SpectraVis: A web application for analyzing dynamic, task-related functional networks

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Summary: Functional network analysis is a growing area of research, but as technology improves and recordings include more sensors, the dimensionality of the networks can make analysis unwieldy and hard to interpret. Dimensionality is particularly problematic with increasing network size, because the number of possible connections in a network scales quadratically with the number of sensors (e.g. electrodes), and the networks can vary over time and frequency. Additionally, researchers may be interested in several spatial scales such as analyzing connectivity within and between brain regions. While careful statistical modeling and strong hypotheses are important for reducing dimensionality, interactive visualizations are an often neglected tool for coping with high-dimensional analyses.

Visualizations allow us to quickly make multiple simultaneous comparisons, easing the cognitive burden on working memory by efficiently encoding properties of the data into features salient to the visual system. Adding interactivity can allow the user to change perspectives and modify analyses on demand, further facilitating comprehension and hypothesis generation.

Here we present an interactive web-based visualization application, SpectraVis, that: (1) displays task-related functional networks over time and frequency, (2) compares individual and associative measures on sensor pairs (e.g. spectra and coherences), (3) compares different measures of association (e.g. correlation vs. coherence, binary vs. weighted networks), and (4) views networks at two spatial scales (sensor- and region-of-interest-level). The different modules of SpectraVis are dynamically linked, highlighting relationships between the metrics in response to user interaction. We demonstrate its capabilities on an electrocorticography (ECOG) dataset collected during an overt reading task. We believe this application will be of interest to the COSYNE audience because visualization is an essential tool for understanding these datasets at all stages of analysis and current practices for visualization of brain networks do not reflect their richness and complexity. Additionally, SpectraVis is open-sourced and open to use and development by the community.

Detail: A working example of the SpectraVis code with the ECOG overt reading task can be found online[1]. The code itself is accessible in a Github repository[2] and is free to use under the GPL-2.0 open source license. Figure 1 shows a typical view of the SpectraVis application.

[1] http://ericdeno.com/research/SpectraVis
[2] https://github.com/edeno/SpectraVis

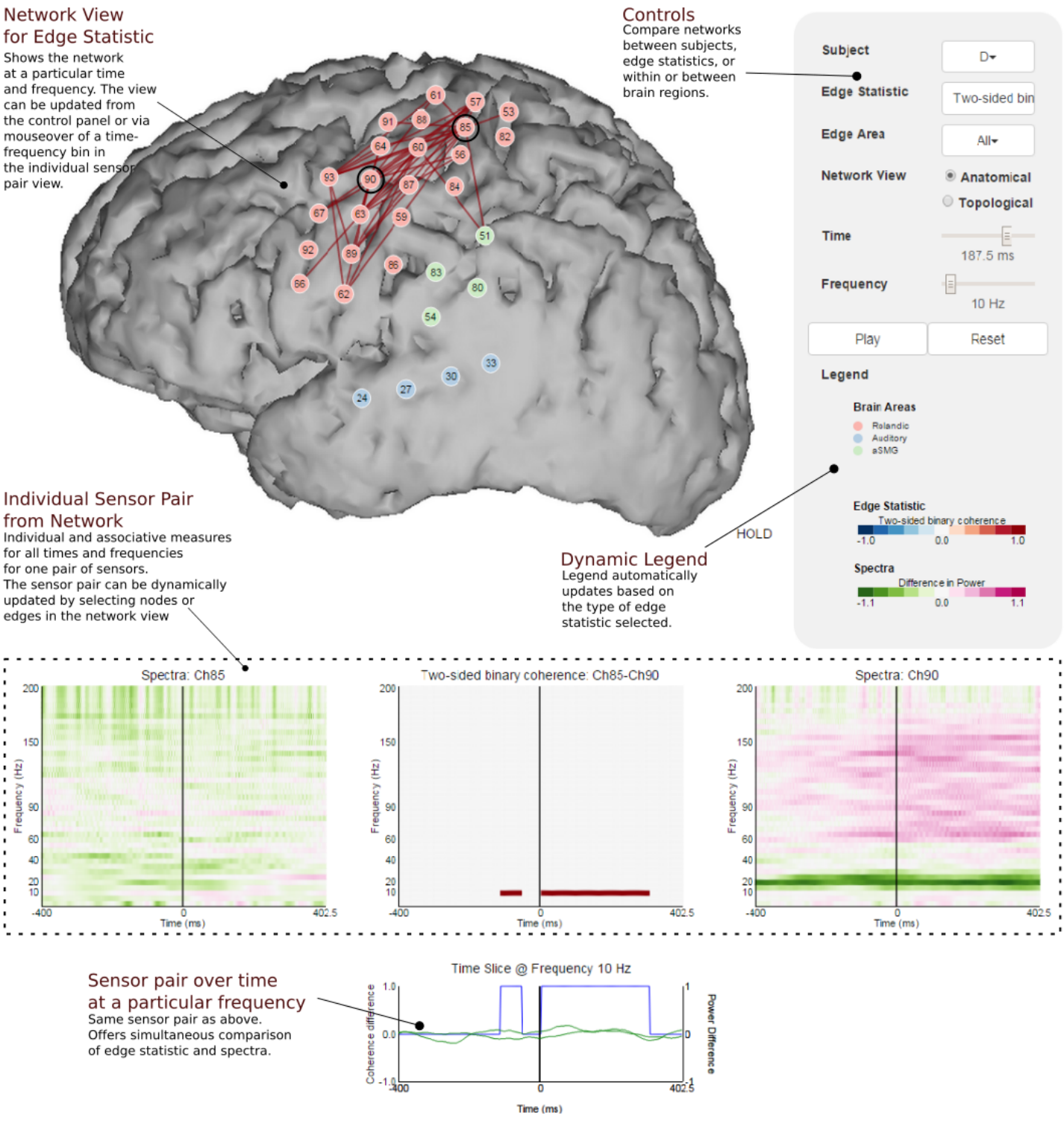

Figure 1: A static screenshot of the SpectraVis interface with the ECOG overt reading data. The network view shows the anatomical location of the sensors (circles) and edges (lines) weighted by a measure of statistical association between the sensors (the edge statistic). In this case, the edges represent significant changes in local field potential (LFP) coherence between *Speech* — subjects reading the words of the Gettysburg Address — and *Silence* at a particular frequency (10 Hz) and time (187.5 ms after speech onset). Below the network view is a individual sensor view, which depicts the relationship (spectra and coherences) between a particular pair of sensors at all times and frequencies. This allows for comparison between individual electrode pairs and the network. Users can use the Controls to compare subjects, edge statistics (e.g correlation instead of coherence), and the network at other times and frequencies.