Advances
in
Event-Related fMRI Design
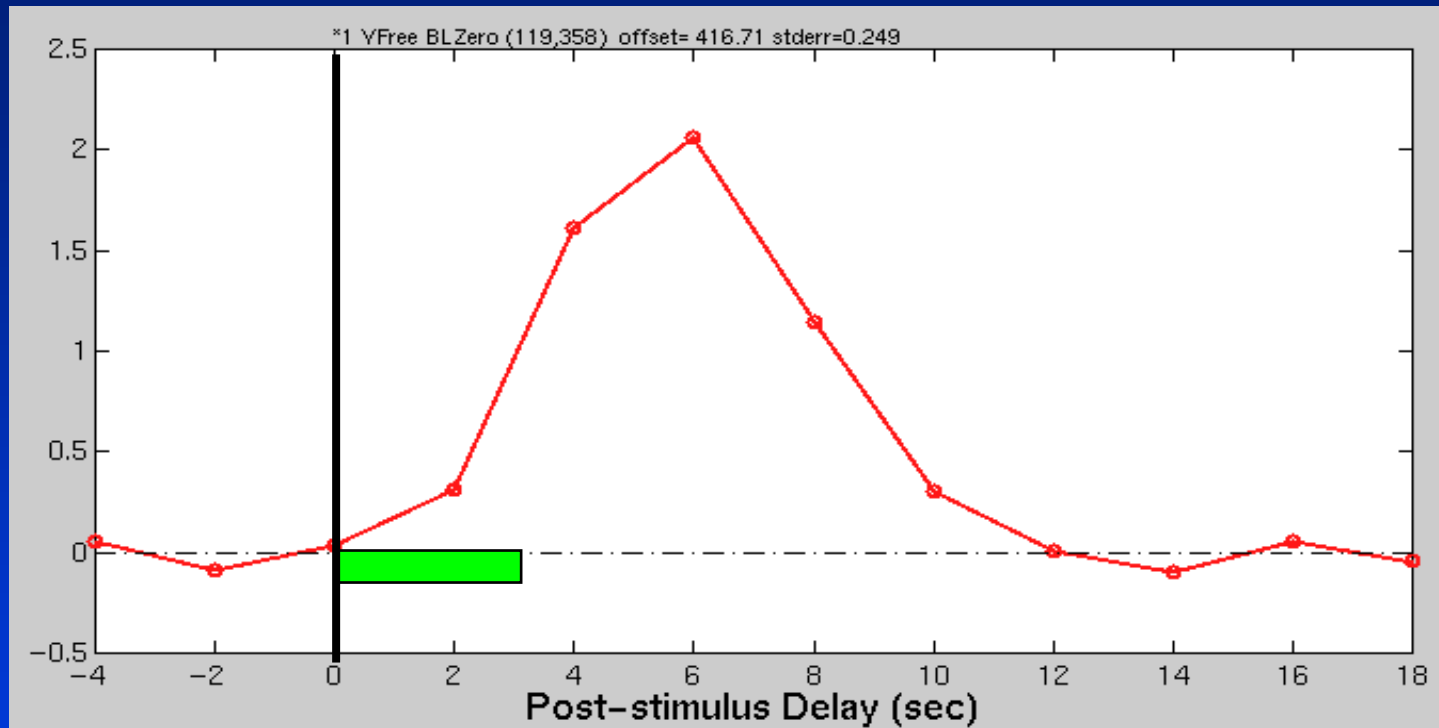