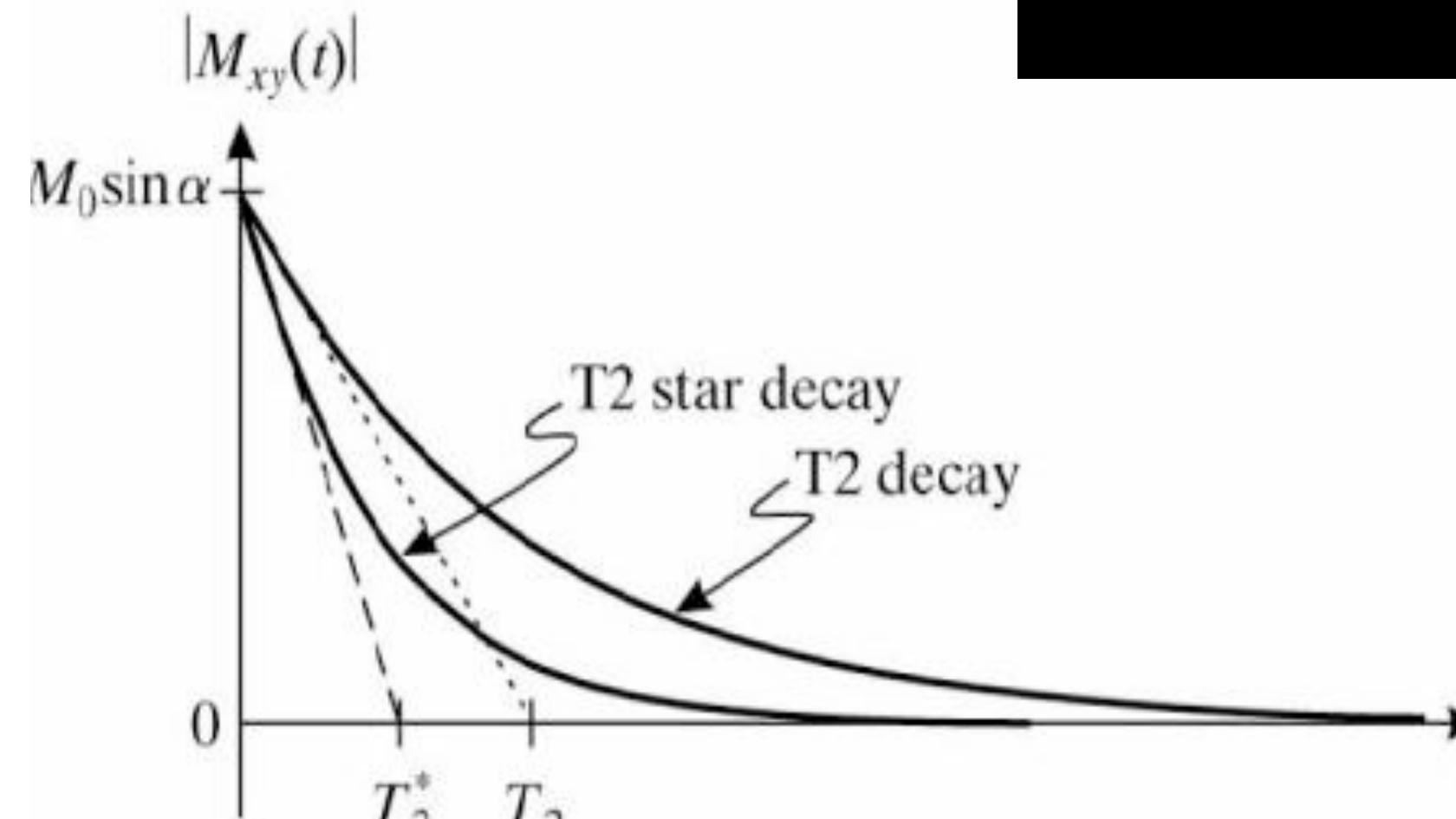
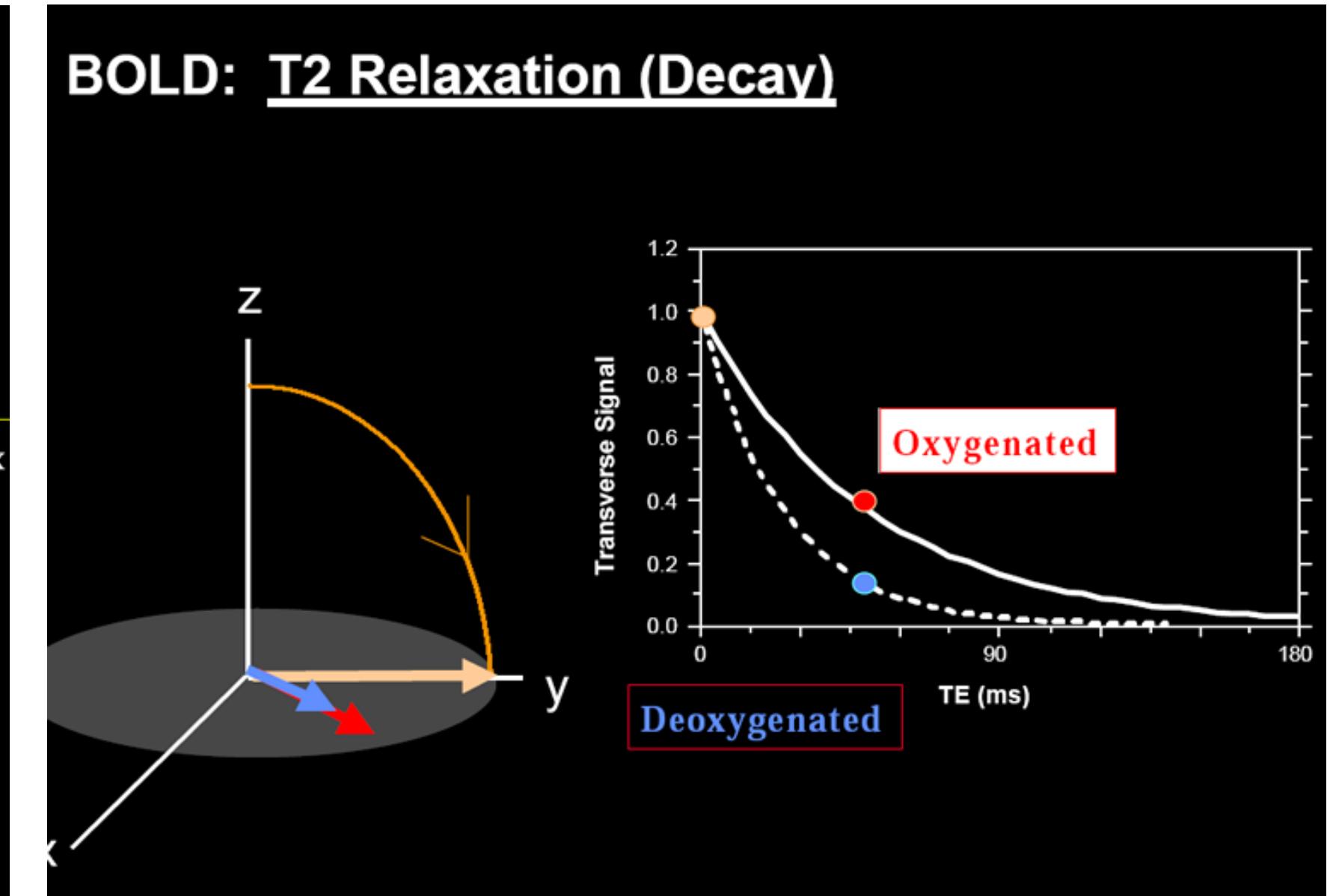
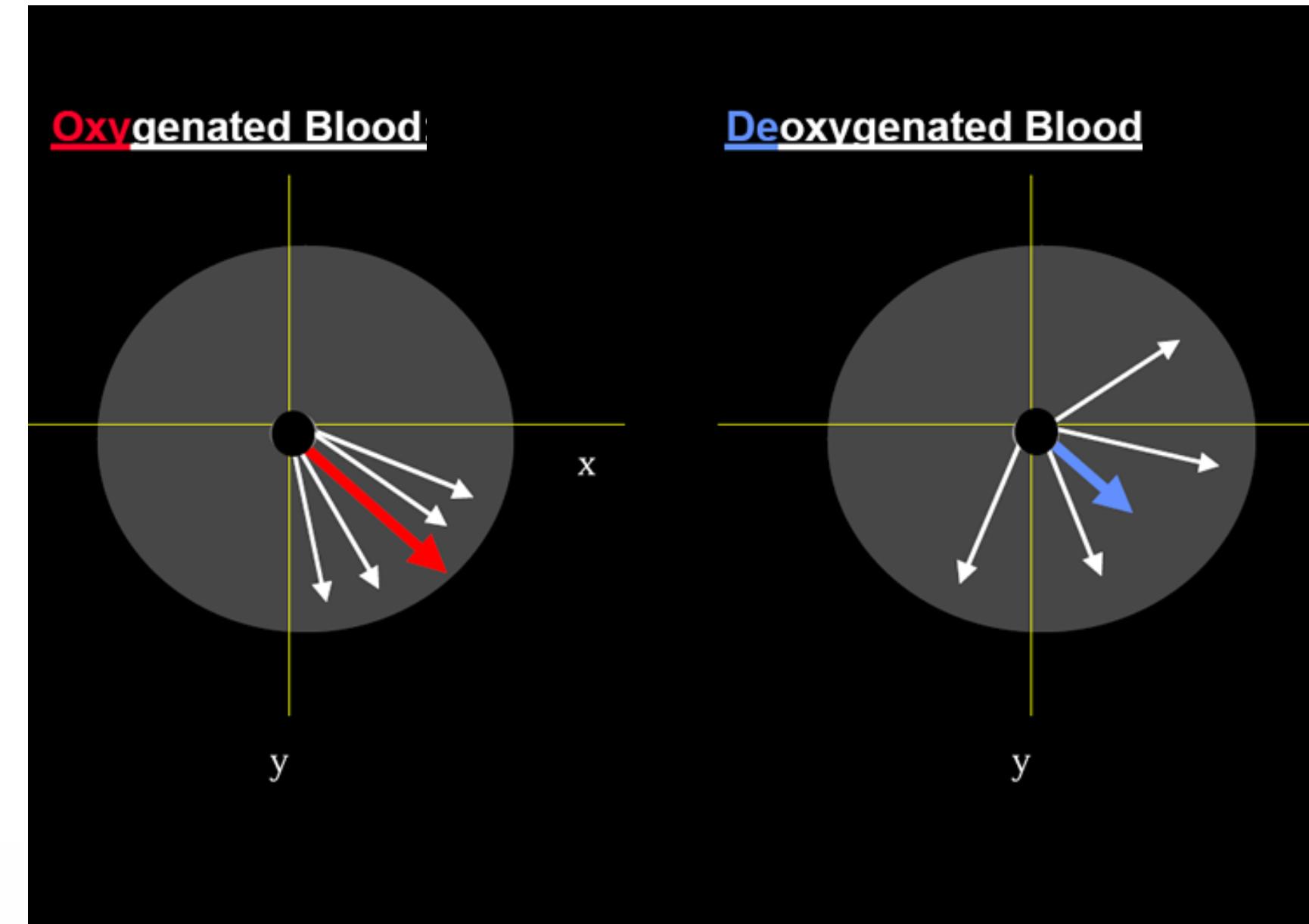
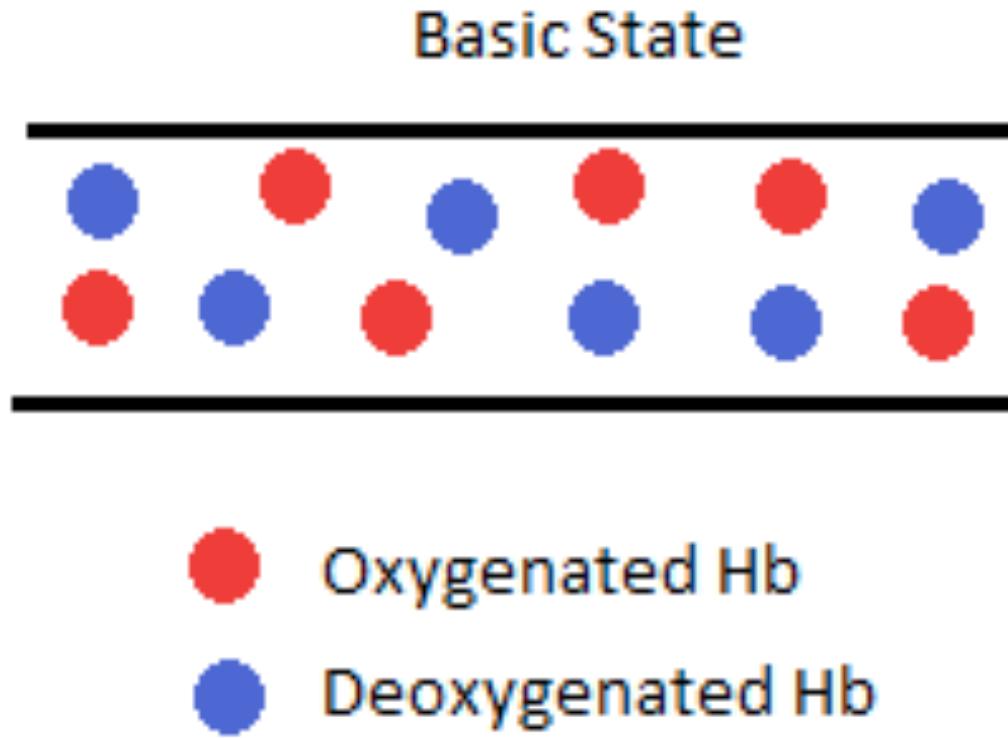


