VISUAL MEMORY

Visual Perception

Memory is unqiue

- Other aspects of visual perception
  - Bombard us with stimuli at every instance
- Memory
  - Helps us to make sense from chain of such instances

Two Theories in 1800s

- Herman Ebbinghaus
  - Undifferentiated memory system
  - One memory overwritten only with “new” memories
- William James
  - Primary memory: 10s of seconds
  - Secondary memory: Years
- 1960s experiments confirmed
  - Short term memory (STM)
  - Long term memory (LTM)
  - Iconic memory (very small memory buffer)

Classify based on

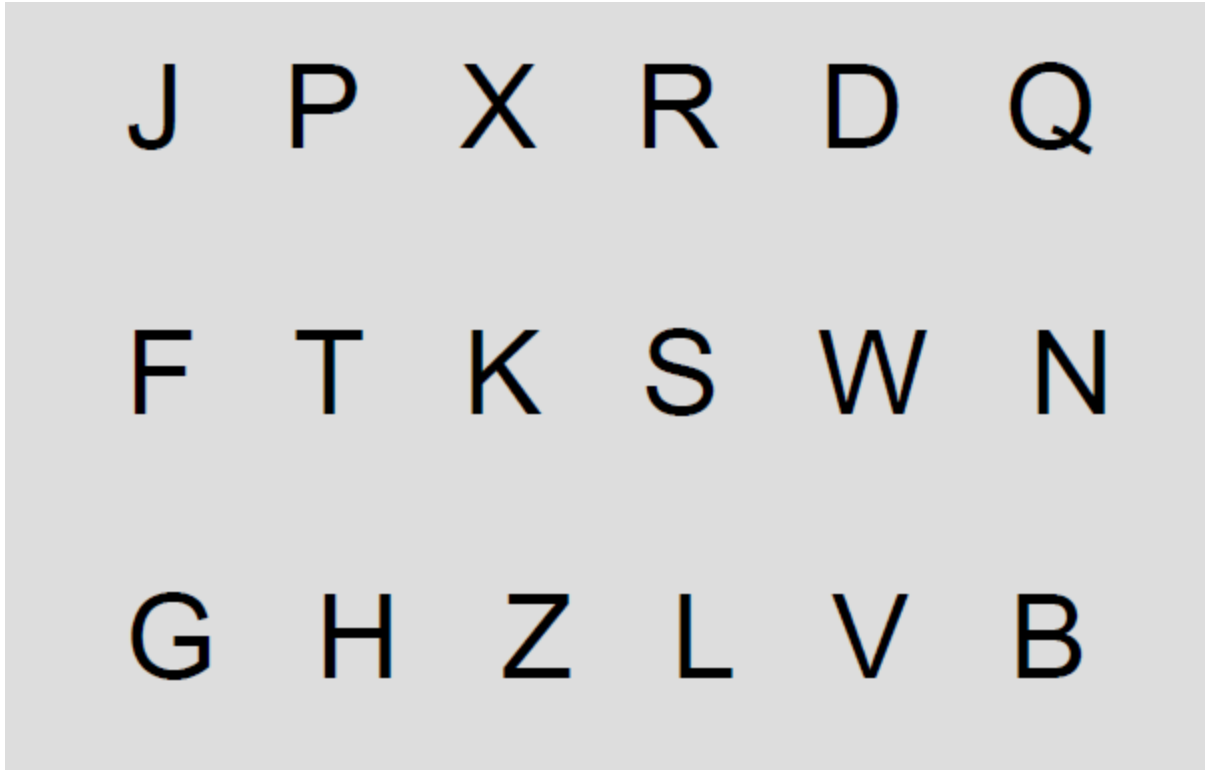
- Duration
  - Amount of time it lasts
- Content
  - Kind of information stored
- Loss
  - Ways of loss of information
    - Autonomous decay vs conflicting new memories
- Capacity
- Maintenance
  - Methods to refresh

Discovery to Iconic Memory

- Early experiments (1880s) studied the **span of apprehension**

  Number of letters a person could perceive in a single, very brief visual presentation
- DEMO!

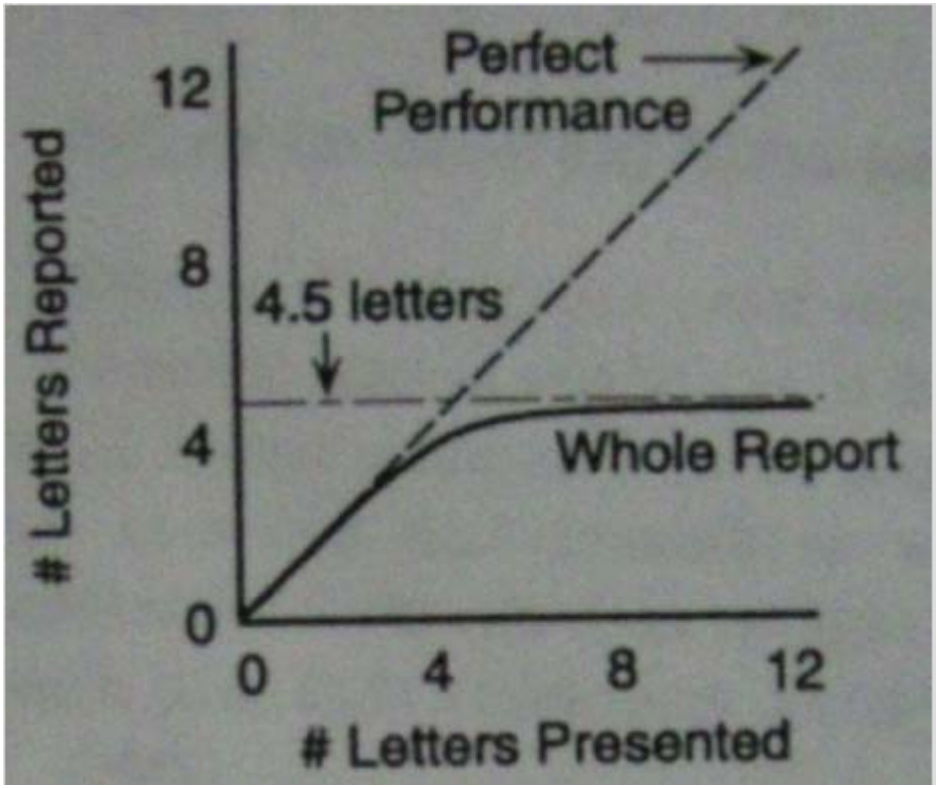
Demo



Span of Apprehension

- How many letters can you report?

