression in (partial) remission allocated to MBCT were included. Prior to each MBCT session, self-reports were obtained on mindfulness, positive affect, and negative affect.

Results Autoregressive latent trajectory (ALT) modeling revealed that, across the MBCT course, larger increases in mindfulness were associated with larger increases in positive affect ($r = .80, p < .050$). Higher general levels of negative affect were associated with smaller increases in mindfulness over time ($r = -.26, p < .001$). Week-to-week effects showed no reciprocal cross-lagged effects between mindfulness and positive affect or negative affect, except for positive affect at session 2 which was positively associated with mindfulness at session 3 ($r = .11, p < .050$).

Conclusions The current study supports a positive association in strength of increase between mindfulness and positive affect, while higher general levels of negative affect might be associated with smaller increases of mindfulness during MBCT for recurrent depression. For future research, experience sampling methods (ESMs) are recommended to capture dynamics on a smaller time scale. ALT modeling techniques are advised to be better able to interpret the processes of stability and change during MBCT for recurrent depression.

Keywords Major depressive disorder · Recurrent depression · Mindfulness-based cognitive therapy · MBCT · Mindfulness · Affect · Autoregressive latent trajectory (ALT) modeling

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Major depressive disorder (MDD) is a common psychiatric disorder in which emotion regulation plays an important role (Joormann and Stanton 2016; World Health Organization 2017). Along with the diminished experience of positive emotions, the frequent experience of negative emotions is a key characteristic of depressive symptomatology (American Psychiatric Association 2013). MDD often runs a chronic and recurrent course, and many patients experience residual depressive symptoms (Nierenberg 2015; Richards 2011). Currently, MDD is a leading cause of disease burden worldwide (World Health Organization 2017).

Mindfulness-based cognitive therapy (MBCT; Segal et al. 2002) has been shown to be effective for relapse prevention in recurrent depression (Kuyken et al. 2016). MBCT consists of 8 weekly group sessions of 2.5 h and a silent day (Segal et al. 2012). The intervention includes mindfulness practices and elements from cognitive therapy for depression (Beck et al. 1979). Mindfulness, in the context of mindfulness-based interventions (MBIs), is most often referred to as paying attention, on purpose, in the present moment and non-judgmentally (Kabat-Zinn 1994) and is considered a skill that can be trained (Segal et al. 2012; Tang et al. 2015).

In order to improve the treatment efficacy of MBCT for recurrent depression, a better understanding of the processes which bring about therapeutic change is needed (Dimidjian and Segal 2015; Kazdin 2007). Research to date proposes various possible mediators for the effect of MBIs on mental health outcomes. A systematic review and meta-analysis of 20 studies, of which 15 randomized controlled trials (RCTs), aimed to identify potential psychological mediating mechanisms underlying the effects of MBIs in mixed samples (Gu et al. 2015). The study found moderate evidence that an increase in mindfulness and a reduction of rumination and worry mediated treatment outcome. Evidence for reduction of cognitive and emotional reactivity and for increases in self-compassion and psychological flexibility mediating treatment outcome was preliminary but insufficient. Another systematic review of 23 studies on MBCT for recurrent MDD, of which there were 20 RCTs, provided evidence for increases in mindfulness, self-compassion, and meta-awareness and decreases in rumination and worry to mediate treatment outcome (van der Velden et al. 2015). In addition, the study found preliminary evidence indicating that changes in attention, memory specificity, self-discrepancy, emotional reactivity, and momentary positive affect and negative affect might be possible mediating mechanisms of change. Despite accumulating evidence for mindfulness and emotion (regulation) as possible mediators for the effect of MBCT on mental health outcomes, findings have been largely based on pre-post assessments of mediators so far, and most studies did not take the temporal order of mediator and outcome variables into account. This makes it difficult to identify causal links between the intervention, the outcome(s), and possible mediators (Kazdin 2007).

More rigorous designs are needed to disentangle causal and mutual associations of possibly mediating factors during MBCT.

According to the mindfulness-to-meaning theory (MMT), mindfulness has been suggested to have a negative reciprocal relationship with negative affect and a positive reciprocal relationship with positive affect (Garland et al. 2015). As residual depressive symptoms (e.g., negative affect) are a predictor for relapse/recurrence depression (Buckman et al. 2018; Watson et al. 1988) and positive affect is suggested to improve well-being and reduce depressive symptoms and risk of relapse/recurrence depression (Bolier et al. 2013; Khazanov and Ruscio 2016; Sin and Lyubomirsky 2009), developing one's level of mindfulness could lead to decreases in negative affect and increases in positive affect, further leading to better outcomes in (recurrent) depressed patients.

Research to date with more advanced methodological approaches, such as experience sampling methods (ESMs; Larson and Csikszentmihalyi 1983), suggests these positive associations between mindfulness and positive affect and, to a lesser extent, negative associations between mindfulness and negative affect during MBCT in recurrently depressed patients. For example, an open-label RCT of MBCT for adults with residual depressive symptoms ($N = 120$) used experience sampling methodology during 6 consecutive days before and after MBCT or waitlist control period. The results showed that MBCT was associated with increased experience of momentary positive affect compared to waitlist control (Geschwind et al. 2011). Another ESM study of mainly patients with recurrent MDD ($N = 29$) showed that a mindful walking intervention resulted in an overall increase of both levels of mindfulness and positive affect and a decrease in negative affect. In addition, time-specific moment-to-moment effects showed that increased mindfulness was associated with subsequent increases in positive affect and decreases in negative affect the next moment during the day and vice versa (Gotink et al. 2016).

