

Beyond broadband: towards a spectral decomposition of EEG microstates

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BACKGROUND

Originally applied to alpha oscillations in the 1970s, MS analysis has since been used to decompose mainly broadband EEG signals (e.g. 1-40 Hz). We hypothesized that MS decomposition within separate, narrow frequency bands could provide more fine-grained information for capturing the spatio-temporal complexity of multichannel EEG.

METHODS

8 min eyes open (EO) and 8 min eyes closed (EC) resting state EEGs recordings were obtained from 203 anonymized participants enrolled in the Mind-Brain-Body study (Babayan et al. 2019). A two-pass forward and reverse, zero-phase, non-causal band-pass FIR filter was used to filter preprocessed data into 5 classical EEG bands:

Broadband (1-30 Hz) • **Delta** (1-4 Hz) • **Theta** (4-8 Hz) • **Alpha** (8-12 Hz) • **Beta** (15-30 Hz)

Microstate segmentation was applied to each combination of frequency x behavioural condition (EO, EC) leading to the computation of 10 optimal clusters using a two stage analysis: maps were first identified.

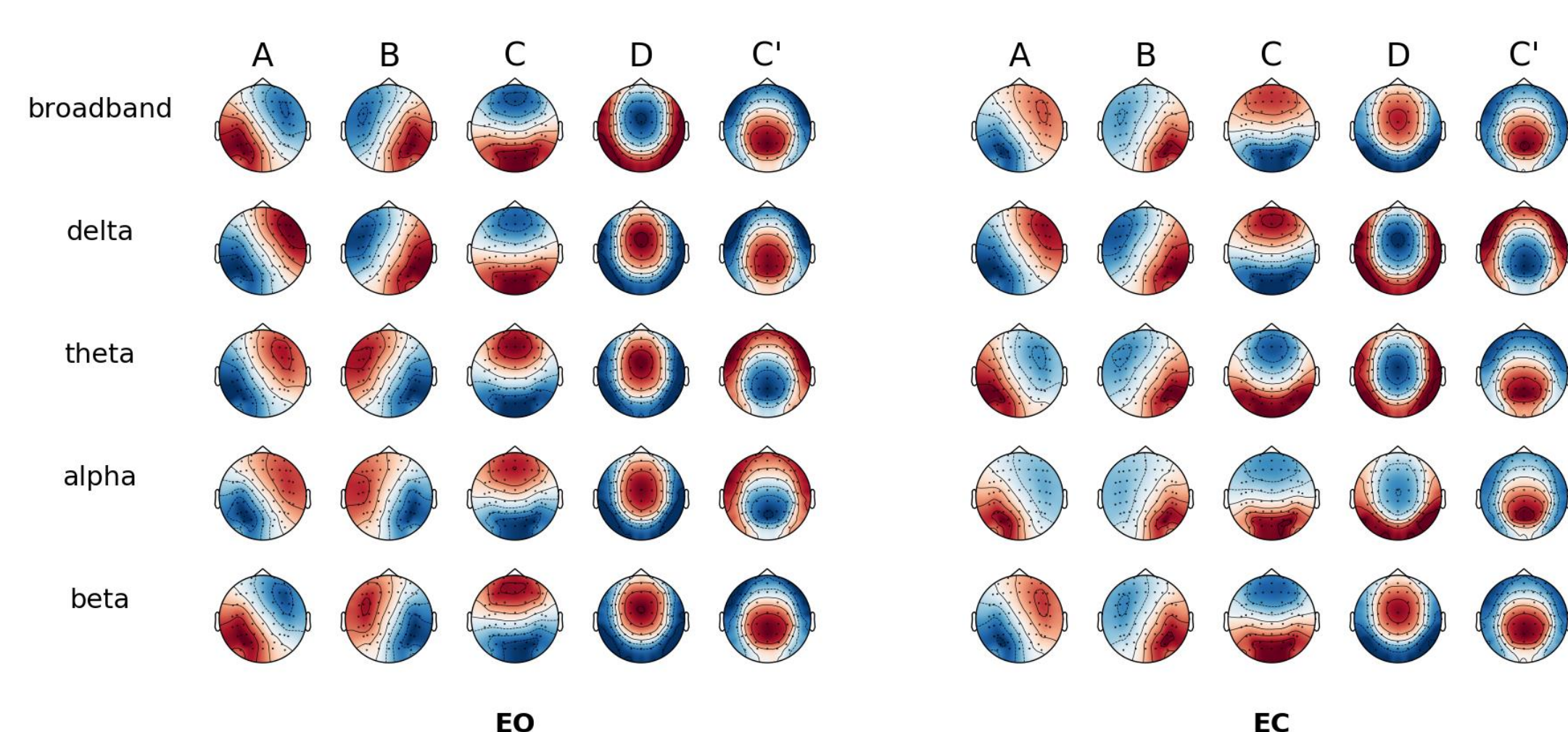


Figure 1: Group MS topographies across different EEG bands and behavioural conditions.

