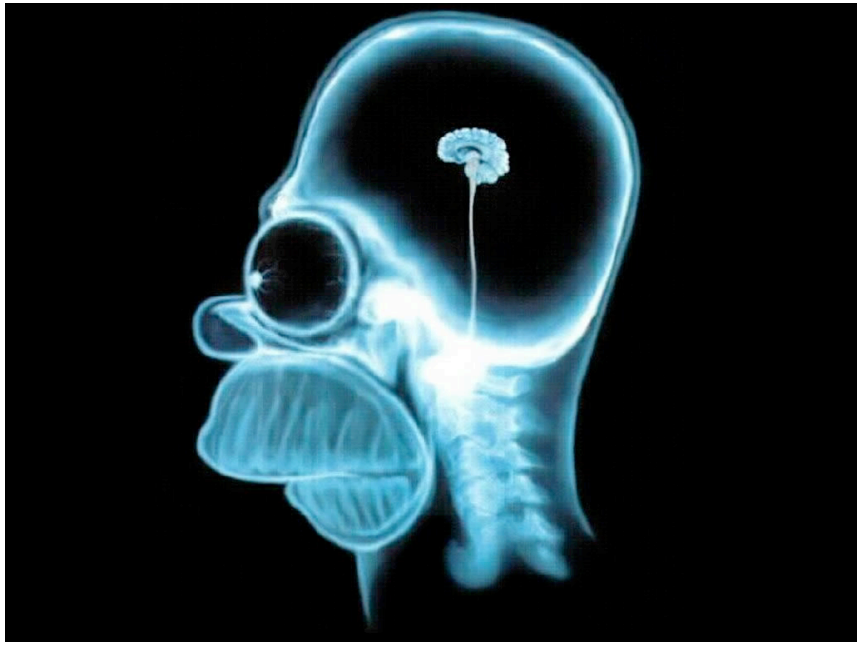
fMRI Methods Step-by-Step

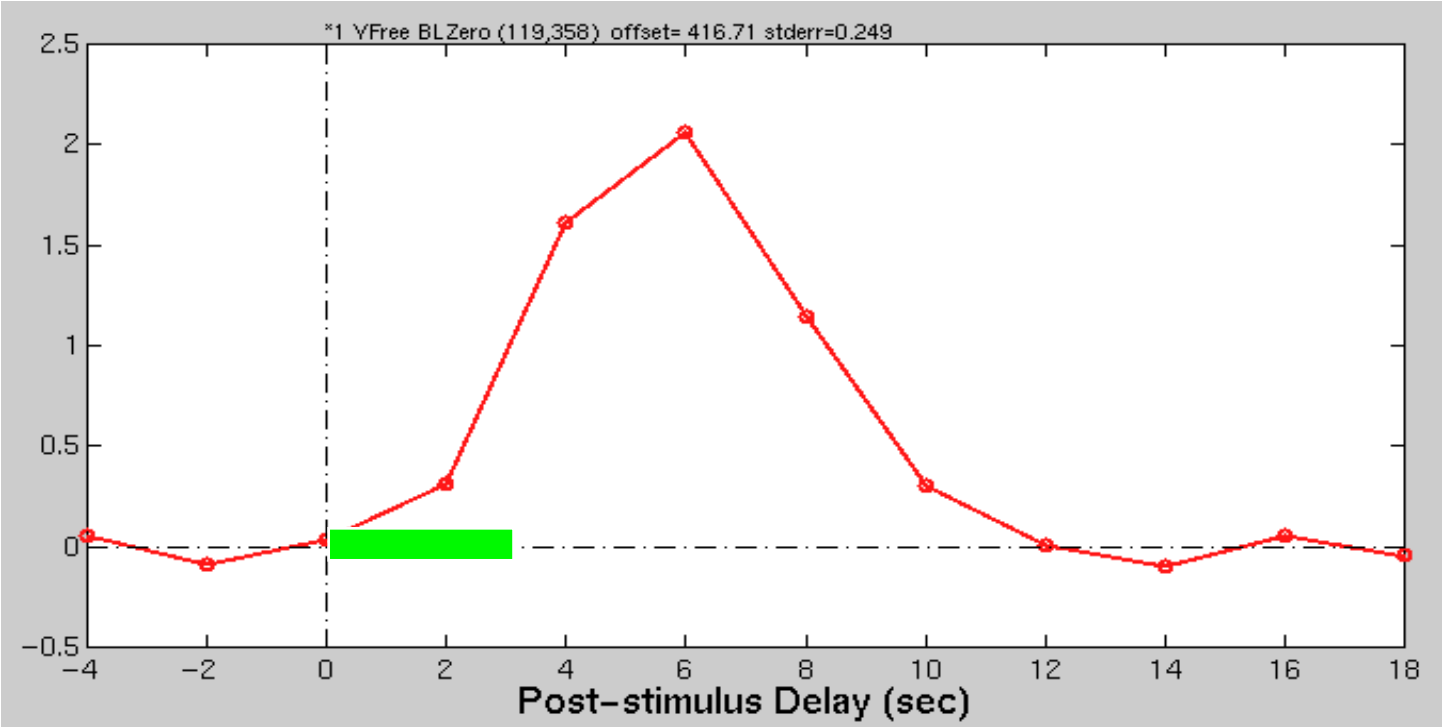


fMRI Methods Step-by-Step

1. Design
2. Collect Data
3. Preprocess data analysis
    a. Convert/Reconstruction
    b. Slice timing correction
    c. Motion correction
    d. Normalization
    e. Spatial smoothing
    f. Temporal Filtering
4. Individual data analysis
    a. Model/Contrasts
    b. ROI analysis
    c. Extract Data
5. Average?

Design

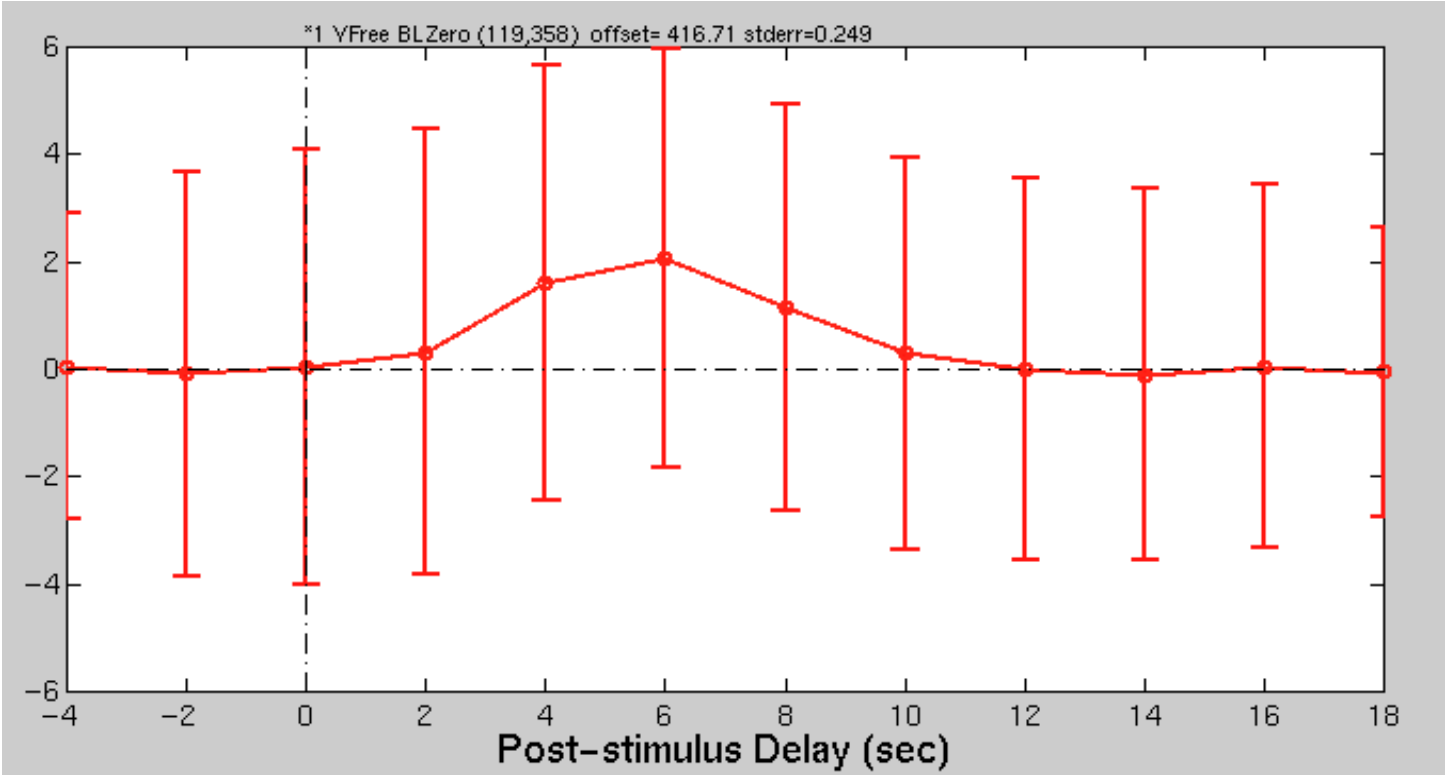
Fact of (fMRI) Life #1: Dispersion



- How closely can trials/events be spaced?

