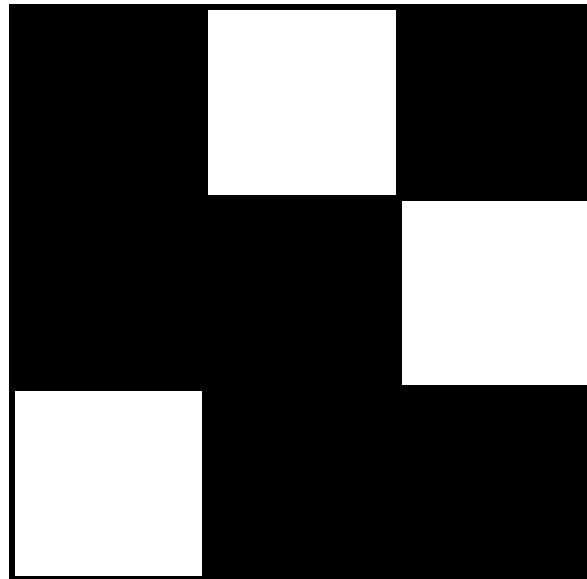


A Square



Visual Memory

- Definition
 - Memory of visual information!
 - Duration unspecified: can range from fractions of a second to decades
- Verbal memory more thoroughly studied
 - Methodologically easier
 - Provides some generalizable results to visual memory

Historical Perspective

- Human memory is a single, undifferentiated system
 - 1885 until 1960s, pioneered by Hermann Ebbinghaus
 - Interference
- Human memory is divided into two sub-systems
 - William James (1890/1950)
 - **Primary memory** lasts 10s of seconds
 - **Secondary memory** lasts for years

Modern Perspective

- Further evidence in the 1960s for James' view
- Modern models contain three components
 - Sensory information stores
 - Very brief “buffer” memory
 - Short-term memory
 - Limited-capacity store of longer duration (10s of seconds)
 - Long-term memory
 - Large-capacity temporally extended store

Distinguishing Memory Systems

- Five important characteristics
 - Duration
 - How long the memories last
 - Content
 - Type of memories stored: visual, auditory, etc.
 - Loss
 - How memories are lost: autonomous decay, interference
 - Capacity
 - How much information can be stored, though varies with duration
 - Maintenance
 - How memories can be refreshed, if at all

Discovery of 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!

J P X R D Q

F T K S W N

G H Z L V B

J P X R D Q

F T K S W N

G H Z L V B

Span of Apprehension

- So how many letters can you report?

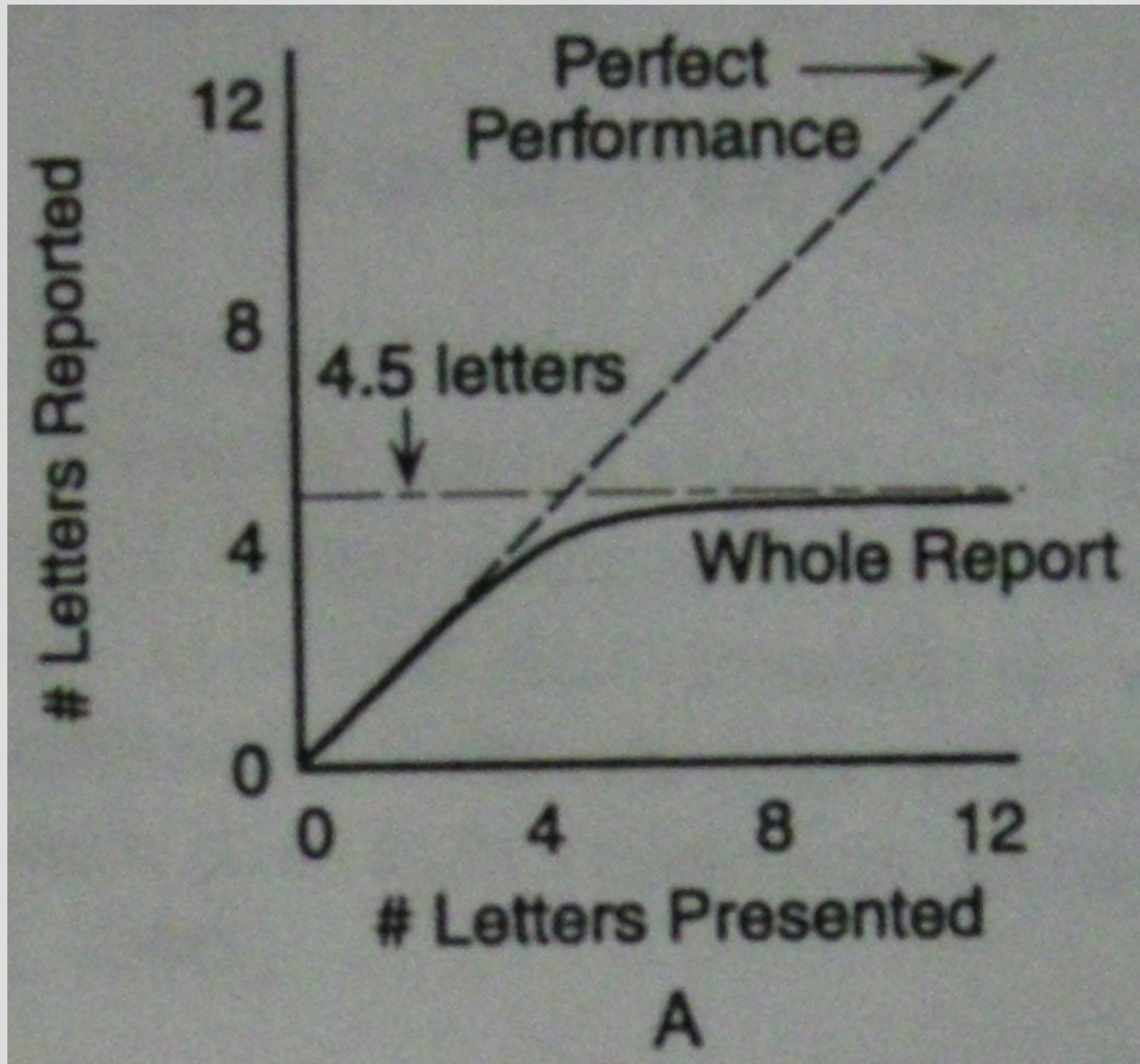
Span of Apprehension

J P X R D Q

F T K S W N

G H Z L V B

Observed Performance



Discovery of Iconic Memory

- George Sperling became interested in this in the 1950s
 - Duplicated earlier results
- Didn't match his visual experience
- Reasoned that the flaw was in the **whole report procedure**
 - Invented the **partial report procedure**