Module 14: Functional MRI Studies

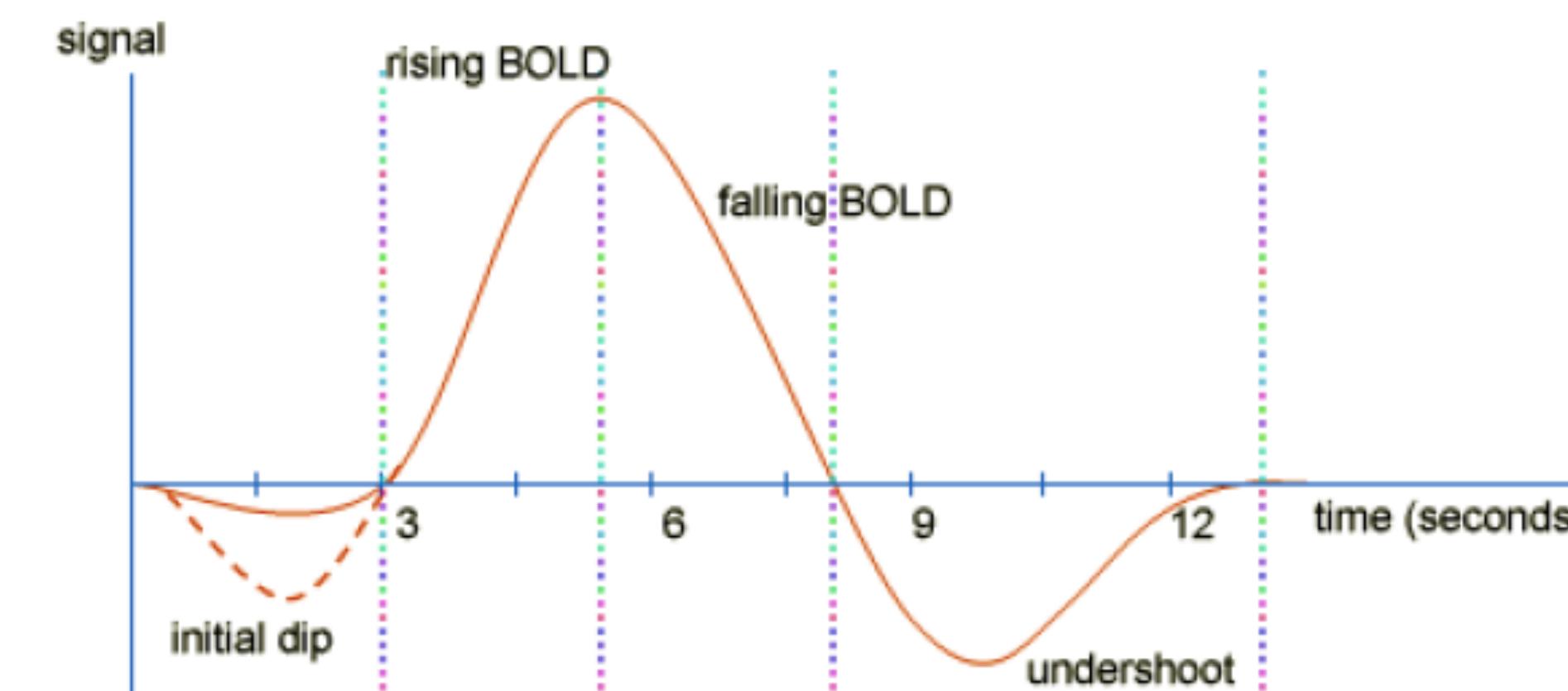
Arnold Bakker

Department of Psychiatry and Behavioral Sciences
Division of Psychiatric Neuroimaging
Johns Hopkins University School of Medicine

BOLD MRI Signal

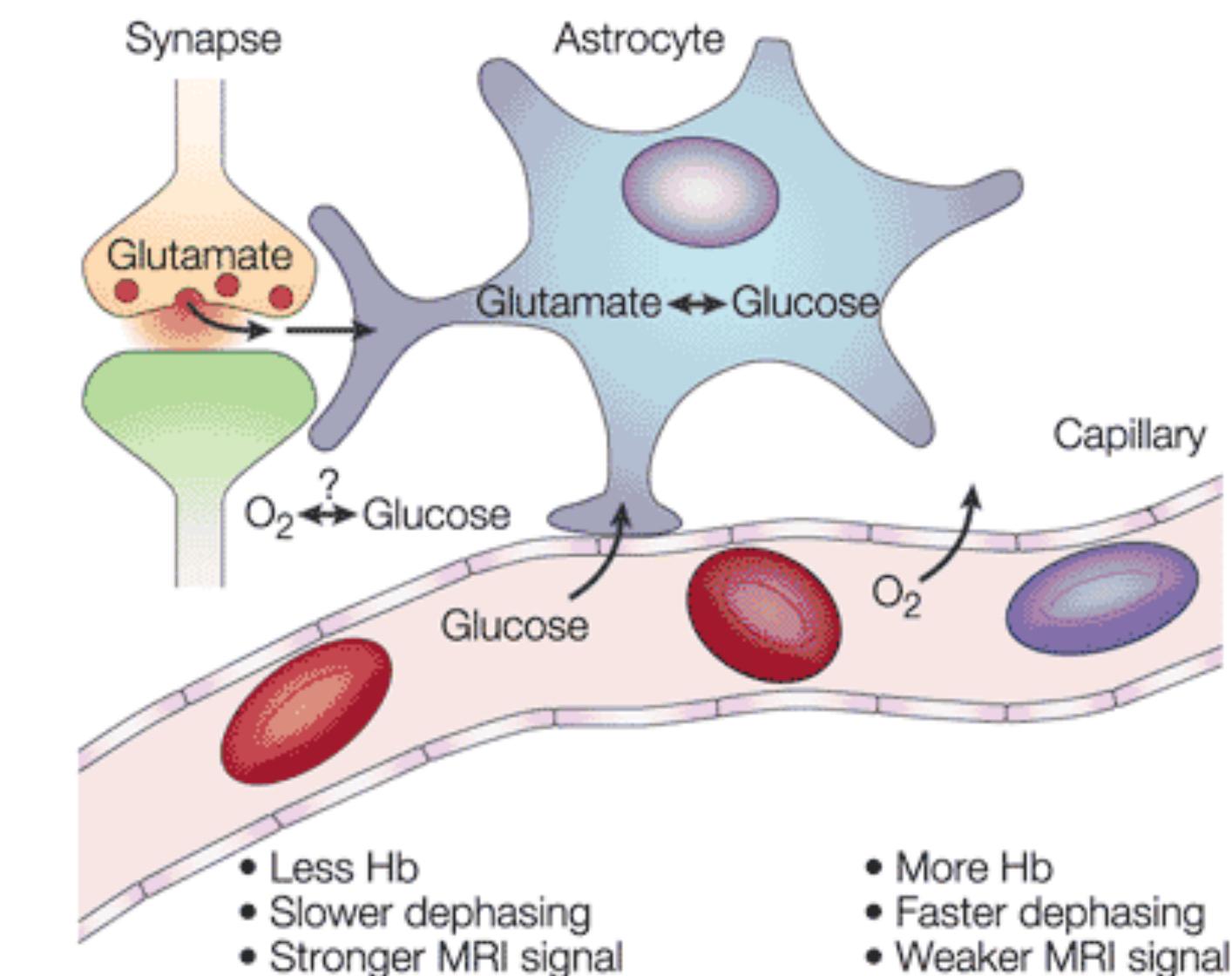
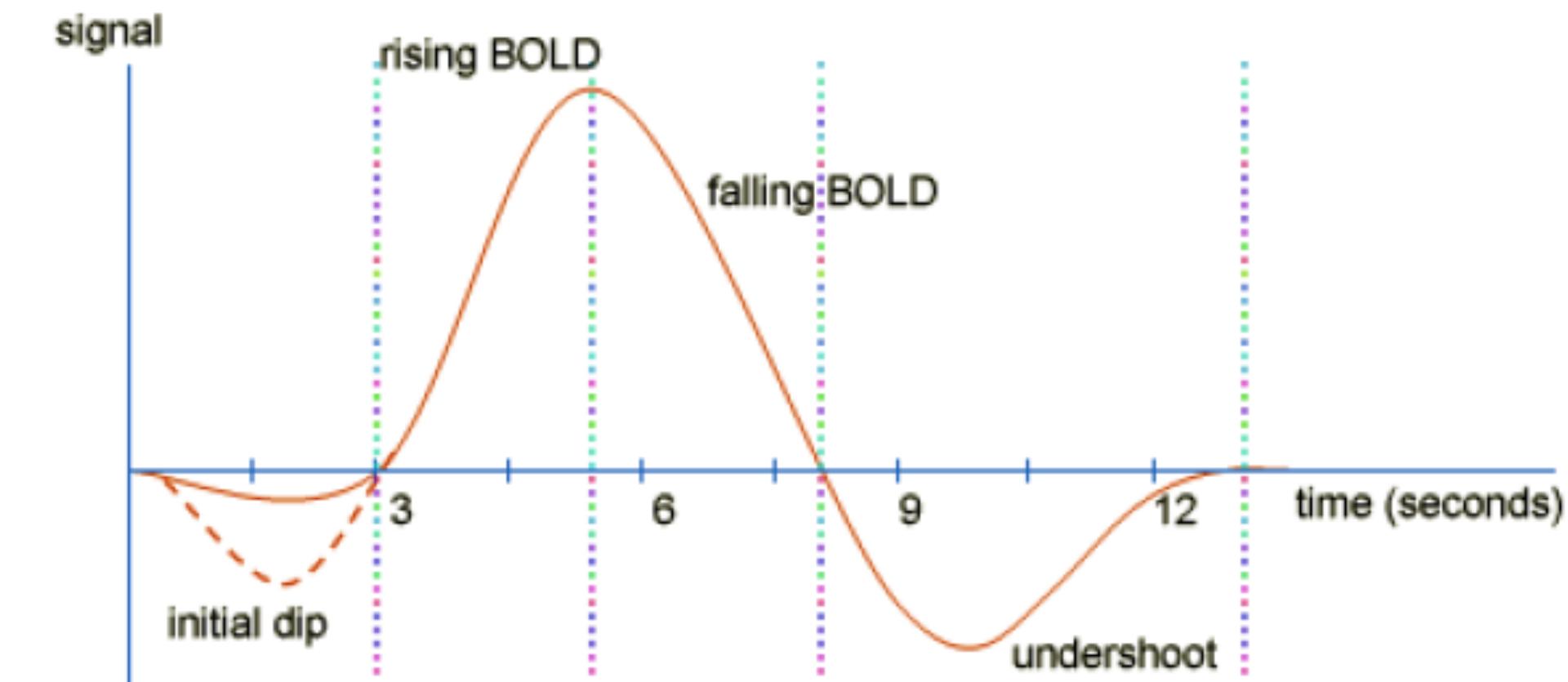


