**Oscillations characteristic of non-epileptogenic neocortex in a resting state**

D.M. Groppe1,2,3, S. Bickel4, C. Keller1,2,3,5, S. Jain1,3, S. Hwang1,3, S. Stevens1,3, C. Harden1,3, A.D. Mehta1,2,3

1Departments of Neurology and Neurosurgery, North Shore Long Island Jewish Health System; 2Feinstein Institute for Medical Research, Hofstra University School of Medicine; 3Harvey Cushing Institutes of Neuroscience; 4Department of Neurology, Albert Einstein College of Medicine; 5Department of Neuroscience, Albert Einstein College of Medicine.

**Introduction**

**Questions**
- What are the dominant frequencies of oscillatory resting activity of different human neocortical areas as measured by the electrocorticogram (ECoG)?
- Are there clearly different types of ECoG oscillations across the entire brain and do they fit conventional frequency bands (e.g., alpha, beta)?

**Background**

Abnormalities in resting neocortical oscillations can be indicative of epileptogenic pathologies. For example, focal slowing and focal attenuation of alpha and beta oscillations may be indicative of a lesion1. Identifying such abnormalities requires characterizing normal patterns of oscillatory activity. However, to the best of our knowledge, comprehensive, quantitative standards for such patterns in ECoG recordings have not been established. Towards creating such standards, we have attempted to quantify the types of oscillations that are normally observed in different ostensibly healthy cortical areas when an individual is at rest.

**Participants & Procedure**

15 individuals with pharmacologically intractable epilepsy (8 male, 14 right handed)
- Mean subject age: 32 (SD=13) years
- Data from 10 participants collected when individuals were asked to rest quietly with eyes closed. Data from remaining participants collected from archived data during periods of time when participants were awake but resting.
- All data acquired at least 17 hours since last clinical seizure.
- Mean clip duration: 4.8 (SD=1.4) minutes

**Methods**

**Electrode Localization**

(A) Posterior CT scan, (B) Manual identification of electrodes via BrainImage Suite, (C) Coregistration of CT scan to preimplant MRI, (D) Coregistration of electrode locations to FreeSurfer pial surface, (E) Electrode locations projected to pial surface

**ECoG Recording & Processing**

On average 103 (SD=21) subdural electrodes were implanted in each subject
- Electrodes with poor signal-to-noise, near anatomical abnormalities, over the ictal onset zone, or exhibiting frequent spikes removed from analysis leaving an average of 81 (SD=26) electrodes per participant.
- ECoG referenced to electrode screwed into the vertex of the skull and re-referenced to average reference offline.
- ECoG whitened by taking its temporal derivative to heighten spectral power peaks.
- Segments of data divided into 1 sec epochs with 0.5 sec overlap.
- Spectral power density (SPD) for each epoch estimated with the mean of two Sleipan tapers and discrete Fourier transform.
- Mean SPD for each electrode derived by taking the 5th trimmed mean of all epochs to ignore outliers.
- SPD normalized to unit area ignoring line noise frequencies and frequencies above 164 Hz.

**Results**

**Most Common Spectral Peaks**

Histogram of SPD peaks across all electrodes and participants

**Anatomically Based Analysis**

SPDs averaged by cortical area: SPDs are color coded to represent cortical area. Only SPDs for cortical areas with data from more than one participant shown.

**Conclusions**

- Cluster analysis suggests seven types of power spectra. These are generally consistent with conventional delta, theta, alpha, and beta frequency bands and suggests two theta sub-bands with peaks at 5 and 7 Hz.
- 7-7 Hz oscillations, are generally the dominant mode of sub-30 Hz activity of the cortical areas sampled. This contradicts previous estimates from scalp EEG which generally found predominant ~10 Hz activity.
- Beta peaks were reliably found in pre- and post-central gyr, middle frontal gyrus, and parietal opercula. Thus beta is characteristic of the frontal lobe but the distribution appears to be more selective than previously reported.
- Alpha peaks generally limited to occipital and parietal areas.
- Gamma peaks too unreliable to characterize but tended to occur over anterior temporal lobe. Results appear to be consistent with previous report of medial temporal gamma.
- Future work will look at how power spectra from ictal onset zones differs from these norms.