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ORIGINAL PAPER

Change in Mindfulness Profiles After Mindfulness-Based Cognitive Therapy for Major Depressive Disorder

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Abstract

Objectives Mindfulness-Based Cognitive Therapy (MBCT) reduces recurrence and current depressive symptoms in patients with major depressive disorder (MDD). To understand how and for whom MBCT works, a person-centered approach focusing on mindfulness profiles can be useful. Four mindfulness profiles, each associated differently with mental health outcomes, have previously been identified. So far, no studies have examined whether profiles change after MBCT and whether these changes are related to treatment outcome.

Method Latent transition analysis (LTA) was performed on pre- and post-MBCT subscale scores of the Five Facet Mindfulness Questionnaire (FFMQ) in patients with current or remitted MDD (n=500). LTA allowed the assessment of individual changes in mindfulness profile after MBCT and the relation between profile change and corresponding changes in measures of mental health, including depressive symptoms, overall functional impairment, worry, and self-compassion.

Results LTA re-established the four profiles previously identified cross-sectionally: "Very low mindfulness" (VLM), "Non-judgmentally aware" (NJA), "Judgmentally observing" (JO), and "High mindfulness" (HM). For 71 out of 168 patients with VLM profiles changed to NJA and for another 30 to HM. For 49 out of the 129 patients with NJA and for 37 out of 141 patients with JO profiles changed to HM. All 61 patients starting with HM kept HM. In general, change was related to greater than average improvement in mental health, while no change in profile was related to less than average improvement in mental health (except for HM).

Conclusions Our findings indicate that changes in mindfulness profile after MBCT was differentially related to clinical change. These results from a person-centered approach offer new avenues to further elucidate the working mechanism of MBCT and improve its outcome.

Preregistration This study was not preregistered.

Keywords Mindfulness-Based Cognitive Therapy (MBCT) · Mindfulness profiles · Latent transition analysis · Major depressive disorder

Mindfulness-Based Cognitive Therapy (MBCT) is a psychological intervention originally developed to prevent relapse in patients with major depressive disorder (MDD) (Segal et al., 2002). In recent years, multiple randomized controlled

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trials have provided strong evidence for MBCT as an efficacious treatment in both reducing recurrence (Kuyken et al., 2016) and current depressive symptoms (Goldberg et al., 2019). Moreover, data on effectiveness in naturalistic settings show that efficacy established in these RCTs translates well to clinical practice (Elices et al., 2022; Geurts et al., 2020; Tickell et al., 2020). Despite these positive results at the group level, there are large person-to-person differences in the effects of MBCT. A person-centered approach, assessing a patient's individual profile, might shed light on these individual differences. The baseline profile of a patient might be key in predicting treatment outcome. Therefore, profiles might enable us to pre-select patients for particular treatments. In addition, profile changes might enhance our understanding of the treatment and enable us to adjust it according to a specific profile, so each patient might optimally benefit. In the current study, our aim is to advance our understanding of how MBCT impacts patients with different mindfulness profiles and how this relates to clinical outcomes.

MBCT is an 8-week multifaceted training program with elements of both cognitive behavioral therapy (CBT) and mindfulness meditation. During MBCT, patients receive psychoeducation and develop their mindfulness skills by practicing the body scan, mindful breathing, and mindful movement. Mindfulness has been described as the ability to pay attention to present moment-to-moment experience in an open, accepting, and non-judgmental way (Kabat-Zinn, 2009). It consists of multiple facets that together comprise a highly complex latent construct. One of the proposed mechanisms by which MBCT sorts its clinical effects is through the acquisition and improvement of mindfulness skills (van der Velden et al., 2015). It is important to advance our understanding of how MBCT affects the different facets of mindfulness to better understand how MBCT can be improved and personalized to optimize mental health.

A key step was taken by Baer et al. (2006, 2008) who performed a factor analysis on items from a number of pre-existing mindfulness scales that led to the identification of the Five Facet Mindfulness Questionnaire (FFMQ) consisting of the *observing*, *describing*, *acting with awareness*, *non-judging of inner experience*, and *non-reactivity to inner experience* facet. While four of those facets consistently load on a higher-order construct of mindfulness and relate consistently to mindfulness-related measures, the observing facet behaves differently in different populations (Baer et al., 2006, 2008; Brown et al., 2015; Fernandez et al., 2010; Gu et al., 2016; Pearson et al., 2015). This finding propelled research on the FFMQ from a person-centered perspective, focusing on profiles, i.e., the within-person relation between the subscales, instead of focusing on total-scores or subscales separately. Latent profile analyses (LPA) in clinical and non-clinical samples point to a relatively robust profile structure, i.e., two uneven profiles—"Non-judgmentally aware" (low on *observing* and high on *non-judging* and *acting with awareness*) and "Judgmentally observing" (low on *non-judging* and *acting with awareness* while high on *observing*)—and one to three even profiles termed "High," "Moderate," or "Low" mindfulness (Bravo et al., 2016, 2018; Bronchain et al., 2021; Calvete et al., 2020; De Souza Marcovski & Miller, 2023; Ford et al., 2020; Gómez-Odriozola & Calvete, 2021; Kimmes et al., 2017; Lam et al., 2018; Lecuona et al., 2022; Pearson et al., 2015; Sahdra et al., 2017; Stanmyre et al., 2022; Zhu et al., 2020).

Within a sample of patients with a history of depression (>3 episodes in full or partial remission), Gu et al. (2020) found four quite similar profiles in both a test (n = 343) and validation (n = 340) sample. We previously replicated and extended the study of Gu et al. (2020) in a large naturalistic cohort of patients (n = 754) with current or remitted MDD. We found a similar four-profile solution with three subgroups that mapped broadly on the groups identified by Gu et al. (2020): "High mindfulness," "Very low mindfulness," and "Non-judgmentally aware," and one subgroup that most resembled the "Judgmentally observing" profile in non-clinical samples. Furthermore, in these MDD samples, the "High mindfulness" subgroup scored best in terms of mental health, the "Very low mindfulness" worst, and the "Moderate mindfulness"/"Judgmentally observing" and "Non-judgmentally aware" subgroups intermediate (Gu et al., 2020; Lubbers et al., 2024).

These profiles offer a fruitful basis to further improve our understanding of the effects of MBCT. In our previous paper, we investigated whether these four profiles established before MBCT were predictive of outcome after MBCT, but this appeared not to be the case (Lubbers et al., 2024). When these profiles are also measured post-treatment, they enable us to assess whether changes occur in a patient's mindfulness profile over the course of treatment, and whether these changes are related to treatment outcome.

Thus, in the current study, we aimed to perform latent transition analysis (LTA) on pre- and post-treatment scores of the five facets of the FFMQ in patients with current or remitted MDD who participated in MBCT in a routine clinical setting (Geurts et al., 2020). LTA is an extension on LPA that offers the possibility to examine changes in profiles over time (Ryoo et al., 2018). While variable-centered methods explain relationships between variables within a population, person-centered approaches like LPA and LTA offer the advantage of identifying distinct subgroups of individuals based on shared attributes, enabling nuanced

understanding of group differences and developmental patterns of subgroups.

Our main objectives were to assess (i) whether the observed mindfulness profiles remain stable throughout the MBCT course, (ii) whether patients' mindfulness profiles change after MBCT, and (iii) whether this hypothesized change is related to treatment outcome in terms of residualized change in primary (depressive symptoms) and secondary (overall functional impairment, worry, self-compassion) outcomes. Because this study represents the initial assessment of mindfulness profiles following a mindfulness-based intervention (MBI), we did not have a strong specific hypothesis for our first objective. Drawing from the previously reported positive clinical results in the same sample (Geurts et al., 2020), we expected that mindfulness profiles would change into more adaptive profiles following MBCT, and that this change would be associated with better treatment outcomes.

Method

Participants

The sample consisted of a naturalistic uncontrolled cohort of patients with current or remitted MDD who participated in MBCT at the Radboud University Medical Centre for Mindfulness, between July 2012 and April 2018 (Geurts et al., 2020). Only those patients who met DSM-IV-TR criteria for current or remitted MDD and for whom at least one of the baseline FFMQ facet scores were present ($n = 754$) were included in the current study.

Procedure

Patients were referred to the Centre for Mindfulness by their general practitioner or attending psychologist or psychiatrist and were clinically assessed by means of a semi-structured psychiatric interview before taking part in the MBCT (see the "Measures" section). Note that the current sample is the same as the sample used by Lubbers et al. (2024) and a subsample of the sample used by Geurts et al. (2020, 2021). Patients were offered MBCT if they were willing and able to participate in a group setting, adhere to homework assignments, and attend at least six out of nine sessions including the day of silence. They were referred to other treatments if they suffered from current substance dependency, acute suicidality, or acute psychotic symptoms. Before the start of the MBCT and after the final session of the MBCT, patients were asked to complete a set of self-report questionnaires as part of routine outcome monitoring (ROM). Demographic and clinical variables were extracted from the electronic patient health records and reported in Table 1.

