NEURAL AND PHENOMENOLOGICAL SIGNATURES OF MEDITATION STATES

Goldsmiths
UNIVERSITY OF LONDON

MSC COMPUTATIONAL COGNITIVE NEUROSCIENCE

MARIA KARAMPELA, TRISTAN BEKINSCHTEIN, PETER HOLLAND, MAX GARAGNANI | MKARA007@GOLDSMITHS.AC.UK

INTRODUCTION

- Phenomenological interview techniques enhance neuroscientific investigations by translating lived experiences into verbal reports.
- These techniques are resource-intensive (Hurlburt, 2011) and rarely integrated with neural data.
- Meditation offers a rich context for studying consciousness, influencing neural activity and subjective experiences (Berkovich-Ohana et al., 2013).
- Previous studies lack real-time assessments of mindfulness and emotional states (Lin et al., 2020).

RESEARCH QUESTION

- How do neural signatures of ***meditative states*** differ across various meditation styles (Breathing, Loving Kindness, Open Monitoring) during meditation, and what are the distinct neural dynamics associated with transitions between different states?

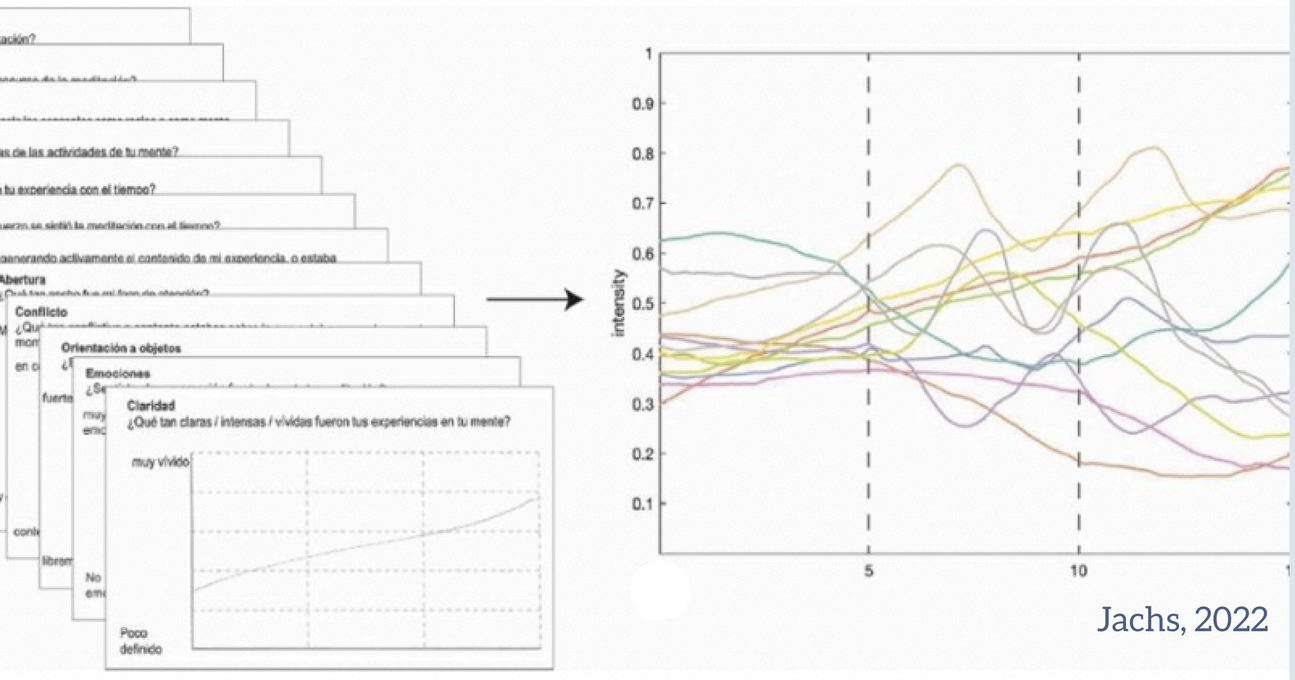
HYPOTHESES

- **Hypothesis H1:**
  - Previous research has shown that different meditation styles (Breathing, Loving Kindness, Open Monitoring) engage distinct neural processes (Schoenberg & Vago, 2019).
  - ***Each meditation style will show unique neural signatures within the same meditative state. These differences will be observed across both meditation practice groups (Retreat and Home).***
- **Hypothesis H2:**
  - Meditation experiences are fluid and can transition between different states (Hasenkamp et al., 2012). Brain activity during meditation reflects these dynamic changes (Fazelpour & Thompson, 2015).
  - ***Transitions between different meditative states will have distinct neural activity patterns across meditative styles and practice groups. (Retreat and Home)***

