Cognitive Psychology

Lecture 10: Visual Imagery

Imagery

- What shape are a german shepard's ears?
- Which is darker green, spinach or lettuce?
- With which hand is that Statue of Liberty holding the torch?

Imagery

- Write a description of any object on a piece of paper. Trade with a neighbor and see if they can identify it.

- Now draw the object.

- What information is different in these 2 representations?

Imagery

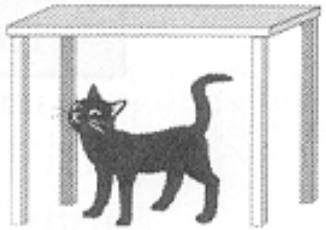
- Mental imagery: experiencing a sensory impression in the absence of sensory input
  - Visual imagery: “seeing” in the absence of a visual stimulus
  - Not limited to visual (e.g., auditory, etc.)
- Provides a way of thinking that adds another dimension to purely verbal techniques

The Imagery Debate

What is the format of representation?

1. Visual / Depictive (e.g., Kosslyn)
   - **Is there a shared system between perception and imagery?**

2. Propositional (e.g., Pylyshyn)
   - "Visual" representation is an *epiphenomenon*
     - Accompanies real mechanism but is not actually a part of it

Representation in words	Propositional	Depictive
A mouse bit a cat	Bite {action} (mouse [agent of action], cat[object])	
Mice are furry	[external surface characteristic] (furry [attribute], mouse [object])	
A cat is under the table	[vertically higher position] (table, cat)	
A cat is an animal	[categorical membership] (animal [category], cat [member])	

Imagery & Perception

- Is there a shared system between imagery and perception?

- If there's a shared mechanism, we should see similarities between perception and imagery

Imagery & Perception: Similarities

- Perky (1910)
  - Asked participants to mentally project an object (e.g., banana) on the screen
  - Unbeknownst to them, the researcher actually projected an object on the screen
    - So dim, they were unaware
  - Mistake actual picture for a mental image
    - Described their "mental image" exactly like the projected

Figure 10.10 Subject in Perky's (1910) experiment. Unbeknownst to the subjects, Perky was projecting dim images onto the screen. © Cengage Learning

Imagery & Perception: Similarities

- Size in the visual field
  - Viewing distance has measurable effects on perception
  - It is difficult to see details for objects further away
    - Will it be the same for mental imagery?

Figure 10.8 Moving closer to an object, such as this car, has two effects: (1) The object fills more of your visual field, and (2) details are easier to see. © Cengage Learning

