SPM8 for Basic and Clinical Investigators

Functional MRI Data Acquisition: Temporal

fMRI Acquisition: Temporal Effects

- Session length
- Repetition time
- Fixed vs. distributed temporal sampling
- Sparse temporal sampling
- Noise source recording
- Prospective motion correction

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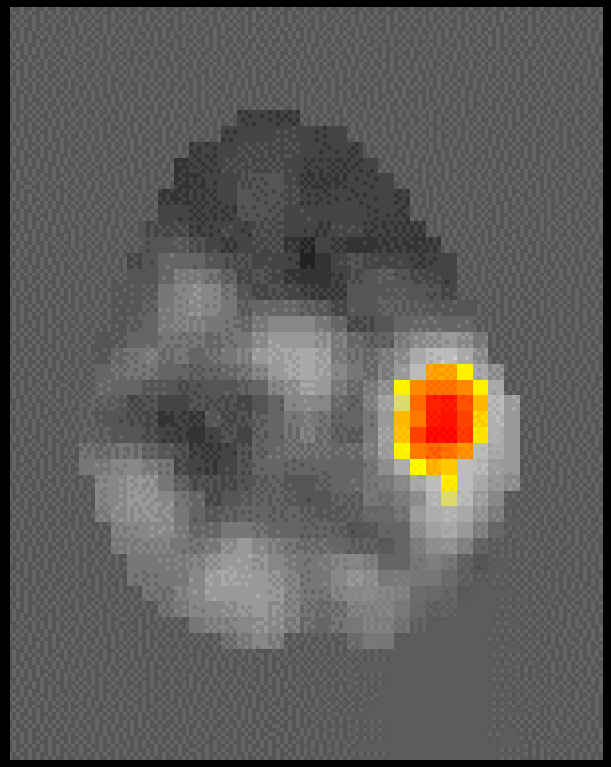


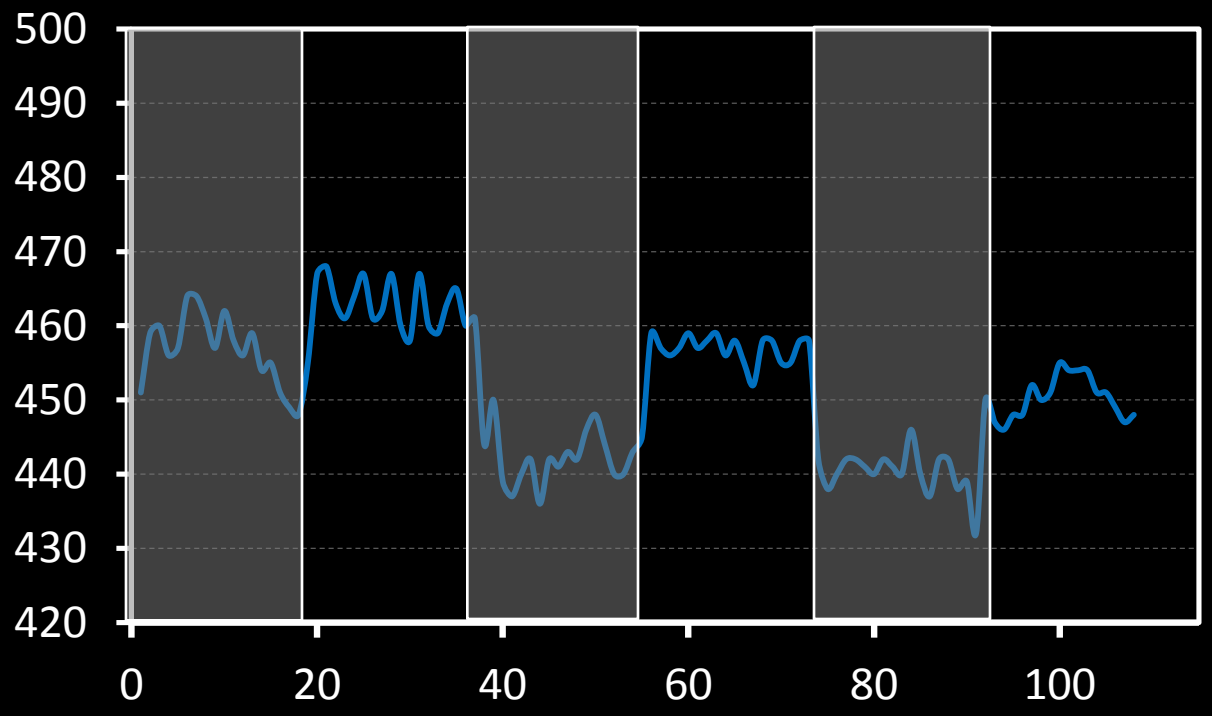
Fixation

Thumb movement

time →

Effect Size

mean (Move) - mean (Rest) / std dev (Rest/Move)



Rest Move Rest Move Rest Move

Methods of Calculating the Standardized Mean Difference (Effect Size)

Direction Calculation Method

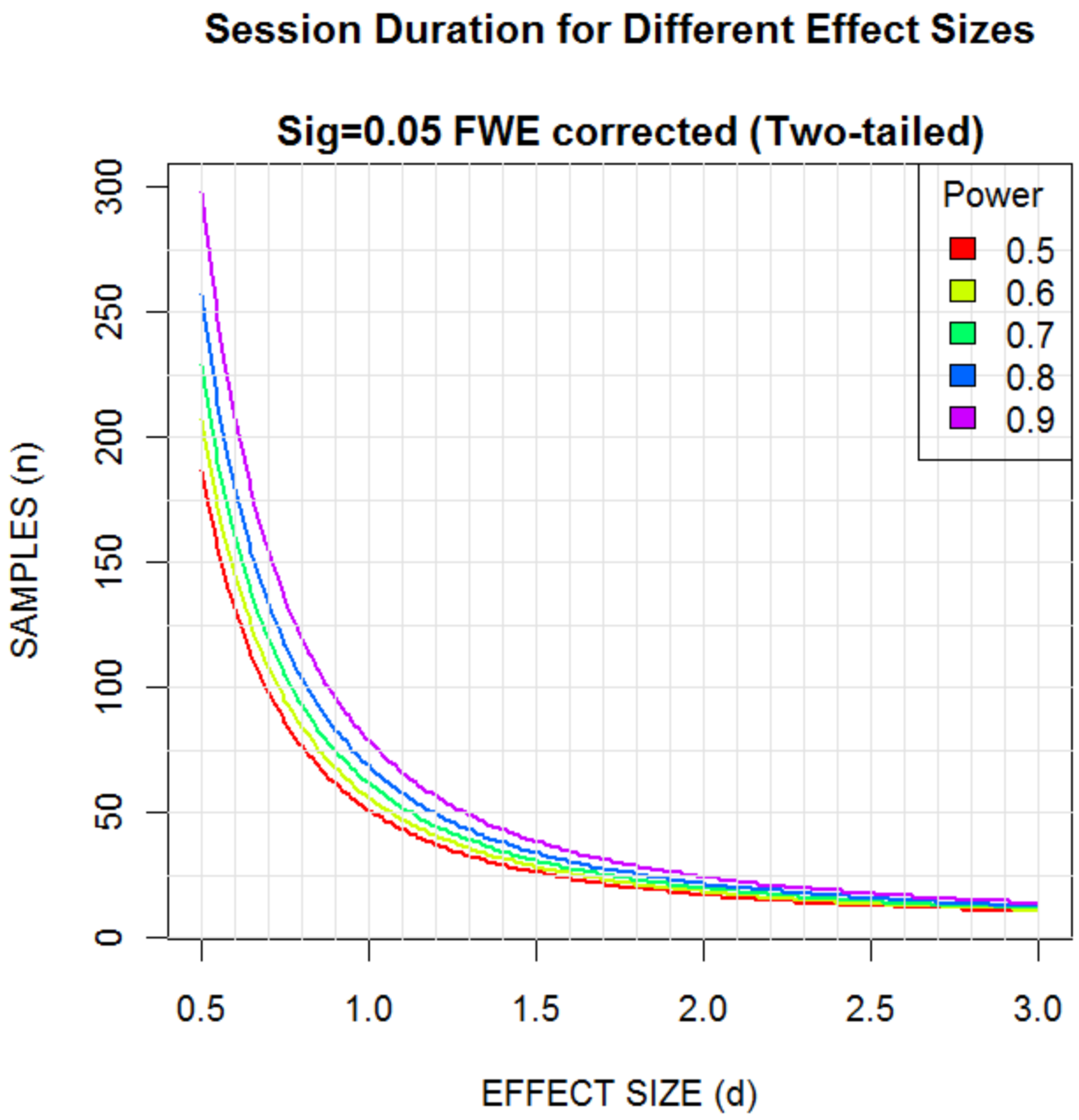
$$ES = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{n_1 + n_2 - 2}}} = \frac{\overline{X}_1 - \overline{X}_2}{s_{pooled}}$$