T_2^* : Transverse magnetization decay from local magnetic field variations



BOLD MRI Signal

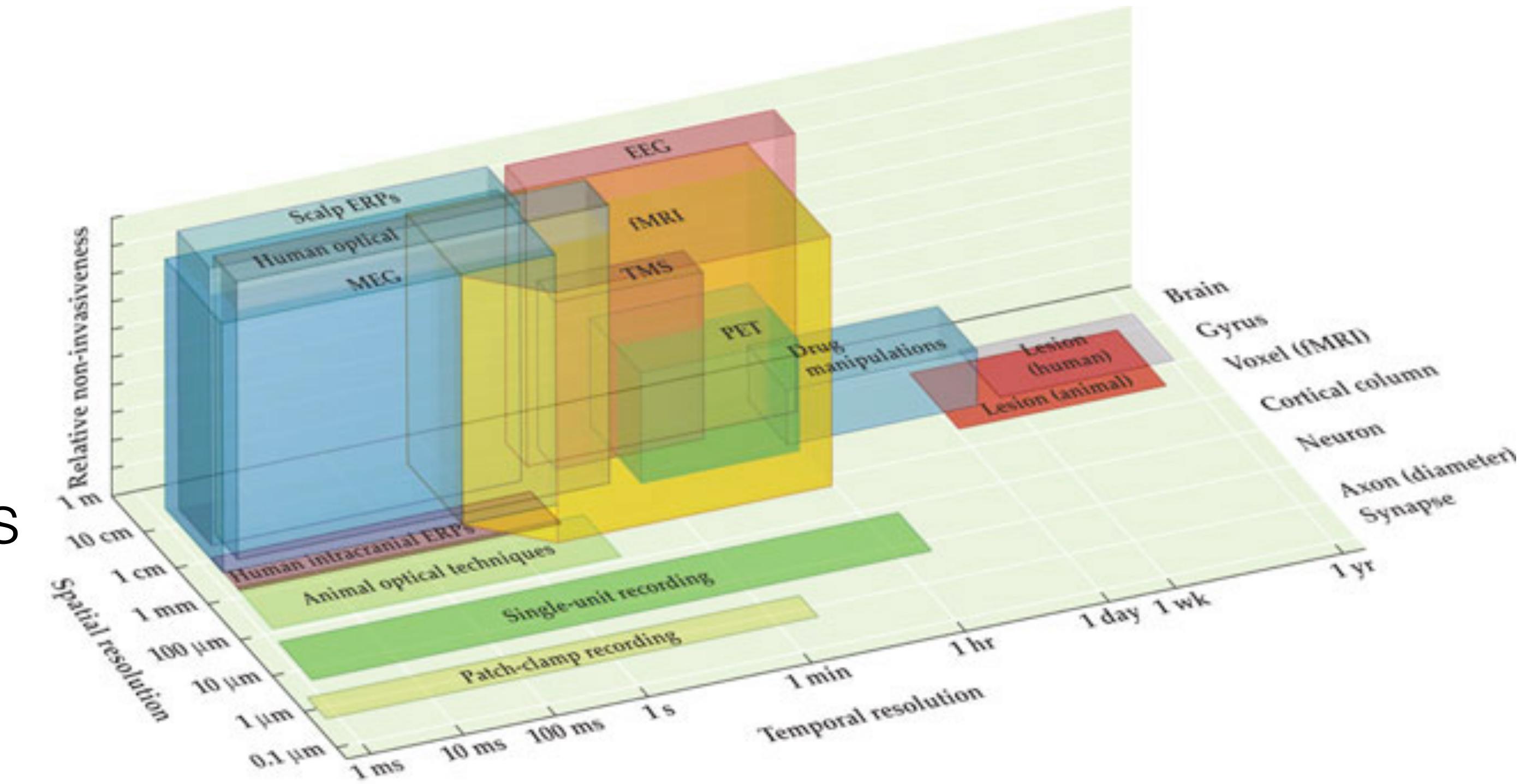
- Important to note that BOLD fMRI is not a measure neural activity directly. Instead it measures metabolic demands (oxygen consumption) of active neurons
- The Hemodynamic response function (HRF) represents changes in the fMRI signal triggered by neural activity



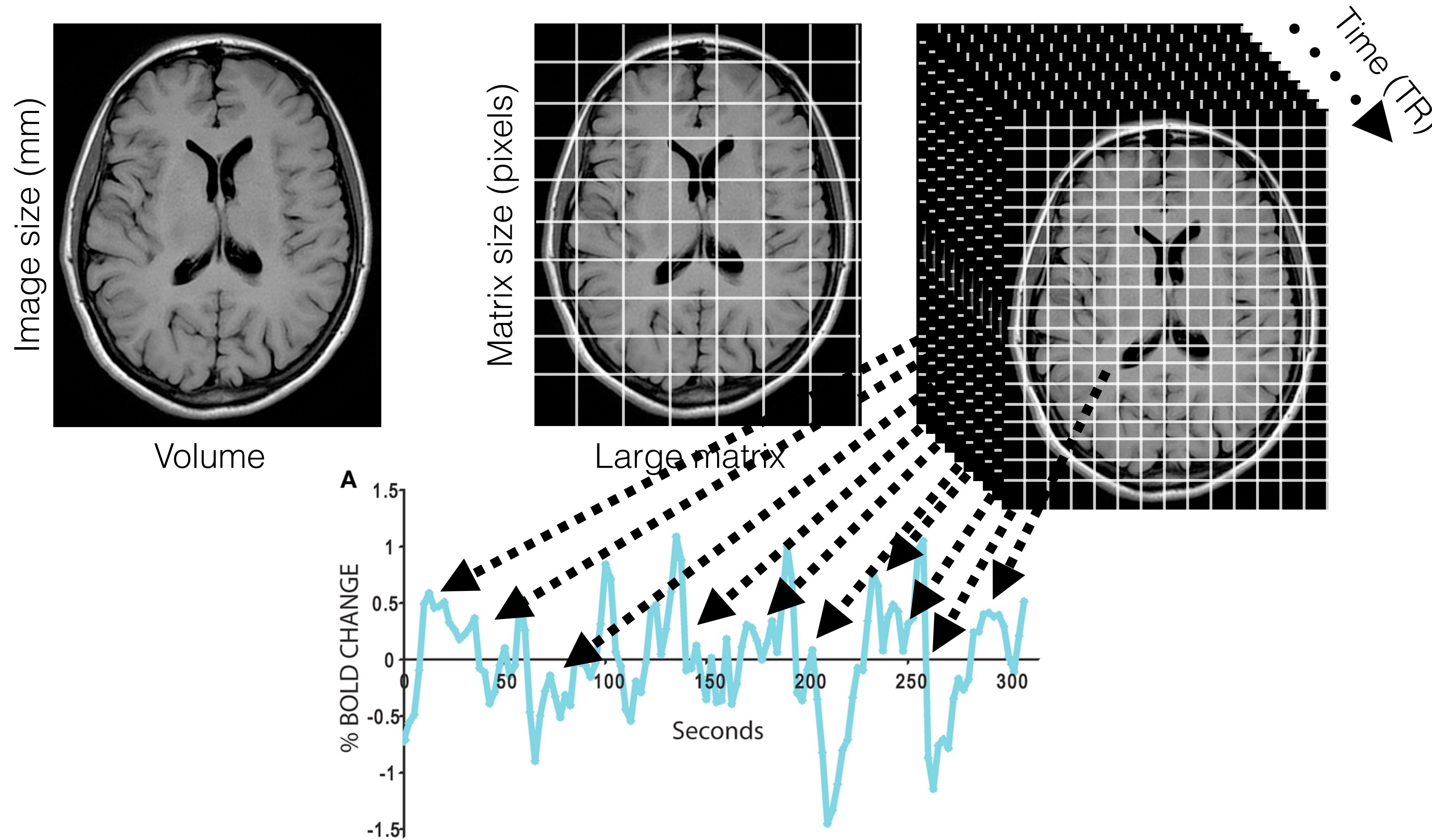
fMRI Experiment

BOLD fMRI:

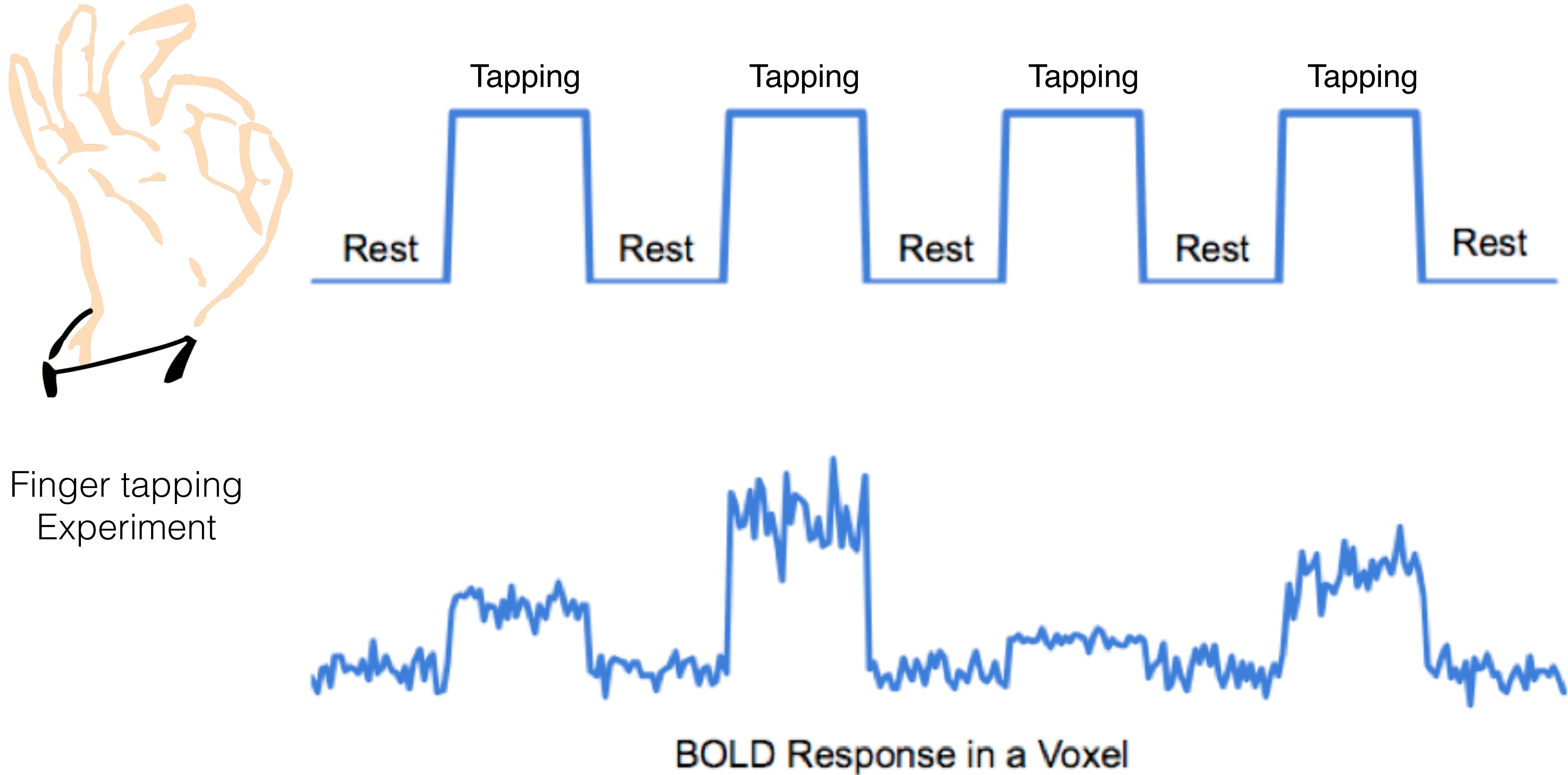
- Non-invasive
- Spatial resolution of 1-1.5 mm
- Temporal resolution of ~0.5 seconds
- No long lasting effects
- Assess function of brain structures and brain networks