Imagery & Perception: Similarities

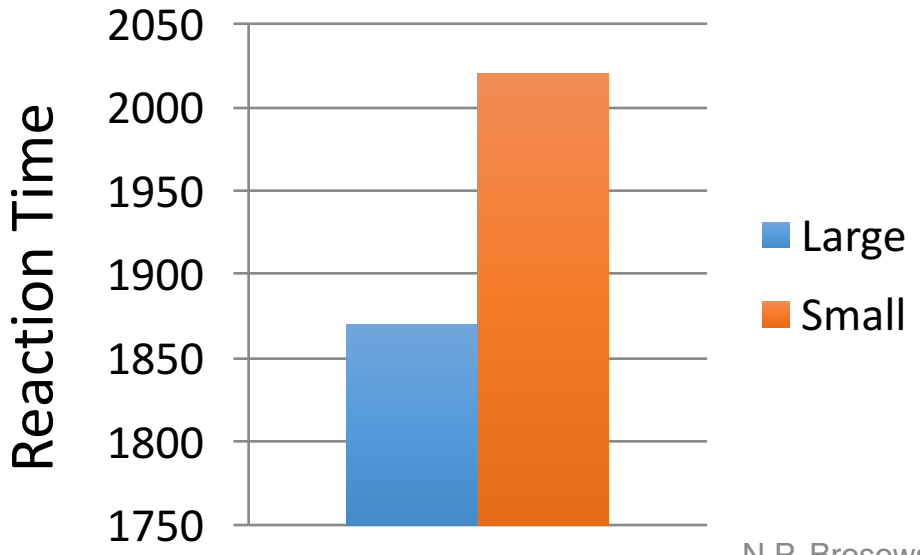
- Size in the visual field

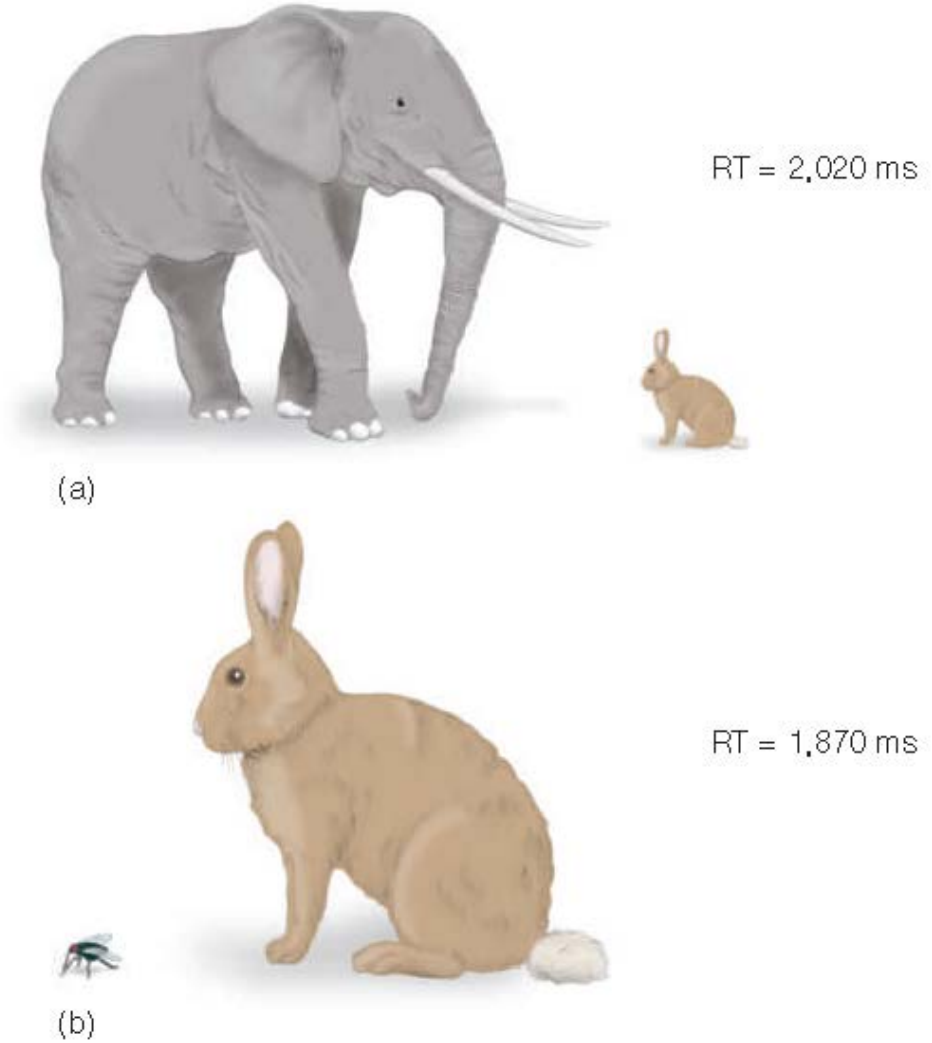
1. Imagine a rabbit and an elephant side-by-side
   - Now (in your mind) walk close enough to them that the elephant takes up most of your visual field
   - Does the rabbit have whiskers?

2. Imagine a rabbit and a fly side-by-side
   - Now (in your mind) walk close enough to them that the rabbit takes up most of your visual field
   - Does the rabbit have whiskers?