Slides: Doug Greve, OptSeq

Fact of (fMRI) Life #2: Noise

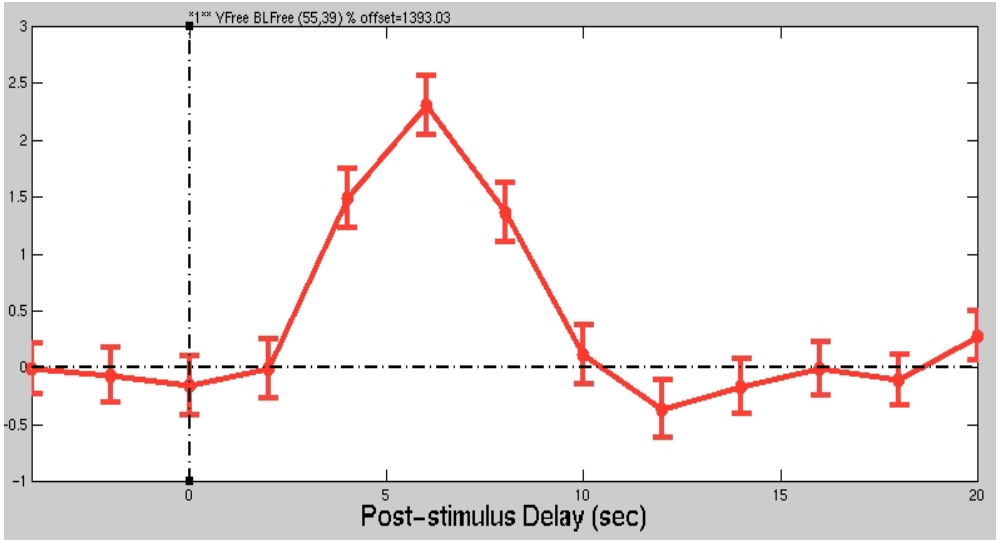


- How much data needs to be collected?

Slides: Doug Greve, OptSeq

Fact of (fMRI) Life #3: Time

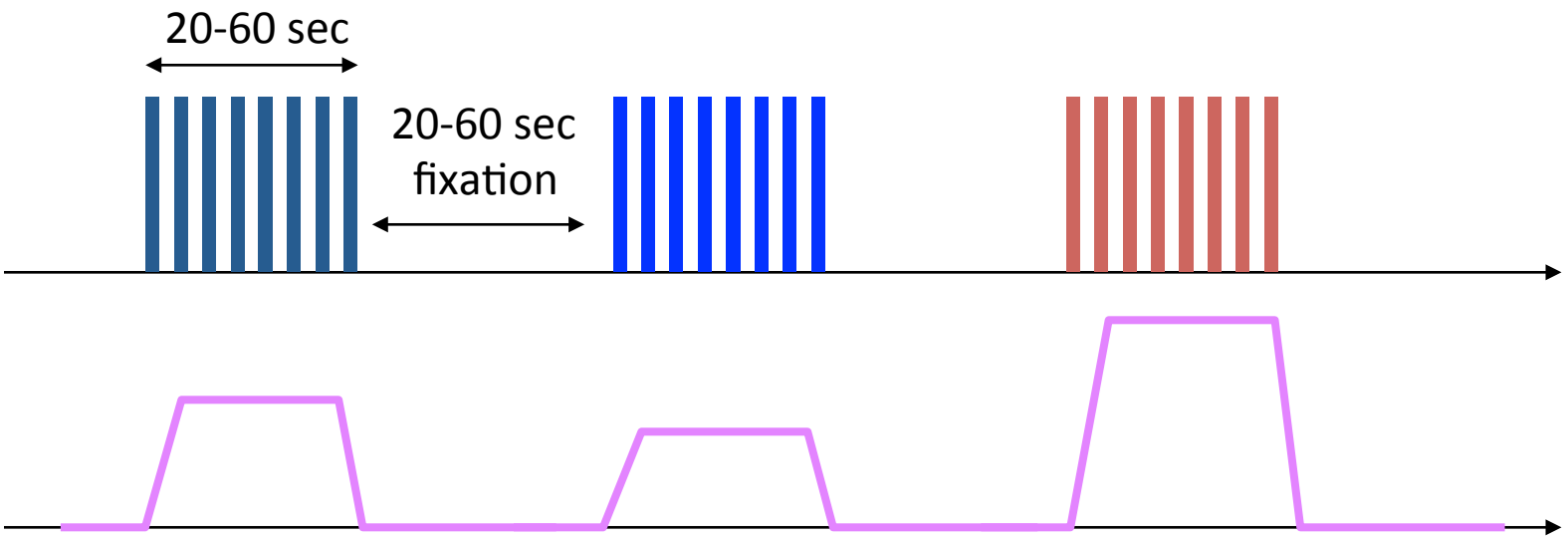
- Collect lots of observations to reduce noise
- Time is Money
- Subjects won't work forever



Slides: Doug Greve, OptSeq

Design

Blocked Design

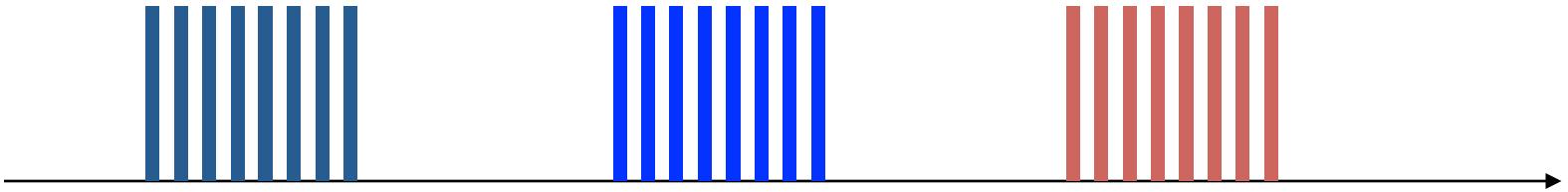


- Consecutive, rapid presentation for long duration.
- Use overlap to build a larger signal.
- Simple analysis.
- Optimal for detection.

Slides: Doug Greve, OptSeq

Design

Blocked Design Drawbacks

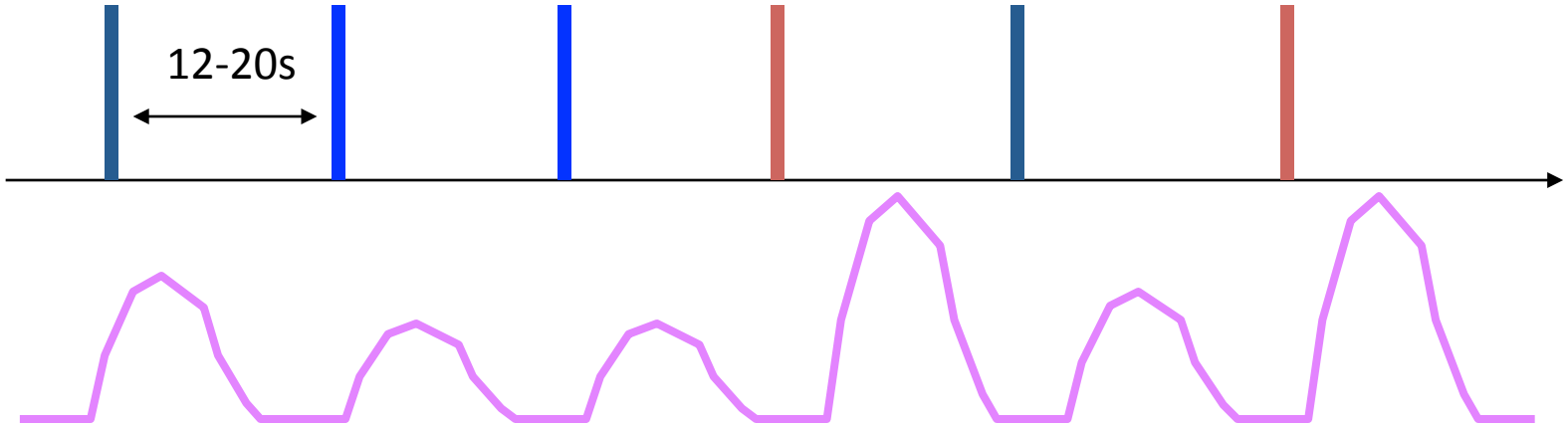


- Lose ability to distinguish individual responses
- Confounding psychological and physiological effects
  - Habituation/Adaptation
  - Expectation
  - Set (Strategy)

Slides: Doug Greve, OptSeq

Design

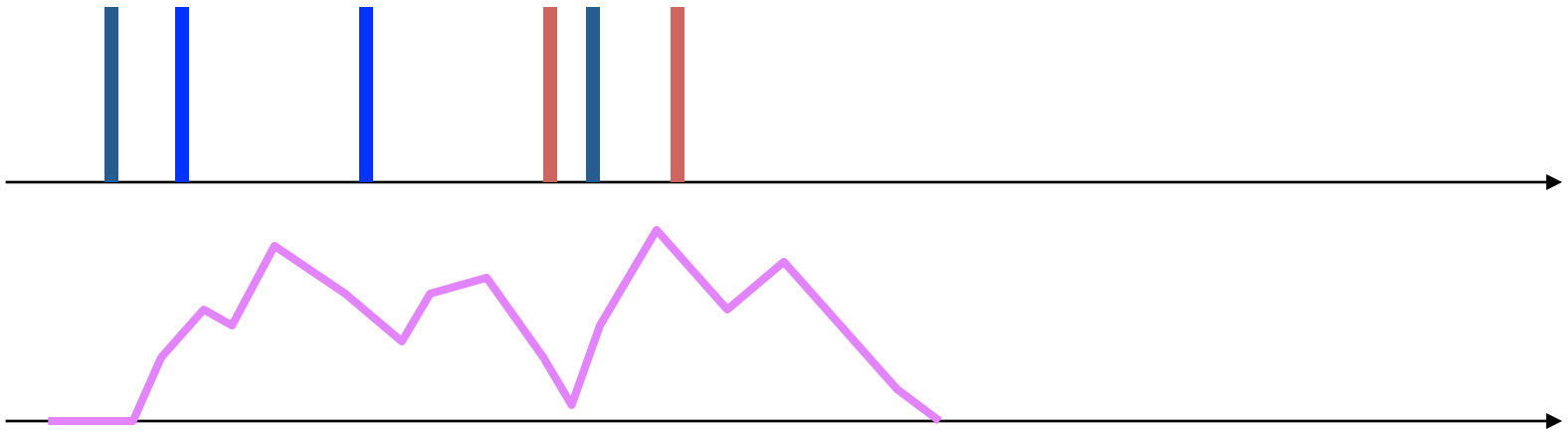
Fixed-Interval Event-Related



- Push trials apart enough to prevent overlap.
- Interval fixed at minimum is most efficient.
- Random Sequence (Counter-balanced)
- Allows Post-Hoc Stimulus Definition
- Inflexible/Inefficient/Boring
- Good if limited by number of stimuli (not scanning time)

