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From a state to a trait: Trajectories of state mindfulness in meditation during intervention predict changes in trait mindfulness

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Abstract

Theory suggests that heightening *state* mindfulness in meditation practice over time increases *trait* mindfulness, which benefits psychological health. We prospectively examined individual trajectories of state mindfulness in meditation during a mindfulness-based intervention in relation to changes in trait mindfulness and psychological distress. Each week during the eight-week intervention, participants reported their state mindfulness in meditation after a brief mindfulness meditation. Participants also completed pre- and post-intervention measures of trait mindfulness and psychological symptoms. Tests of combined latent growth and path models suggested that individuals varied significantly in their rates of change in state mindfulness in meditation during the intervention, and that these individual trajectories predicted pre-post intervention changes in trait mindfulness and distress. These findings support that increasing state mindfulness over repeated meditation sessions may contribute to a more mindful and less distressed disposition. However, individuals' trajectories of change may vary and warrant further investigation.

Keywords

Mindfulness; state; trait; meditation; latent growth

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1.0 Introduction

Although mindfulness-based interventions fundamentally rely on the cultivation of mindfulness, the nature of this cultivation process is not well understood scientifically. Mindfulness is characterized by a nonjudgmental awareness of and attention to moment-by-moment cognition, emotion, and sensation without fixation on thoughts of past and future (cf. Kabat-Zinn, 1990). It has been conceptualized as a *state* practiced in mindfulness meditation (e.g., Lau et al., 2006) and as a *trait*, in terms of one's predisposition to be mindful in daily life (e.g., Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). Without intervention, trait mindfulness appears to be stable over time (e.g., Brown & Ryan, 2003). However, several studies have found that mindfulness-based interventions (MBIs; e.g., Mindfulness-Based Stress Reduction, or MBSR; Kabat-Zinn, 1990) increase trait mindfulness on average and that such changes in trait mindfulness contribute to psychological health benefits from MBIs (e.g., Carmody, Reed, Kristeller, & Merriman, 2008; Shahar et al., 2010; Shapiro et al., 2008). In MBIs repeated meditation practice is thought to cultivate greater state mindfulness over time, which presumably contributes to increases in trait mindfulness. The scientific literature has not adequately examined, however, whether trajectories of change in state mindfulness in meditation over the course of an MBI relate to changes in trait mindfulness and psychological health.

Buddhist-based theories, and MBIs derived from them, posit that individuals can increase their propensity toward mindfulness in everyday life – i.e., trait mindfulness – by evoking the state of mindfulness repeatedly across meditation sessions (Garland et al., 2010; Davidson, 2010; Vago & Silbersweig, 2012). Theoretically, as individuals engender deeper states of mindfulness during meditation, they develop a greater tendency to exhibit mindful attitudes and behaviors outside of meditation, in the context of daily life. From a neurobiological standpoint, it likewise has been proposed that recurrent activation of the neural networks that instantiate state mindfulness in meditation lead to neuroplastic changes over time in brain function and structure which would promote greater trait mindfulness (Garland et al., 2010). Neuroscientific evidence on meditation and mindfulness practitioners provides some indirect support for this proposition, in that practitioners evidence significant differences (compared to non-meditators) and changes (pre-post intervention) in the function and structure of neural circuits that subserve neurocognitive processes linked with mindfulness (cf. Holzel et al., 2011).

In spite of this theorizing, little research has directly tested the proposition that increases in state mindfulness in meditation contribute to increases in trait mindfulness over the course of an MBI. Carmody and colleagues (2008) examined whether pre-post MBI changes in state mindfulness (assessed immediately after a brief period of quiet sitting, not meditation specifically) were associated with pre-post changes in trait mindfulness. Surprisingly, the relation was not significant. Other studies have examined the relation between state and trait mindfulness more generally, cross-sectionally (e.g., Thompson & Waltz, 2007), but this approach does not test the directional hypothesis of increases in state mindfulness (i.e., learning) through meditation leading to increases in trait mindfulness. Even a simple pre-post approach, such as Carmody et al.'s (2008), may be limited. Assessing only two sessions pre- and post-intervention may not reliably represent an individual's developmental

trajectory (Rogosa & Willett, 1985) as a mindfulness practitioner. To more reliably assess trajectories of change in state mindfulness in meditation during an MBI, state mindfulness may need to be measured repeatedly, over multiple meditation sessions, during the intervention period.

