# Aperiodic Component Variability in Power Spectral Densities from Two Conditions of Resting State EEG

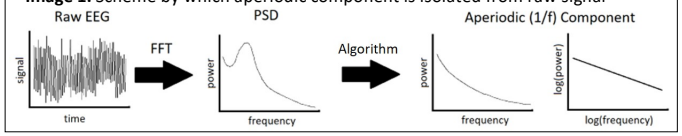
Nicholas LaPlant, Sarah Glier, Alana Campbell
Department of Psychiatry, University of North Carolina at Chapel Hill

## Overview

- Electrical signals detected by EEG exhibit both periodic and aperiodic features
- Aperiodic 1/f component of neural power spectra is less studied
- Aperiodic component is linked to the relative excitation or inhibition of the underlying neuronal population[1]
- Spectral parameterization algorithm[1] makes parameterizing neural power spectral densities into the aperiodic signal and periodic oscillations easy
- Used algorithm with custom Python script to explore how aperiodic features in resting state EEG changed in response to visual stimulation

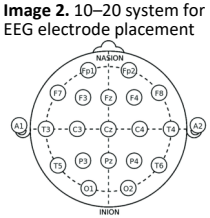
## Methods

**Image 1.** Scheme by which aperiodic component is isolated from raw signal




- Participants: from UNC-CH Psychology Research pool (n = 18)
- BioSemi ActiveTwo system sampling at 1024 Hz using DRL and CMS connections
  - 3 min of resting state EEG, eyes open (RO), participants instructed to focus on point on screen
  - 3 min of resting state EEG, eyes closed (RC), participants instructed only to stay awake
- Downsampled to 256 Hz, filtered from 1-100 Hz, and cleaned with artifact subspace reconstruction using custom MATLAB scripts in EEGLAB environment
- Noisy channels were interpolated and referenced to the average
- Eye-blinks were identified and corrected for by independent component analysis; Artifacts were rejected based on improbable or noisy data
- Calculated power spectral densities (PSDs) in single Hz steps using the Darbeliai plugin in EEGLAB with fast Fourier transform (FFT) on 2 sec overlapping segments
- Aperiodic component fits and PSDs at 9 electrodes of interest (F3, Fz, F4, C3, Cz, C4, P3, Pz, and P4) for each participant were found with a custom Python script utilizing the algorithm library

**Image 2.** 10–20 system for EEG electrode placement




## Results

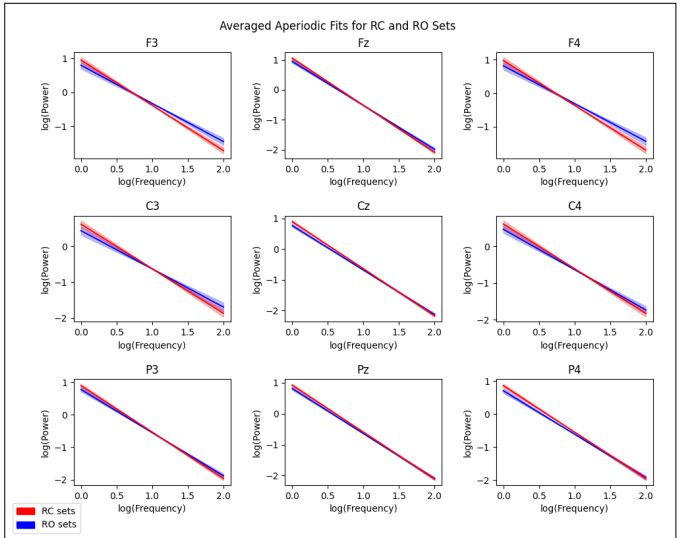



**Figure 1.** Displayed are the generated fits for the aperiodic 1/f component in log-log space with shaded regions indicating 95% confidence intervals. Generally, RO sets (blue) exhibited a more negative slope in log-log space compared to RC sets (red).

