A Task Interrupted Becomes a Prospective Memory Task

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Incidents due to Interruptions

- Interruptions caused by ATC, mechanics, flight attendants, pilots
- Some other events attributable to interruption of flows and procedures:
  - –Checklist items missed: Taxiing, ATC communications
  - –Wrong runway approach
  - –entry door emergency slides not disarmed
  - –MEL restrictions not met
  - –Takeoff warning horns
  - –Programming the FMC - neglect selection of some transition route
- See Loukopoulos, Dismukes and Barshi (2001), in *Proceedings of the 11th International Society of Aviation Psychology*

Why is it hard to remember to resume interrupted tasks?

- Interruptions create a form of Prospective Memory task, so a resumption failure is a prospective memory failure.
- Definition of Prospective Memory
  - –Tasks that have to be remembered to be done in the future.
  - –The PM task usually drops out of attentional focus while other tasks are performed.
  - –No obvious prompting for commencing the PM task.

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- Cannot study it in actual aircraft because of safety reasons.
- Can study it in simulators, but error rates are very low.
- Laboratory experiment - provides a lot of control over many factors.

Laboratory Studies

Disadvantages

Lose Richness of the Real World

Sparse set of competing associations at retrieval

Transferable to other situations?

Advantages

Can control factors one at a time

Easy to do

Get many datapoints per subject

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TRY TO INCORPORATE AS MANY REAL WORLD FACTORS AS POSSIBLE THAT CONTRIBUTE TO THE DISRUPTIVE EFFECTS OF INTERRUPTIONS

Basic Outline

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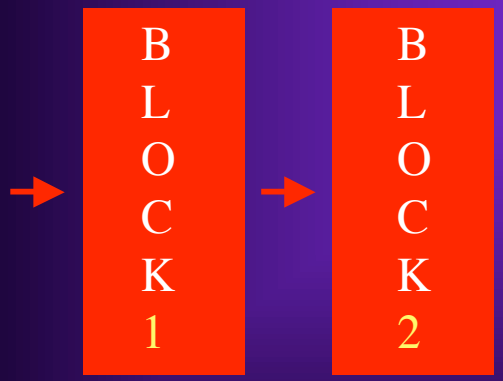
BLOCK 1

Basic Outline



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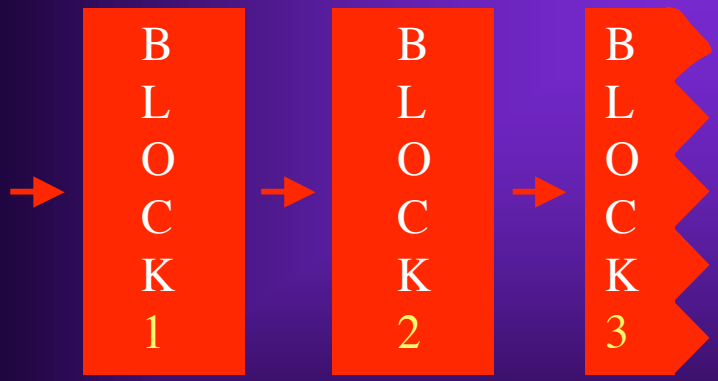

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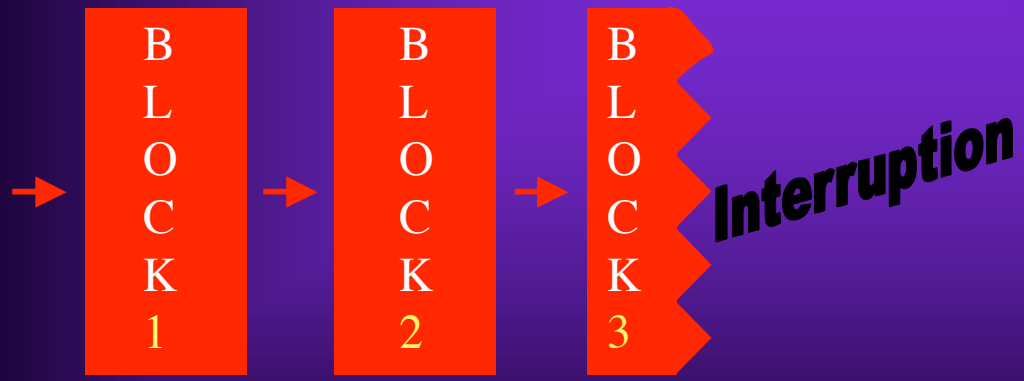