In short, overall increases in mindfulness appear to be associated with overall increases in positive affect and decreases in negative affect. However, knowledge of the dynamic process and temporal order of these changes in recurrently depressed patients is still scant. The dynamic interplay between levels of mindfulness, positive affect, and negative affect during MBCT for recurrent depression has not been investigated yet. The present study expands the previous literature by investigating the course and mutual associations of mindfulness and both positive affect and negative affect in patients with recurrent depression following MBCT based on a large sample originating from two multicenter RCTs (Huijbers et al. 2012). Moreover, assessments of mindfulness, positive affect, and negative affect took place prior to each MBCT session. Finally, the current study uses autoregressive latent trajectory (ALT) modeling to analyze the data, which permits a distinction between overall trajectories across the entire intervention

and week-to-week effects of mindfulness, positive affect, and negative affect. This makes it highly suitable for analyzing dynamic processes. Over the course of the MBCT, it is expected that mindfulness and positive affect increase, while negative affect decreases. In addition, the strength of increase in mindfulness is expected to be associated with the strength of increase in positive affect and decrease in negative affect. Finally, reciprocal week-to-week associations are expected between mindfulness and affect. Specifically, higher levels of mindfulness at a certain week are expected to precede higher levels of positive affect and lower levels of negative affect in the subsequent week. Meanwhile, higher levels of positive affect and lower levels of negative affect at a certain week are expected to precede higher levels of mindfulness in the subsequent week.

Method

Participants

Adult patients were recruited via direct referral from mental health professionals and media advertisements between September 2009 and January 2012 at 12 different secondary and tertiary psychiatric outpatient clinics across the Netherlands. Native Dutch-speaking patients with recurrent depression (≥ 3 prior episodes) according to the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association 2000) using the Structured Clinical Interview for DSM Axis I Disorders (SCID-I; $\kappa = .70$, $p = .001$, 95% CI = .46–.94; First et al. 1996), who were on a stable dose of antidepressant medication (≥ 6 months) and currently in (partial) remission, were included after written informed consent had been obtained. Exclusion criteria were as follows: bipolar disorder, psychotic disorder, neurological disorder, somatic disorder, current alcohol and/or drug dependency as assessed by the Mini International Neuropsychiatric Interview (MINI; Sheehan et al. 1998), use of a high dose of benzodiazepines, electric convulsive therapy ≤ 3 months, previous mindfulness training or considerable meditation experience, current psychological treatment ($\geq 1 \times 3$ weeks), and visual hearing/cognitive impairments impeding full participation. Patients were included only after written informed consent had been obtained. Participants from both multicenter trials who received an adequate dose of the intervention, i.e., at least 4 MBCT sessions (Kuyken et al. 2010; Teasdale et al. 2000), were included in the current study ($N = 235$). Table 1 contains a detailed description of demographic and clinical characteristics of the participants of the current study. Participants participated, on average, 7.16 sessions (range = 4–8, SD = 1.08) and performed 58% (range = 0–1, SD = .23) of the given formal homework exercises.

Table 1 Baseline demographic and clinical characteristics of patients with recurrent depression receiving mindfulness-based cognitive therapy ($N = 235$)

Variable	<i>N</i> (%)
Female	157 (67)
Marital status	
Single	55 (24)
Married or cohabiting	137 (60)
Divorced or widowed	38 (16)
Missing	5 (2)
Level of education	
Low	19 (8)
Middle	65 (29)
High	144 (63)
Missing	7 (3)
Employed	155 (66)
Previous CBT	137 (58)
Type of mADM	
SSRI	162 (69)
TCA	46 (20)
Other ^a	27 (11)
Remission	
Full ($IDS-C30 \leq 11$)	125 (53)
Partial ($IDS-C30 > 11$)	110 (47)
Suicide attempt (lifetime)	43 (18)
Variable	Mean (SD)
Age in years	50.70 (10.81)
Depressive symptoms ($IDS-C30$)	12.58 (9.74)
Previous MDEs	5.91 (5.72)
Age at MDD onset ^b	25.89 (11.84)

CBT cognitive behavioral therapy, mADM maintenance antidepressant medication, SSRI selective serotonin reuptake inhibitor, TCA tricyclic antidepressant, $IDS-C30$ Dutch Inventory of Depressive Symptomatology-Clinician rated, MDEs major depressive episodes, MDD major depressive disorder

^a Including serotonin-norepinephrine reuptake inhibitors, monoamine oxidase-inhibitors, and mirtazapine

^b Based on self-report

Procedures

The current study used data from the MOMENT study which consists of two related multicenter RCTs. The first RCT was a non-inferiority trial that compared the combination of MBCT and maintenance of antidepressant medication (ADM) with MBCT alone (Huijbers et al. 2016). The second RCT was a superiority trial that compared the combination of MBCT and ADM with ADM alone (Huijbers et al. 2015). For study details, participants' demographic and clinical characteristics, and outcomes of both RCTs, see the respective papers (Huijbers et al. 2015, 2016).

