Module 15: Experimental Design

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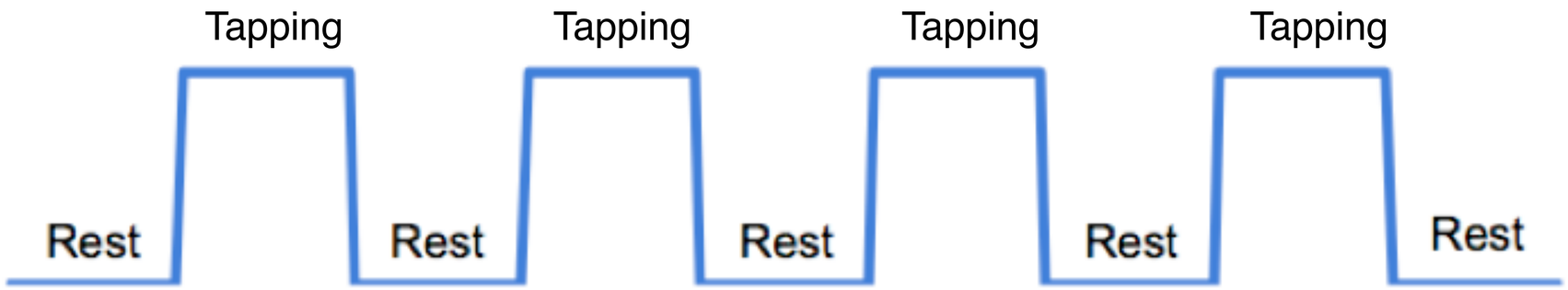
Experimental design

Goal of the experiment:

- Use stimuli to induce psychological state of interest
- Measure brain activity associated with the psychological state of interest

fMRI Experiment

Finger tapping Experiment



BOLD Response in a Voxel

Experimental design

Considerations:

- Technical limitations
- Psychological state
- Statistical design

Technical limitations

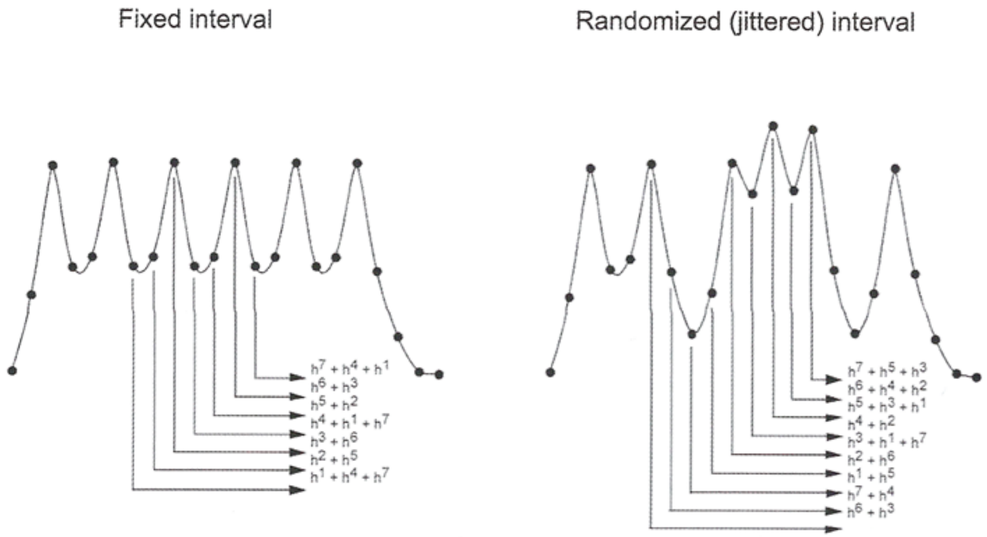
Technical limitations:

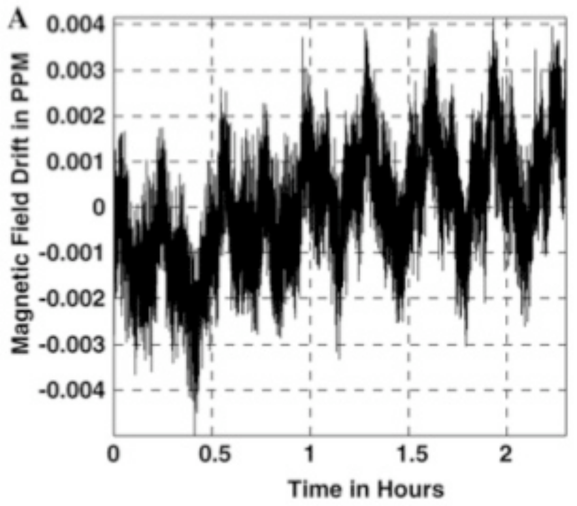
- Limited visual field and response options