Intervention

Patients received MBCT in accordance with the protocol originally developed by Segal et al. (2002), consisting of 8 weekly sessions of 2.5 hr, one 6-hr silent day in between Sessions 6 and 7, and daily home practice of ± 30–45 min. The MBCT sessions consisted of psychoeducation, elements of cognitive therapy, and meditation exercises as well as dialogue and inquiry about those exercises. Groups that received MBCT consisted of 8–12 patients and were typically heterogeneous, mostly consisting of patients with unipolar (recurrent) MDD, either currently depressed or in (partial) remission, but also patients with anxiety disorder, attention-deficit hyperactivity disorder, autism, and/or personality disorder (Geurts et al., 2021). MBCT was taught by teachers meeting the advanced criteria of the Association of Mindfulness-Based Teachers in the Netherlands and Flanders, which are in concordance with the Good Practice guidelines of the UK Network of Mindfulness-Based Teacher Trainers (Crane et al., 2012).

Measures

Demographic and Clinical Variables

Psychiatric disorders were assessed by the Mini International Neuropsychiatric Interview Plus (MINI-Plus), a semi-structured psychiatric diagnostic interview consisting of DSM-IV-TR criteria and with good psychometric properties (Sheehan et al., 1998). The MINI-Plus was conducted by trained residents in psychiatry and psychologists supervised by consultant psychiatrists to assess patients for MDD and other comorbid disorders, that is, dysthymia, bipolar, anxiety, somatization, ADHD, addiction, and eating disorders (Geurts et al., 2021). Autism spectrum disorders and personality disorders were classified either (i) based on previous classifications in the patient history or (ii) when suspected based on the initial interview, additional diagnostic interviews were conducted, i.e., the structured clinical interview for DSM-IV personality disorders (SCID-II, First et al., 1997), and the Dutch Interview for diagnosing autism spectrum disorders (NIDA; Vuijk, 2016).

Five Facet Mindfulness Questionnaire–Short Form

The Five Facet Mindfulness Questionnaire–Short Form (FFMQ-SF; Bohlmeijer et al., 2011) was used to measure mindfulness skills. The 24-item questionnaire scores the level of mindfulness skills on a 5-point Likert scale (1 – 5) across the five domains: "observing," "describing," "acting with awareness," "non-judgment of inner experience," and "non-reactivity to inner experience" (Baer et al., 2006). Calculation of the subscales was done by

Table 1 Demographics, clinical characteristics, and outcome measures at baseline compared between patients with a full dataset (full dataset) and those without a post-MBCT measurement (no post-MBCT), and pre- to post-MBCT comparisons on outcome measures for patients with a full dataset

	No post-MBCT Baseline (n=254)	Full dataset Baseline (n=500)	Full dataset Post-MBCT (n=500)	Cohen's d pre- to post-MBCT
Gender (female)	156 (61.4%)	323 (64.6%)		
Age**				
Mean (*SD*)	44.6 (13.8)	47.7 (12.7)		
Major depressive disorder				
Recurrent remitted	135 (53.1%)	227 (45.4%)		
Single remitted	26 (10.2%)	47 (9.4%)		
Recurrent current	71 (28.0%)	178 (35.6%)		
Single current	22 (8.7%)	48 (9.6%)		
Psychiatric comorbidity				
No comorbidity	115 (45.3%)	256 (51.2%)		
One comorbid disorder	100 (39.4%)	194 (38.8%)		
Multiple comorbidities	39 (15.4%)	50 (10.0%)		
Anxiety disorder	56 (22.0%)	118 (23.6%)		
Somatization disorder	10 (3.9%)	35 (7.0%)		
Dysthymia	10 (3.9%)	31 (6.2%)		
Developmental disorder***	51 (20.1%)	37 (7.4%)		
Addiction	9 (3.5%)	11 (2.2%)		
Eating disorder	1 (0.4%)	10 (2.0%)		
Personality disorder*	43 (16.9%)	53 (10.6%)		
Somatic comorbidity				
Missing	1	2		
No somatic comorbidity	149 (58.9%)	283 (56.8%)		
Somatic comorbidity	104 (41.1%)	215 (43.2%)		
Education level				
Missing	56	114		
Lower	18 (9.1%)	32 (8.3%)		
Intermediate	48 (24.2%)	74 (19.2%)		
Higher	132 (66.7%)	280 (72.5%)		
Work				
Missing	23	39		
Employed/student/homemaker	145 (62.8%)	308 (66.8%)		
Sick leave	28 (12.1%)	48 (10.4%)		
Unemployed	58 (25.1%)	105 (22.8%)		
Number of sessions attended***				
Mean (*SD*)	6.6 (2.6)	8.4 (0.9)		
More than four sessions attended***	209 (82.3%)	498 (99.6%)		
Outcome measures				
BDI-II total score				0.87***
Mean (*SD*)	20.2 (11.7)	21.7 (10.2)	13.9 (10.2)	
OQ-45 total score				0.66***
Missing	26	86	28	
Mean (*SD*)	73.2 (22.5)	76.1 (20.1)	65.5 (21.1)	
PSWQ total score***				0.67***
Missing	2	2	0	
Mean (*SD*)	57.6 (12.9)	59.9 (12.1)	53.4 (12.2)	
FFMQ				

Table 1 (continued)

	No post-MBCT Baseline (n=254)	Full dataset Baseline (n=500)	Full dataset Post-MBCT (n=500)	Cohen's d pre- to post-MBCT
Observing				0.53***
Missing	0	2	0	
Mean (*SD*)	3.4 (0.8)	3.4 (0.8)	3.7 (0.7)	
Describing				0.24***
Missing	0	2	0	
Mean (*SD*)	3.4 (0.9)	3.3 (0.8)	3.5 (0.8)	
Acting with awareness				0.42***
Missing	0	2	2	
Mean (*SD*)	2.8 (0.7)	2.8 (0.7)	3.0 (0.6)	
Non-judging				0.44***
Missing	0	3	0	
Mean (*SD*)	2.9 (0.7)	2.8 (0.8)	3.1 (0.7)	
*Non-reactivity****				0.73***
Missing	0	2	0	
Mean (*SD*)	2.6 (0.7)	2.5 (0.6)	2.9 (0.6)	
Self-compassion				
SCS total score *				0.85***
Missing	4	8	5	
Mean (*SD*)	20.1 (5.9)	19.1 (5.1)	23.3 (5.3)	

Asterisks within the first column indicate significant differences between patients with a full dataset and patients without a post-MBCT measurement at demographics, clinical characteristics, and outcome measures at baseline.

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

This table was adopted from the study in which we employed LPA on the same dataset previously published in Mindfulness (Lubbers et al., 2024)

calculating the mean of corresponding item scores, which is in accordance with relevant previous LPA literature (Bravo et al., 2016; Bravo et al., 2018; Gu et al., 2020; Pearson et al., 2015). Scores on negatively worded items were reversed prior to calculation of the mean scores. Cronbach's alpha/McDonald's omega for the individual subscales in the current sample at baseline were 0.78/0.78 (*observing*), 0.87/0.88 (*describing*), 0.83/0.84 (*acting with awareness*), 0.78/0.78 (*non-judgment of inner experience*), and 0.77/0.77 (*non-reactivity of inner experience*). For the current study, we use the abbreviation FFMQ to refer to the short form of the Five Facet Mindfulness Questionnaire.

Beck Depression Inventory–Second Edition

The Beck Depression Inventory–Second Edition (BDI-II; Beck et al., 1996) was used to assess severity of depressive symptoms. The 21 items of the BDI-II relate to a symptom of depression and measures each symptom on a 4-point Likert scale ranging from 0 to 3. A total score was calculated by summing the individual items. Cronbach's alpha/McDonald's omega in the current sample at baseline was 0.91/0.91.

Penn State Worry Questionnaire

The Penn State Worry Questionnaire (PSWQ) is a self-report questionnaire that contains 16 items and assesses the propensity to worry on a 5-point Likert scale ranging from 1 to 5 (Meyer et al., 1990; van Rijsoort et al., 1999). Cronbach's alpha/McDonald's omega in the current sample at baseline was 0.92/0.92.

Outcome Questionnaire–45

The Outcome Questionnaire–45 (OQ-45; Lambert et al., 1996) measures psychological and general functioning and is commonly used in routine outcome monitoring to assess the effect of treatment because it is sensitive to change over short periods of time. In the current study, the Dutch version of OQ-45 (de Jong & Spinhoven, 2008) was used to calculate a total score (ranging from 0 to 180) as a measure of overall

functional impairment. Higher scores on the OQ-45 indicate poorer overall functioning. Cronbach's alpha/McDonald's omega in the current sample at baseline was 0.92/0.92.

Self-Compassion Scale

The Self-Compassion Scale (SCS; Neff, 2023) is a self-report questionnaire that assesses levels of self-compassion on six different domains: self-kindness, self-judgment, common humanity, isolation, mindfulness, and overidentification (Neff, 2003). In the current study, the Dutch version of the SCS was used (Neff & Vonk, 2009) which is highly similar to the original but uses a 7-point Likert scale instead of 5 and includes 24 items instead of 26. Subscales scores for the different domains were computed by calculating the mean of the relevant item scores (range 0–7). The total score was calculated by summing the subscale (mean) scores. Negatively worded items were reverse-scored prior to calculation of the subscales and total score. Cronbach's alpha/McDonald's omega for the total score at baseline was 0.91/0.92.