MBCT was delivered in a real-life setting, from university hospitals to community mental health centers across the Netherlands. Participants attended MBCT classes together with non-trial participants, i.e., patients with recurrent depression from regular clinical practice. The MBCT was largely based on the protocol of Segal et al. (2002) with some adaptations (2.5-h instead of 2-h sessions and additionally 1 silent day between the 6th and 7th sessions). Adding the silent day has been suggested in the most recent version of the MBCT protocol (Segal et al. 2012). Groups consisted of 8 to 12 patients during 8 weekly sessions. MBCT included formal meditation exercises, such as the body scan, sitting meditation, walking meditation, and mindful movement as well as informal exercises, such as bringing present-moment awareness to everyday activities. Cognitive behavioral techniques included education, monitoring and scheduling of activities, identification of negative automatic thoughts, and devising a relapse prevention plan. Participants were encouraged to practice meditation at home for about an hour a day using CDs. At the start of each weekly session, questionnaires were filled out by participants. A total number of 21 teachers recruited from regular clinical practice participated in both trials. Videotapes were available for 15 primary teachers and examined with the Mindfulness-Based Interventions: Teaching Assessment Criteria (MBI:TAC; Crane et al. 2013). Teacher ratings were “proficient” ($n = 3$), “competent” ($n = 4$), “advanced beginner” ($n = 6$), and “beginner” ($n = 2$). The mean teacher competency score was 3.53 ($SD = .92$, range = 2.00–5.15). Seven of the 15 teachers met the advanced criteria of the association of mindfulness-based teachers in the Netherlands and Flanders (www.vmbn.nl), which are in accordance with the UK good practice guidelines (UK Network of Mindfulness-Based Teachers 2015).

Measures

The Mindful Attention Awareness Scale (MAAS) was administered to assess the characteristic of dispositional mindfulness, namely open or receptive awareness of and attention to what is taking place in the present (Brown and Ryan 2003). This questionnaire consists of 15 items formulated in a negative way (e.g., “I find it difficult to stay focused on what’s happening in the present”). Items are rated on a 6-point Likert scale ranging from “almost always” to “almost never”. Higher values represent higher levels of mindfulness. In this study, participants were instructed to choose the answers for each statement that best reflected their experiences of the past week, including the current day. The average scale score was used in this study. The Dutch version of the MAAS has shown the expected 1-factor structure, a good internal consistency, and theoretically coherent correlations with, e.g., well-being and stress among a Dutch non-clinical population

(Schroevers et al. 2008). The internal consistency in the current study was excellent ($\alpha = .95$).

Positive affect and negative affect were assessed with the International Positive and Negative Affect Schedule Short-Form (I-PANAS-SF; Thompson 2007). This questionnaire consists of ten items of which 5 assess positive affective states (e.g., enthusiastic, excited) and 5 assess negative affective states (e.g., irritable, nervous) relating to the last week, including the day itself. The items are scored using a 5-point Likert scale anchored from “never” to “always”. Higher values indicate higher levels of positive/negative affective states. Thompson (2007) investigated the cross-sample stability, internal reliability, temporal stability, and convergent and criterion-related validities of the scale and found the scale to be psychometrically acceptable. The average scale score was used in the current study. The internal consistency in the current study was excellent for positive affect ($\alpha = .93$) and good for negative affect ($\alpha = .89$).

Data Analyses

The current study used the ALT modeling technique which combines a latent trajectory model (LTM) with an autoregressive (AR) model. The LTM allows each individual in the sample to have a different overall trajectory as marked by a different (subject-specific) intercept and slope when tracked over time. The intercept can be interpreted as a general level of a variable and is constant over time. Its variance represents differences in general levels between individuals. The slope can be interpreted as an overall rate of change (positive or negative) of a variable over the intervention period, and its variance represents inter-individual differences in the rate of change. However, reciprocal week-to-week associations between variables during the intervention period are not captured with a LTM. AR models can investigate reciprocal week-to-week associations between variables, so-called cross-lagged (CL) effects, while allowing the prior value of a variable to determine the current value of the same variable (AR effects). Although AR models allow investigating reciprocal CL effects, caution is warranted. Indeed, when not accounting for the (differences in) overall trajectories in the variable(s) over the intervention period, spurious CL effects might appear while they actually do not exist (Voelkle 2008). Therefore, combining both the AR model and LTM into an ALT model makes it possible to study reciprocal CL effects properly while controlling for overall trajectories. This enables a better interpretation of the processes of stability and change during MBCT for recurrent depression.

