Mapping EEG Brain Dynamics During Resting and Meditative States

Duke BASS CONNECTIONS

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Brain & Society

INTRODUCTION

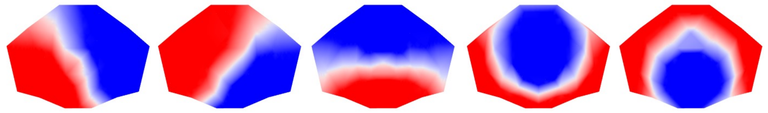
- Mindfulness-based interventions have been shown to have positive effects on mental health, but the changes in brain networks related to these positive effects are unknown.
- Electroencephaolography (EEG) microstate analysis is a method for identifying patterns of electrical activity from the scalp – *microstates* – that reflect short periods of synchronized neural activity (i.e., brain networks) evolving dynamically over time.
- A small number of microstates have been shown to explain most of spontaneous EEG activity. Each can be characterized by its coverage; the percentage of EEG recording time for which it was present.
- Indeed, we can investigate whether mindfulness-based interventions change the coverage of these microstates and improve mental health, which may be especially important to understand in college students whose mental health is worsening according to recent studies.
- This preliminary study aimed to answer the following questions:
  - Aim 1: Does the coverage of each microstate differ *within* and *between* resting and meditative states?
  - Aim 2: Does the order of administration (resting or meditation first) affect the coverage of each microstate?
  - Aim 3: Does the content of participants' thoughts during each condition relate to the coverage of microstates?

METHOD

- Duke University Bass Connections project studying the effect of Koru mindfulness compared to a student health intervention on mind wandering, mindfulness, and psychological distress in Duke undergraduate students.
- So far, 32-channel EEG data has been collected from 14 participants during 10 minutes of resting and meditation conditions. The order of each condition was counterbalanced across participants. Only the pre-intervention data was analyzed.
- EEG data were cleaned, and microstate analysis was performed using *k*-means clustering.
- The *New York Cognition Questionnaire* (NYC-Q) was completed by participants after each EEG condition to assess what participants were thinking and feeling during the recordings.
- Statistical analyses were performed in JASP:
  - Aims 1 & 2: Two-way ANOVAs with microstate and (a) condition or (b) order and their interaction as the independent variables, and coverage as the dependent variable.
  - Aim 3: Correlations between coverage and NYC-Q subscales.

FIGURE 1 — Five EEG Microstates

Microstate Topographies and their Coverage Values



Microstate A **16.06%** (4.61) | **Microstate B** **16.41%** (4.71) | **Microstate C** **32.55%** (11.07) | **Microstate D** **18.68%** (5.26) | **Microstate F** **16.30%** (5.27)

* Coverage values presented as **mean %** (standard deviation)

FIGURE 2 — Aim 1 Results

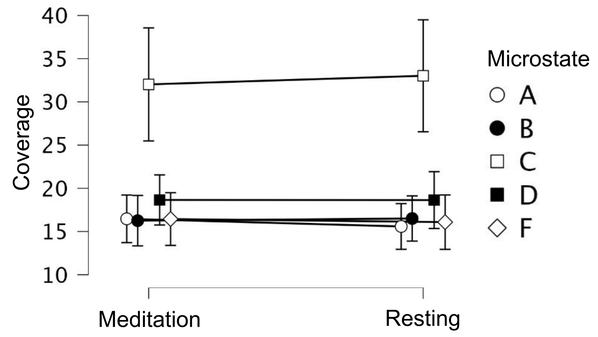


FIGURE 3 — Aim 2 Results

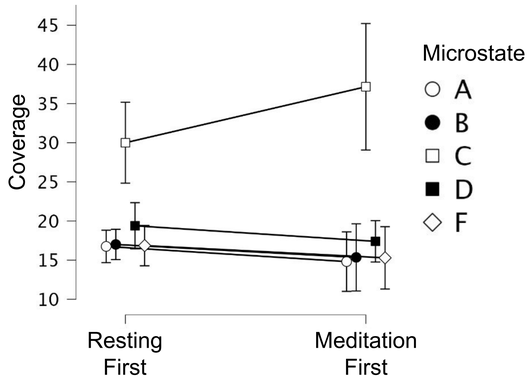
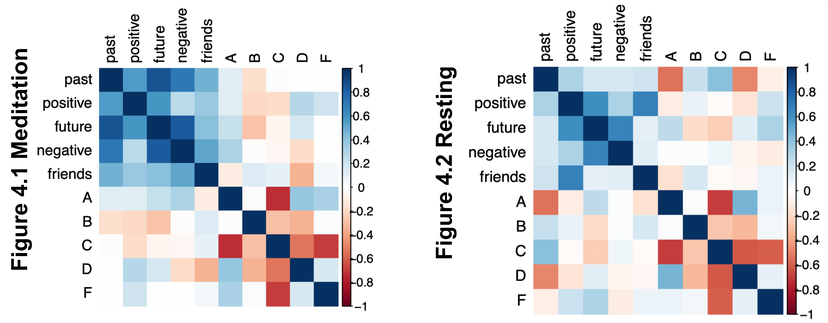


FIGURE 4 — Aim 3 Results



RESULTS

- Five microstates were identified (**Figure 1**).
- Aim 1 results are plotted in **Figure 2**.
  - Significant main effect of microstate class on coverage values ($p < .001$). Microstate C exhibited significantly larger coverage values compared to Microstates A, B, D, and F ($p < .001$).
  - No effect of condition ($p > 0.99$) or a microstate class by condition interaction ($p = .99$).
- Aim 2 results are plotted in **Figure 3**.
  - Main effect of microstate class on coverage as reported above.
  - No effect of condition order ($p > 0.99$).
  - The interaction between microstate class and condition order was marginally significant, ($p = .05$). Specifically, there was an increase in the coverage of Microstate C when meditation was first ($p = .006$).
- Aim 3 correlations are presented in **Figure 4**.
  - Overall, correlations between the NYC-Q subscales and the coverage of each microstate were slightly larger during resting (**Figure 4.2**) compared to meditation (**Figure 4.1**).

DISCUSSION

- Microstate C had greater coverage than the other microstates during both resting and meditation. Microstate C has been previously shown to represent the Default Mode Network.
- Coverage values did not differ between resting and meditation for any microstate. This may reflect that participants were not able to reach a meditative state pre-intervention.
- Microstate C showed greater coverage when meditation was first. If this effect becomes significant with more participants, it will inform whether we must control for order in future analyses.
- Most correlations between coverage and participants' thoughts were not significant, but correlations were stronger during resting than meditation. Participants may have allowed their mind to wander more freely during resting as they were instructed.
- Future Directions:
  - Re-rerun analyses with more participants.
  - Assess whether Koru compared to control had positive effects on mental health and changed microstate dynamics.

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Acknowledgments: This work was generously funded by Duke University Bass Connections and the Mind and Life Institute Varela Grant awarded to Joseph Diehl.