Partial Report Procedure

- As before, multiple lines presented

J P X R

F T K S

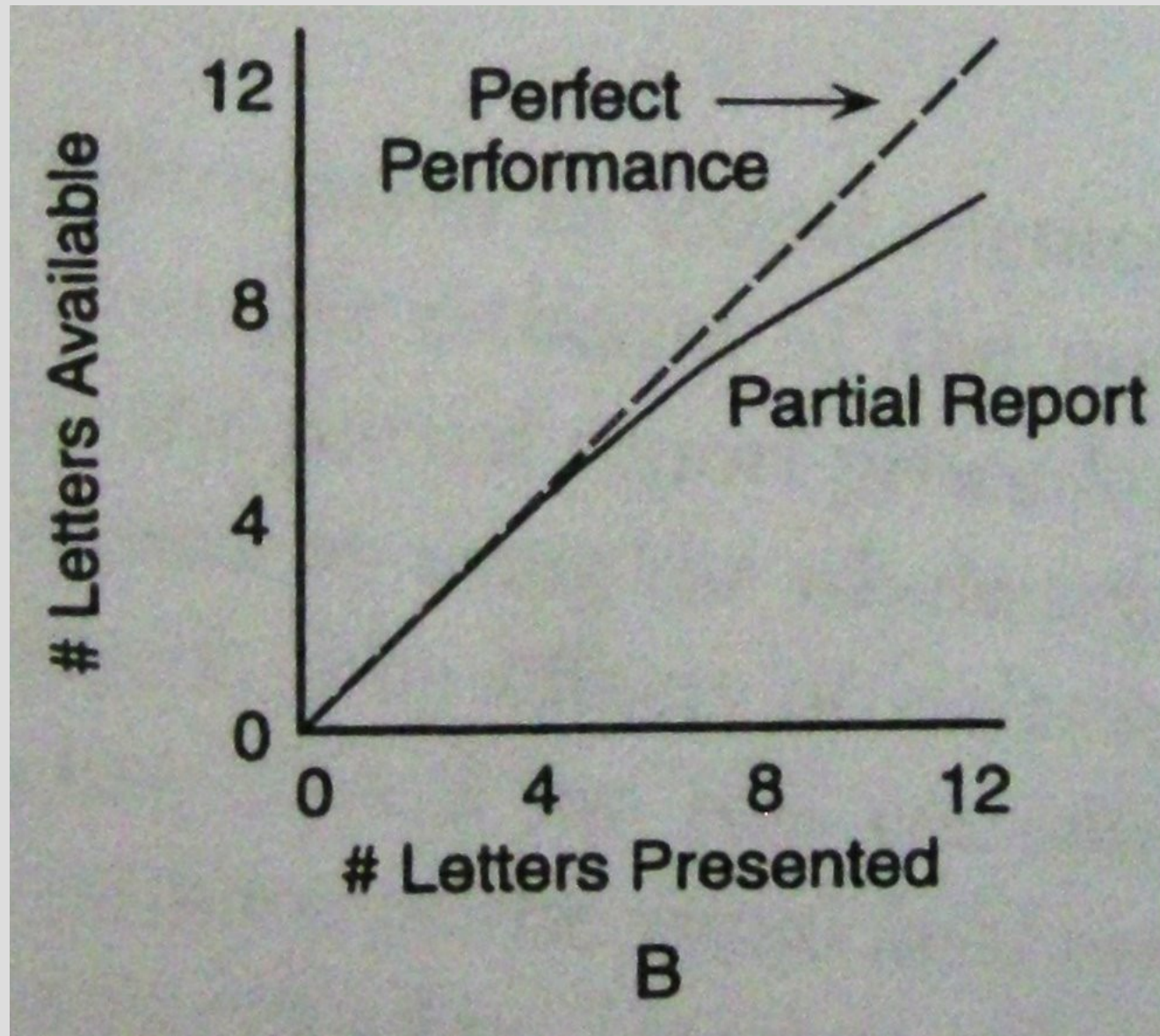
G H Z L

Partial Report Procedure

- Rather than being asked to report everything, only a single line is cued
 - Play a high, medium or low tone after the visual presentation
 - Cannot selectively attend

J	P	X	R
F	T	K	S
G	H	Z	L

Partial Report Performance



Partial Report Demo

- Use a visual bar marker to cue individual letters
 - Leads to higher estimates of capacity

C O Z L E P

I Q R T N V

X W U K Y F

C O Z L E P

I Q R T N V

X W U K Y F



—





—





Partial Report Demo

- What was the letter?

C O Z L E P

I Q R T N V

X W U K Y F

L S P H I M

O W X A J U

B D T Z E Y

L S P H I M

O W X A J U

B D T Z E Y











Partial Report Demo

- What was the letter?

L S P H I M

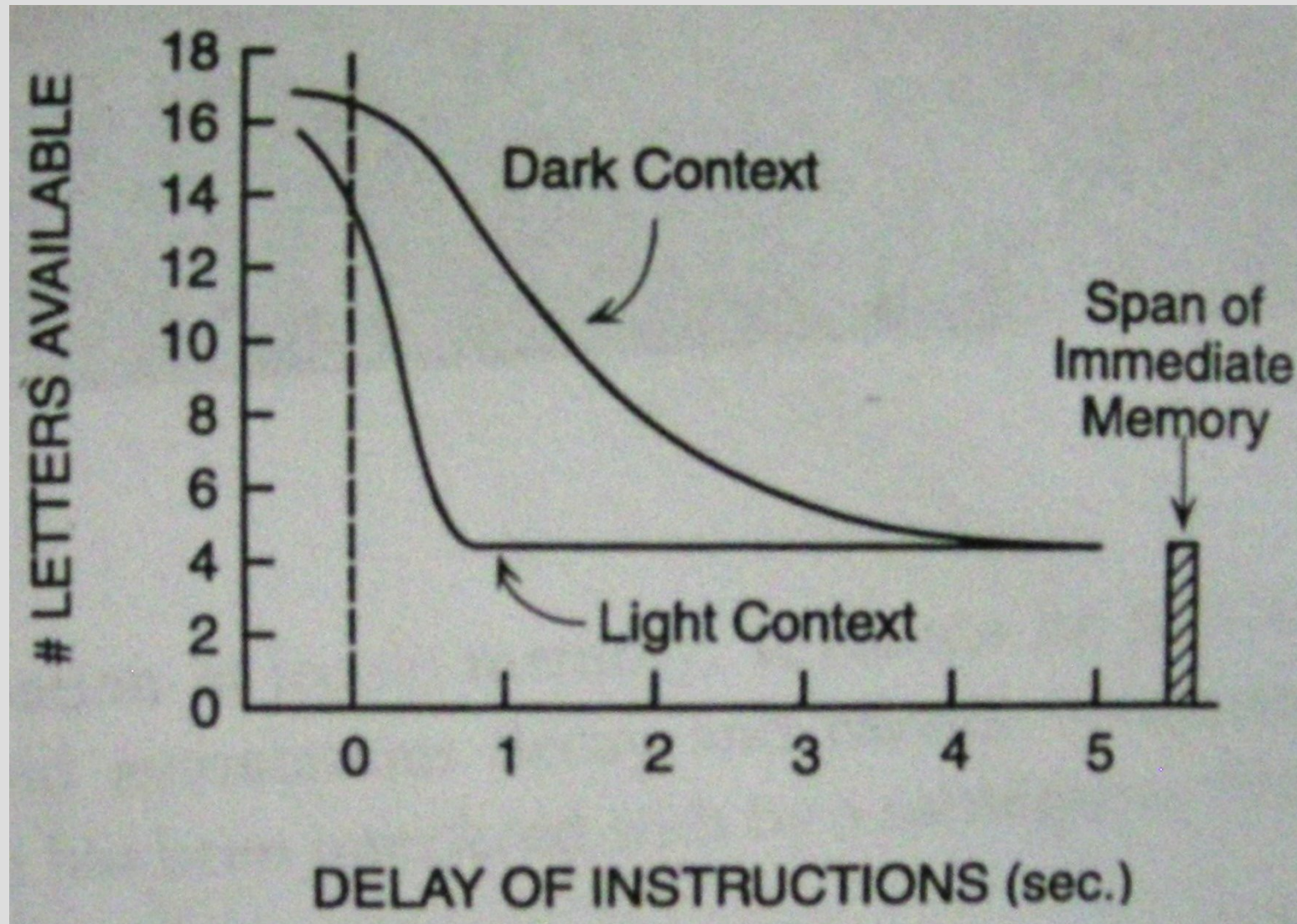
O W X A J U

B D T Z E Y

Duration of Iconic Memory

- How long does iconic memory last?
 - Averbach and Sperling (1960)
 - Reporting delay
 - If the delay is sufficiently long, performance should degrade to **whole report** levels

Duration of Iconic Memory



Content of Iconic Memory

- Clearly contains visual information, but of what type?
 - Spatial information
- Elegant experiment by von Wright (1970, 1972)
 - Effect of cue type partial report performance

Content of Iconic Memory

- Effective cues
 - Spatial
 - Color
 - Size
 - Shape
- Ineffective cues
 - Category
- Iconic memory is precategorical

L 6 K V

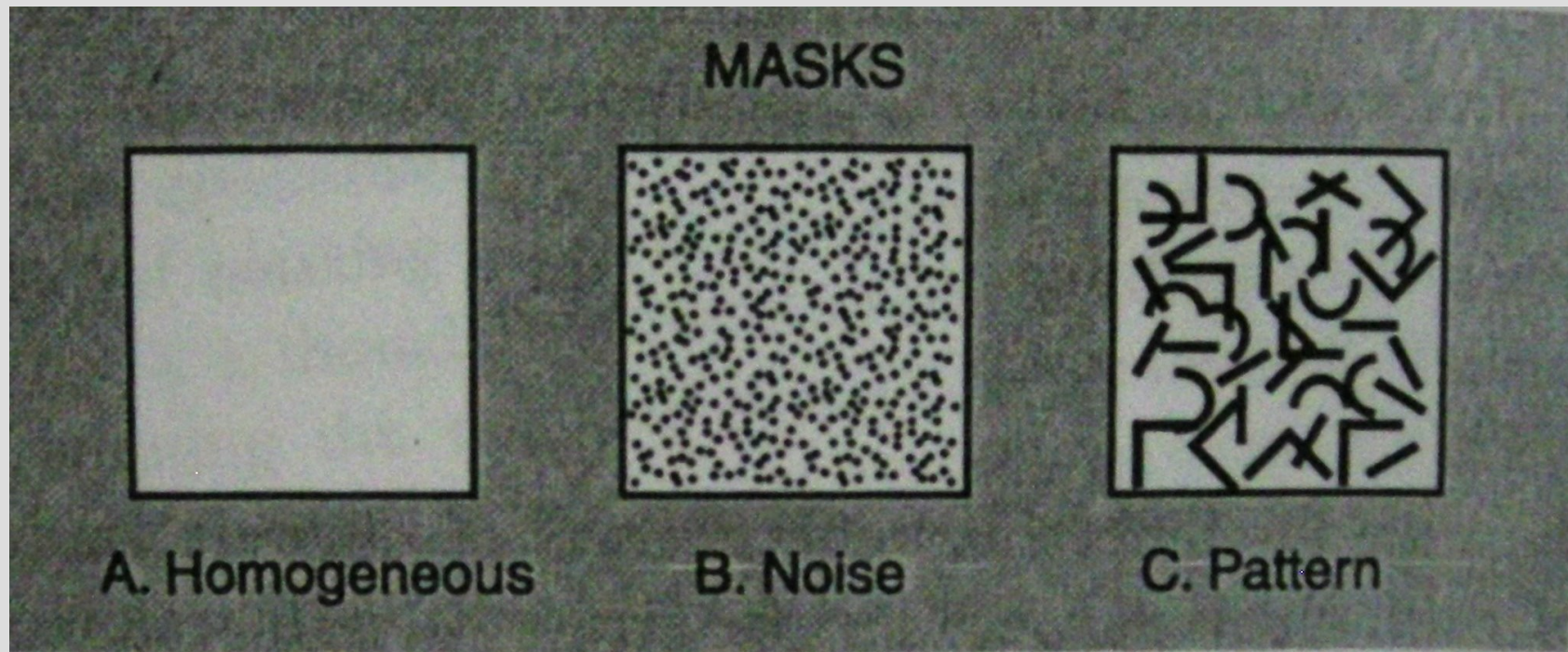
9 3 W 5

Maintenance and Loss

- Maintenance
 - Cannot voluntarily maintain information in iconic memory
- Loss
 - Loss by autonomous decay
 - Loss by interference, called **masking**