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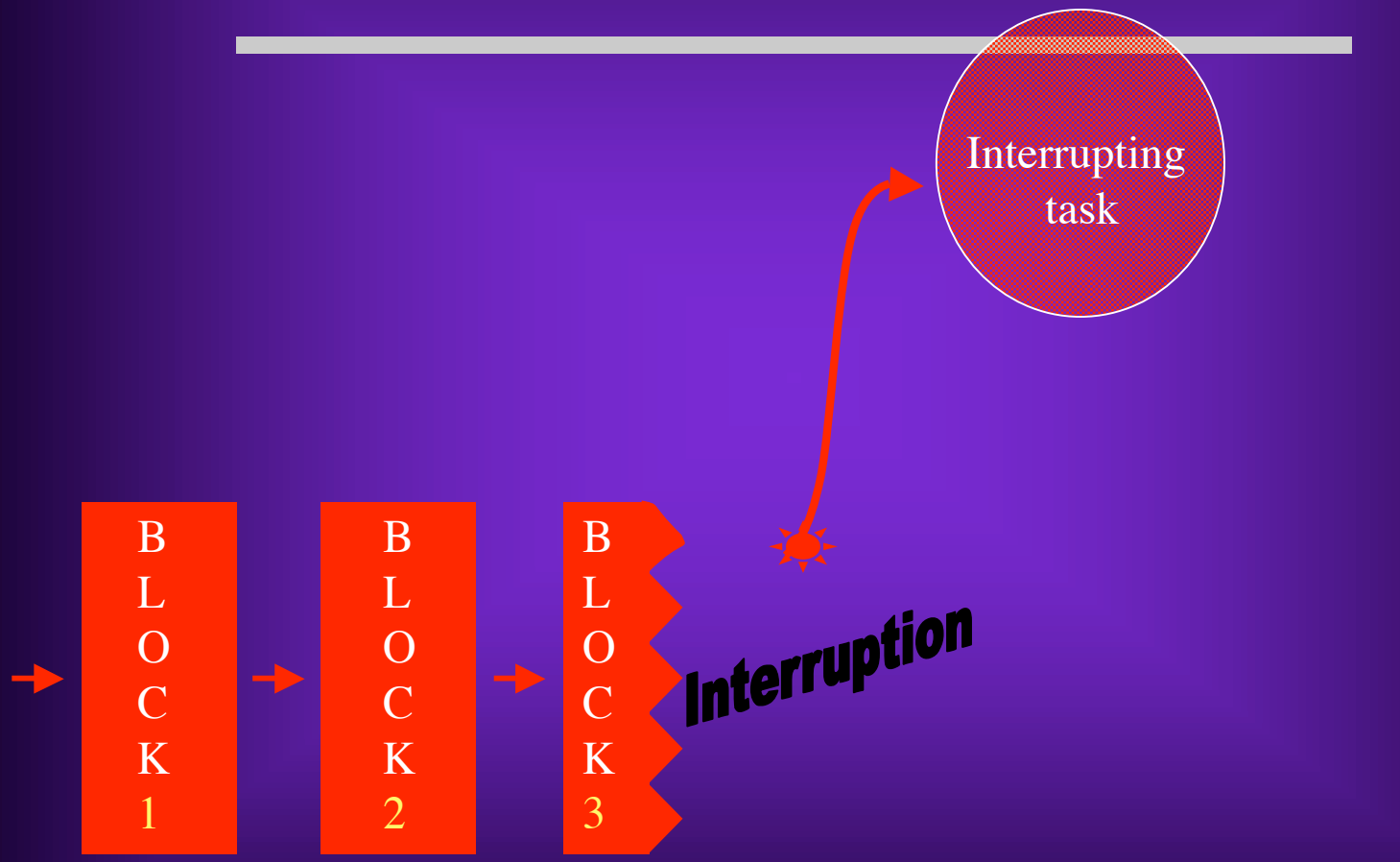

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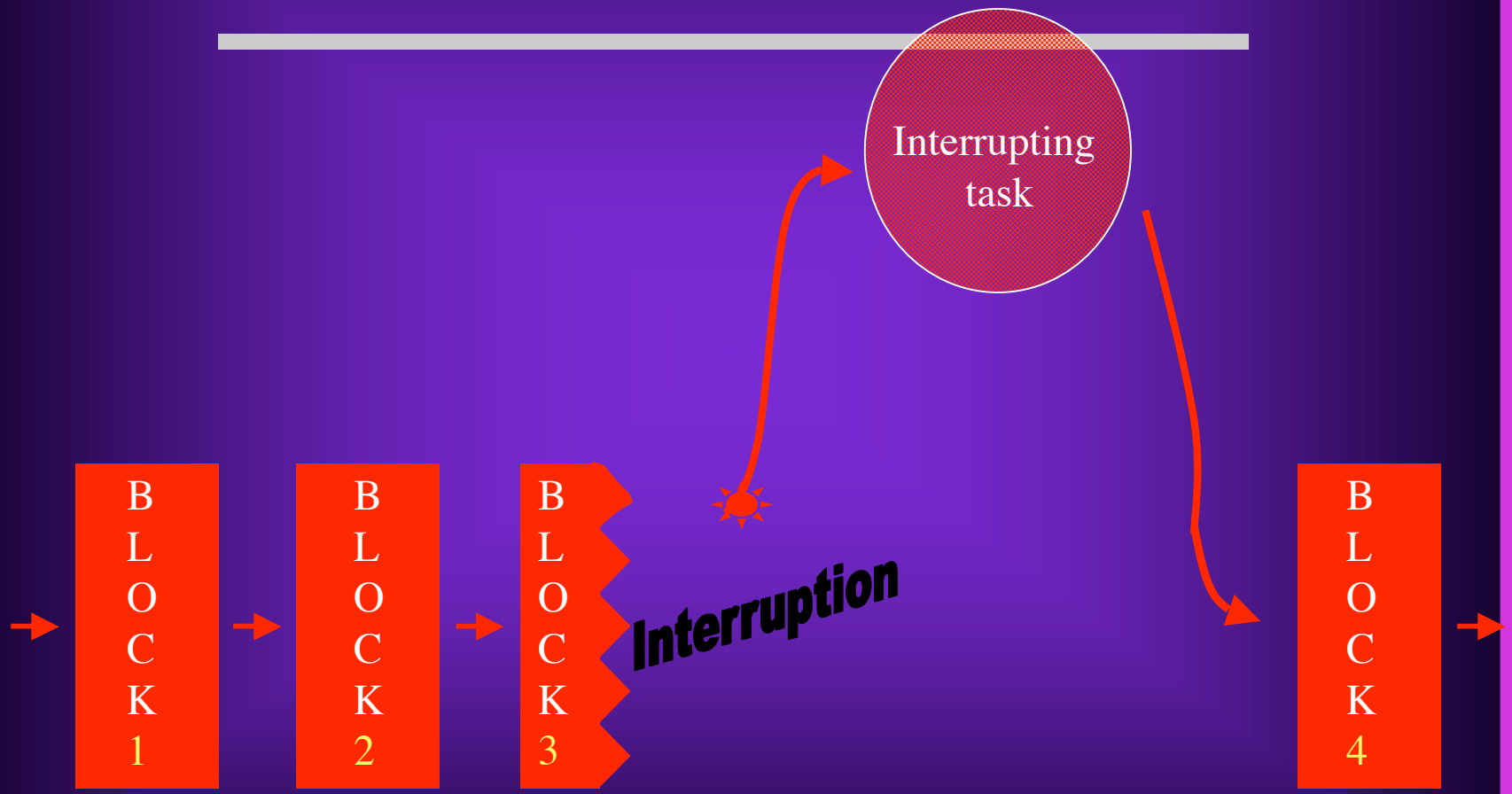