Data Analyses

Curation and visualization of the data was carried out in R (RStudio Team. 2019). Specifically, the dataset used by Geurts et al. (2020) was further adapted into a dataset suited for the previous LPA in the same sample (Lubbers et al., 2024) and the LTA of the current study (e.g., filtering out patients that had missing data on all subscales of the FFMQ). Additionally, we visualized mindfulness profiles and the relationship between transitions in these profiles and changes in depressive symptoms following MBCT. Possible differences in demographics, clinical characteristics, and outcome measurements at baseline between patients with a full dataset and those with missing data post-MBCT were tested using χ^2 (categorical variables) or ANOVA (continuous variables) statistics. Pre- to post-change in FFMQ subscales and outcome measures for patients with a full dataset were tested using paired samples *t*-tests. Within-group Cohen's *d* effect sizes were calculated by dividing the pre- to post-MBCT mean difference in outcomes by the standard deviation of the differences. LPAs and LTAs were conducted in M*plus* version 8.6 (Muthén & Muthén, 1998–2017). Specific Mplus code for the conducted analyses can be found within the Radboud Data Repository (see Supplementary Materials).

Latent Transition Analysis

We largely followed the framework for LTA model building proposed by Ryoo et al. (2018). Maximum likelihood estimation with robust standard errors (MLR) was used to fit LPA and LTA models to the data. We first explored data cross-sectionally by performing LPAs on raw scores of the five FFMQ subscales and determined the optimal number of profiles at the separate time points (before and after MBCT). The Bayesian Information Criterion (BIC), sample-size adjusted BIC (SABIC), and bootstrap likelihood ratio test (BLRT) were used as superior indicators for the optimal number of latent profiles (Nylund et al., 2007; Tein et al., 2013). Smaller (SA) BIC values indicate a better model fit. The BLRT tests whether a model with k profiles fits significantly better compared to a k-1 profile solution. Because model selection is not always straightforward, we also considered previous research and theory to decide upon the optimal number of profiles in the current study, as recommended by other researchers (see Spurk et al., 2020). Subsequently, we performed three LTAs with respectively the optimal number of profiles from the first step, one more and one less latent profile. For interpretational purposes, the number of latent profiles were constrained to be equal across time points for these LTA models. To evaluate model fit and determine the optimal number of profiles for the LTAs, we used the BIC and the Akaike information criterion (AIC) as indicators because the efficiency of the BLRT for LTA has not yet been established (Ryoo et al., 2018). Similar to the BIC, smaller AIC values indicate better model fit. Next, we tested for longitudinal measurement invariance. We compared models for which FFMQ subscale means for the different profiles were held equal or were free to vary across time points, using a chi-square difference test of loglikelihood values (Muthén, see *M*plus website: ttps://www.statmodel.com/chidiff.shtml). Although longitudinal measurement invariance did not hold (see Supplementary Materials), profiles were very similar in both models. Because interpretation of transition is more straightforward when means are held equal across time, it was decided to run the restricted (invariant) model as main analysis and the unrestricted (variant) as sensitivity analysis, and compare results.

The manual "Bolck, Croon, and Hagenaars" (BCH) method in M*plus* was used to determine the relationship between the transitional paths (from a pre-treatment profile to a post-treatment profile) and treatment outcome. Treatment outcome was operationalized as residualized change scores of the different mental health measures. The BCH method is the most robust and recommended method for this type of analysis (Asparouhov & Muthén, 2014; Bakk & Vermunt, 2016). To illustrate, a LTA model with four latent profiles at baseline and four profiles post-treatment could result in 16 possible combinations. The BCH method evaluates the mean of distal outcomes (such as residualized change scores of mental health measures) across those different possible combinations while accounting for classification errors in profile assignment. The BCH method uses weights reflecting this measurement error of the latent class variables. Transition paths with transition probabilities that were (close to) zero were left out because parameters in

(nearly) empty paths cannot be estimated. An overall chi-square test was performed to test whether the residualized change scores were significantly different between the transition paths. In addition, it was evaluated whether specific transition paths significantly differed from zero by dividing the parameter estimates by their corresponding standard errors, resulting in *z*-scores for which a two-tailed *p*-value was calculated. A (significant) negative residualized change score for depressive symptoms, overall functional impairment, and worry indicates that patients within such a path improved more compared to the full sample average (residualized change score of 0) whereas a positive score indicates that patients did worse compared to the full sample. For self-compassion, the meaning of negative and positive residualized change scores is inverted. Wald chi-square tests were used for pairwise comparisons of residualized change scores between different transition paths. The transition from a pre-treatment mindfulness profile to a different post-treatment mindfulness profile following MBCT will be referred to as "change in/of (a) mindfulness profile" for clarity and ease of understanding. To visualize differences in change on the primary outcome between patients that do or do not change in mindfulness profile, patients were assigned to their "most likely transition path" based on posterior classification probabilities, after which pre- and post-MBCT depression scores together with least square regression lines were plotted for those transition paths. To explore whether demographic and/or clinical characteristics (Table 1) predict a differential transition path for patients with the same baseline profile, chi-square tests (or Fisher's exact test in case data did not allow chi-square) of association were performed. If these overall tests of association had a p-value < 0.10, pairwise comparisons between individual paths representing patients whose mindfulness profile changed versus patients that did not change in mindfulness profile were performed. Because of the explorative nature of the study, for all performed analyses (including pair-wise comparisons) all original *p*-values were reported uncorrected for multiple comparison.

Sensitivity Analyses: Multiple Imputation of Missing Values

We note that we restricted all the above analyses to participants for whom a baseline and post-MBCT measurement were available ($n = 500$). Including the 254 patients (34%) for whom post-MBCT measurements were missing might lead to non-reliable results with full information maximum likelihood (FIML) estimation (M*plus* Support, see supplementary analyses). However, to assess robustness of the results, analyses were repeated in 10 datasets ($n = 754$) for which missing values were imputed. As previously described (Lubbers et al., 2024), the M*plus* DATA IMPUTATION feature was used to impute missing values in indicators and mental health measures at baseline and post-MBCT, after which residualized change scores were recalculated. (Demographic) variables that may have been related to missingness were included in the imputation process for a more accurate imputation of missing values. First, the LPAs at pre- and post-MBCT from two up to eight profiles were run by using the type = IMPUTATION feature within in *M*plus. This feature allows for running all imputed datasets within one run, providing summary output (mean and SD of fit criteria, and average model solution) of those ten datasets. Second, LTAs were run using the same type = IMPUTATION feature, and summary output was reported. Estimation of residualized change scores across the transition paths could not be done using the type = IMPUTATION feature (limitation *M*plus, see Supplementary Materials for an elaborate explanation). Therefore, residualized change scores were estimated across transition paths of invariant and variant four-profile LTA models for the first three datasets and results are reported within the Supplementary Materials.

Results

Study Population

From the 754 patients with current and remitted MDD who completed the mental health measures at baseline, 500 (66%) who also completed them at post-MBCT were included in the main analyses. Patients who did not complete measures at post-MBCT were slightly younger, had more comorbid developmental and personality disorders, attended less MBCT sessions, and reported slightly lower levels of worry and slightly higher levels on the *non-reactivity* subscale of the FFMQ and the total SCS (Table 1). In the current sample, scores on all FFMQ subscales and all other mental health measures improved after MBCT (Table 1), as reported previously (Geurts et al., 2020).

Latent Transition Analysis

Based on fit indices of cross-sectional LPAs (Table 2) and previous research, invariant (mean-restricted) and variant (subscale means freely estimated) three-, four-, and five-profile LTA models were explored (Tables 3 and 4). Taken together (for details, see Supplementary Materials) the fit indices of the LTA models (Table 3), visual inspection (Figures 1 and 2, Supplementary Figure S1-S4), theory, and previous research, the four-profile LTA solution was adopted as most meaningful solution. Further results and considerations that involved model selection, including fit indices of cross-sectional LPA, fit indices of longitudinal LTAs, and measurement invariance testing, are described in detail within the Supplementary Materials. Taken together, performing a time-invariant (mean-restricted) four-profile LTA

Table 2 Fit indices for one through eight profiles for cross-sectional latent profile analyses before and after Mindfulness-Based Cognitive Therapy (MBCT)

Number of profiles	*df*	BIC	SABIC	Entropy	Bootstrapped LRT/*p*-value
Baseline					
2	16	5527.07	5476.29	0.59	< 0.001
3	22	5518.49	5448.66	0.63	< 0.001
4	28	5511.86	5422.99	0.66	< 0.001
5	34	5525.82	5417.90	0.63	0.01
6	40	5543.13	5416.17	0.62	0.07
7	46	5557.71	5411.70	0.65	0.04
8	52	5581.82	5416.77	0.68	0.54
Post-MBCT					
2	16	5090.39	5039.60	0.65	< 0.001
3	22	5081.60	5011.77	0.60	< 0.001
4	28	5079.63	4990.76	0.66	< 0.001
5	34	5082.51	4974.59	0.68	< 0.001
6	40	5096.82	4969.86	0.68	0.02
7	46	5121.28	4975.27	0.69	0.51
8	52	5146.78	4981.73	0.71	0.66

df degrees of freedom, *BIC* Bayesian Information Criterion, *BLRT* bootstrapped likelihood ratio test

Table 3 Fit indices of latent transition models for three through five profiles

Number of profiles	*df*	AIC	BIC	Entropy
Invariant (mean-restricted) models				
3	53	10246.60	10469.97	0.77
4	75	10118.29	10434.39	0.75
5	99	10026.05	10443.29	0.80
Variant (free) models				
3	68	10143.74	10430.33	0.85
4	95	10034.07	10434.46	0.82
5	124	9953.63	10476.24	0.84

df degrees of freedom, *AIC* Akaike information criterion, *BIC* Bayesian information criterion

as main analysis (which facilitates interpretation), alongside a variant four-profile LTA as sensitivity analysis, was judged to be best suited to answer our research questions.