Masking Terminology

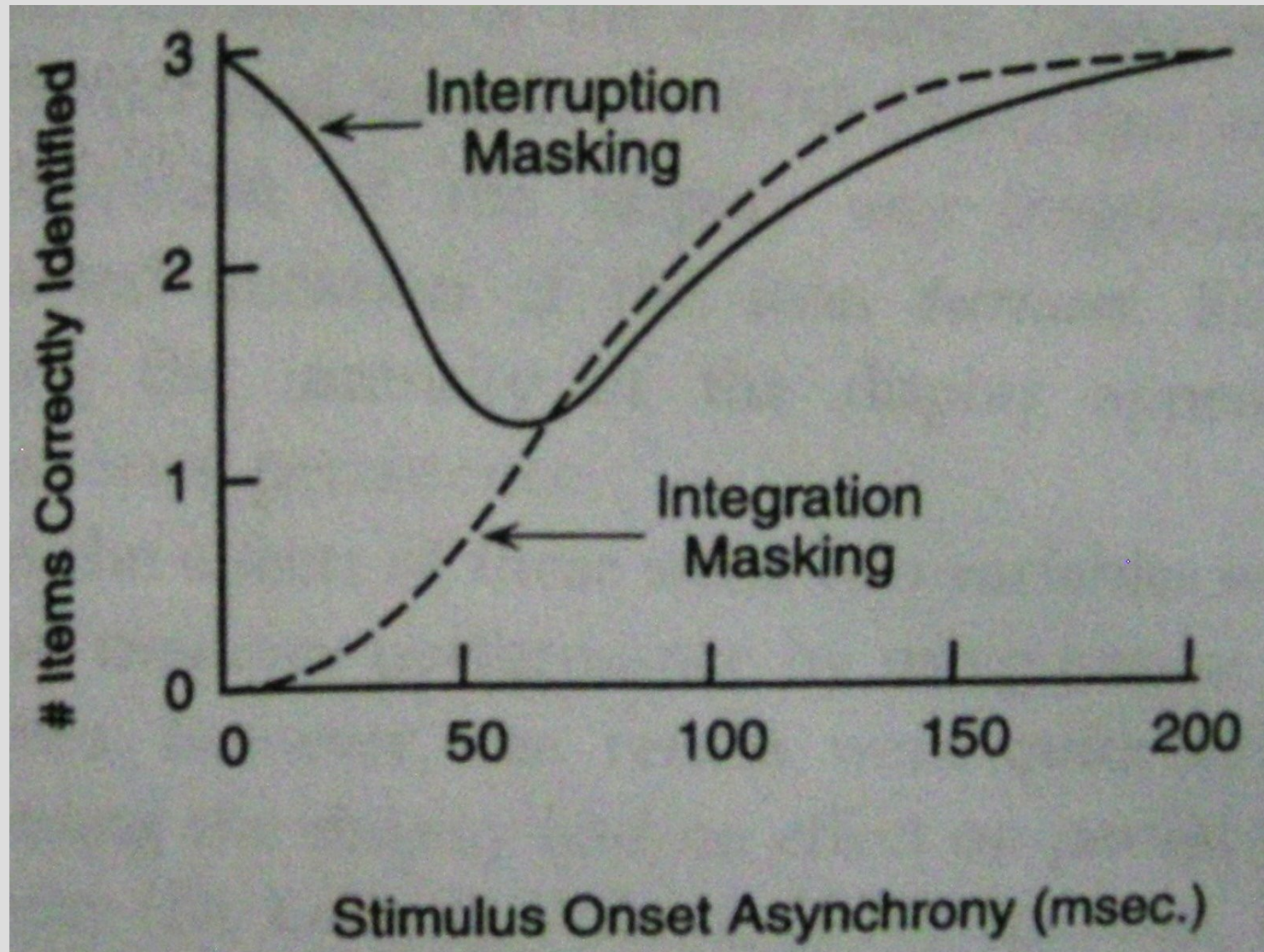
- Forward versus Backward Masking
 - If the mask is presented before or after the target
- Homogeneous vs Noise vs Pattern Masks



Two Different Mechanisms

- Integration Masking
 - Target and mask added together
 - Occurs if optically superimposed or temporally close
- Interruption Masking
 - Mask occludes target
 - Occurs if the mask interrupts perceptual processing after presentation

Two Different Mechanisms



Metacontrast Masking (Erasure)

- Averbach and Coriell (1961) were experimenting with different kinds of spatial cues
 - Circle instead of bar
- DEMO

