

Variability of peak alpha frequency within single subjects examined with independent component analysis

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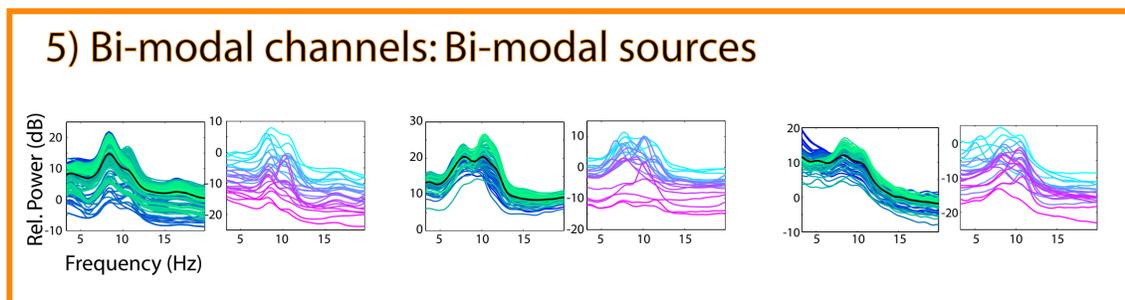
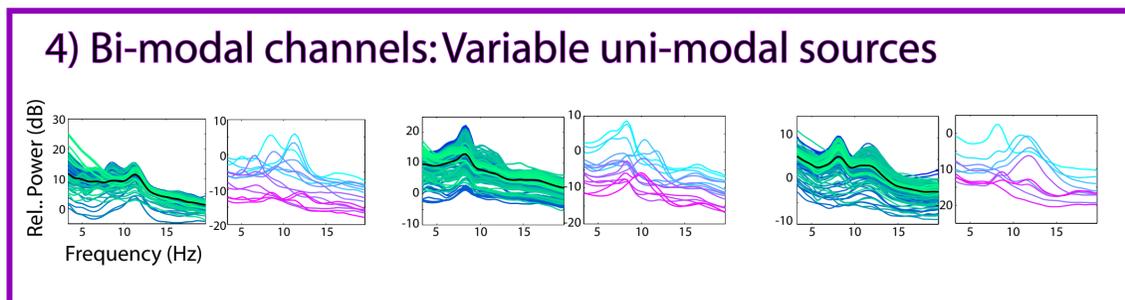
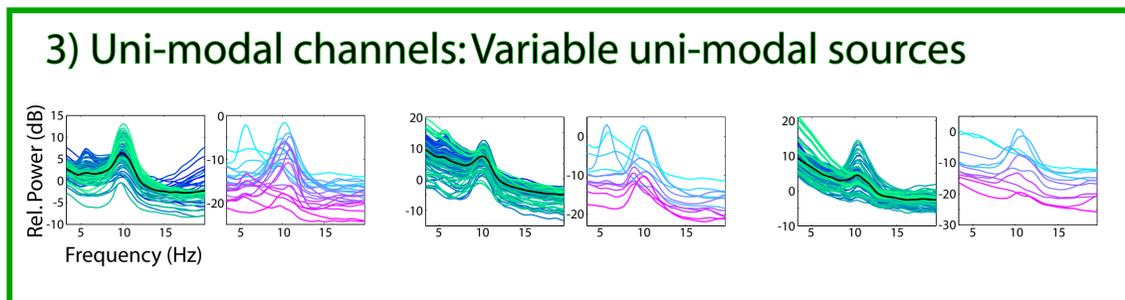
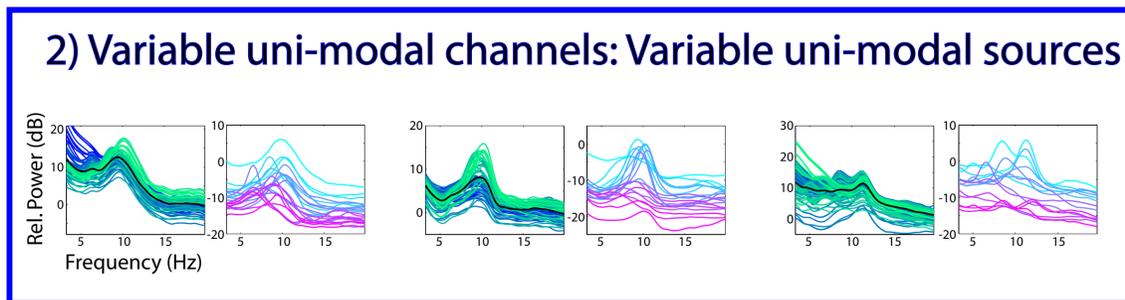
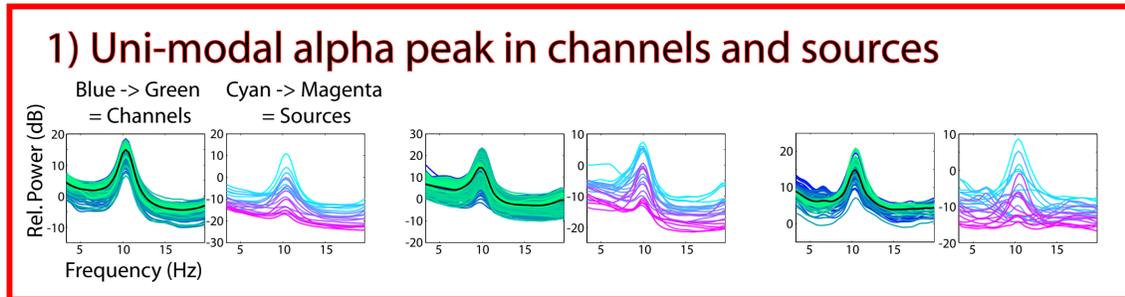
ABSTRACT