Description and Labeling of Profiles

The mean scores on the FFMQ subscales across the latent profiles for the invariant four-profile model are presented in Table 5 and visualized in Figure 1. Profile 1 was labeled "Very low mindfulness" because patients had relatively low scores on all FFMQ subscales. About 168 (34%) patients had this "Very low mindfulness" profile at baseline and 67 (13%) patients had it post-treatment. Profile 2 was labeled "Judgmentally observing" because patients scored relatively high on *observing* while low on *non-judging*. About 141 (28%) patients had the "Judgmentally observing" profile at baseline and 106 (21%) patients had it at post-treatment. Profile 3 was labeled "High mindfulness" because patients had relatively high scores on all FFMQ subscales. At baseline, about 62 (12%) patients had the "High mindfulness" profile while about 179 (36%) patients had it at post-treatment. Profile 4 was labeled "Non-judgmentally aware" because patients had relatively high scores on the *non-judging* and *acting with awareness* subscales while lowest on the *observing* subscale. About 129 (26%) patients had the "Non-judgmentally aware" profile at baseline while about 149 (30%) patients had it at post-treatment (Table 5).

Transition Probabilities and Outcome Measures Across Transition Paths

Considerable transition in profiles occurred over time (Figure 4). For 189 out of all 500 (38%) patients, their mindfulness profile changed (Table 6). More specifically, for 117 out of all 500 (23%) patients, profiles changed to "High mindfulness." The majority (60%) of the 168 patients with a "Very low mindfulness" profile at baseline acquired another mindfulness profile across MBCT: 30 (18%) "High mindfulness" and 71 (42%) "Non-judgmentally aware." For 49 out of the 129 (38%) patients with a "Non-judgmentally aware" profile at baseline and for 37 out of 141 patients (26%) with a "Judgmentally observing" profile at baseline, change to "High mindfulness" had taken place. Notably, patients with "High mindfulness" at baseline did not change in profile. Moreover, no patients' profile changed to "Very low mindfulness." Similarly, virtually no change took place towards "Judgmentally observing."

The subsequent analysis involved assessing whether (and how) specific transition paths were related to treatment outcome. Results indicate that for each outcome measure, residualized change scores were different across the different transition paths (Table 7). More specifically, change from any baseline profile to "High mindfulness" was related to greater reduction in depressive symptoms relative to the group-average reduction (Figure 4). In addition, patients whose mindfulness profile did not change across MBCT scored worse in terms of improvement in depressive symptoms compared to the group average, except for the patients who already had a "High mindfulness" profile (Figure 4). These latter patients still seemed to profit on average from the MBCT. A similar pattern was observed for the other mental health outcomes: overall functional impairment, worry, and self-compassion (Table 7).

Next, we investigated whether patients whose mindfulness profile changed indeed improved more compared to those that kept the same profile. Pair-wise comparisons

Table 4 Test for measurement invariance across time for LTA models with three up to five profiles

Model	LL	p	SCF	*df*	cd	TRd	*p-value*[#]
3-restricted	−5070.30	53	1.17	15	0.69	191.74	< 0.001
3-free	−5003.87	68	1.06				
4-restricted	−4984.15	75	1.16	20	1.15	107.57	< 0.001
4-free	−4922.04	95	1.16				
5-restricted	−4914.02	99	1.05	25	1.13	108.54	< 0.001
5-free	−4852.81	124	1.07				

LL loglikelihood, *p* number of parameters estimated, *df* degrees of freedom of chi-square difference test, *SCF* scaling correction factor

TRd test statistic = −2*(LL0-LL1)/cd, cd = (p0*c0−p1*c1)/(p0−p1*)*

[#]*p*-value for chi-square difference test based on loglikelihood-values and scaling correction factor, see instructions by Muthén https://www.statmodel.com/chidiff.shtml

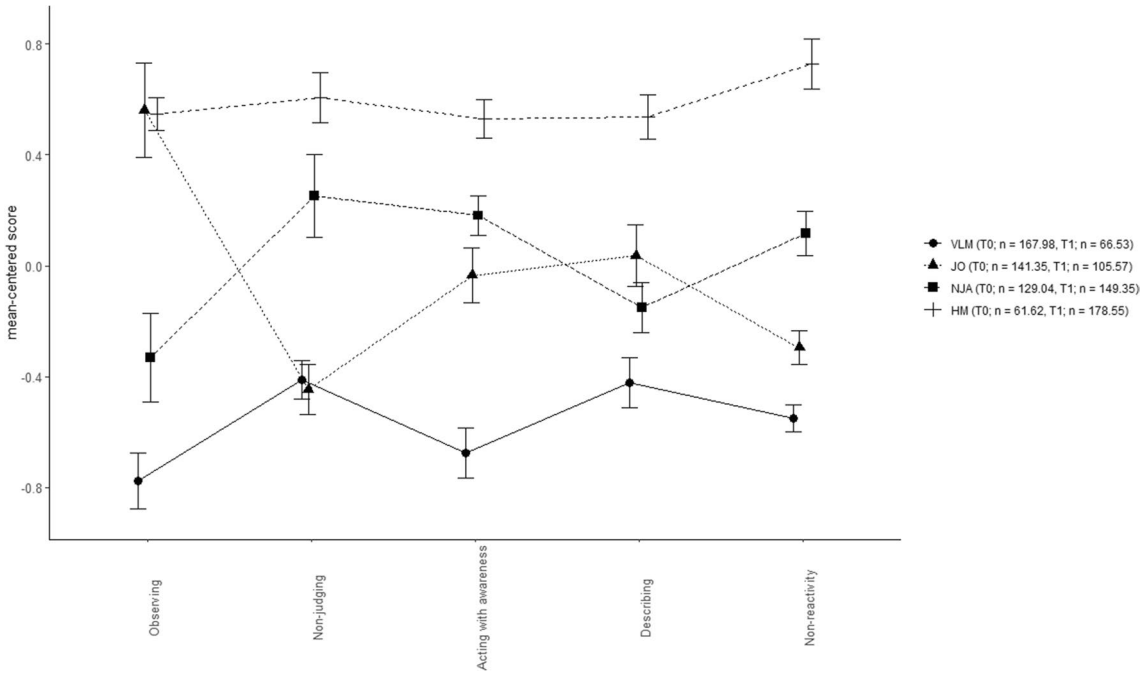

Fig. 1 Latent profile structure of four-class LTA model with restricted facet means of the Five Facet Mindfulness Questionnaire (FFMQ) across time. Note: This figure displays the four-profile solution of the LTA model for which mean scores of the FFMQ facets were held equal across time points (restricted LTA model). The FFMQ facet scores were mean-centered across the different profiles (i.e., the mean of each facet over the different profiles is 0) for ease of interpretation. Error bars represent standard errors. The legend shows prevalences to latent profiles at baseline (T0) and post-MBCT (T1) based on the estimated model. VLM, Very low mindfulness; JO, Judgmentally observing; NJA, Non-judgmentally aware; HM, High mindfulness

revealed that patients whose mindfulness profile changed showed a larger decrease in depressive symptoms (Table 8, Figure 3) compared to patients that did not acquire another profile. Again, for all the other outcome measures, similar patterns were observed (Table 8). Subsequently, overall chi-square (or Fisher's exact test) tests of association were performed to assess whether demographic and/or clinical characteristics could predict a differential transition path for patients starting with the same baseline profile. None of the demographic and clinical characteristics predicted a differential transition path (Supplementary Table S8).

