

Increased Phase-Amplitude Coupling in Parkinson's Disease: Evidence from Source Localized Electroencephalography

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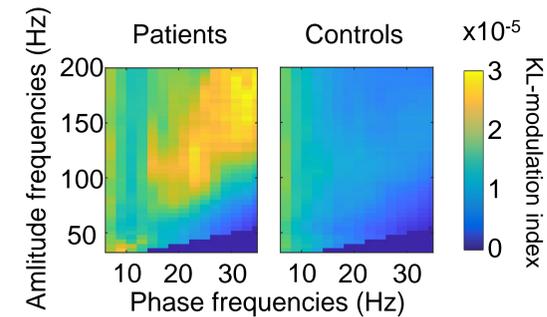
Introduction

Enhanced phase amplitude coupling (PAC) between beta activities (13-30Hz) and broadband gamma (50-150Hz) oscillations has been suggested to be an electrophysiological biomarker of Parkinson's disease (PD) which could be obtained with non-invasive scalp electroencephalography (EEG) [1]. It may provide insights into the pathophysiology of PD and represent an essential role for developing state-informed non-invasive brain stimulation (NBS) treatment. However, the spatial origin and underlying mechanism of PAC are still obscure, limiting the possible use for understanding and treating PD.

Results

Figure 1

A. Enhanced PAC in source located M1 of PD patients compared with controls.



B. PAC spatial specificity on hemisphere contralateral to patients' more affected side.

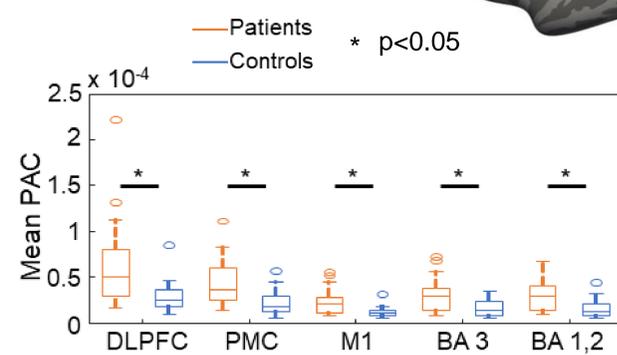
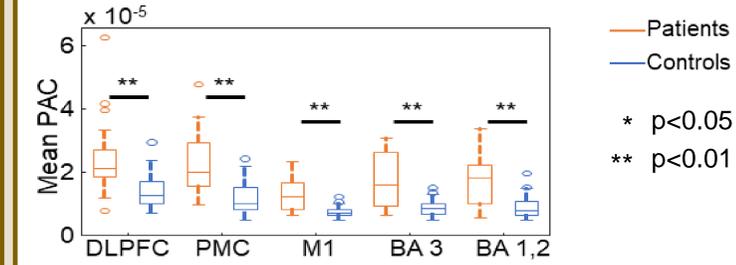
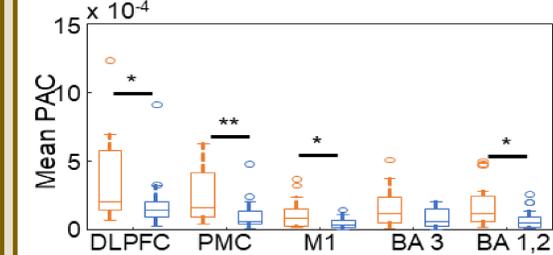


Figure 2

➤ PAC for the interaction between different components (PAC_{inter})



➤ PAC for identical component (PAC_{iden})



Correlation between PAC and clinical scores

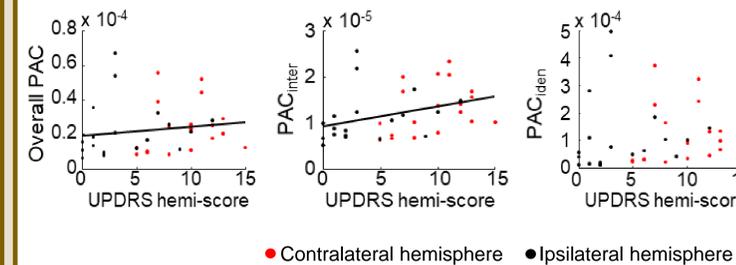
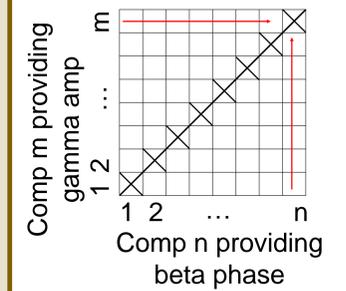
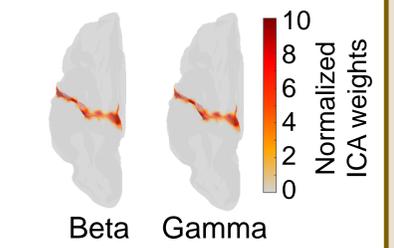