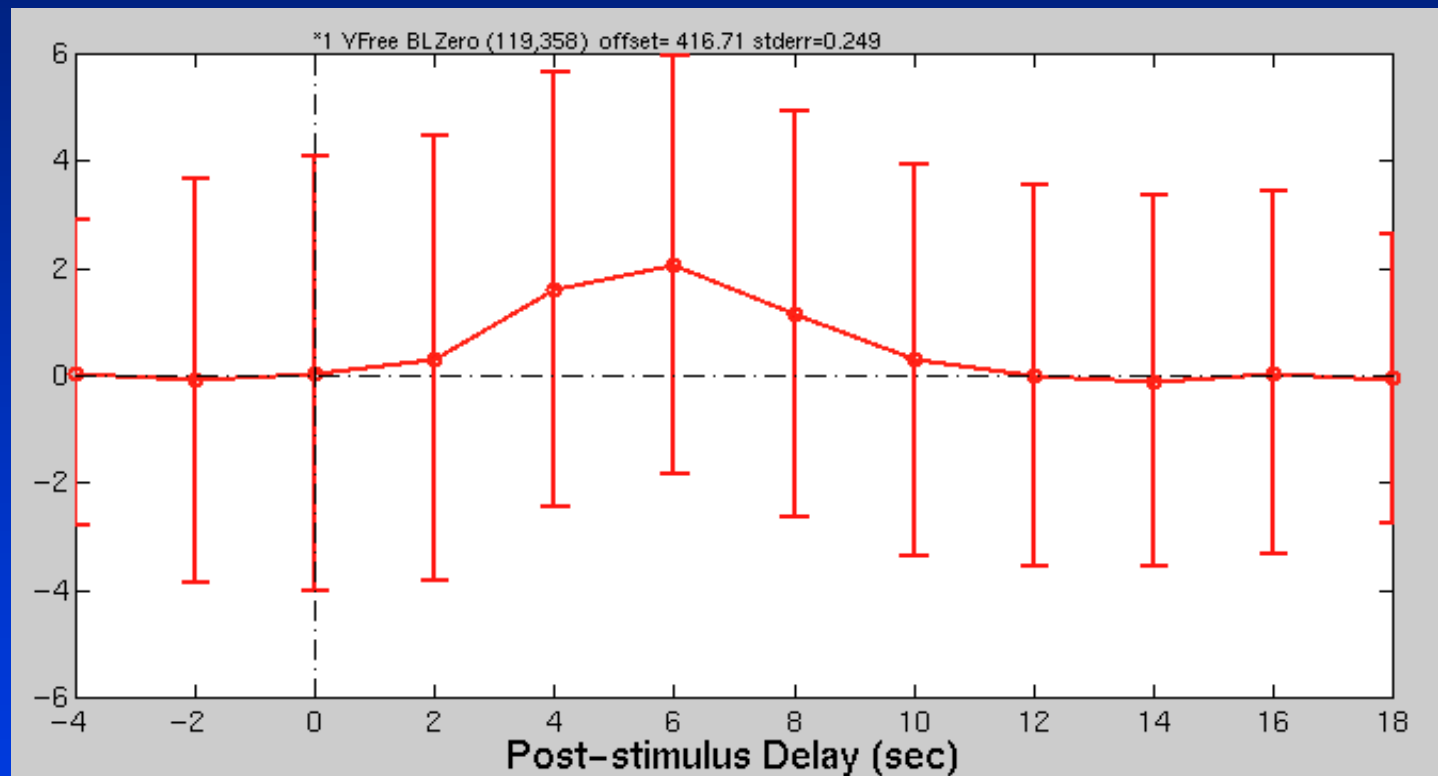
Outline