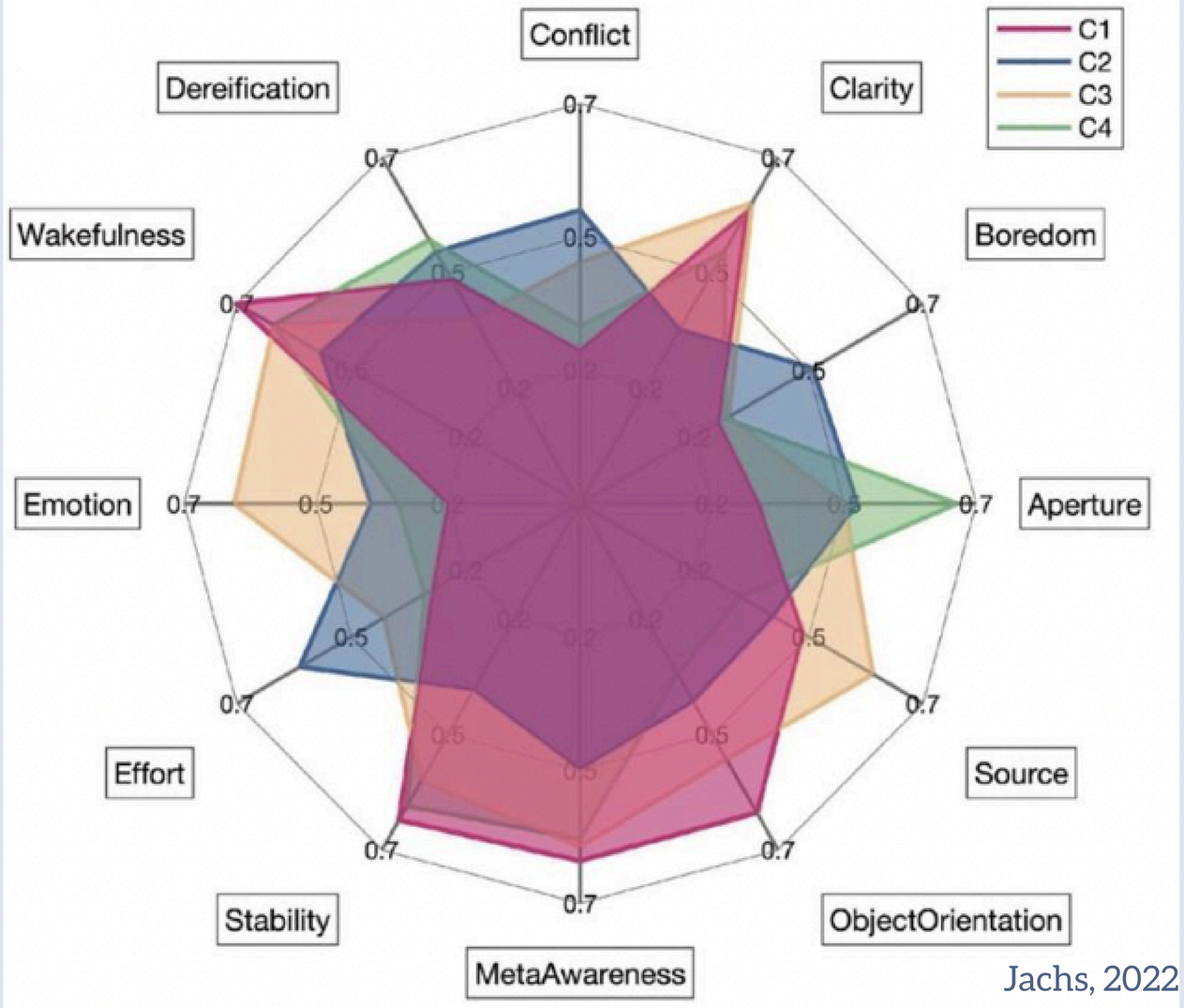
OBJECTIVES/AIMS

- To determine whether meditation styles (Breathing, Loving Kindness, Open Monitoring) exhibit unique neural activation patterns during meditation.
- To investigate the neural activity patterns associated with transitions between different meditative states across these meditation styles.

