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Disruption of functional gradient in patients with genetic generalized epilepsy: evidence from high-density EEG

Juanli Zhang[1], Serge Vulliémoz[1], Nicolas Roehri[1]

[1]EEG and Epilepsy Unit, University Hospitals and Faculty of Medicine, University of Geneva, Geneva, Switzerland

BACKGROUND & AIMS

- Genetic generalized epilepsy (GGE) is characterized by generalized (poly)spike-and-wave (GSW) discharges during the interictal state; however, the GSW can be scarce.
- Previous studies, based on discrete regional or network analysis, have shown that GGE is accompanied by abnormal activity of multiple networks and communication between them.
- Yet, it remains elusive how the spatial arrangement of the networks in GGE is represented in a continuous space.
- Functional gradient, which has been well-established from fMRI studies, could provide a tool to represent connectomes into a the lower-dimensional space and depict the spatial arrangement of the macroscale networks in a continuous manner.

Aims:
1) Extending the gradient to functional connectome provided by EEG

2) Investigate how the spatial re-arrangement of the functional networks along the gradual axis of gradient alters in patients with GGE
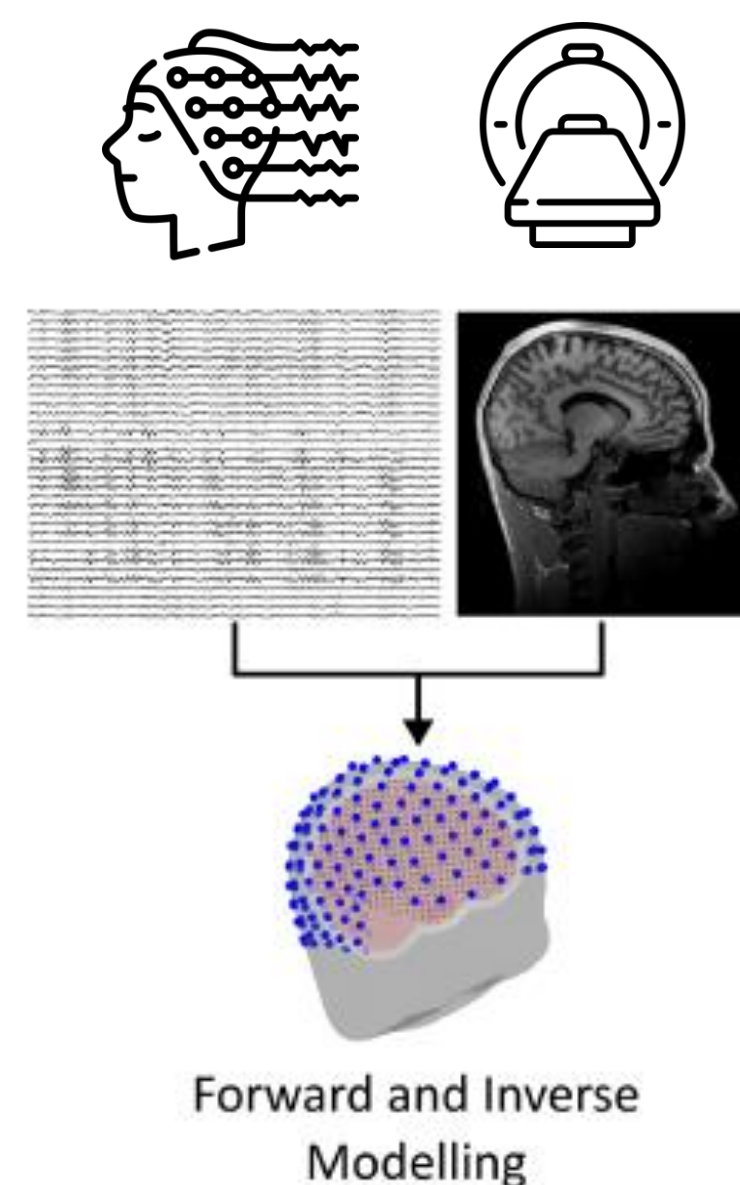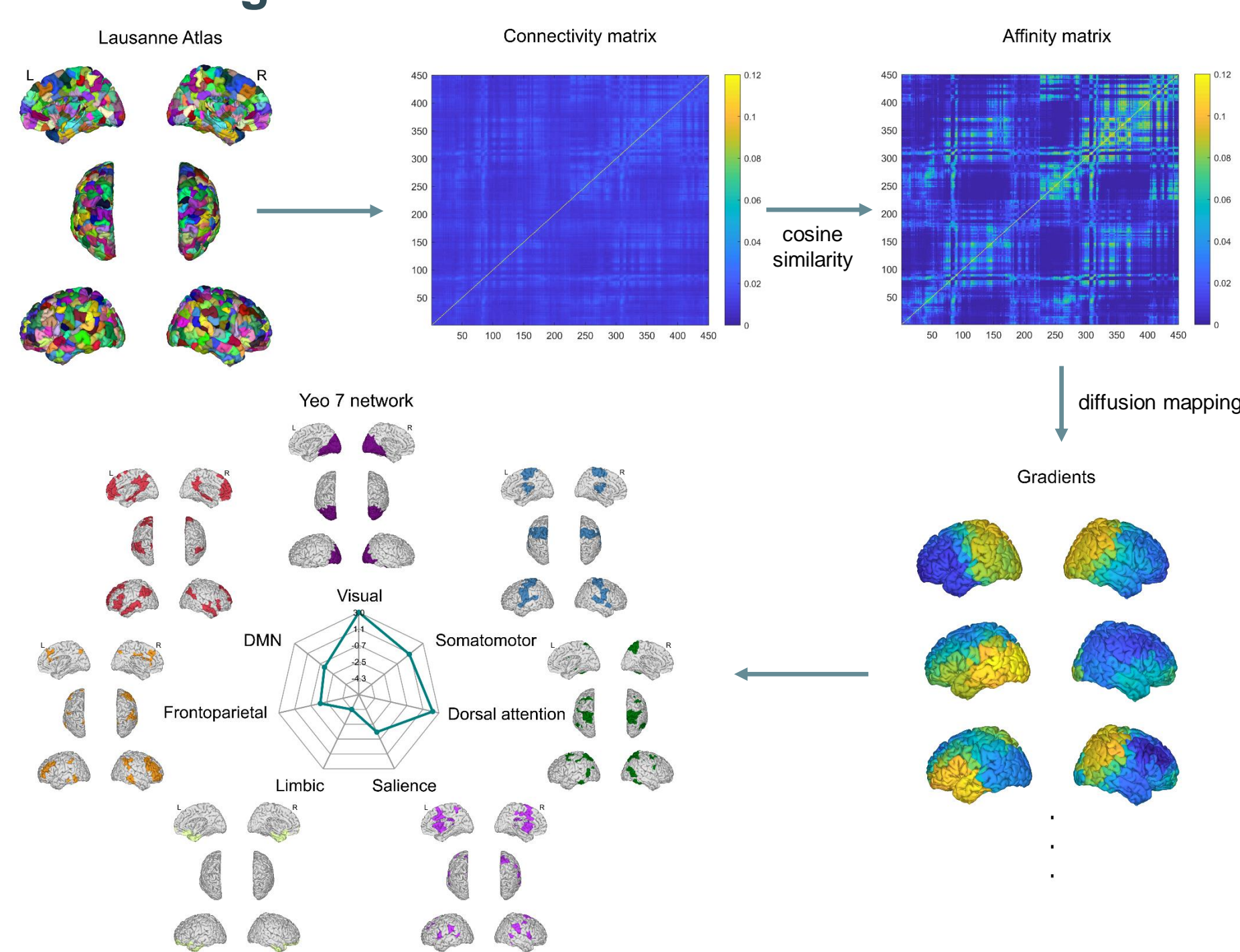
METHODS

Subjects:
- Twenty patients with GGE; twenty age and sex matched healthy control (HC)

Recordings:
- Eyes-closed resting state for at least 10 minutes with high-density EEG (256 electrodes)
- individual T1-weighted MRI (3T)

Forward and Inverse Modelling

Functional gradient estimation:

CONCLUSION

- Significant hierarchical position change of the FPN indicates a re-ordering of the functional networks in GGE: along the gradient axis, FPN moves towards the remaining networks which might promote the wide-spread of pathological activity

- Alterations in gradient scores at multiple networks show a close association with epilepsy duration: a gradual alteration of network hierarchy along the development and progression of epilepsy