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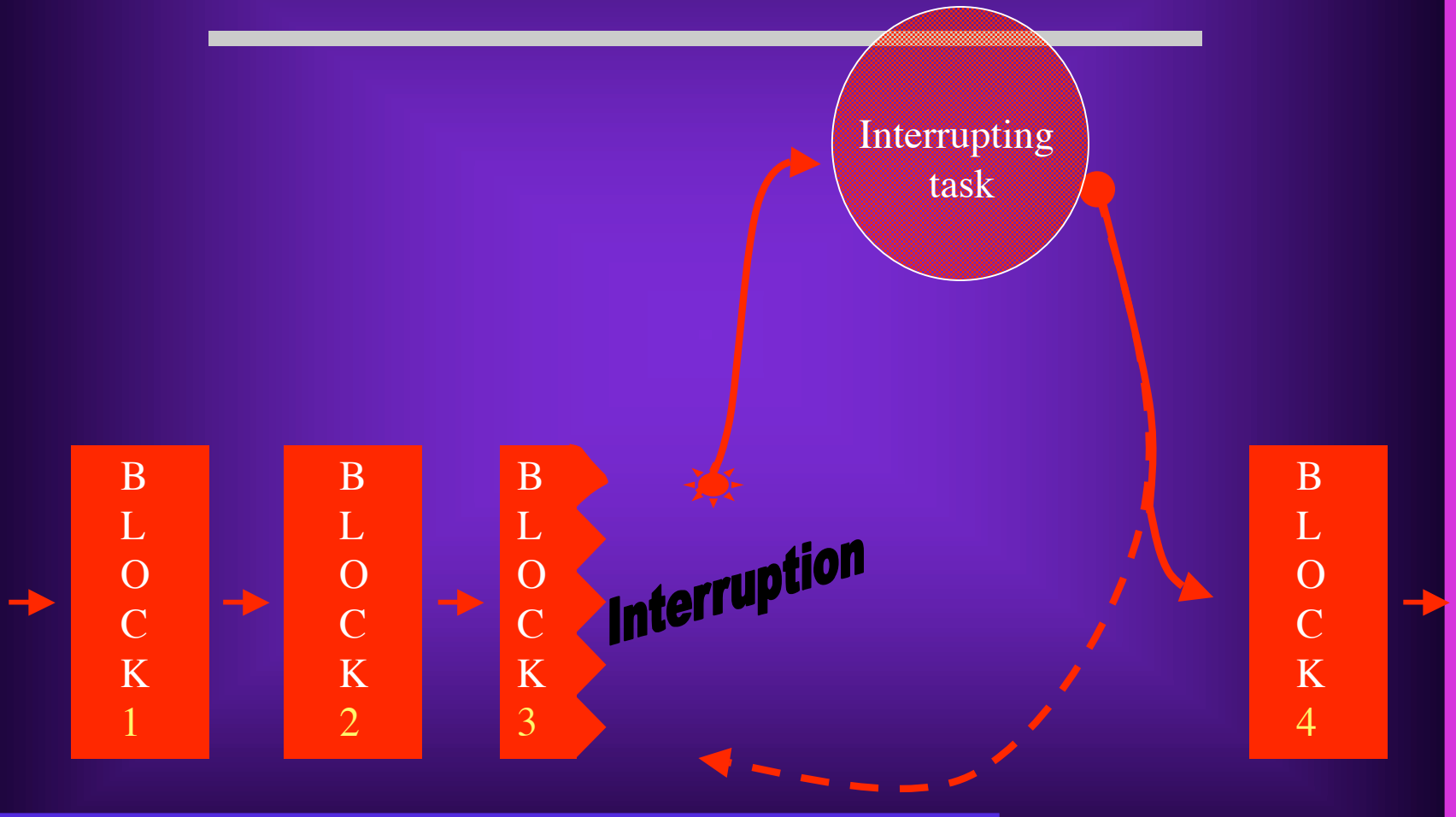


Real world characteristics incorporated into experiment design

1. Habitual task

   Ongoing task is repeated in many blocks. It is a task subjects are already familiar with.

2. “Garden path”

   One task leads immediately onto the next task.Transition between tasks is almost immediate (2.5 second delay). After the end of the interrupting task, the subjects is led onto the next task in the sequence. Reduces opportunities to encode and retrieve intention to resume.

3. Moderate sense of urgency

   Interruption has to be attended immediately.

   A message asking them to hurry up if they spend too long on the task

Real world characteristics incorporated into experiment design

4. No obvious physical cues

   At the moment the intention is supposed to be retrieved, the transition to the next block looks exactly the same as after the end of regular blocks. The PM task is to hit the back-arrow key.

