Comparison of resting-state EEG and MEG in detecting the effects of healthy aging

SungJun Cho[1], Mats van Es[1], Chetan Gohil[1], Mark W. Woolrich[1,2]
[1]Oxford Centre for Human Brain Activity, Department of Psychiatry, Warneford Hospital, University of Oxford, United Kingdom
[2]Wellcome Centre for Integrative Neuroimaging, John Radcliffe Hospital, University of Oxford, United Kingdom
Contact: sungjun.cho@psych.ox.ac.uk

1. Introduction

Aging is a significant risk factor for many neurological and psychiatric disorders. While the effects of healthy aging have been consistently reported in resting-state EEG and MEG data, a formal comparison of these modalities in capturing such effects remains lacking.

Objectives

Here we contrast the ability of two modalities to detect the effects of healthy aging by investigating:

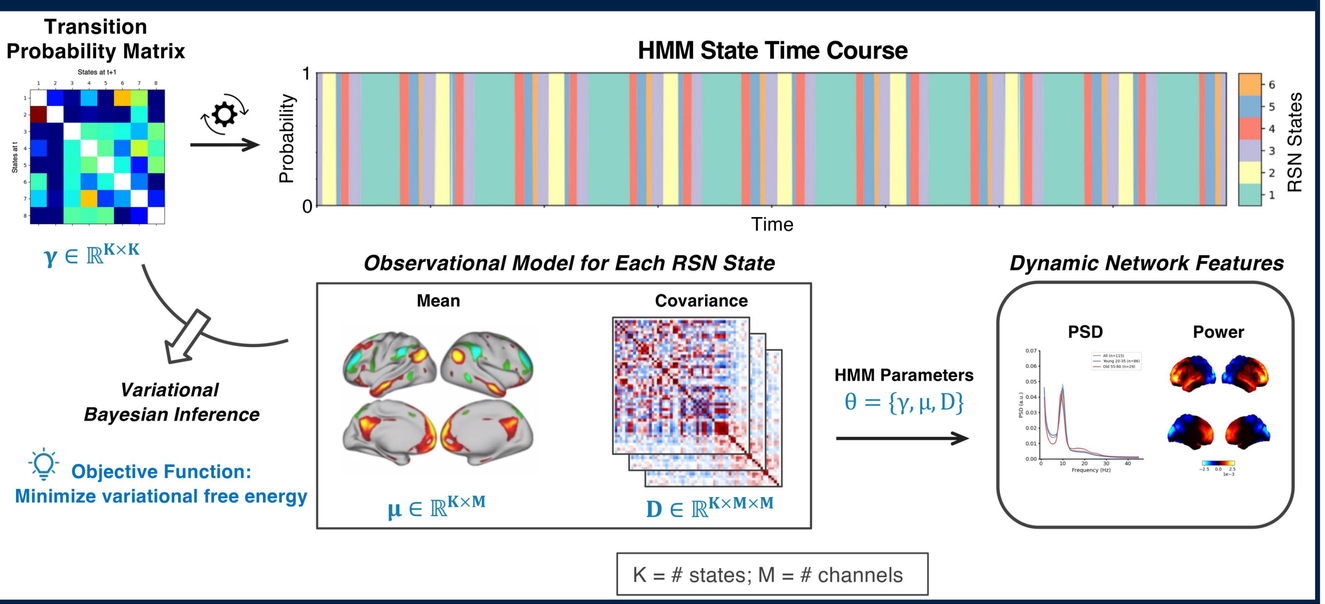
(1) how static and dynamic resting-state network (RSN) features represent healthy aging in each modality
(2) whether EEG or MEG show higher sensitivity to such effects in source space

2. Data & Methods: Dynamic Brain Network Modeling

Dataset
- Resting-state
- Eyes-closed
- EEG LEMON [1]
- MEG CamCAN [2]