Figure 3

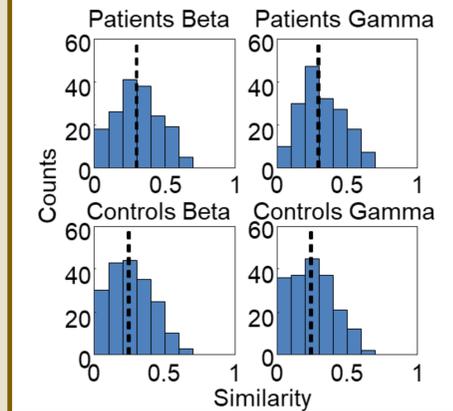
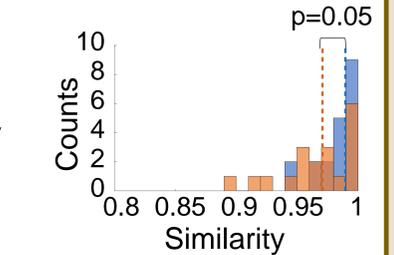
Pairwise PAC Matrix



Weighted average ICA topography



➤ Beta-gamma topographic similarity within subjects



➤ Topographic similarity across subjects

Method

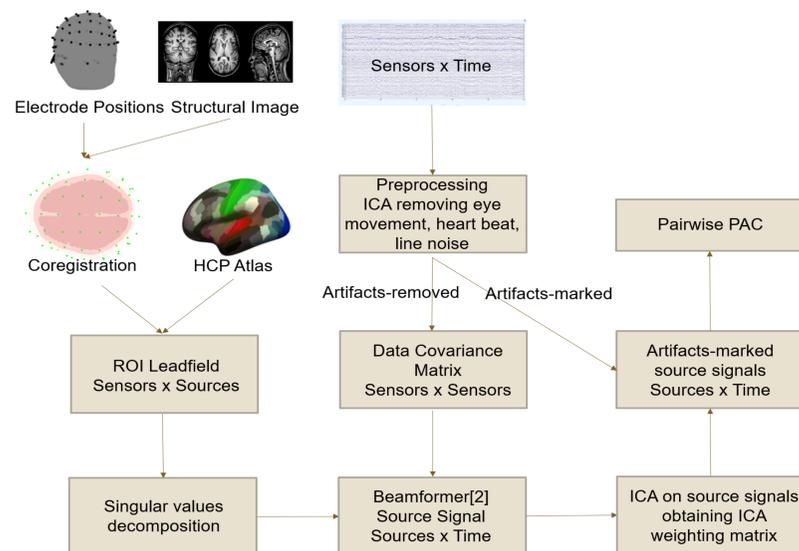
Participants

- Nineteen PD patients were recruited (age: 60.89±10.80).
- Twenty sex and aged-matched healthy controls (age: 62.55±7.85)

EEG Recording

- 64 channels EEG signals were recorded in 5min resting state, 2000Hz sampling rate

ROI-based source analysis



Conclusion

To sum up, our findings suggest that 1) Enhanced PAC in Parkinson patients originates from the coupling in several brain regions involved in motor and cognitive control (Figure 1). 2) Only the coupling from different ICA components appears to have pathophysiological significance, suggesting that therapeutic approaches breaking the abnormal lateral coupling between neuronal circuits may be more promising than targeting PAC per se (Figure 2&3). 3) With the development of real-time beamforming technique, it is promising to combine EEG with NIBS for treatment of Parkinson patients at individual level in future clinical appliance (Figure 3).

Reference

- The results were reproduced from the paper "Spatiotemporal features of β - γ phase-amplitude coupling in Parkinson's disease derived from scalp EEG", accepted by Brain [1] Swann NC, et al. Elevated synchrony in Parkinson disease detected with electroencephalography. Annals of neurology, 2015.
- [2] Oostenveld R, et al. FieldTrip: open source software for advanced analysis of MEG, EEG, and invasive electrophysiological data. Computational intelligence and neuroscience 2011.