G X A L E D

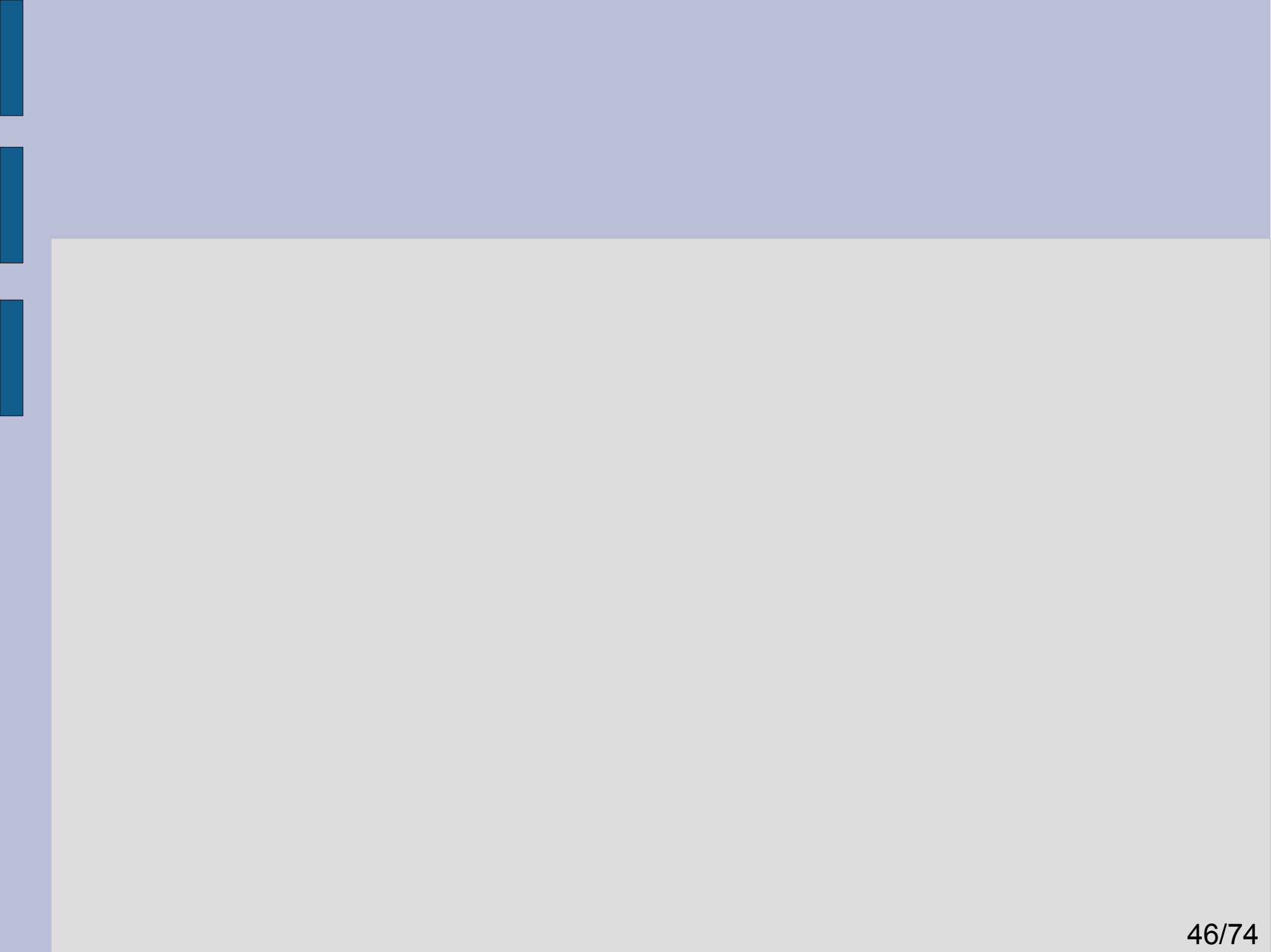
N F Y S C O

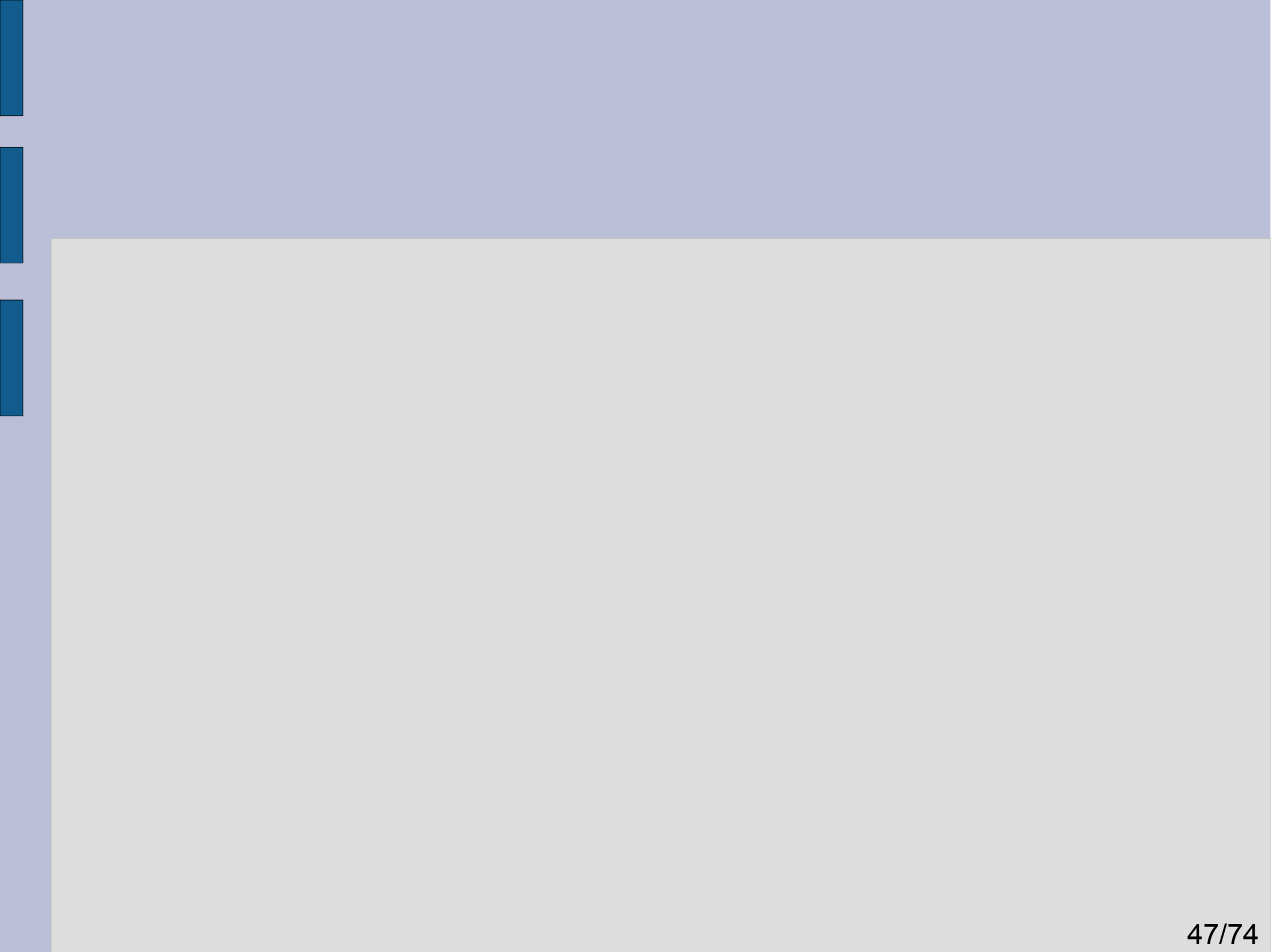
I R H V K T

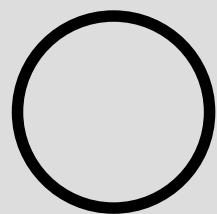
G X A L E D

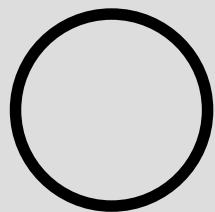
N F Y S C O

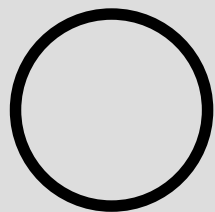
I R H V K T

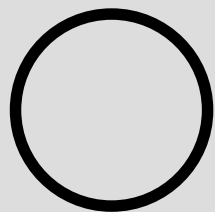


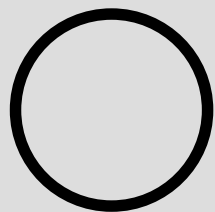












Metacontrast Masking Demo

- What was the letter?

G X A L E D

N Ⓡ Y S C O

I R H V K T

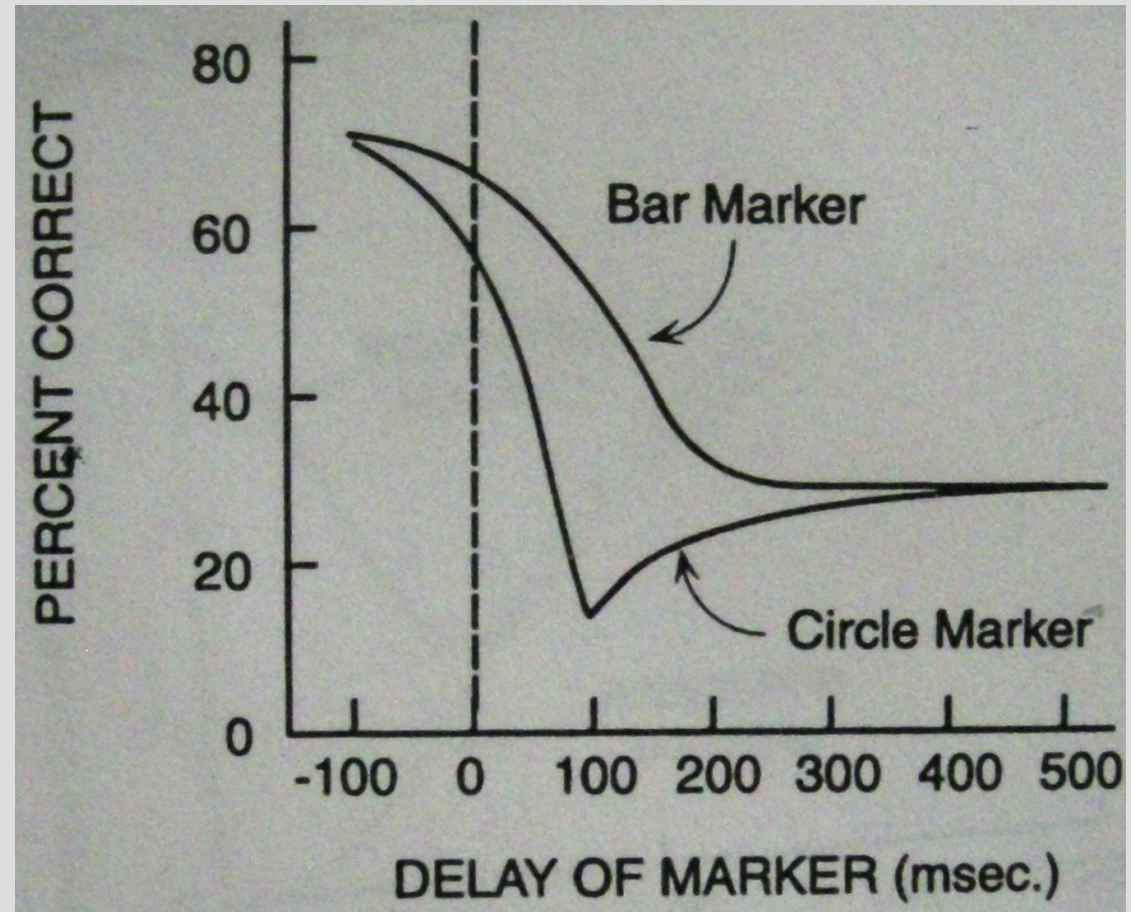
G X A L E D

N O Y S C O

I R H V K T

Metacontrast Masking (Erasure)

- Circle sometimes erased the letter
 - Subjects would report seeing an empty circle
- Masking the circle with a larger circle undoes the effect!