The analytical strategy followed Bollen and Curran’s (2004) recommendations. At first, univariate unconditional AR models, LTMs, and several ALT models were estimated separately for each variable—mindfulness, positive affect, and negative affect—and compared to identify which model best represented the course of these variables separately

during MBCT. Secondly, bivariate unconditional AR models, LTMs, and various ALT models were fitted and compared for both mindfulness and positive affect as well as negative affect to examine which model best represented the course and possible mutual associations of mindfulness and positive/negative affect during MBCT. For a detailed description of the model building steps of both the univariate and bivariate models, model fit, and data handling, see Supplementary Material 1. Descriptive analyses were performed with SPSS, version 22 (IBM Corporation 2013). All structural equation models (SEMs) were estimated by using IBM Amos SPSS, version 25.0 (Arbuckle 2017). As significance level, a two-sided alpha level of .050 was used.

Results

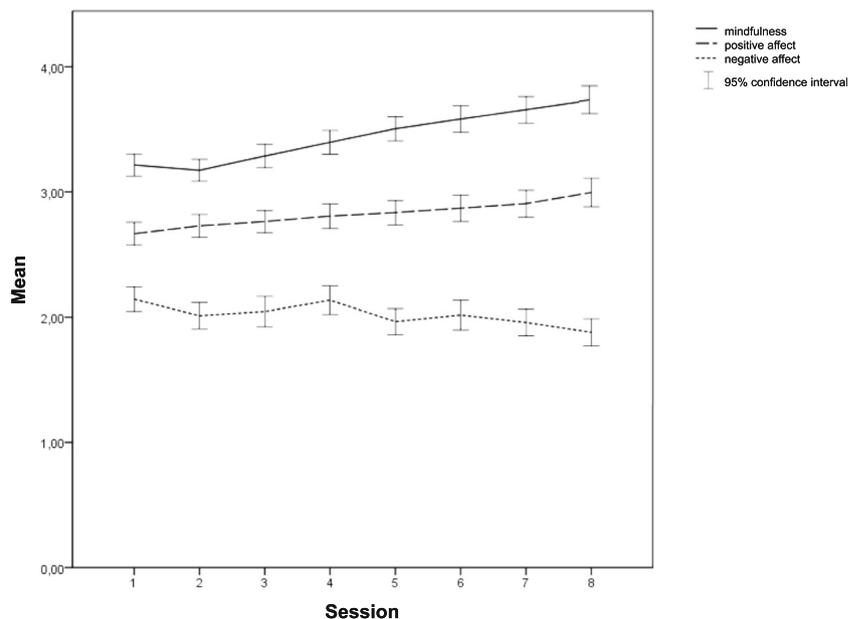
The descriptive statistics of and correlations between all studied variables are presented in Supplementary Material 2, Tables 2.1 and 2.2. Mindfulness and positive affect steadily increased over the intervention period, while negative affect showed a more irregular course. See Fig. 1 for a visual representation of the overall means of these variables per session. In addition, mindfulness had high autocorrelations between the weekly sessions, whereas these autocorrelations were moderate for positive affect and negative affect. At each session separately, mindfulness correlated positively with positive affect and negatively with negative affect. As the assumption of normality was violated for negative affect, a logarithmic transformation was applied to all measurement points of this variable before further analyses were performed. For a detailed

description of the univariate and bivariate models that were fitted and the results of the final univariate ALT models, see Supplementary Material 2. To improve readability and interpretation, only the results of the final bivariate ALT model of both mindfulness and positive affect as well as negative affect are presented below.

Mindfulness and Positive Affect

The final bivariate ALT model showed an excellent model fit ($\chi^2 = 83.51$, $df = 84$, $p = .495$; comparative fit index (CFI) = 1.000; Tucker-Lewis index (TLI) = 1.000; root-mean-square error of approximation (RMSEA) < .001). The significant parameter estimates are depicted in Fig. 2, with the (co)variance and correlation estimates being reported in Table 2. A positive covariance was observed between both intercepts ($\Psi_{\alpha_{MFN}, \alpha_{PA}} = .077$, $SE = .031$, $p = .013$) and between both slopes ($\Psi_{\beta_{MFN}, \beta_{PA}} = .002$, $SE = .001$, $p = .047$). This indicates that participants with higher general levels of mindfulness showed higher general levels of positive affect. In addition, participants with larger increases in mindfulness showed larger increases in positive affect. In addition to these general trajectories over the MBCT course, week-to-week effects were found. Both mindfulness ($\rho_{AR(1)} = .327$, $SE = .051$, $p < .001$) and positive affect ($\rho_{AR(1)} = .187$, $SE = .048$, $p < .001$) had a clear stable AR component. This indicates that higher levels of mindfulness respectively positive affect on a given session predicted higher levels of mindfulness respectively positive affect on the following session. The CL parameter estimates showed that the CL effect from positive affect at session 2 to mindfulness at session 3 was positive and

Fig. 1 Evolution of the mean score of mindfulness, positive affect, and negative affect over time during MBCT for recurrent depression, including 95% confidence interval bars