With sufficient repeated measures of state mindfulness in meditation during an MBI, individual variability in trajectories of change can be examined. This has not been an explicit focus in previous research but may be important for understanding how recurrent activation of the state of mindfulness can be consolidated into the trait of mindfulness. Individual differences in rates of learning and change have been observed in other domains (Ackerman, 1987; Rogosa & Willett, 1985) and may exist for MBI practitioners. Anecdotally, some participants bemoan their difficulties learning to be mindful in meditation while others seem to take to the practice more quickly. Such difficulty versus ease of learning may stem at least partly from individual differences (e.g., personality traits, gene X environment interactions; cf. Uher, 2011) in predisposition toward neuroplastic changes proposed to underlie increases in mindfulness. Individuals who are predisposed to more rapidly develop the capacity to access deeper states of mindfulness across repeated meditation sessions may be more likely to increase in trait mindfulness by the end of an MBI. Therefore, individual variability in the rate of increase in state mindfulness over repeated meditations is important to assess and may be critical for understanding the relation between changes in state mindfulness in meditation and changes in trait mindfulness.

Individual rates of change in state mindfulness in meditation over the course of an MBI may also be important for improvements in psychological health. At least two studies have found that pre-post MBI changes in state mindfulness are associated with psychological health outcomes (Gayner et al., 2012; Lau et al., 2006). As mentioned earlier, changes in trait mindfulness also are associated with such outcomes (e.g., Carmody et al., 2008; Shahar et al., 2010; Shapiro et al., 2008). Given that increases in state mindfulness in meditation are theorized to lead to greater trait mindfulness over time and trait mindfulness benefits psychological health, it seems likely that trajectories of change in state mindfulness in meditation might be associated with psychological health only indirectly, through changes in trait mindfulness. On the other hand, it also is conceivable that individuals' rates of change in state mindfulness may be indicative of propensity to change in other adaptive ways as well; from this perspective, rates of change in state mindfulness may also uniquely predict changes psychological health. Such questions remain relatively unexplored and require better assessment of mindfulness practitioners' trajectories of state mindfulness in meditation along with measures of trait mindfulness and psychological health.

Therefore, the purpose of the present research was to prospectively examine individual trajectories of state mindfulness in meditation over the course of an MBI, using multiple repeated measures of state mindfulness in meditation, in relation to changes in trait mindfulness and psychological health. We had three hypotheses:

1. There would be significant variability in individual trajectories of state mindfulness in meditation.

2. These individual trajectories of state mindfulness in meditation would predict residualized change in trait mindfulness from pre- to post-intervention.
3. Individual trajectories of state mindfulness in meditation would predict residualized change in psychological distress from pre- to post-intervention. We did not have a specific *a priori* hypothesis for whether trajectories of state mindfulness would be linked to post-intervention distress only indirectly, through changes in trait mindfulness, or also directly, independent of trait mindfulness. Therefore, we explored both possibilities.

2.0 Method

The study employed prospective, observational design with repeated measures over the course of a mindfulness-based intervention.

2.1 Participants

Participants were recruited from an eight-week, self-pay, community-based mindfulness program that is based on MBSR (Kabat-Zinn, 1990) and offered several times each year by the University of North Carolina Program on Integrative Medicine. At an orientation session prior to the start of the intervention, program participants were given the option to enroll in the research for a modest reduction in the program fee. Program participants were eligible for the study if they were at least 18 years old, fluent in English, and able to complete repeated surveys online.

