

fMRI Experimental Design

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1. A basic plan for a imaging study/an experiment

- (1) Research question (novelty? Importance? Theoretical background?)
 - Mental processes vs. /or brain mechanisms?
 - Technology: Why fMRI, MEG or EEG?
 - How about behavioural performance?
- (2) Hypothesis (define mental process to examine)
 - How a given manipulation should change measurements
- (3) Experiment (design task to manipulate that process):
 - A. Independent variables and dependent variables
 - B. Between-subject or within-subject (number of subjects)
 - C. Tasks and designs (sufficient number of trials per each cell/condition)
 - D. Trial structure and events codes
- (4) Data acquisition (neuroimaging measures and behavioural data)
 - A. Operating status of the system and set-up
 - B. Preparation of the participant
 - C. General tech acquisition setup: fMRI, EEG, MEG, behavioural responses...
- (5) Analyses, statistics and inferences (according to the design, extracting signals based on the stimulus event of interest)
 - A. Parametric statistics: e.g. z-test, t-test, F-test...
 - B. Non-parametric statistics

2. Experimental design considerations

- (1) What are the goals of experimental design?
 - A. To test specific hypotheses (hypothesis-driven)
 - B. To generate new hypotheses (data-driven)
- (2) fMRI design types:
 - A. Blocked design
 - B. Event-related design
 - C. Mixed design
- (3) What should we control?
 - A. Stimulus properties
 - B. Timing issues: stimulus, inter-stimulus interval, Inter-trial interval (randomisation)
 - C. Whenever possible, conditions/tasks/stimuli should be varied within blocks rather than

between blocks

- D. Instructions
- E. Responses
- F. Confounding variables
- G. Noises (internal and external)
 - (a) Between-subject variations
 - (b) Trial-by-trial variations
 - (c) Artifacts
 - (d) Environmental noise

3. Other considerations

- (1) Participants: metal-free, stable, large numbers...
- (2) Experimental time: about 50-60 minutes.
- (3) Presentation software: E-prime, NBS Presentation, Matlab, Superlab...
- (4) Runs of 4-6 minutes with a short break.
- (5) Always look at the data throughout the experiment.
- (6) Keep participants happy. Talk to them during break.
- (7) Do a proper analysis for the first participant's data before running anyone else. Check event codes and timing.

4. Design strategies

- (1) Keep the experiment as simple as possible
- (2) Avoid confounds
- (3) Probably need additional experiments
- (4) Focus on specific (or large) effects
- (5) Use well-studied experimental manipulations
- (6) Large trial numbers, few conditions
- (7) Decide in advance the key experimental comparisons of interest (why?)

5. Advanced experimental design

- (1) Categorical designs
 - A. Subtraction
 - B. Conjunction
- (2) Factorial designs
 - A. Main effects
 - B. Interactions
- (3) Parametric designs
 - A. Linear
 - B. Nonlinear
 - C. Model-based