Technical limitations

Technical limitations:

- Limited visual field and response options
- Stimulus timing and length

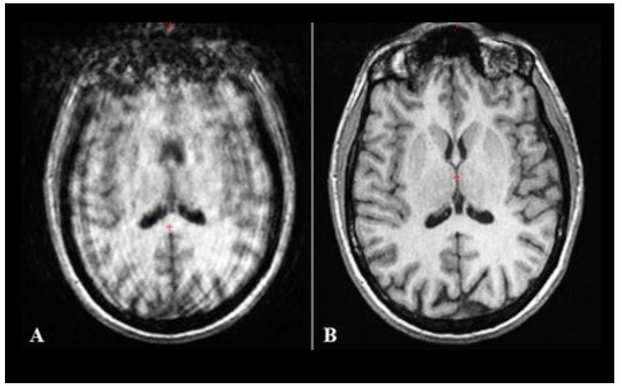


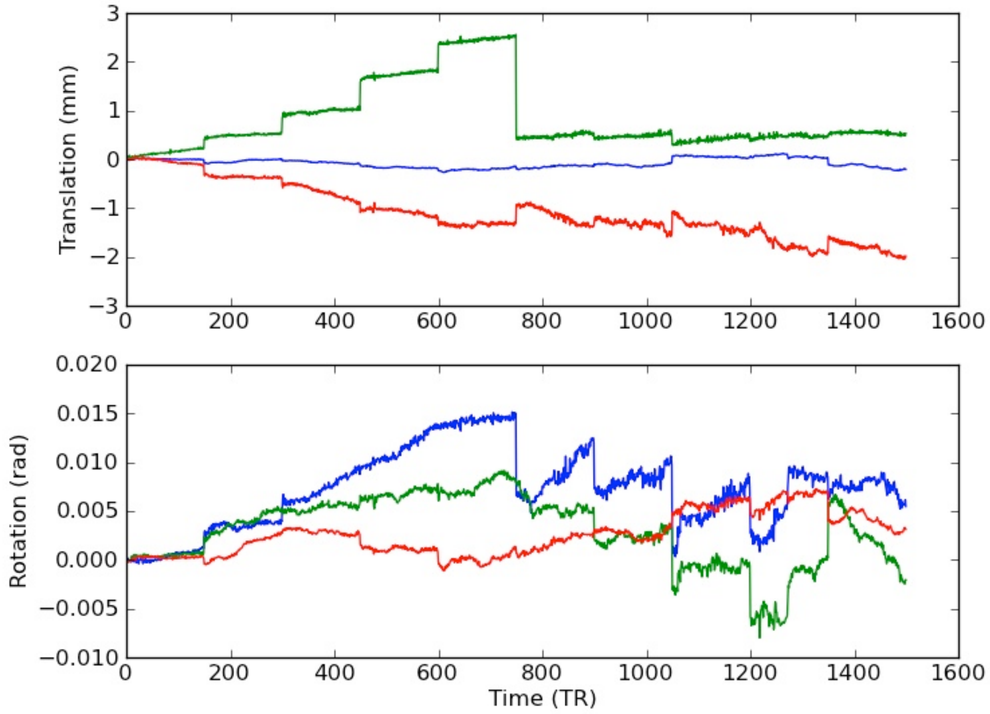


Technical limitations

Technical limitations:

- Limited visual field and response options
- Stimulus timing and length
- Subject motion