Methods of Calculating the Standardized Mean Difference (Effect Size)

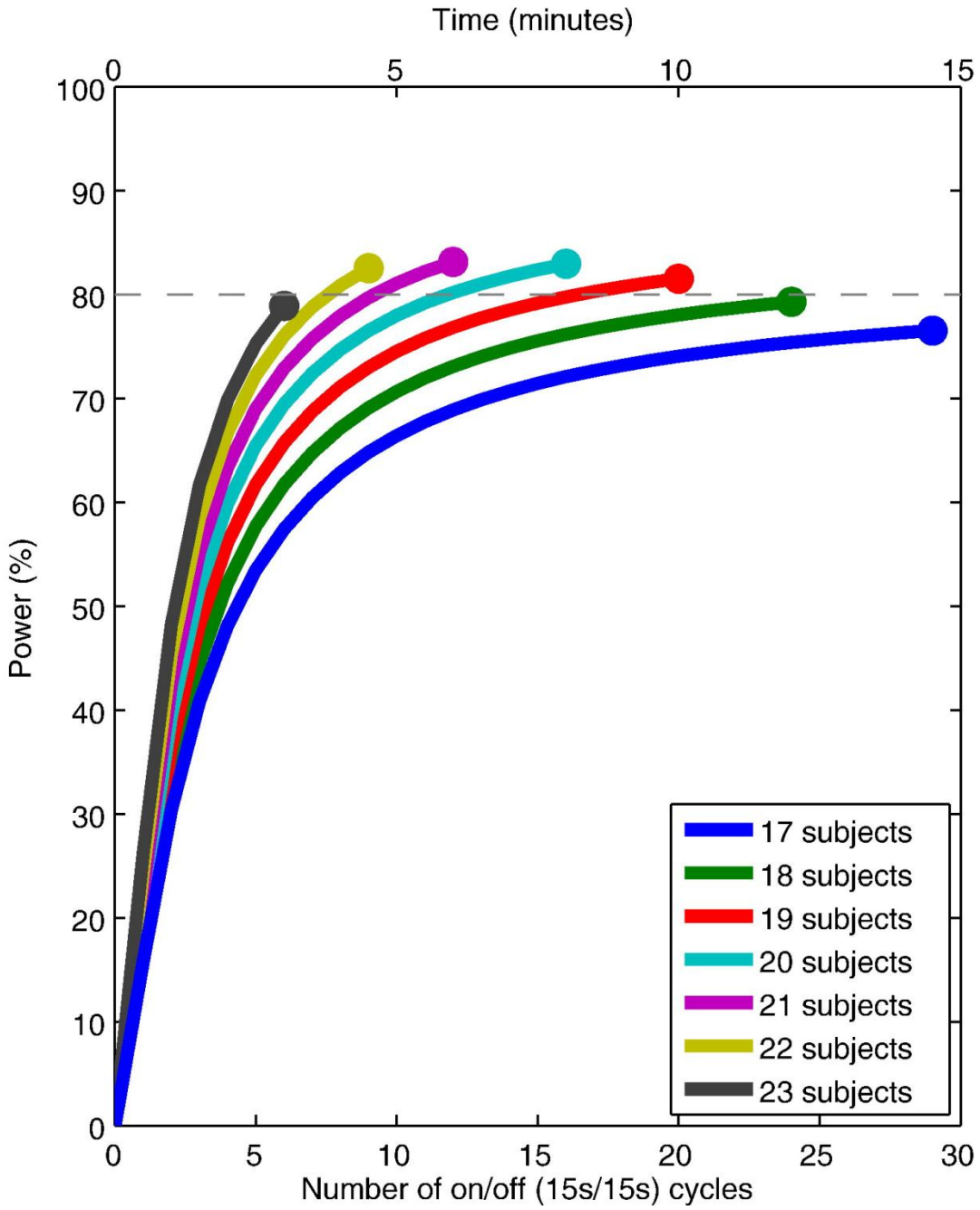
Algebraically Equivalent Formulas:

$$ES = t\sqrt{\frac{n_1 + n_2}{n_1 n_2}}$$ independent t-test

$$ES = \sqrt{\frac{F(n_1 + n_2)}{n_1 n_2}}$$ two-group one-way ANOVA



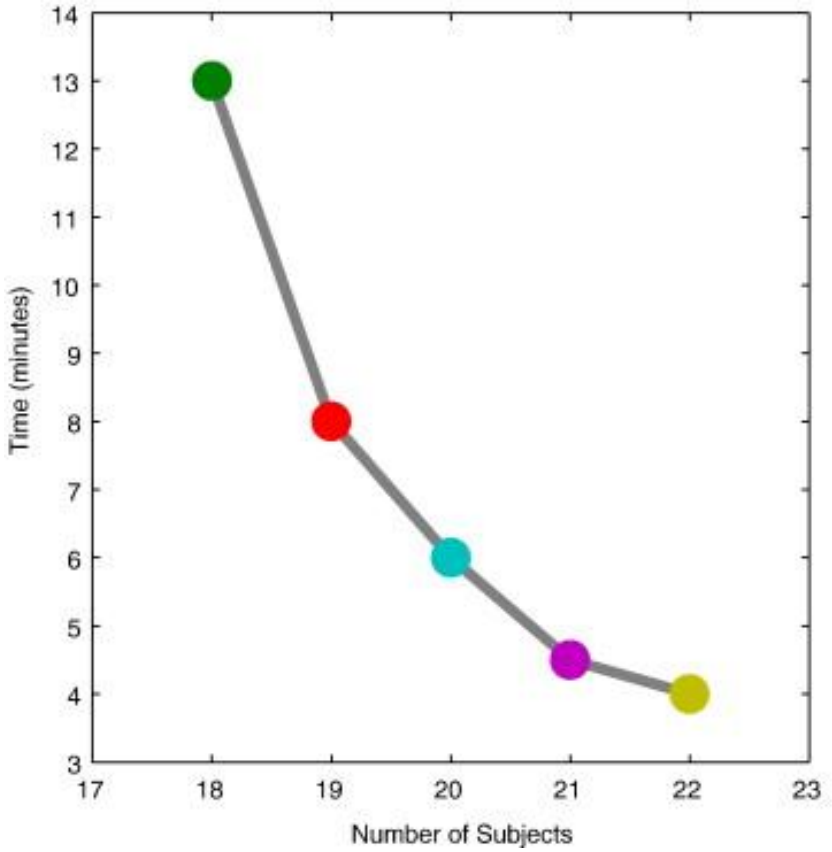
Individual Detection Sensitivity Increases with Session Length

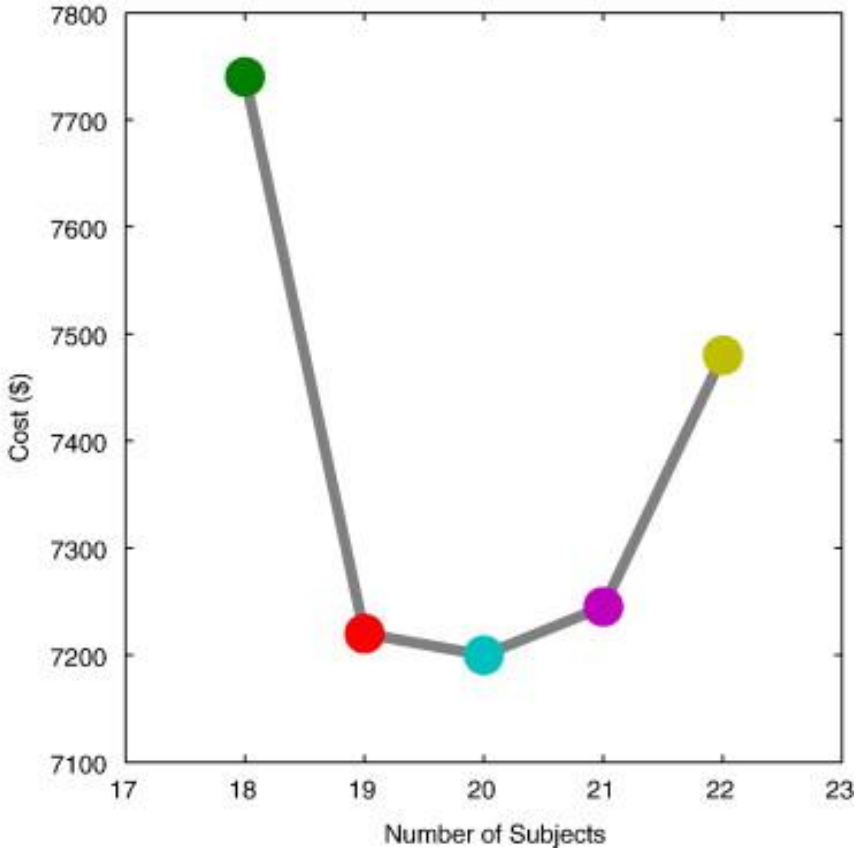


Group Detection Sensitivity Increases with Sample Size

Mumford and Nichols, Neuroimage (2008)