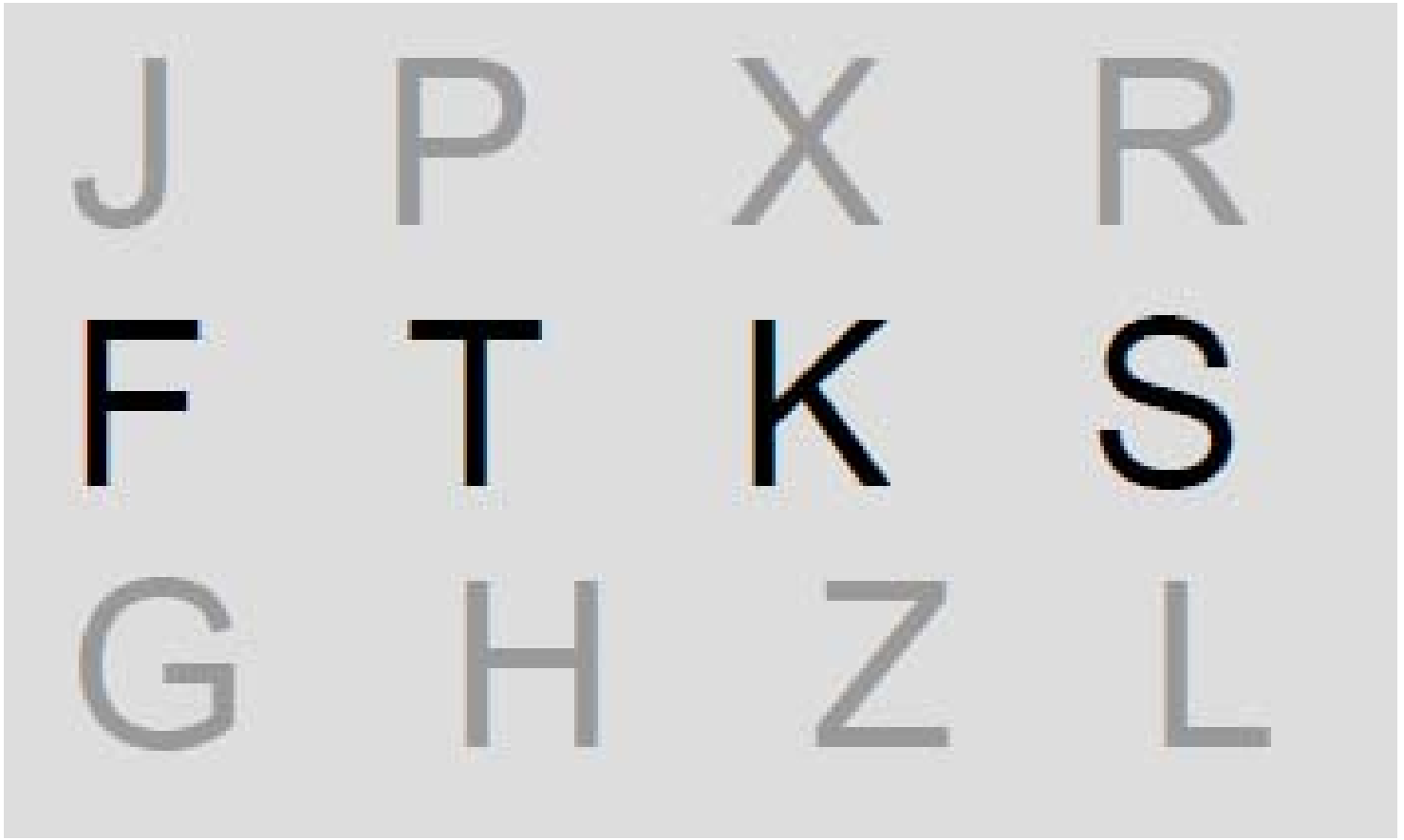
Whole Report Performance



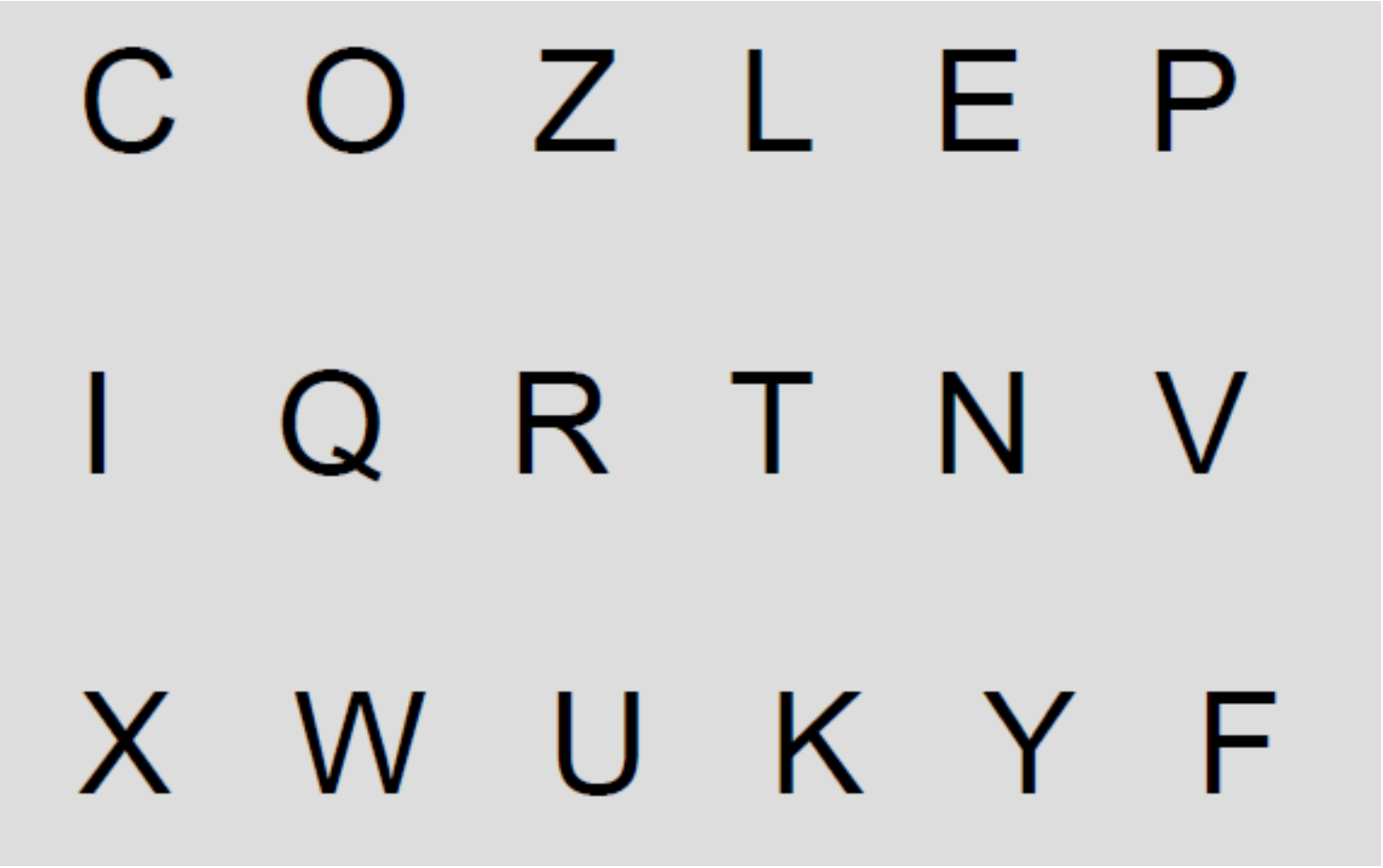
Discovery of Iconic Memory

- In 1950 George Sperling duplicated results
- Did not match visual experience
- Reporting is taking too long
  - Cannot report all that is retained within the time provided
- Changed the reporting
  - Cue based reporting on a fraction of letters

Audio cue (after letter display)