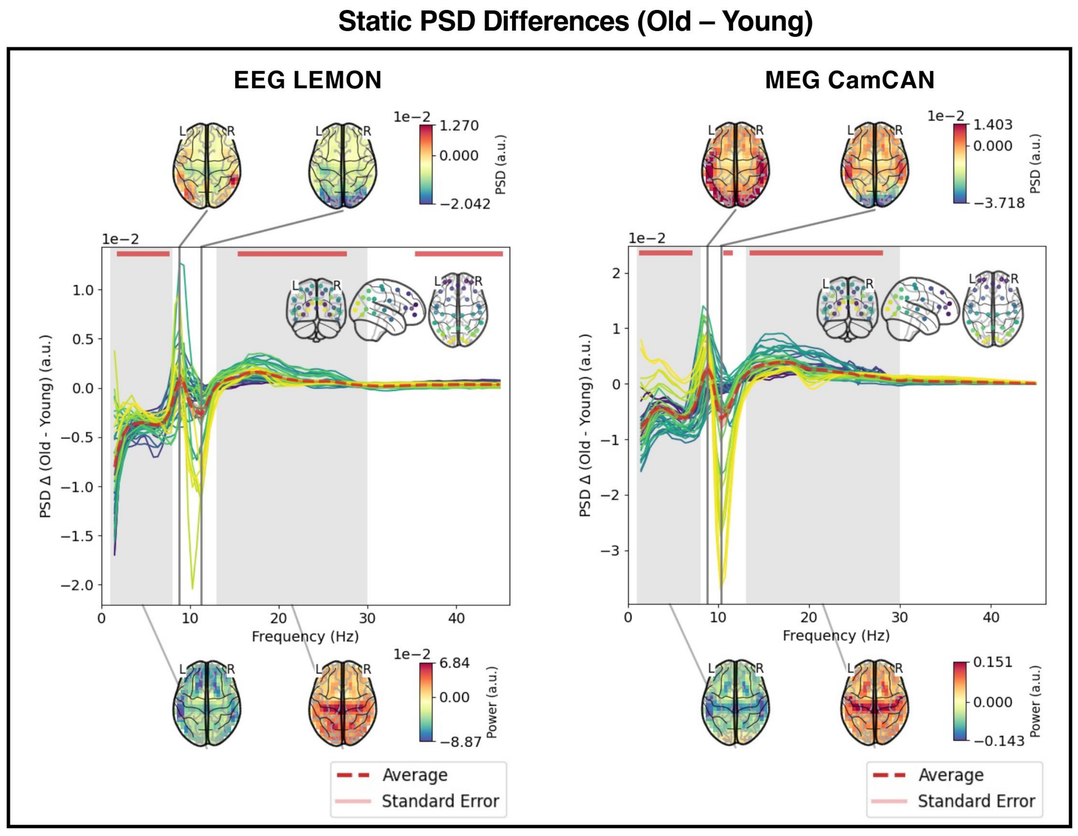
Groups
- 98 subjects
- Young (20-35 years)
- Old (55-80 years)
- 60 young, 36 old subjects

Dynamic Modeling
- Time-Delay Embedded Hidden Markov Model (TDE-HMM) [3]