METHODS

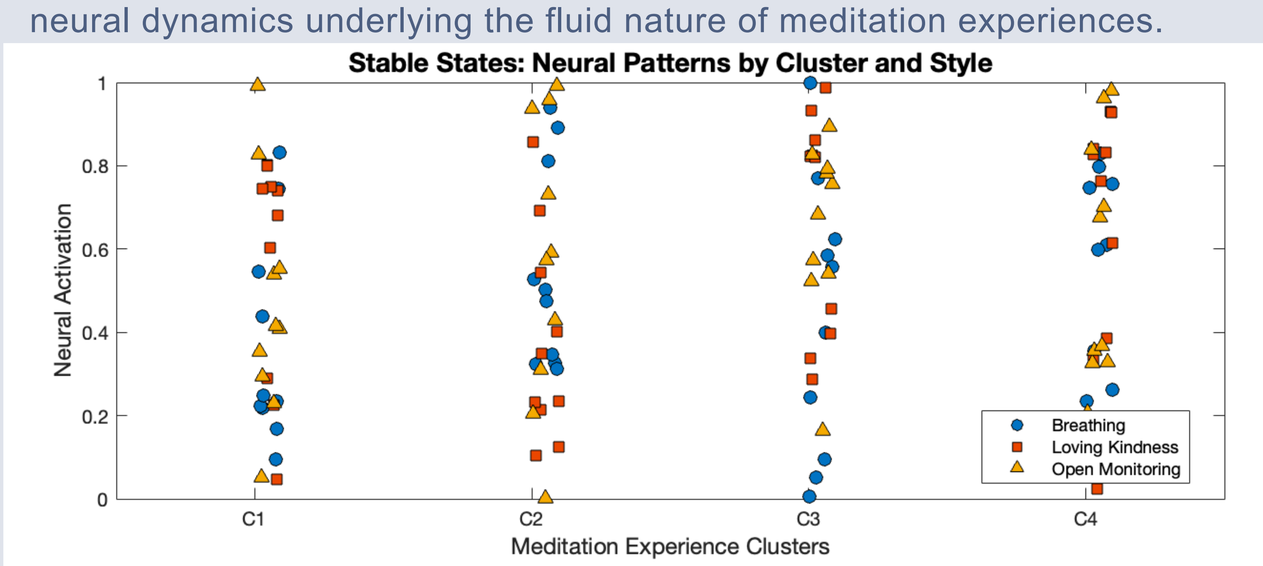


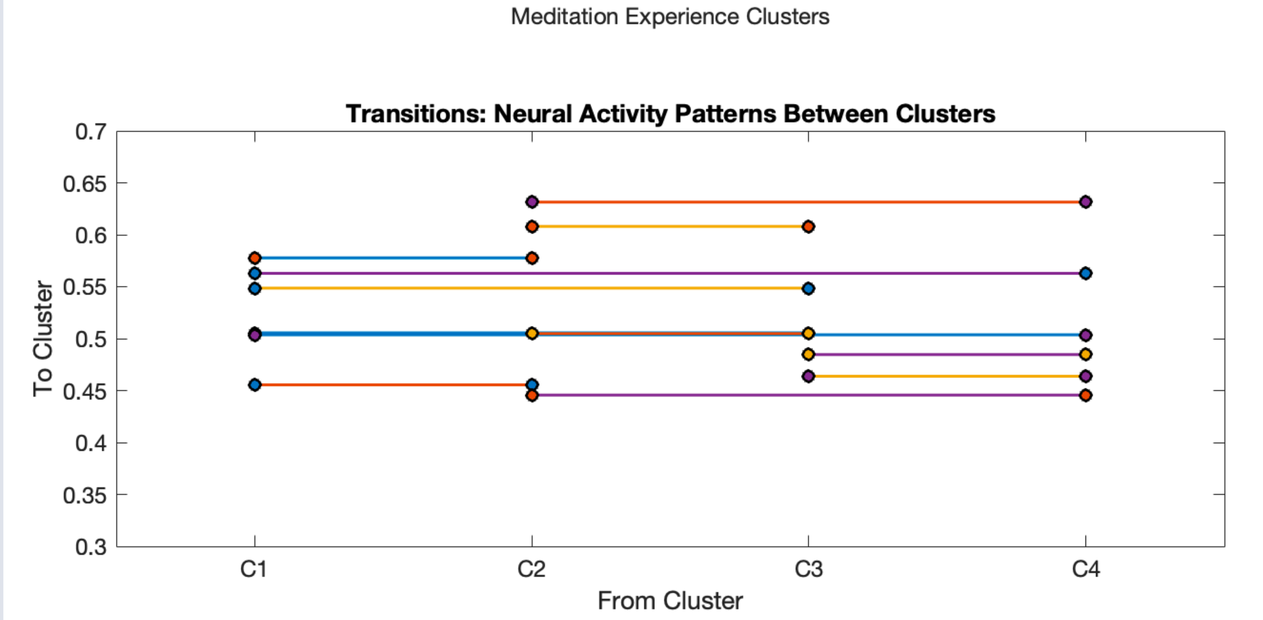
- **Temporal Experience Tracing (TET):** The **novel contribution** of this project lies in the use of TET, a method that captures real-time, dynamic changes in meditative experiences. (see Figure above)
- **Data Collection:** Participants graphically represented changes in meditation experience intensity over time, while portable EEG headsets recorded neurophysiological data.
- **Experimental Design:** A repeated-measures between-group design was employed to explore the temporal dynamics of meditation using TET.
- **Participant Groups:**
  - **Retreat Group:** Novice meditators (<1 year), 10 participants, three-day retreat, 7 sessions each of Breathing, Loving Kindness, and Open Monitoring (15 min), using EEG headsets (Dreem 2) and experience graphs.
  - **Home Group:** Intermediate meditators (4.2 years), 12 participants, 35 at-home sessions, practicing various meditation styles (20 min), using EEG headsets and online questionnaires with experience graphs.
- **Clustering (e.g. K-means):** Uses TET data to identify distinct clusters and transitions between **meditative states**.
- **EEG Data**: Neural activity patterns, e.g. connectivity, and information theory will be calculated from the EEG data.
- **Multivariate Similarity Analysis (MVPA)**: Compares neural patterns across different meditation styles within the same cluster and 12 possible transitions between clusters for each pair of meditative states.
  - Select features, train classifiers, perform cross-validation, and evaluate performance.
- **Statistical Analysis:** Perform ANOVA or other statistical tests to compare classifier performance across different meditation styles.



EXPECTED RESULTS

