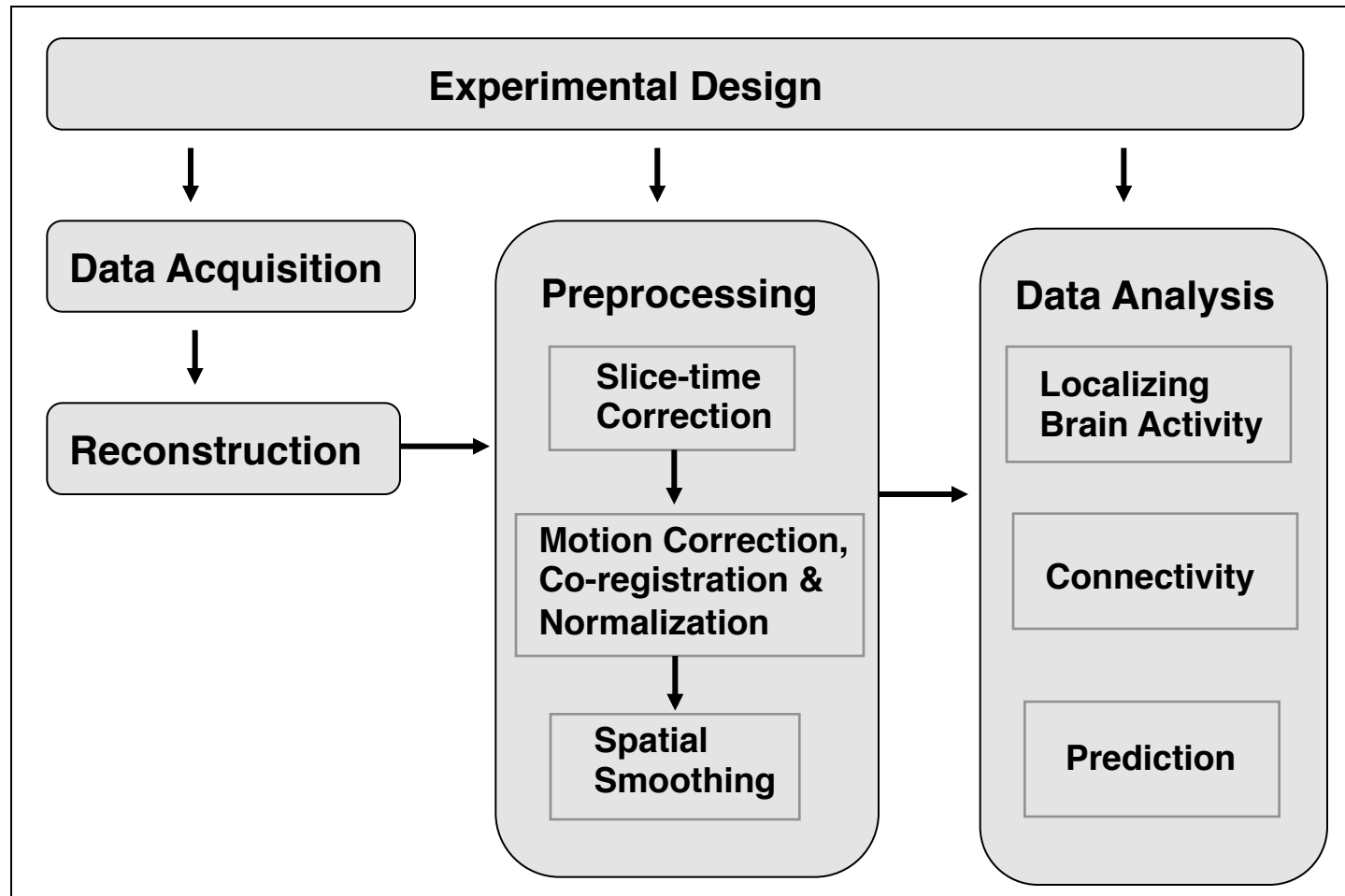


Module 7:

Experimental Design

Data Processing Pipeline



Experimental Design

- The goals of experimental design are to:
 - Induce subjects to perform or experience the psychological states you are interested in studying.
 - Effectively detect brain signals related to those psychological states.
- Not always so easy in practice.
 - Both psychological and statistical considerations need to be taken into consideration.

Experimental Design

- Properties of the BOLD signal conspire to make experimental design difficult.
 - The signal is both weak and noisy.
 - It is not an absolute measure of neuronal activity.
- Need to use **contrasts** and **repetitions** to be able to detect effects of interest.
 - Compare the task of interest with some control task where subjects are either at rest or performing a simple baseline task.
 - Repeat the tasks as often as possible.