fMRI Experiment



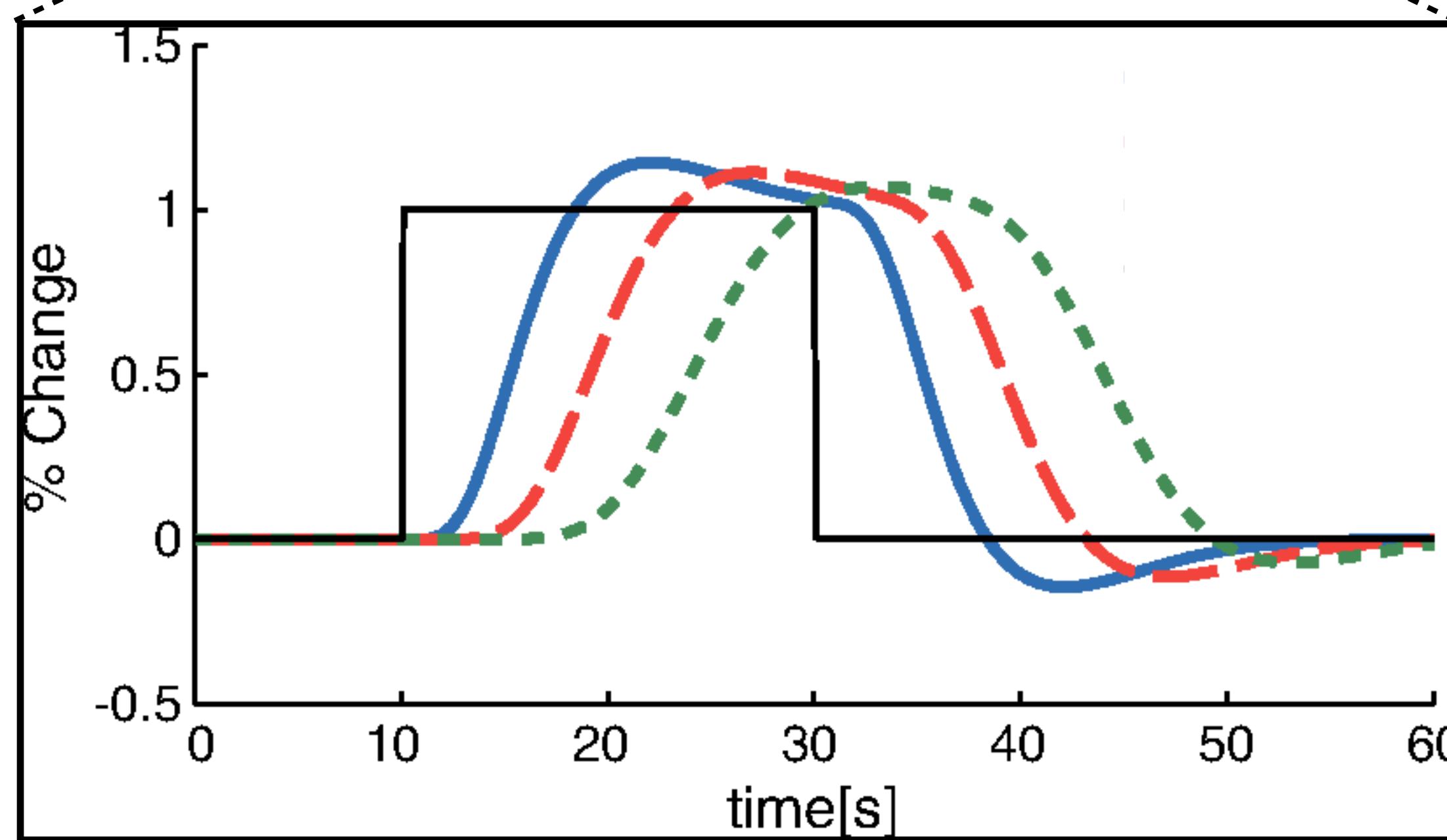
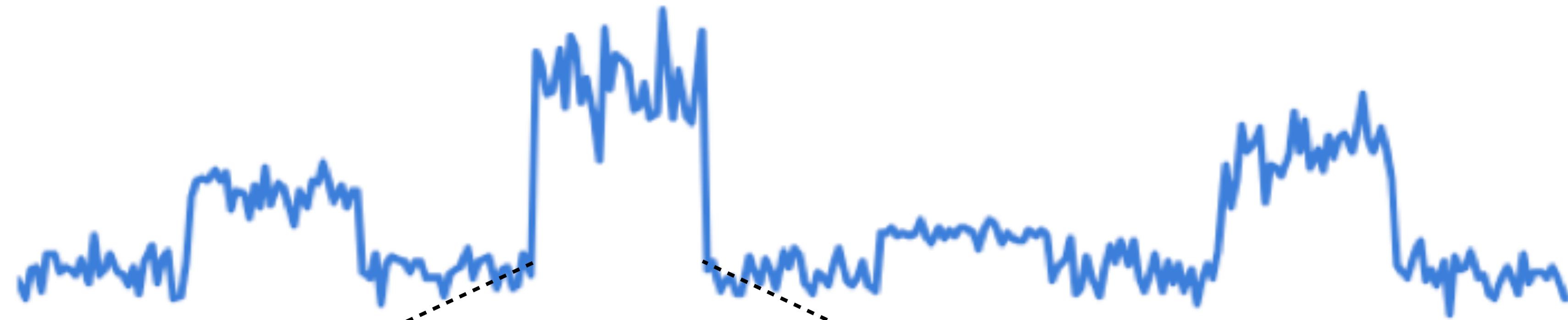
fMRI Experiment



fMRI Experiment



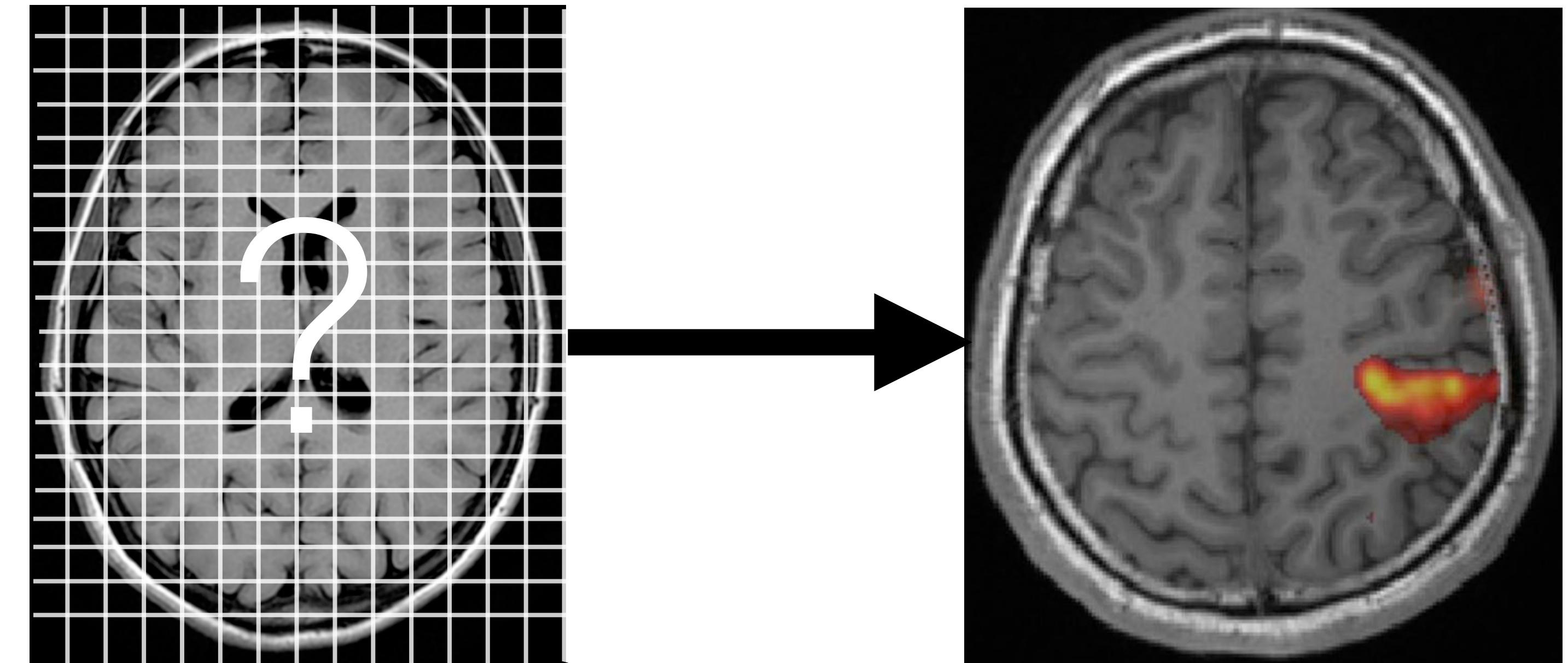
Finger tapping
Experiment



fMRI Experiment



Finger tapping
Experiment



BOLD Response in a Voxel

Block design

Advantages of fMRI block design

- Block or epoch designs are simple to design and implement
- Analysis is straightforward
- Robust activation due to large number of trials
- Robust to uncertainty in the timing and shape of the hemodynamic response