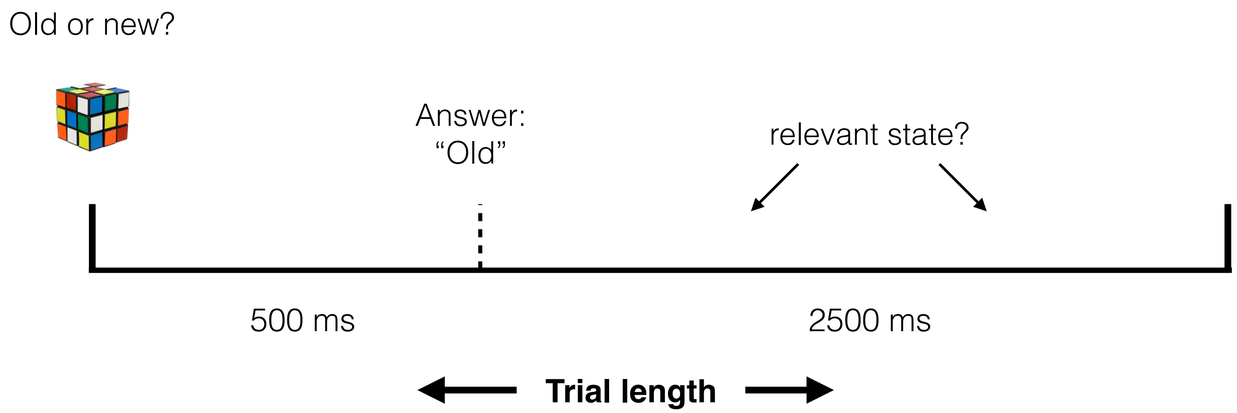




Psychological state

Does the stimulus induce the psychological state intended:

- Is the subject effectively engaged in the intended task?



Psychological state

Does the stimulus induce the psychological state intended:

- Is the subject effectively engaged in the intended task?
- Is the subject employing a shortcut or strategy?

Go-no-Go task: N P S X R Q S X T X S X

Psychological state

Does the stimulus induce the psychological state intended:

- Is the subject effectively engaged in the intended task?
- Is the subject employing a shortcut or strategy?
- How long does the psychological state last?
    - Complexity of the cognitive task
    - Emotional responses

Psychological state

Does the stimulus induce the psychological state intended:

- Is the subject effectively engaged in the intended task?
- Is the subject employing a shortcut or strategy?
- How long does the psychological state last?
- Does the task induce unintended psychological states

Statistical design

- What are the dependent and independent variables
- Will independent variables have multiple levels
- How will the stimuli be organized? Block? Event-related?

Statistical design

Common experimental designs:

- Subtraction design
- Factorial design
- Parametric design
- Individual differences approaches
- Outcome measures designs

Fundamental trade off:

- Fewer conditions result in better power but less specificity
- More conditions result in worse power but better potential for inference

Statistical design

Subtraction design:

- Subtracting activation during the control task from activation during the experimental task shows only the activation related to the cognitive process in question. Task A - Task B.

- Works in cases where the cognitive process is expected to be categorical

Famous faces task

Experimental condition

Control condition

Statistical design

Factorial design

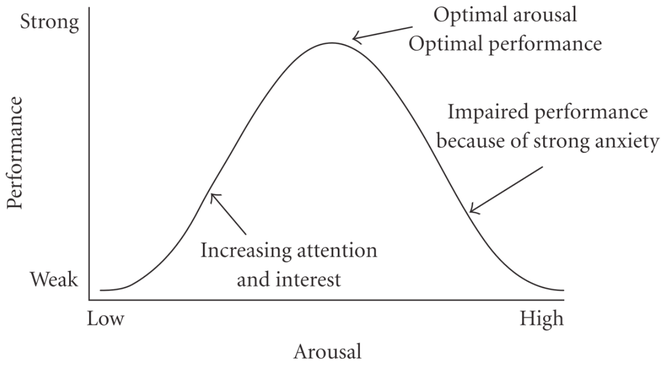
- Allows for testing of multiple factors and the interaction between them
- Interactions sometimes difficult to interpret

