

Network modeling analysis

- Resting state preprocessing
- Node definition and edge calculation
- Group analysis and challenges
- Comparison of resting state methods



Overview of resting state methods



Voxel-based

- Seed-based correlation analysis
- Independent component analysis
- Amplitude of low frequency fluctuations
- Regional homogeneity



Node-based

- Network modelling analysis
- Graph theory analysis
- Dynamic causal modelling
- Non-stationary methods



Seed-based correlation

- Easy to interpret
- No correspondence problem
- Seed-selection bias
- Only models seed-effect (ignoring complex structure & noise)

Bijsterbosch et al (2017)







MANN MANNAMMANN MANNAMANN MANNAMANN









Seed-selection bias

Seed-based correlation results are strongly influenced by small changes is seed location







- Multivariate: decompose full dataset
- Test for shape & amplitude
- Can be hard to interpret
- No control over decomposition (may not get breakdown you want)

ICA





Graph theory

- Simple summary measures (derived from network matrix)
- Network matrix often binarised
- Difficult to meaningfully interpret (abstract and far removed from data)





Rubinov et al (2010)



Dynamic causal modelling

- Directional interpretation (effective connectivity)
- Biophysical model
- Assumes HRF homogeneity
- Limited model comparisons



Daunizeau et al (2011)



Overview of node-based methods

clusters / hierarchies, network hubs, network summary statistics (e.g. small-worldness, efficiency)

network modelling from FMRI data

effective connectivity

more complex, more meaningful, pre-specify (constrain) network model, harder to estimate, can handle fewer nodes

bottom-up neural network simulations

network of individual neurons simulated

closeness to (interaction with) real FMRI data network of groups of neurons simulated (e.g. neural mass model)

<u>Smith et al (2013)</u>

graph theory





Node-based versus voxel-based





Bijsterbosch et al (2017)



Node-based versus voxel-based

- Node-based methods
 - Not sensitive to shape changes in connectivity patterns
 - Smaller multiple comparison correction problem
- Voxel-based methods
 - Seed-based correlation additionally tests for spatial (voxelwise shape) changes in connectivity patterns
 - Group ICA can test for shape and amplitude changes



Which method to chose?





Resources

- FSL mailing list
- Book (<u>Amazon</u>/ <u>OUP</u>) \bullet
- All references on the bottom of slides contain 'clickable' links

OXFORD NEUROIMAGING PRIMERS

Introduction to **Resting State fMRI Functional Connectivity**



Janine Bijsterbosch Stephen Smith Christian Beckmann

Series editors: Mark Jenkinson and Michael Chappell

OXFORD