Slides: Doug Greve, OptSeq

Rapid-Presentation Event-Related

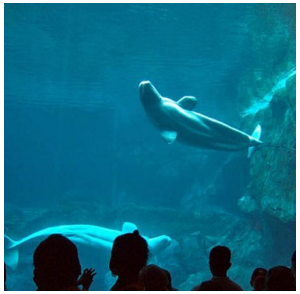
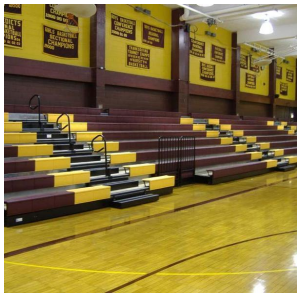
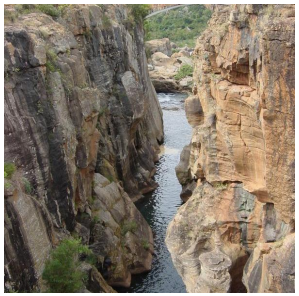


- Closely Spaced Trials (Overlap!)
- Raw signal uninterpretable
- More Stimulus Presentations for given scanning interval
- Random Sequence
- Jitter = "Random" Inter-Stimulus Interval (ISI/SOA)

Slides: Doug Greve, OptSeq

Design

What's the question?


fMRI: pattern of activity for each exemplar


1s

\+

7s


1s

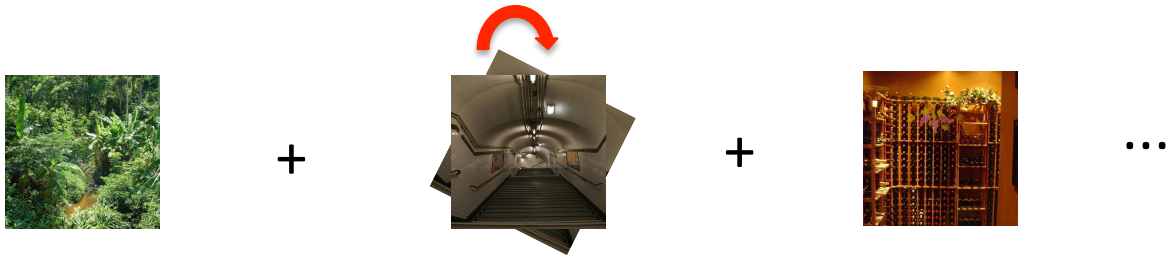
\+

7s


1s

…

Design



100 Stimuli = ~ 14 min

Time:

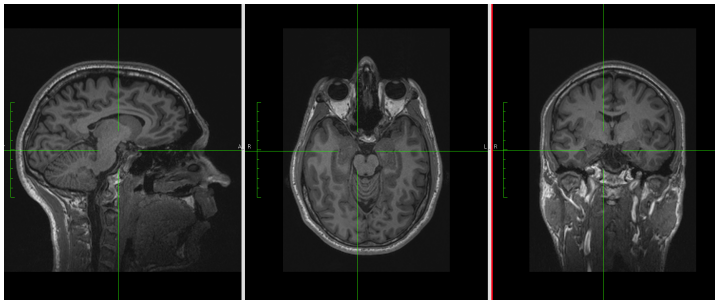
- Participant needs to stay still
- Participant needs to stay awake

2 Sessions – 6 total repetitions

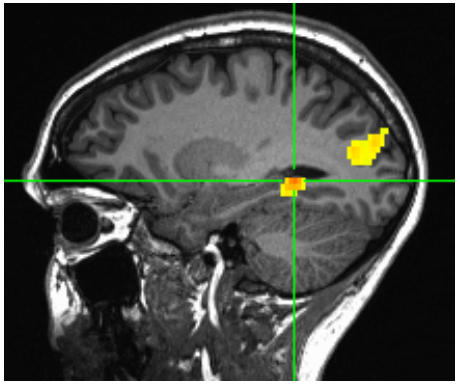
Design

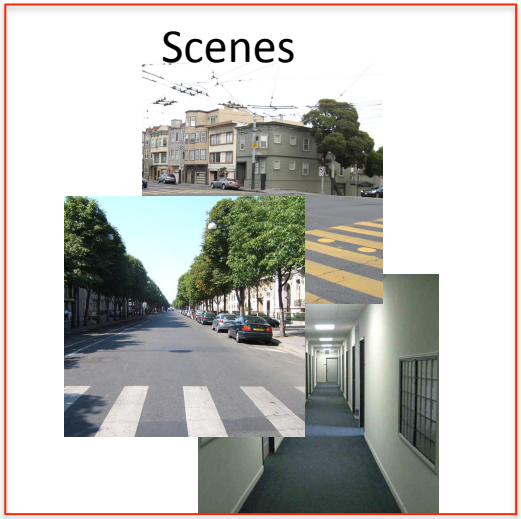
Other Scans During Experiment

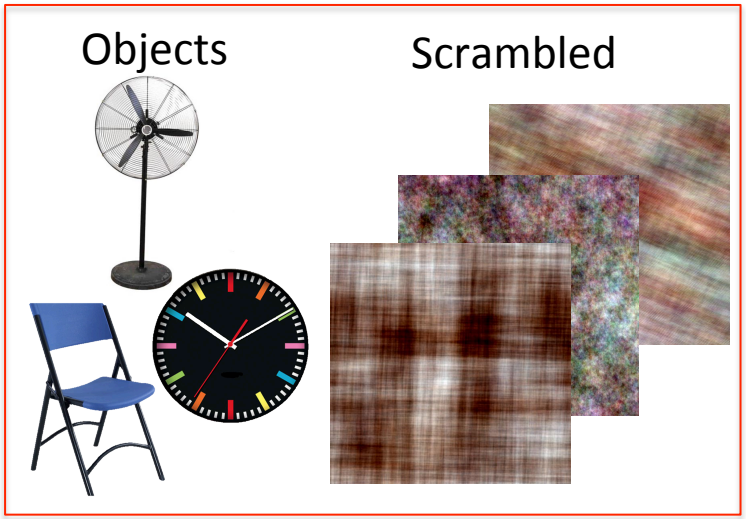
Hi Resolution Anatomical



Functional Localizer (vs. whole brain)