- What is Event-Related Design?
- Blocked Design
- Fixed-Interval Event-Related
- Rapid-Presentation (Jittered) Event-Related
- Efficiency and Event Scheduling

Fact of (fMRI) Life #1: Dispersion

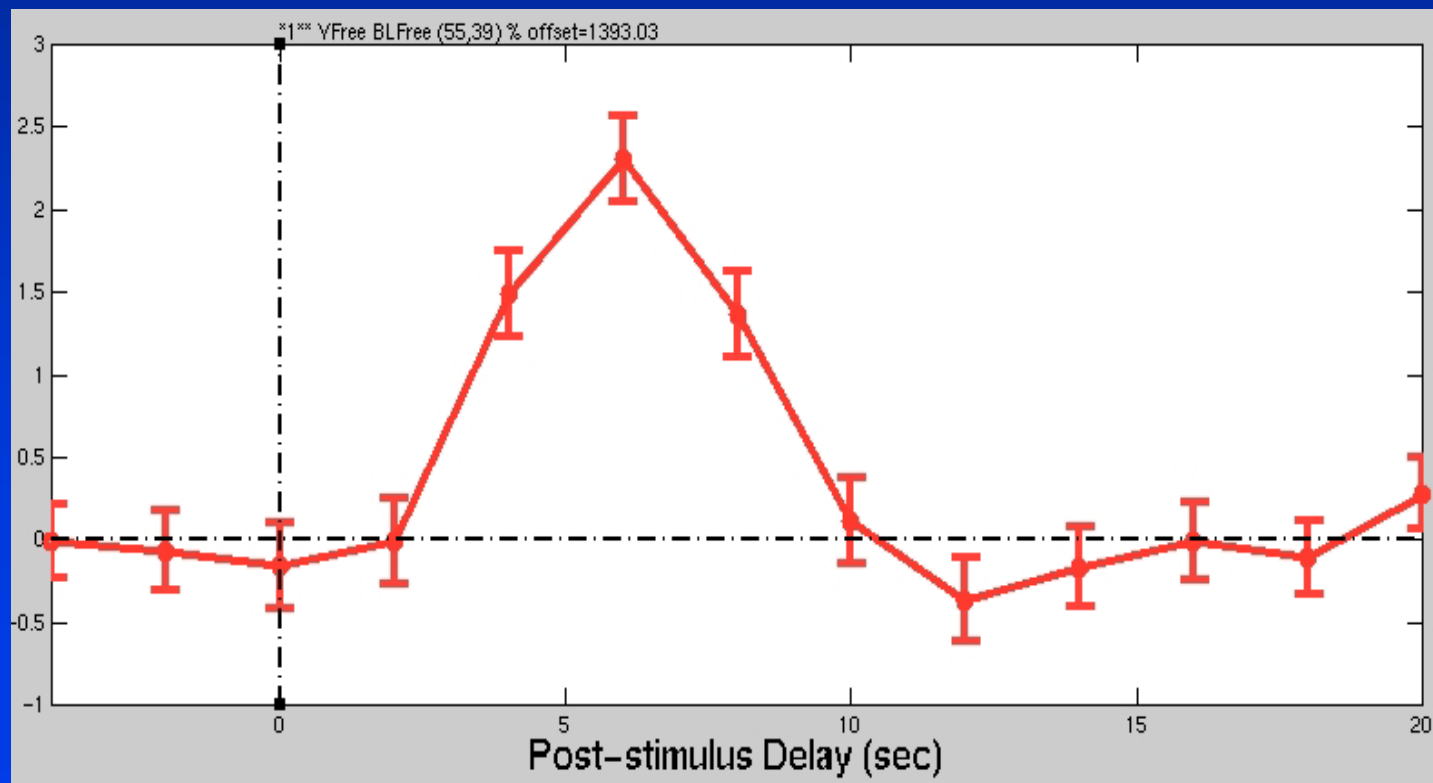- How closely can trials/events be spaced?
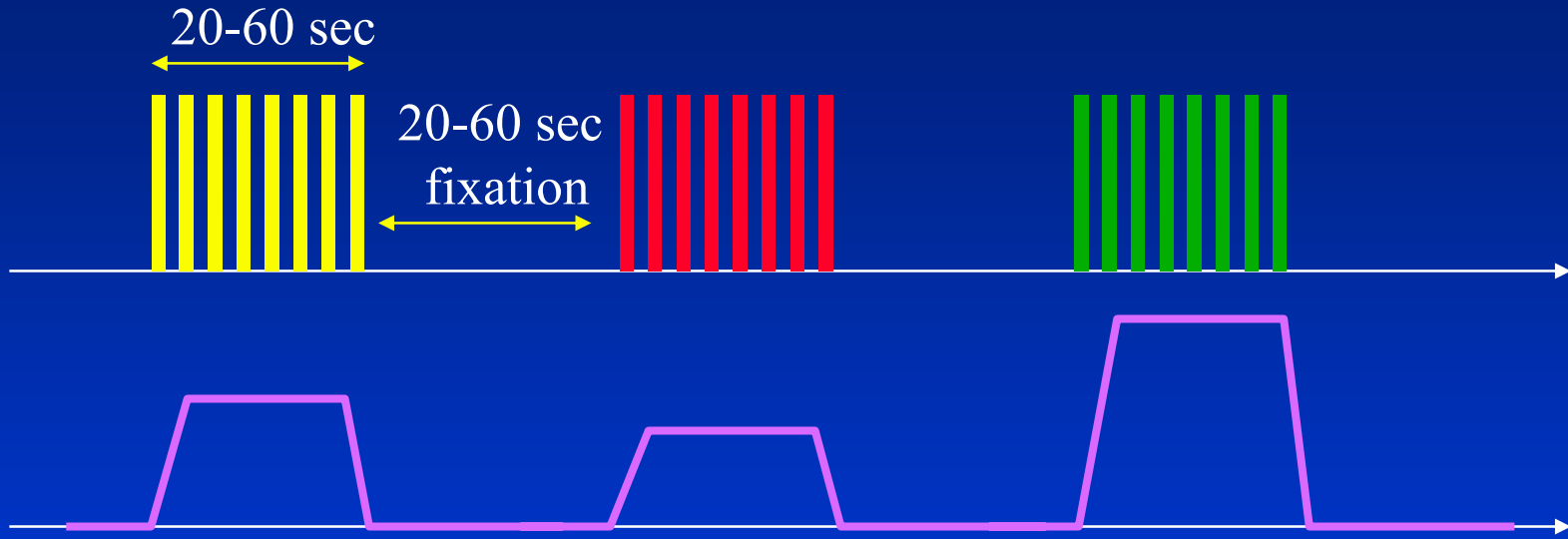
Fact of (fMRI) Life #2: Noise