RESULTS

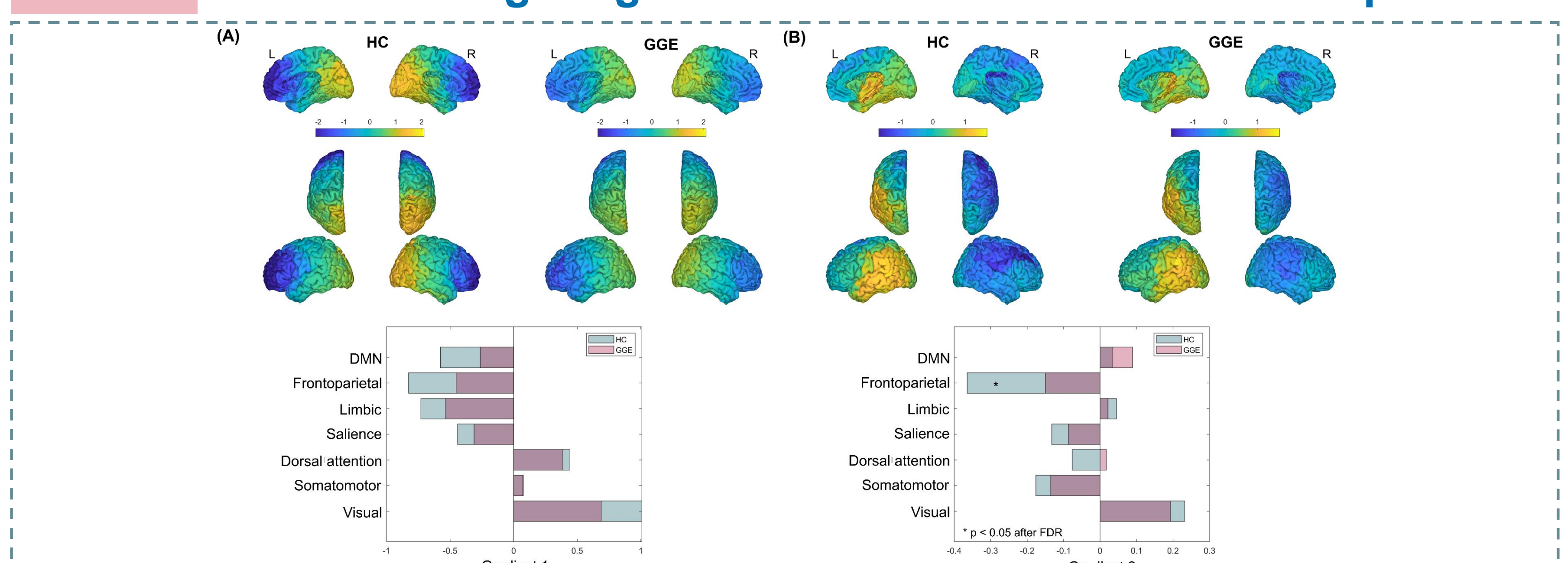**Result 1** **Beta band: higher gradient scores in FPN in the GGE patients**

Figure 1. An increase in the gradient scores of the FPN (frontoparietal network) of the G2 (second gradient) in GGE patients compared to HC. Topographies for the G1 and G2 (top A and B, respectively) and bar charts show the network-level gradient scores for GGE and HC groups.