Study Cost and Detection Sensitivity





Mumford and Nichols, Neuroimage (2008)

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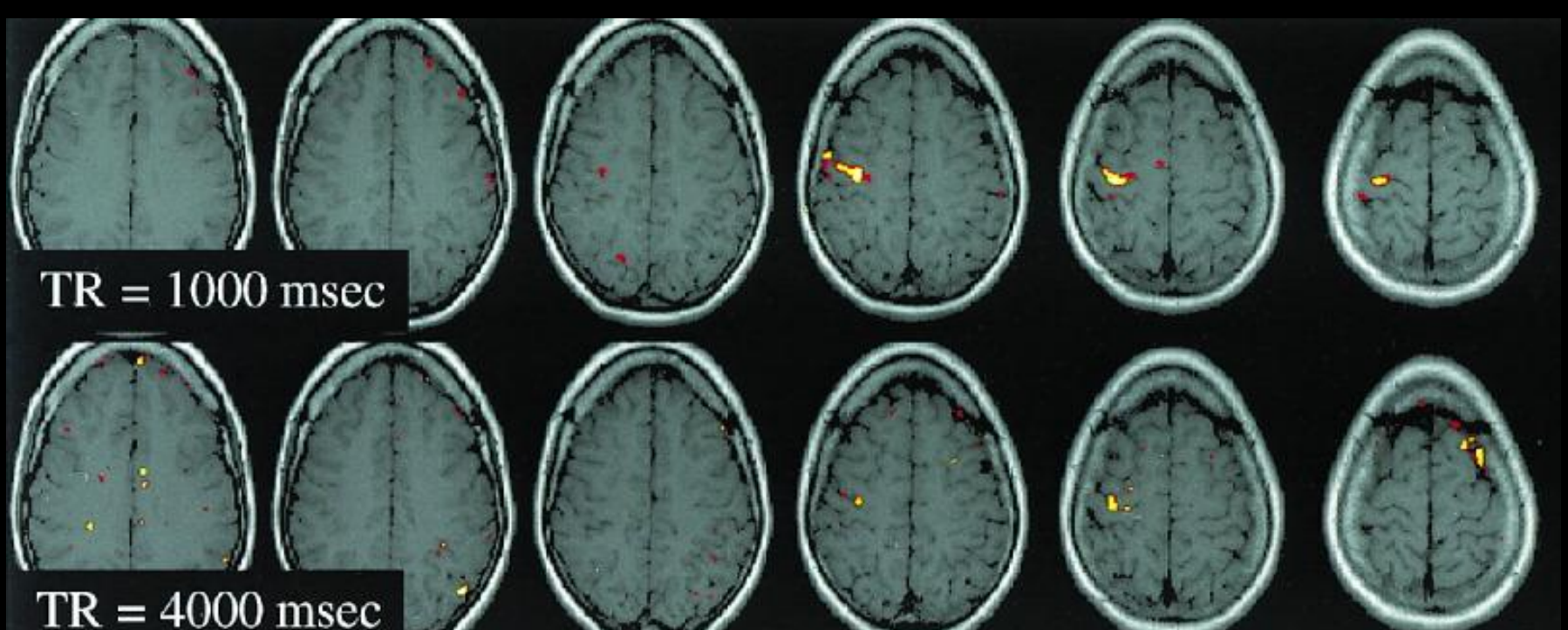
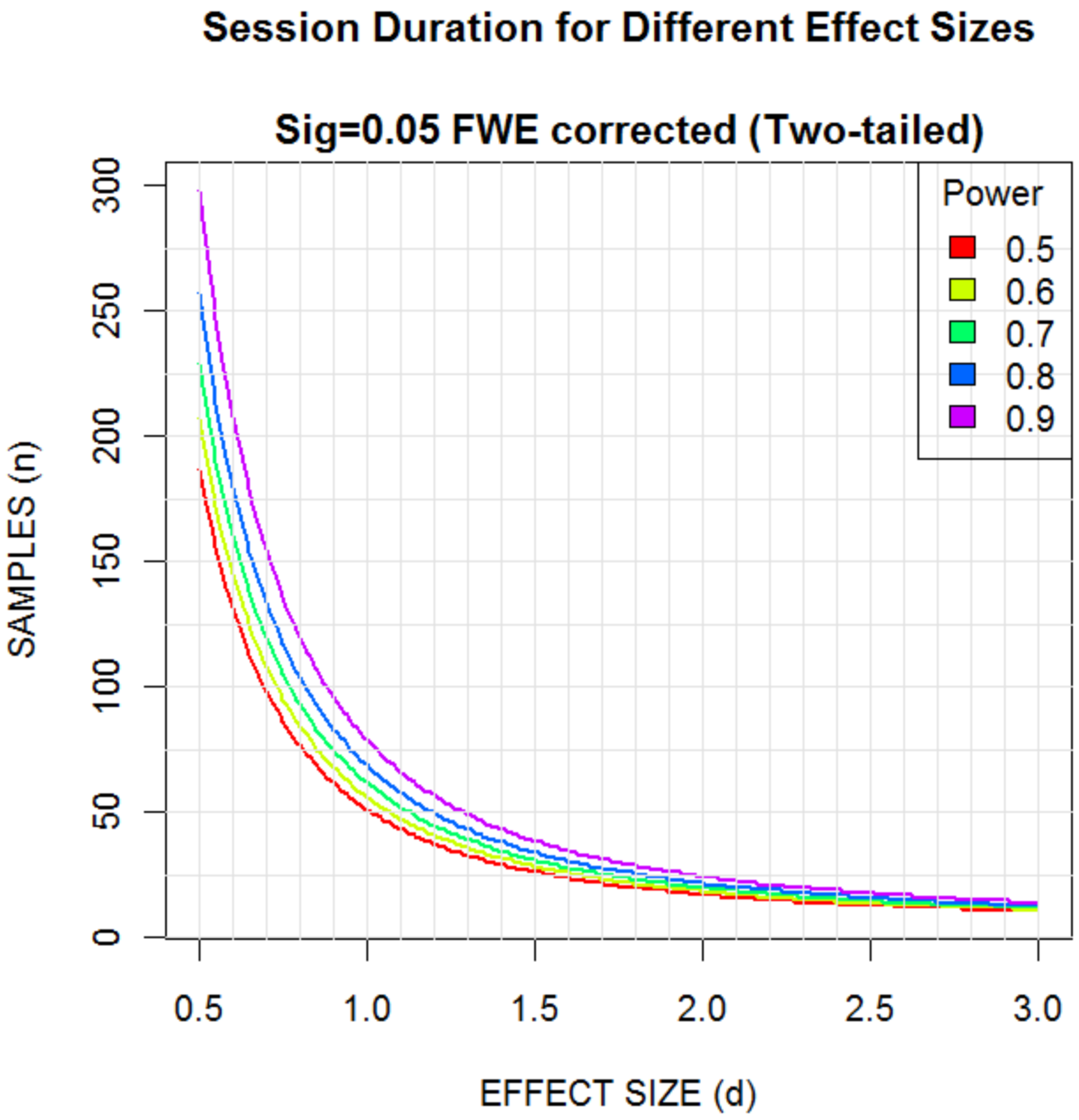
A Short Repetition Time Increases Sensitivity