Interocular Masking

- Further support for dual mechanisms
 - Homogeneous masks only degrade performance when presented to the same eye as the target
 - Effect occurs prior to area V1 of the visual cortex
 - Pattern masks degrade performance no matter which eye they are presented to
 - Effect occurs at or after area V1

Persistence vs Processing

- Does iconic memory work by visual persistence?
 - You can report it because you can still see it
- Haber and Standing (1970)
 - Measure visible persistence experimentally
 - Time to onset/offset
 - Increasing the duration or brightness of the display **decreased** the phenomenal duration
 - Effects were either non-existent or positive on the partial report procedure

Persistence vs Processing

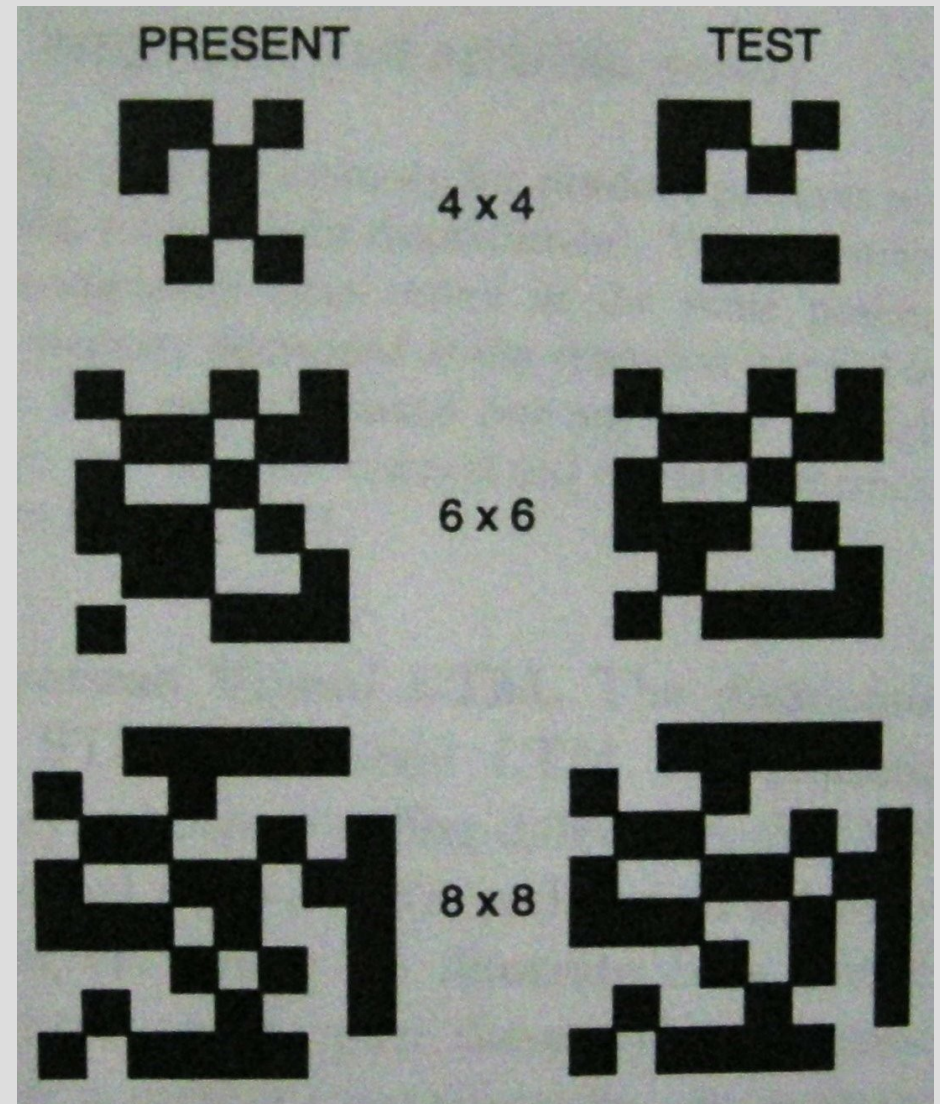
- Why do we have iconic memory?
 - Used to process information during saccadic eye moments?
 - Used in motion processing?
 - By-product of some other mechanism, such as residual retinal activity in the rods?

Visual Short-Term Memory

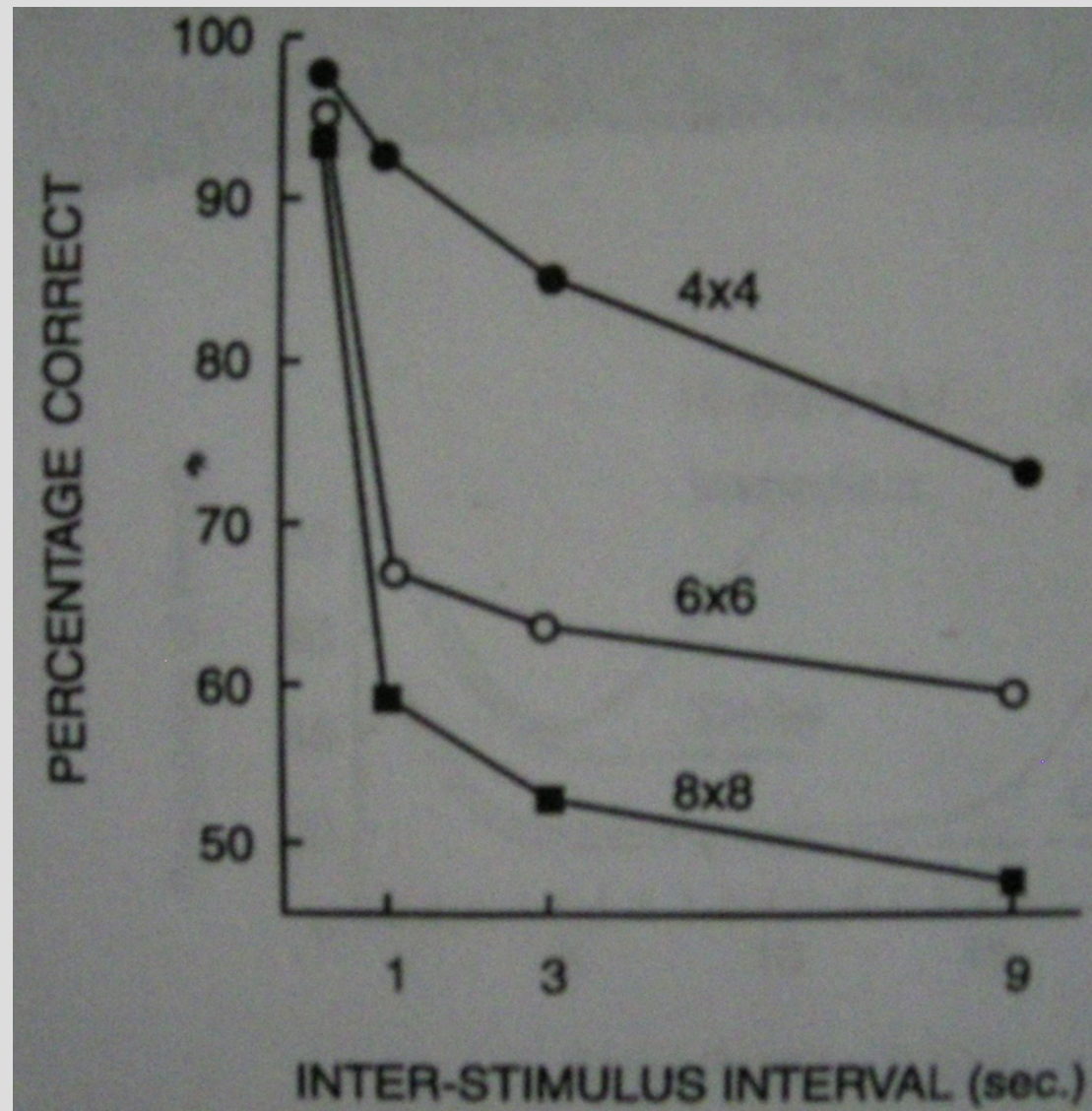
- Iconic memory lasts at most 1s
 - Too short to bridge the gap to long-term visual memory
- Suggests a short-term postcategorical visual memory
 - How to demonstrate its existence?
 - Unable to use meaningful visual material – interference
 - Need to isolate visual short-term memory – use meaningless visual material

Meaningless Patterns

- William Phillips (1974) showed subjects patterns of black and white squares
 - Retention interval ranging from 0-9s
 - Same/different judgments