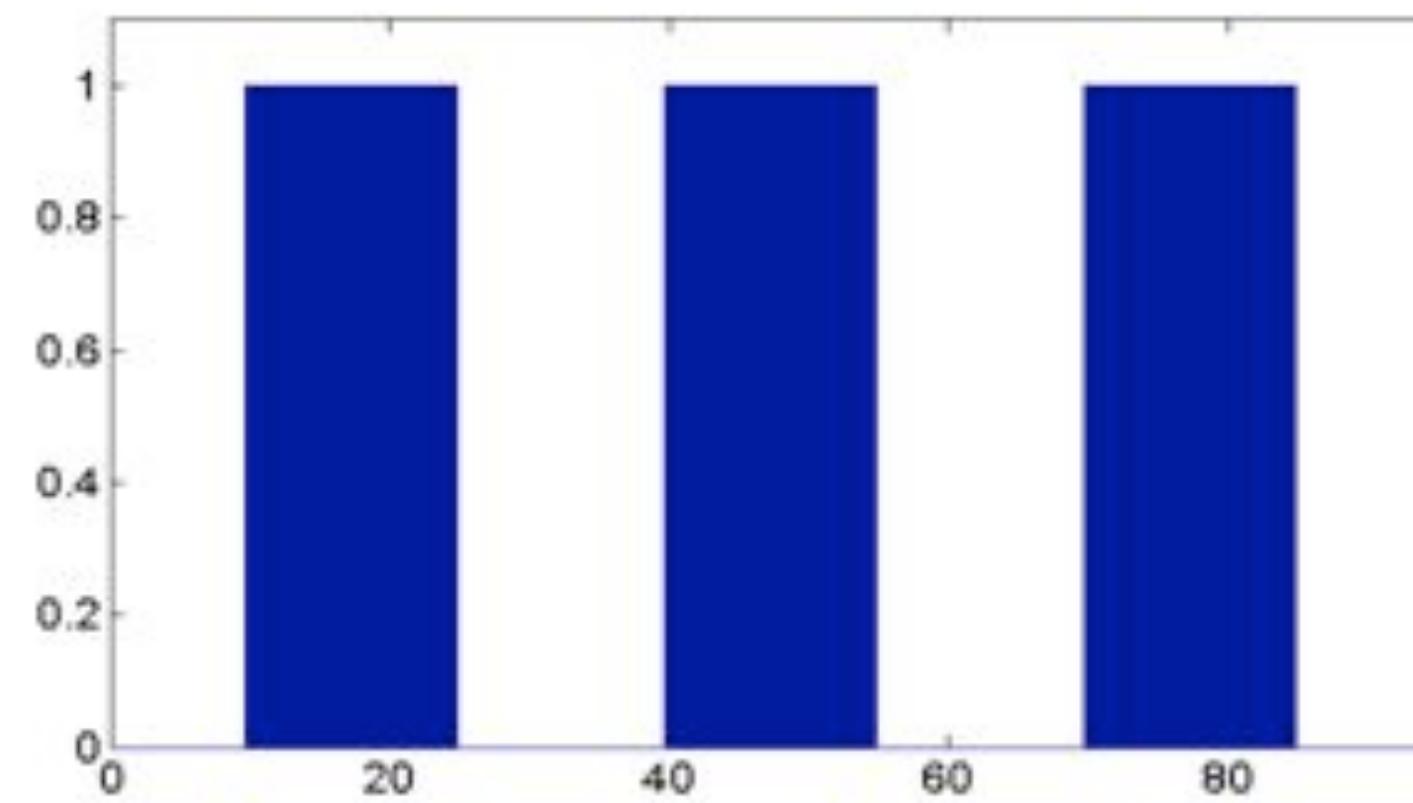
Block design

Disadvantages of fMRI block design

- Have to assume single mode of activation at a constant level over time
- Cannot infer any information regarding the individual events
- Can not infer anything about the time course of the hemodynamic response

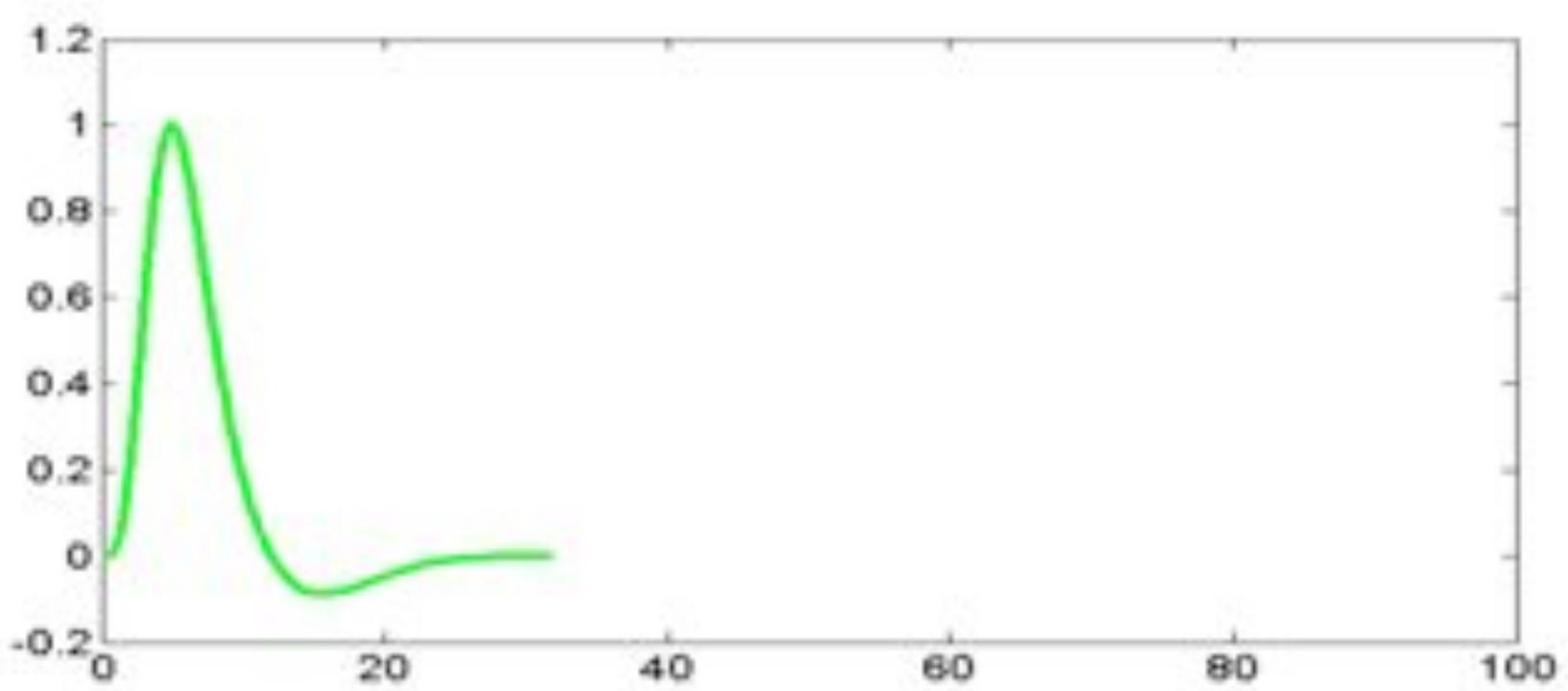
fMRI Experiment

Task design



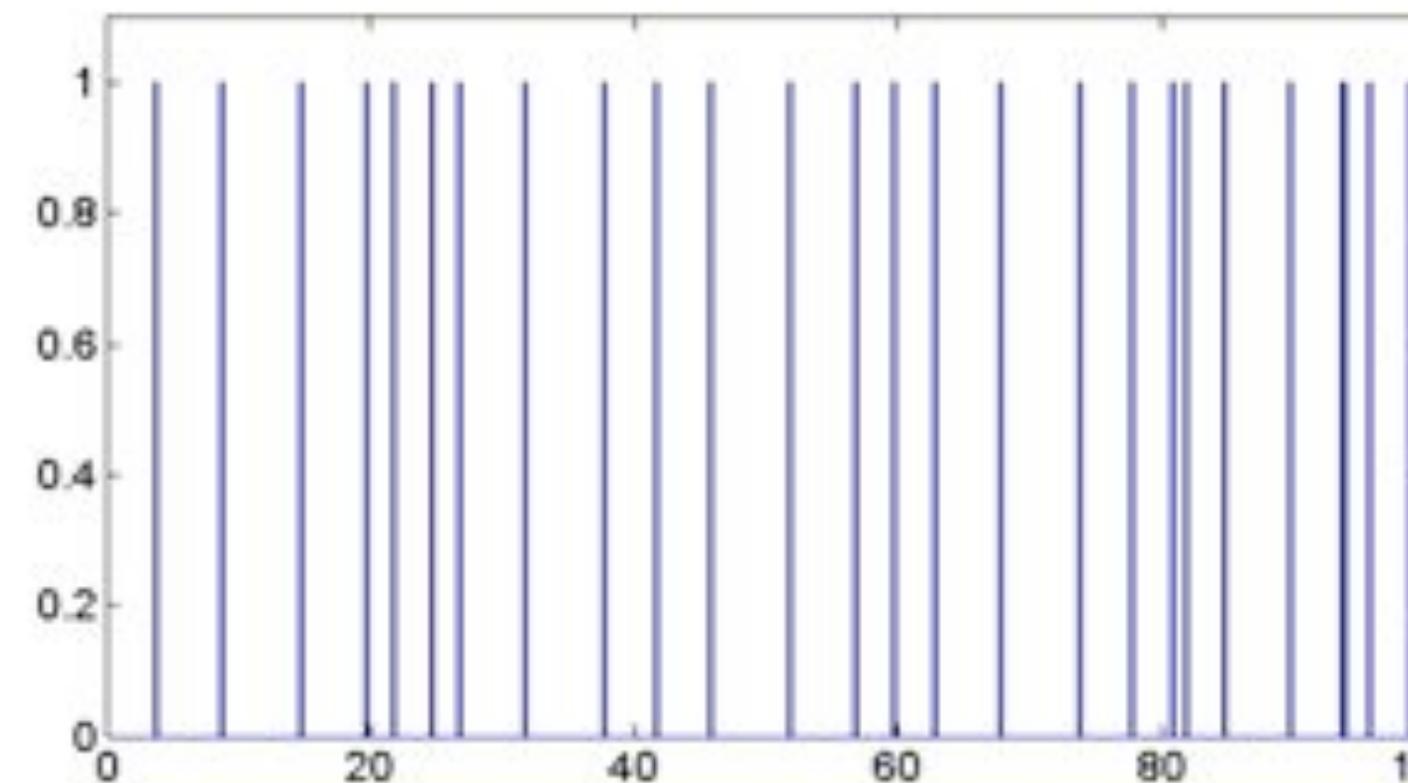
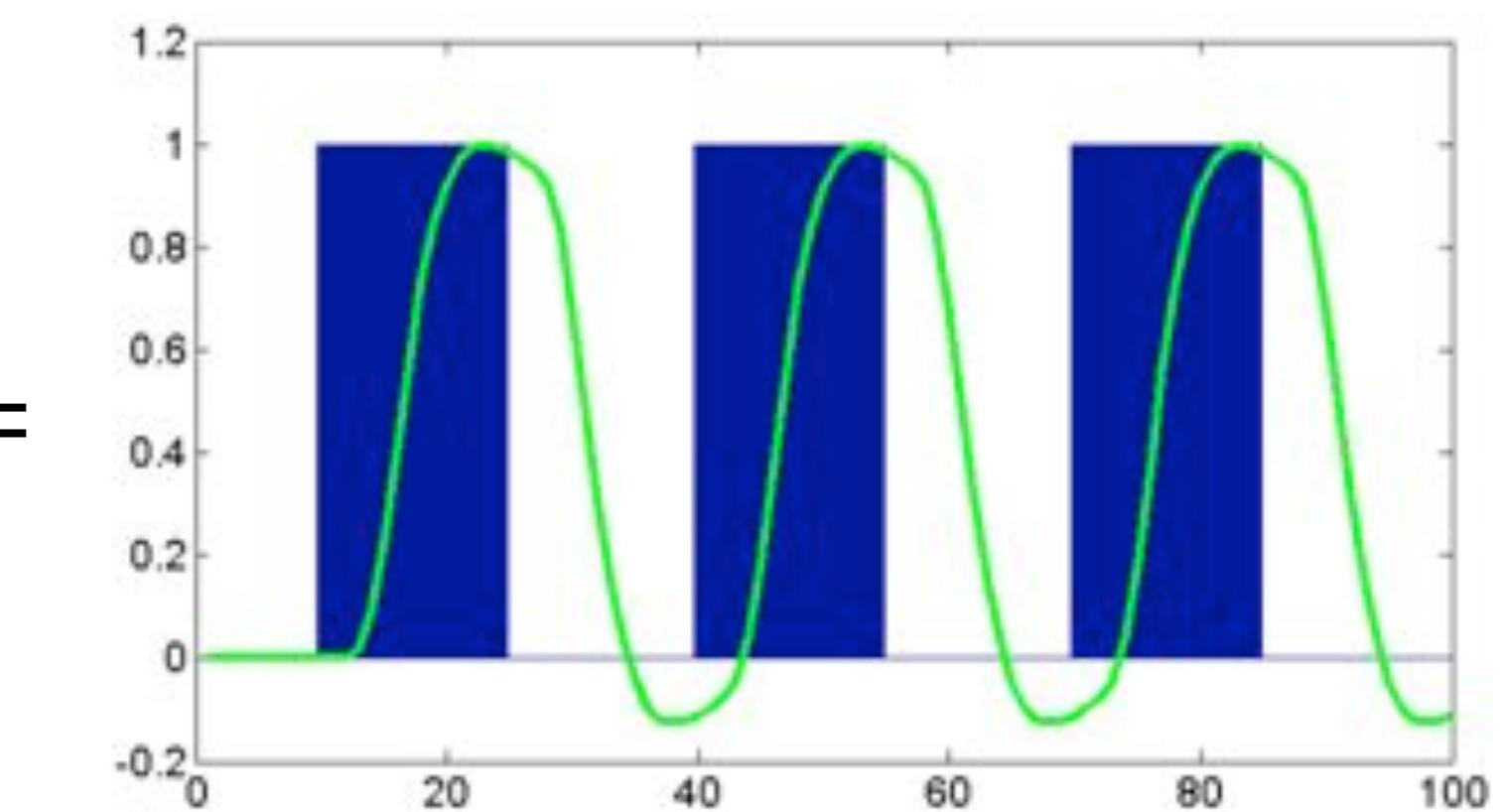
X