Fera et al., MRM (2003)



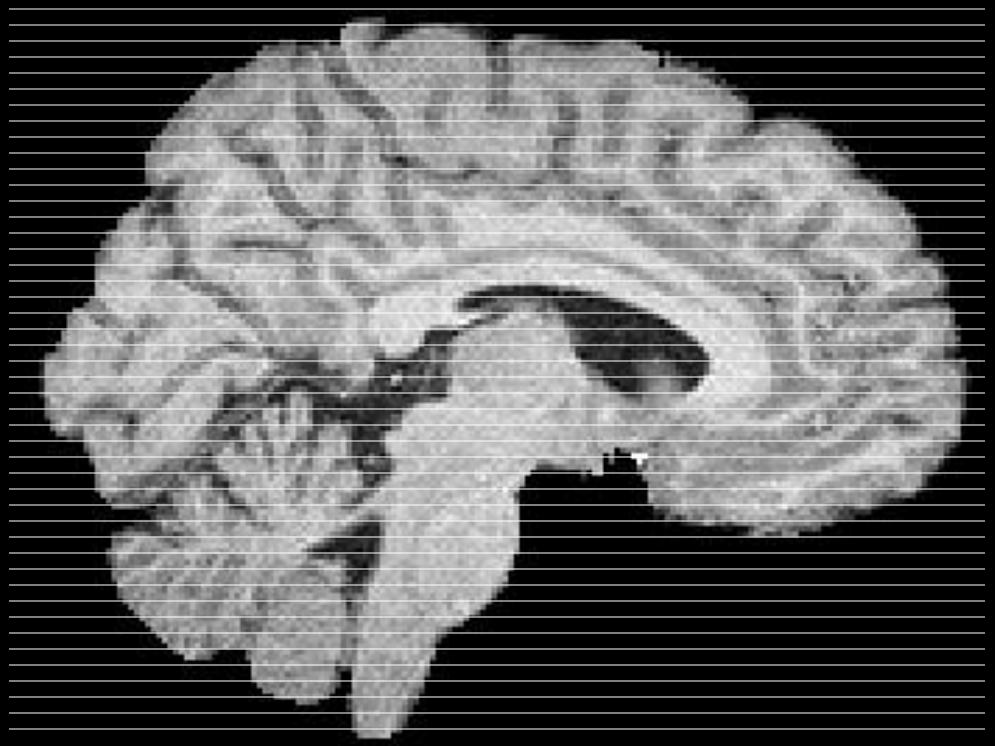
- For a given effect size, sensitivity increases with the number of time points

- Assuming fixed session length, a shorter TR will result in higher sensitivity

- Example assumes no temporal autocorrelation

Optimal Repetition Time Selection

- Make the TR as short as possible given the constraints of voxel size and overall spatial coverage



- Make certain that the TR is NOT an even multiple of the task timing!

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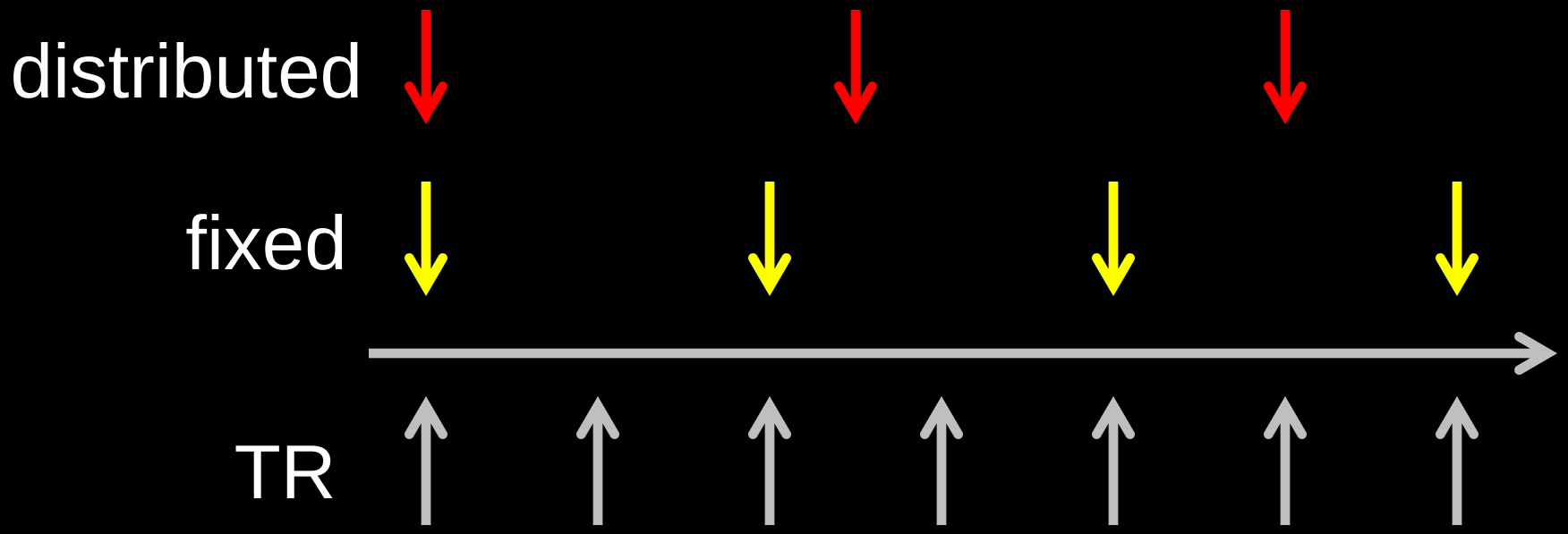
Distributed Temporal Sampling