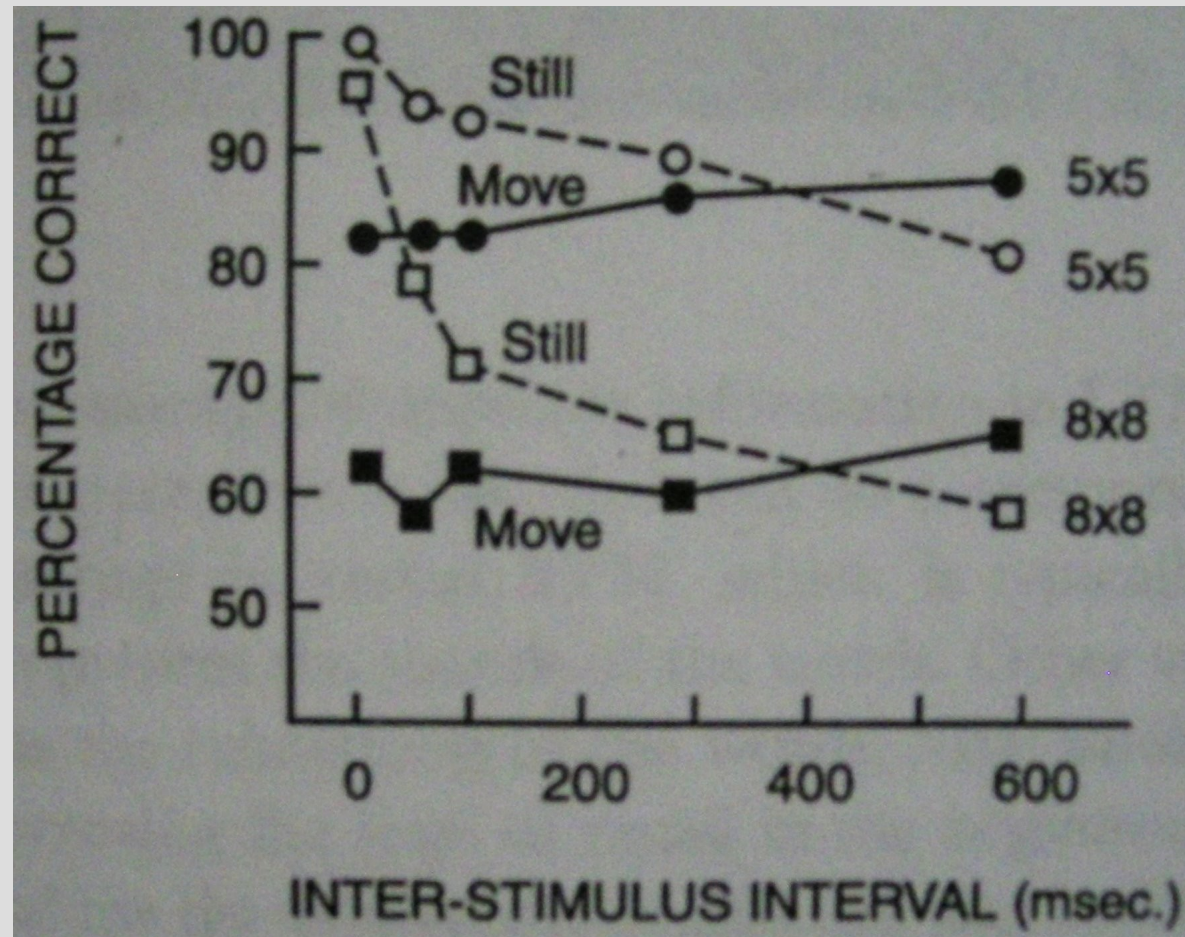


Proof of Visual STM



Further Investigation

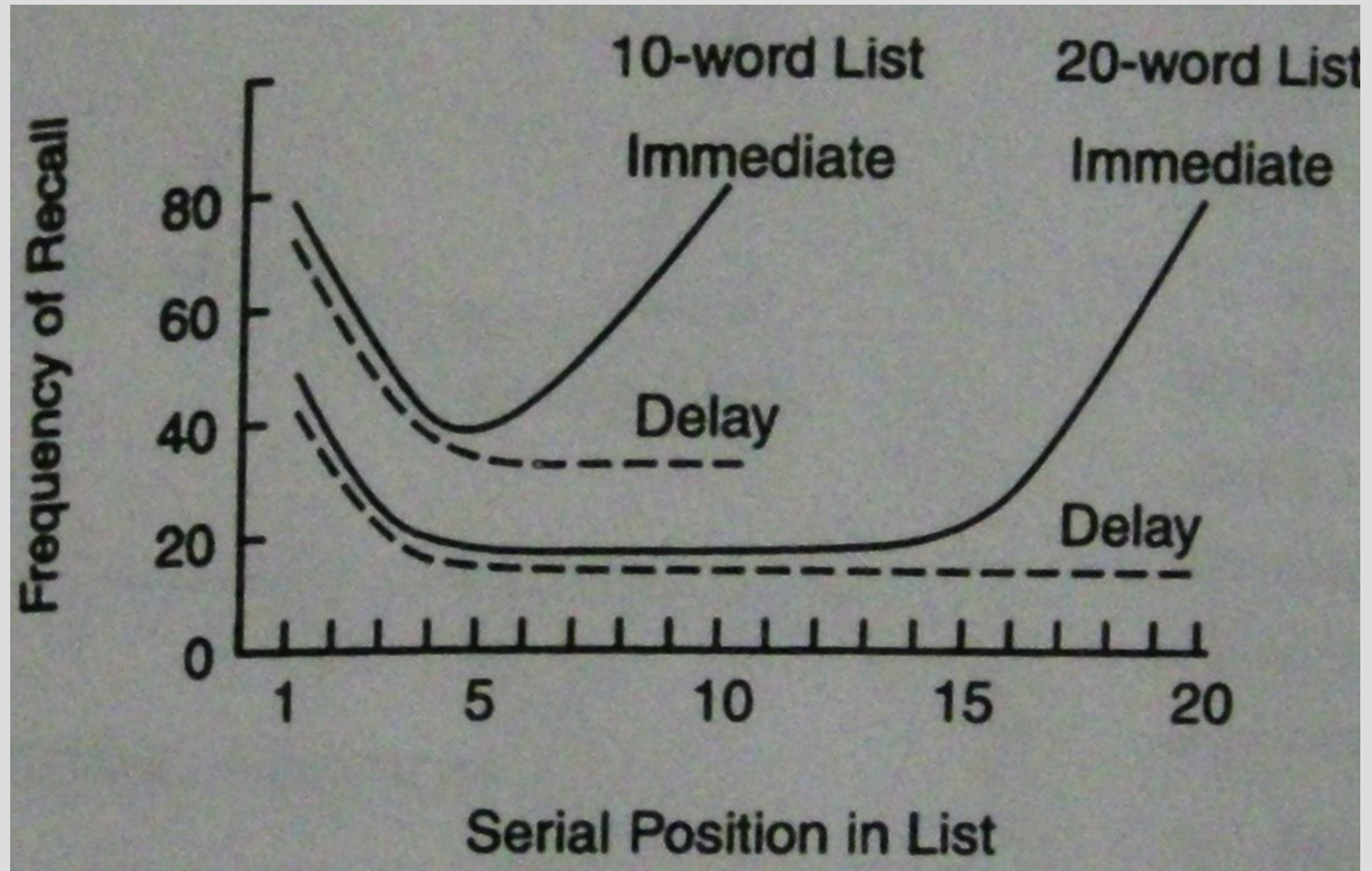
- Iconic memory
 - Spatially coded in absolute retinal coordinates
- Visual STM
 - Coded in object-based reference frames



STM vs LTM

- Brief digression
 - Verbal STM differentiated from verbal LTM
- Free recall
 - List of words
 - Recall as many words as possible
 - Results exhibit a serial position curve
 - Primary and a recency effect for immediate recall
 - Delayed recall exhibits only a primacy effect
 - Cognitively demanding distracter task eliminates STM contribution

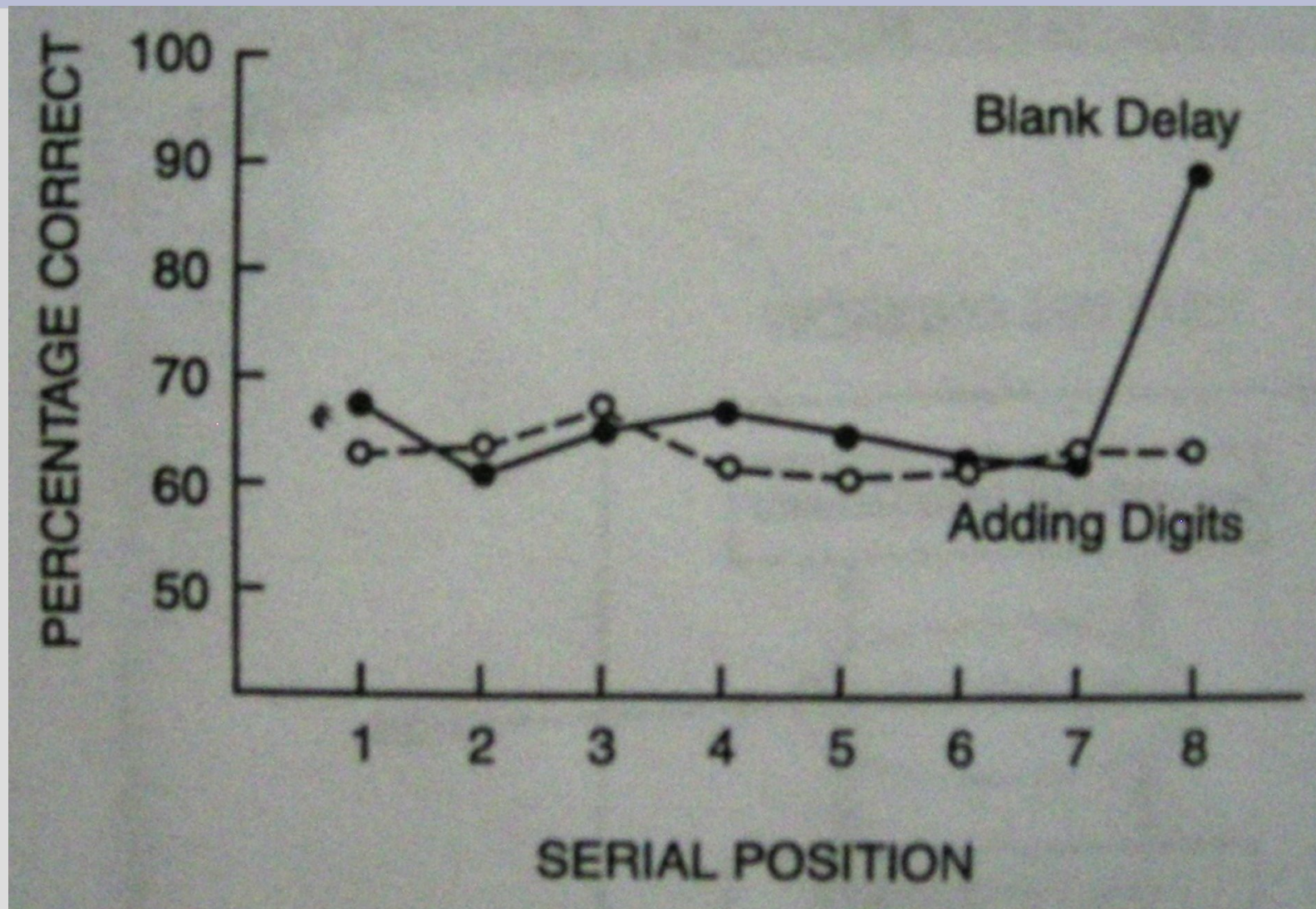
Serial Position Curve



Visual Serial Position

- Phillips and Christie (1977)
 - Series of black and white square patterns
 - Forced choice task, rather than recall
- Shows a recency effect, but only for the last item presented
 - A cognitively demanding distracter task eliminates the recency effect
 - Faster presentation rate reduces general performance, but left recency effect unchanged