- How much data needs to be collected?

Fact of (fMRI) Life #3: Time

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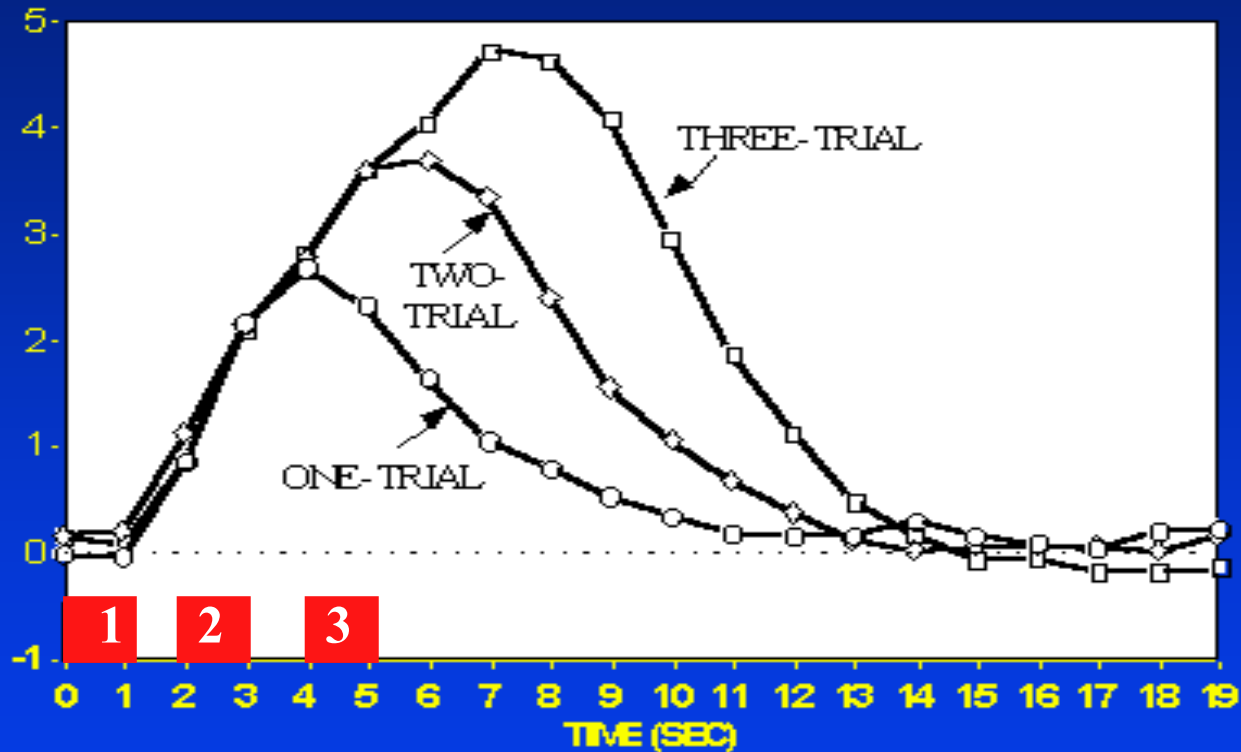- Time is Money
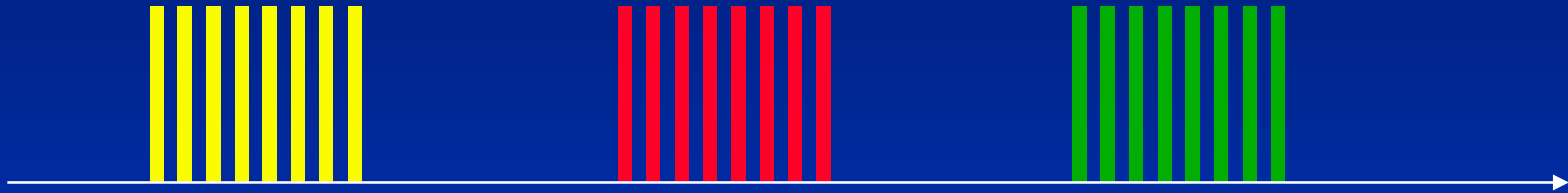- Subjects won't work forever