Sensitivity Analyses

The primary advantage of an invariant LTA model is the equality of the means of FFMQ subscales across time points within profiles. This ensures that profiles retain the same meaning over time, thereby simplifying the interpretation

of transitions between profiles. In contrast, a variant LTA model, where FFMQ subscale means are freely estimated, may result in (slightly) different profiles across time, potentially altering their interpretation. Although formal longitudinal measurement variance was not observed (as reported in the Supplementary Materials), the profiles before and after MBCT in the variant model closely resembled each other in terms of FFMQ subscale scores (Figure 2, Table 9) and were highly similar to those within the invariant model (Figure 1, Table 5). Consequently, we deemed it reasonable to assume that profiles maintain consistent meaning over time, prompting us to conduct the invariant LTA model as our primary analysis. To assess the impact of choosing the invariant over the variant model, we compared the results presented above with those of the variant LTA model. The results of the variant LTA model in terms of (i) transition paths, and (ii) the relation between those transition paths and treatment outcome are to a large extent similar to the restricted invariant model (Tables 5/9, Figures 1/2). The most important difference between both models lies in the number of patients acquiring a different profile after MBCT: only 12% within the variant LTA model compared to 38% within the invariant model. But, subsequent results of the models were consistent: neither model exhibited transitions into profiles considered to be associated with poorer mental health, and change (into a more adaptive profile) was associated with more than average improvement in mental health. Detailed considerations on model choice and specific results and differences between the two models are described in the Supplementary Materials. In addition, further sensitivity analyses based on ten imputed datasets further confirm robustness of our findings. Details on the multiple imputation analyses and outcomes can be found in the Supplementary Materials.

Discussion

The aim of this study was to investigate whether mindfulness profiles of patients with MDD change after MBCT and whether these changes are related to treatment outcome in terms of depressive symptoms and other measures of mental

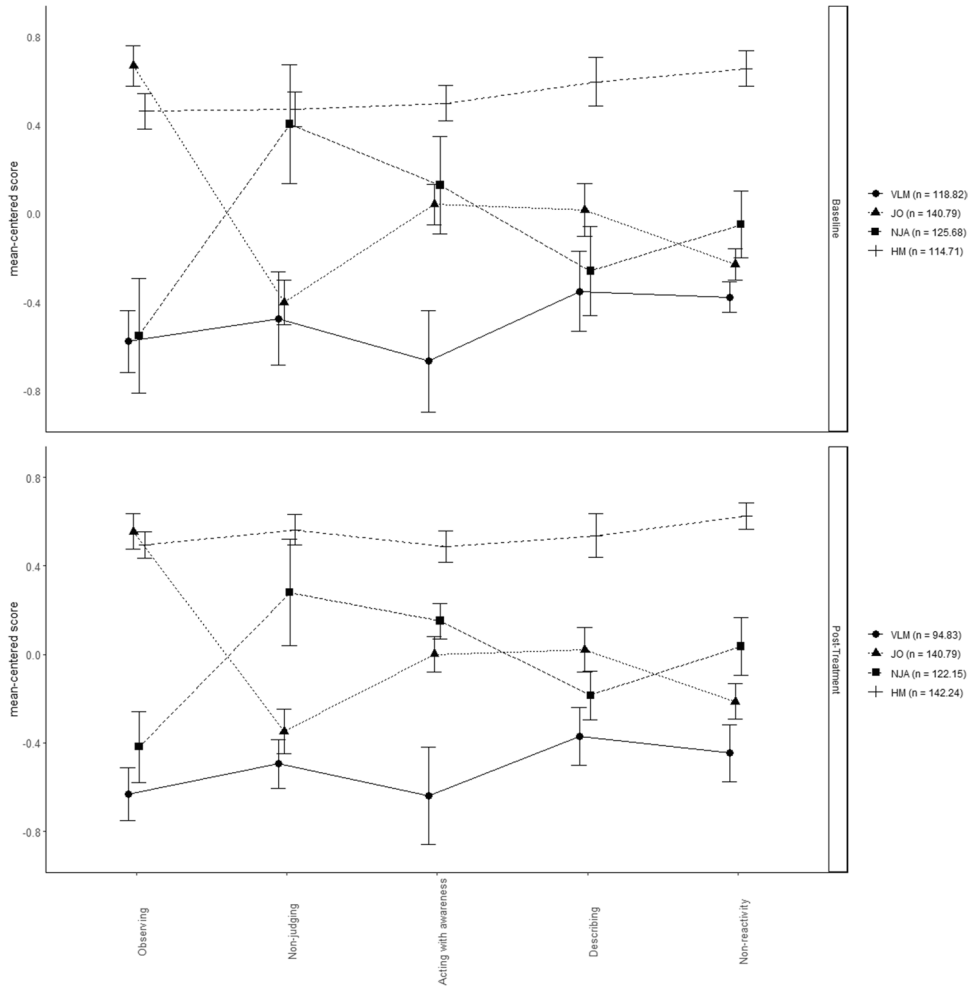

Fig. 2 Latent profile structure of four-class LTA model for which facet means of the Five Facet Mindfulness Questionnaire (FFMQ) were freely estimated at each time point. Note: This figure displays the four-profile solution of the LTA model for which mean scores of the FFMQ facets were freely estimated at baseline and after MBCT. FFMQ subscale scores were mean-centered across the different profiles. Error bars represent standard errors. The legend shows prevalences to the latent profiles at baseline (upper panel) and post-MBCT (bottom panel) based on the estimated model. VLM, Very low mindfulness; JO, Judgmentally observing; NJA, Non-judgmentally aware; HM, High mindfulness

Table 5 Latent profile membership counts and mean scores on mindfulness facets of the Five Facet Mindfulness Questionnaire (FFMQ) across the latent profiles for the four-class LTA model for which means were restricted across time points

	Very low mindfulness	Judgmentally observing	Non-judgmentally aware	High mindfulness
Latent profile membership count (*n*) and proportions at baseline and post-treatment				
	n (proportion)	*n* (proportion)	*n* (proportion)	*n* (proportion)
Baseline	167.98 (0.34)	141.35 (0.28)	129.04 (0.26)	61.62 (0.12)
Post-treatment	66.53 (0.13)	105.57 (0.21)	149.35 (0.30)	178.55 (0.36)
Mindfulness facets (unstandardized scores) at baseline				
	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)
Observing	2.80 [2.60, 3.00] (0.10, 0.39)	4.14 [3.81, 4.47] (0.17, 0.23)	3.25 [2.93, 3.56] (0.16, 0.49)	4.12 [4.00, 4.24] (0.06, 0.37)
Describing	2.96 [2.79, 3.13] (0.09, 0.60)	3.42 [3.20, 3.64] (0.11, 0.66)	3.23 [3.05, 3.41] (0.09, 0.58)	3.92 [3.76, 4.08] (0.08, 0.30)
Acting with awareness	2.23 [2.06, 2.39] (0.09, 0.28)	2.87 [2.67, 3.07] (0.10, 0.43)	3.09 [2.95, 3.22] (0.07, 0.27)	3.44 [3.31, 3.56] (0.07, 0.56)
Non-judging	2.52 [2.39, 2.65] (0.07, 0.38)	2.49 [2.32, 2,66] (0.09, 0.41)	3.19 [2.90, 3.47] (0.15, 0.46)	3.54 [3.36, 3.72] (0.09, 0.48)
Non-reactivity	2.16 [2.06, 2.26] (0.05, 0.23)	2.38 [2.27, 2.49] (0.06, 0.23)	2.79 [2.64, 2.95] (0.08, 0.28)	3.41 [3.24, 3.57] (0.09, 0.23)
Mindfulness facets (unstandardized scores) at post-treatment				
	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)
Observing	2.80 [2.60, 3.00] (0.10, 0.41)	4.14 [3.81, 4.47] (0.17, 0.23)	3.25 [2.93, 3.56] (0.16, 0.30)	4.12 [4.00, 4.24] (0.06, 0.22)
Describing	2.96 [2.79, 3.13] (0.09, 0.49)	3.42 [3.20, 3.64] (0.11, 0.62)	3.23 [3.05, 3.41] (0.09, 0.43)	3.92 [3.76, 4.08] (0.08, 0.39)
Acting with awareness	2.23 [2.06, 2.39] (0.09, 0.22)	2.87 [2.67, 3.07] (0.10, 0.33)	3.09 [2.95, 3.22] (0.07, 0.17)	3.44 [3.31, 3.56] (0.07, 0.33)
Non-judging	2.52 [2.39, 2.65] (0.07, 0.36)	2.49 [2.32, 2,66] (0.09, 0.29)	3.19 [2.90, 3.47] (0.15, 0.36)	3.54 [3.36, 3.72] (0.09, 0.39)
Non-reactivity	2.16 [2.06, 2.26] (0.05, 0.30)	2.38 [2.27, 2.49] (0.06, 0.21)	2.79 [2.64, 2.95] (0.08, 0.16)	3.41 [3.24, 3.57] (0.09, 0.23)

health. We confirmed four mindfulness profiles identified cross-sectionally in previous research: "Very low mindfulness," "Non-judgmentally aware," "Judgmentally observing," and "High mindfulness." We also demonstrated that patients show changes in their profiles across MBCT. It is notable that no patients' profile changed to "Very low mindfulness" and all patients starting with "High mindfulness" kept this profile. Furthermore, change in profile versus keeping the same profile (except for keeping "High mindfulness") was related to better treatment outcome: patients

Table 6 Latent transition probabilities based on the estimated model for the four-class LTA model for which means were restricted across time points