Visual Serial Position

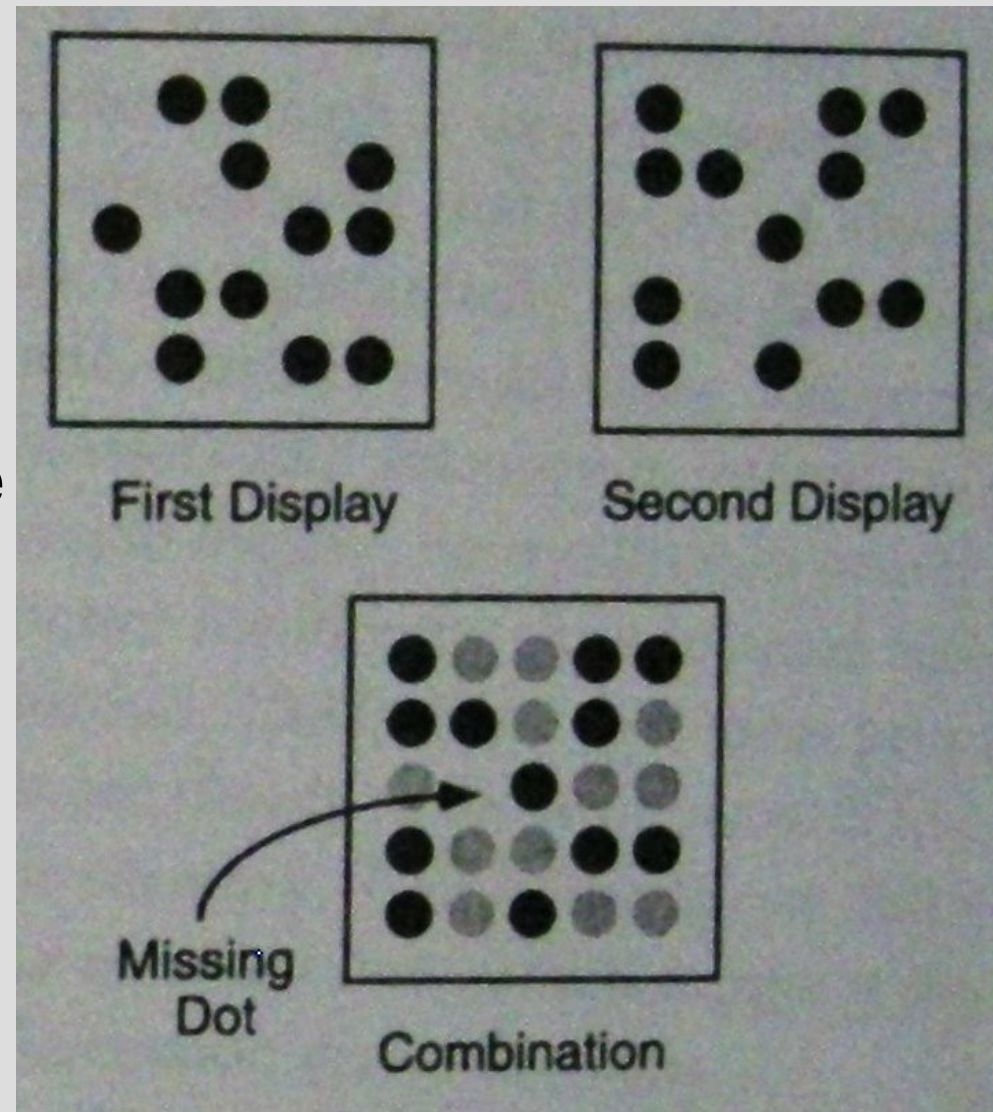


Visual STM Summary

- Duration
 - At least 10s, probably longer if no interference
- Content
 - Spatial information, represented in object-based coordinates
 - Postcategorical
- Capacity
 - A single item
- Loss
 - Mainly through replacement, though possibly decay if no rehearsal
- Maintenance
 - Appears to be rehearsable

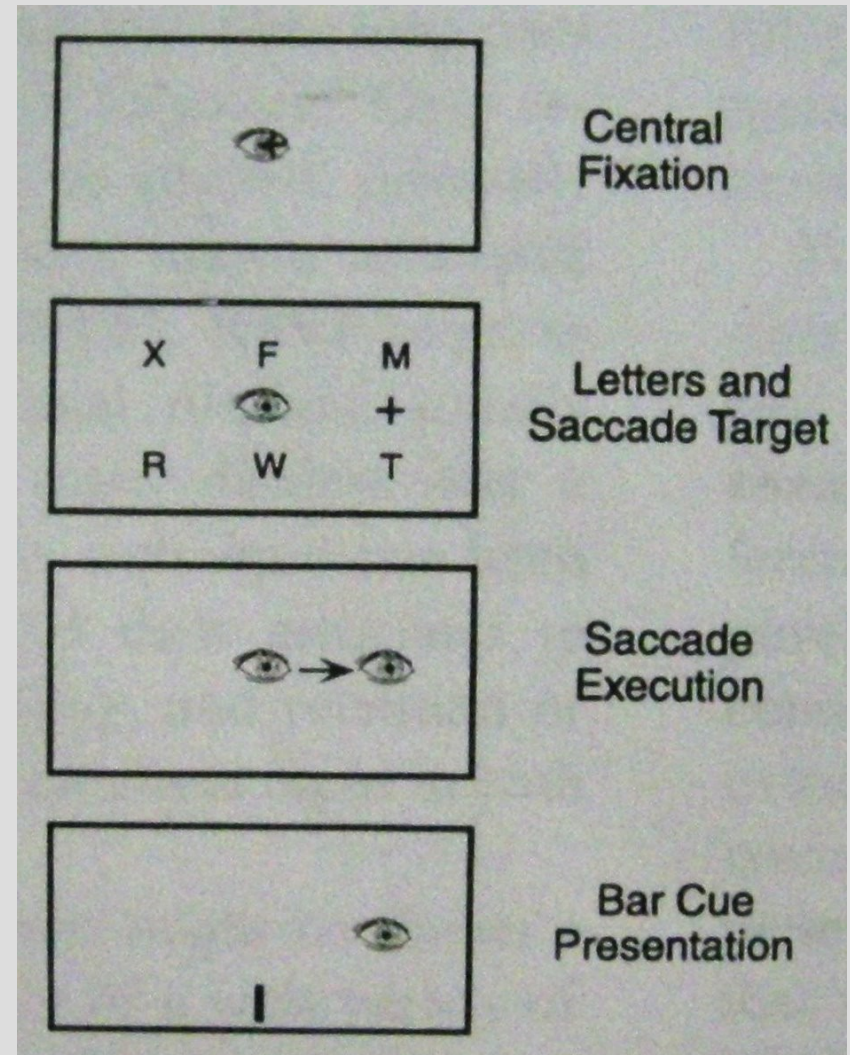
Transsaccadic Memory

- Rayner, McConkie and Erlich (1978)
 - An integrative visual buffer that superimposes the contents of successive visual fixations
- Irwin, Yantis and Jonides (1983)
 - Found no evidence of spatiotopic fusion



Transsaccadic Partial Report

- Irwin (1992) did further experimentation
 - Modified the partial report procedure to force saccades
 - Spatial alignment, but loss of retinal alignment
 - Performance degrades dramatically



Transsaccadic Memory

- Corresponds closely to visual STM rather than iconic memory
 - Limited to about 4 items
 - Decays little in a full second
 - Better for identity than location
- We perceive a stable world not because our visual system integrates images, but because the world is stable
 - As long as the target object remains unmoved, general changes will go unnoticed during a saccade

Conceptual Categorization

- Meaningless visual materials
 - Used to prevent interference from conceptual categorization
 - How to study this categorization? How long does it take? How is it forgotten?
- Rapid serial visual presentation (RSVP)
 - Display images at rates varying between 100ms and 2s per image

RSVP

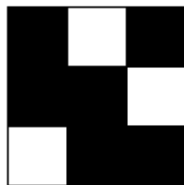
- Before being shown the image stream, asked to:
 - Detect the presence of a picture fitting an abstract conceptual description (“picnic scene”, “two people drinking”)
 - Remember them for a later old/new recognition task
- At fast presentation rates (100 ms), detection is still good, but recognition is at chance levels

Conceptual Masking

- With fast presentation rates, something stops a stable memory trace from being formed
 - Recall for a quick presentation is quite good
 - Meaningless visual masking has little effect
 - Presenting another meaningful picture within 500 ms causes a masking effect
- Conceptual short-term memory posited
 - Takes 100-200 ms to get information into CSTM
 - Takes an additional 400 ms to conceptually process it
 - If interrupted during that time, the memory is lost

Long term memory

Long term memory



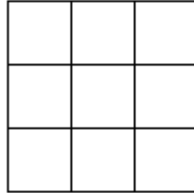
Long term memory

- Types of long term memory
 - Semantic memory
 - “Hammers are a kind of tool”
 - Procedural memory
 - “You use a hammer by swinging it like this”
 - Episodic memory
 - “Last time I used a hammer, the following happened:”
 - Visual routines.
 - Visual analogs to all of the above.