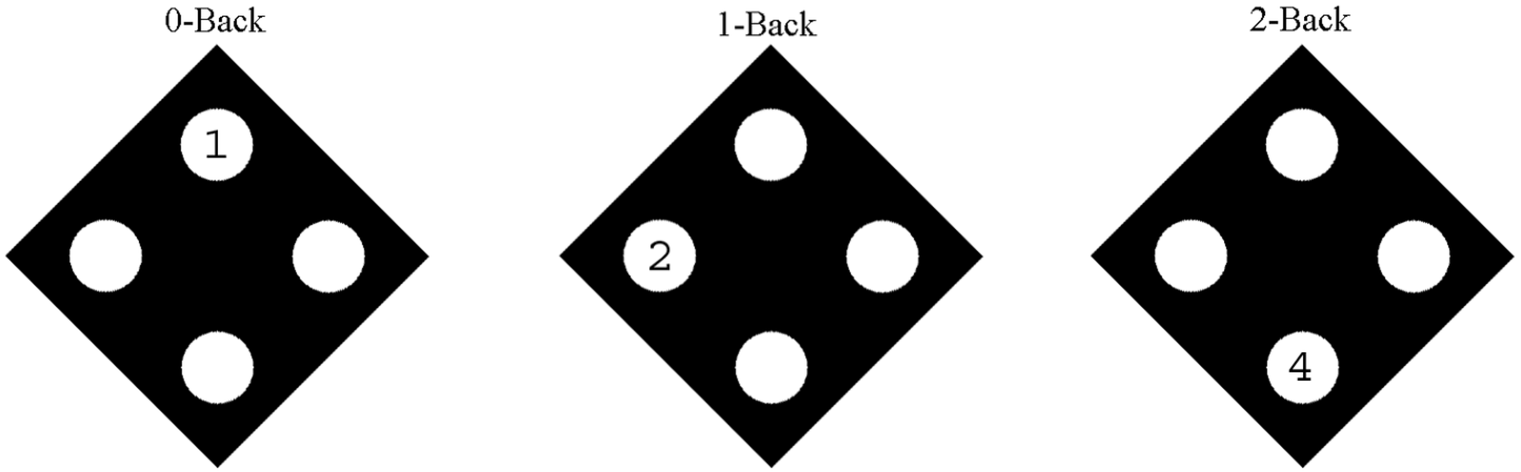
Statistical design

Parametric design:

- Localized activity varies as a result of difficulty or cognitive demand
- Use tasks with levels of difficulty

Psychological states may not be linear!