The sample of consisted of $N = 235$ research participants. Demographic characteristics of the sample were: 75% female; 83% White; $M_{age} = 44.83$, $SD_{age} = 14.32$; 62% with graduate degrees; 60% with household income > $60,000. Approximately 57% of participants completed at least four weekly assessments and pre-post measures.

2.2 Measures

2.2.1 Trait mindfulness—The Five-Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) is a widely used, 39-item inventory assessing trait mindfulness overall and as a multidimensional construct. Several studies attest to the instrument's psychometric properties (e.g., Baer et al., 2006; Christopher, Neuser, Michael, & Baitmangalkar, 2012). Items were rated on a 5-point scale ranging from 1 (*never or very rarely true*) to 5 (*very often or always true*). Higher total scale scores indicate higher overall trait mindfulness, the focus of the present research.

2.2.2 State mindfulness—The Toronto Mindfulness Scale (TMS; Lau et al., 2006) is a 13-item instrument assessing state mindfulness, with good psychometric properties. Items are rated on a 5-point scale ranging from 0 (*not at all*) to 4 (*very much*). Higher total scores indicate higher overall state mindfulness.

2.2.3 Psychological distress—The Symptom Checklist 90 – Revised (SCL-90-R; Derogatis, 1983) is a 90-item instrument that is widely used to assess psychological distress across nine symptom dimensions. Internal consistency, temporal stability, and validity of the scale have been established (e.g., Hafkenscheid, 1993). The items are rated on a 5-point

scale ranging from 0 (*not at all*) to 4 (*extremely*). Altogether, higher mean scores indicate greater distress severity, the focus of the present research.

2.3 Procedure

Instructions for research participation were first provided at the mindfulness program orientation session, a week before the start of the intervention. After this orientation, consented participants were emailed a link to an online survey to be completed prior to the first mindfulness class. The survey contained the FFMQ and the SCL-90-R, followed by other measures that were unrelated to the present study. This online survey was emailed to participants again after completion of the eight-week mindfulness program, to administer the FFMQ and SCL-90-R within the week following the intervention.

Additionally, after each weekly class during the mindfulness program, participants received an emailed link to a different online survey. Participants were instructed to first complete a 10-minute mindfulness meditation, using a technique learned in the intervention (e.g., body scan, mindful breathing). Immediately after the meditation, participants were presented with the TMS and asked to use this scale to rate their experience during the meditation.

2.4 Statistical Analyses

Preliminary analyses assessed bivariate correlations between variables. Additionally, a repeated measures ANOVA assessed whether state mindfulness scores increased during the intervention, on average.

To test the main hypotheses, we employed latent growth curve (LGC) modeling. LGC modeling was well-suited to our interests because it assesses variability in individuals' trajectories of change in a variable over time, and it also can be expanded to test antecedents and consequences of such trajectories of change. In a basic LGC model, a latent variable is used to represent individual (and potentially variable) trajectories of change on a measure over time. Paths from this latent trajectory variable to the repeated observed scores are used to indicate the rate of time. If trajectories of change are linear, then they can be represented as a latent slope variable that loads onto the repeated observed scores with a constant increment of change (e.g., change per week over seven weekly measures, as in the present research). Preliminary testing with our data confirmed that a latent slope model fit the data better than curvilinear trajectories. In addition to the latent trajectory/slope variable, a separate latent variable represents individual intercepts, or estimated initial status.

This basic LGC model was the basis for the first model that we tested, Model 1 (see top section of Figure 1). Beyond overall model fit, of interest in Model 1 was the estimated mean and variance of the latent slope of state mindfulness. The variance indicates the degree of individual variability in the rate of change in state mindfulness over the course of the MBI.

If it is determined that such a LGC model fits the data well, then the model can be expanded by adding additional variables as predictors and/or consequences of the intercept and slope latent variables. In the present research, these additional variables were baseline and post-

intervention levels of trait mindfulness and distress, which we added as observed variables to form combined LGC and path models. Three such models were tested.

In the first combined model, Model 2, we examined whether the slope of state mindfulness (representing individual trajectories of change) would predict post-intervention trait mindfulness, beyond the influence of baseline trait mindfulness. This model also tested whether baseline trait mindfulness predicted the slope of state mindfulness.