Location Cue



Location Cue

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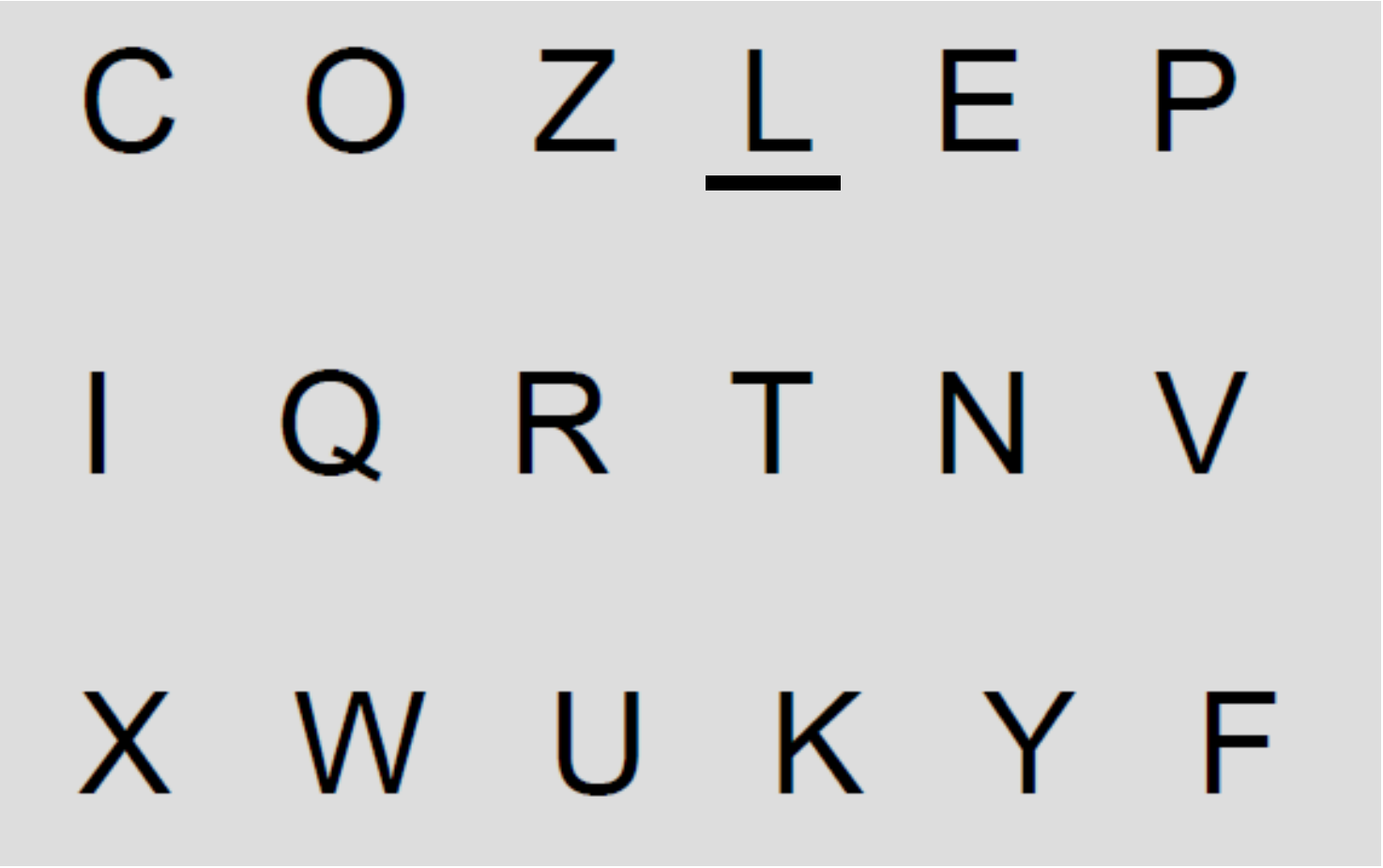
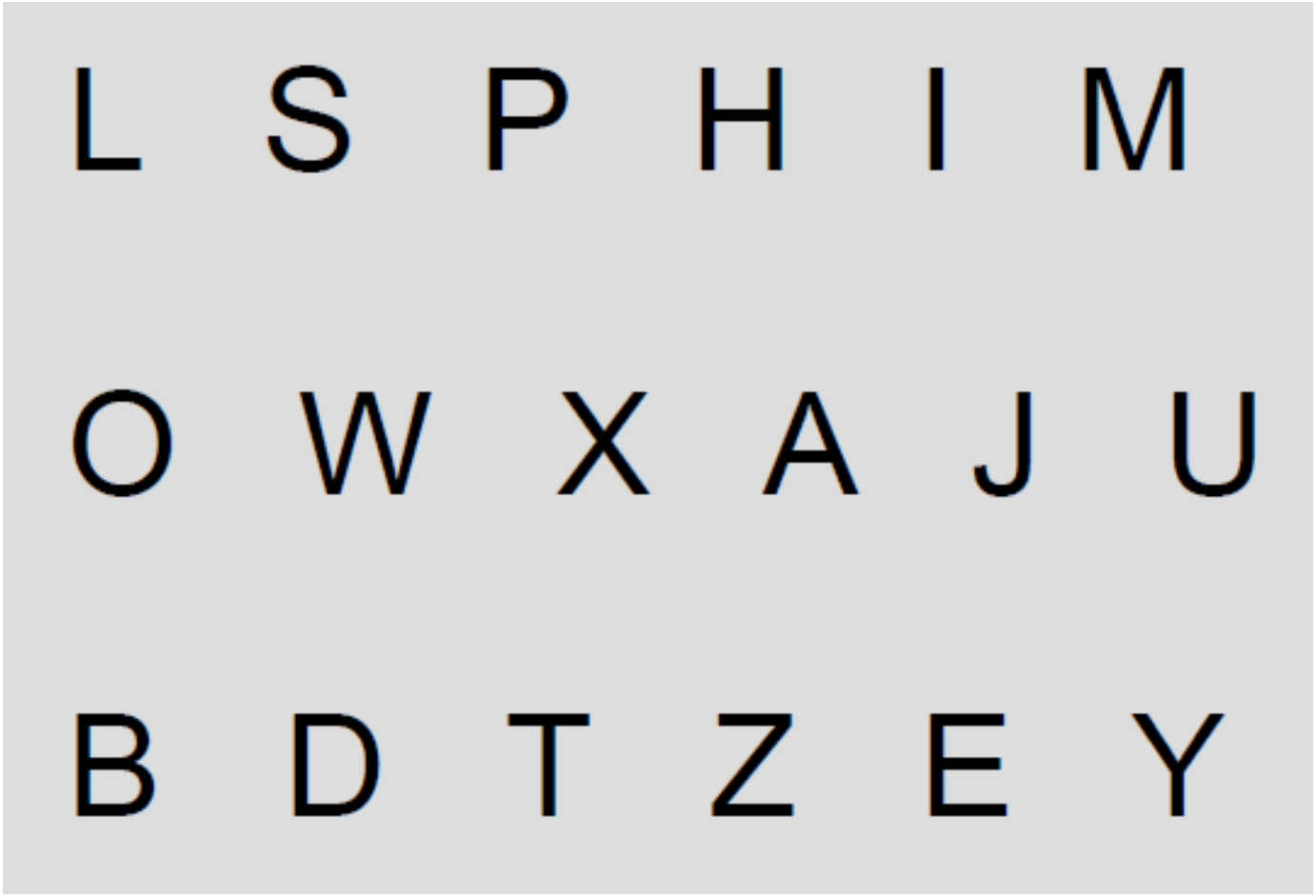