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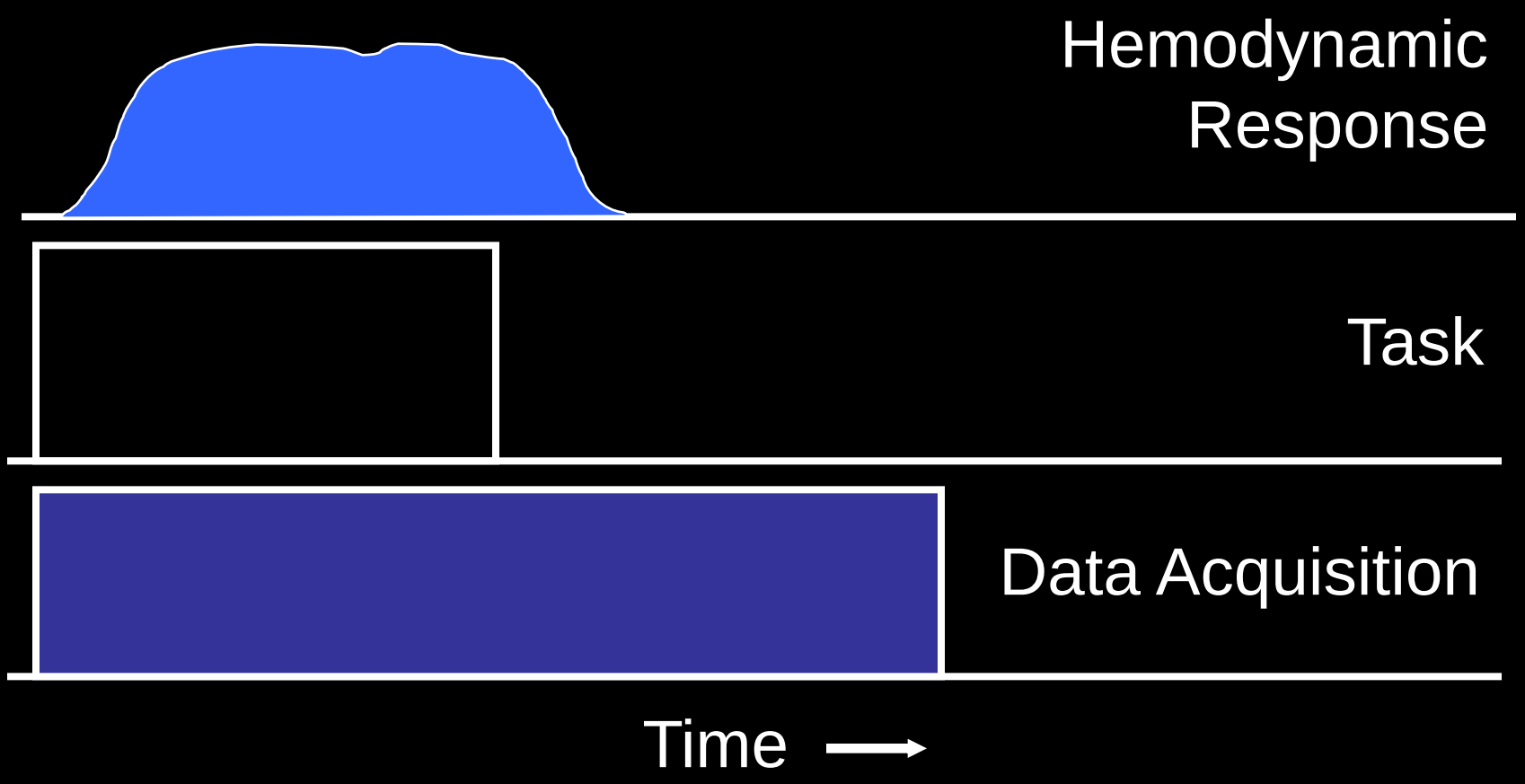
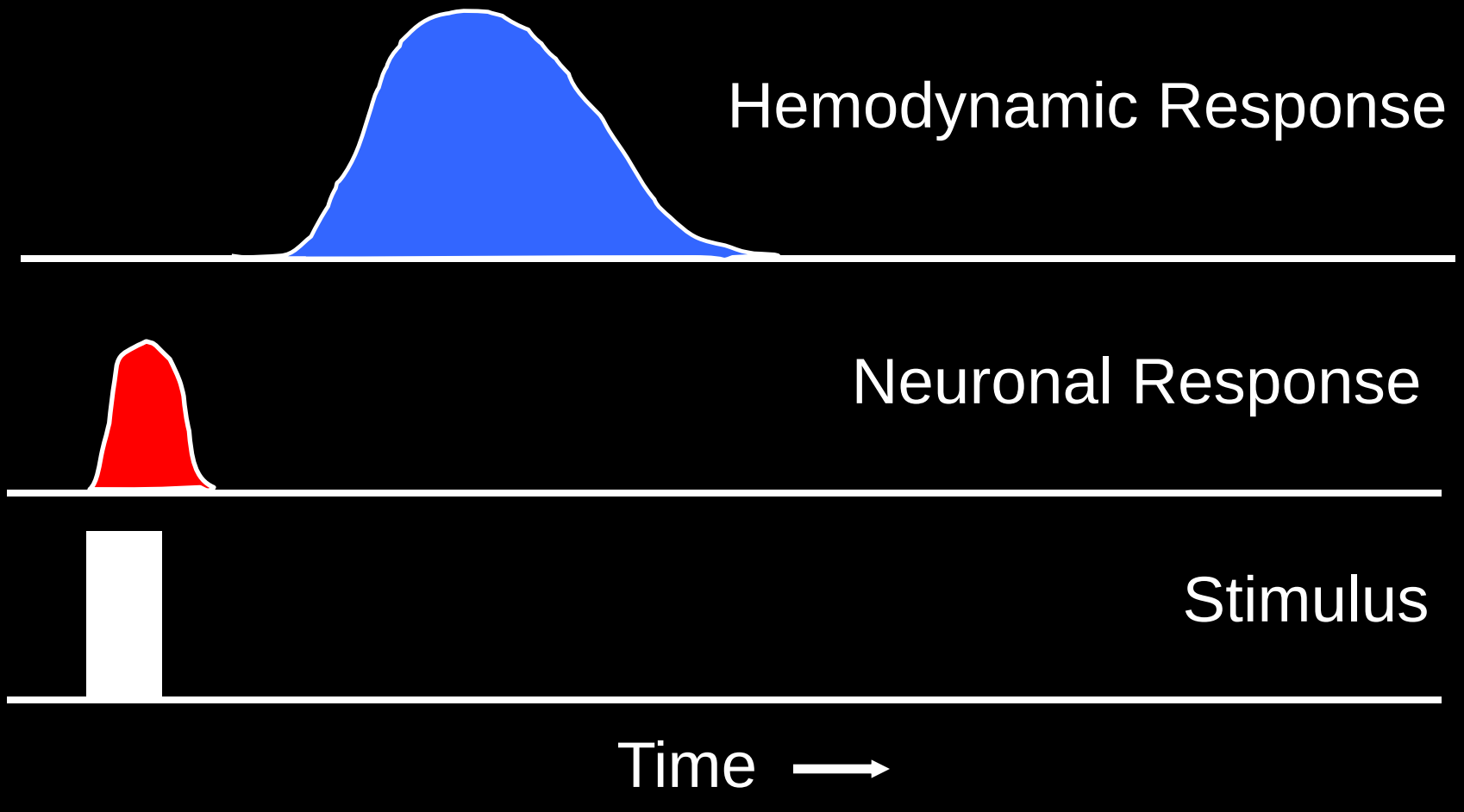
Sparse Temporal Sampling Reduces:

- Unintended auditory system stimulation
- Auditory stimulus masking
- Task interference
- Susceptibility artifacts from jaw movement