Then, we added baseline distress and post-intervention distress to test the full model shown in Figure 1. In this model, Model 3, we tested whether the slope of state mindfulness predicted post-intervention levels of both trait mindfulness and distress, after accounting for baseline levels of these variables, allowing for trait mindfulness and distress to covary at both time points. We also tested whether baseline distress predicted the slope of state mindfulness.

A final model, Model 4, tested whether the data would better fit a model in which the slope of state mindfulness was not directly related to distress, such that its influence was only indirect, through trait mindfulness. Model 4 thus differed from Model 3 only by constraining the direct path from the slope of state mindfulness to post-intervention distress to zero (indicating no direct relation).

All models were run in Mplus version 7.11. Overall model fit was determined based on: the chi-square value divided by the degrees of freedom (X^2/df; acceptable fit < 2.0; Carmines & McIver, 1981); the comparative fit index (CFI; good fit > .95 and adequate fit > .90; Hu & Bentler, 1999); and the root-mean-square error of approximation (RMSEA; good fit < .06 and adequate fit < .08; Hu & Bentler, 1999). These standards can be relatively difficult to attain with LGC models, including those combined with path models (Widaman & Thompson, 2003). Therefore, LGC models with good fit by these standards are notable. The comparison of Model 3 with Model 4 was performed using a chi-square difference test. Missing data were handled using Full Information Maximum Likelihood estimation.

3.0 Results

3.1 Preliminary analyses

Inter-correlations and descriptive statistics, including means, standard deviations, and Cronbach's alphas for all measures, are shown in Table 1. Baseline levels of trait mindfulness and psychological distress were positively associated with respective post-intervention levels, although paired *t*-tests confirmed that trait mindfulness increased ($t[101] = 11.53$, $p < .001$, $d = 1.14$) and psychological distress decreased ($t[86] = -5.93$, $p < .001$, $d = -.64$) from baseline to post-intervention. Additionally, a repeated measures ANOVA indicated that, on average, state mindfulness scores increased in a linear fashion over the seven weekly assessments, Wilks' Lambda = .33, $F(6, 34) = 11.74$, $p < .001$, $\eta^2_{partial} = .67$.

3.2 Model 1 (Hypothesis 1): Did individuals' slopes of state mindfulness during the intervention vary?

The basic latent growth curve model fit the data well, $X^2/df = 1.55$, RMSEA = .05 (95% CI = .01–.09), CFI = .98. There was significant variability in the slope of state mindfulness ($M = 1.94$, $SD = 1.52$; $ps < .001$). That is, while on average state mindfulness increased by almost two points (scale range = 0 – 43), the rate of increase in state mindfulness was greater for some individuals than for others (including no change for some). The slope and intercept of state mindfulness did not significantly covary, indicating no relation between individuals' estimated baseline status of state mindfulness and their rate of change.

3.3 Model 2 (Hypothesis 2): Did individual slopes of state mindfulness predict post-intervention trait mindfulness?

Model 2 tested relations between the slope of state mindfulness and trait mindfulness. The model fit the data adequately, $X^2/df = 1.76$, RMSEA = .06 (95% CI = .03–.08), CFI = .95. As hypothesized, after accounting for the significant relation between baseline and post-intervention trait mindfulness, the slope of state mindfulness significantly predicted post-intervention trait mindfulness. Model 2 accounted for 38.9% of the variance in post-intervention trait mindfulness. Additionally, baseline trait mindfulness did not significantly predict the slope of state mindfulness.

3.4 Model 3 (Hypothesis 3): Did individual slopes of state mindfulness also predict post-intervention distress?

Model 3 built on Model 2 by also examining psychological distress (see Figure 1). The model fit the data well, $X^2/df = 1.59$, RMSEA = .05 (95% CI = .03–.07), CFI = .96. In Model 3, the slope of state mindfulness significantly predicted both post-intervention trait mindfulness and distress (inversely); these two post-intervention variables also were inversely correlated. Baseline trait mindfulness and distress remained significant predictors of respective post-intervention levels. Altogether, Model 3 accounted for 40.3% of the variance in post-intervention trait mindfulness and 44.6% of the variance in post-intervention distress. Neither baseline trait mindfulness nor baseline distress significantly predicted the slope of state mindfulness.