Location Cue



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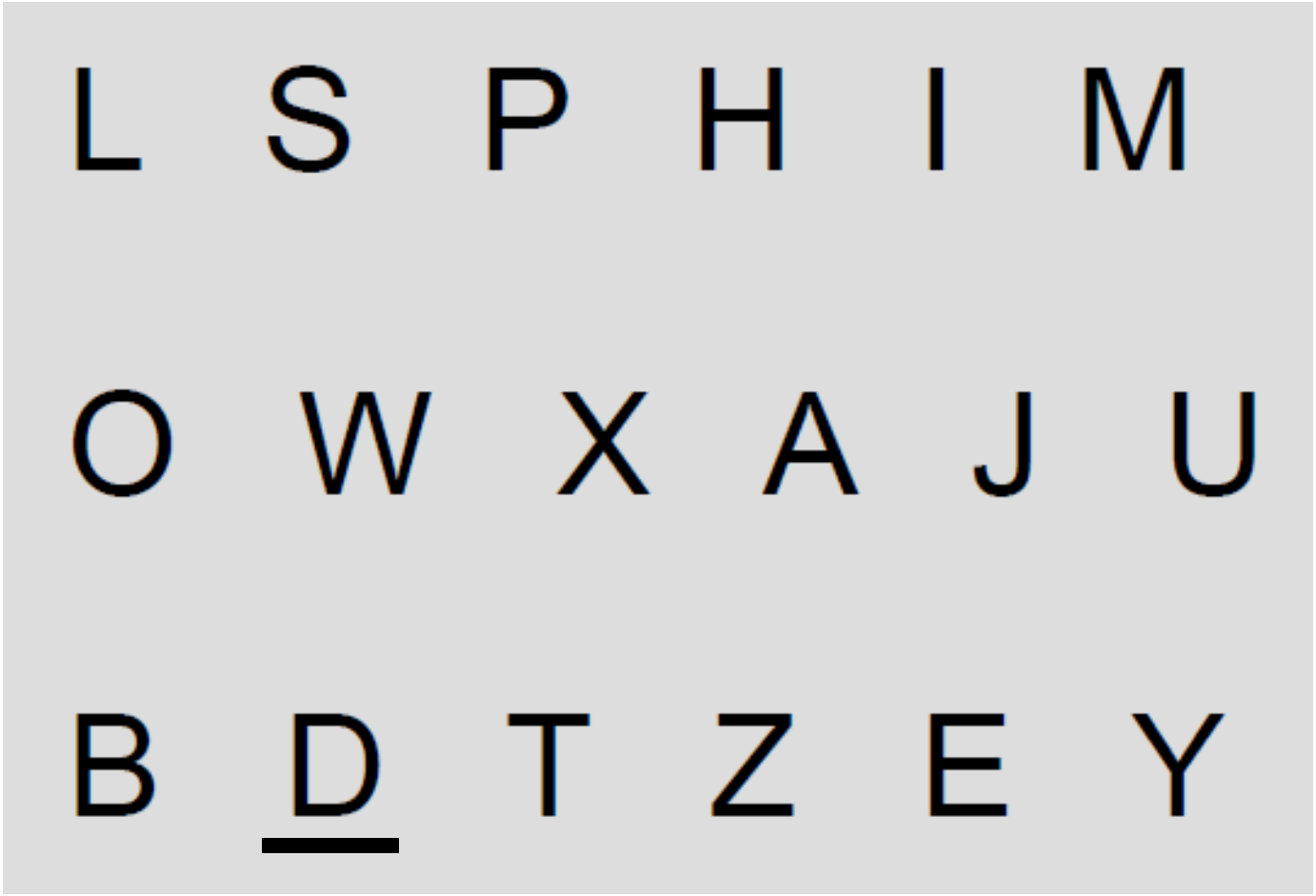
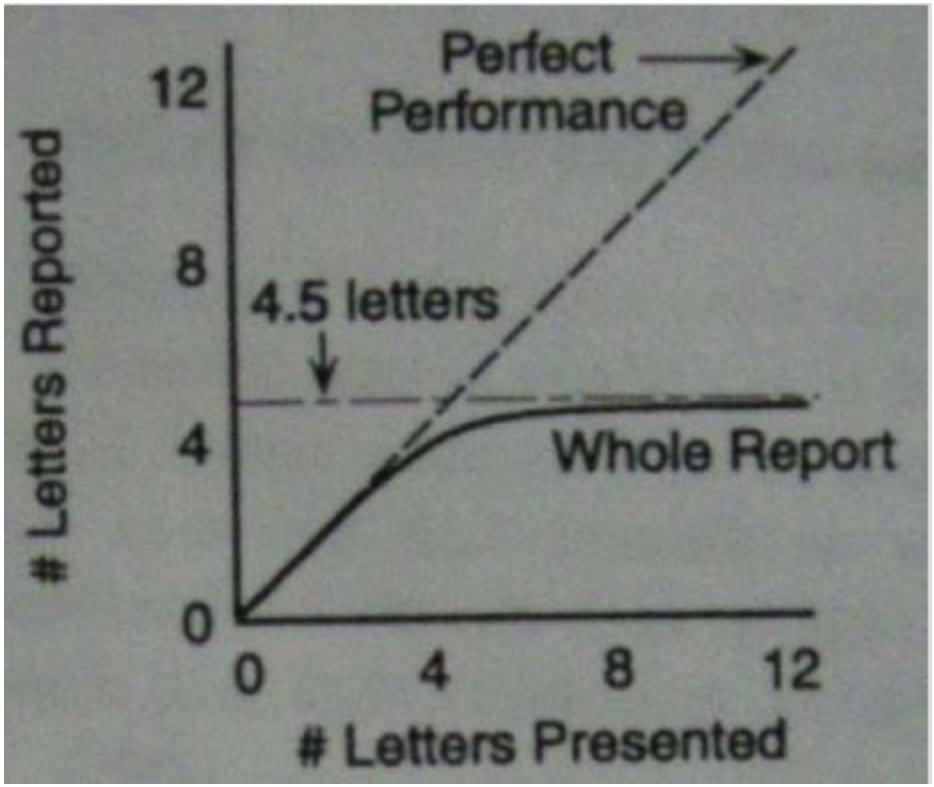
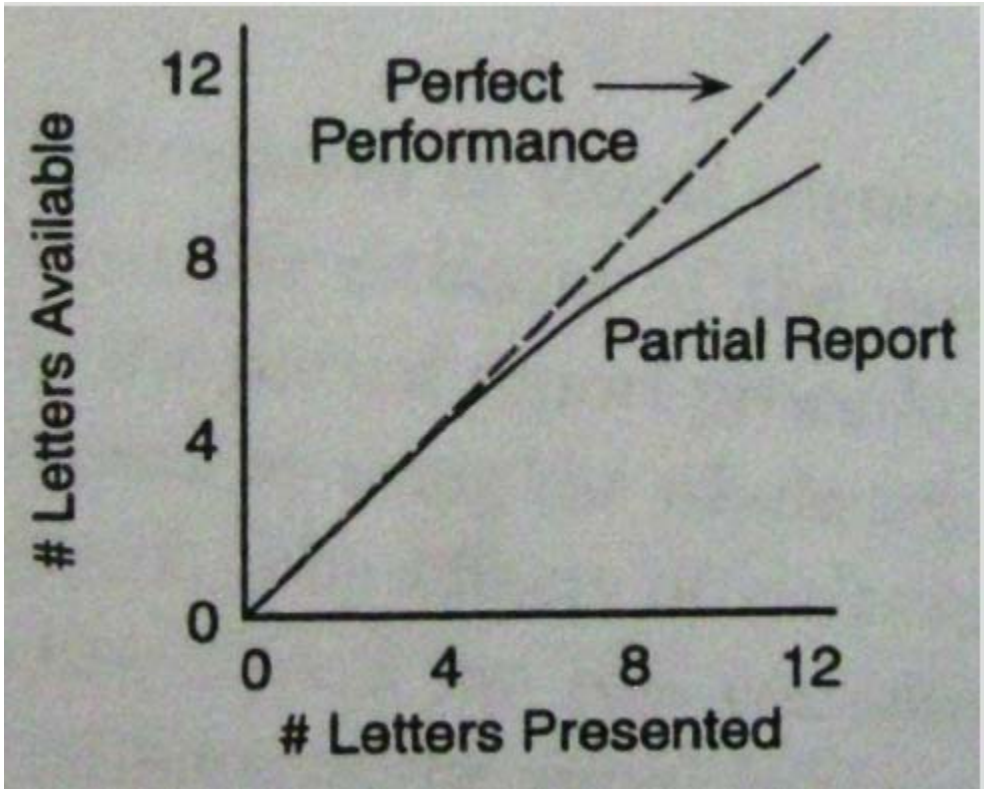


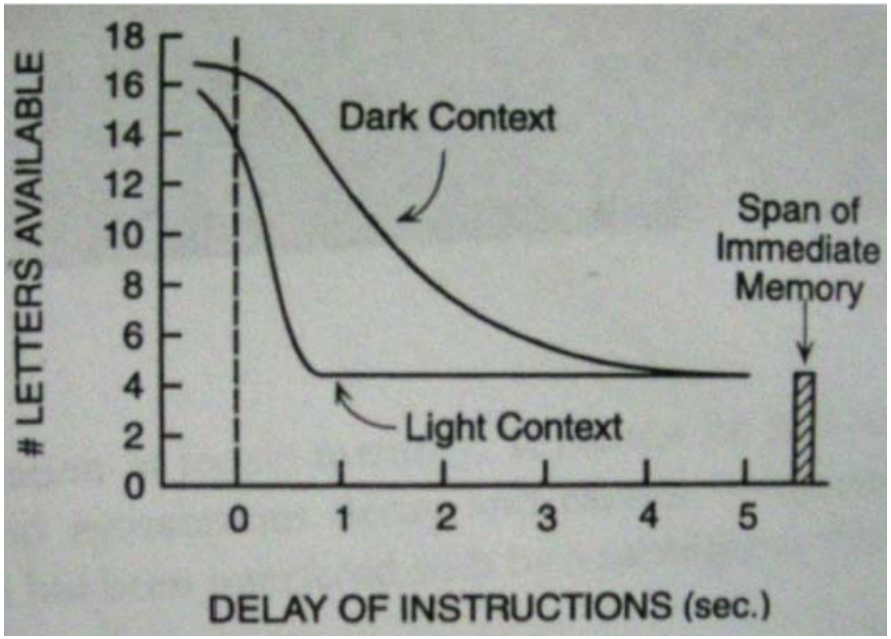
Partial Report Performance





Duration of Iconic Memory

- Delay between display and cuing
- If delay is long enough, partial report will be similar as whole report plot
- Effect of context
  - Mostly light