Blocked Design

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

Using Overlap to Increase Amplitude

# Blocked Design Drawbacks

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

# What is Event-Related Design?
(c.f. Blocked Design)

- Measure Average Response to Single Event Type
- Post Hoc Event Assignment based on Subject's Response
- Random Order of Events
- Historical: EEG/Evoked Potentials
- Less Powerful than Blocked

Fixed-Interval Event-Related

12-20s
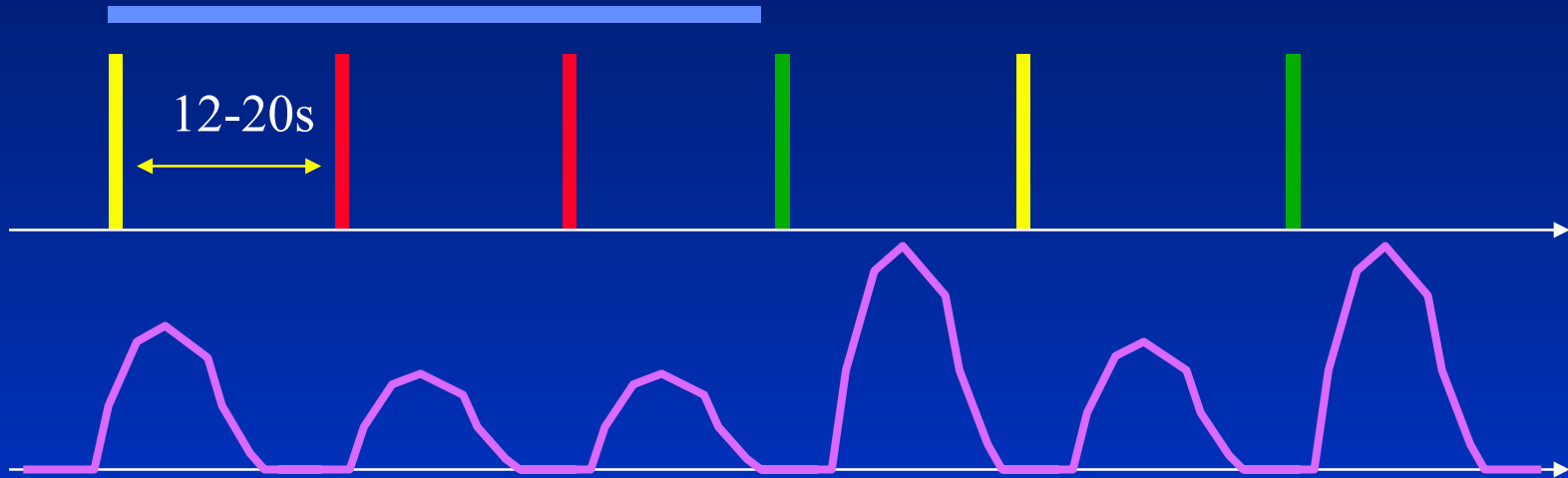
- Push trials apart enough to prevent overlap.
- Interval fixed at minimum is most efficient.
- Random Sequence (Counter-balanced)
- Allows Post-Hoc Stimulus Definition
- Mitigates Habituation, Expectation (?), and Set
- Inflexible/Inefficient/Boring
- Good if limited by number of stimuli (not scanning time)