HRF



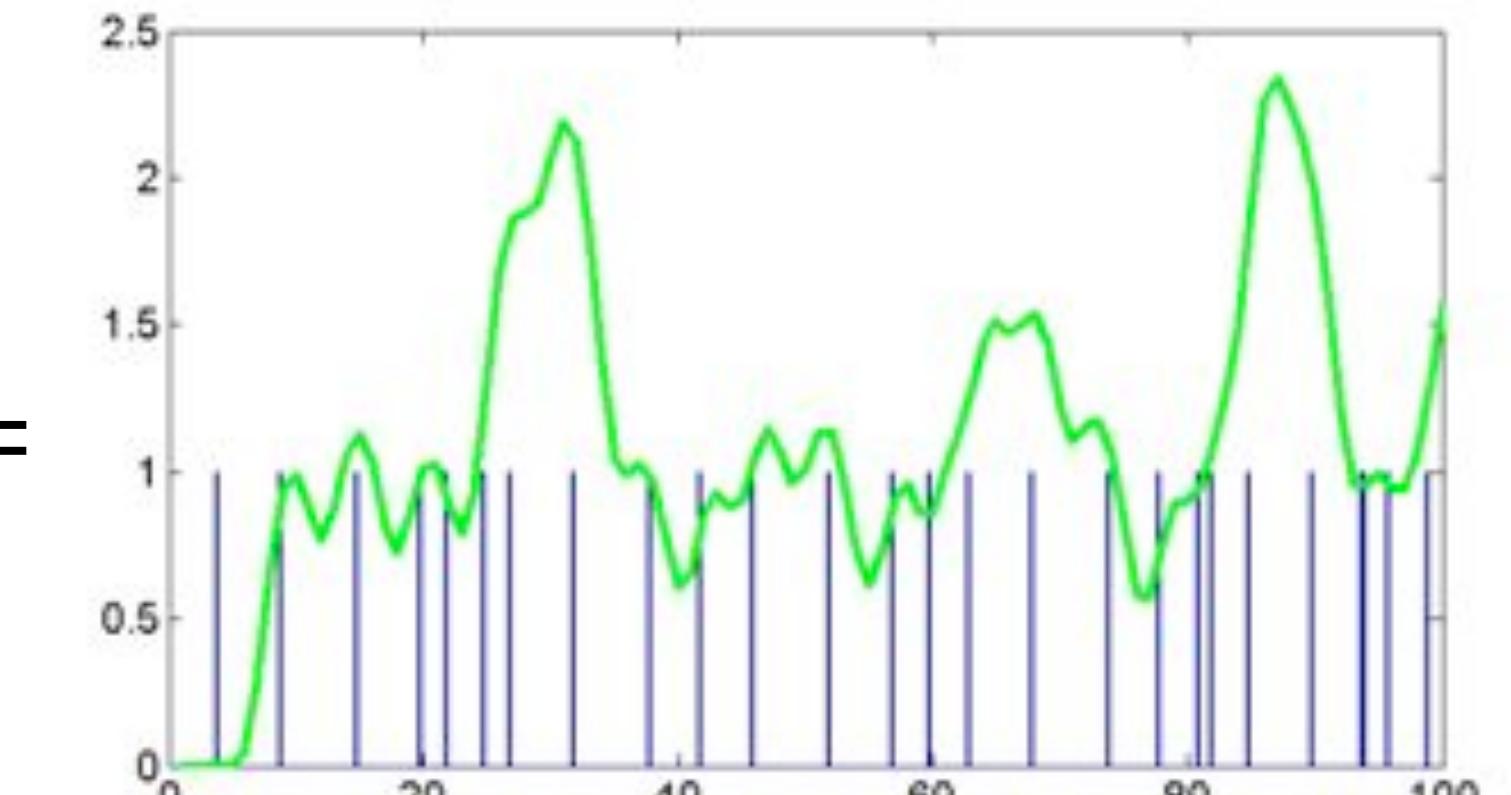
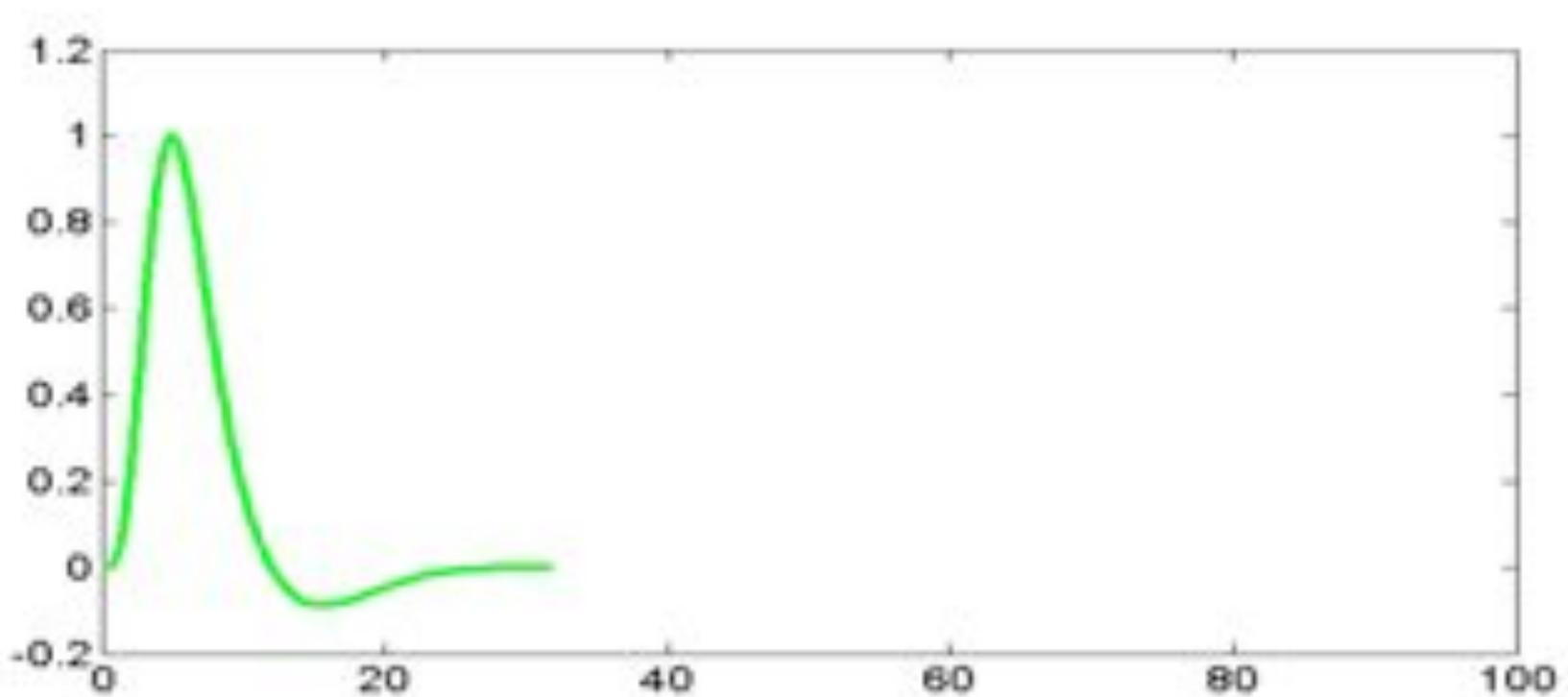
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Expected signal



