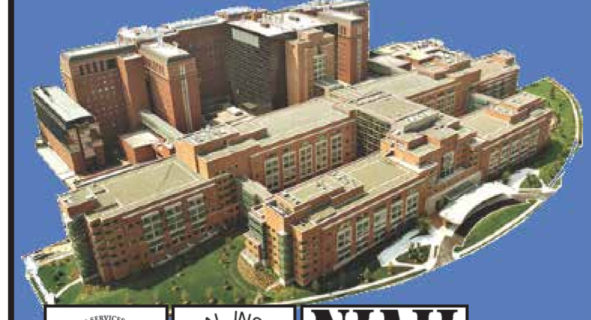

RESTING STATE FREQUENCY SIGNATURES ACROSS REGIONS

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INTRODUCTION

Resting state networks have been observed across many studies. Although these networks are consistently identified, there is still little understanding about what aspects of fMRI signal fluctuations distinguish the networks. Connectivity changes across time have been shown to vary periodically in ways that can be used to distinguish brain regions[1]. This could occur if different brain regions have distinct frequency profiles. Such frequency differences are not visible with direct comparisons of power spectra in typical resting state scans.

In this study, we calculate power spectra using 60 minute resting data to see if the reduced noise due to averaging more spectra across time helps better identify subtle differences. Additionally, we use a new method to examine relative changes across voxels within each subject. This approach is able to highlight brain regions with consistently higher or lower power compared to other brain regions even if the power values vary widely across subjects.

Data are from 11 healthy adults as they were told to relax with their eyes closed for 60 minutes. 3T GE MRI, 32-channel receive-only head coil. TR=1s, TE=27ms, ASSET=2. Data were collected as part of a previous study[2].

Preprocessing included despiking, rigid body motion correction, slice-time correction, scaling to percent change from mean, RETROICOR[3], RVT[4], and RHR[5] corrections for cardiac and respiratory fluctuations, >0.4mm motion scrubbing, ANATICOR[6], and 0.01-0.25Hz bandpass filtering.