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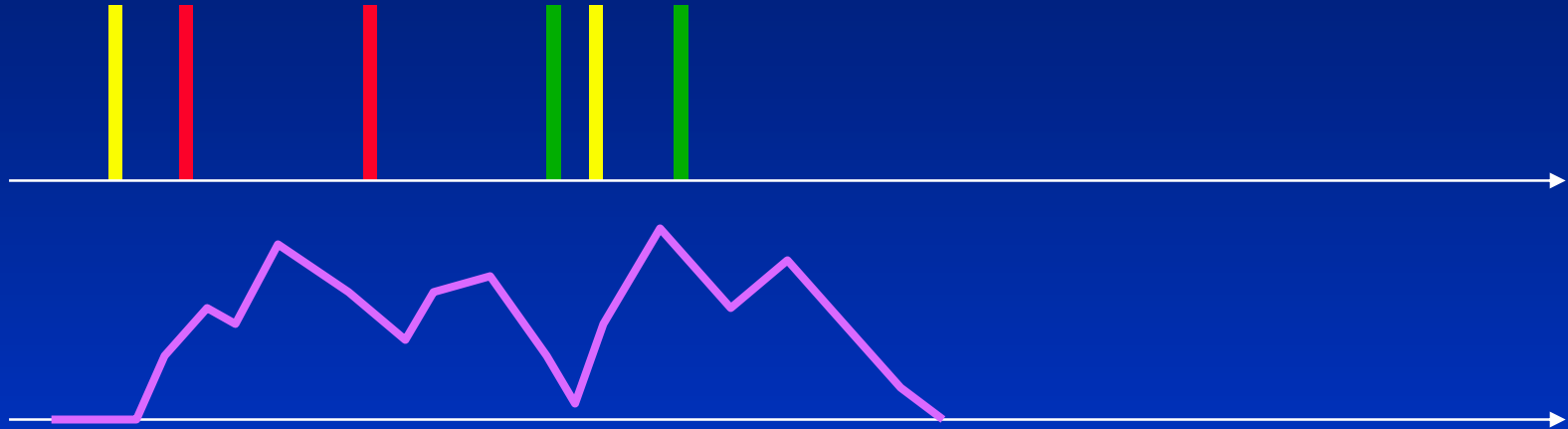
- Closely Spaced Trials (Overlap!)
- Raw signal uninterpretable
- More Stimulus Presentations for given scanning interval
- Random Sequence
- Jitter = "Random" Inter-Stimulus Interval (ISI/SOA)

Where does jitter come from?
## (What's a Null Condition?)

- "Null" condition – fixation cross or dot
- By hypothesis, no response to null
- Insert random amounts of null between task conditions
- Differential ISI = Differential Overlap
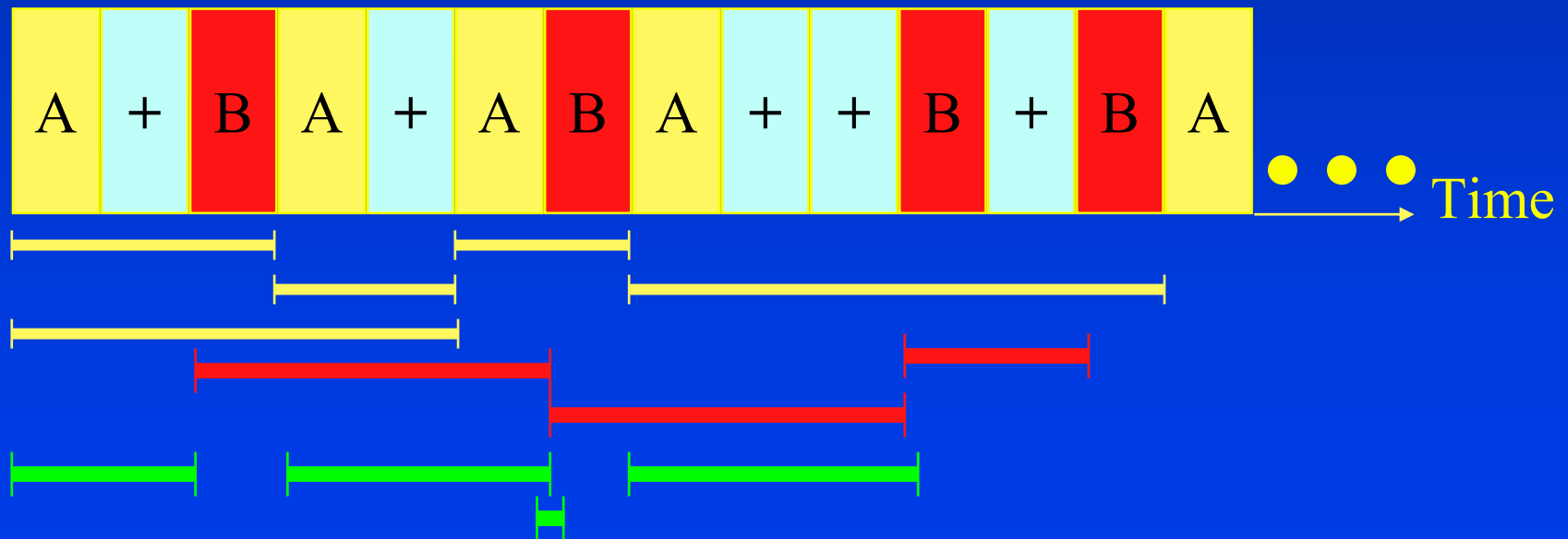
Rapid-Presentation Properties