5. Window of opportunity for PM task

   Fairly large amount of time during which back-arrow key can be pressed - whole section after interrupting task. False alarms result in penalty of lost time.

Experiment Design and Procedure

- All factors were between-subjects
- 20 blocks of 11 questions. Each block had one cateogry: math, general knowledge, vocabulary or analogies.
  - 5 blocks were interrupted by another block of questions.
  - 2.5 seconds between blocks
- Dependent variable was whether or not subject pressed back-arrow key to resume suspended task during the window of opportunity immediately after an interruption.
- Instructions and practice trials showed subjects how and when to resume interrupted tasks.
- At the end of the experiment, subjects were given a debriefing during which we verified they had understood instructions.

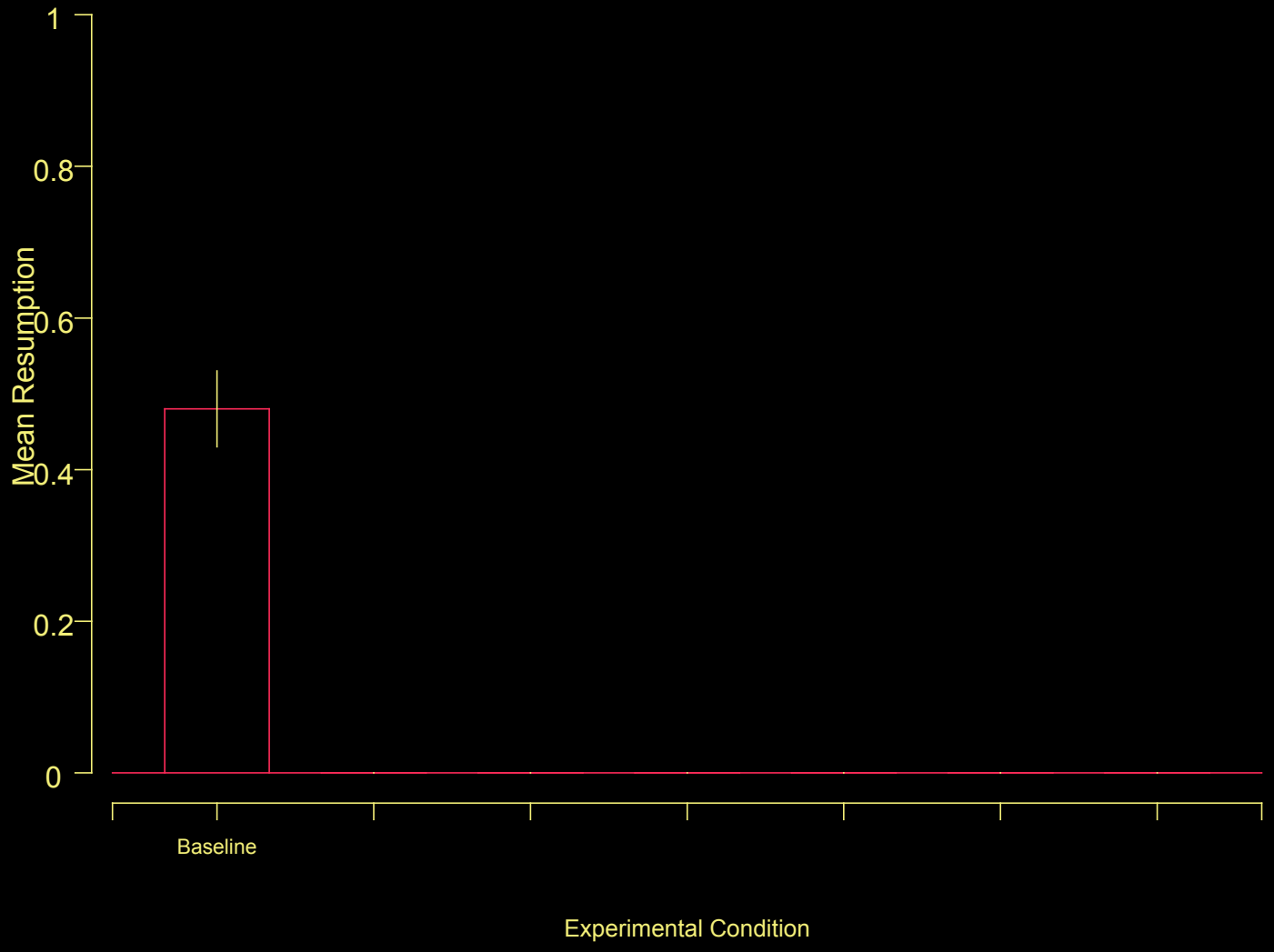
Five Manipulations

- Baseline
- Encoding
  - 4 second interruption lag with reminder to resume interrupted task
  - 4 second interruption lag with blank screen
- Retrieval
  - “End of Interruption” message
  - 8 to 12 second retrieval lag
- Encoding/Retrieval
  - 4 second interruption lag with reminder and 8 to12 second retrieval lag.

Baseline Condition

- Participants are expected to have imperfect resumption rates because of a mismatch between the encoding of the interruption and the conditions at retrieval.
- The sudden onset of the interruption prevents participants from encoding or at least fully encoding intention to resume.
- At retrieval, the next section begins very soon after the end of the interruption. Task demands may not allow the participant to fully process and interpret the cues that can trigger the resumption intention.