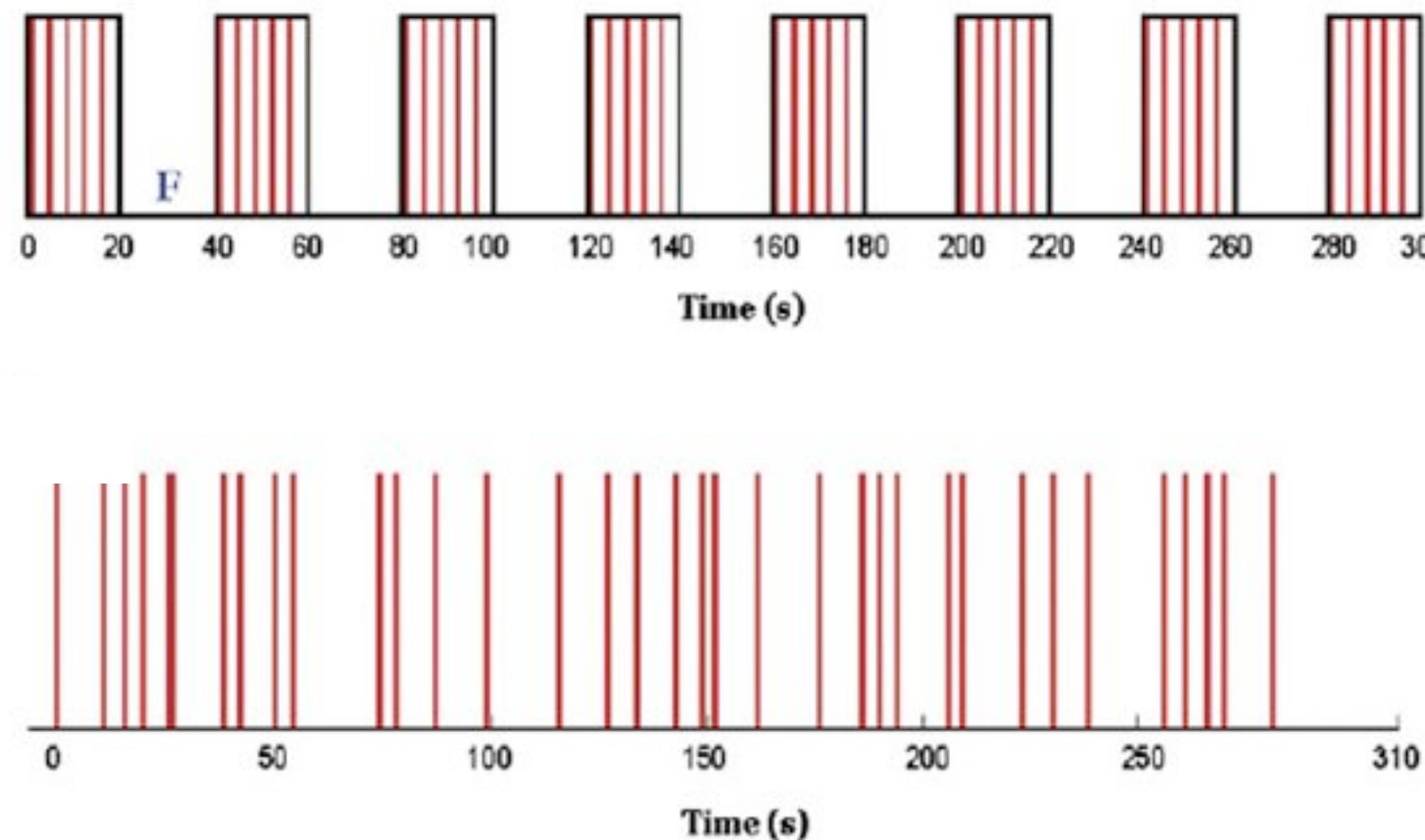
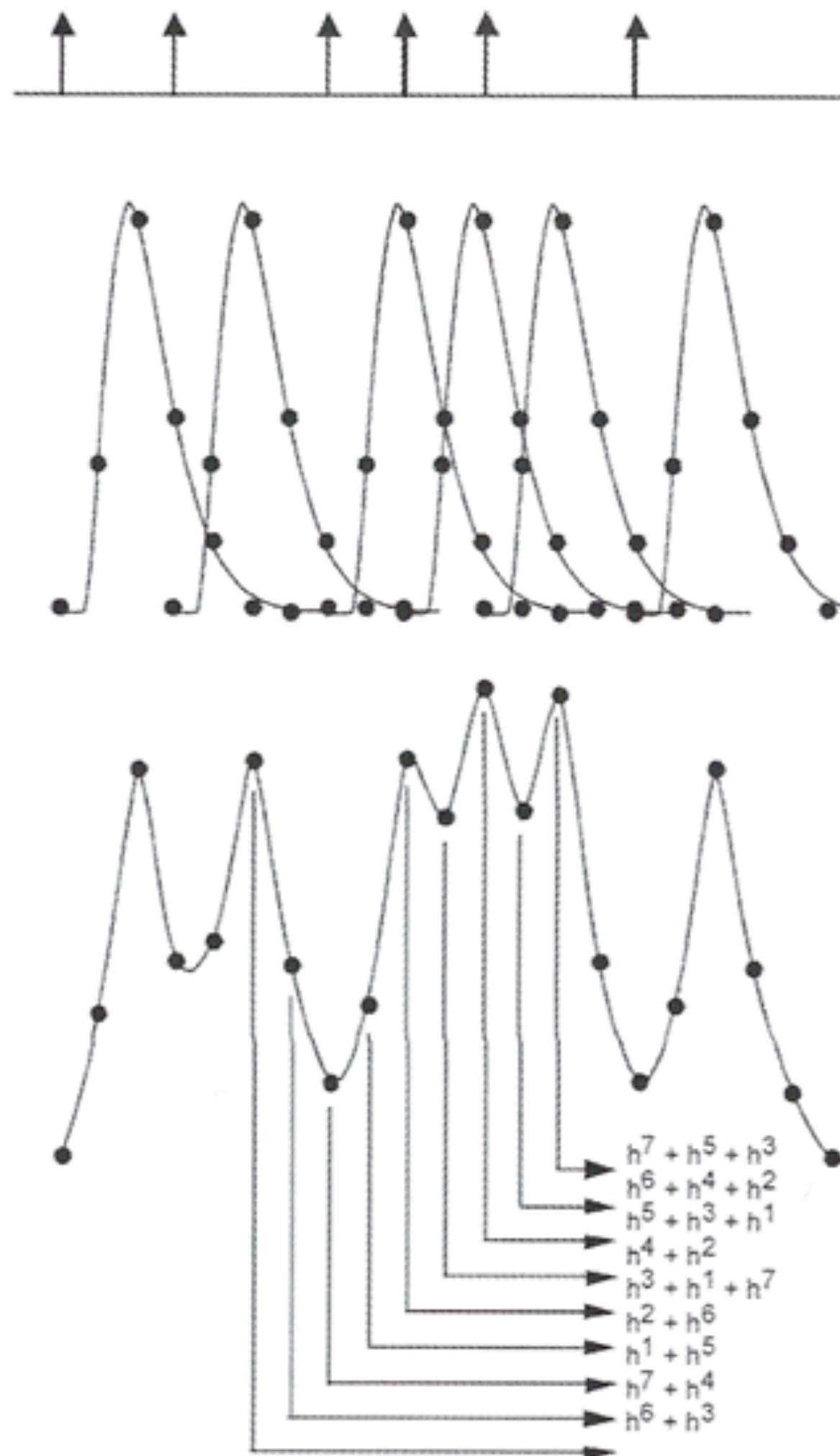
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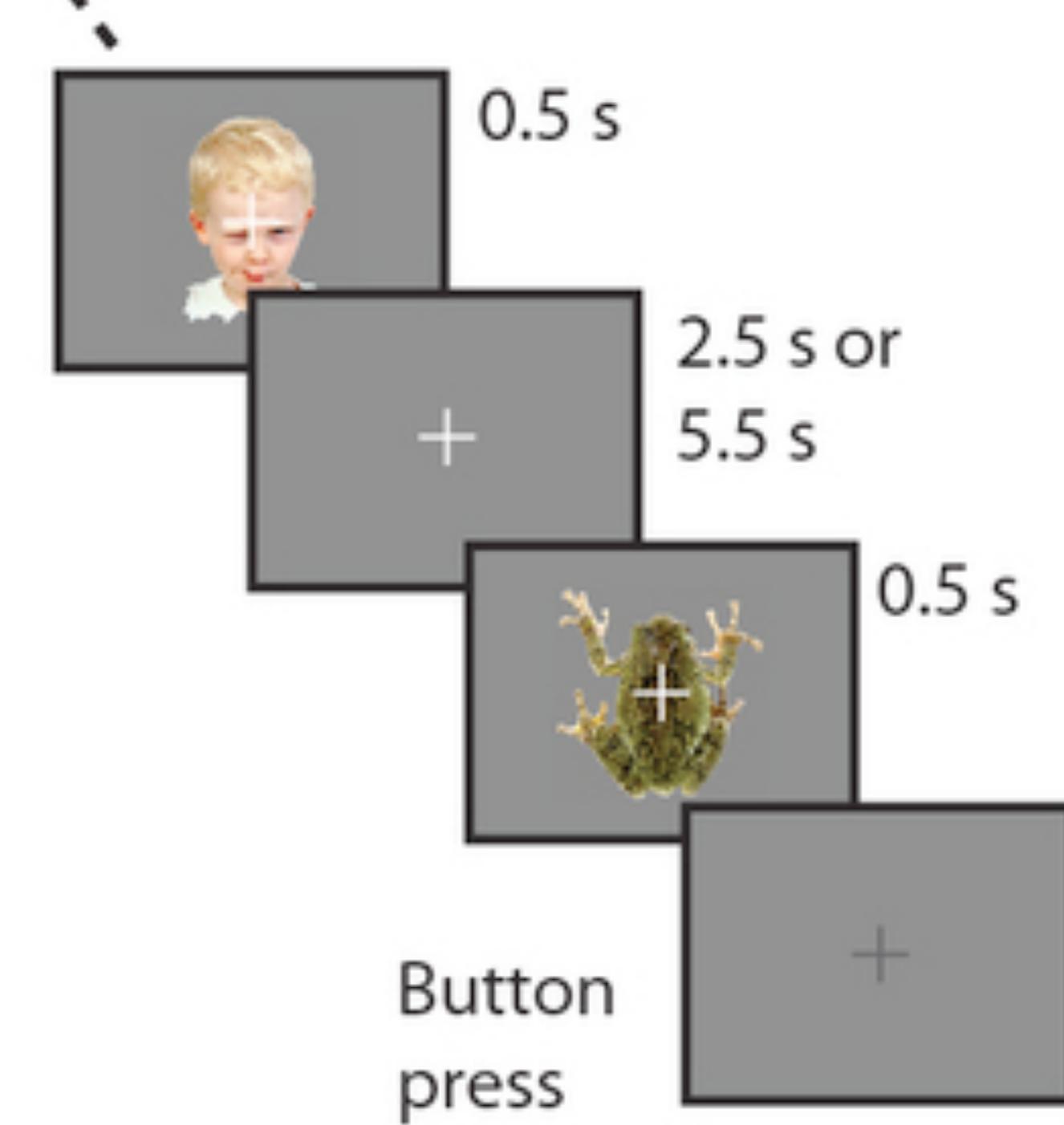
fMRI Experiment

Randomized (jittered) interval



Event related design

fMRI



Event related design

Advantages of fMRI event related design

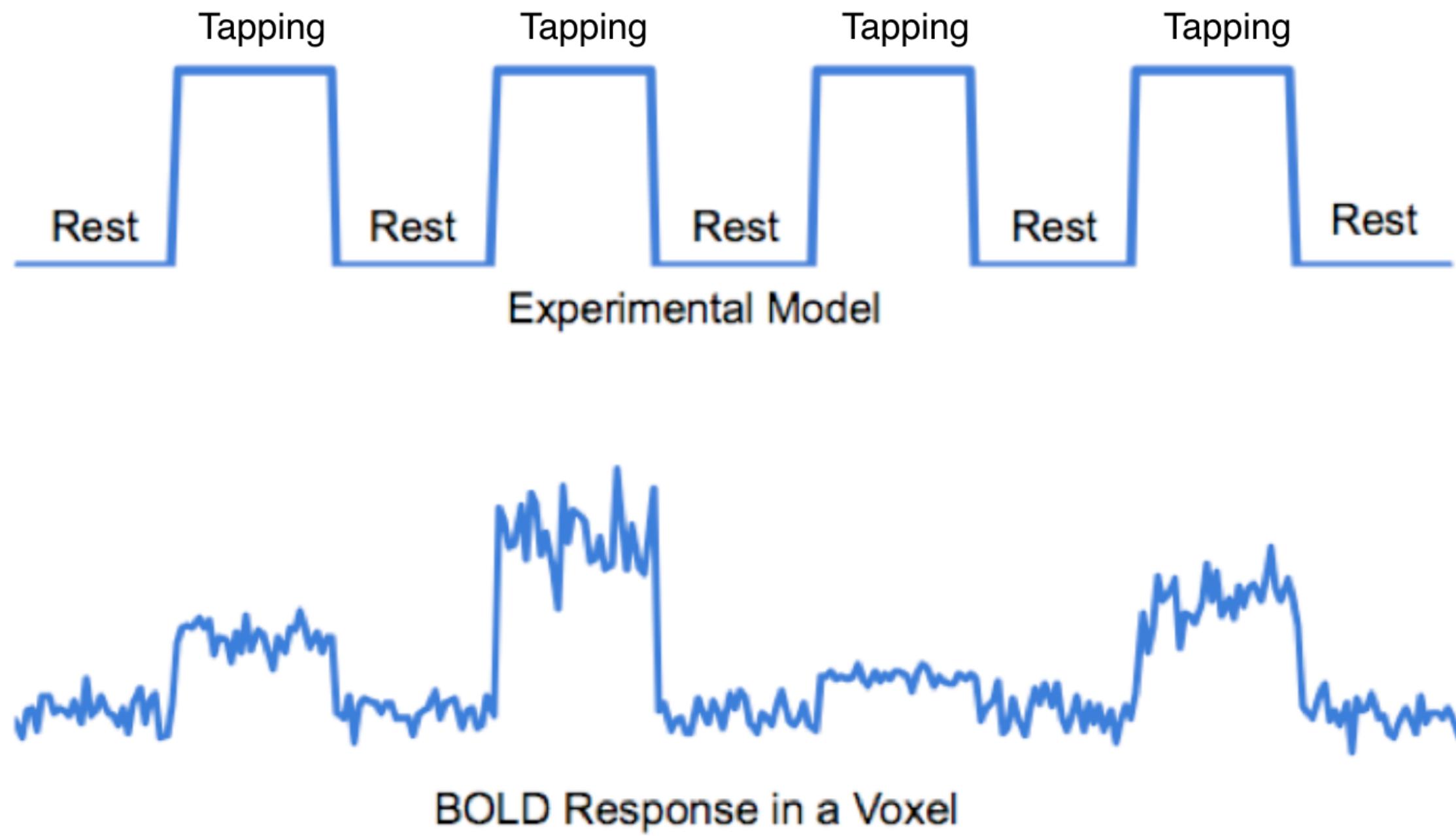
- Allows for inferences about timing of neuronal activity
- Allows for flexible analysis of the data
- Allows for post-hoc trial sorting
- Jittering ensures that anticipatory effects do not confound responses

