

The Art and Pitfalls of fMRI Preprocessing

Organizer:

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Awareness of the critical importance of fMRI pre-processing is increasing for both task-based and especially resting-state fMRI research. Most resting-state studies address questions of functional connectivity, i.e. target the correlation of brain activity in one area with activity in a different brain area. This means that regressors used in first-level linear models of resting-state fMRI come from the brain itself, rather than from externally generated task designs that are unaffected by acquisition artifacts or pre-processing steps in task-based fMRI. In contrast to task-based fMRI, independent and dependent variables are thus both affected by artifacts and pre-processing steps, and there is a greater chance of artificially induced functional connectivity than task-based activation. It follows further that those common pre-processing pipelines which have gained acceptance in task-based fMRI practices should not necessarily be carried over to resting-state studies of functional connectivity. After attending our proposed educational course the audience should have gained a thorough understanding (1) of the kinds of artifacts are affecting the hemodynamic signal recorded in fMRI scanners and (2) of the state-of-the-art tools to counteract these artifacts. Beyond these initial learning objectives, course attendees should have gained awareness of the problem of pipeline dependence and the ability to follow, and possibly engage in, methodological research that aims at pipeline optimization using real-world as well as simulated data. Feedback from the previous 2 years when this course was held was incorporated: (1) practical aspects of familiarization with the three major software packages (SPM,AFNI, FSL) were incorporated; (2) an emphasis on pre-processing as an important, as yet “unfinished”, area of methodological research of vital importance for the integrity of neuroscience at large.

Course Schedule:

8:00-8:10

Introductory remarks: the problem of pre-processing pipeline dependence for task-based and resting-state fMRI

Christian Habeck, Columbia University, New York, NY, United States

8:10-8:35

Temporal Preprocessing (slice-timing, temporal filtering, spike removal)

Blaise Frederick, Harvard Medical School, McLean Hospital, Boston, MA, United States

8:35-9:00

Spatial Preprocessing (Spatial Alignment, Normalization, and Smoothing)

Ray Razlighi, Columbia University, New York, NY, United States

9:00-9:25

Artefact Removal (motion-related)

Christian Windischberger, Medical University Vienna, Vienna, Austria

9:25-9:50

Physiological noise removal

Rasmus Birn, University of Wisconsin, Madison, WI, United States

9:50-10:15

FSL pre-processing pipeline

Mark Jenkinson, Oxford University, Oxford, United Kingdom

10:15-10:25

Break

10:25-10:45

Q&A

10:45-11:10

An SPM perspective on fMRI pre-processing

Lars Kasper, University of Zurich and ETH Zurich, Zurich, Switzerland

11:10-11:35

AFNI Pre-Processing – Outline, Recommendations, New Stuff

Robert Cox, NIMH Intramural Program, Bethesda, MD

11:35-12:00

Wrap Up and Discussion