Imagery & Perception: Similarities

- Size of visual field
  - Quicker to detect details on the larger object





Imagery & Perception: Similarities

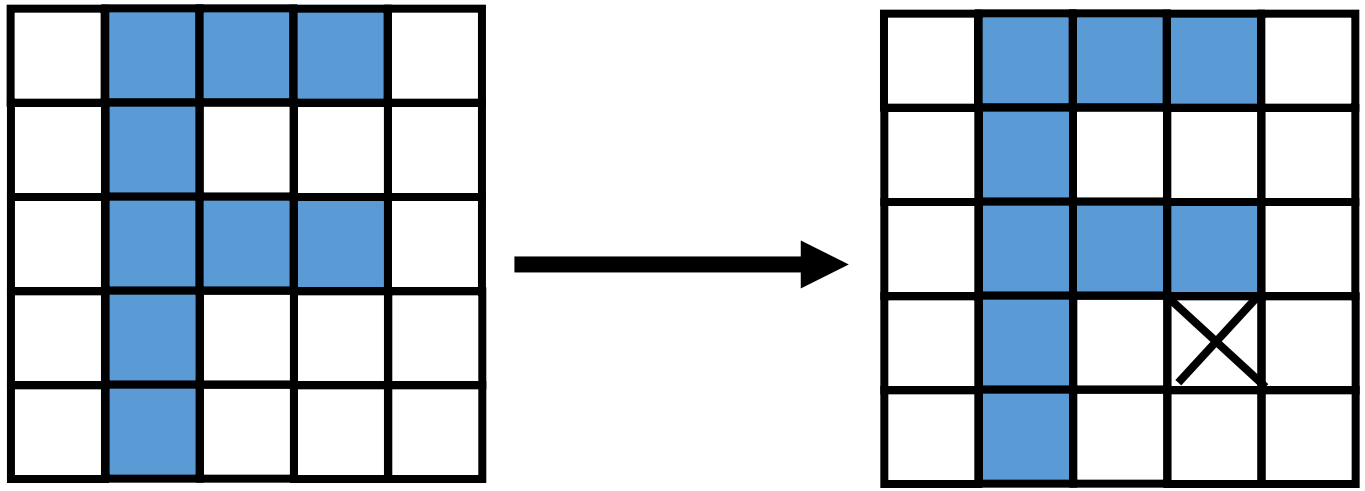
- Size of visual field
  - **Mental Walk Task**
    1. Imagine a [rabbit or elephant]
    2. Now (in your mind) walk towards the [rabbit / elephant] until it fills your visual field entirely
    3. How far away from the [rabbit / elephant] are you?

  - Rabbit = < 1 foot away
  - Elephant = 11 feet away

Imagery & Perception: Similarities

Podgorny & Shepard (1978).

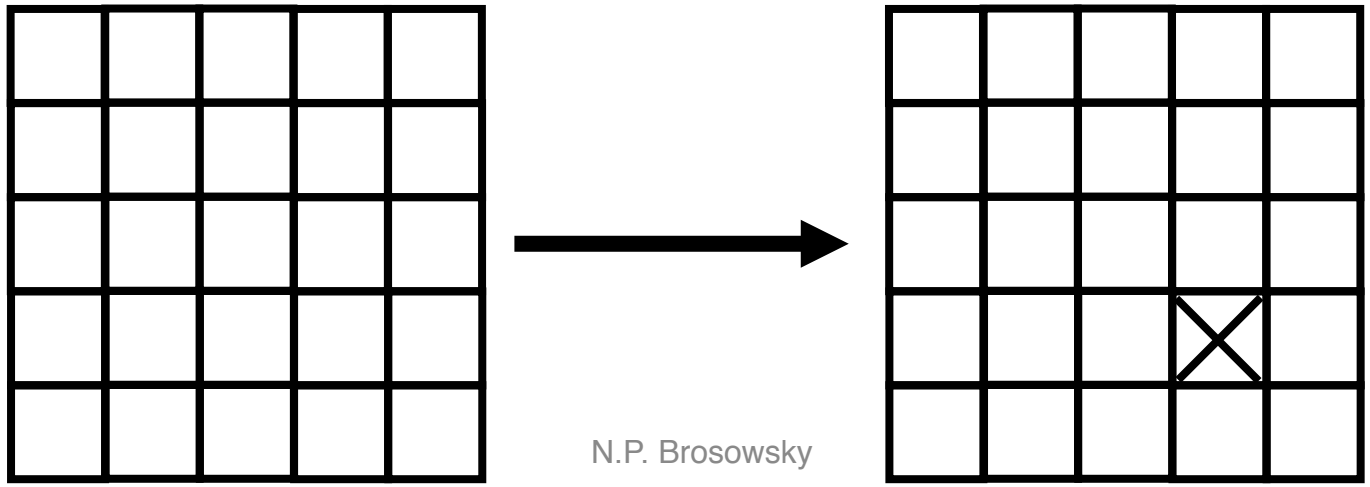
Perception



Is the ‘X’ on the letter?