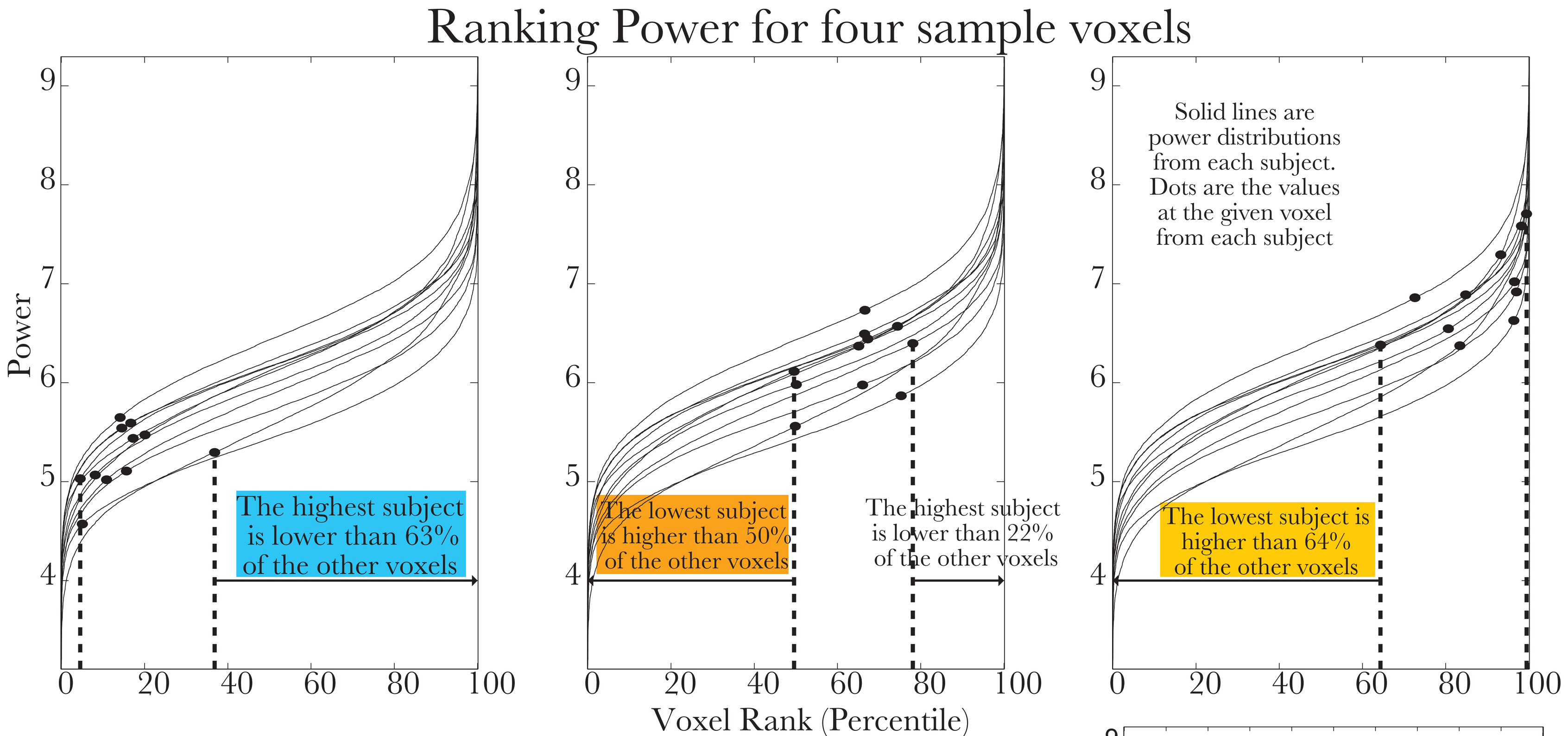
Power spectra were calculated using Welch's averaged periodogram method with 32 timepoint windows (0.0156Hz frequency bins). Time series were scaled to mean=0 and standard deviation=1 to normalize overall power.

Spectra were averaged across ICA-based networks defined in Smith et al[7].