Definitions

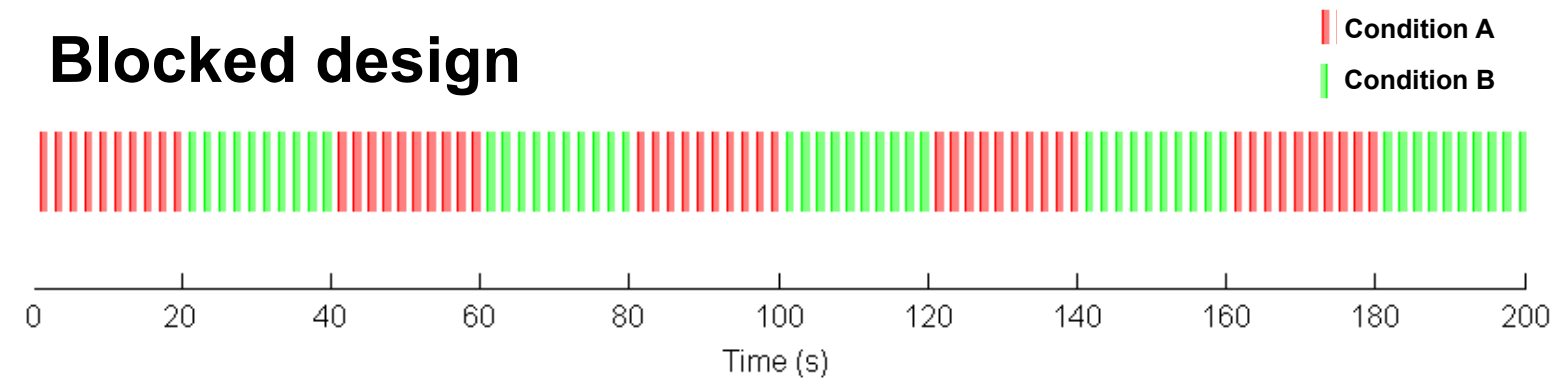
- An **event** is a single experimental manipulation.
- The **inter-stimulus interval** (ISI) is the time between two successive stimuli.



- A **block** is a time interval that contains events from a single condition.

Experimental Design

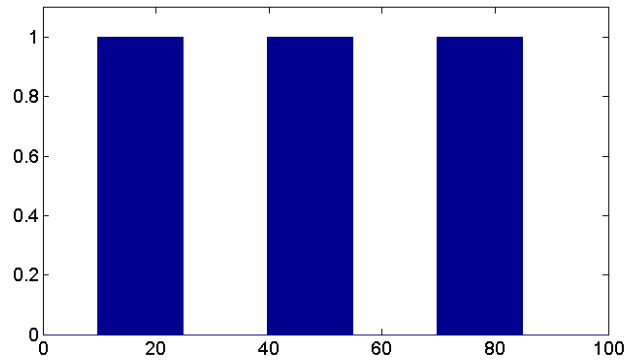
- Blocked design: Similar events are grouped



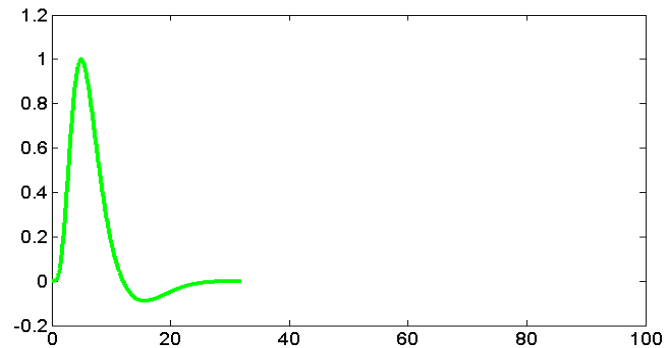
- High statistical power to detect activation and robust to uncertainties in the shape of HRF.
- Can't directly estimate features of the HRF.