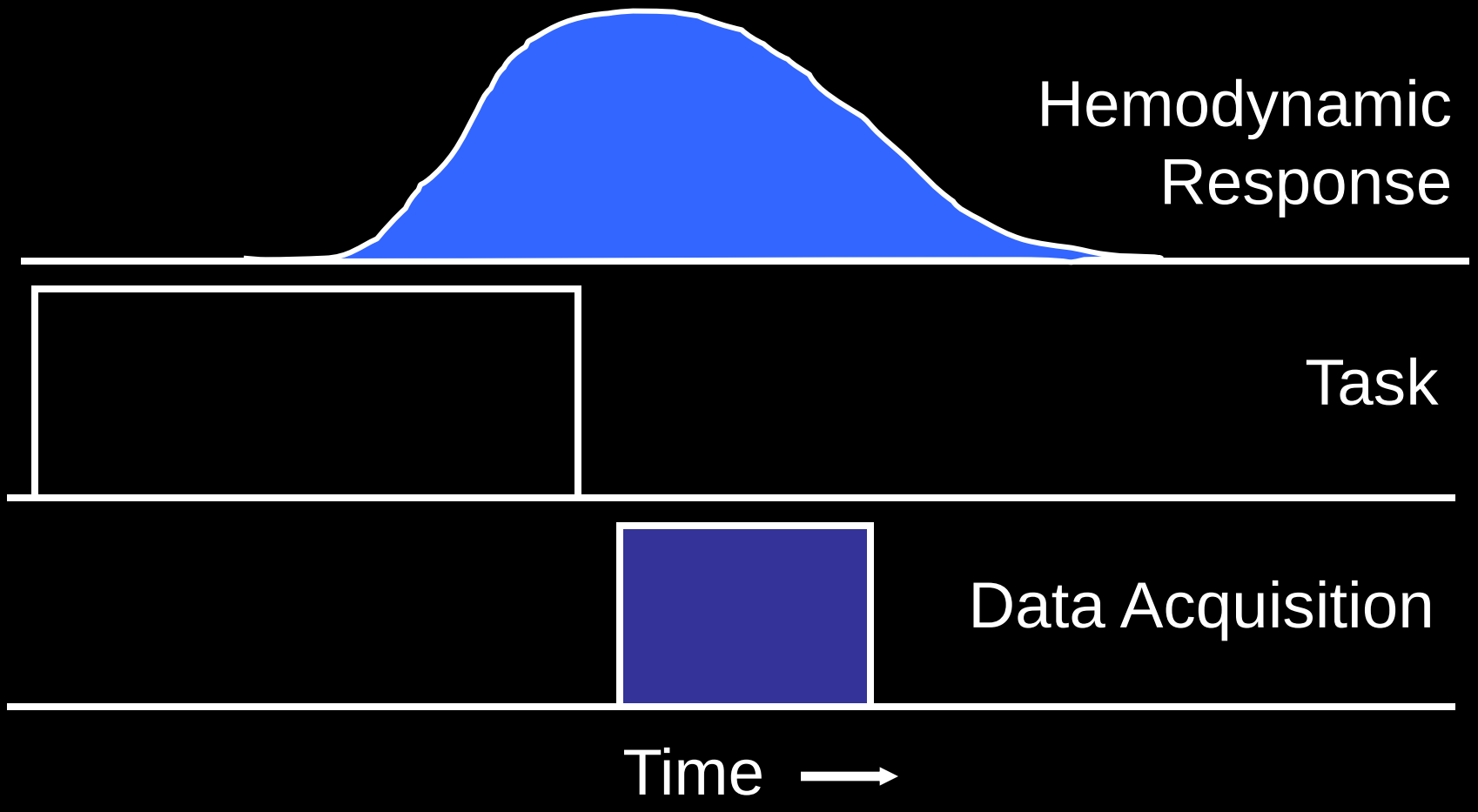
Data Acquisition Concurrent with Task



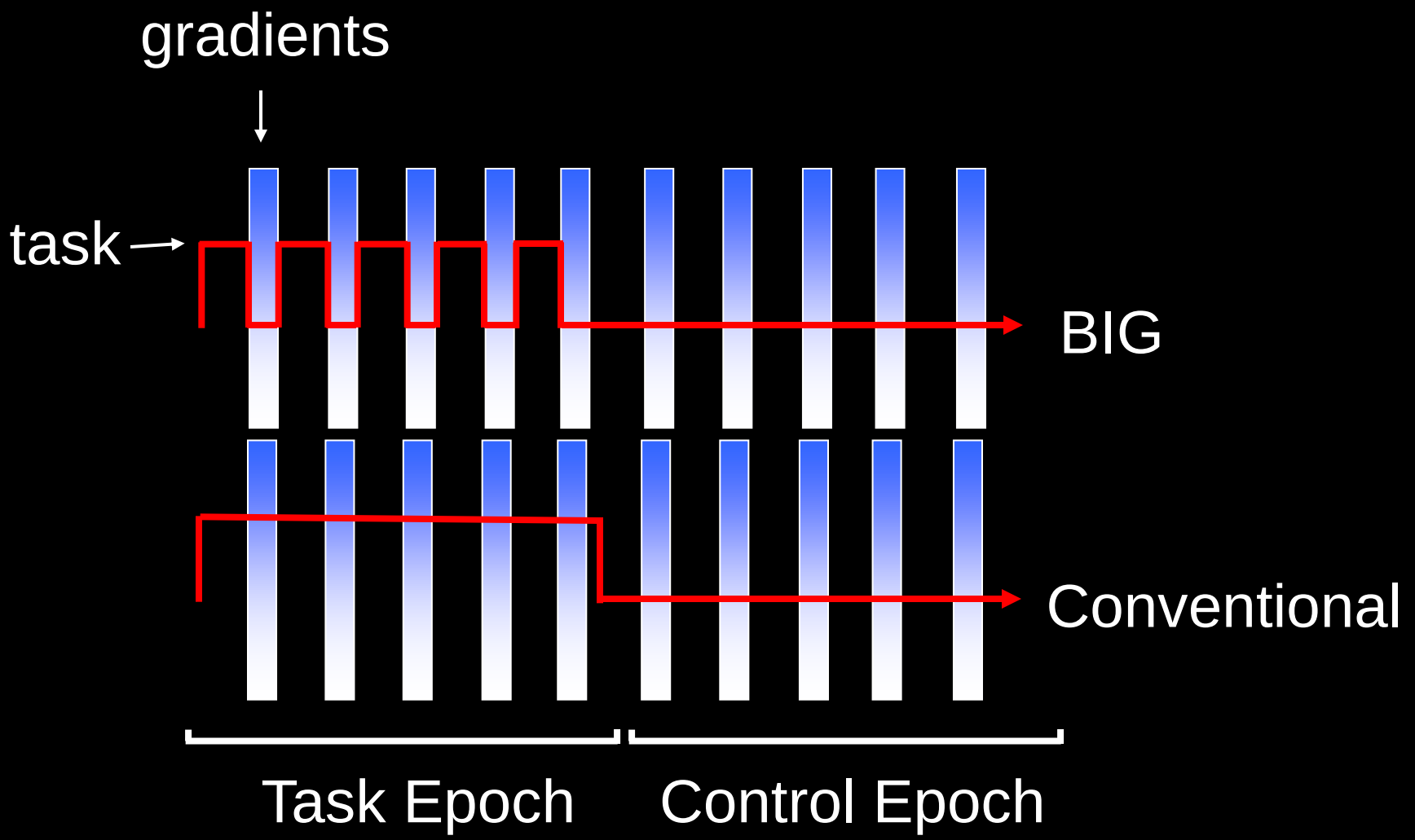
Hemodynamic Delay and Dispersion

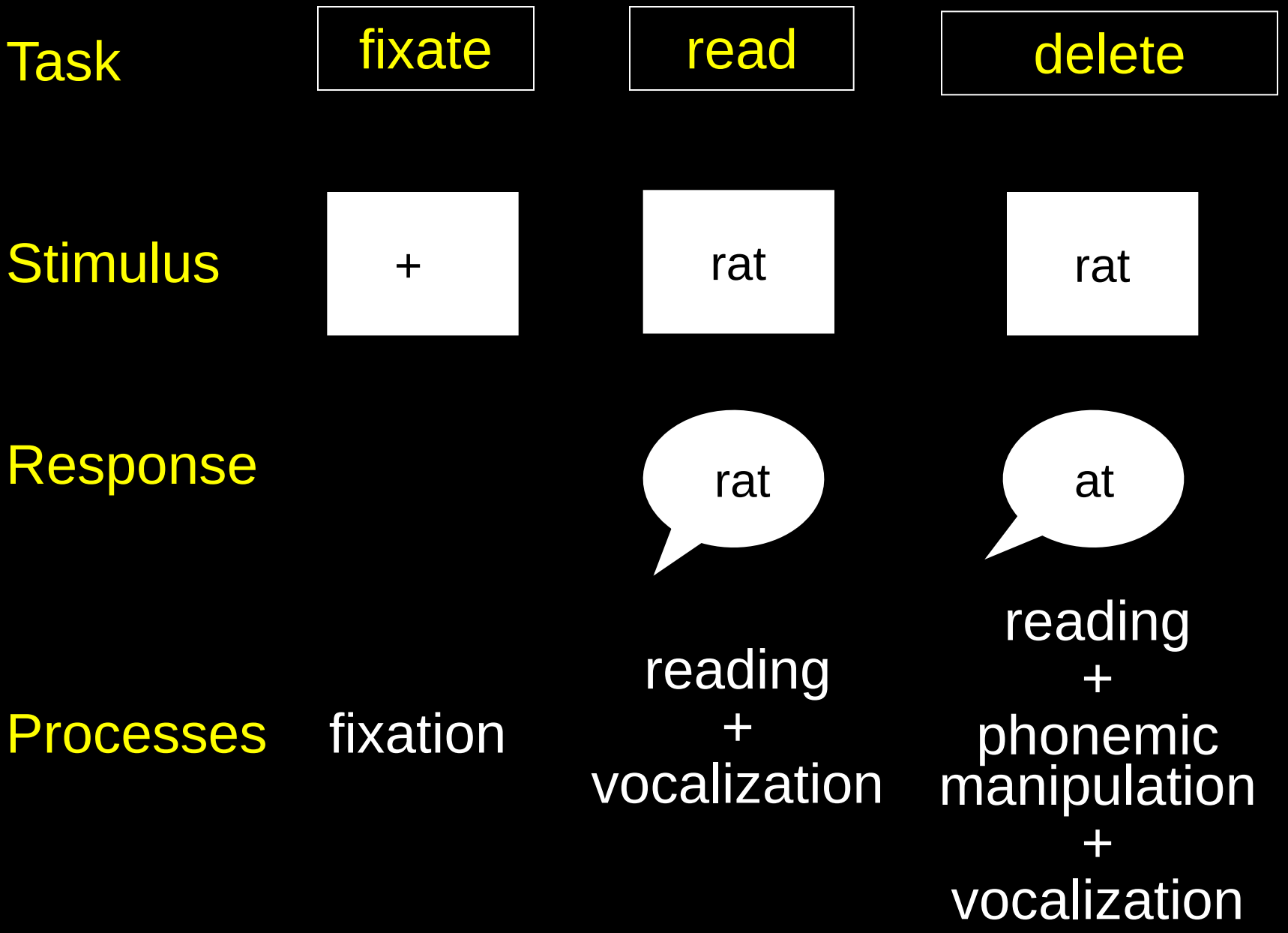


Data Acquisition After Task Completion



Behavior Interleaved Gradients

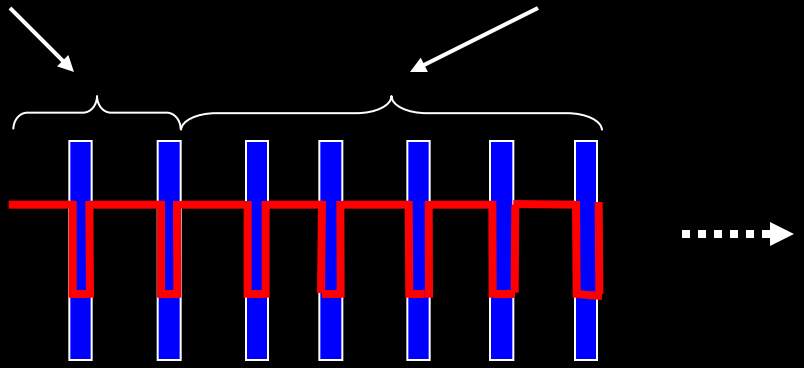



Task
fixate
read
delete
Stimulus
+
rat
rat
Response
rat
at
Processes
fixation
reading
+
vocalization
reading
+
phonemic
manipulation
+
vocalization