Event related design

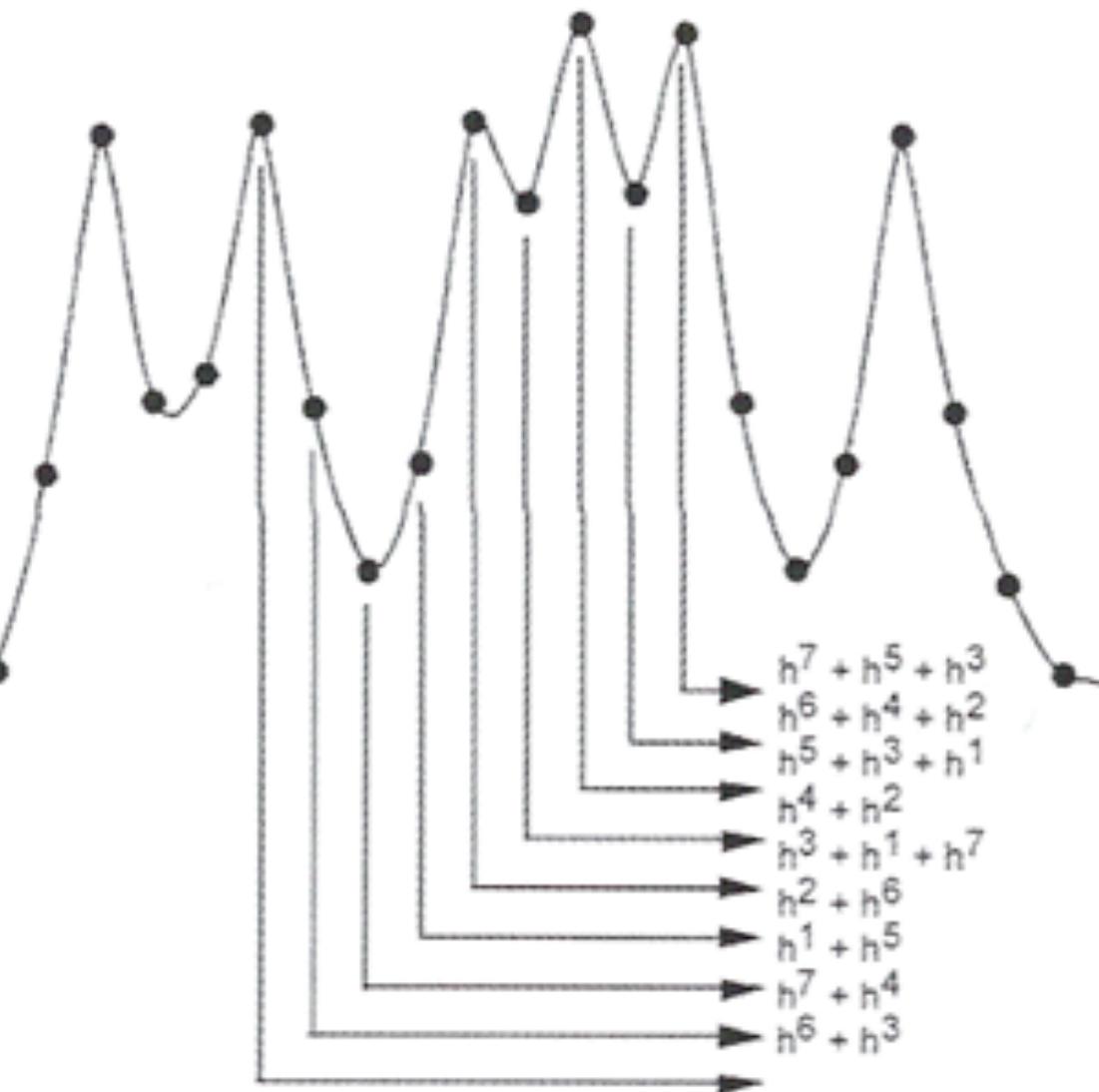
Disadvantages of fMRI event related design

- Reduced detection power compared to epoch design
- Sensitive to errors in the hemodynamic response function
- Refractory effects can influence the analysis

fMRI Experiment



Block design

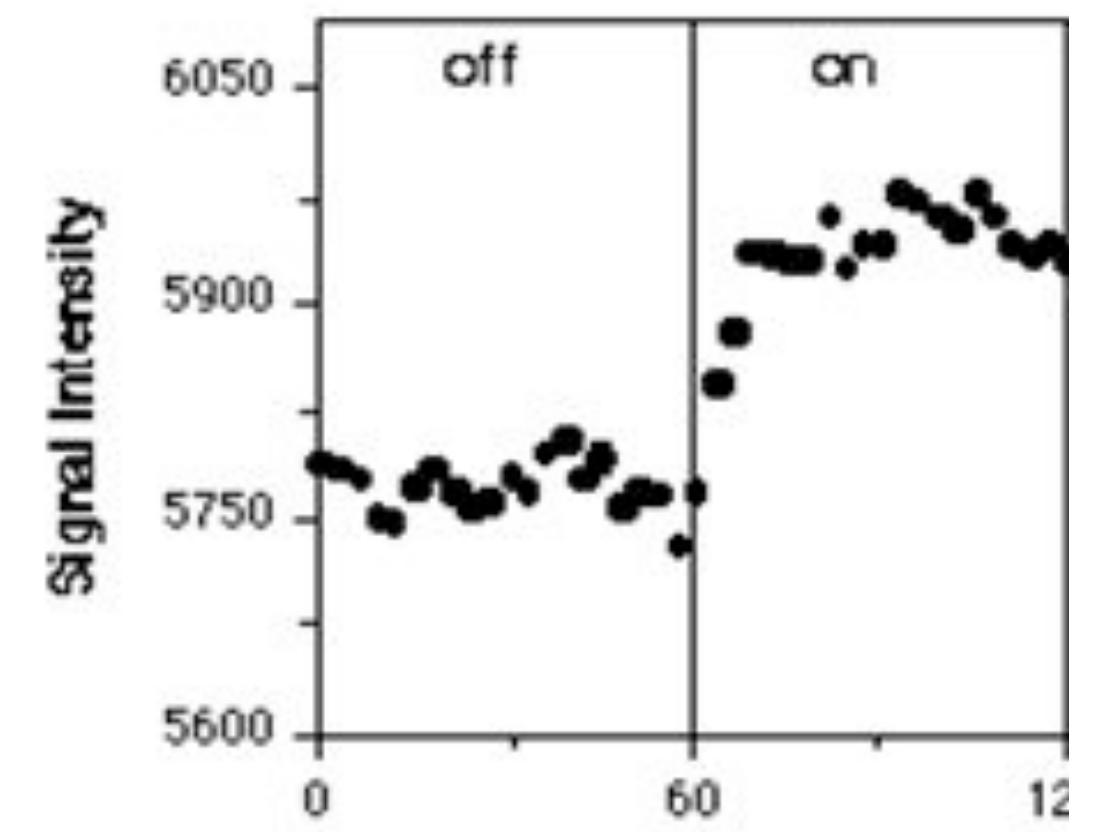
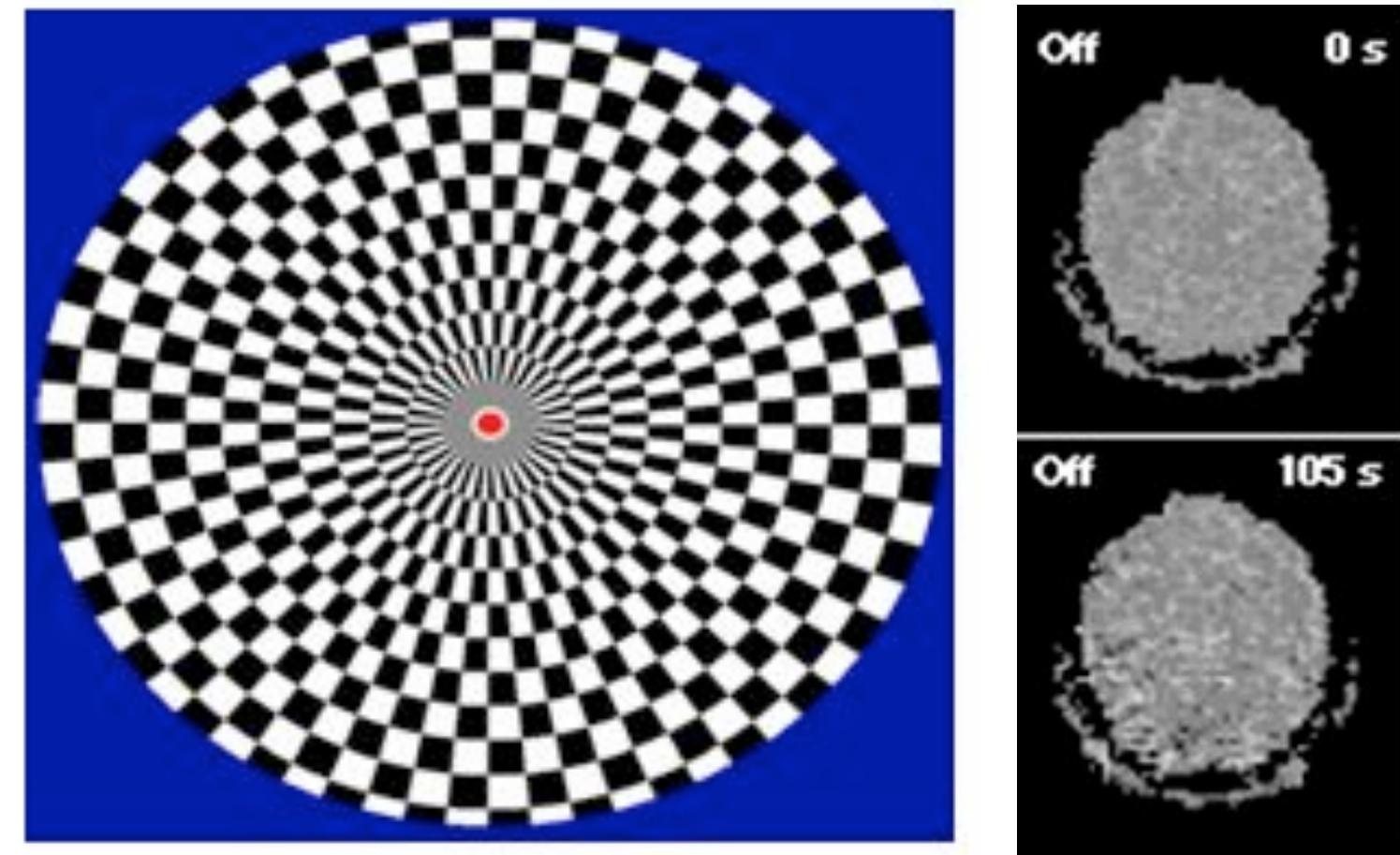


Event related design

Cognitive subtraction

Cognitive Subtraction

- Also known as categorical design
- Assumes that different cognitive components are independent in space, e.g. memory in the hippocampus, etc...
- Pure insertion (Donders, 1968): Processes in complex conditions are simply added on top of those in simpler or baseline conditions.
- 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.



Flickering checkerboard

Cognitive Subtraction

Choice of control condition:

- Subtraction of two conditions is only valid if the conditions differ in only one property.
- Any factor that covaries with the independent variable is a confounding factor and must be controlled for.

When zero is not zero: The problem of ambiguous baseline conditions in fMRI

Craig E. L. Stark[†] and Larry R. Squire^{†‡§¶||}

Departments of [†]Psychiatry, [‡]Neurosciences, and [§]Psychology, University of California at San Diego, La Jolla, CA 92093; and [¶]Veterans Affairs Medical Center, San Diego, CA 92161

Contributed by Larry R. Squire, August 31, 2001

By using blocked and rapid event-related functional MRI studies of memory, we explored the implications of using rest periods as a

the parahippocampal gyrus (and sometimes also in the hippocampal region) in association with viewing novel pictures

Cognitive Subtraction

Subtraction of two conditions is only valid if the conditions differ in only one property.



Face



Scrambled



Faces > Places + Scram

