Age-related changes in alpha and mu oscillation amplitude and waveform asymmetry

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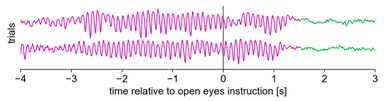
Introduction

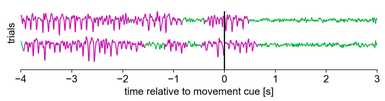
Two prominent alpha-band (8–13 Hz) oscillations

Alpha (8–13 Hz)

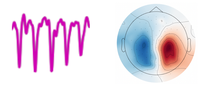


- Strongest with eyes closed
- Triangular shape
- Most prominent in occipital cortex

Mu (8–13 Hz)

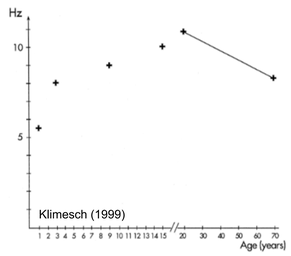


- Strongest when stationary
- μ-shaped
- Most prominent in somatosensory cortex



Alpha-band oscillations and aperiodic activity both change during aging

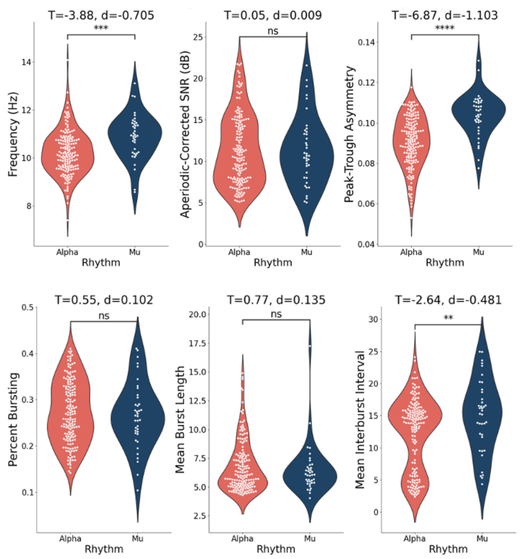
- The aperiodic exponent decreases with age, such that the power spectrum becomes 'flatter' across adulthood (Voytek et al., 2015)
- Both the center frequency (Knyazeva et al., 2018) and amplitude (Rossini et al., 2007) of occipital alpha decrease during aging
- Only the center frequency decrease cannot be accounted for by changes in aperiodic activity (Cesnaite et al., 2021)
- Changes in sensorimotor mu center frequency or amplitude have not been documented



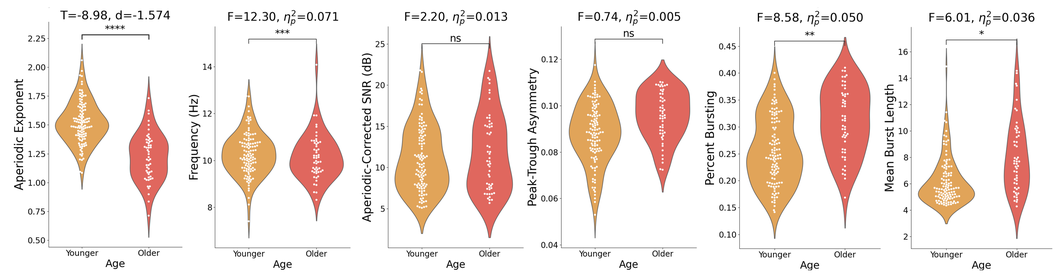
<u>Research Question</u>: How do alpha and mu waveforms change across adulthood, independent of the well-documented changes in aperiodic activity?