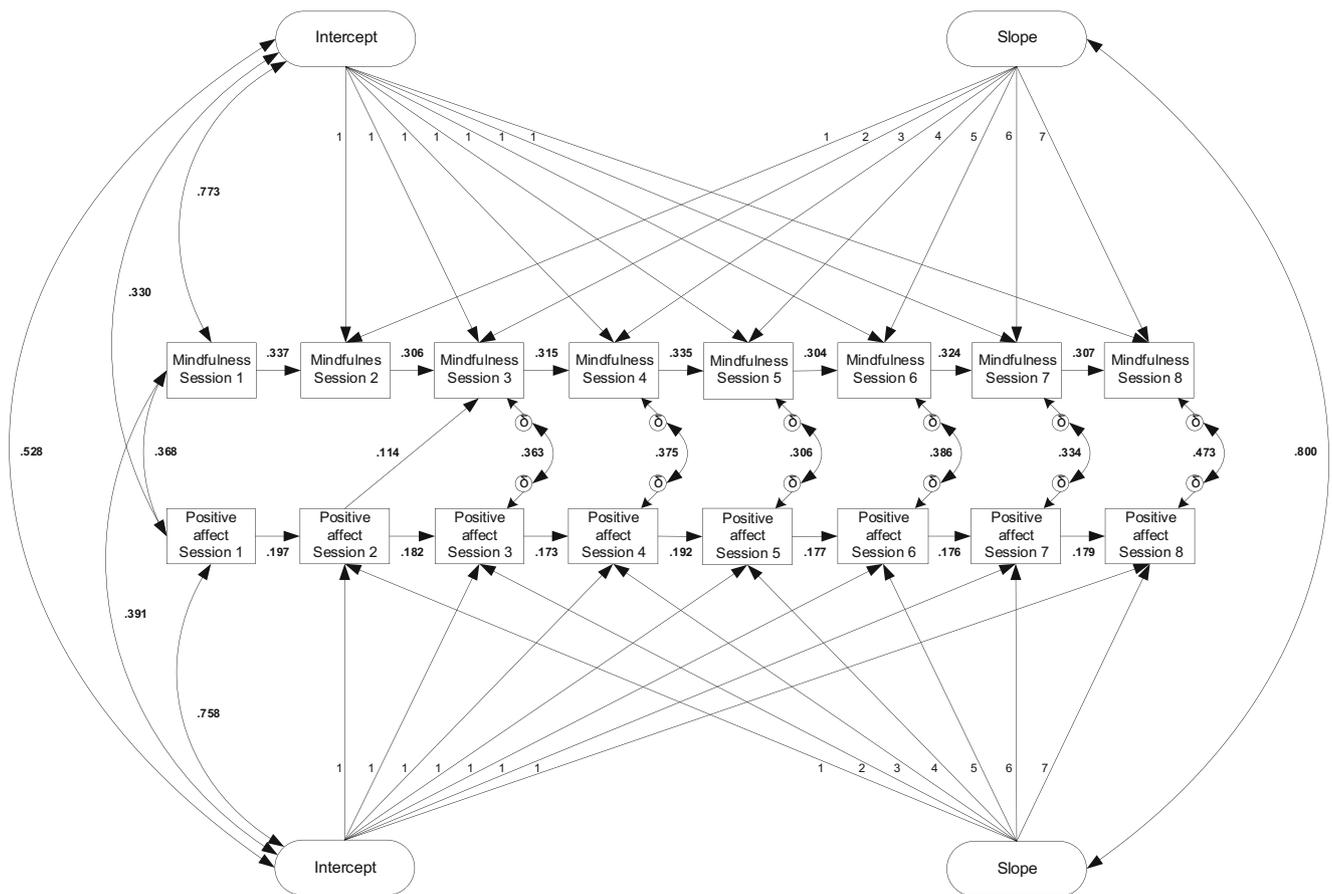


Fig. 2 Standardized parameter estimates of the final unconditional bivariate ALT model of mindfulness and positive affect. Estimates of (error) correlations and autoregressive and cross-lagged parameters that are non-significant are not shown. Significant paths are depicted by solid lines. Double-headed arrows represent correlations

Table 2 Variances, covariances, and correlations between the first measurements (session 1) and the intercepts and slopes of mindfulness and positive affect (upper part), and of mindfulness and negative affect (lower part) based on the final bivariate ALT models

	S1.MFN	S1.PA	Intercept MFN	Intercept PA	Slope MFN	Slope PA
S1.MFN	.423 (.040)***	.368	.773	.391	-.209	-.193
S1.PA	.163 (.032)***	.465 (.044)***	.330	.758	.091	.085
Intercept MFN	.189 (.032)***	.085 (.030)**	.142 (.034)***	.528	.100	-.344
Intercept PA	.099 (.034)**	.201 (.034)***	.077 (.031)*	.151 (.043)***	.200	.013
Slope MFN	-.006 (.004) ^{ns}	.003 (.005) ^{ns}	.002 (.003) ^{ns}	.003 (.004) ^{ns}	.002 (.001) ^{ns}	.800
Slope PA	-.007 (.005) ^{ns}	.003 (.005) ^{ns}	-.007 (.004) ^{ns}	<.001 (.005) ^{ns}	.002 (.001)*	.003 (.001)*
	S1.MFN	S1.NA	Intercept MFN	Intercept NA	Slope MFN	
S1.MFN	.423 (.040)***	-.272	.781	-.262	-.229	
S1.NA	-.026 (.007)***	.021 (.002)***	-.238	.734	-.108	
Intercept MFN	.201 (.030)***	-.014 (.005)**	.156 (.033)***	-.315	.040	
Intercept NA	-.016 (.005)**	.010 (.001)***	-.012 (.004)**	.009 (.001)***	-.258	
Slope MFN	-.007 (.003) ^{ns}	-.001 (.001) ^{ns}	.001 (.003) ^{ns}	-.001 (.001)*	.002 (.001)*	