CONCLUSION

- MS topographies were spatially equivalent across all frequencies, matching the canonical broadband maps. We observed strong informational independence of MS temporal sequences between spectral bands.
- We were able to predict the eyes-open vs closed-behavioural state significantly better using alpha-band MS features compared with broadband features (80% vs 73% accuracy).

RESULTS

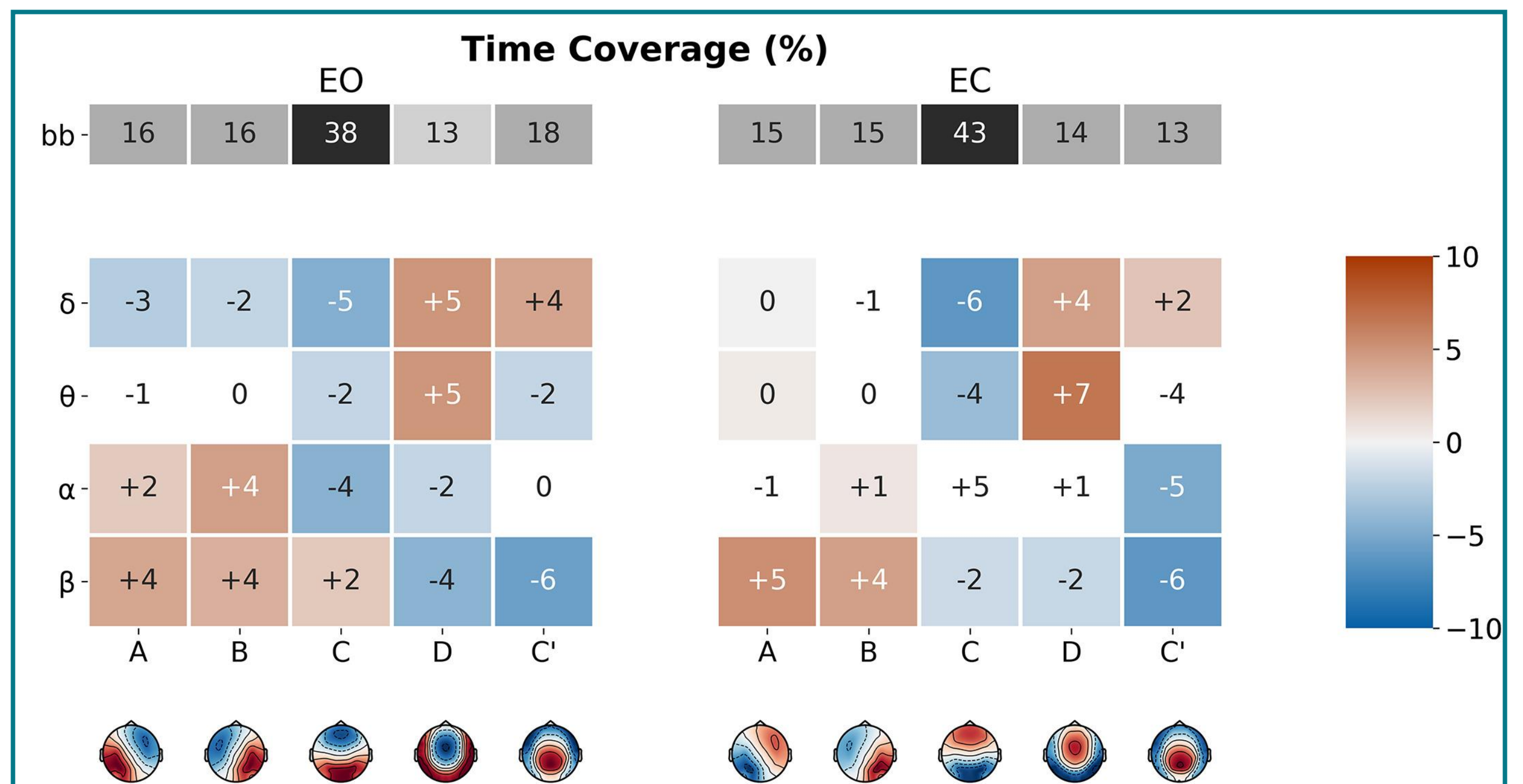


Figure 3: Broadband vs narrowband microstate map differences in Time coverage (%)