Baseline


1
0.8
0.6
0.4
0.2
0
Mean Resumption
Baseline
Experimental Condition

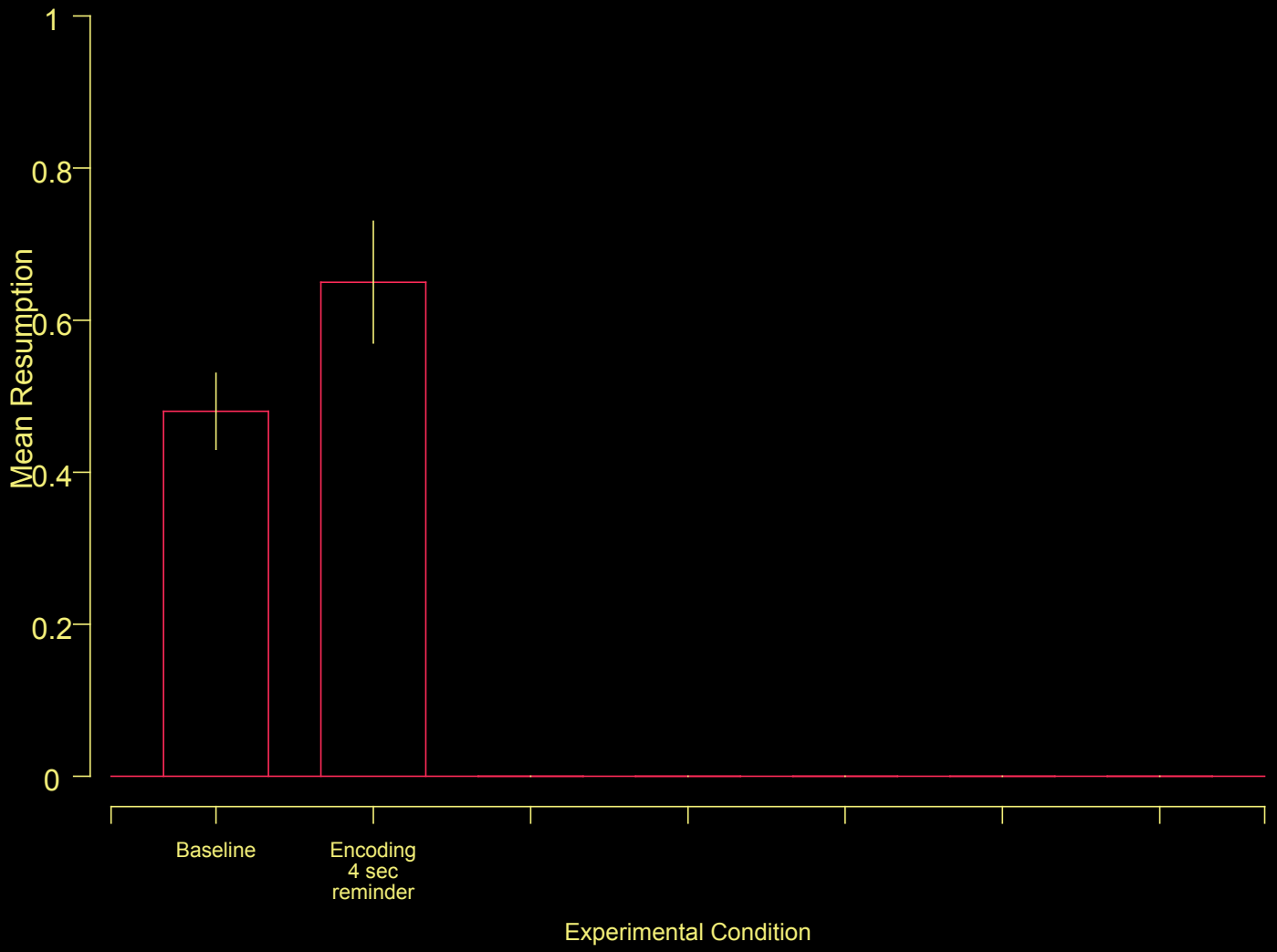
Manipulation 1
4 second interruption lag with reminder

- At the moment of interruption, subjects encode the episodic event of the interruption, but may not encode the intention to resume the interrupted task, or encode it weakly.
- In order to force subjects to encode the intention to resume the interrupted task, they were given a message on a screen that said:

  Please remember to return to the section that was just interrupted

- *We hoped that at the end of the interruption, an episodic retrieval of this reminder, or just stronger encoding of the intention, would increase resumption rates.*