Interleaved Image Data Acquisition

fixate
(2 volumes)

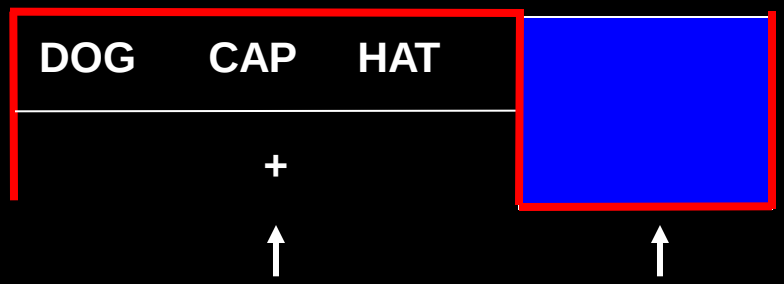
read or delete
(5 volumes)



total of 62
volumes

words

fixation

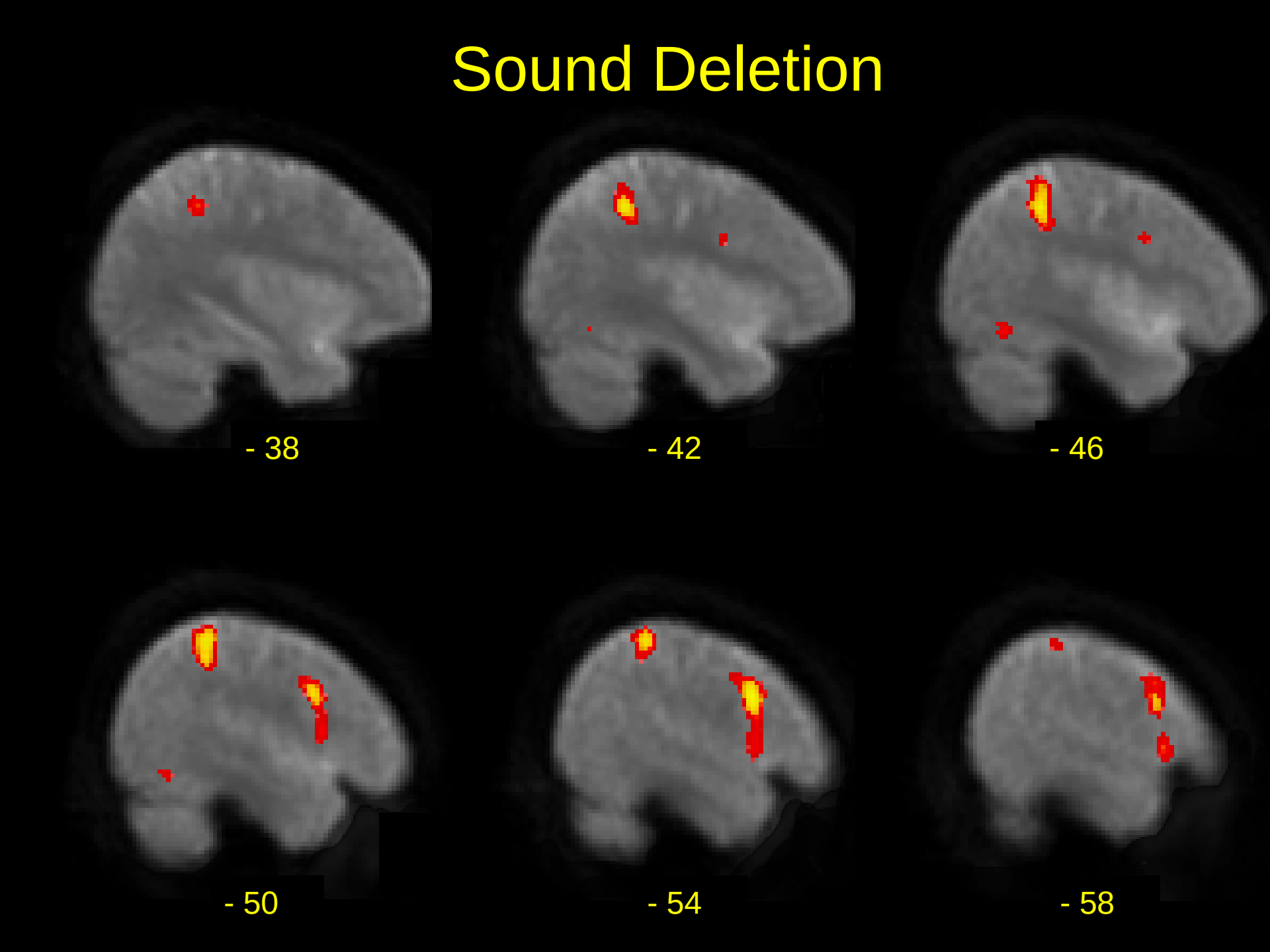


task
9 sec

rest
4 sec

19-34 group

Sound Deletion



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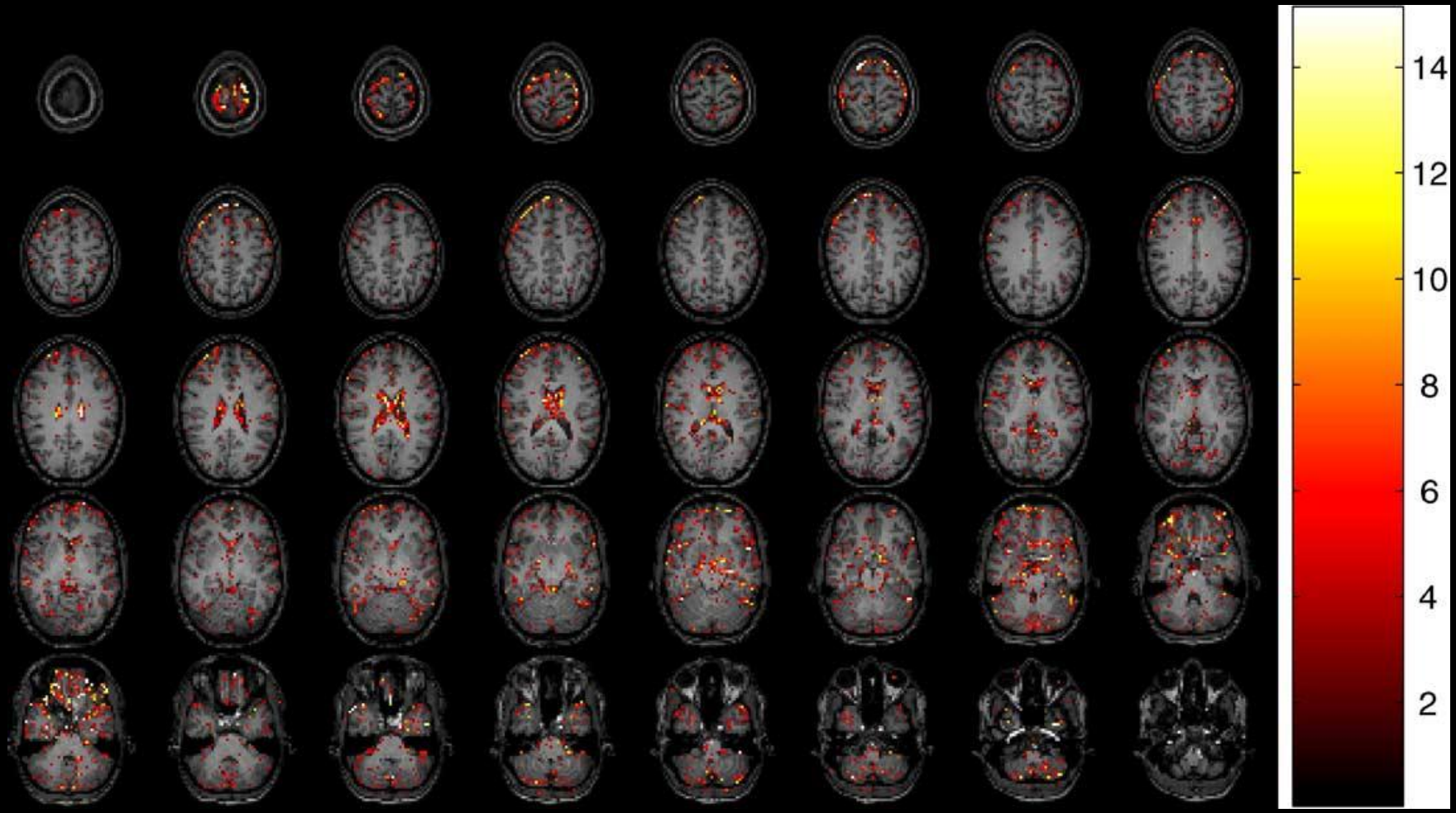
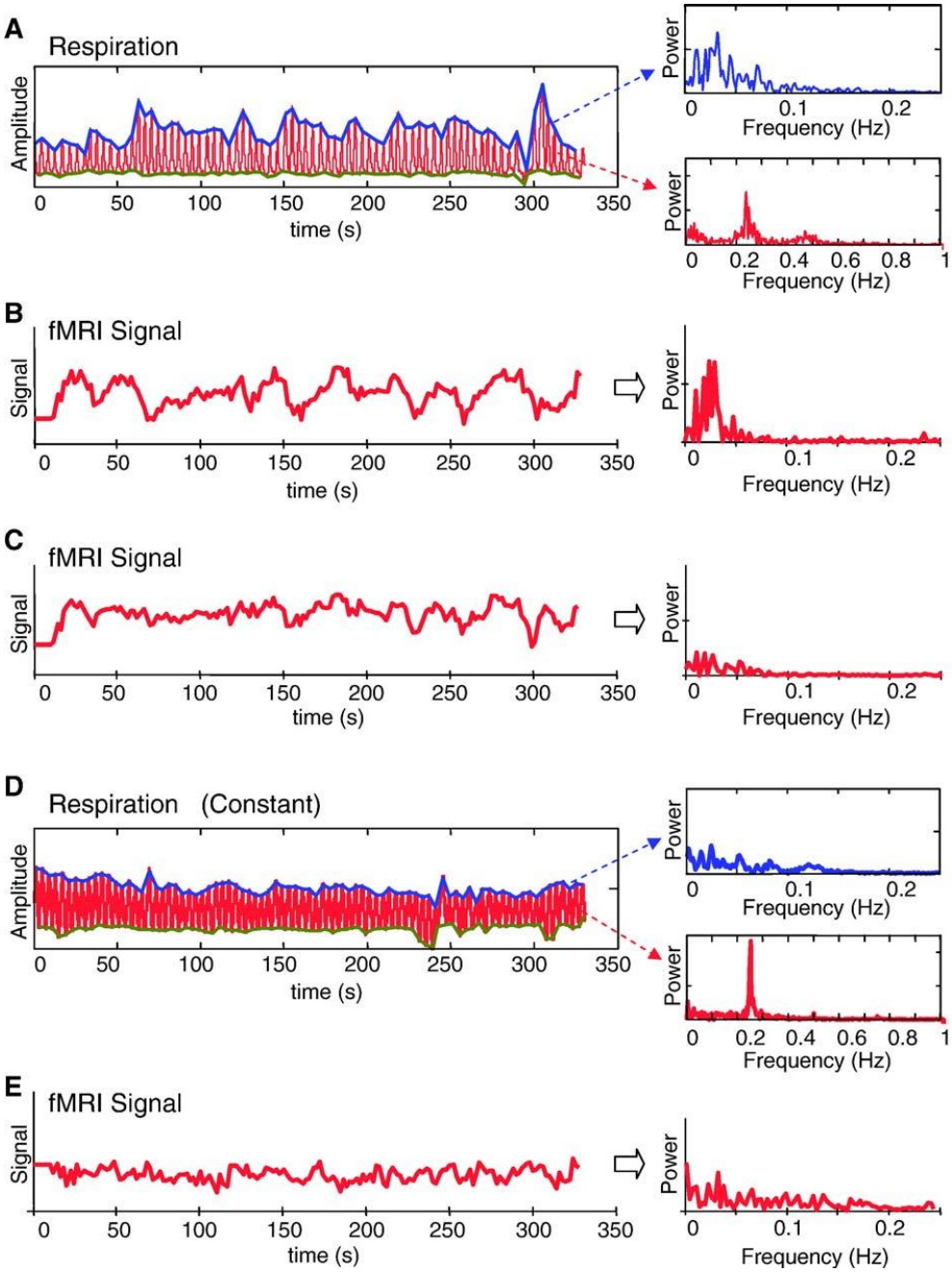
Respiration Modulates BOLD Contrast