Variances are depicted on the diagonal, covariances below, and correlations above the diagonal. Standard errors are shown between parentheses. Level of significance is indicated for the covariances and variances only

S1 observed variable of the first session, MFN mindfulness, PA positive affect, NA negative affect (logarithmic transformed)

^{ns} $p \geq .050$; * $p < .050$; ** $p < .010$; *** $p < .001$

significant ($b_{PA(t),MFN(t)} = .118, SE = .046, p = .011$), whereas this effect was not significant for other sessions ($-.044 < b_{PA(t-1),MFN(t)} < .057, p > .174$). No CL effects were found from mindfulness to positive affect ($b_{MFN(t-1),PA(t)} = .049, SE = .061, p = .423$).

Mindfulness and Negative Affect

The final bivariate ALT model showed a good model fit ($\chi^2 = 106.67, df = 102, p = .356; CFI = .998; TLI = .998; RMSEA = .014$). The significant parameter estimates are graphically represented in Fig. 3, with the (co)variance and correlation estimates being displayed in Table 2. A negative covariance was observed between the intercepts of mindfulness and negative affect ($\Psi_{\alpha_{MFN}, \alpha_{NA}} = -.012, SE = .004, p = .009$), which indicates that higher general levels of mindfulness were associated with lower general levels of negative affect. The final model did not contain a slope for negative affect, which implies that there was no increase or decrease of negative affect over the course of the MBCT. A negative covariance was observed between the

intercept for negative affect and the slope for mindfulness ($\Psi_{\beta_{MFN}, \alpha_{NA}} = -.001, SE = .001, p = .036$), which suggests that patients with higher general levels of negative affect showed smaller increases in mindfulness over the MBCT course. Week-to-week effects showed substantial AR effects for mindfulness ($\rho_{AR(1)} = .303, SE = .049, p < .001$) and negative affect ($\rho_{AR(1)} = .218, SE = .037, p < .001$) which were stable over time. No CL effects were found from mindfulness towards negative affect ($b_{MFN(t-1),NA(t)} = -.010, SE = .010, p = .291$) or vice versa ($b_{NA(t-1),MFN(t)} = -.137, SE = .102, p = .181$). As such, the level of mindfulness at a certain session did not predict the level of negative affect at the next session or vice versa.

Discussion

The current study was based on data from patients with recurrent depression in (partial) remission receiving an 8-week MBCT as part of two multicenter RCTs. The overall trajectory and week-to-week associations of mindfulness and positive/

