Specialty area: **Thinking Outside the Black Box**

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fMRI: How to Find Activation & Influence Significance

Highlights

- Optimise experimental design and data acquisition based on understanding the interactions with the analysis of task-based fMRI data (resting-state fMRI will not be covered)
- Review the state-of-the-art for distortion correction, motion correction and physiological noise correction
- Understand more about the differences between volumetric and surface-based analysis

Target Audience:

Those who perform analysis of task-based fMRI data; mainly for those with either no experience or an intermediate level of experience.

Objectives:

To understand better the different options and processes involved in fMRI data analysis, in order to optimise the design of experiments, acquisition of data, and statistical significance of results.

Purpose:

Many options are available for analysing fMRI data, and this short talk will highlight some of the most important parts in the fMRI processing chain. Various choices, and their consequences in the final analysis, are explained.

Main Topics:

- Relationship between data acquisition, experimental design and data analysis
  - extra acquisitions which are beneficial (e.g. high-quality structural scans, fieldmaps)
  - good and bad experimental designs
- Registration, distortion correction and surface-based analysis
  - distortion and signal loss in EPI
  - fieldmap-based distortion correction and acquisition-based distortion minimization
  - registration to structural and standard spaces
  - cortical surface modelling, registration and analysis
- Motion artifacts and their correction
  - retrospective and prospective correction methods
  - stimulus-correlated motion artifact
  - motion parameter regression, outlier correction, and ICA-based cleanup
- Physiological monitoring and noise correction
  - nature and impact of physiological noise
  - acquisition of physiological recordings

- RETROICOR-based correction methods, including heart rate and RVT
- ICA-based correction methods

Discussion:

The above list covers many of the key areas in fMRI analysis, but not all. In each case there are a number of options and a good understanding of the fundamental points, without needing to know all the intricate details, is of huge benefit for the fMRI experimenter. Although all areas cannot be covered in this talk, it will provide the attendee with information that can be immediately applied to improve their experiments as well as a basis to follow up with further reading.

Conclusion:

In order to conduct a good task-based fMRI experiment it is necessary to understand the fundamentals of experimental design, data acquisition, and data analysis. Better understanding will lead to experiments requiring less subjects, minimizing artifacts and producing more accurate and robust findings.

General References:

- Poldrack, Mumford and Nichols; Handbook of Functional MRI Data Analysis; Cambridge University Press
- Huettel, Song and McCarthy; Functional Magnetic Resonance Imaging; Sinauer Associates, 2nd Edition

Specific References:

- Glasser, et al.; The Minimal Preprocessing Pipelines for the Human Connectome Project; NeuroImage, 80:105-124, 2013.
- Glover, Li, and Ress; Image-based method for retrospective correction of physiological motion effects in fMRI: RETROICOR, Magnetic Resonance in Medicine; 44(1):162-167, 2000.
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- Beckmann; Modelling with independent components; NeuroImage, 62(2):891-901, 2012.
- Jezzard and Balaban; Correction for geometric distortion in echo planar images from B0 field variations; Magnetic Resonance in Medicine; 34(1):65-73, 1995.
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