MINDFULNESS MEDITATION STYLES SHAPE BRAIN STATE DYNAMICS AND COMPLEXITY

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Background: Mindfulness meditation, categorized into focused attention meditation (FAM) and open monitoring meditation (OMM), has been extensively explored through theoretical, affective, neurophysiological, and clinical research. In particular, the high temporal resolution of magnetoencephalography (MEG) can be successfully exploited to fill the gap between personal experience of meditation and its neural correlates. Mounting evidence, in fact, shows that human brain activity is highly dynamic, transiting between different brain states.

Aims: In this study, we aimed to: derive source-level brain states and investigate modulations of their temporal dynamics across the different meditation practices, and investigate modulations of brain state sequence complexity across different practices.

Method: Ten Theravada Buddhist monks with substantial meditation expertise participated in an experiment encompassing FAM, OMM, and resting state (REST). MEG data were acquired, preprocessed, and source-reconstructed by eLoreta for brain state analysis. State classes were identified using k-means clustering on source-level topographies, backfitting allowed to derive the sequence of states and various metrics (Duration, Coverage, Occurrence). Finally, criticality indices (Hurst exponent, Lempel-Ziv complexity) were computed from the state sequences. Statistical analyses were conducted to assess differences in state metrics and criticality indices across conditions and explore potential relationships with meditation expertise.

Preliminary results: Nine brain states, with distinct topographies, were extracted by concatenating source-space data in all participants and all conditions. Significant differences in state-specific metrics across conditions were found: coverage of brain state 1 (right-lateralized visual synchronized activity) and 5 (ventral attentional network areas) is significantly affected by practice style; occurrence revealed increased values during OMM for brain state 5 and a progression from REST to FAM to OMM in brain state 8 (temporo-occipital areas). Criticality indices demonstrated condition-specific effects, with Hurst exponent higher in REST and increasing Lempel-Ziv complexity from REST to FAM to OMM. Moreover, a positive correlation was observed between meditation expertise and individual Lempel-Ziv complexity differences between OMM and FAM. Overall, our results indicate a state-like effect of meditation on brain activity and complexity.

Keywords: Mindfulness meditation, Magnetoencephalography, Brain states, Complexity, Detrend fluctuation analysis

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