Encoding – 4 sec reminder



Manipulation 2
4 second interruption lag with blank screen

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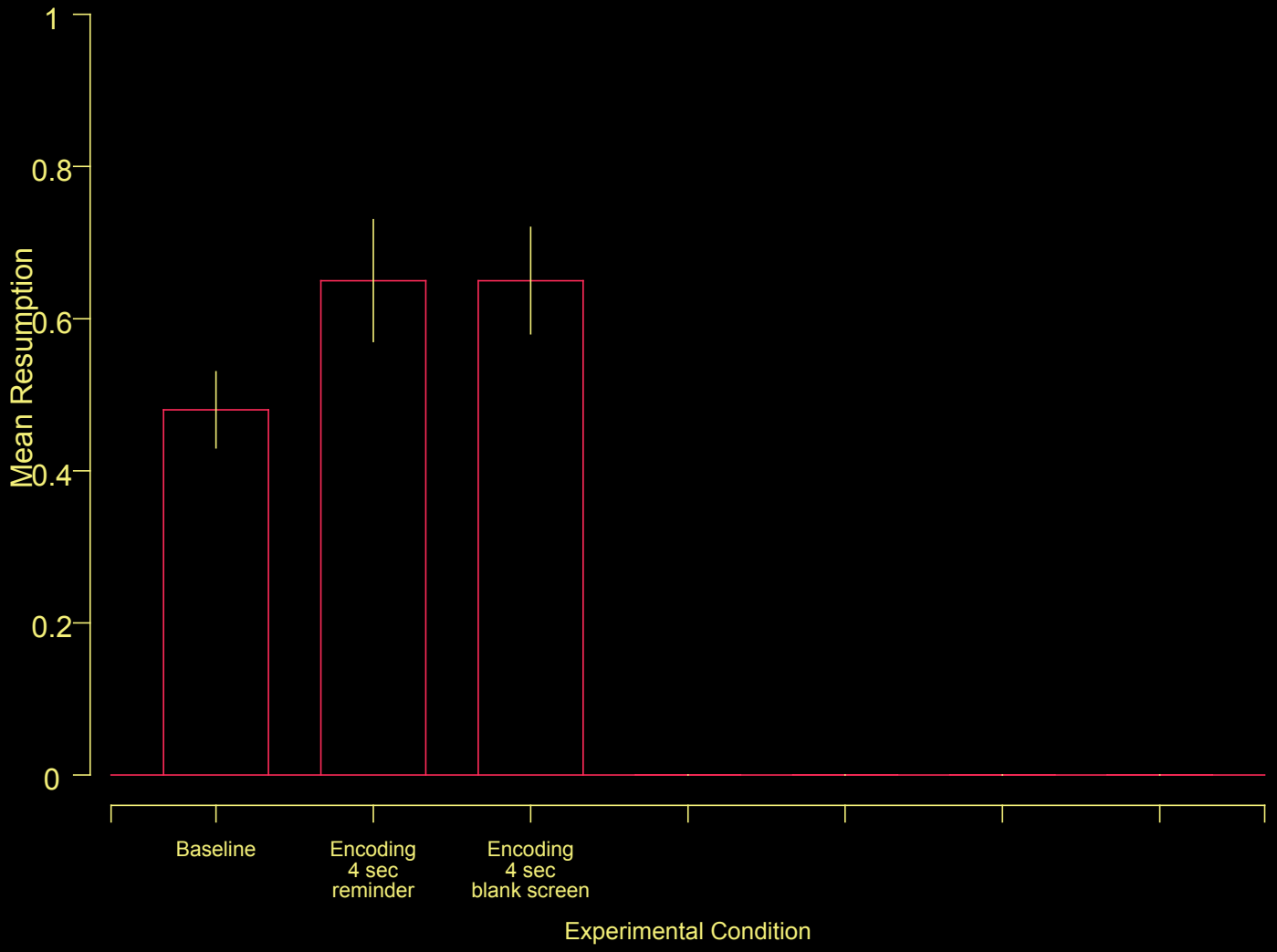
- Retrieval of the episodic event of the interruption may be enough to trigger the resumption intention, or,
- Subjects may use the 4 second interruption lag to encode the resumption intention more strongly anyway.
- So the reminder may be unnecessary.

Encoding – 4 sec blank screen



Manipulation 3
"End of Interruption" Message

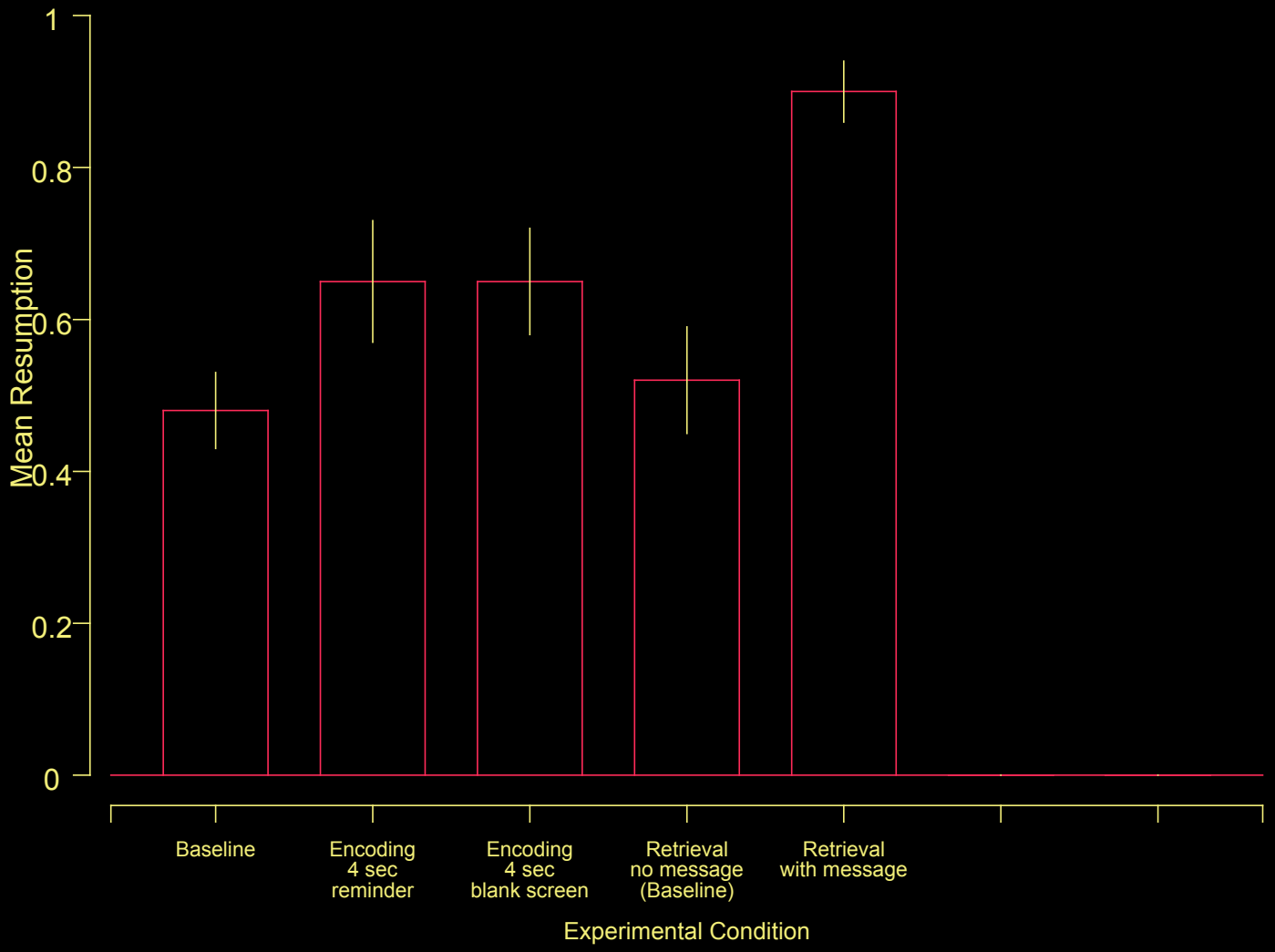
One of the greatest causes for failures of PM is the lack of a suitable cue at retrieval. In traditional PM paradigms, there is an explicit match between the stored intention/cue and the actual cue presented at retrieval. In the real world, cues signaling the opportunity to execute intentions may not closely match the form of the stored representation.