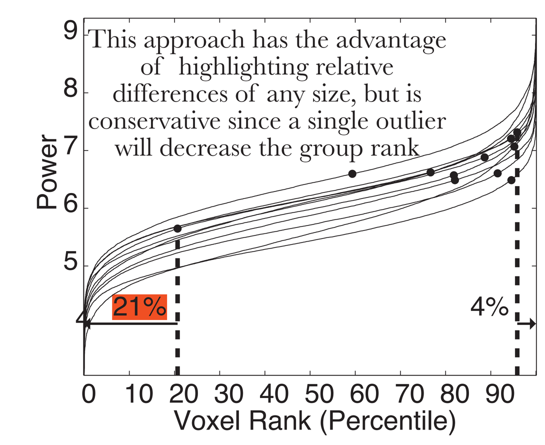
Data processing used AFNI & MATLAB

METHODS

Ranking Power for four sample voxels

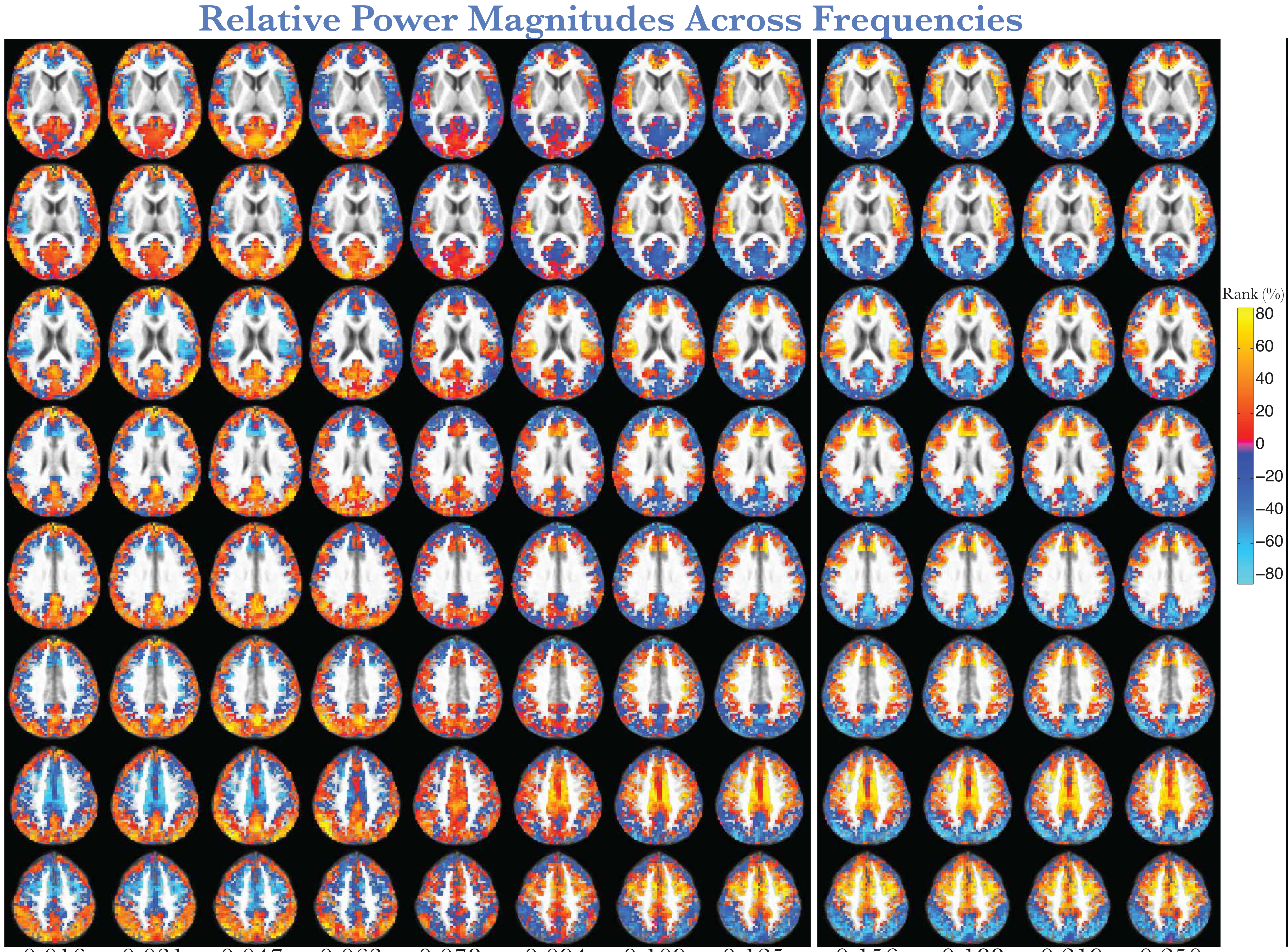


A goal is to identify voxels with relatively larger power at specific frequencies. For each frequency bin in each subject, the power across voxels within a gray matter mask were sorted and ranked. For each voxel, in each subject, the power can be transformed into a rank. Each voxel is ranked by its most conservative extrema (i.e. The low percentile is defined by the subject with highest rank and the high percentile is defined by the subject with the lowest rank.) These values are assigned colors to use in the relative power maps.