- Efficient (not as efficient as blocked)
- Can distinguish responses despite overlap
- Highly resistant to habituation, set, and expectation
- Flexible timing (Behavioral, EEG, MEG)
- Linear overlap assumption
- Analysis: Selective Averaging/Deconvolution (GLM)
- How to schedule stimulus onsets?

Scheduling and Efficiency

A: N=5

B: N=10

C: N=10
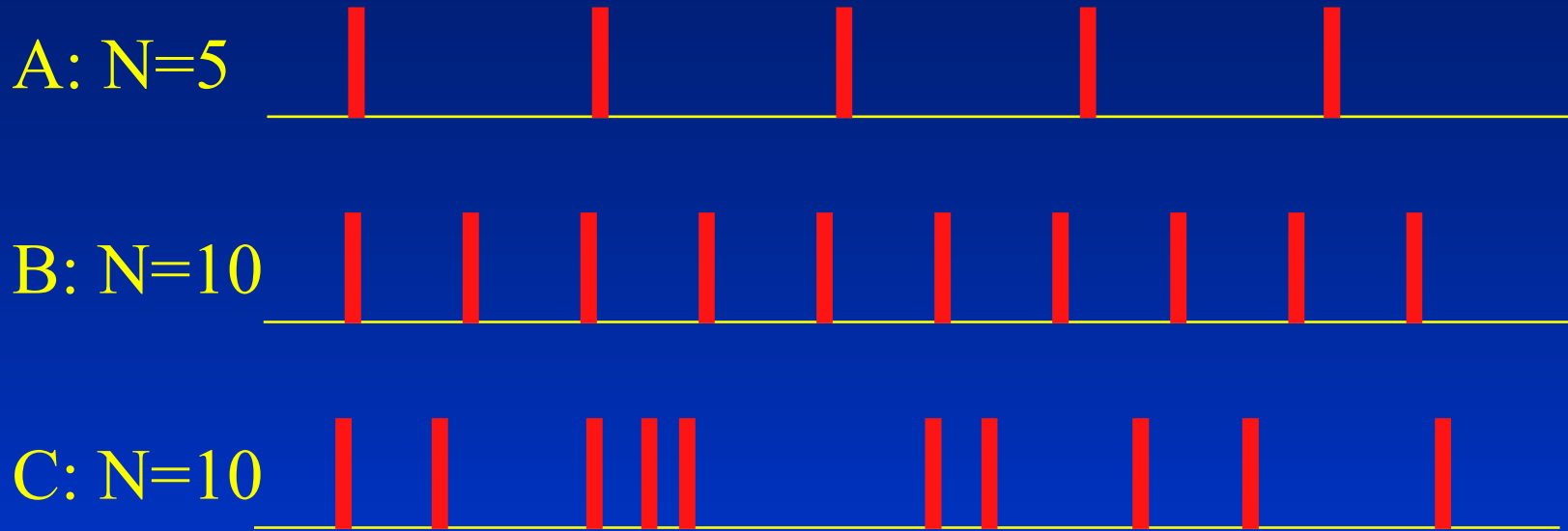
- Efficiency: statistical power/SNR/CNR per acquisition
- Efficiency increases with N
- Efficiency decreases with overlap
- Efficiency increases with differential overlap
- Choose schedule with optimum efficiency ***before*** scanning

Summary

- Facts of Life: Dispersion, Noise, Time
- Blocked - Habituation, Expectation, Set, No Post-Hoc
- Fixed-Interval Event-Related – Inefficient/Boring
- Rapid-Presentation Event-Related
  - Randomized inter-stimulus onsets
  - Overlap Linearity
  - Efficient - Optimization Tool
  - Identical designs for Behavioral, fMRI, EEG, and MEG