3.5 Model 4 (Hypothesis 3): Is the relation between the slope of state mindfulness and post-intervention distress only indirect, through trait mindfulness?

Although Model 3 supported that the slope of state mindfulness predicts post-intervention distress after accounting for trait mindfulness, it still was important to test the more parsimonious hypothesis that the relation between the slope of state mindfulness and distress is better represented only as indirect, through trait mindfulness. The fit indices for this model, Model 4, were adequate, $X^2/df = 1.74$, RMSEA = .06 (95% CI = .04–.08), CFI = .94, although not quite as good as those for Model 3. Model 4 also accounted for less variance in post-intervention distress, 27.7%. Models 3 and 4 were compared using a chi-square difference test, which was highly significant ($p < .005$). Based on this result and the statistics for each model, Model 3 fit the data better.

4.0 Discussion

The results of the present research supported the hypotheses, in that individuals varied in their trajectories of state mindfulness in repeated meditation practice over the course of an MBI (hypothesis 1), and that individuals with greater rates of increase in state mindfulness increased more in trait mindfulness (hypothesis 2) and decreased more in psychological distress (hypothesis 3).

These findings are important for several reasons. First, they provide preliminary empirical evidence to substantiate the common assumption that increasing state mindfulness in meditation practice over time leads to greater trait mindfulness. This finding is notable because it suggests that the trait-like propensity to be mindful in everyday life may be modifiable (for at least some individuals) through intentional practice of evoking the corresponding state during meditation. Such interpretations are consistent with neuroscientific evidence reporting that meditation can change brain function and structure in ways that would support being more mindful (Holzel et al., 2011).

Our findings are also consistent with psychological evidence that individuals' rates of learning and change may vary (Ackerman, 1987; Rogosa & Willett, 1985). Using a multiple repeated measures approach for increased reliability, we found significant variability in individual rates of change in state mindfulness in meditation over the course of the MBI, which then predicted change in trait mindfulness. These results suggest that some MBI participants may learn to be mindful through meditation more readily than others. Although the focus of the present study was to determine whether individual trajectories of state mindfulness in meditation predicted changes in trait mindfulness and distress, we also found that individuals' state mindfulness trajectories were not predicted by their initial levels of trait mindfulness, distress, or state mindfulness in meditation.[1] It could be useful in future research to identify variables that do predict trajectories of state mindfulness in meditation. Researchers might consider both individual predispositions and aspects of meditation training as potential predictors. In terms of individual predispositions, researchers might examine baseline personality dimensions (e.g., openness to experience) and worldviews (e.g., those that align with the Buddhist influences on MBIs). In terms of meditation training, researchers also might consider whether home meditation practice during an MBI (e.g., frequency, type, interruptions) and instructor-student fit play roles in individual differences in rates of change.

A final question raised by the present findings, based on our comparisons of Models 3 and 4, is why individual trajectories of state mindfulness in meditation predict reductions in distress beyond changes in trait mindfulness. That is, although we did find that increases in trait mindfulness predicted decreases in distress, consistent with a larger evidence base (e.g., Carmody et al., 2008; Shahar et al., 2010; Shapiro et al., 2008), we also found an independent relation between rates of change in state mindfulness and changes in distress – a novel finding with important potential implications. It may be that faster increases in state mindfulness in meditation over time are indicative of propensity to change in other adaptive

[1]Additionally, demographic variables did not predict trajectories of state mindfulness in meditation.

ways that improve psychological health. Some evidence suggests that a mindful state in meditation may have immediate, even if temporary, effects on cognition and attitudes (Alberts & Thewissen, 2011; Kiken & Shook, 2011) which, theoretically, might yield moments of insight into more adaptive psychological functioning (cf. Grabovac, Lau, & Willett, 2011). Therefore, future research might examine whether individuals who increase more readily in state mindfulness in meditation during an MBI also experience parallel rates of improvement in other psychological resources that contribute to psychological health, such as cognitive reappraisal (cf. Garland et al., 2010). Similarly, researchers might examine individual variability in the degree to which state mindfulness in meditation yields positive emotions, because positive emotions build psychological resources that contribute psychological health (cf. Fredrickson, 2013).