Results

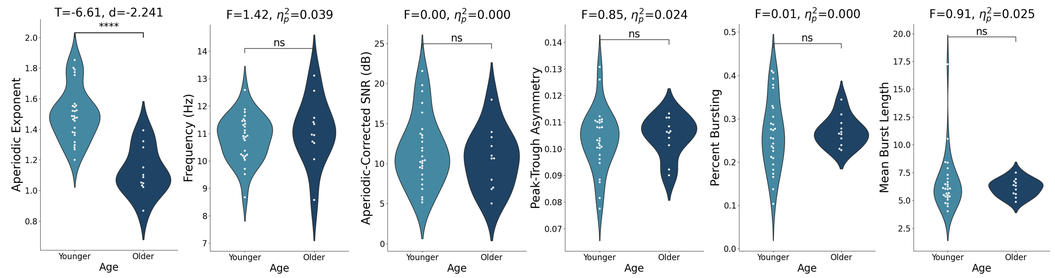
Alpha and mu components have significantly different waveform shape (n = 169 subjects)



Alpha waveforms change independently of the aperiodic exponent in aging (n =165 subjects)

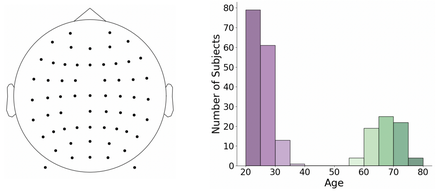


Mu waveforms are stable across adulthood (n = 38 subjects)

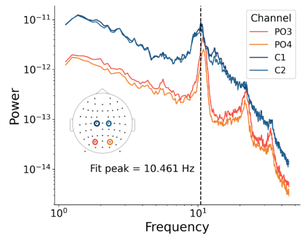


Methods

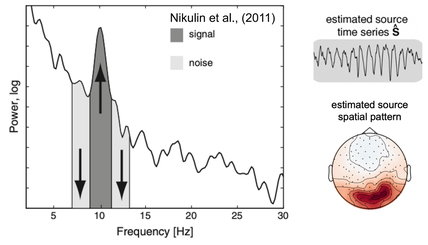
I) Using resting-state EEG data for 179 participants aged 20-80 from the Leipzig Mind-Brain-Body dataset (Babayan et al., 2019), perform minimal preprocessing (interpolation of high variance channels)



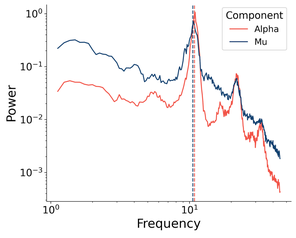
II) Find peak frequency in 6–13 Hz range using FOOOF (Donoghue et al., 2020) in occipital and sensorimotor channels



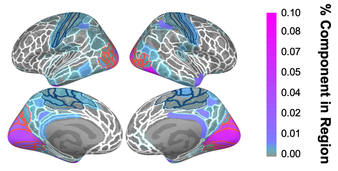
III) Extract oscillatory sources with high alpha SNR using spatio-spectral decomposition (SSD) (Nikulin, et al., 2011)



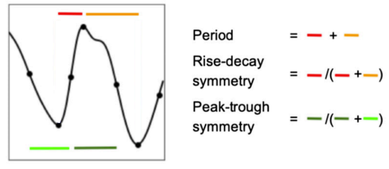
IV) Find peak frequency in 6–13 Hz range using FOOOF (Donoghue et al., 2020) for each SSD component



V) Using dipole estimation, classify components with SNR > 5 dB and sources in the occipital cortex as alpha components and sources in somatosensory, motor, paracentral lobular, and midcingulate cortices as mu components



VI) Calculate waveform shape features from alpha and mu component time series using bycycle package (Cole & Voytek, 2019)



Cole & Voytek (2019)

Summary

1. Consistent with previous qualitative observations, we quantifiably demonstrated that mu oscillations are far more asymmetrical than alpha oscillations in a large dataset (n = 179 subjects).
2. We replicated previous findings of (1) an aperiodic exponent decrease (flattening of the power spectrum) and (2) an alpha oscillation frequency decrease during aging and demonstrated that these phenomena are statistically independent.
3. Alpha waveforms have consistent shape across adulthood, but burst more often and for more cycles in older adults than in younger adults.
4. Mu waveforms are stable during aging, with no significant differences observed in frequency, SNR, shape, nor bursting statistics between younger and older adults.

Acknowledgements

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