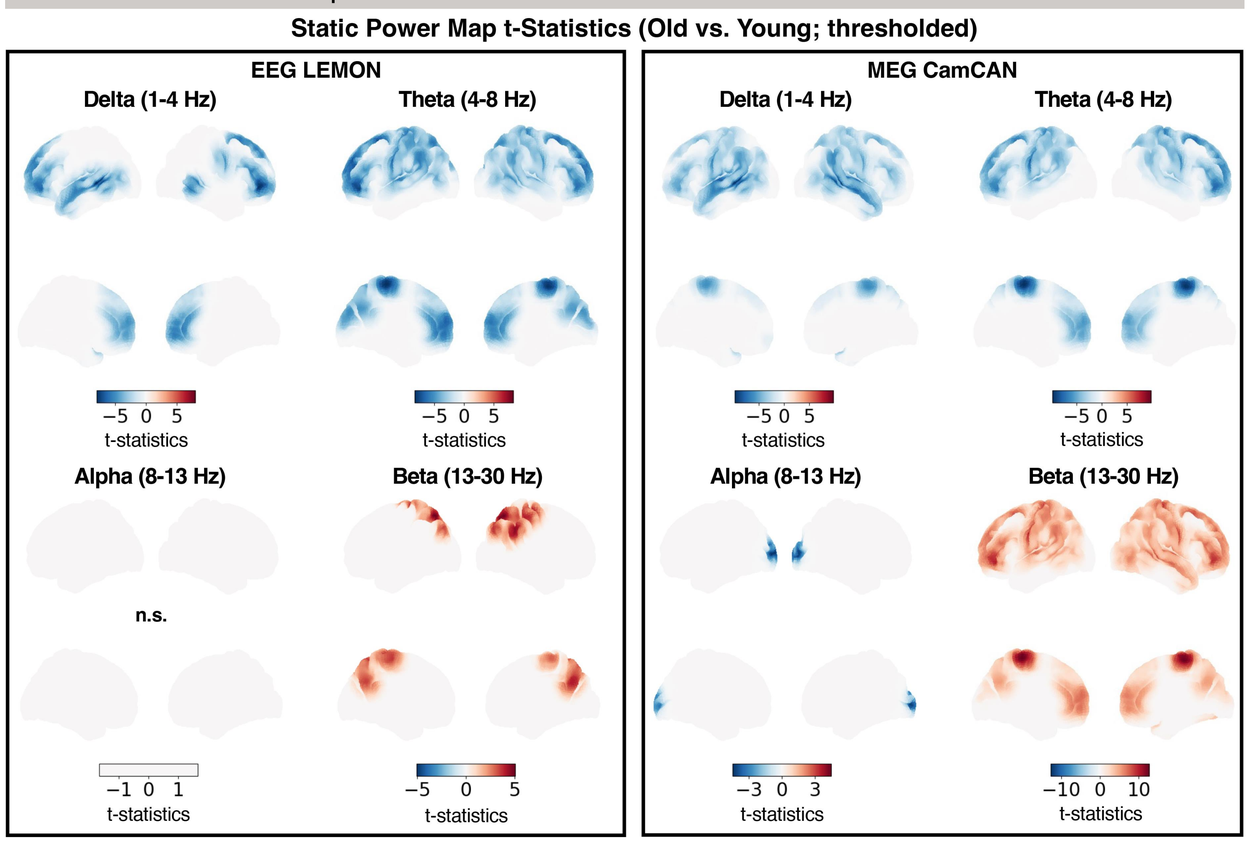


3. Resting-state M/EEG reveal comparable age effects in static PSDs and power maps within source space

- Parcel-averaged power spectral densities (PSDs) show **similar** age effects in the delta/theta (1-8 Hz) and beta (8-13 Hz) bands across modalities.

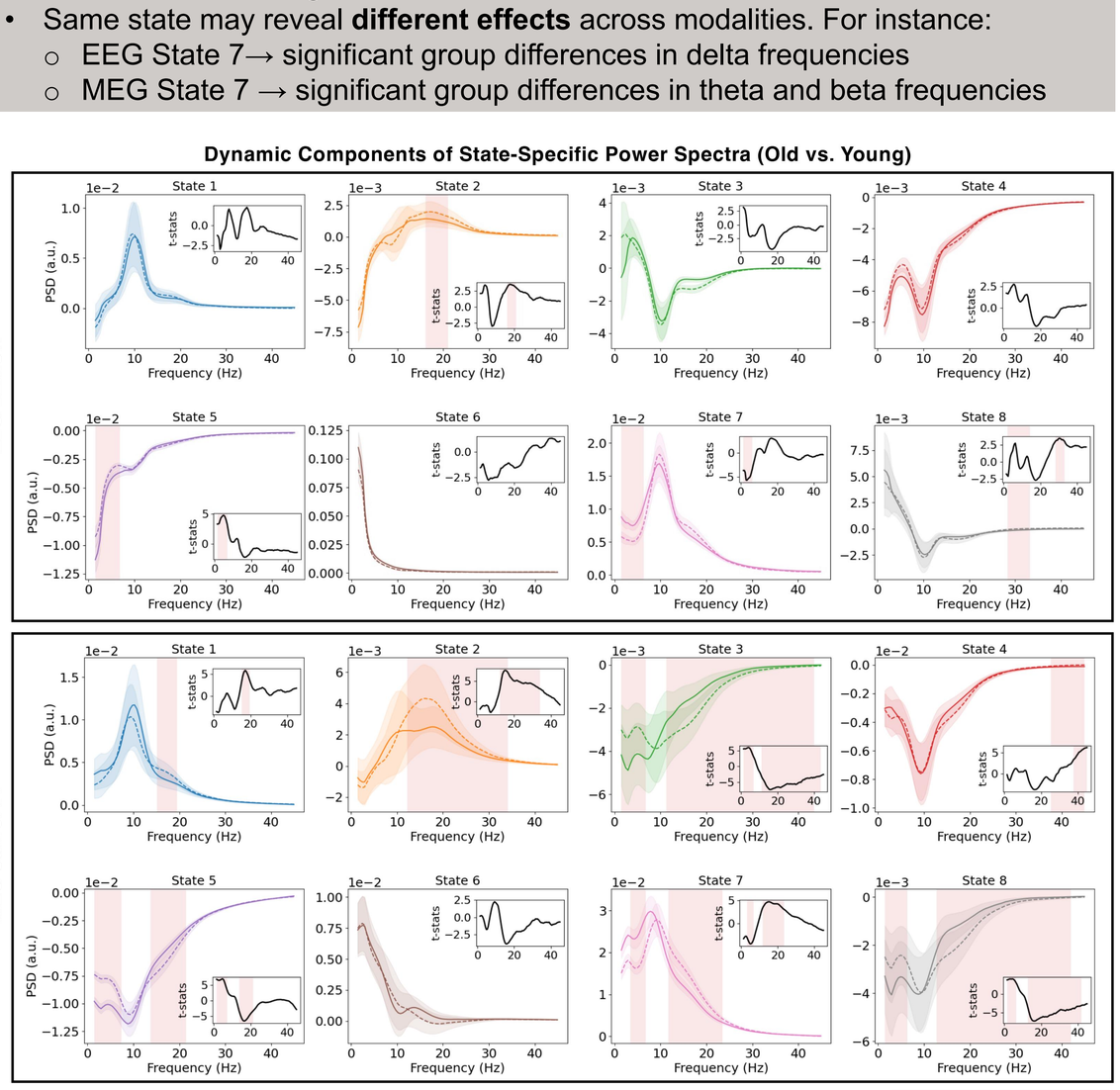


- Static narrow-band power maps show **comparable** age effects across modalities.
- A few caveats are *(1)* non-significance in EEG alpha power & *(2)* enhanced effects in MEG delta and beta powers.