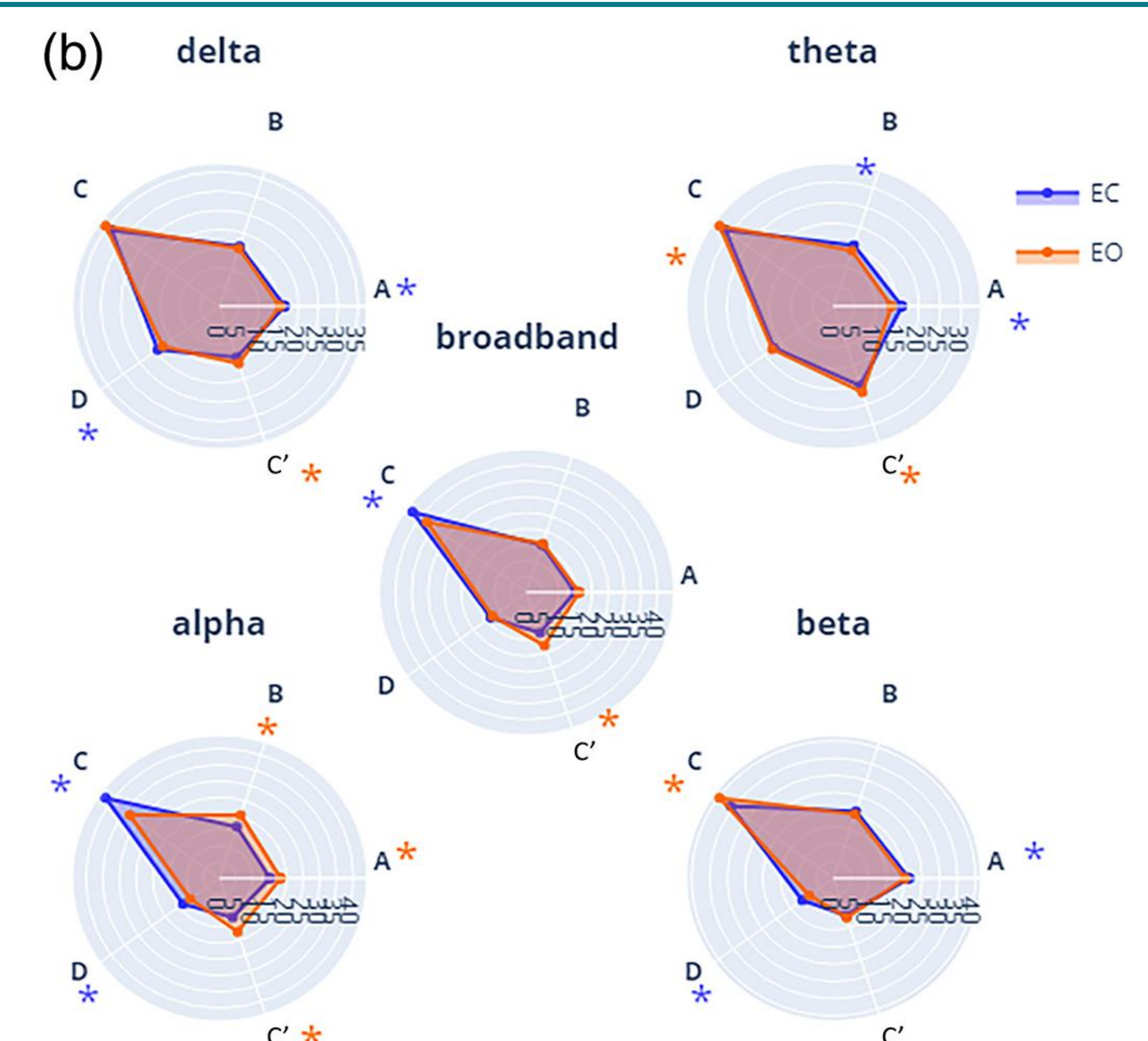


Figure 4: EO vs EC comparison using frequency specific microstate parameters: Time coverage (%)