To provide a more direct match between encoding/retrieval cues we presented an

End of interruption

message at the end of some of the interrupting tasks.

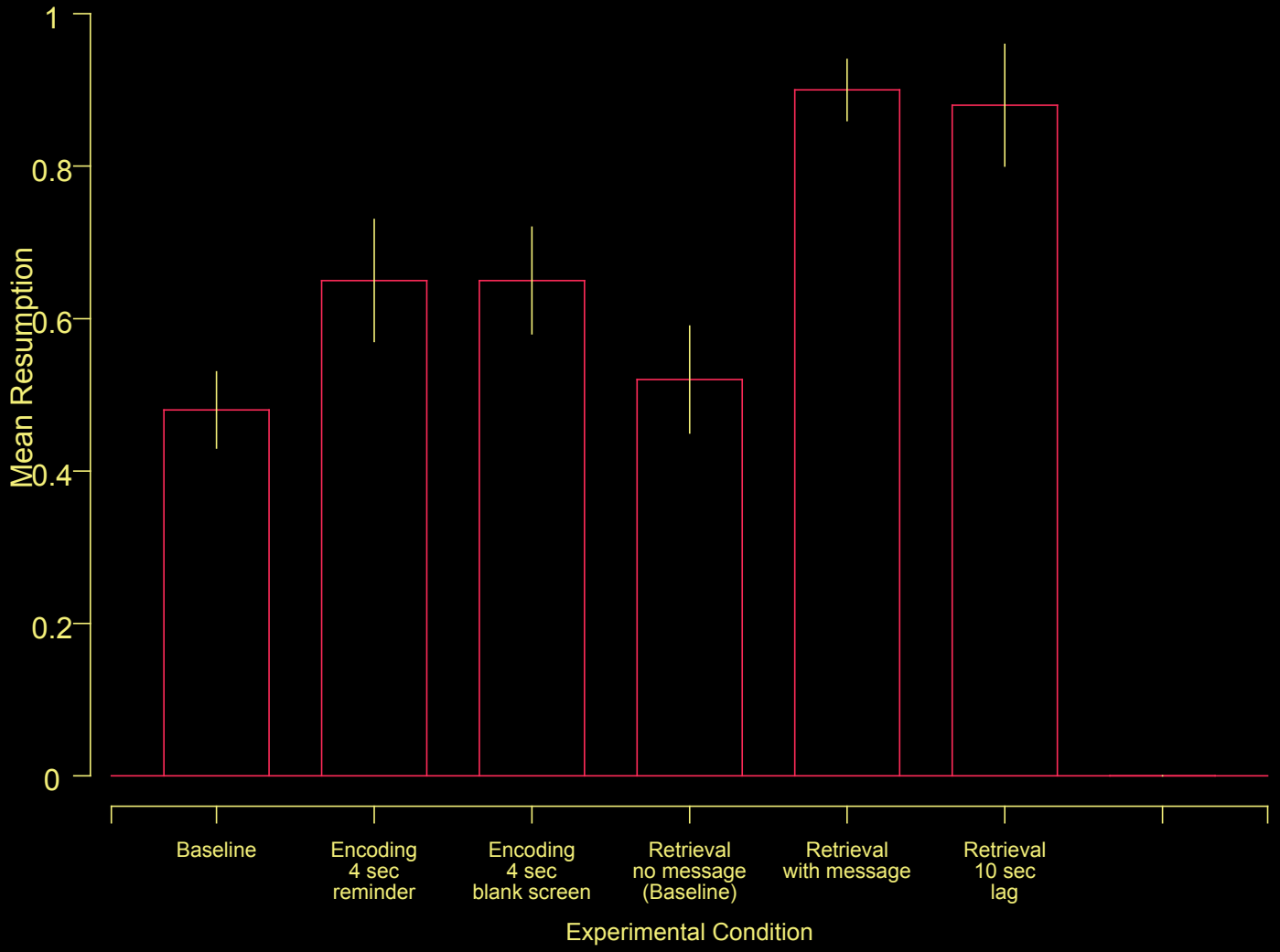
Retrieval – “End of Interruption” message



Manipulation 4
Longer retrieval lag - 8 to 12 seconds

- Resumption of interrupted tasks should be improved by decreasing competing demands for attention during the window of opportunity for returning to the interrupted task.
- The time between the end of the interrupting task and the beginning of the next section was increased from 2.5 seconds to 8-12 seconds.