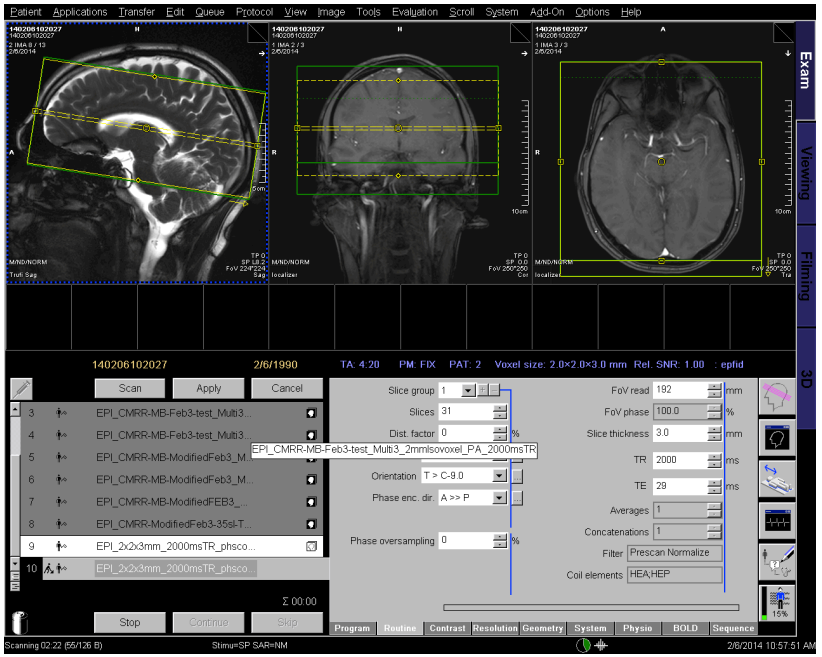
fMRI Methods Step-by-Step

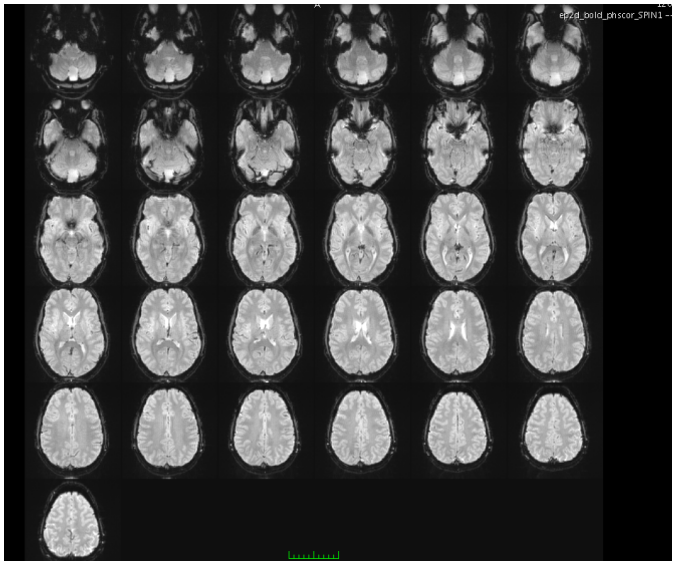
1. Design ✓
2. Collect Data

Collect Data

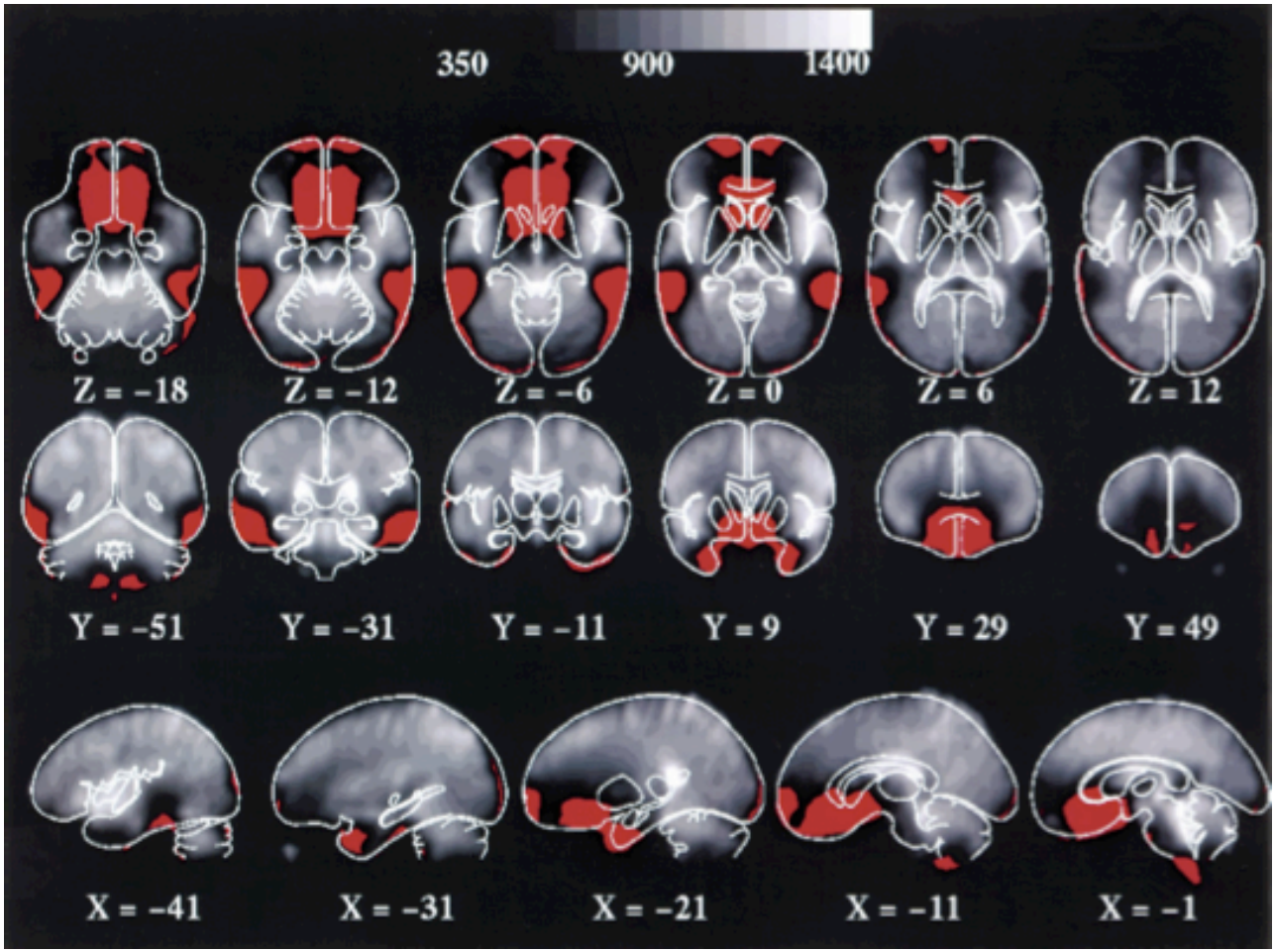
Acquisition Parameters

- # of slices
- Slice angle
- Slice thickness
- Voxel size
- TR (time of repetition)
- TE (time to echo)
- Field of view (FOV)
- Flip Angle
- Slice Acquisition Order
- Phase encoding
- Bandwidth
- Grappa/IPAT
- Diff in magnets/head coils