A proposed method for normalizing peak electroencephalographic (EEG) frequencies across subjects in an experimental pool is to determine the 'individual alpha frequency' (IAF) for each subject and create individualized theta and alpha bands according to this frequency (Doppelmayr, M., Klimesch, W., Pachinger, T., Ripper, B., 1998. Biol Cybern 79, 49-57). We show here that the mean peak alpha frequency across scalp electrodes represents an average of possibly widely varying frequency peaks of independent EEG processes. When mixed signals at scalp electrodes were decomposed using independent component analysis (ICA), independent sources with variable peak alpha frequencies were revealed. Our results demonstrate not only considerable inter-subject variability in peak frequencies (as has been noted in the literature), but also that a variety of peak frequencies were commonly exhibited by independent sources in the same brain. This finding suggests that reports showing task-related power changes exclusive to 'lower' or 'upper' alpha frequency bands could in fact reflect power variation in peak alpha frequencies of different EEG sources.

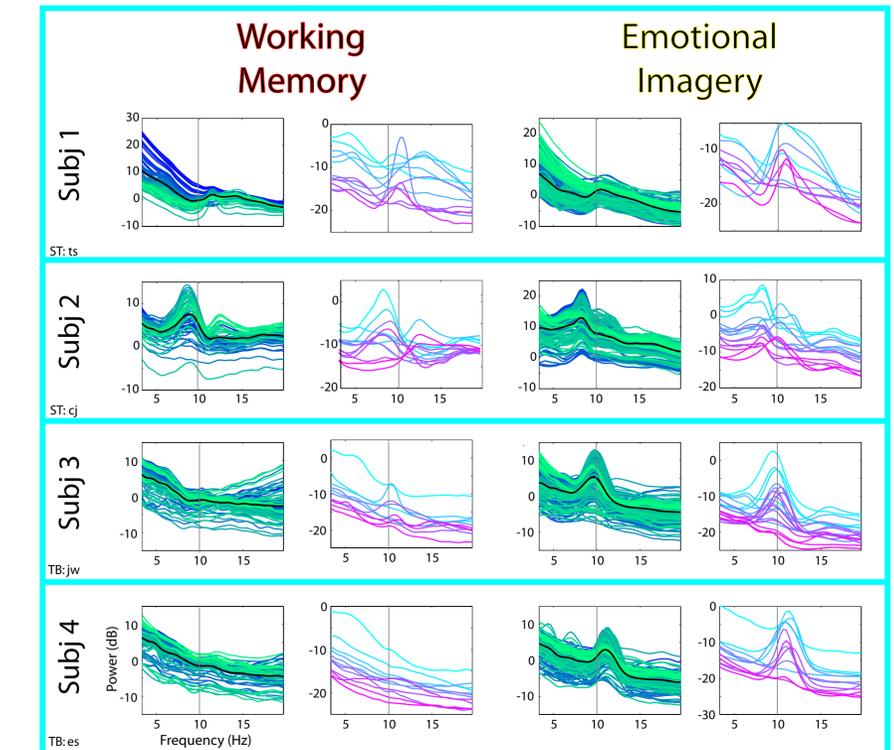
METHODS

~ Mixed sources of EEG activity were revealed using Infomax Independent Component Analysis (ICA). Equivalent dipoles were fitted for each component and those with residual variance from the projected forward model of more than 15% were removed from further analysis.
 ~ Mean peak alpha frequencies were determined by finding the most prominent peak between 8 and 12 Hz from the mean power spectrum of all channels (thick black lines in green/blue plots) across the entire experiment.
 ~ For the dipole density plots, peaks in the power spectra were found using a custom algorithm which is illustrated in Figure A. In steps of 1 Hz, consecutive windows of 9 Hz were regressed to find the linear trend of each segment and remove it. This procedure was intended to remove, much as possible, the 1/f trend characteristic of power spectra. These regression lines are illustrated in red. The blue lines represent the resulting power spectrum after having subtracted the regression line (red). Finally, each point was evaluated for whether it was larger than the surrounding 6 points. If this criterion was satisfied, then this point was labelled as a peak. Because of the overlapping nature of the method, many 'peaks' will be found which are not the true peak. This was accounted for by choosing peaks which were repeated multiple times, and, of contiguous points, the true peaks were defined as the maximum power value. In the illustrated example, 2 peaks were found, one near 7 Hz and another near 11 Hz.
 ~ Dipole densities were plotted by choosing components from each subject that expressed a power spectral peak (see Figure A and explanation) that was within a given frequency range relative to the mean peak alpha frequency for each subject. The number of possible spectral peaks was not restricted, so components may be represented more than once in different plots (as would the component illustrated in Figure A).
 ~ Group densities were determined by calculating, for each voxel, the sum of 3D gaussian weighted spheres around each dipole. Further, each voxel considered only the closest equivalent dipole from each subject to eliminate confounding biases arising from differences in numbers of dipolar components from each subject.

How do source spectra relate to channel spectra?



How stable are power spectra across experiments?



How does source peak frequency distribute in the brain?

