2015 MEG 教育講習課程 I: MEG 實驗設計

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1. A basic plan for an M/EEG study
   (1) Research question (novelty? Importance? Theoretical background?)
      - Mental processes vs. /or brain mechanisms?
      - Technology: Why MEG or EEG?
   (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 (sufficient number of trials per each cell/condition)?
         (a) Large effect: 30-60
         (b) Medium effect: 150-200
         (c) Small effect: 400-800
         (d) Double with children or patients
      D. Trial structure and events codes
   (4) Data acquisition (measure M/EEG and behavioural data)
      A. Operating status of the system and set-up
      B. Preparation of the participant
      C. General acquisition setup
         (a) Eye movements and blinks
         (b) ECG (or EKG)
         (c) Head movements
         (d) Anatomical MRI (if source localisation is part of planned analysis)
   (5) Analyses, statistics and inferences (according to the design, extracting signals based on the stimulus event of interest)
      A. Sensor-based data analysis:
         (a) Event-related potential or magnetic field (ERP or ERMF)
         (b) Spectral analysis: evoked/induced oscillation (power and phase)
         (c) Spatial distribution (or topographical analysis)
      B. Source-based data analysis:
         (a) Source localisation for ERP/ERMFs

(b) Source localisation for oscillations
(c) Functional and effective connectivity analyses

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) What should we control?
      A. Stimulus properties
      B. Stimulus timing
      C. Inter-stimulus interval
      D. Inter-trial interval (randomisation)
      E. Whenever possible, conditions/tasks/stimuli should be varied within blocks rather than between blocks
      F. Instructions
      G. Responses
      H. Noises (internal and external)
         (a) Trial-by-trial variations
         (b) Artifacts (eyes-closed alpha, eye blinks and movements, muscle activity, skin potentials, etc.)
         (c) Environmental noise
   (3) Combined techniques: MEG+fMRI, MEG+EEG

3. Other considerations
   (1) Presentation software: E-prime, NBS Presentation, Matlab, Superlab…
   (2) Participants: metal-free, large numbers.
   (3) Amplifier and filter settings.
   (4) Experimental time: about 50-60 minutes (given whole session is about 1.5-2 hours).
   (5) Runs of 4-6 minutes with a short break.
   (6) Always look at the M/EEG recording throughout the experiment.
   (7) Keep participants happy. Talk to them during break.
   (8) Do a proper analysis for the first participant's data before running anyone else. Check event codes.

4. Design strategies
   (1) Keep the experiment as simple as possible
   (2) Probably need additional experiments
   (3) Focus on specific (or large) effects (e.g. ERP/ERMF or frequency band)
   (4) Use well-studied experimental manipulations
   (5) Large trial numbers, few conditions

(6) Avoid confounds

(7) Decide in advance the key experimental comparisons of interest

Recommendations for reading:

1. MEG: An introduction to methods, Oxford University Press, 2010
2. Luck, S. J. (2005). An introduction to the event-related potential technique. Cambridge, MA: MIT Press.
3. Gross et al., (2013). Good practice for conducting and reporting MEG research. NeuroImage, 65, 349-363.
4. Lopes da Silva (2013). EEG and MEG: Relevance to Neuroscience. Neuron, 80, 1112-1128.

Check this out: http://www.megcommunity.org/