Susceptibility Artifacts

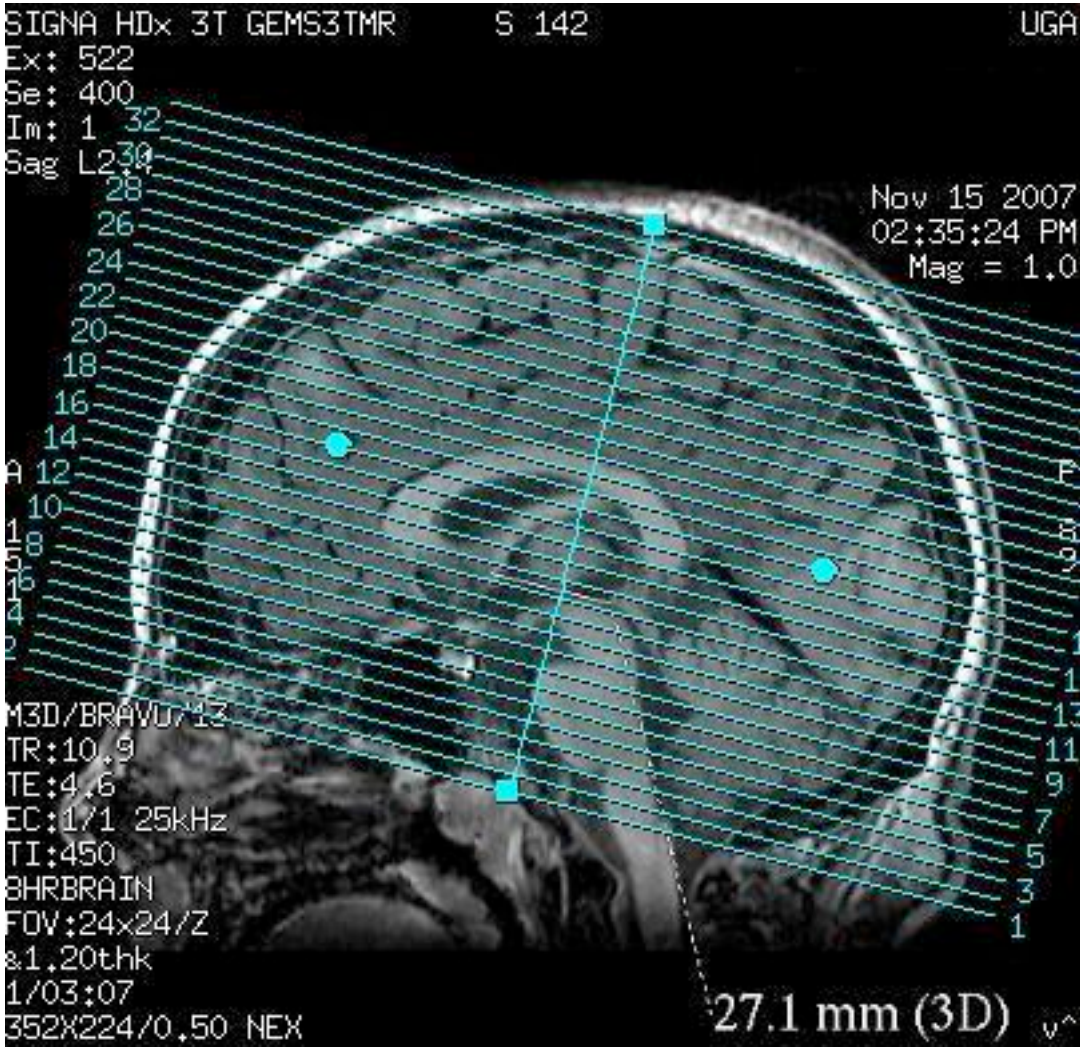


Ojemann, NeuroImage 1997

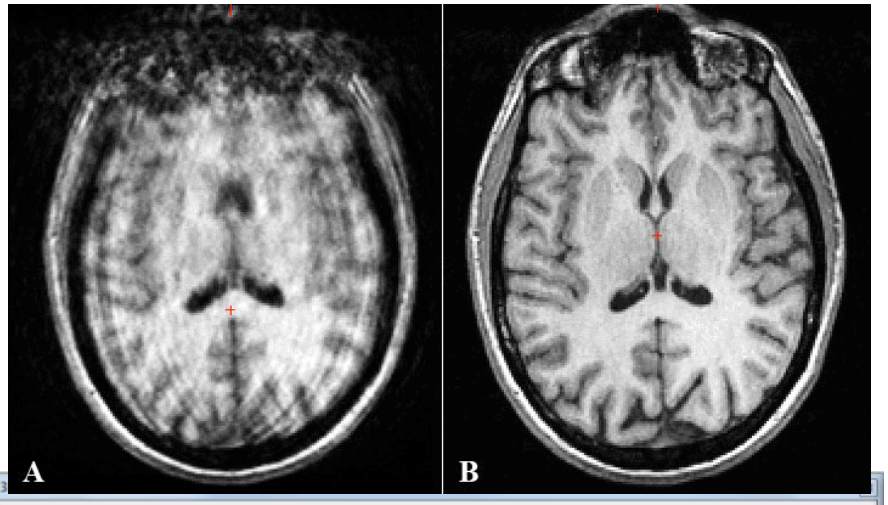
fMRI Methods Step-by-Step

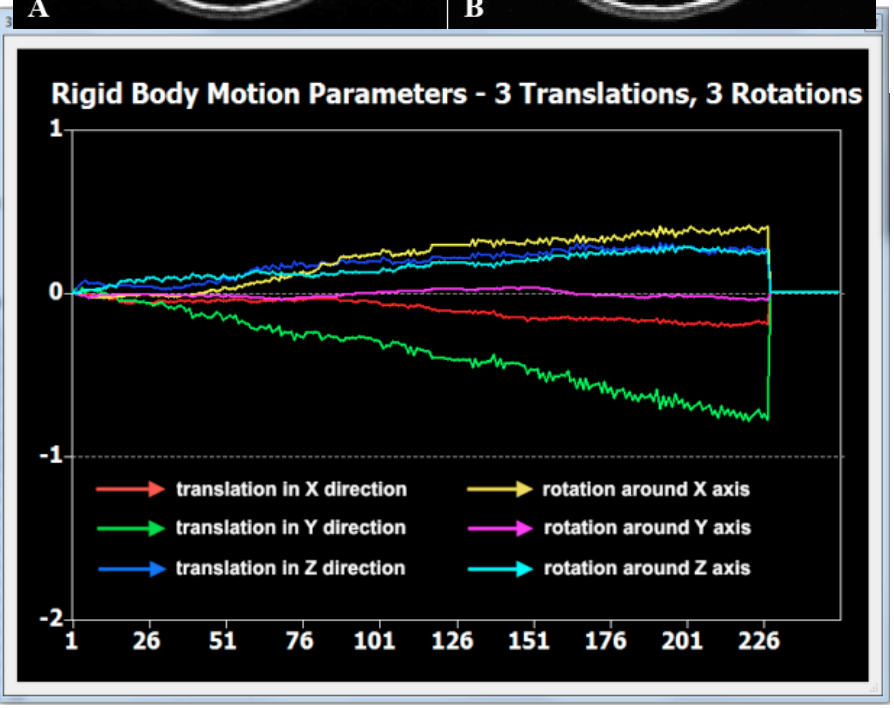
1. Design ✓
2. Collect Data ✓
3. Preprocess data analysis
    a. Convert/Reconstruction
    b. Slice-timing correction

Preprocessing
Slice-Timing Correction

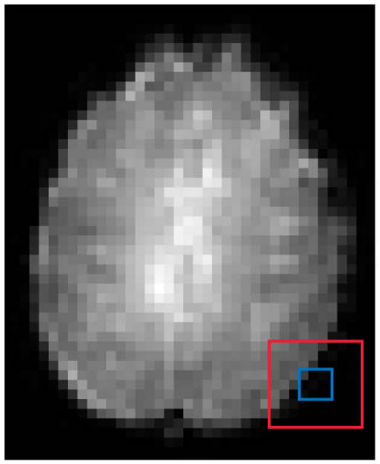


Preprocessing
Motion Correction

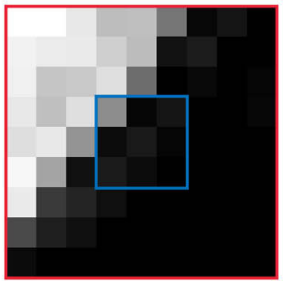




(A)

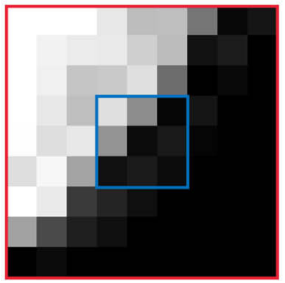


(B)

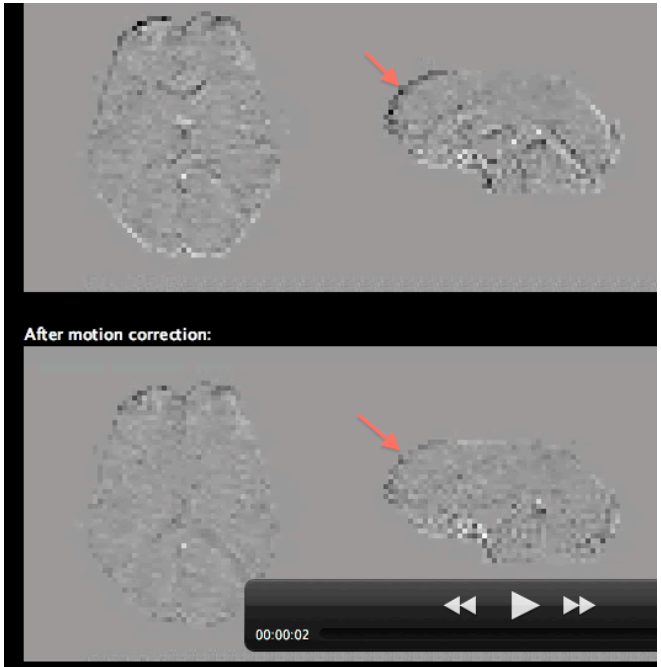


507	89	154
119	171	83
179	117	53

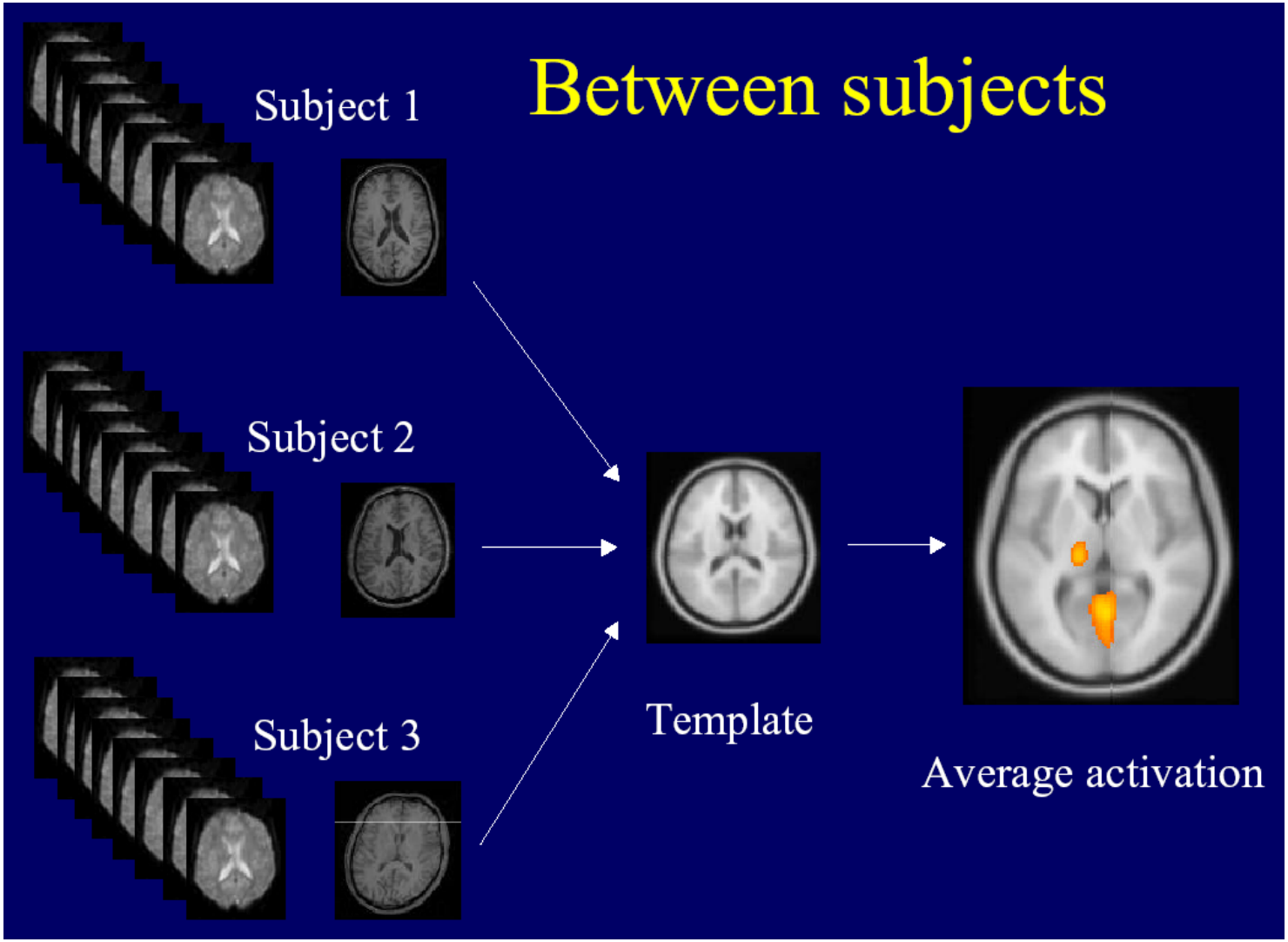
(C)