Iconic memory duration: ½ sec

Content of Iconic Memory

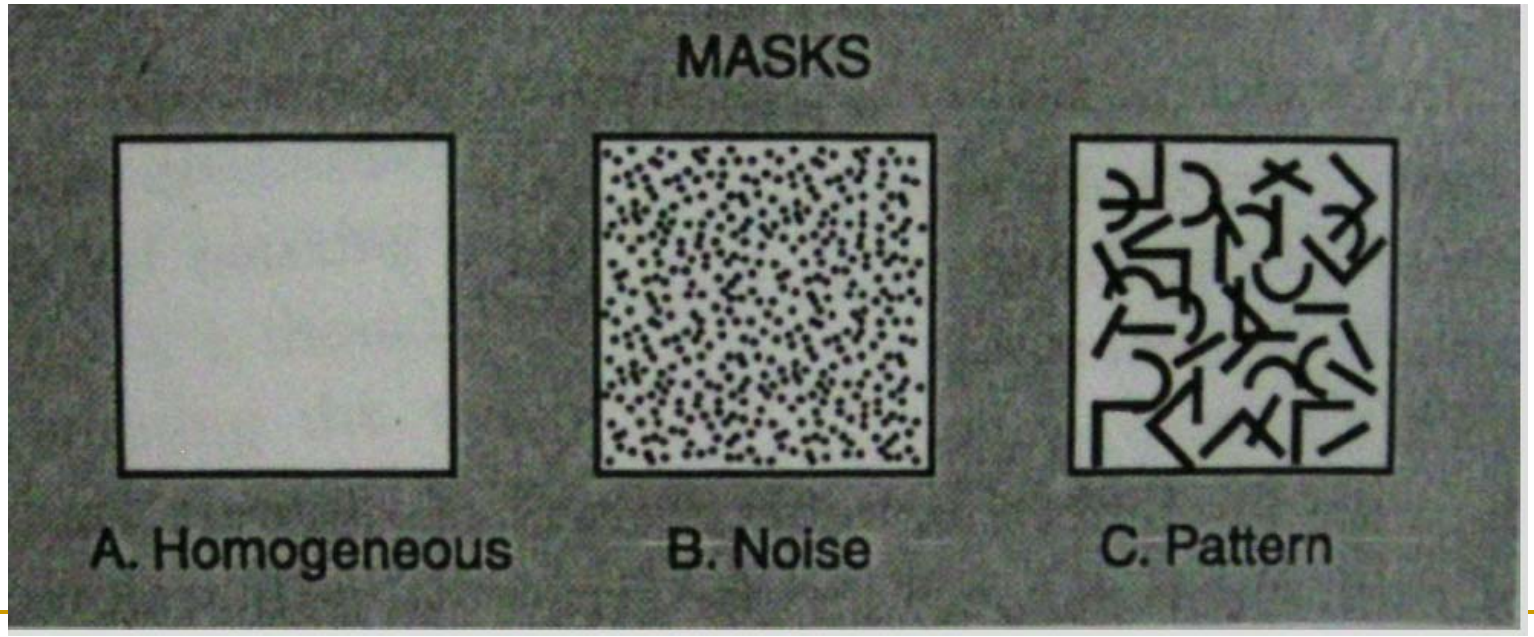
- Effectiveness of different cues
  - Spatial position
- Tone cuing for color, letter/number, row etc
- Effective cues
  - Position, Color, Shape, Size
- Category is ineffective
  - Pre-categorical

Maintenance and Loss

- Cannot be maintained voluntarily
- Loss
  - By autonomous decay
  - By interference
    - Called **masking**
    - Discovered by accident
      - Cuing by a circle
      - Completely erased signal
      - Metacontrast masking or erasure

Masking Terminology

- Forward or Backward Masks
- Homogeneous vs Noise vs Patterned
- Simultaneous Onset Asynchrony (SOA)



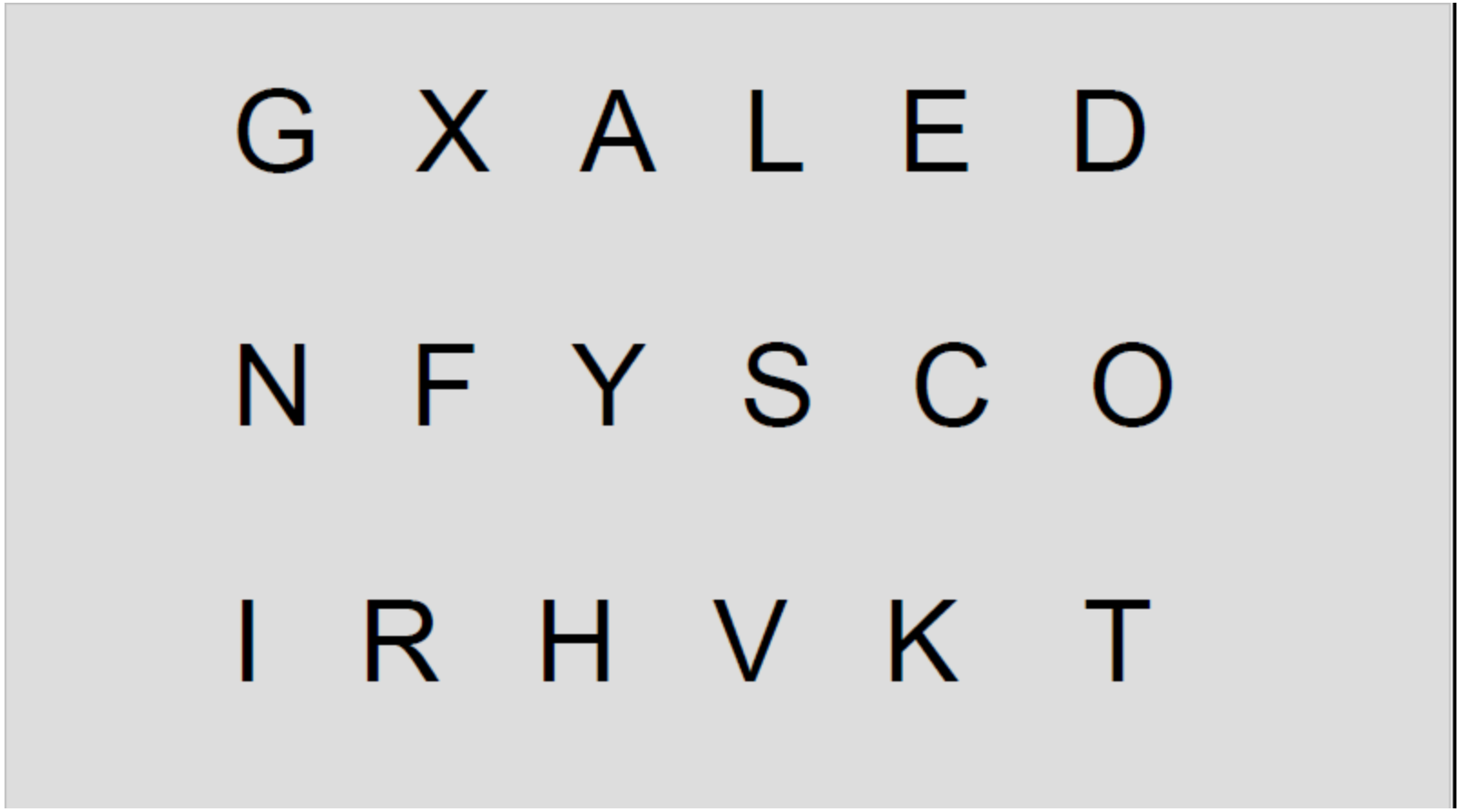
Integration Masking

- Flat color mask
  - Double the intensity of the target
- No target identification for 0-16ms
- Improves as SOA increases
- Complete identification at 200ms

