# Bayesian mixture modeling of fMRI connectivity in cross-sectional and longitudinal studies.

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**Abstract**

We propose a Bayesian hierarchical mixture model to study brain connectivity. The mixture distributions represent the “connected'” and “non-connected” brain regions. The approach allows inference to be drawn on the population level, the subject level, and the region pair level. Posterior probabilities of being connected can be computed for each pair of regions, and we advocate them as measures of connectivity for the pair level analysis. Posterior probabilities reflect connectivity of a brain region pair in relation to overall connectivity pattern of an individual which is neglected in a traditional correlation analysis. Additionally, we show that significant results when using correlation as a connectivity measure may be driven by unreliable connections. This might be avoided by using instead posterior probabilities in the analysis. The sparsification of the connectivity matrix using the posterior probabilities is shown in a simulation to outperform the absolute thresholding based on a correlation. The introduced method is applied in a study of functional resting-state brain connectivity in relation to chronological age and cognition.

We also develop a model for longitudinal resting-state functional brain connectivity that provides valid inferences when dropout from the study is not at random. We consider a case of two scheduled measurements with dropout at the second measurement occasion. The properties of the model and the method proposed are explored in a simulation study using designs based on real data. It is shown that longitudinal estimates of connectivity ageing may be at odds with results obtained with cross-sectional data and ignoring dropout mechanism (like, e.g., complete case analysis) yields invalid conclusions on ageing.