		Post-MBCT			
		Very low mindfulness	Judgmentally observing	Non-judgmentally aware	High mindfulness
Baseline	Very low mindfulness	0.34	0.00	0.42	0.18
	Judgmentally observing	0.00	0.74	0.00	0.26
	Non-judgmentally aware	0.00	0.01	0.61	0.38
	High mindfulness	0.00	0.00	0.00	1.00

Table 7 Residualized change scores for the primary (BDI-II) and secondary outcomes for the specific transition paths of the four-class LTA model for which means were restricted across time points

		Post-MBCT				Wald-chi-square test statistic (df = 7)
		Mean (*SE*)	Mean (*SE*)	Mean (*SE*)	Mean (*SE*)	
		Depressive symptoms (BDI-II)				94.17 ***
		Very low mindfulness	Judgmentally observing	Non-judgmentally aware	High mindfulness	
Baseline	Very low mindfulness	5.01 (1.25)***		−2.86 (1.31)*	−12.05 (3.02)***	
	Judgmentally observing		1.82 (0.81)*		−8.98 (1.98)***	
	Non-judgmentally aware			3.38 (0.90)***	−4.42 (1.63)**	
	High mindfulness				0.62 (0.60)	
		Overall functional impairment (OQ45)				63.68 ***
		Very low mindfulness	Judgmentally observing	Non-judgmentally aware	High mindfulness	
Baseline	Very low mindfulness	9.05 (2.21)***		−4.24 (2.40)	−37.52 (9.09)***	
	Judgmentally observing		3.41 (1.60)*		−14.41 (4.82)**	
	Non-judgmentally aware			6.93 (1.83)***	−3.42 (3.44)	
	High mindfulness				−1.54 (1.99)	
		Worry (PSWQ)				113.69 ***
		Very low mindfulness	Judgmentally observing	Non-judgmentally aware	High mindfulness	
Baseline	Very low mindfulness	6.37 (0.84)***		−2.51 (1.24)*	−19.26 (3.93)***	
	Judgmentally observing		2.70 (0.83)**		−3.91 (2.39)	
	Non-judgmentally aware			2.72 (0.90)**	−5.94 (2.35)*	
	High mindfulness				−1.11 (1.18)	
		Self-compassion total score				177.99 ***
		Very low mindfulness	Judgmentally observing	Non-judgmentally aware	High mindfulness	
Baseline	Very low mindfulness	−3.73 (0.46)***		1.47 (0.59)*	9.68 (1.90)***	
	Judgmentally observing		−2.19 (0.36)***		4.27 (1.30)**	
	Non-judgmentally aware			−1.26 (0.39)**	3.33 (1.12)**	
	High mindfulness				1.11 (0.47)*	

Asterisks indicate whether the mean residualized change score for a specific transition path is significantly different from 0 (i.e., whether Mean/SE ≥ 1.96 or ≤ −1.96). A (significant) negative residualized change score for depressive symptoms, overall function, and worry would indicate that patients within such a path did better (improved more) compared to the full sample average (residualized change score of 0) whereas a positive residualized change score would indicate that patients did worse compared to full sample. For self-compassion, the meaning of negative and positive residualized change scores are inverted.

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

whose profile did not change showed less than average improvement (relative to the full sample), patients changing in profile showed a greater than average improvement (relative to full sample) in mental health outcomes. Patients who kept "High mindfulness" showed an average improvement in mental health outcomes (Figure 4).

The four profiles we now identified by LTA were highly similar in structure compared to profiles previously identified by latent profile analysis (LPA) in another depression sample (Gu et al., 2020), other clinical samples (Lam et al., 2018; Wang et al., 2022), and non-clinical samples (Bravo et al., 2016; Bravo et al., 2018; Bronchain et al., 2021; Calvete et al., 2020; Ford et al., 2020; Pearson et al., 2015; Sahdra et al., 2017). In the same sample as used in the current paper, we previously established this similar four-profile solution by means of LPA (Lubbers et al., 2024). It is important to note that demonstrating the same four profiles with LTA as were found with LPA is not trivial. In contrast to LPA, by including measurements at two timepoints, LTA allows for more unbiased estimation

Table 8 Pair-wise comparison between transition paths that represent patients whose mindfulness profile changed versus those patients who did not change in mindfulness profile

Transition path of patients whose mindfulness profile changed	Residualized change of patients whose mindfulness profile changed – residualized change of patients who did not change in profile (*SE*)	*p*-value
Depressive symptoms (BDI-II)		
VLM → HM	−17.06 (3.24)	< *0.001*
VLM → NJA	−7.87 (1.96)	< *0.001*
JO → HM	−10.80 (2.23)	< *0.001*
NJA → HM	−7.80 (1.98)	< *0.001*
Overall functional impairment (OQ-45)		
VLM → HM	−46.57 (9.34)	< *0.001*
VLM → NJA	−13.28 (3.53)	< *0.001*
JO → HM	−17.81 (5.25)	0.001
NJA → HM	−10.34 (4.18)	0.013
Worry (PSWQ)		
VLM → HM	−25.63 (4.03)	< *0.001*
VLM → NJA	−8.88 (1.59)	< *0.001*
JO → HM	−6.61 (2.62)	0.012
NJA → HM	−8.66 (2.64)	0.001
Self-compassion (SCS) total score		
VLM → HM	13.41 (1.96)	< *0.001*
VLM → NJA	5.20 (0.80)	< *0.001*
JO → HM	6.45 (1.38)	< *0.001*
NJA → HM	4.59 (1.23)	< *0.001*

[#]For each outcome measure, transition paths of patients with the same baseline profile and whose profile changed into another profile are compared with paths of patients whose profile did not change; e.g., for depressive symptoms, the path "JO to HM" is compared to the path "JO – JO"; a difference score of −10.80 and *p*-value of < 0.001 indicates that the patients whose mindfulness profile changed improved more compared to those who did not change in mindfulness profile.

VLM very low mindfulness, *JO* judgmentally observing, *NJA* non-judgmentally aware, *HM* high mindfulness

of baseline profiles, as it takes into account within- and between-patient variability.

Based on these four profiles, we now performed a crucial next step by assessing whether patients' mindfulness profiles change over the course of MBCT and whether these changes are related to treatment outcomes. Indeed, our main analysis shows that a considerable part of patients (38%) acquire another mindfulness profile after MBCT. Whether a patient will change his/her profile (transitions to another subgroup) may depend on the magnitude of change, but also on the specific domains of improvement. Moreover, the mindfulness profiles of these patients exclusively changed to profiles previously found to be related to better mental health. In line with this, our results show that MBCT was more beneficial for patients whose mindfulness profile changed compared to those that kept the same profile after MBCT. Being able to predict for which patients a beneficial change in mindfulness profile is more or less likely to occur might help in deciding for which patients MBCT works best. In this study, none of demographic and clinical characteristics predicted whether a patient with a certain baseline profile (e.g., "Very low mindfulness") did or did not show a change in profile.

To arrive at the study results, we employed latent transition analysis, an innovative method, and a notable strength of this study. Specifically, we utilized LTA as a person-centered approach to contribute to current literature by advancing our understanding of differential changes in mindfulness profiles after MBCT. While variable-centered methods examine overall associations between variables and provide average clinical effects, LPA and LTA identify subgroups based on similarities in a set of response variables (such as the five facets of mindfulness). This allows assessment of whether (i) patients with a specific mindfulness profile relate differentially to measures of mental health; (ii) whether different profiles are predictive for treatment response, potentially enhancing personalized treatment allocation;

Table 9 Latent profile membership counts and mean scores on mindfulness facets of the Five Facet Mindfulness Questionnaire (FFMQ) across the latent profiles for the four-class LTA model for which means were freely estimated at each time point