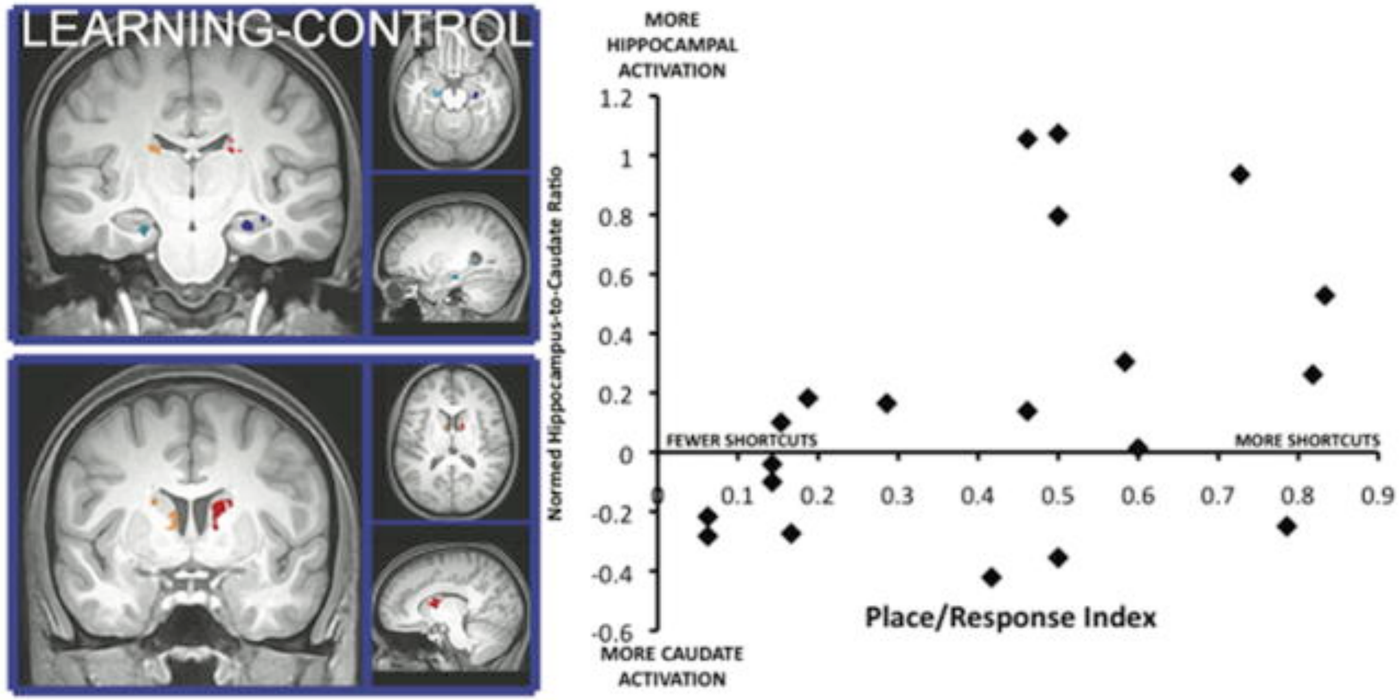


N-Back task

Statistical design

Individual differences design

- Correlate individual subject's performance with neural response



Marchette, Bakker and Shelton, J. Neurosci, 2011

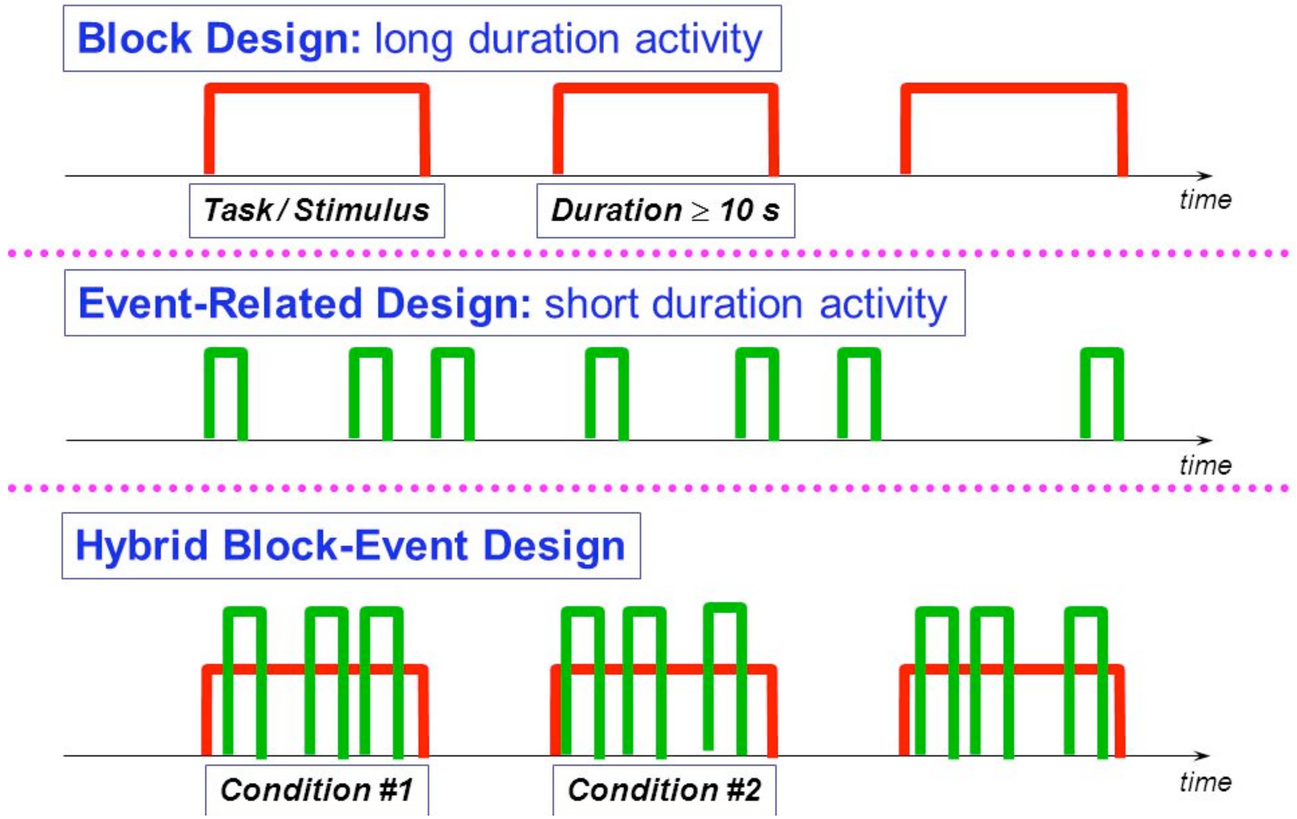
Statistical design

Outcome measures design

- Within subjects design
- Testing the effect of a type of intervention:
  - Drug
  - Practice or training
  - DBS, TMS or ECT

Statistical design

How will the stimuli be organized?



Experimental design

Careful experimental design and selection of experimental and control conditions is critical to the outcome of the study.