Characteristics of Beta Waveform Shape in Parkinson’s Disease Detected with Scalp EEG

Nick Jackson¹, Scott R. Cole², Bradley Voytek², Nicole C. Swann¹
Department of Human Physiology, University of Oregon¹; Department of Cognitive Science, University of California, San Diego²

Background

- Parkinson’s Disease (PD) is a neurodegenerative disorder characterized by degeneration of dopaminergic cells. The hallmark symptoms are rigidity, bradykinesia, and akinesia.
- Neural activity in the beta frequency range (13-30 Hz) is excessively synchronized in PD.
- This synchrony can be detected as phase amplitude coupling, PAC, between beta phase and broad-band gamma amplitude. Sensorimotor PAC is elevated in PD in recordings using both electroencephalography (EEG) and electrocorticography (ECoG).

Methods

- We re-analyzed a previously published EEG dataset from another lab.
- 3 minutes of resting data from 15 PD patients, on and off medications.
- 512 Hz using a 32 channel BioSemi ActiveTwo System.
- Analysis of C3 and C4 channels, which are closest to the sensorimotor cortex.
- F7 and F8 channels, which are closest to temporalis muscles.
- Waveform shape was calculated using a previously published method:
  1) Identify zero-crossings in the raw signal.
  2) In the raw signal, find peaks and troughs between these zero-crossings.
  3) Calculate sharpness and steepness

Results

- Sharpness ratio is calculated with the following equations:
  \[
  \text{sharpness} = \frac{\text{peak} - \text{trough}}{\text{trough} - \text{peak}}
  \]
- Steepness ratio is calculated with the following equations:
  \[
  \text{steepness} = \frac{\text{peak} - \text{trough}}{\text{trough} - \text{peak}}
  \]

- In ECOG recordings, sensorimotor waveform shape differentiates PD patients on and off medication.
- Beta (13-30 Hz) and gamma (35-150 Hz) rhythms are isolated using FIR filters. Gamma amplitude and beta phase are extracted from the Hilbert transform of each of their components. The preferred coupling phase was then calculated.

Conclusions

- Waveform shape can differentiate PD patients on and off medications using scalp EEG.
- For temporalis channels, sharpness ratio, steepness ratio, and PAC did not differentiate groups (p=0.733, p=0.156, p=0.394, respectively), arguing against the idea that the pathophysiology underlying PD is manifest in waveform shape at the scalp.
- While on average higher for PD off meds, these measures are not static and do exhibit dynamic fluctuations during a recording, even at rest. Each was calculated for a representative patient off medication using a 30 second sliding window with a 25 second overlap.

References and Acknowledgments

3) Hemptinne et al. 2013 PNAS.

The Swann Lab is currently recruiting PhD students! Please visit swannlab.uoregon.edu or contact Dr. Nicki Swann at nschwann@uoregon.edu.