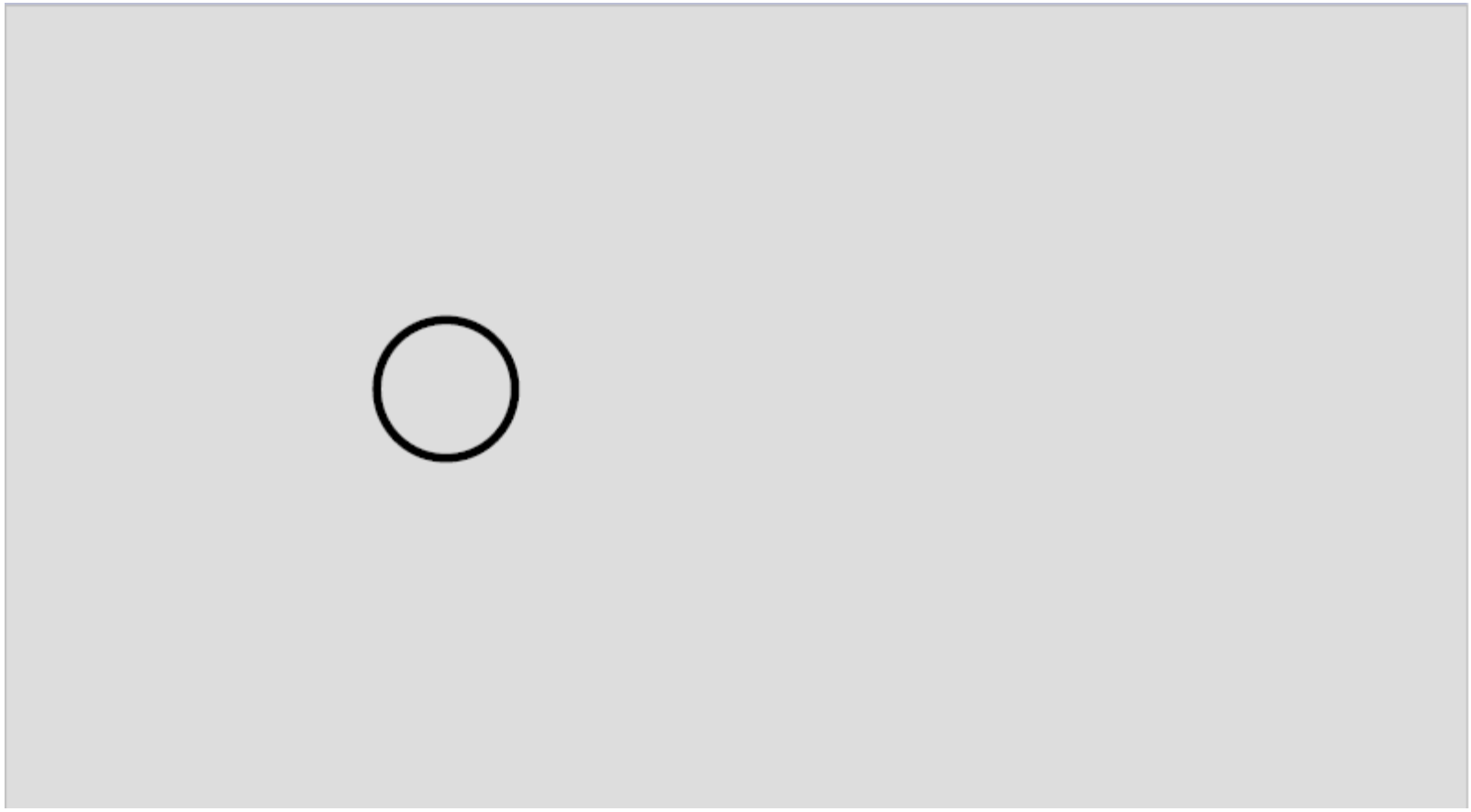
Interruption Masking

- Brightness of mask halved instead of doubled
- No masking at 0ms
- Masking maximizes at 50ms
- Then improves

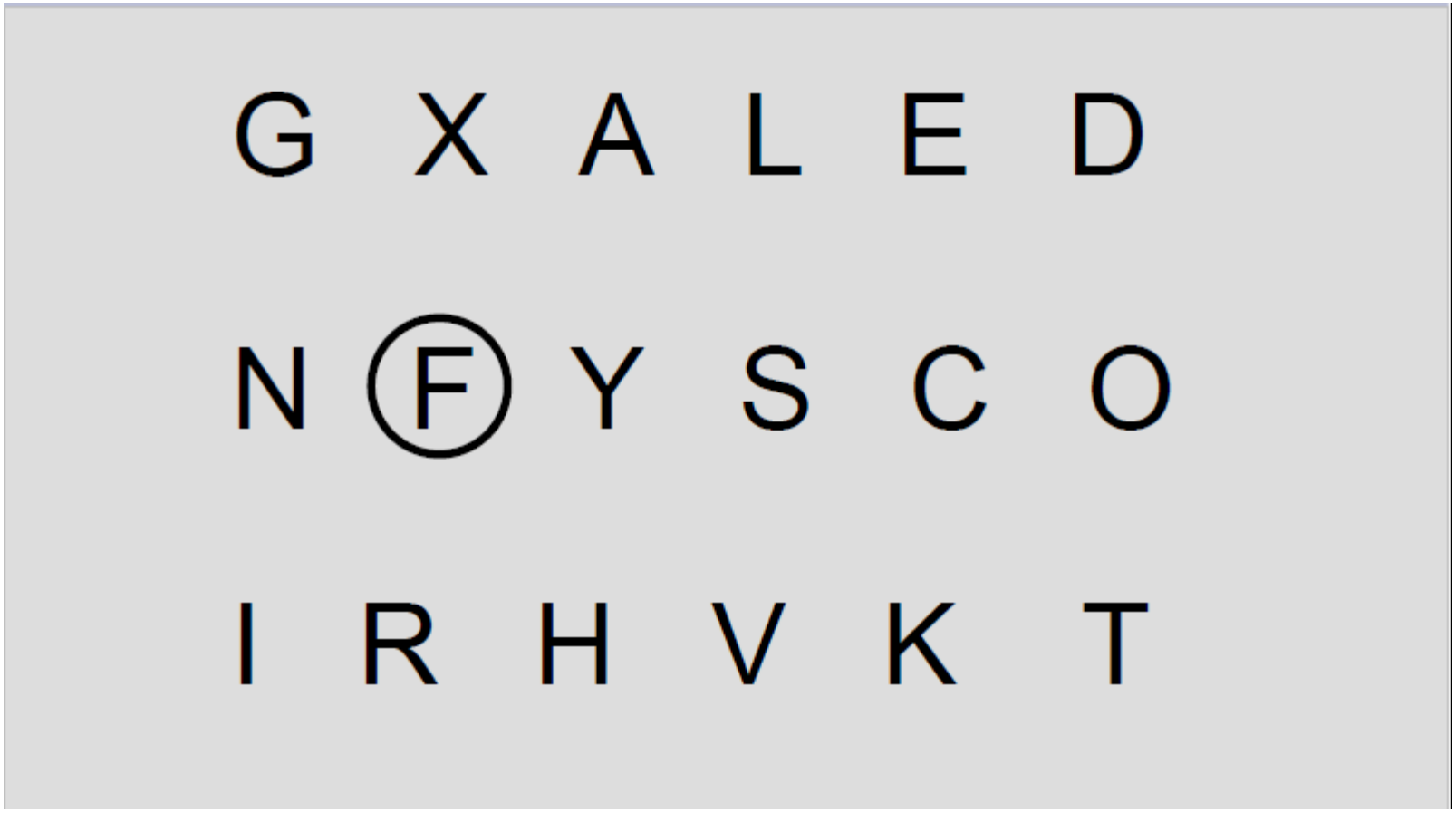
Metacontrast Masking (interruption)