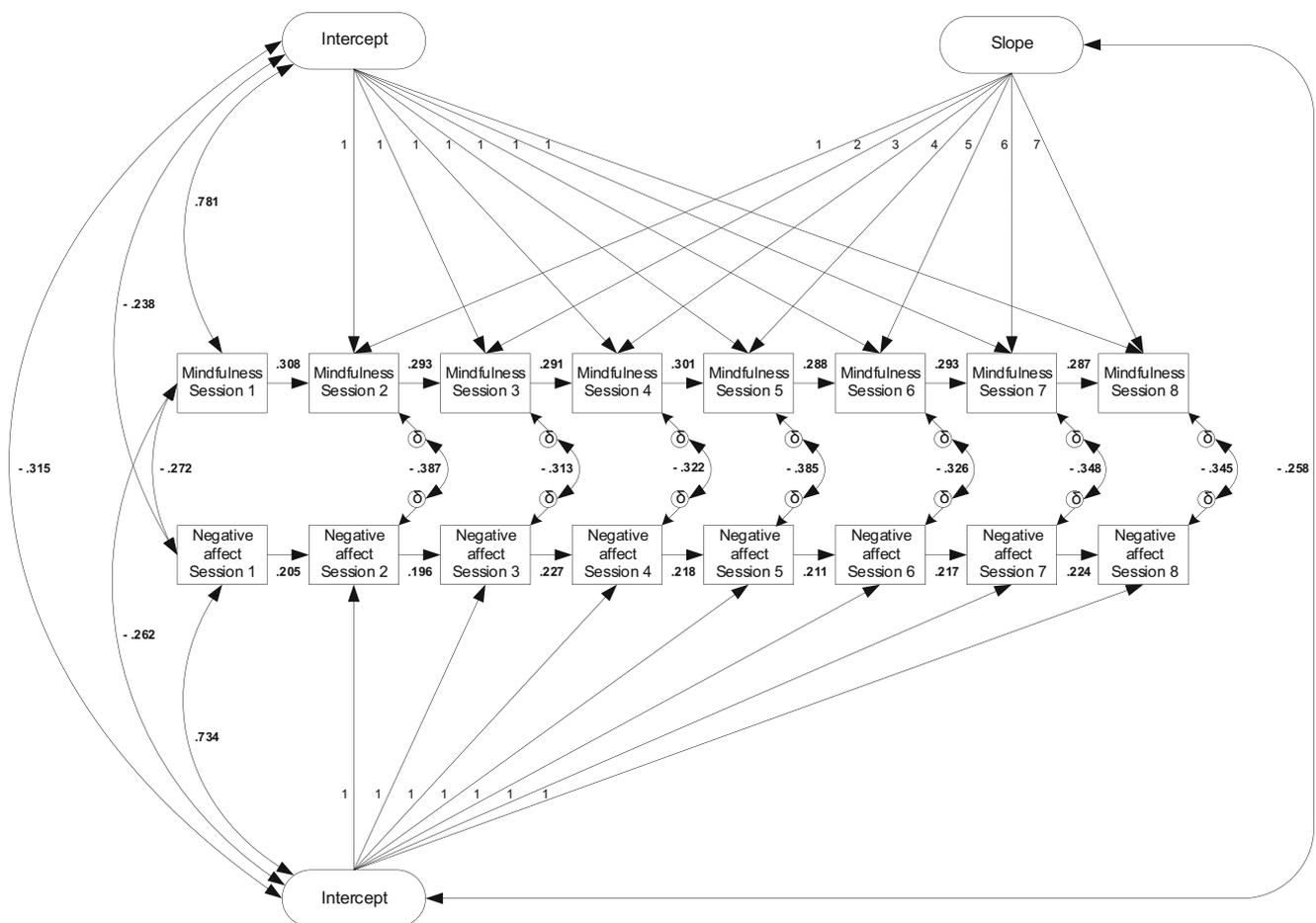


Fig. 3 Standardized parameter estimates of the final unconditional bivariate ALT model of mindfulness and negative affect (logarithmic transformed). Estimates of (error) correlations and autoregressive and

cross-lagged parameters that are non-significant are not shown. Significant paths are depicted by solid lines. Double-headed arrows represent correlations

negative affect were investigated across the intervention period by using the ALT modeling technique. When looking at overall trajectories, mindfulness and positive affect significantly increased, while the overall decrease of negative affect was non-significant. Patients with larger increases in mindfulness showed significantly larger increases in positive affect. In addition, patients with higher general levels of negative affect showed significantly smaller increases in mindfulness. Week-to-week effects showed no significant reciprocal CL effects between mindfulness and positive affect or negative affect, except for positive affect at session 2 which was positively associated with mindfulness at session 3.

Mindfulness and Positive Affect

As expected, patients with larger increases in mindfulness showed significantly larger increases in positive affect over the MBCT course. This is in accordance with existing theories (e.g., Garland et al. 2009, 2015) suggesting positive (reciprocal) associations between mindfulness and positive affect. In addition, it is in line with previous research showing effects of MBIs on increasing positive affect (e.g., Geschwind et al. 2011; Schroevers and Brandsma 2010). However, the current study did not find significant effects between mindfulness and subsequent positive affect on a weekly basis, while only positive affect at session 2 positively significantly predicted mindfulness at session 3. The latter might be explained by the given home practice during session 2 for the coming week, namely registering one pleasant event on a daily basis with accompanied thoughts, emotions, and bodily sensations. However, this is speculative. Another study investigating mindfulness and positive affect in a community sample also did not find changes in positive affect on a certain day to predict changes in mindfulness the following day, although reverse associations were found (Snippe et al. 2015). In contrast, positive moment-to-moment relations between mindfulness and subsequent positive affect, and vice versa, were found in patients with recurrent MDD during a mindful walking intervention using experience sampling methodology (Gotink et al. 2016). Perhaps, the time span used in the current study was not fine-grained enough to detect these CL effects. More importantly, however, the differences in outcomes could be explained by the different analytic techniques adopted. When not taking overall changes during the intervention period and inter-individual differences therein into account (i.e., fitting intercept-only models while inter-individual differences in slopes exist), unmodeled overall changes could “show up” as spurious CL (and AR) effects, rendering the substantive interpretation of these effects impossible. Simulation studies show that ignoring or misspecifying (i.e., assuming linearity when true changes are non-linear) the overall change over time results in incorrect estimates for CL and AR effects (Voelkle 2008). Indeed, when a bivariate intercept-only ALT model was fitted for mindfulness and

positive affect in the current study, instead of a bivariate intercept and slope model, CL effects from mindfulness to positive affect became significant, as half of the CL effects from positive affect to mindfulness. It is therefore very important to carefully build a model that captures the overall trajectories of the variables correctly and that simultaneously accounts for time-specific effects.