Block Design

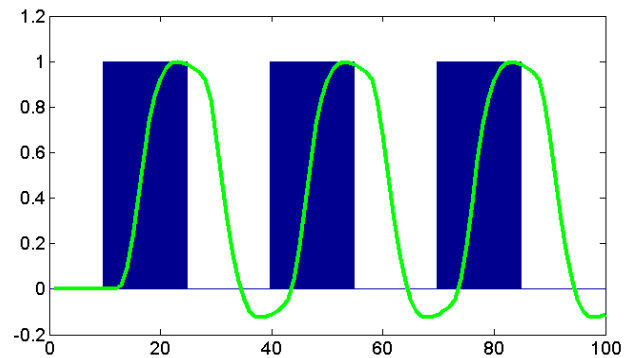
Experimental
Stimulus Function



Hemodynamic
Response
Function

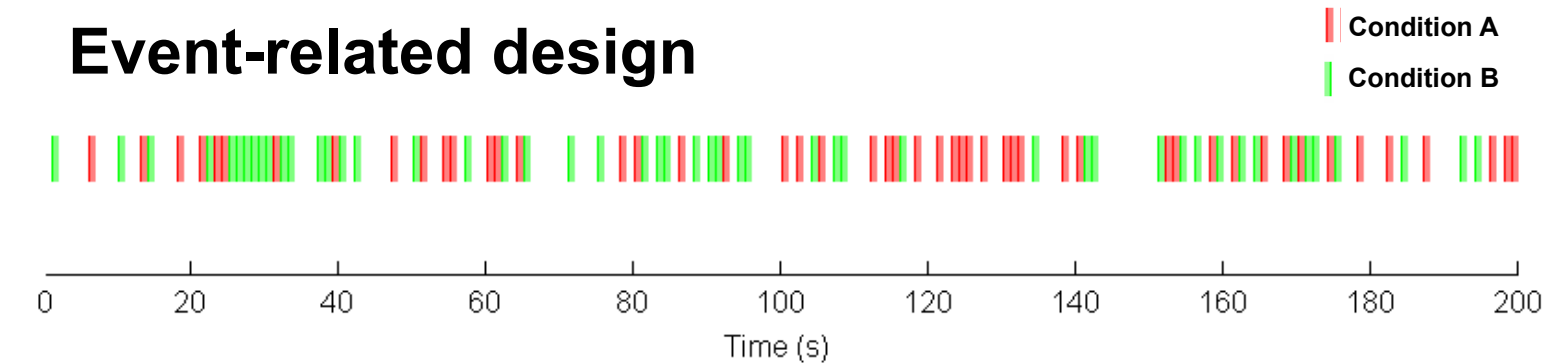


Predicted
Response



Experimental Design

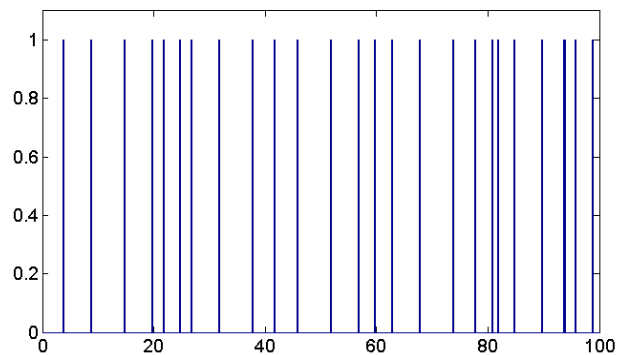
- Event-related design: Events are mixed



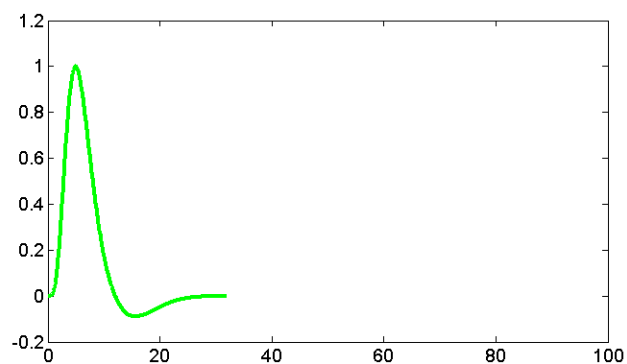
- Allows for the estimation of features of the HRF.
- Decreased power to detect activation.

Event-Related

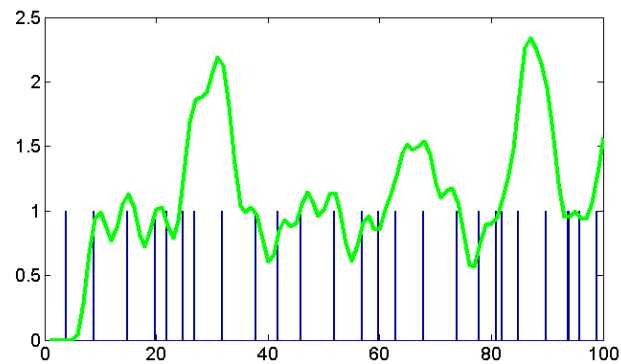
Experimental
Stimulus Function



Hemodynamic
Response
Function



Predicted
Response



Psychological Considerations

- It is important that the task induces the subject to think or perform in the intended manner.
 - Don't make the study too predictable as this may influence the subjects psychological state.
 - Make sure to keep subjects on task by giving them just the right amount of time to perform it.
 - Make sure that different stimulus configurations don't afford different strategies.
 - What you expect from subjects should fit with what they can actually do.
 - Keep in mind that subjects' brains may be responding to things you didn't tell them to do.

Statistical Considerations

- Blocked designs typically yield high experimental power, but provide imprecise information about the particular psychological processes that activate a brain region.
- Event-related designs allow brain activation to be related more precisely to the particular cognitive processes engaged in certain types of trials, but suffer from decreased power.

Five Guidelines for fMRI Design

1. Scan as many subjects as possible; scan as long as you can, considering psychological effects (fatigue, habituation).
2. Use short blocks (< 40 s) if you care about detecting differences, and event-related designs if you want to link activity to particular events.
3. Limit the number of conditions; pairwise comparisons far apart in time decrease power and overlap with low-frequency noise
4. In event-related designs, randomize the ordering of events that are close together in time
5. Randomize ('jitter') intervals between events that need to be distinguished.

Optimal Designs

- If you know in advance what your statistical model is going to look like you can tailor the design to minimize the variance of certain parameter estimates.
- There exist computer-aided design algorithms for determining appropriate designs using M-sequences (Buracas & Boynton, 2002) or the genetic algorithm (Wager & Nichols, 2003).

End of Module



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