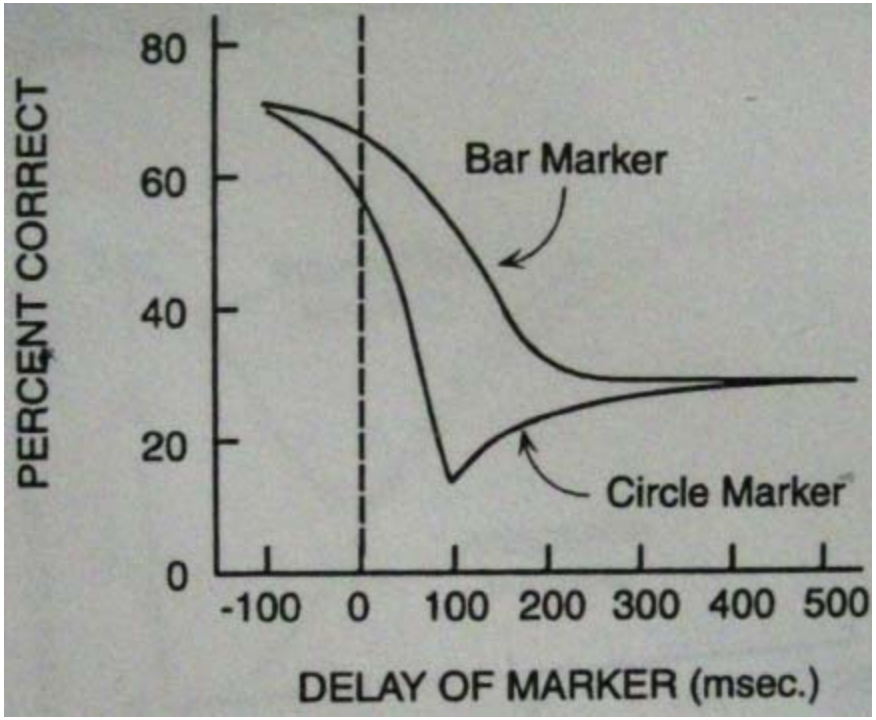
Metacontrast Masking (interruption)



What was the letter?



- Circle sometimes erased the letter
- Masking circle with a bigger circle undoes the effect!!



Interocular Masking

- Dual mechanisms
  - Homogeneous masks only degrade performance is presented to the same eye as the target
    - Processing occurs prior to V1 area of cortex
  - Patterned masks degrade performance irrespective of which eye they are presented to
    - Processing occurs after V1 area of cortex

Persistance

- Does it work by persistence?
  - You can report since you can still see
- Measured by a clever method
  - Set a tone along with start of stimulus
  - Have user stop the tone when he no longer sees it
  - This time is found to be longer than stimulus
  - Subtract stimulus time to find persistance
  - Increasing brightness or duration reduced persistance

What is the use of iconic memory?

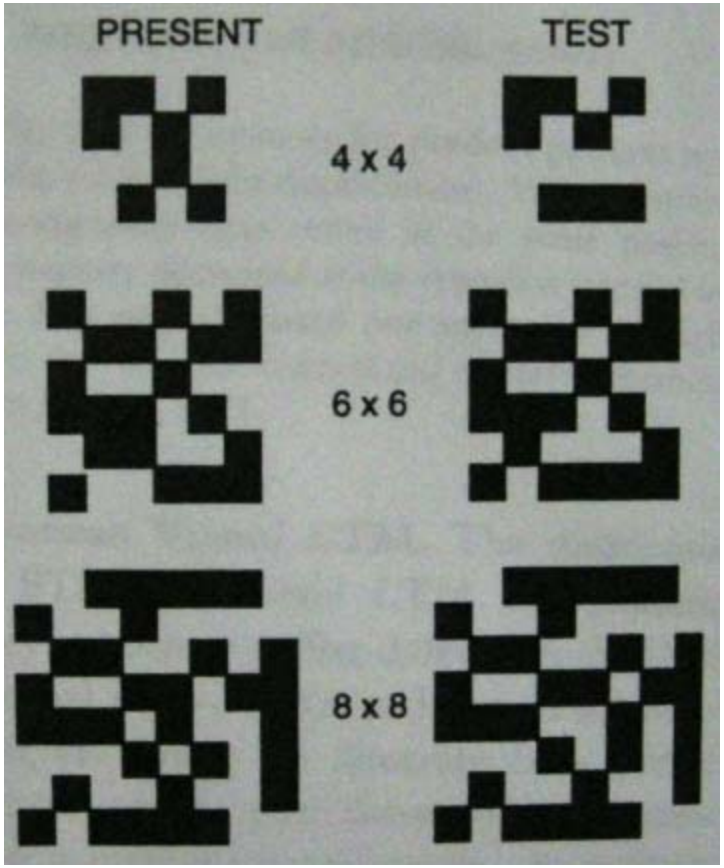
- Processing during saccadic movements?
- During motion processing?
- By-product of some other mechanism?

Visual Short Term Memory (STM)

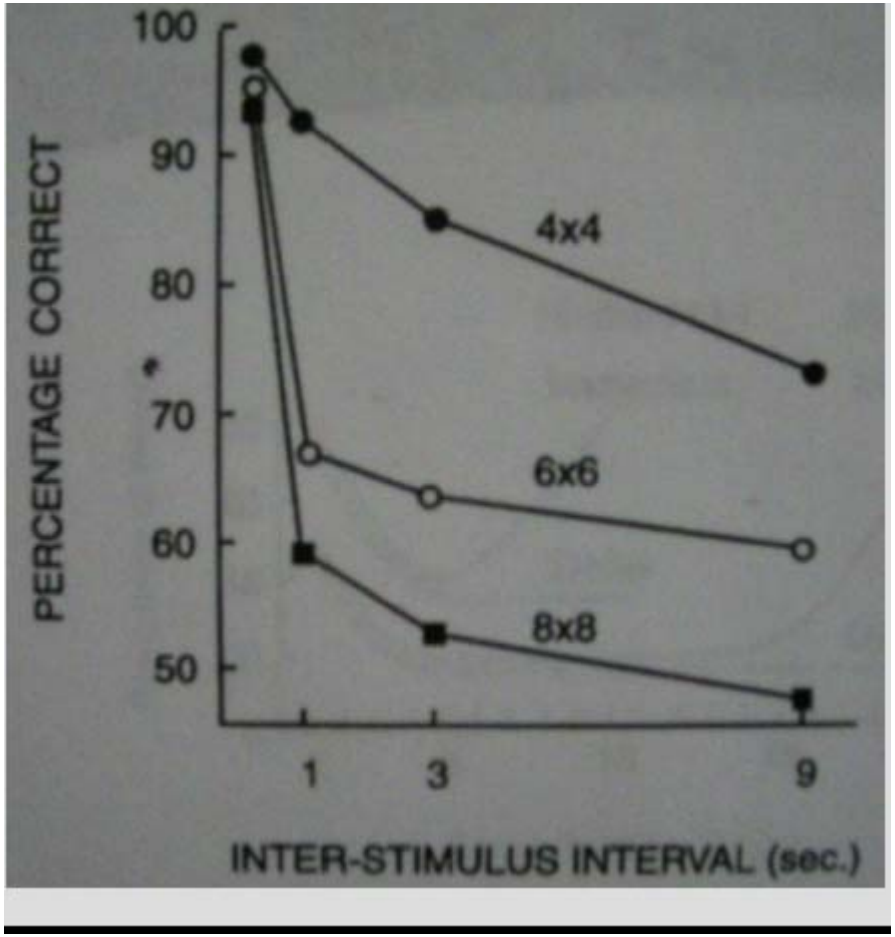
- Gap between iconic and long term memory
  - Iconic memory is for less than 1 sec
  - Even meaningful conversations cannot be explained by either iconic or long term memory
- How to measure?
  - Present meaningful stimulus and ask after 1 sec
  - But subjects will categorize
    - Was it knowledge or STM
  - Need stimulus that cannot be categorized

Meaningless patterns

- William Philips in1975
- Show meaningless grid of random squares
  - Test for retention after 0-9 seconds
  - Same/different answer