4. M/EEG report distinct sets of dynamic RSNs with age-related effects in PSDs

Age effects in dynamic state-specific PSDs (averaged over parcels)
- Age effects in static PSDs are **distributed** across states in both M/EEG.
- MEG unveil **more states** with age effects than EEG.
- Sets of states with age effects are **distinct** between modalities.
- Same state may reveal **different effects** across modalities. For instance:
  - EEG State 7→ significant group differences in delta frequencies
  - MEG State 7 → significant group differences in theta and beta frequencies

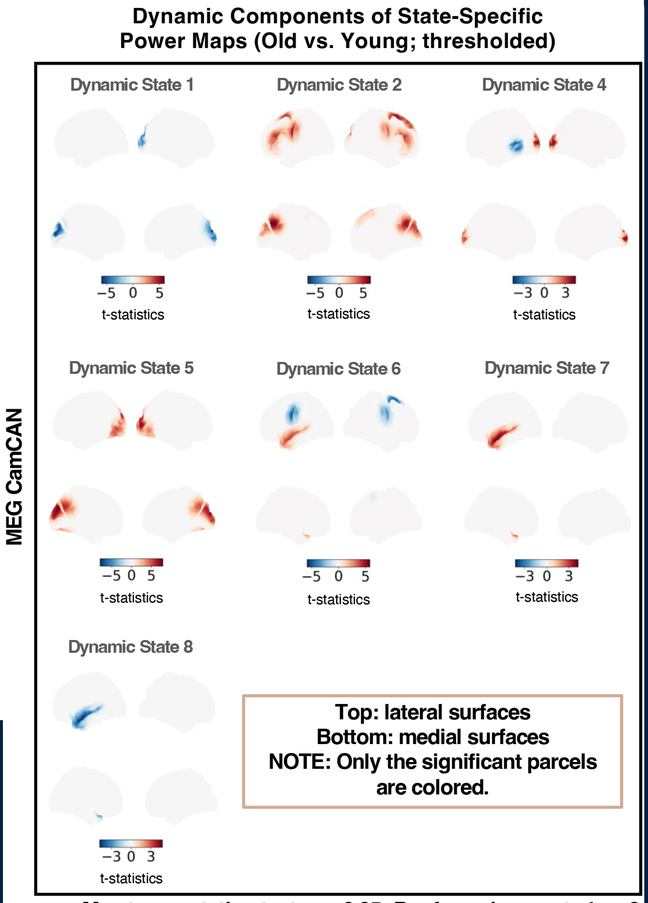


5. Dynamic age effects in state-specific power maps are observed solely in MEG

Age effects in dynamic state-specific power maps (averaged over wide-band, 1-45 Hz)
- Only reported in **MEG** HMM state powers
- States 1, 4, 6, 8
  Decreased activity in occipital, temporal, and central sulcus regions with age
- States 2, 4, 5, 6, 7
  Increased activity in frontal, occipital, and temporal regions with age

∴ While age effects are observed across different HMM states in MEG, they are **absent** in EEG.

∴ This suggests that in the source space, MEG may have **higher sensitivity** to age effects than EEG, although the use of different datasets and a larger number of sensors in MEG need to be considered.



5. Conclusion

(1) Age effects in the **static** PSDs and power maps are generally analogous across different frequency bands within source space in both MEG and EEG.
(2) However, age effects in the **dynamic** RSN features are distinct across modalities, with MEG exhibiting higher sensitivity to such effects than EEG.

References
[1] Babayan A et al. (2019). A mind-brain-body dataset of MRI, EEG, cognition, emotion, and peripheral physiology in young and old adults. *Scientific Data*, 6:180308.
[2] Shafto M et al. (2014). The Cambridge Centre for Ageing and Neuroscience (Cam-CAN) study protocol: a cross-sectional, lifespan, multidisciplinary examination of healthy cognitive ageing. *BMC Neurology*, 14:204.
[3] Vidaurre D et al. (2018). Spontaneous cortical activity transiently organises into frequency specific phase-coupling networks. *Nature Communications*, 9:2987.

For more information, please visit the website!