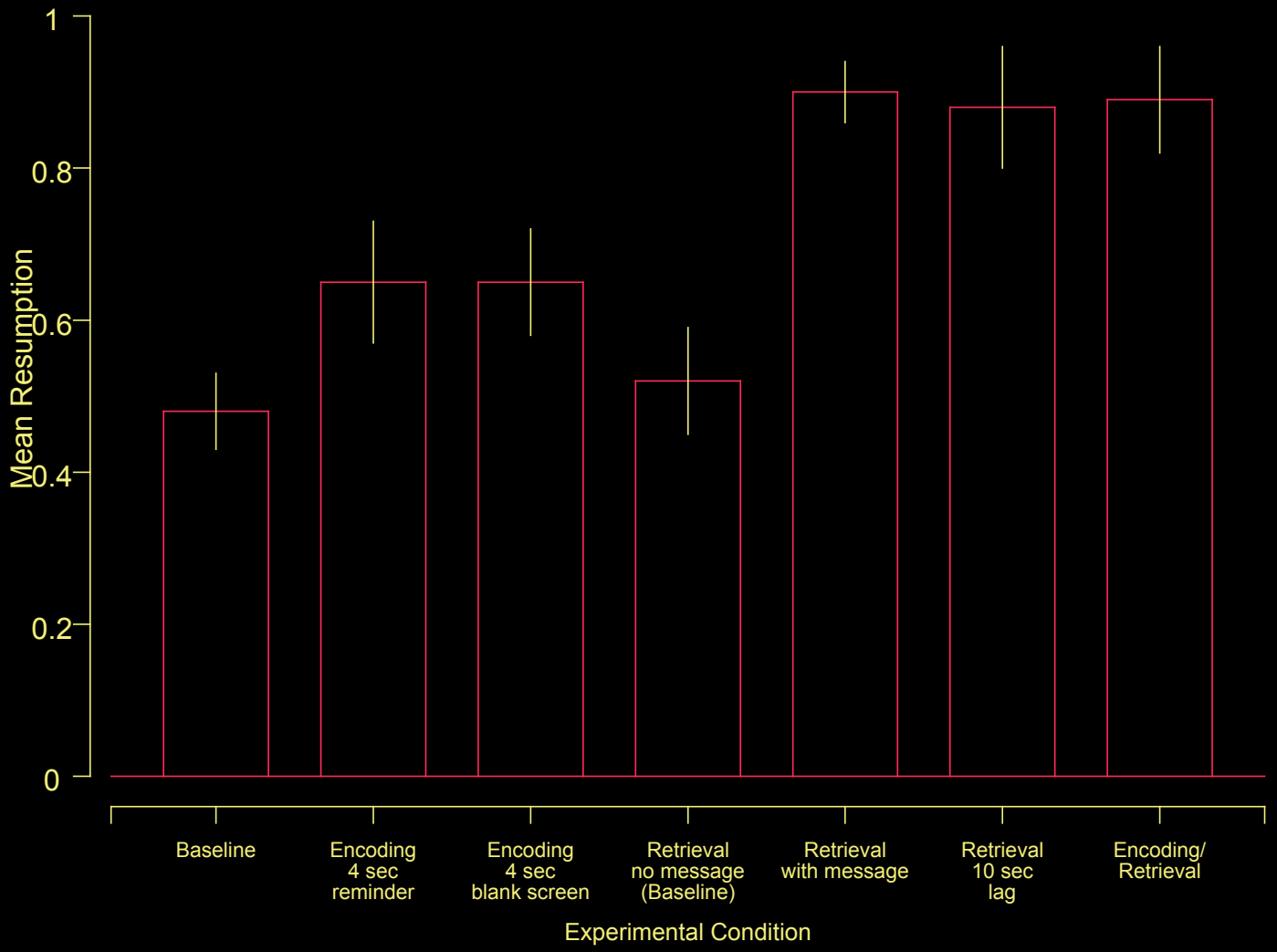
Retrieval – 8 to 12 sec lag



Manipulation 5
4 sec reminder and longer retrieval lag

- The effects of the encoding and retrieval manipulations may or may not be additive.
- Subjects were given a reminder during the 4 second interruption lag and an 8-12 second retrieval lag.

Encoding (4 sec reminder) / Retrieval (8-12 sec lag)



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1. Forced encoding of an explicit intention to resume an interrupted task results in greater resumption of the interrupted task
2. Retrieval cues closely matching encoding result in greater resumption.
3. Breaking the “Garden path” of continuing tasks results in greater resumption of the interrupted task.

Implications for Aviation and the Real World

- Airline operations are often of a “garden path” variety.
- Countermeasures against the effects of interruptions for pilots:
  - –See Dismukes, Young and Sumwalt (December 1998) in *ASRS Directline*
  - –Pause at critical junctures and review status of systems.
  - –Recognize interruptions, and take a moment to form an explicit intention to resume the interrupted task.
  - –Create salient retrieval cues.

Other Sources of Variance

- Encoding
  - –Strength of association between intention and retrieval cues
  - –Divided attention
  - –Type of reminder, type of initial instructions
- Retention
  - –Length, workload, etc. of interrupting task
- Retrieval
  - –Retrieval cues

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