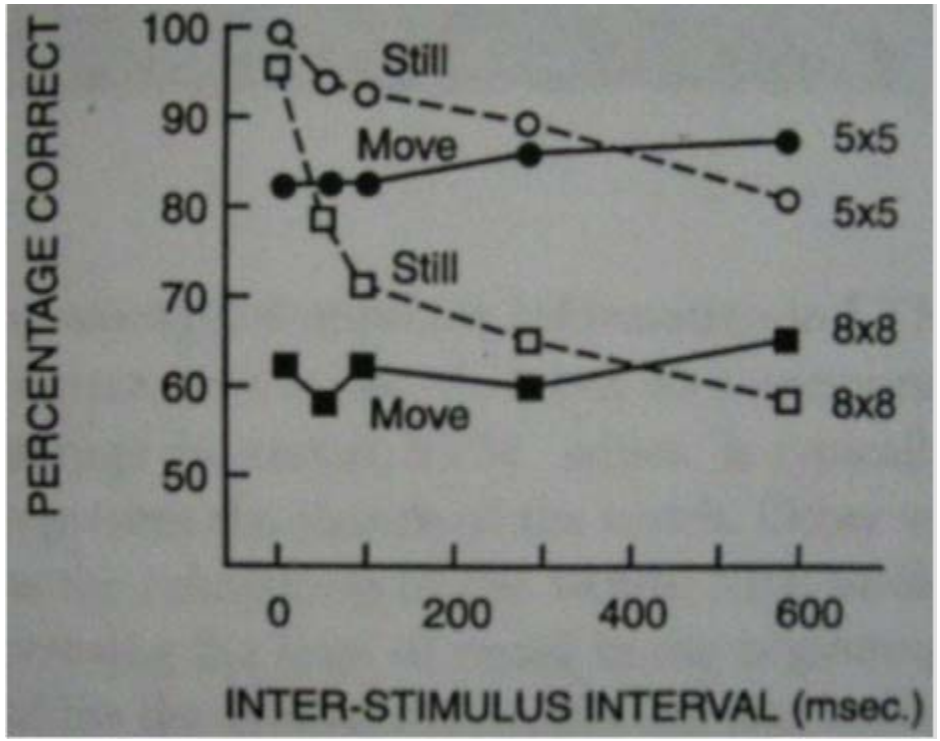
Proof of STM



- Near perfect memory for less than 1 sec
  - Iconic memory
- Performance goes down dramatically after that
  - Well above chance (50%)
  - For smaller grids
- This is proof for existance of STM

Further proof of STM

- Iconic memory is spatially dependent
- If second stimulus shifted in position, iconic memory fails
- STM recall increases in performance

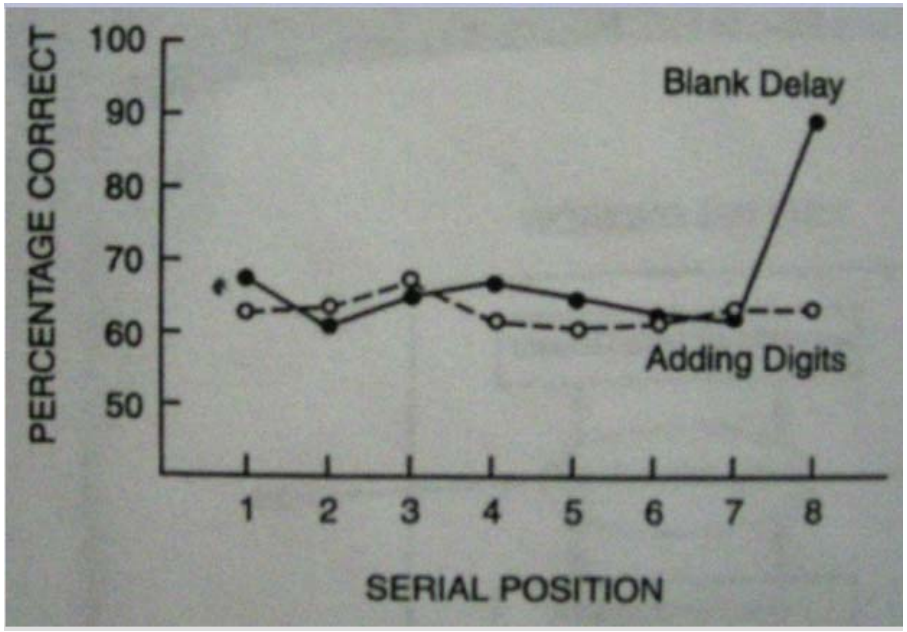


STM or LTM

- Learning from verbal experiments
  - Present a list of words
  - Free recall
  - Serial position curve
    - First and last set of words are better recalled
  - Recency effect: Higher recall of last set of words
  - Delay recall by a distracting task removes recency effect
  - Recency effect is due to STM
  - Slowing presentation increases recall from LTM

STM vs LTM

- Same experiment repeated with grid patterns
  - Forced choice rather than recall
- Recency effect for last grid
  - Eliminated by a coginitively demanding distractor
- Faster rates reduces performance
  - Recency effect persists

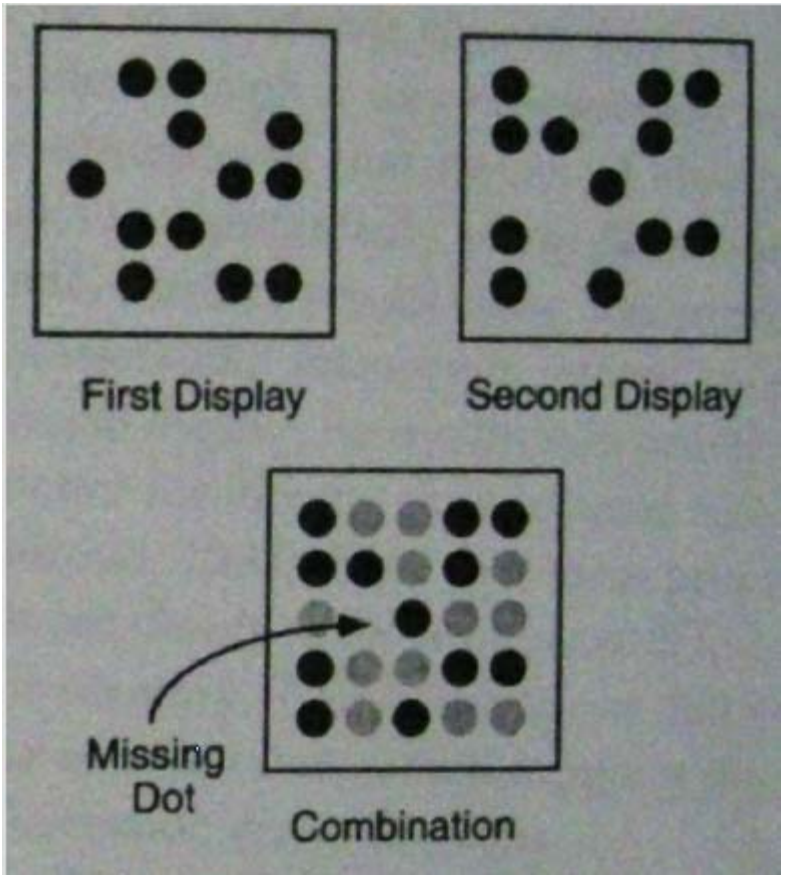


STM properties

- Duration:10 seconds, longer if no interference
- Content: Object based spatial coordinates, Post-categorical
- Capacity: Single item
- Loss: Mainly through replacement, though maybe decay if no rehearsal
- Maintenance: Can be rehearsed

Transaccadic Memory

- Conjecture: Fusion of visual stimuli during saccade
- Experiment
  - Two displays
  - Locate the missing dot
  - With and without saccade
    - Iconic vs transaccadic memory
  - Failure with saccade
- No evidence of fusion



Same as STM

- STM is acting rather than iconic memory
  - Limited to 4 items: Capacity
  - Almost no decay within a second: Duration
  - Better for identification than location
- How do we perceive stable world during saccade?
  - Not due to fusion
  - If target is unmoved, other changes go unnoticed during saccade

Conceptual Organization

- Meaningless visual materials
  - To reduce interference conceptual categorization
  - How to study conceptual categorization?
  - How long does it take?
- Rapid Series Visual Presentation (RSVP)
  - Series of pics presented for 1-1000s
  - Each picture presented for 100ms-2s
  - Detection (e.g. did you see a picnic scene?)
  - Recognition (e.g. What did the picnic scene show?)

Results of RSVP

- Fast presentation rate (100ms), detection is possible, but no recognition
- Cannot comprehend pictures shown for 100-200ms
- However, standalone pictures shown for same duration with noise mask can be both detected and recognized
- Meaningful image within 500ms has a masking effect

Conceptual Short Term Memory

- Takes 100-200ms to log in CSTM
- Takes another 400ms to process for recognition
- If interrupted at that time, the image is lost