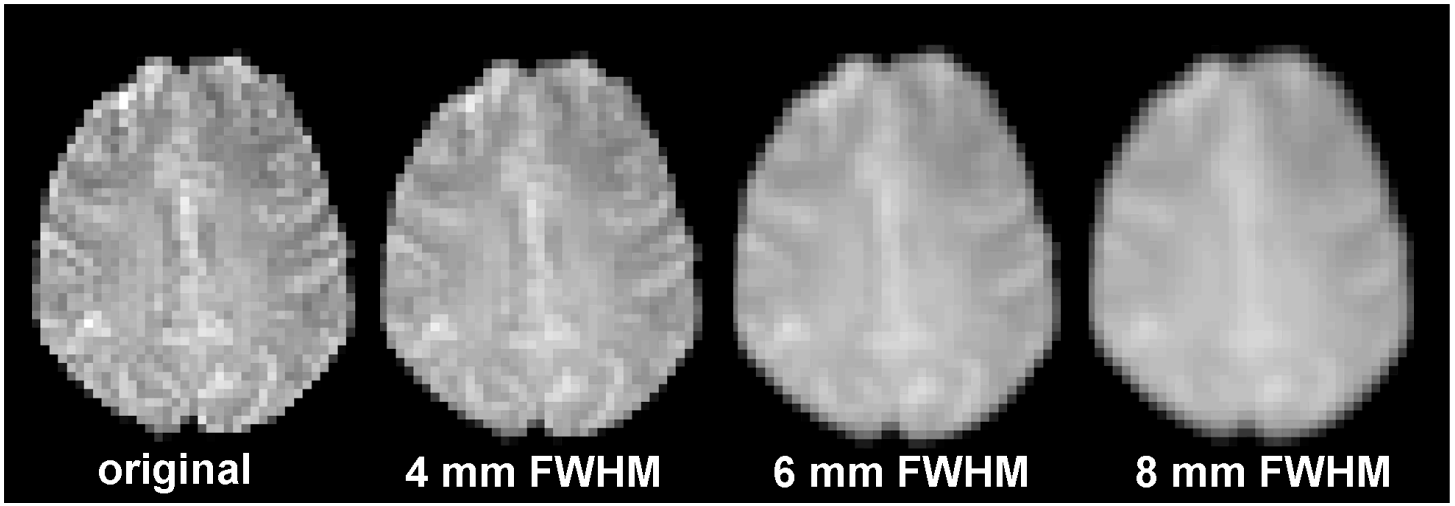
663	507	89
520	119	171
137	179	117

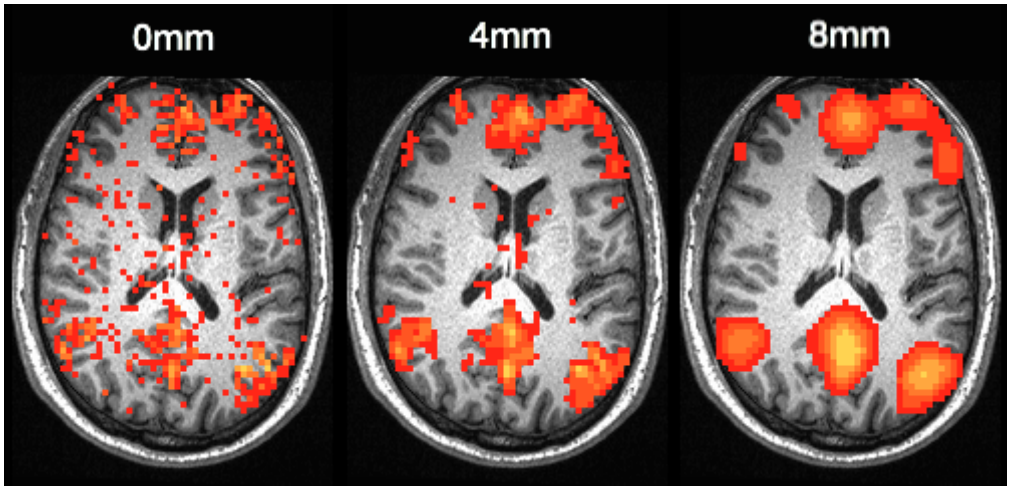


Preprocessing
Normalization (only when averaging)



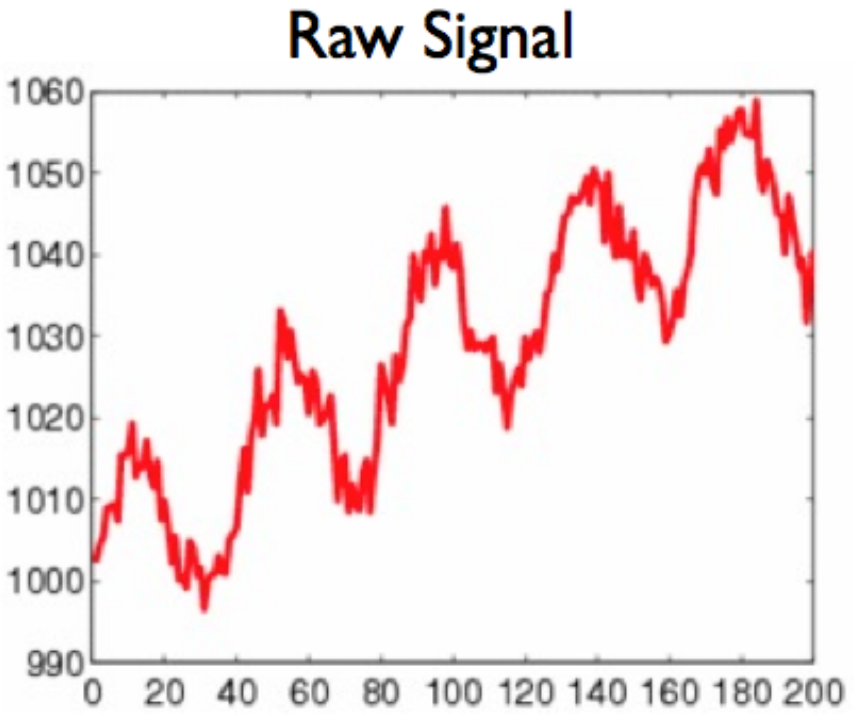
Preprocessing
Spatial Smoothing

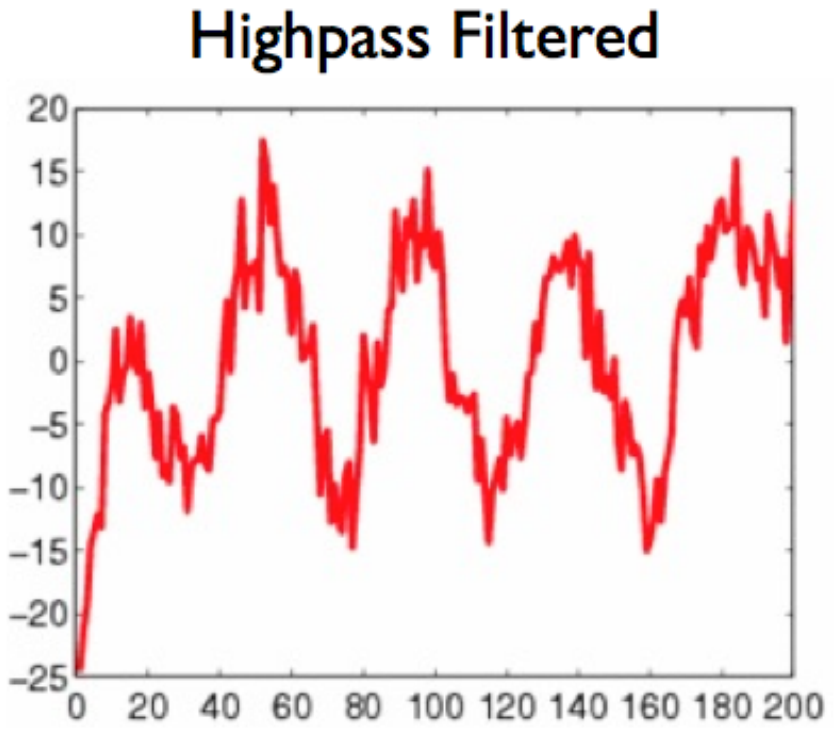




- + average activity within a large region
- + removing noise
- + averaging
- - subtle effects
- - pattern of activity