Imagery

“Imagine an “F” on the grid”



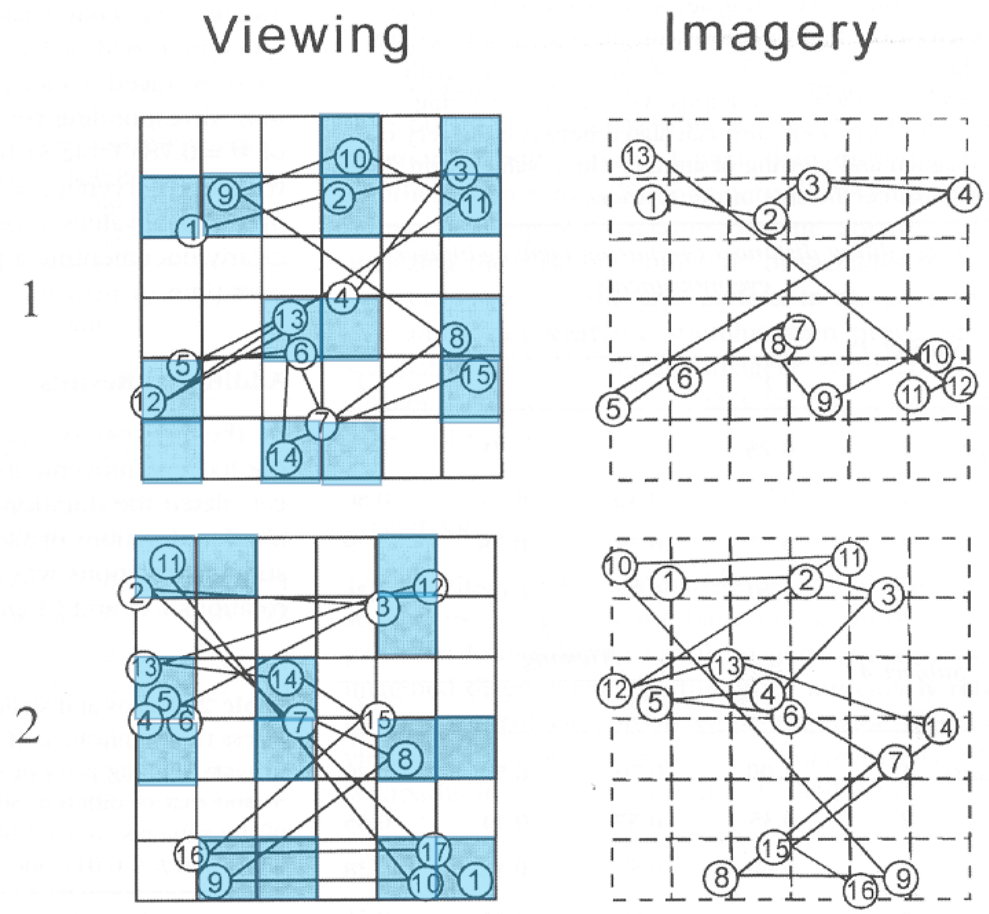
Is the ‘X’ on the letter?

Imagery & Perception: Similarities

- Which RT would be longest?
  - On the F
  - Near the edge of the F
  - Far from the edge of the F
- Is it the same or different for perception and imagery?
- Longest for Near Edge in perception & imagery