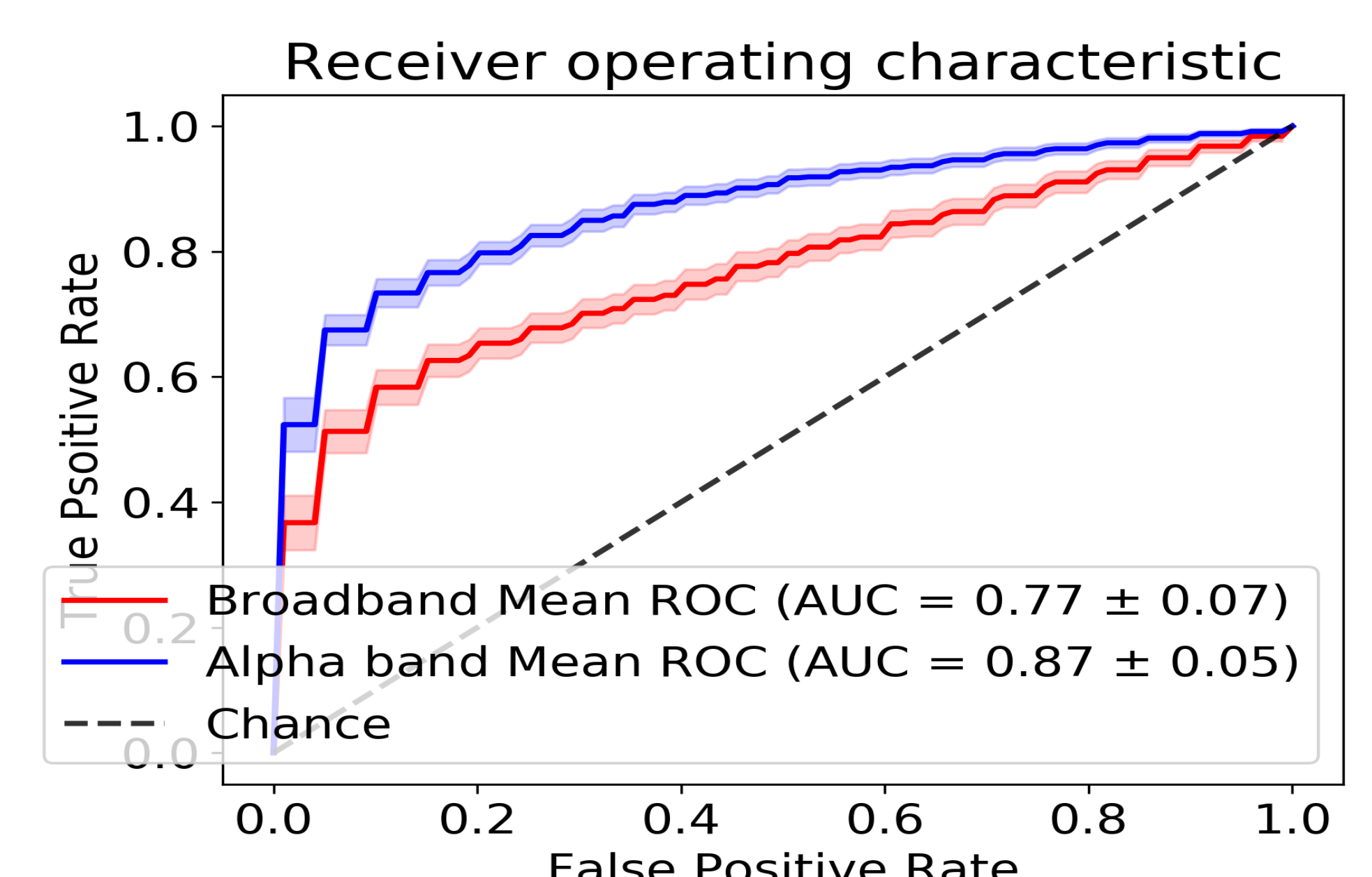


Figure 5: Classifying EO vs EC states with support vector machine, using broadband vs narrowband microstate measures.