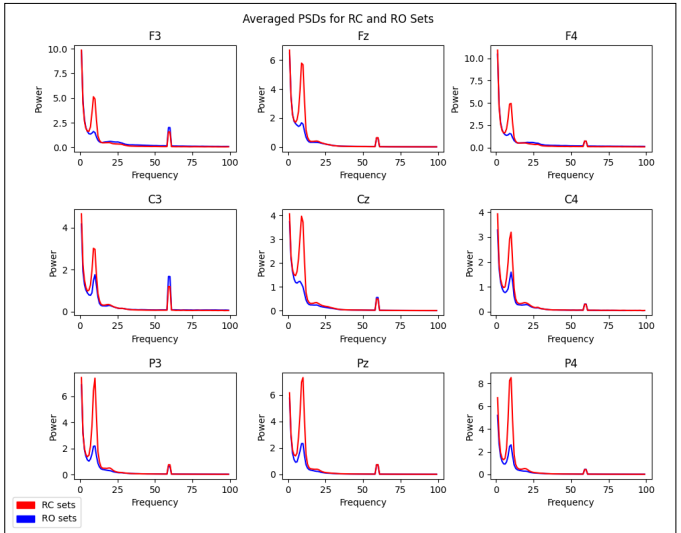



**Figure 2.** Displayed are the PSDs for RC (red) and RO (blue) sets averaged across all participants. Frequencies between 4-12 Hz are weaker in RO compared to RC.

## Results (contd.)

**Table 1.** Alpha (8-12 Hz) power band activity averaged over all participants

| Electrode | RO alpha powers ($\mu V^2$/Hz) | RC alpha powers ($\mu V^2$/Hz) |
|---|---|---|
| F3 | 1.266 | 3.482 |
| Fz | 1.297 | 3.940 |
| F4 | 1.275 | 3.393 |
| C3 | 1.208 | 2.104 |
| Cz | 0.905 | 2.715 |
| C4 | 1.123 | 2.217 |
| P3 | 1.634 | 4.727 |
| Pz | 1.709 | 4.875 |
| P4 | 1.841 | 5.651 |

**Table 2.** Theta (4-8 Hz) power band activity averaged over all participants

| Electrode | RO theta powers ($\mu V^2$/Hz) | RC theta powers ($\mu V^2$/Hz) |
|---|---|---|
| F3 | 1.547 | 2.149 |
| Fz | 1.561 | 2.352 |
| F4 | 1.566 | 2.107 |
| C3 | 0.873 | 1.275 |
| Cz | 1.227 | 1.976 |
| C4 | 0.851 | 1.272 |
| P3 | 1.252 | 2.050 |
| Pz | 1.216 | 2.365 |
| P4 | 1.147 | 2.266 |

- Aperiodic component fits in log-log space exhibited a positive slope shift from RC to RO as shown in **Figure 1**.
- RC sets exhibited stronger alpha and theta power bands than RC sets as shown visually **Figure 2** and quantitatively in **Table 1** and **Table 2**.

## Conclusions

- It is well known that alpha activity in EEG is dominant during eyes-closed resting state, and is suppressed with visual stimulation[2]
- In the absence of periodic activity, the aperiodic fits showed a log-log slope shift from RC to RO (**Figure 1**)
- These changes in the aperiodic component may indicate an overall shift in how the resting state brain acts in response to visual stimulation

## References

1. Donoghue, T., Haller, M., Peterson, E. J., Varma, P., Sebastian, P., Gao, R., Noto, T., Lara, A. H., Wallis, J. D., Knight, R. T., Shestyuk, A., & Voytek, B. (2020). Parameterizing neural power spectra into periodic and aperiodic components. *Nature neuroscience, 23*(12), 1655–1665. https://doi.org/10.1038/s41593-020-00744-x

2. Barry, R. J., Clarke, A. R., Johnstone, S. J., Magee, C. A., & Rushby, J. A. (2007). EEG differences between eyes-closed and eyes-open resting conditions. *Clinical neurophysiology : official journal of the International Federation of Clinical Neurophysiology, 118*(12), 2765–2773. https://doi.org/10.1016/j.clinph.2007.07.028