Imagery & Perception: Similarities

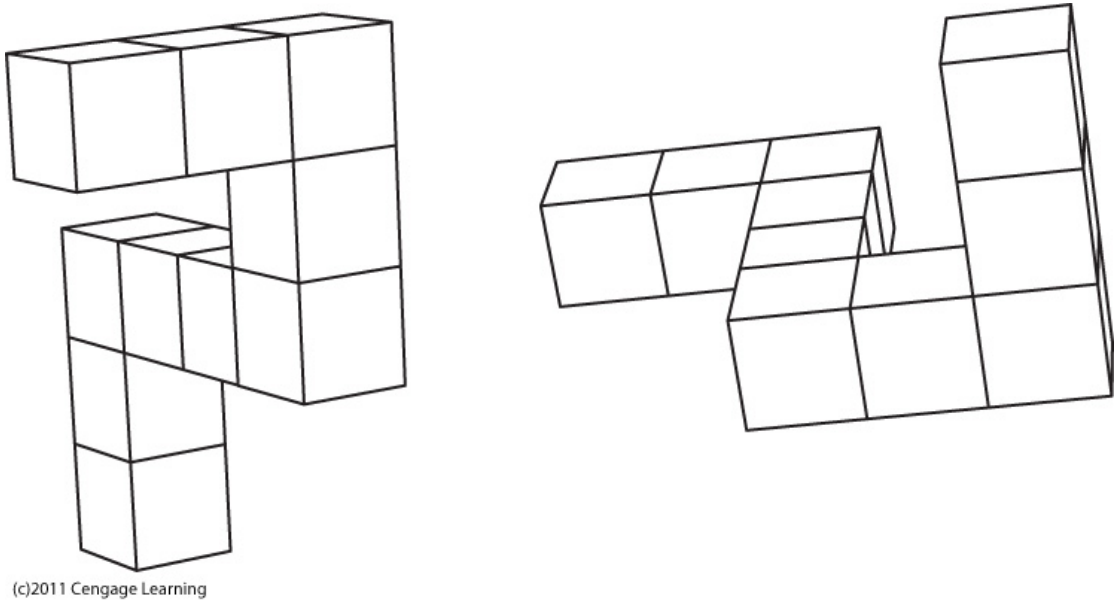
- Brandt & Stark (1997)
- Subjects told to remember grid patterns using imagery
  - Pattern rotated every 20 seconds
- Eye movements similar during viewing and imagery
  - Eye movements during imagery was not random but reflected the content of the visualized scene