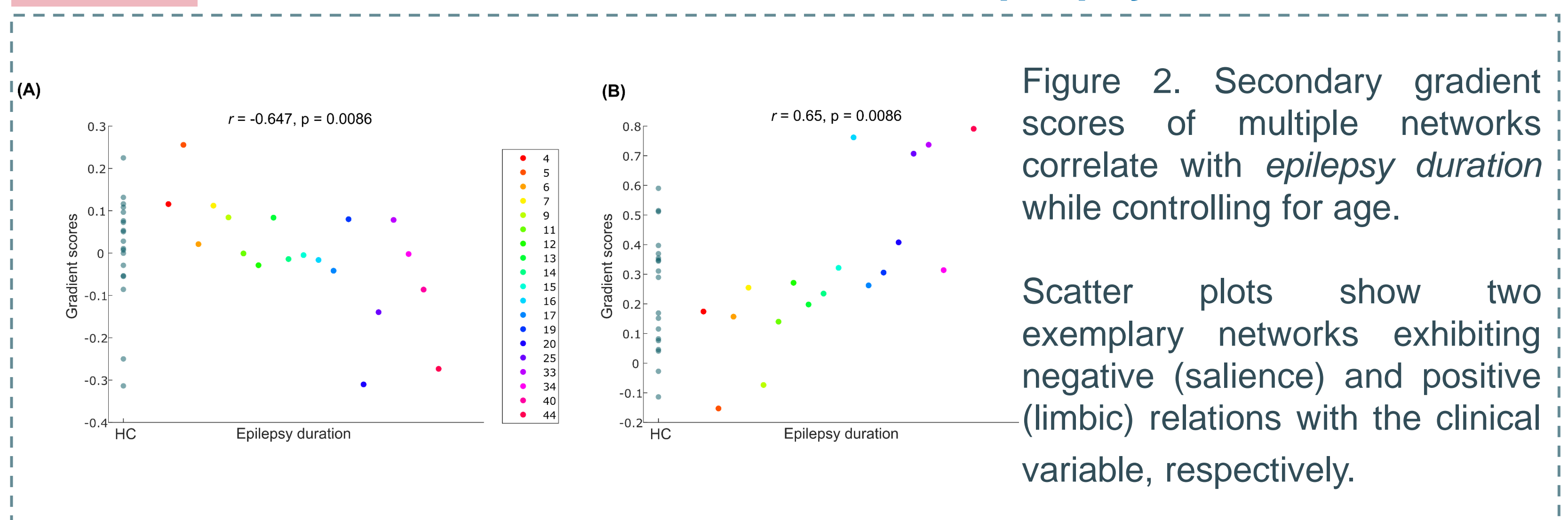**Result 2** **Theta band: close association with epilepsy duration**

Figure 2. Secondary gradient scores of multiple networks correlate with *epilepsy duration* while controlling for age.

Scatter plots show two exemplary networks exhibiting negative (salience) and positive (limbic) relations with the clinical variable, respectively.

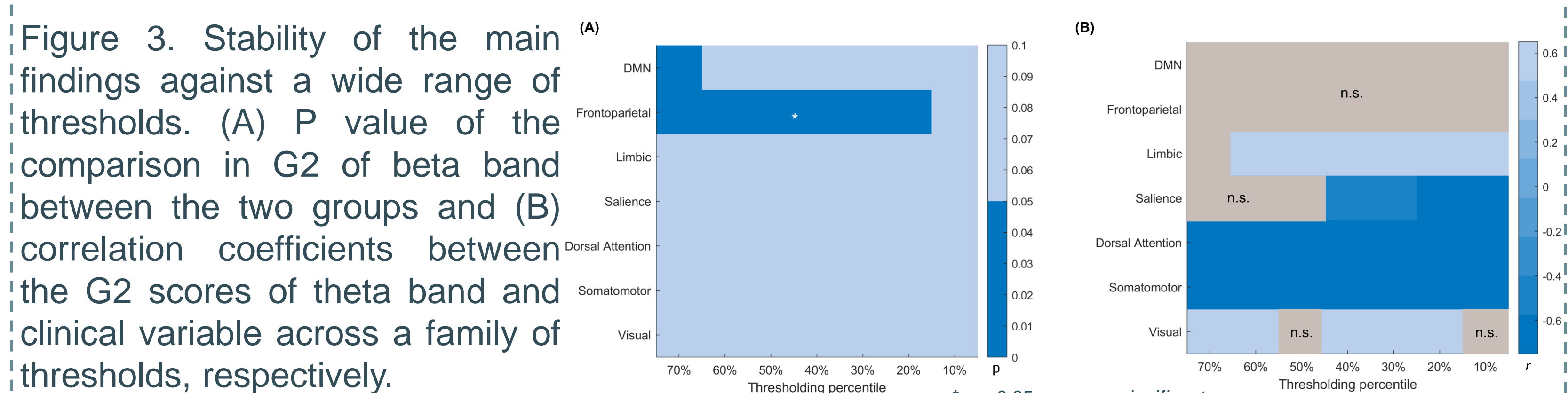**Validation** **Main results are robust against the thresholding parameter**

Figure 3. Stability of the main findings against a wide range of thresholds. (A) P value of the comparison in G2 of beta band between the two groups and (B) correlation coefficients between the G2 scores of theta band and clinical variable across a family of thresholds, respectively.

* p < 0.05; n.s.: non-significant

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