Mindfulness and Negative Affect

Against expectations, negative affect did not significantly decrease over the MBCT course, which is contrary to previous studies (van der Velden et al. 2015). However, it seems in line with the absence of a clear main effect of MBCT on depression severity found in the clinical trials from which the current data were derived. Another explanation could be that participants were more able to accept negative affect rather than engaging in elaboration or rumination (Garland et al. 2015), therefore having more room for positive affect. Across the intervention period, higher general levels of negative affect were associated with significantly smaller increases in mindfulness, which suggests that negative affect might act as a barrier to develop mindfulness during MBCT. This is in line with the mindfulness-to-meaning theory (Garland et al. 2015), which asserts that negative emotions narrow the scope of awareness. Week-to-week CL associations between mindfulness and subsequent negative affect were non-significant. This is inconsistent with previous research by Gotink et al. (2016), which found moment-to-moment negative associations between mindfulness and subsequent negative affect during a mindful walking intervention in mainly recurrently depressed patients. However, in an ESM study in a general sample, increases in mindfulness on a certain day preceded decreases in negative affect the next day, but not the other way around (Snippe et al. 2015). One explanation could be that the current study included participants who were (partly) in remission which may have resulted in a restriction of a range of negative affect. More pronounced effects of mindfulness on negative effect or vice versa might be found when MBCT targets acutely depressed individuals. In addition, the relatively low average level of teacher competence compared to previous studies (e.g., Kuyken et al. 2015) may have attenuated the effect of MBCT on negative affect in general. Finally, the same methodological shortcomings apply to these findings as mentioned above (i.e., time span used and differences in analytical techniques adopted).

Strengths

The current study is the first to investigate the mutual associations of mindfulness and positive affect and negative affect during MBCT for recurrent depression. It included weekly assessments during the intervention in 235 patients and used

an advanced analysis technique which enables to make a distinction between the overall trajectories across the entire MBCT course and week-to-week effects of mindfulness, positive affect, and negative affect. This made it possible to study processes of mindfulness and affect in much more detail compared with pre-post studies and increased the statistical power to find potential associations between them. Finally, data from the present study were based on two highly ecologically valid RCTs which were embedded in a standard clinical care setting. This real-life setting increases generalization of our findings to patients with remitted recurrent depression in both secondary care and tertiary care.

Limitations and Future Research

There were also some limitations. First, no weekly assessments took place in the control group, which makes it unclear whether similar effects would be observed with the passing of time or in any other group activity. In subsequent research, MBCT should be compared to both passive and active control groups in order to determine whether changes in mindfulness and affect are specific for MBCT. Second, results of the current study are limited to patients with remitted depression and cannot be generalized to patients with acute depression. For future research, it is recommended to investigate changes in mindfulness and affect across individuals with different mental health problems with different levels of severity receiving MBCT (e.g., anxiety disorder) in order to determine the specificity of changes in mindfulness and affect. Third, another possible methodological problem concerns the questionnaires that were used in the current study. Mindfulness was assessed with the MAAS (Brown and Ryan 2003), which has been questioned in terms of its validity and ability to measure mindfulness (Van Dam et al. 2010). The MAAS taps into one aspect of mindfulness: (lack of) “attention towards the present moment”. The “purposeful orientation to one’s experience with a non-judgmental attitude” is not captured by the MAAS. In addition, the I-PANAS-SF (Thompson 2007) might have limitations in terms of representing only highly aroused forms of positive and negative feelings (Diener et al. 2009). Moreover, the negative affect scale of the I-PANAS-SF includes a wide range of different emotions (e.g., anger, fear), which each might follow a different course during MBCT for recurrent depression.

In future research, it would be recommended to include regular measurements administering different facets of mindfulness such as the facets from the Five-Facet Mindfulness Questionnaire short form (FFMQ-15; Baer et al. 2008). With regard to momentary affect measures, it seems important to include more subtle emotions too (e.g., calm, relaxed), considering that, particularly, these emotions are assumed to increase during meditation (Jones et al. 2018). Furthermore, it would be valuable to repeatedly assess depressive symptoms

to further determine changes in mindfulness and affect as the possible mechanisms of change in MBCT for depression. Moreover, it is encouraged to use ESMs, in order to capture dynamics on a smaller time scale. Finally, it is very important to carefully build a model that captures the overall trajectories of the variables correctly and that simultaneously accounts for time-specific effects. Authors should aim to provide ample insight into the analysis techniques and methods that were used, in order to increase the chance to replicate findings and properly compare results.

In summary, the current study supports a positive association in strength of increase between mindfulness and positive affect during MBCT for recurrent depression. Negative affect might run a more irregular course and might be associated with a smaller increase in mindfulness during MBCT for recurrent depression. Reciprocal CL associations between mindfulness and positive/negative affect that were established in previous research were generally not confirmed, possibly due to the more rigorous methodology of the current study and the time frame used. For future research, it is encouraged to use ESM in order to capture dynamics on a smaller time scale. In addition, the use of the ALT modeling technique is highly recommended to enable a better interpretation of the processes of stability and change during MBCT for recurrent depression.

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Authors’ Contributions MA prepared the data, performed the analyses, and wrote the manuscript. CG supervised MA throughout the full process and assisted with writing. MH contributed to the study conception and collected the data. TW assisted with the data analyses and with writing of the method and results section. AS contributed to the study conception. PS contributed to the study conception and assisted with the data analyses. All authors contributed to the study design, commented on previous versions of the manuscript, and approved the final manuscript for submission. None of the authors of the current study were teachers in the study.

Data Availability The data analyzed in the current study are available from the corresponding author on reasonable request.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed were in accordance with the ethical standards of the Medical Ethics Committee of Arnhem-Nijmegen (CMO; No. 2008/242), and local feasibility was approved by local ethics committees.

Informed Consent All patients were included only after written informed consent had been obtained.

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