Lund et al., Neuroimage (2006)



Respiration Modulates BOLD Contrast Time Series

Birn et al., Neuroimage (2006)

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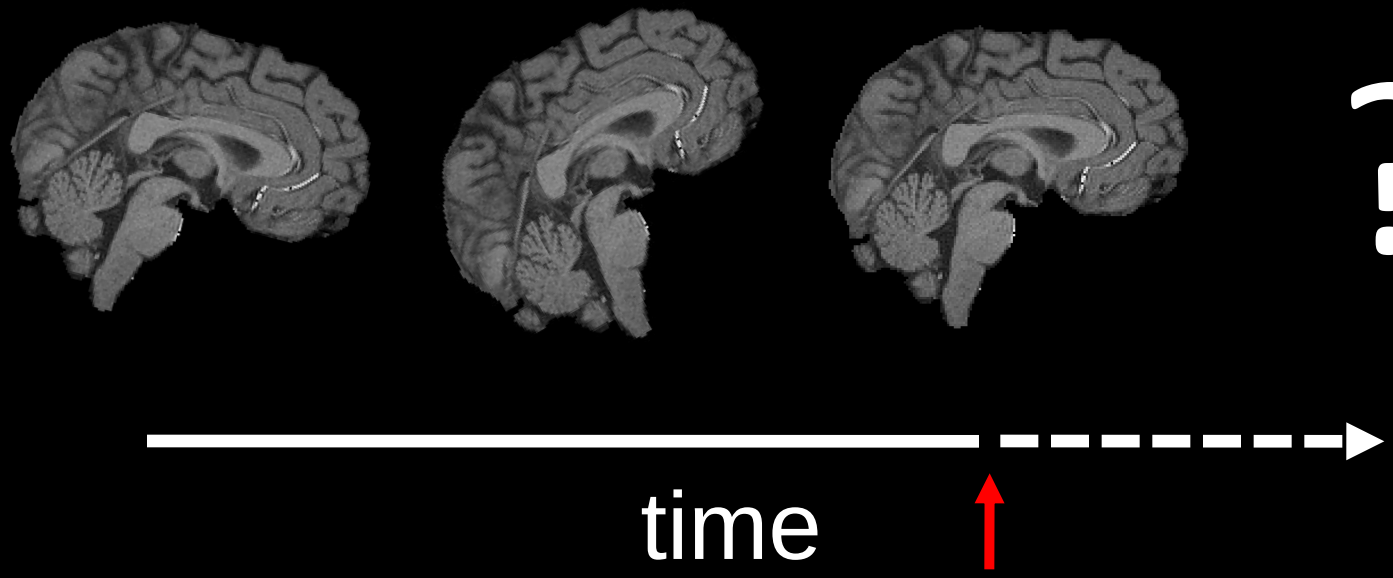
Prospective Motion Correction



Prospective motion correction makes predictions that may be dependent on outdated information.


“We drive into the future using only our rearview mirror.” - Marshall McLuhan

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