Optimal number of communities extracted from tensor decomposition of resting fMRI data

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Background: Resting brain functional connectivity is not stationary and tensor decomposition has been demonstrated as a method for studying spatio-temporal dynamic functional connectivity in fMRI data (Ponce-Alvarez et al. 2015, PLOS Comp. Biol.). This method decomposes fMRI data into several communities, reflecting groups of synchronised nodes, with fluctuating levels of expression in time. To identify the optimum number of communities to extract, we investigated the correlation coefficients between groups of extracted communities and the order parameter over a range of community extractions.

Methods: Ten healthy control subjects underwent a 10 minute eyes-closed resting-state fMRI scan (296 timepoints). Preprocessed data were bandpassed between 0.04-0.07 Hz (Glerean et al. 2011, Brain Connectivity) and a Hilbert transform was applied. The AAL atlas was used to divide the brain into 90 cortical regions, with each region represented by the first principle component of the instantaneous phase of all voxels in the region. We estimated a binary synchronisation matrix at each timepoint with regions considered to be synchronised if the phase difference was less than $\pi/6$, giving 296 binary synchronisation matrices for each subject. We extracted different numbers of communities from the data (4, 16, 25, 36, 64, 81) and calculated correlation coefficients between the cumulative strength of all communities at each timepoint with the instantaneous order parameter.

Results: The largest correlation coefficients were found at 4, 9 and 16 communities (0.77 ± 0.18, 0.78 ± 0.12 and 0.79 ± 0.09). Higher numbers of community extractions resulted in a decreasing trend of correlation coefficients.

Conclusions: The results suggest an optimum number of communities at 16 as this level of decomposition best describes the level of synchronisation at the global scale. In using tensor decomposition to study fluctuating sub-networks in the brain, it is important to limit the number of extracted communities within this optimum range.