Preprocessing
Temporal Filtering





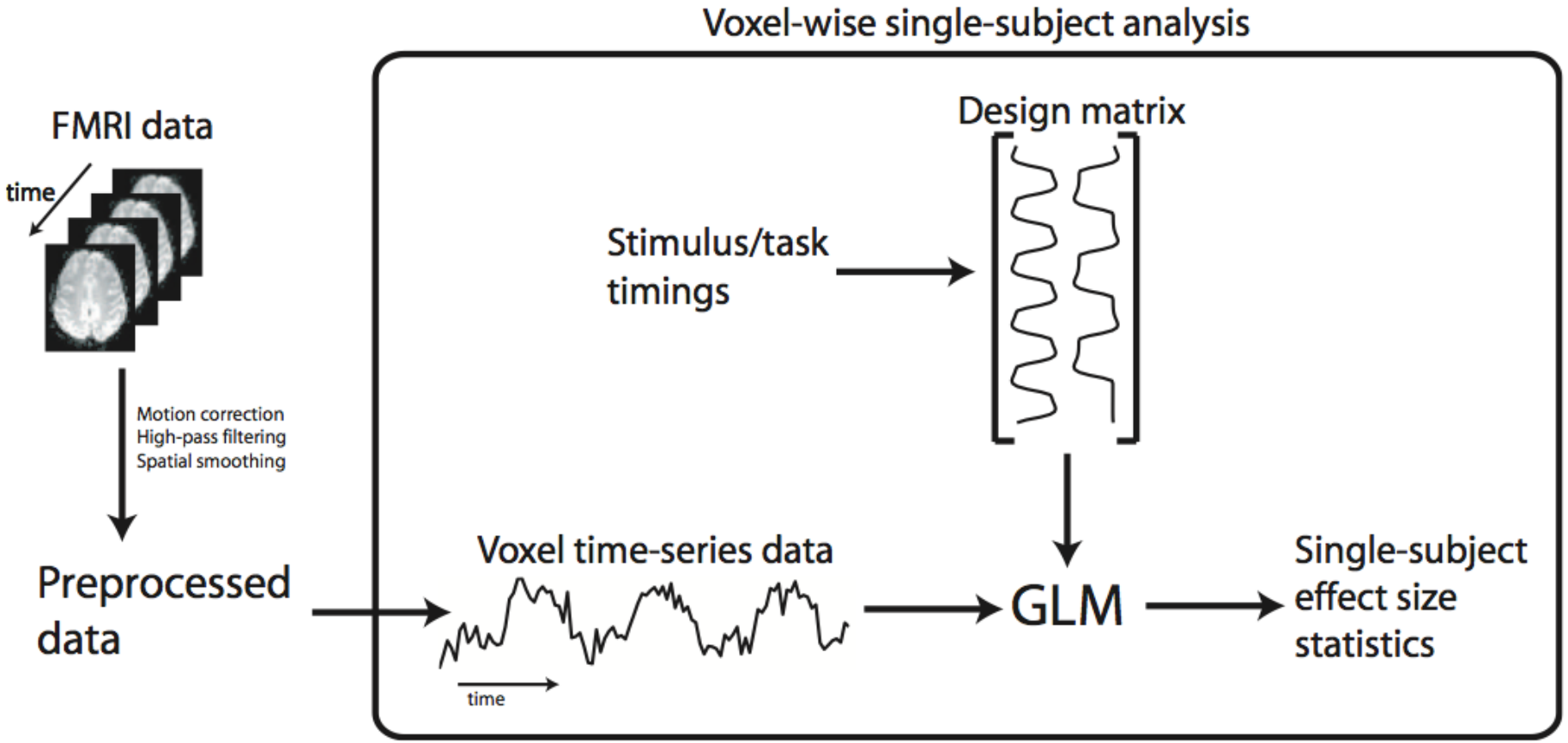
Removes low frequency signals – including linear drift

Slides: FSL

fMRI Methods Step-by-Step

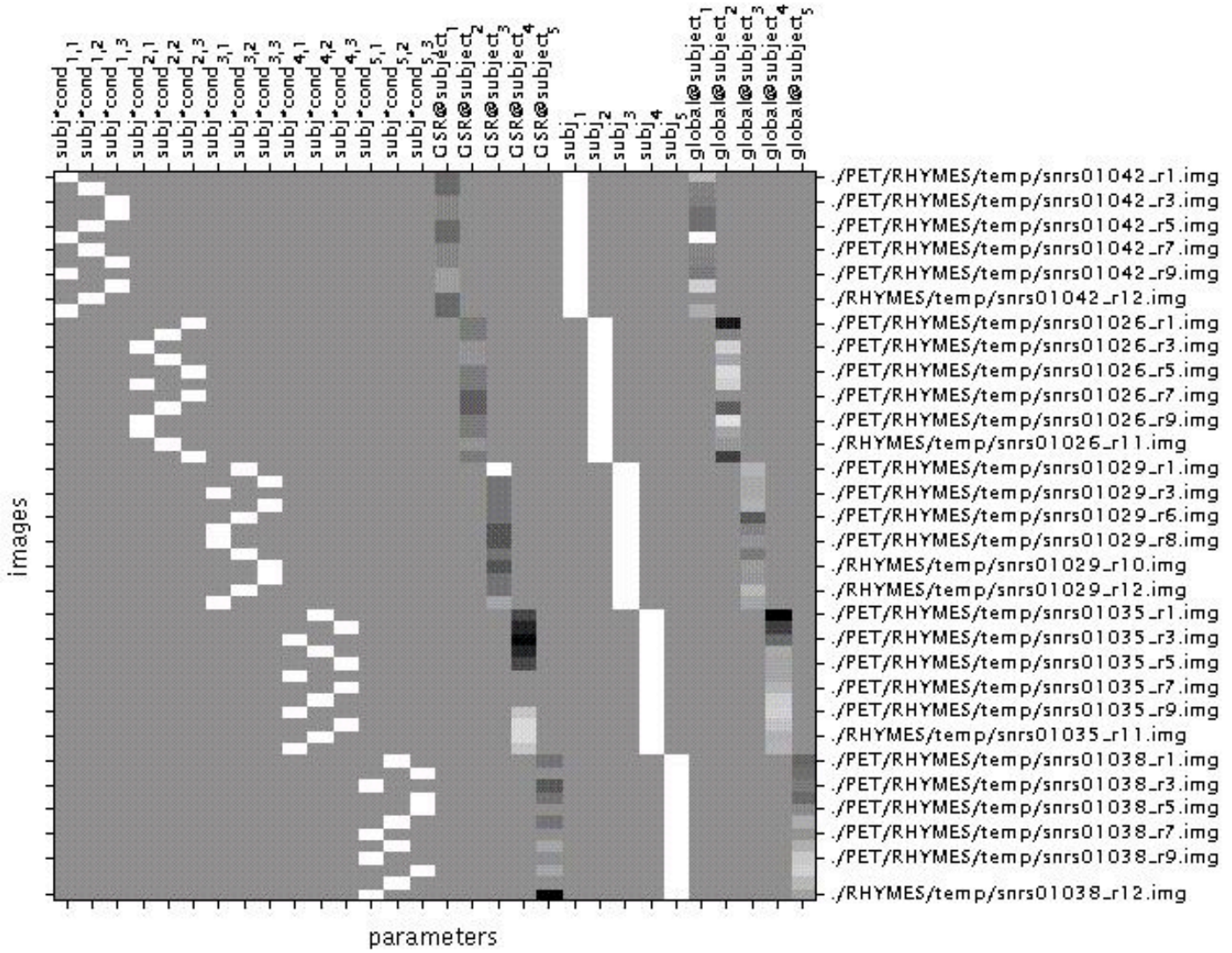
1. Design ✓
2. Collect Data ✓
3. Preprocess data analysis ✓
   a. Convert/Reconstruction
   b. Slice timing correction
   c. Motion correction
   d. Normalization *(not for NEIL data)*
   e. Spatial smoothing *(not for NEIL data)*
   f. Temporal Filtering
4. Individual data analysis
   a. Model/Contrasts
   b. ROI analysis
   c. Extract Data
5. Average?