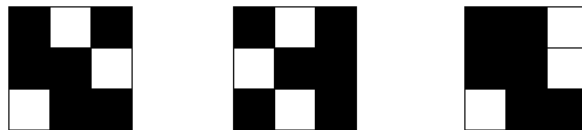
Long term memory

- Visual routines
 - Ullman '84
 - Primitive routines that are combined into higher level routines.
 - Shifting the focus
 - Indexing
 - Bounded activation
 - Boundary tracing
 - Maxing

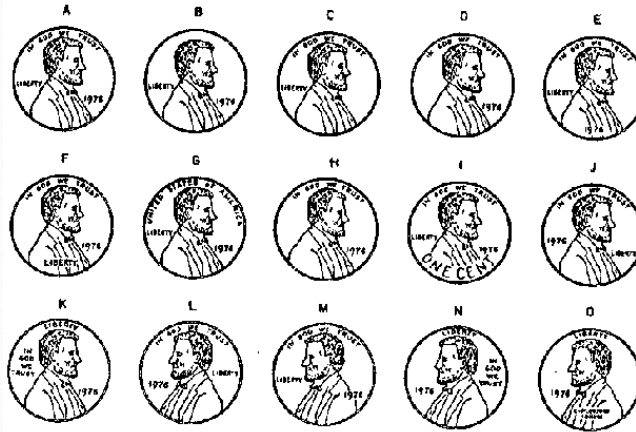
Recall



Recognition



Harder example of recognition



Recall and recognition

- Accuracy of recognition depends on many different factors.
 - Similarity of images.
 - Experience with the original image.
 - Attention given to image.
 - Penny not noticed very often.
 - Features noticed are shape and color.
 - Not text.

Mnemonic aids

- Visual imagery is often used as a mnemonic device.
 - We can remember lists of abstract items more readily if we associate them with visual images.
 - The technique involves associating the list with a series of connected images.
 - This technique is known have been used by Roman orators.

Episodic visual memory

- Dual coding theory (Paivio '69)
 - Two linked storage systems
 - Visual\imagistic
 - Verbal\audio
 - Imageable words are stored in both locations and are easier to recall.
 - Problem: Doesn't work the other way around.
 - Subjects who describe images are less likely to recognize them.
 - Verbal overshadowing.

Unusual forms of memory

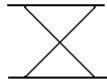
- Photographic Memory
 - Found in less than 7% of children and decreases with age.
 - Images are experienced differently from normal memory images.
- Menemonists
 - Those with extraordinary memory often had a visual component to their experiences which was sometimes disorienting.

Unusual forms of memory.

- Amnesia
 - Retrograde amnesia
 - Involves loss of past memories.
 - Anterograde amnesia
 - Involves inability to form new memories.
 - Short term memory unaffected.

Distortion effect on visual information

- Table or hourglass?



- Memory of object depends on the description.

Distortion effect on visual information

- Subjects shown video tape of automotive collision.
 - The subjects estimated the speed of the cars.
 - Produced higher estimation of speed when told the cars smash together rather than hit.
- Similar results in other experiments.
 - Subject shown a green car driving through a stop sign.
 - Visual memory of the scene changes depending if the subjects are asked “Did the blue car go through the stop sign?” or “Did the green car drive through the yield sign?”

Distortion effect on visual information

- Two theories on what is happening.
 - Misinformation distorts or changes the original memory.
 - Misinformation creates a false memory
- Argument against the first theory is that the misinformation is only biasing the subjects who retained no clear memory of the event.

Representational Momentum

- Add pictures here.

Visual imagery

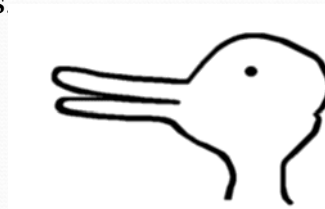
- Are images in memory symbolic representations or essentially pictures in the head?
 - Analog/Propositional debate.
 - How do you decide the question?
 - Introspection.
 - No mechanism for comparison between researchers.
 - Observable behavior.
 - Images are internal and not a kind of behavior.
 - Memory testing.
 - Objective behavior turned out to be influenced by mental images.

Visual Imagery – Analog Position

- Mental images are like pictures.
 - Uninterrupted.
 - Determinate.
 - Spatial format.
 - Continuous.
 - Processes that can be done on pictures can be done on mental images.
 - Images are viewed by the “mind’s eye”.
- Challenges to this position
 - How do we find the right image?
 - Images are intrinsically interpreted.
 - Images are often indeterminate.
 - Not all the details are as clear as others.

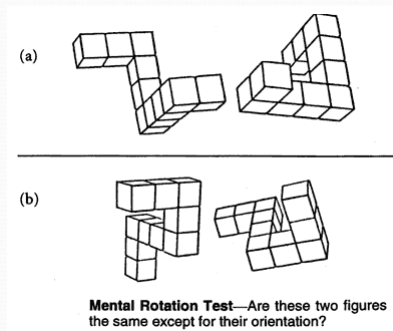
Visual imagery – Propositional position

- Mental images are like symbols
 - Interpreted.
 - Indeterminate.
 - Spatial content.
 - Discrete.
- The image on the right would be stored as “This is a duck” or “This is a rabbit”



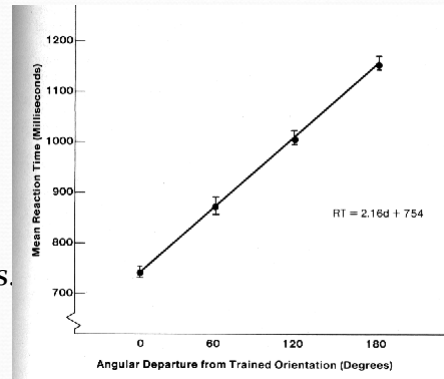
Visual imagery

- Mental rotation cast some light on the analog\propositional debate.
- Two figures are given.
 - Varying degrees of rotation.
 - Are they the same figure?
 - Reaction times measured.



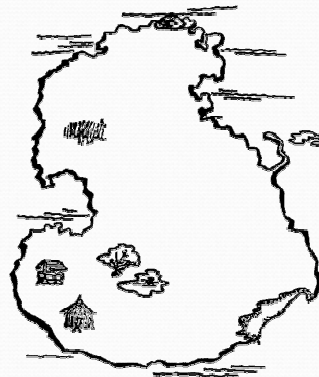
Visual imagery

- Mental rotation results:
- Holds even after 1000 trials.
 - Shows people still perform mental rotation without learning features.



Visual imagery

- Other kinds of mental transformation support analog position.
 - Bigger images take longer to rotate.
- Scanning across images occurs in linear time.
 - Time to mentally scan between two points on the island varies depending on distance and size of image.



Visual imagery

- Mental Psychophysics
 - Subjects told to “zoom in” on their mental image until the mental image overflowed the boundaries and this point, subjects estimate distance from image.
 - From this, the angle of the mental viewing field can be estimated.
 - Mental image ~20% to ~60%
 - Normal vision 120% vertical and 180% horizontally.

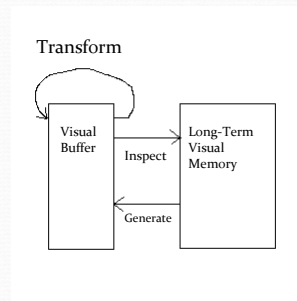
Visual imagery

- Reinterpreting the duck\rabbit image.
- Subjects unable to reinterpret the mental image but were able once they drew it.
- Support for propositional theory.
 - Disputed as too complex.
 - Simple mental images able to be reinterpreted.



Kosslyn's Model of imagery

- Need a hybrid approach that incorporates both analog and propositional positions.
- Three components:
 - Visual Buffer.
 - Long Term memory.
 - Image Operations.



Imagery and perception

- How connected are visual perception and imagery?
- Behavioral studies.
 - Attempting to form visual images degrades perception.
 - Implies both share similar mechanisms.
- Neuropsychological
 - Damage to perceptive ability often correlated with difficulty in forming visual images.
 - Brain activity shows similar areas of excitation in both activities.