RESULTS

Relative Power Magnitudes Across Frequencies



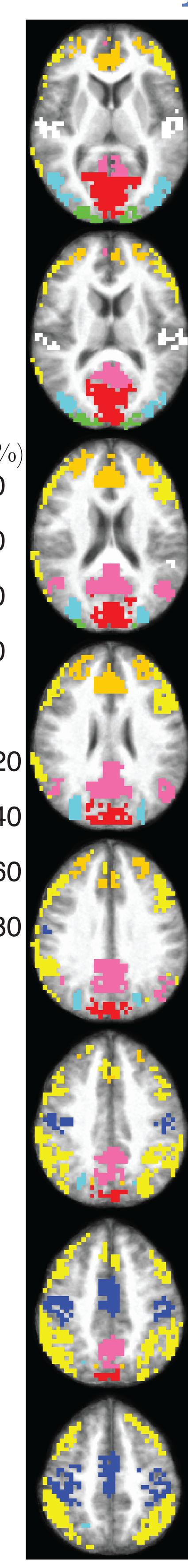
Each column is the relative power map within a frequency bin. The maps above 0.125Hz were similar so only every other bin is skipped.

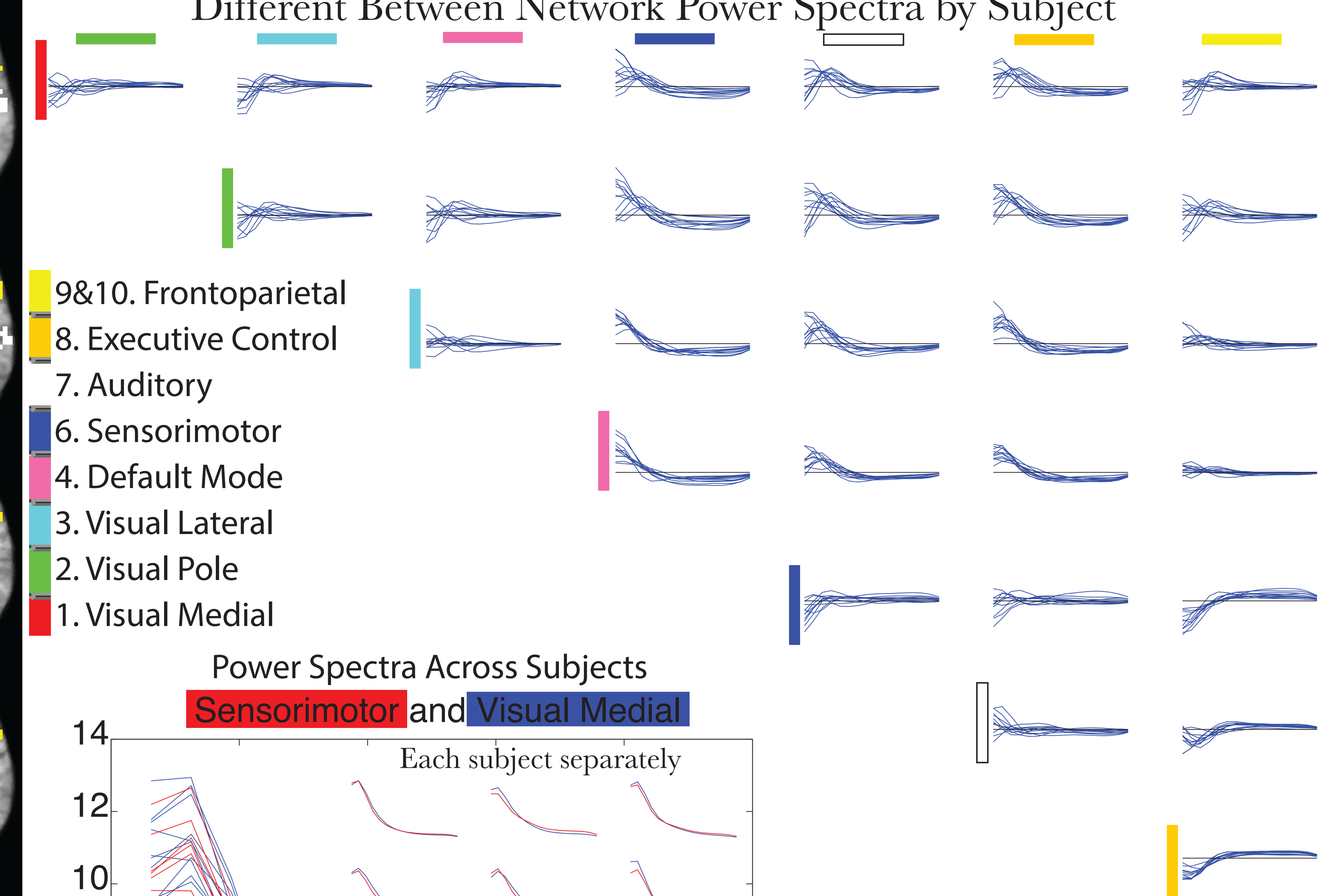
The regions with the highest and the lowest ranked voxels shift with frequency