	Very low mindfulness	Judgmentally observing	Non-judgmentally aware	High mindfulness
Latent profile membership count (*n*) and proportions at baseline				
	n (proportion)	*n* (proportion)	*n* (proportion))	*n* (proportion)
Baseline	118.82 (0.24)	140.79 (0.28)	125.68 (0.25)	114.71 (0.23)
Post-treatment	94.83 (0.19)	140.79 (0.28)	122.15 (0.24)	142.24 (0.28)
Mindfulness facets (unstandardized scores) at baseline				
	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)
Observing	2.80 [2.53, 3.07] (0.14, 0.37)	4.04 [3.87, 4.22] (0.09, 0.24)	2.82 [2.31, 3.34] (0.26, 0.47)	3.84 [3.68, 4.00] (0.08, 0.34)
Describing	2.96 [2.61, 3.31] (0.18, 0.58)	3.33 [3.09, 3.56] (0.12, 0.65)	3.05 [2.66, 3.43] (0.20, 0.61)	3.90 [3.68, 4.13] (0.11, 0.36)
Acting with awareness	2.12 [1.68, 2.56] (0.23, 0.24)	2.83 [2.66, 2.99] (0.09, 0.42)	2.91 [2.49, 3.34] (0.22, 0.35)	3.28 [3.12, 3.49] (0.08, 0.46)
Non-judging	2.33 [1.92, 2.73] (0.21, 0.27)	2.40 [2.20, 2.60] (0.10, 0.41)	3.20 [2.67, 3.74] (0.27, 0.48)	3.27 [3.11, 3.43] (0.08, 0.42)
Non-reactivity	2.10 [1.95, 2.24] (0.07, 0.26)	2.24 [2.11, 2.38] (0.07, 0.21)	2.42 [2.13, 2.72] (0.15, 0.22)	3.13 [2.98, 3.28] (0.08, 0.26)
Mindfulness facets (unstandardized scores) at post-treatment				
	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)	Mean [CI 95%] (*SE*, variance)
Observing	3.03 [2.80, 3.26] (0.12, 0.39)	4.22 [4.06, 4.37] (0.08, 0.22)	3.24 [2.93, 3.56] (0.16, 0.31)	4.16 [4.04, 4.27] (0.06, 0.20)
Describing	3.04 [2.80, 3.29] (0.13, 0.48)	3.44 [3.24, 3.63] (0.10, 0.59)	3.23 [3.01, 3.45] (0.11, 0.44)	3.95 [3.76, 4.15] (0.10, 0.33)
Acting with awareness	2.36 [1.93, 2.78] (0.22, 0.23)	3.00 [2.84, 3.15] (0.08, 0.31)	3.15 [2.98, 3.31] (0.08, 0.15)	3.48 [3.35, 3.62] (0.07, 0.34)
Non-judging	2.56 [2.35, 2.78] (0.11, 0.30)	2.71 [2.51, 2.91] (0.10, 0.33)	3.34 [2.87, 3.81] (0.24, 0.38)	3.62 [3.48, 3.76] (0.07, 0.37)
Non-reactivity	2.42 [2.18, 2.67] (0.13, 0.27)	2.66 [2.49, 2.82] (0.08, 0.24)	2.91 [2.66, 3.16] (0.13, 0.19)	3.50 [3.38, 3.61] (0.06, 0.23)

and (iii) whether patients develop their set of skills differentially during treatment, which may help tailoring the intervention to individual needs.

Notwithstanding the advantages, conducting LTA is a complex process involving several potentially impactful decisions (on model selection) informed by a range of (fit) criteria and other deliberations. Because this is, to our knowledge, the first LTA study employed within the context of MBCT, we believe these choices merit a timely discussion. For example, the fit indices of the cross-sectional LPAs and the LTA models of profiles did not consistently point to a four-profile solution, but neither to any neighboring profile solution, which is common in LPA/LTA research (Ryoo et al., 2018; Spurk et al., 2020). In line with recommendations by other researchers (see, Spurk et al., 2020), we included previous studies and theory upon deciding on the optimal number of profiles. In combination with visual inspection of our profiles, we settled for the four-profile LTA models. It is important to note, however, that future research may benefit from exploring other solutions (e.g., five profiles).

Another key decision was to present the invariant LTA model as the main analysis and the variant model as sensitivity analysis. This decision is debatable because longitudinal measurement invariance could not be established, suggesting that a variant model would be more suitable for our data. However, (visual) inspection of the four profiles of the variant LTA model revealed strikingly similar profiles at both time points. We argue that since patients improved on all aspects of mindfulness at the group level, the variant model yielded slightly higher means for each facet within equivalent profiles. Consequently, relatively more patients were assigned to the equivalent profile before and after MBCT, which led to less transition between profiles in the variant model (12%) compared to the invariant model (38%). The invariant model was preferred because it made interpreting changes over time more straightforward and was less affected by data sparseness in terms of nearly empty transition paths. Most importantly,

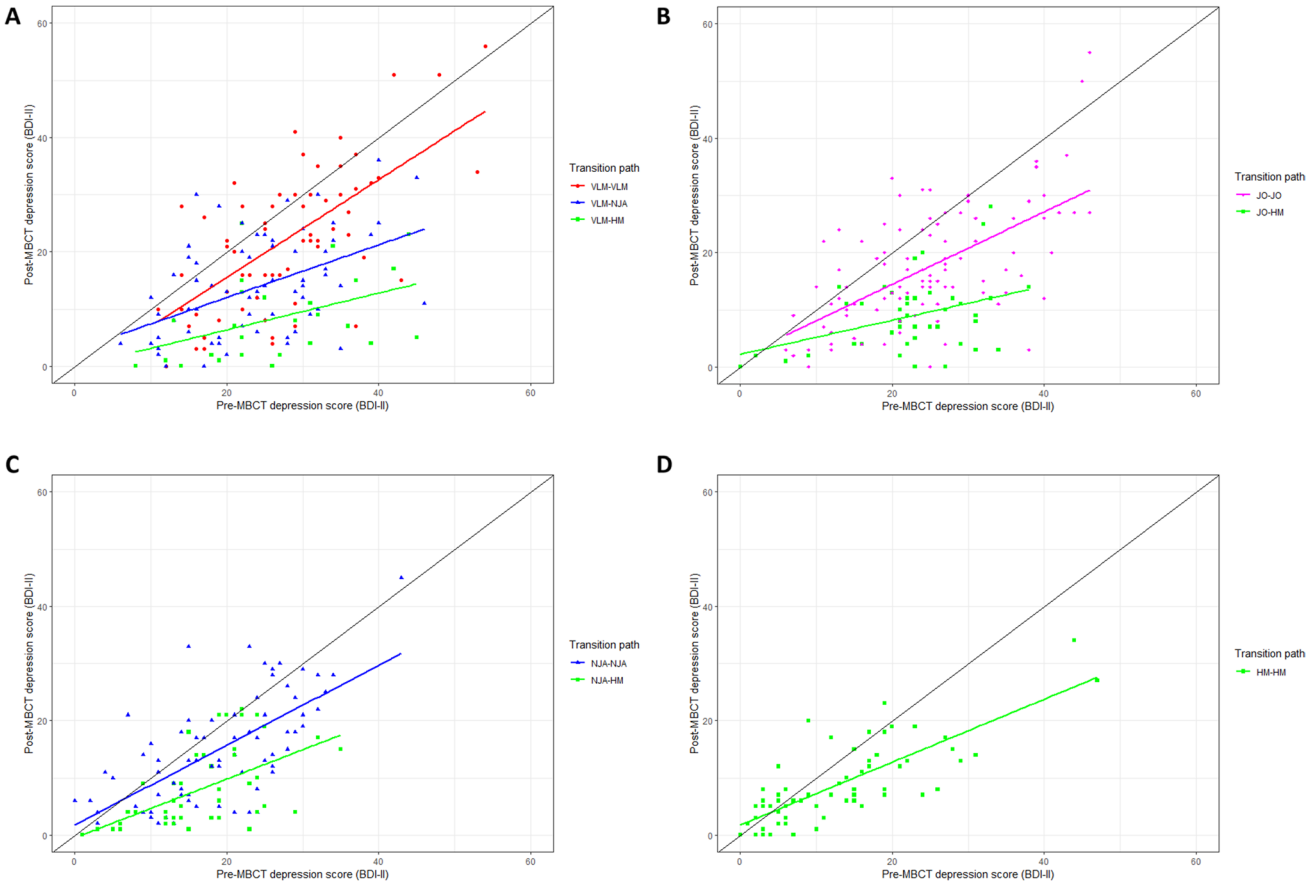

Fig. 3 Comparison of the differential relations between transition paths from the different mindfulness profiles and change in depression scores across MBCT. Note: This figure shows individual pre- and post-MBCT depression scores and least square regression lines for the different transition paths. The different panels (**A**–**D**) compare patients whose mindfulness profile changed versus those patients that do not change in mindfulness profile, that had pre-treatment profile **A** "Very low mindfulness," **B** "Judgmentally observing," **C** "Non-judgmentally aware," and **D** "High mindfulness." VLM = Very low mindfulness; JO = Judgmentally observing; NJA = Non-judgmentally aware; HM = High mindfulness

the direction of change of both models was consistent: neither model showed transition into profiles considered to be related to poorer mental health. These converging results on the two models point towards robustness of our results.

Previous research has shown that mindfulness training induces both state and trait changes, potentially even exerting long-term effects on personality (Crescentini & Capurso, 2015; Tang & Tang, 2017). For example, large pre- to post-changes in mindfulness after MBCT predicted long-term changes in neuroticism at 15 months follow-up (Spinhoven et al., 2017). LTA offers a compelling approach to study how states of mindfulness cultivated through MBCT would result in long-term changes in dispositional aspects of mindfulness, and how these changes may eventually impact personality traits.

To be able to determine how MBCT changes state and trait aspects of mindfulness, distinguishing between them within a measurement tool is crucial. Initial steps have been taken to distinguish trait-like and state-like aspects of mindfulness within the FFMQ by Truong et al. (2020). Changes in state mindfulness could not be reliably captured by either the total score or the subscale scores of the two FFMQ measures (original FFMQ and 18-item FFMQ-SF developed by Medvedev et al., 2018). Moreover, stable long-lasting effects in trait mindfulness could be reliably assessed with the FFMQ total score while the individual subscales were less reliable in detecting these long-term changes. In addition, they found that the *non-judgmental* subscale contained most state items, indicating that the various aspects of being non-judgmental are most dynamic and amendable and therefore should be the primary target of MBIs (Truong et al., 2020).

