Multilevel Modeling of the Influences of Meditation Type on Mindfulness and Affect
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Introduction
One under-examined and sometimes puzzling issue with regard to meditation practice is the relationship between practice time and observed effects. In a meta-analysis of 30 Mindfulness-Based Stress Reduction (MBSR) studies, Carmody and Baer (2009) found no correlation between either the number of MBSR classes and outcomes or assigned meditation minutes and outcomes. They also analyzed several permutations of subsets of the 30 studies, never finding a significant correlation. Indeed, some correlations were negative.

These results suggest that there are substantial individual differences in responsiveness to meditation practice. These individual differences may be mediated, in part, by the type of meditation practiced (Barnhofer et al., 2010). We used hierarchical linear modeling (HLM) to explore the relative efficacy of loving-kindness meditation (LKM) and concentration meditation (CM) in increasing mindfulness and positive affect, while decreasing negative affect. HLM is a powerful statistical technique for examining both individual change and group differences. HLM enables a form of growth curve modeling, which yields relatively detailed information about the nature of individual differences.

Method
Participants (N = 31) were drawn from a freshman-level course jointly taught by the CJM and SEH at Carroll University. Participants were randomly assigned to either a CM condition (n = 15) or an LKM condition (n = 16). One participant in the LKM group was eliminated from all analyses due to excessive missing data.

We employed a multiple-baseline ABA withdrawal design. Participants in both conditions were tested at multiple time points before (A1), during (B), and after (A2) meditation practice. Baseline duration ranged from 1 week to 4 weeks. Participants then meditated for 5 weeks, and ceased meditating for 1-3 weeks. Participants were asked to meditate 15 minutes/day for 3 days/week. The average meditation time for the CM group was 213.73 minutes (SD = 21.89), compared to 210.93 minutes (SD = 25.38) for the LKM group.

For each week of testing, participants filled out an Freiburg Mindfulness Inventory (FMI) and Positive Affect Negative Affect Schedule (PANAS) survey twice a week.

Results
Figure 1 depicts the pattern of total FMI score over time for each participant. Meditation had a discernible effect for some participants, but not for others. Qualitative analysis was used to guide the development of the best HLM. The slopes of change from baseline to the meditation period (β_3) and from the meditation period to the withdrawal period (β_5) were modeled as random effects since there was substantial individual variability, whereas levels (intercepts) were modeled as fixed effects:

Level-1 Model (Time)
\[ y_{ij} = \beta_0 + \beta_1 \text{TIME}_{ij} + \beta_2 Y_{ij} + \beta_3 \text{START}_{ij} + \beta_4 \text{STOP}_{ij} + \beta_5 \text{STOP}_{ij} \times \text{TIME}_{ij} + r_{ij} \]

Level-2 Model (Individuals)
\[ \beta_0 = \gamma_00 + \gamma_01 \text{GROUP}_{ij} + u_0 \]
\[ \beta_1 = \gamma_10 + \gamma_11 \text{GROUP}_{ij} + u_1 \]
\[ \beta_2 = \gamma_20 + \gamma_21 \text{GROUP}_{ij} + u_2 \]
\[ \beta_3 = \gamma_30 + \gamma_31 \text{GROUP}_{ij} + u_3 \]
\[ \beta_4 = \gamma_40 + \gamma_41 \text{GROUP}_{ij} + u_4 \]
\[ \beta_5 = \gamma_50 + \gamma_51 \text{GROUP}_{ij} + u_5 \]

Individual LKM and CM models were also run by removing the GROUP term in the Level-2 model. All random effects were significant except for SSTOP in the CM-only model for all variables, SSTOP in negative affect in the combined and LKM-only models, and SSTART for negative affect in the LKM-only model.

To determine the relative amount of variance that each level of our HLMs could explain, we calculated the intraclass correlation coefficients (ICCs) for each dependent variable. The ICC for FMI was .58, indicating that 58% of the total variance of the unconditional model is attributable to differences between individuals, whereas 42% represents variation between time points within individuals. The ICC for positive affect was similarly high at .51, while negative affect registered the lowest ICC of .36, signifying greater variance across time than between participants.

The significance of regression coefficients are listed in Table 1. Combined-model HLMs are plotted in Figure 2.

![Figure 1. Mindfulness (FMI) score over each of the three phases of the study for each participant. Participants 1-15 practiced CM, and participants 16-30 practiced LKM.](image)

![Figure 2. Segmented regression HLM for concentration meditators (CM) and loving-kindness meditators (LKM) on mindfulness (above left) and positive affect (PA) and negative affect (NA; above right) for each phase of the study.](image)

Table 1. Significance of regression coefficients for combined (Comb) and individual (CM, LKM) HLMs.

<table>
<thead>
<tr>
<th></th>
<th>Comb</th>
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<th>CM</th>
<th>CM</th>
<th>LKM</th>
<th>LKM</th>
<th>LKM</th>
<th>LKM</th>
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<tr>
<td>Mindfulness</td>
<td>0.003</td>
<td>n.s.</td>
<td>0.044</td>
<td>0.028</td>
<td>n.s.</td>
<td>n.s.</td>
<td>0.047</td>
<td>n.s.</td>
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<td>Positive</td>
<td>n.s.</td>
<td>n.s.</td>
<td>0.036</td>
<td>&lt;0.00</td>
<td>n.s.</td>
<td>0.092</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Affect</td>
<td>n.s.</td>
<td>0.066</td>
<td>0.050</td>
<td>n.s.</td>
<td>0.009</td>
<td></td>
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Conclusions
We compared the relative effects of 5 weeks of either concentration or loving-kindness meditation (CM, LKM) on mindfulness and affect using a multiple baseline ABA design. Hierarchical linear modeling (HLM) indicated that 36-58% of the total variance was attributable to individual differences. In contrast to those practicing LKM, CM practitioners did not exhibit significant individual differences during the post-meditation withdrawal period for any variable. Single meditation HLMs indicated that while meditating, CM practitioners experienced progressive increases in mindfulness, while LKM practitioners exhibited increases in mindfulness and positive affect. When practitioners ceased meditating, CM individuals had marginal decreases in mindfulness throughout the cessation period. Positive affect also increasingly fell and negative affect rose, while LKM practitioners experienced no significant changes following meditation.

Though individual HLMs indicated some differences between meditation types, a combined HLM with both meditation groups showed no group differences in the baseline, meditation, or cessation phases of the study. Both CM and LKM had salutary effects on mindfulness and affect, with indications that LKM had a particularly beneficial impact on positive affect. Differences between meditation types were not dramatic, however. More substantial were individual differences in response to meditation—these point to the necessity of using either large sample sizes in group means testing or techniques permitting individual-based analysis such as HLM and single-subject designs.

One limitation of the current research was the relatively limited number of time points for each phase of the study. This constrained our regression analyses to linear trends. More time points would enable an examination of non-linear growth patterns to better characterize individual differences.

Further research will enable researchers and clinicians to better understand individual differences with respect to meditation—both in terms of whether and how much individuals respond to different types of meditation, and in isolating the comparative effects of different meditation practices. This, in turn, will enhance prosaic advice about meditation practice.

References


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