Individual data analysis



Slides: FSL

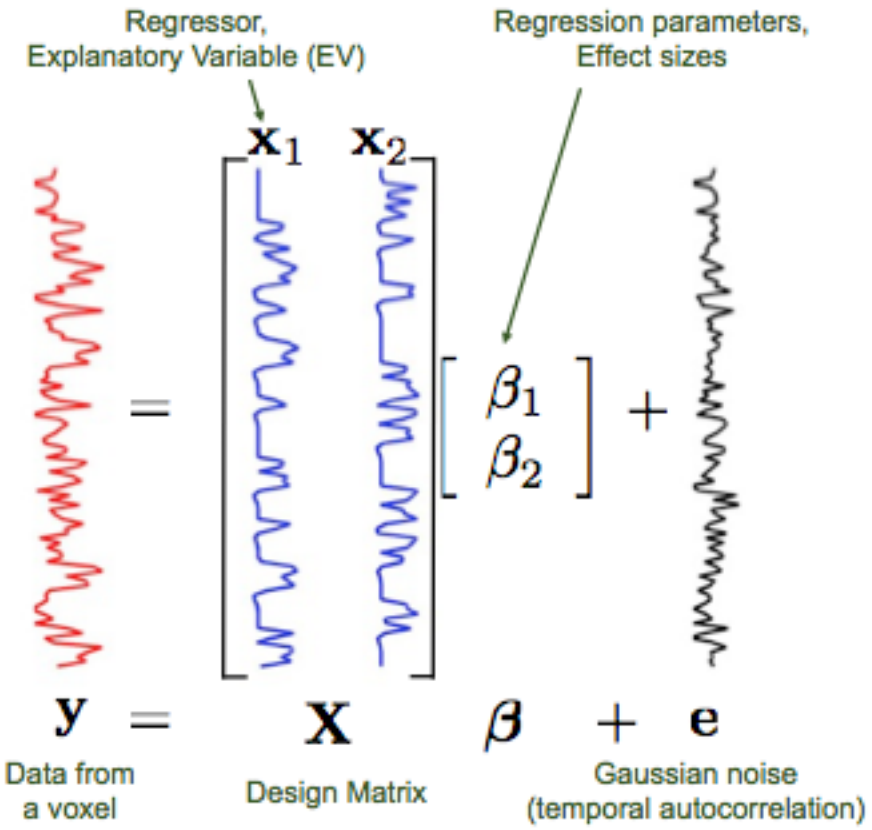
Individual data analysis



Individual data analysis

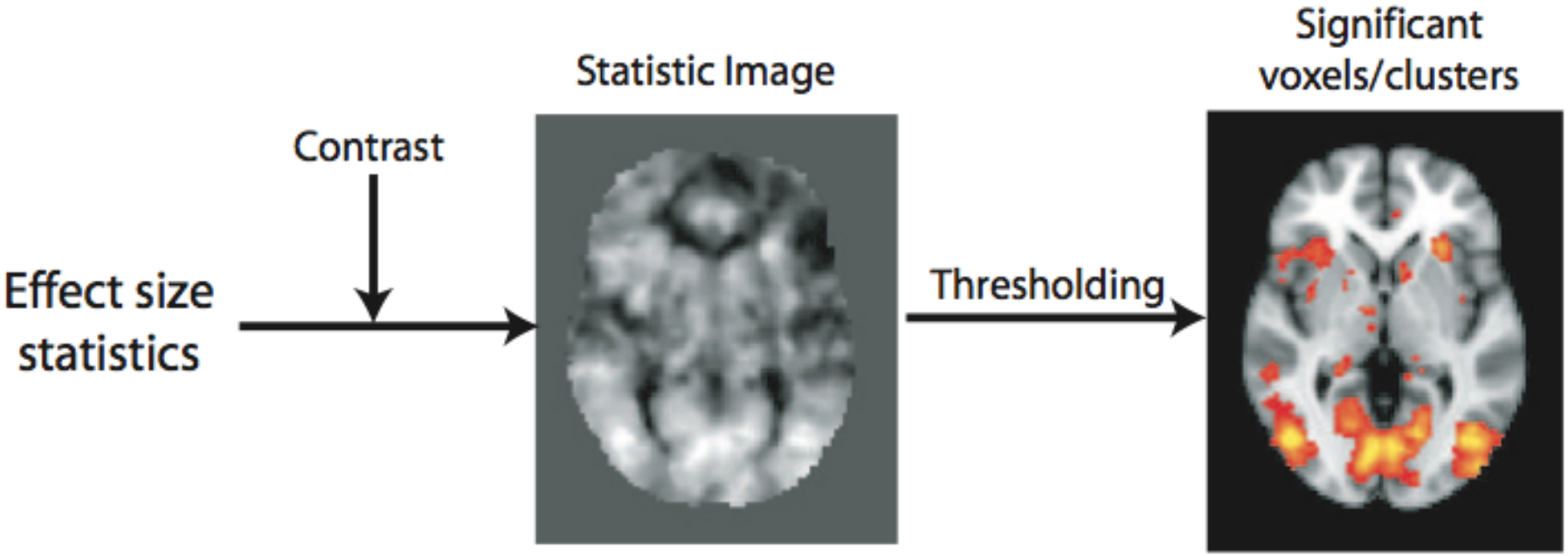
General Linear Model (GLM)

This is placed into the General Linear Model (GLM) framework



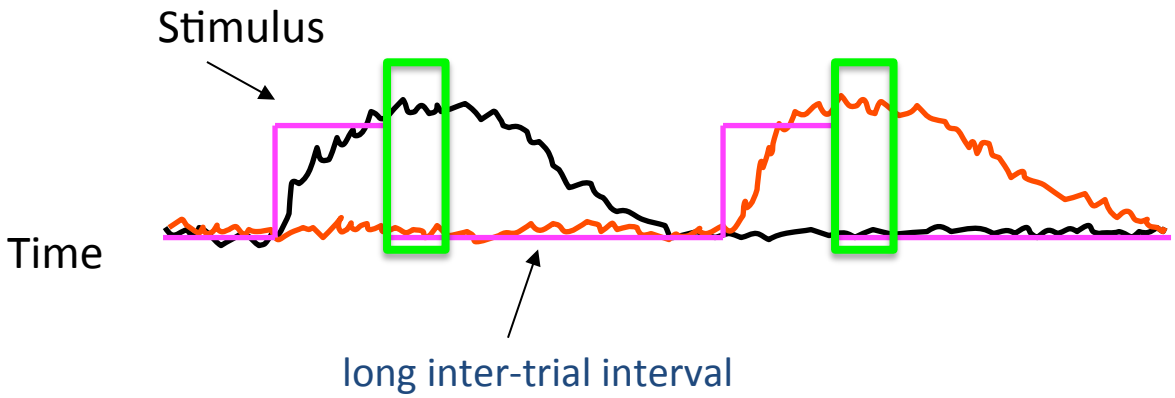
Slides: FSL

Individual data analysis



Slides: FSL

Individual data analysis
NEIL Data does not use a GLM



100 Scenes presented 6 times

- Apply scene onsets for all data
- Extract data from peak time points
- Average across trials/sessions

fMRI Methods Step-by-Step

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   a. Convert/Reconstruction
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4. Individual data analysis
   a. Model/Contrasts ✓
   b. ROI analysis
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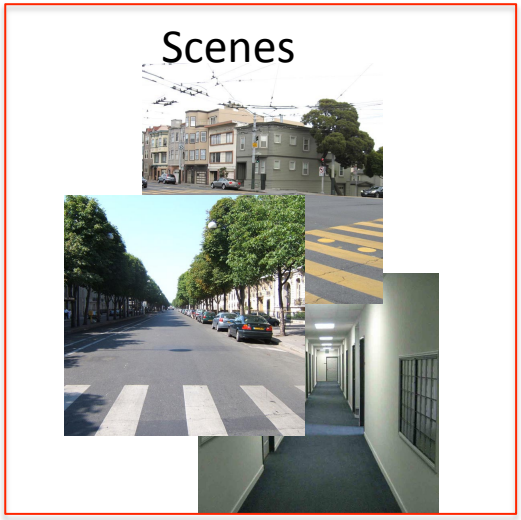
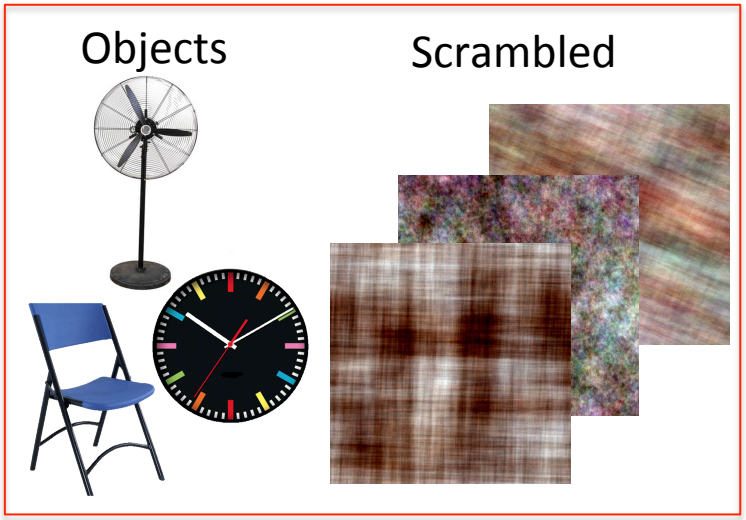
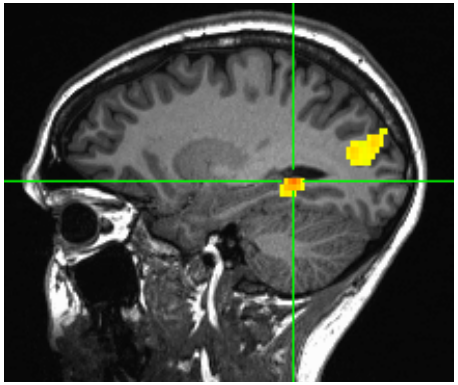
Individual data analysis
Functional Localizer



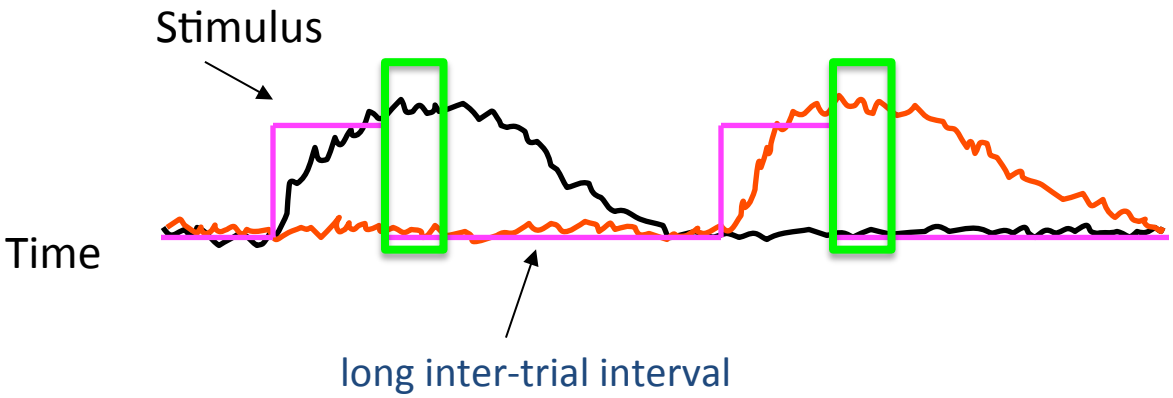


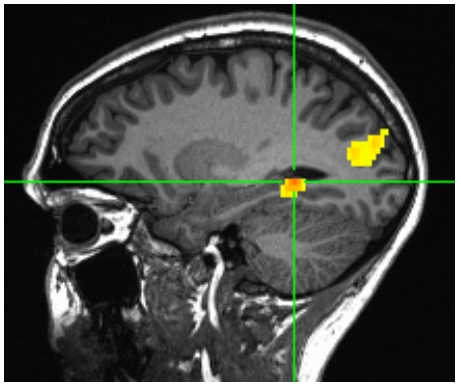
GLM for this data (block design)

- Canonical HRF
- Parameter estimates for each condition
- T contrast
- Define regions of interest (ROI)



Individual data analysis





DATA!

fMRI Methods Step-by-Step

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   a. Convert/Reconstruction
   b. Slice timing correction
   c. Motion correction
   d. Normalization *(not for NEIL data)*
   e. Spatial smoothing *(not for NEIL data)*
   f. Temporal Filtering
4. Individual data analysis ✓
   a. Model/Contrasts
   b. ROI analysis
   c. Extract Data
5. Average? (whole brain, ROI)
6. More stats on data