- **For Hypothesis H1:** We anticipate distinct neural patterns corresponding to each meditation style within the same cluster, reflected in high classifier accuracy and clear separation in visualizations. Expected to be consistent across both Retreat and Home groups.
- **For Hypothesis H2:** We expect to observe significant variability in neural activity during transitions between clusters, with classifiers able to accurately distinguish between different transitions, indicating specific neural dynamics underlying the fluid nature of meditation experiences.





Berkovich-Ohana, A., Dor-Ziderman, Y., Glicksohn, J., & Goldstein, A. (2013). Alterations in the sense of time, space, and body in the mindful..ess-trained brain: A neurophenomenologically-guided MEG study. *Frontiers in Psychology, 4*(December), 912.
Fazelpour, S., & Thompson, E. (2015). The Kantian brain: brain dynamics from a neurophenomenological perspective. *Current Opinion in Neurobiology*, 31, 223–229.
Hasenkamp, W., & Barsalou, L. W. (2012). Effects of meditation experience on functional connectivity of distributed brain networks. *Frontiers in Human Neuroscience*, 6, 38.
Hurlburt, R. T. (2011). Descriptive experience sampling, the explicitation interview, and pristine experience in response to Froese, Gould and Seth. *Journal of Consciousness Studies*, 18(2), 65–78.
Jachs, B. (2022). *The neurophenomenology of meditative states*: Introducing temporal experience tracing to capture subjective experience states and their neural correlates. Retrieved from University of Cambridge Repository.
Lin, Y. P., Wang, C. H., Jung, T. P., Wu, T. L., Jeng, S. K., Duann, J. R., & Chen, J. H. (2010). EEG-based emotion recognition in music listening. *IEEE Transactions on Biomedical Engineering*, 57(7), 1798–1806.
Schoenberg, P. L. A., & Vago, D. R. (2019). Mapping meditative states and stages with electrophysiology: concepts, classifications, and methods. *Current Opinion in Psychology*, 28, 211–217.