The current research should be interpreted with several limitations in mind. The study design did not control for extraneous variables, so true causal conclusions cannot be drawn. For example, we did not assess quantity or other aspects of home meditation practice. Additionally, reliance on self-report measures may have increased risks of expectancy and demand effects, and all self-report measures of mindfulness may be limited in terms of operationalizing a construct that derives from ancient spiritual traditions (Grossman & Van Dam, 2011). Finally, our sample was not a clinical one and was comprised largely of middle-aged, highly educated White females, so caution should be exercised in generalizing to other populations. To address these limitations, future randomized controlled trials with normative and clinical samples could attempt to replicate our findings and supplement self-reports with objective measures putatively linked to state and trait mindfulness.

Study limitations notwithstanding, the present findings provide some of the first evidence in the empirical literature to support the notion that increasing state mindfulness in repeated meditation practice may contribute to a more mindful and less distressed disposition. Moreover, these findings highlight that individuals' trajectories of change vary and warrant further investigation.

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Highlights

- We assessed state mindfulness in meditation weekly during a mindfulness intervention.
- Individuals' rates of change in state mindfulness in meditation varied significantly.
- These individual trajectories predicted pre-post changes in trait mindfulness.
- They also directly and indirectly predicted changes in psychological distress.

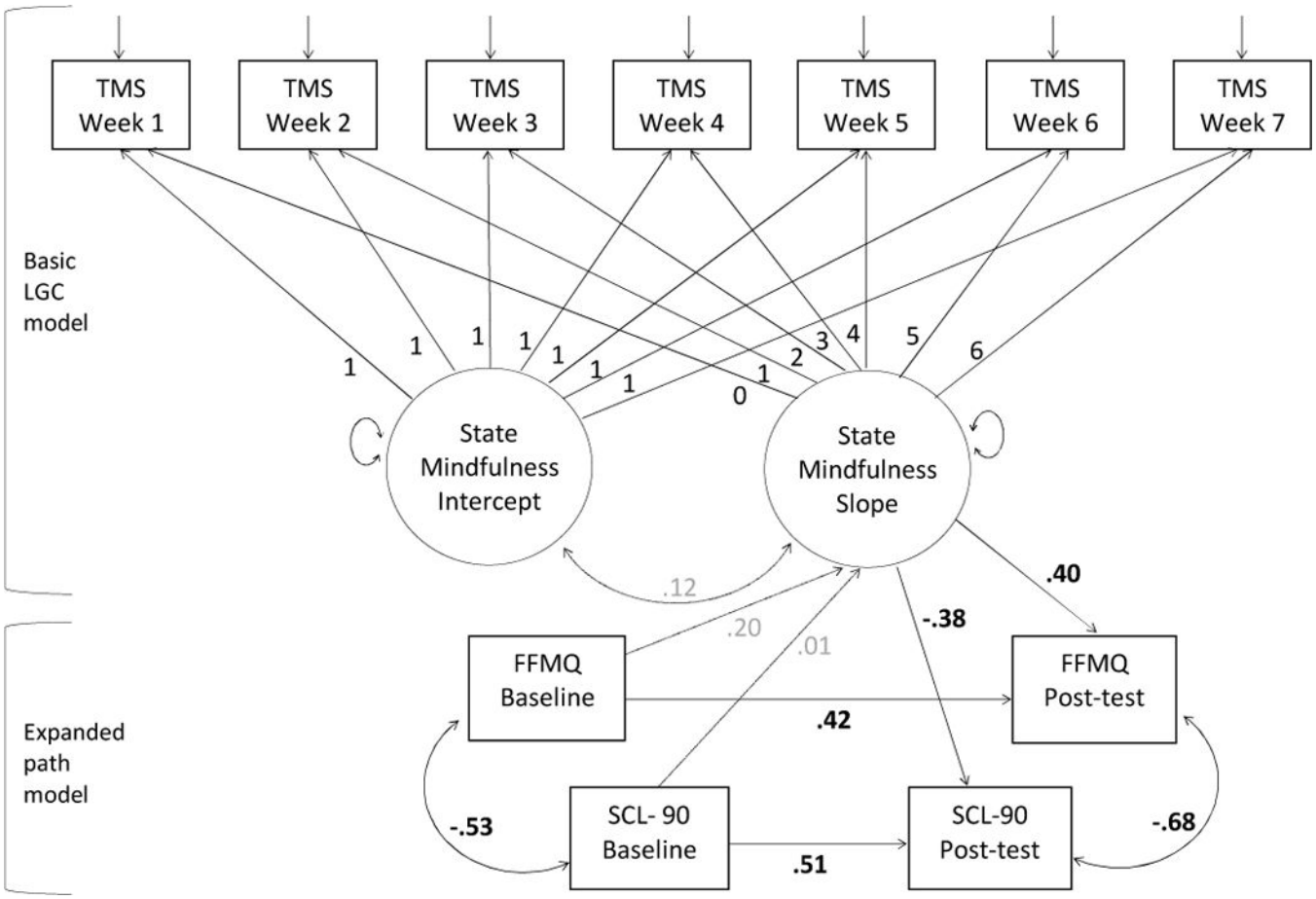

Figure 1. Model 3: Latent growth curve and path model

Individual slopes of state mindfulness predict residualized change on FFMQ and SCL-90, which remain correlated. Paths from the intercept to the weekly TMS measures each were fixed at 1.0, representing that estimated baseline status was assumed to contribute equally to each assessment. Paths from the slope to the weekly TMS measures were fixed to increase by increments of 1.0 each week, representing a consistent, linear rate of change. Standardized parameter estimates are shown, with significant values **bolded**.

Table 1

Inter-correlations and descriptive statistics for all measures.

Measure 1	1	2	3	4	5	6	7	8	9	10	11
1. Pre-FFMQ	1										
2. Pre-SCL-90	−.54**	1									
3. TMS Week 1	.14†	−.07	1								
4. TMS Week 2	.25**	−.06	.68**	1							
5. TMS Week 3	.24*	−.15	.63**	.69**	1						
6. TMS Week 4	.30**	−.08	.58**	.63**	.77**	1					
7. TMS Week 5	.25*	−.21	.56**	.51**	.66**	.72**	1				
8. TMS Week 6	.23†	.04	.47**	.63**	.74**	.76**	.87**	1			
9. TMS Week 7	.34*	−.26[a]	.72**	.72**	.79**	.84**	.89**	.88**	1		
10. Post-FFMQ	.44**	−.27*	.25**	.34**	.31**	.38**	.43**	.49**	.55**	1	
11. Post-SCL-90	−.21†	.47**	−.03	−.14	−.11	−.10	−.31*	−.31*	−.36†[a]	−.68**	1
Mean	118.26	.74	23.09	26.73	27.72	29.53	30.10	31.17	32.73	138.75	.48
SD	19.65	.43	8.89	8.43	8.65	9.25	9.45	10.95	10.98	17.34	.35
Cronbach's α	.94	.96	.90	.92	.92	.93	.93	.96	.96	.93	.96

Note: FFMQ = Five Facet Mindfulness Questionnaire (Baer et al., 2006); SCL-90 = Symptom Checklist 90 – Revised (Derogatis, 1983); TMS = Toronto Mindfulness Scale (Lau et al., 2006)

† $p < .10$,

* $p < .05$,

** $p < .01$;

[a] $n < 30$