For example, the calcarine sulcus is ranked highly while the middle frontal gyrus has a low rank at 0.047Hz. The middle frontal gyrus is highly ranked at 0.109Hz.

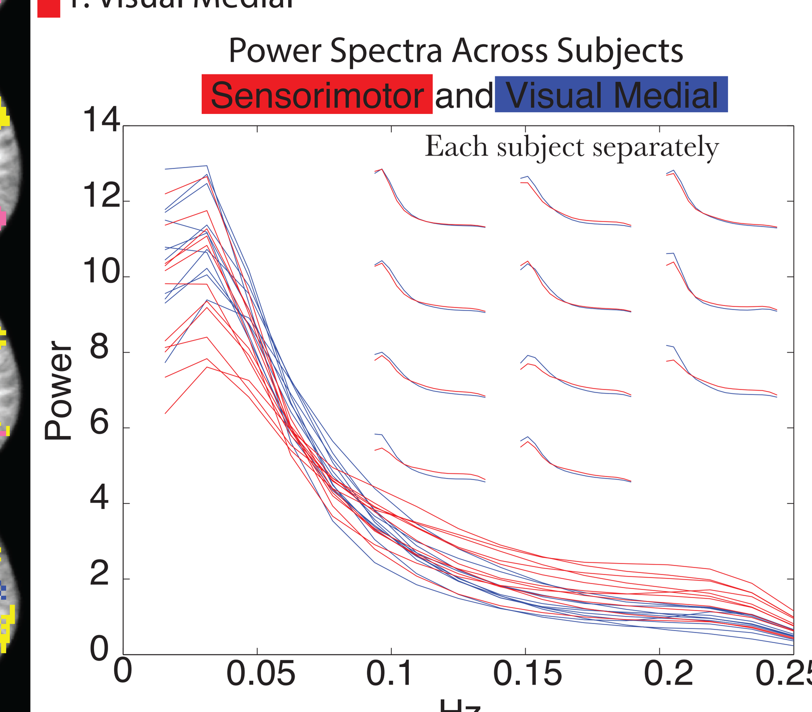
As frequency increases, there is a qualitative shift from the posterior to the anterior voxels having the highest relative power.

Power Magnitudes Across Networks





These plots show the within subject spectra differences between every pair of networks. All subjects are either above or below 0 (black line) within specific frequency ranges. Power in these plots ranges from -3 to 4.3



Gray matter ROIs were made based on the 10 ICA-based networks defined in Smith et al[7]. Our data didn't include a sufficient number of cerebellar voxels and the left and right frontol parietal networks were merged. The brain slices show the 8 defined ROIs. For each ROI, an average power spectrum was calculated for each subject. Each subjects' spectra from two ROIs are shown above. While it is difficult to see a clear effect when all subject's data are overlapping, paired spectra from individual subjects show that the visual medial network is reliably highter than sensorimotor at lower frequencies and has lower power at higher frequencies

CONCLUSIONS

Given sufficient data, there are clearly observable relative power differences between brain regions. These differences are visible both in maps and when averaging across regions of interest.The neural meaning of these differences still needs to be explored

The ranking approach used for the brain maps has the ability to highlight subtle, but consistent magnitude changes and present these results on a brain volume. Without this ranking, summarizing this information would require multiple contrasts between regions or voxels.

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