The current study utilized the Dutch FFMQ-SF (Bohlmeijer et al., 2011) to assess changes in trait mindfulness. In line with previous research using variable-centered analyses, our results show that mindfulness questionnaires (among which the FFMQ-SF: Bohlmeijer et al., 2011) are sensitive to

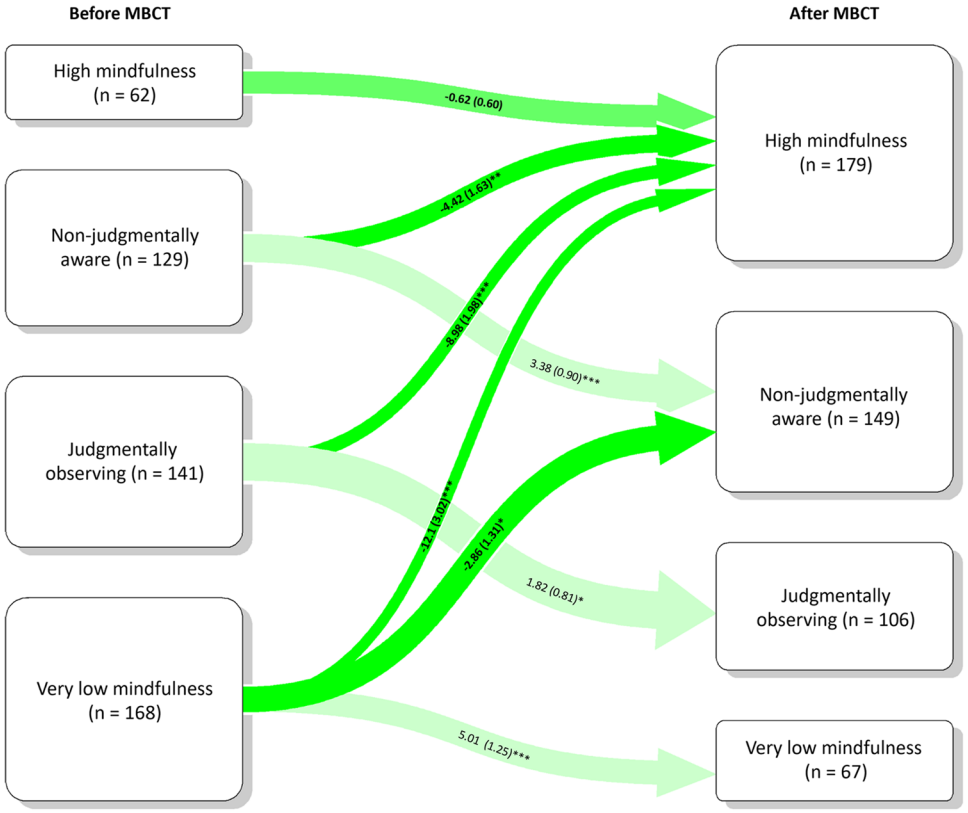

Fig. 4 Change in mindfulness profile across MBCT and its differential relation to residualized change in depressive symptoms. Note: The arrows shows transition of MDD patients' mindfulness profiles after participation in Mindfulness-Based Cognitive Therapy (MBCT). Thickness of the arrows represent the relative amount of patients within a transition path. Pre- to post-MBCT change in terms of residualized change (standard error) of depressive symptoms are depicted within the arrows. Negative residualized change scores (bright green) indicate greater than average improvement, whereas positive residualized change (dull green) indicates less than average improvement in depressive symptoms. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

pick-up changes in the five facets of mindfulness in response to an MBI and that those changes are related to improvements in mental health outcomes.

Limitations and Future Research

There are important limitations to consider. First, patients with and without post-treatment measurements differed slightly in terms of demographic and clinical variables, which may have caused a bias in obtained results. For instance, although patients without a full dataset attended a considerable number of session (6.6 out of 9 on average; 82% ≥ 4 sessions), they attended less sessions compared to patients with a full dataset (8.4 out of 9; 99.6% ≥ 4 sessions). This might have led to overestimation of MBCT (transition) effects, assuming that fewer sessions lead to less effects. To address this limitation, we have ran a four-profile invariant and variant latent LTA on ten imputed datasets ($n = 754$). The results of these sensitivity analyses were consistent with those presented above. Second, notwithstanding the large sample of this study, which is a strength, it is based on a naturalistic retrospective cohort of patients from a single treatment site. Collecting data at one site might limit generalizability. As mentioned, independent samples from other sites and countries show comparable baseline profiles, but as this is the first study making use of LTA from pre-to-post MBCT, replication is warranted. Third, because we do not have an (active) control condition, our inferences about the causal effects of MBCT in change over time have to be further explored in controlled trials. In line with this, a recent meta-analysis (Baer et al., 2019) provided only partial support for the differential sensitivity of mindfulness questionnaires in response to treatment-induced changes. Drawing from 37 RCTs comparing evidence-based MBIs to active controls, Baer et al. (2019) found that the total score, and specific facets—*observing, non-judging, and non-reactivity*—demonstrated differential sensitivity to change. However, this sensitivity diminished after controlling for session time. This underscores the need for further clarification on how mindfulness skills are acquired in MBIs and whether revisions of existing mindfulness scales would increase their specificity to changes in mindfulness (Baer et al., 2019). Fourth, the LTA was restricted to pre- and post-MBCT measurements which prevented more pronounced conclusions about the timing of change (of mindfulness profiles) during MBCT, and limits inferences that can be made regarding the stability of mindfulness profiles over a longer follow-up period.

The field of MBCT for depression would benefit from well-powered longitudinal studies measuring outcomes and possible mediating variables at multiple time points, also during the intervention period. This may provide more insight into the temporal order of change (for different subgroups) and stability of change through time (Kazdin, 2007). Finally, although the FFMQ is one of the most commonly

used questionnaires to assess mindfulness skills, differences in instruments (Park et al., 2013) could potentially result in different LPA/LTA results. Future research should examine whether the identified profiles are robust across various measures of mindfulness.

The presented findings suggest (but do not prove) that an MBCT that changes the mindfulness skills of a person (here operationalized as change in mindfulness profile) might be more effective than an MBCT that leaves profiles unchanged. This might mean that treatment outcome might improve by tailoring MBCT more to the needs of someone with a particular profile. More specifically, as can be derived from Figure 4, a considerable number of patients has a "Judgmentally observing" or "Non-judgmentally aware" profile before MBCT, and the majority with such an uneven profile did not change in profile through training. Patients with "Judgmentally observing" may benefit more from MBCT if emphasis is put on approaching difficult emotions in a more self-compassionate and non-judgmental way. Patients with a "Non-judgmentally aware" profile, on the other hand, might improve most by making thoughts, emotions, and sensations more explicit (*observing* and *describing*). Alternatively, or additionally, tailoring homework (exercises) to specific needs of individuals based on their mindfulness profile may also increase chances of acquiring a more adaptive profile. This hypothesis could be tested in an RCT where patients with a "Non-judgmentally aware" or "Judgmentally observing" profile are randomized to a profile-informed or generic arm. Another option would be to make use of upcoming factorial study designs such as those proposed for mindfulness by Buskbjerg et al. (2023). Another additional line of thought would be to study whether post-treatment profiles can inform further treatment allocation, for example, for offering a Mindfulness-Based Compassionate Living (MBCL: Van den Brink & Koster, 2015) training directly after MBCT for those with a "Judgmentally observing" profile after MBCT.

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Author Contribution Jelle Lubbers: methodology, data curation, formal analysis, visualization, writing—original draft. Philip Spinhoven: methodology, investigation, formal analysis, conceptualization, supervision, writing—review and editing. Mira Cladder-Micus: conceptualization, writing—review and editing. Jan Spijker: conceptualization, supervision, writing—review and editing. Anne Speckens: clinical director of the Radboudumc Centre for Mindfulness where diagnostic assessments took place and MBCT courses were provided, conceptualization, supervision, supervision of clinical assessments and MBCT courses, writing—review and editing. Dirk Geurts: investigation, data curation, conceptualization, supervision, writing—review and editing.

Data Availability The data and Mplus code used in the analyses performed in this study are publicly available in the Radboud Data Repository: https://doi.org/10.34973/ffww-3195. The supplementary materials contain a detailed description on the folder structure and files within the data repository.

Declarations

Ethics Statement The study procedures were conducted in accordance with the 1964 Helsinki Declaration and its subsequent amendments. Informed consent was obtained by means of an opt-out system, meaning that patients were informed that their anonymized outcome data could be utilized for scientific research purposes. The medical ethical committee waived the need for approval (CMO dossier: 2020–7226) under the Dutch Medical Research Involving Human Subjects Act, as participants were not subjected to additional procedures or required to follow rules of behavior.

Artificial Intelligence Statement Artificial intelligence was used to improve English language of the manuscript.

Conflict of Interest The authors declare no competing interests.

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