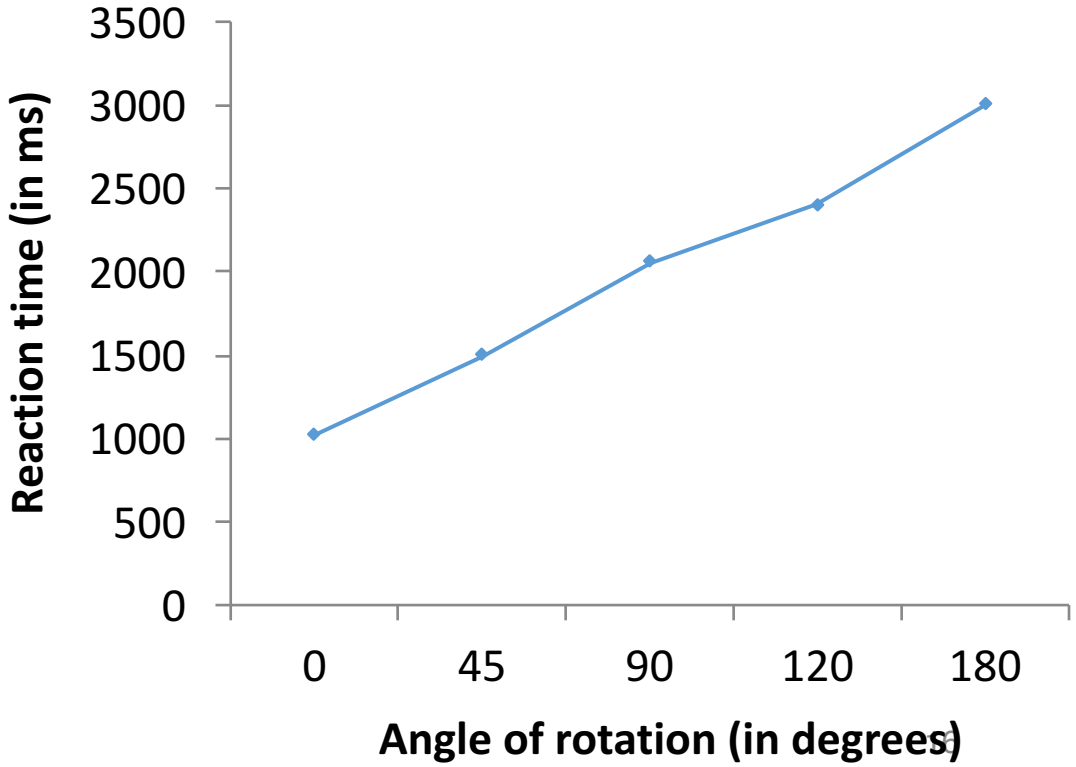


Imagery & Perception: Similarities

Mental rotation

- Time to rotate corresponds to degree difference

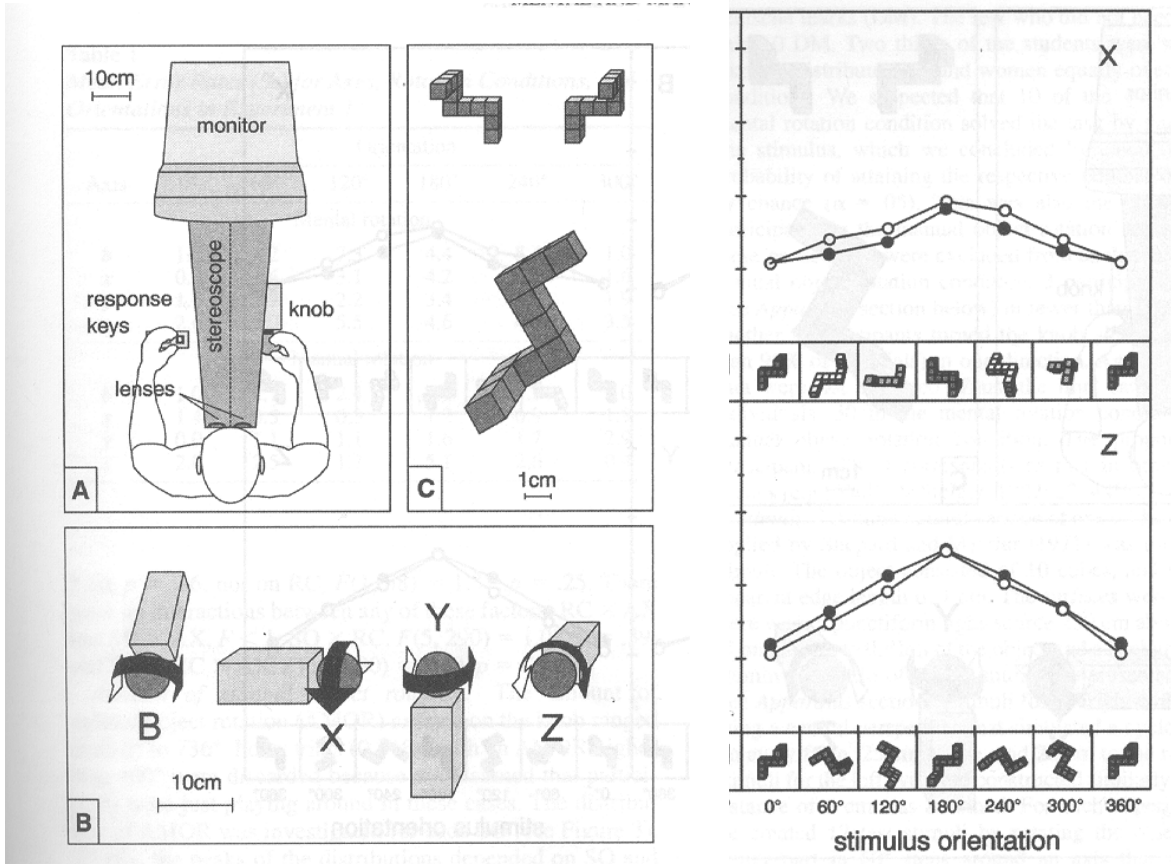




Imagery & Perception: Similarities

Mental rotation

- Wohlschläger & Wohlschläger
  - Mental rotation RTs similar to manual rotation of the same objects



Imagery & Perception: Similarities

Mental Scanning

- Kosslyn (1973)
  - Memorize picture, create an image of it
  - In image, move from one part of the picture to another
    - It took longer for participants to mentally move long distances than shorter distances
  - Like perception, imagery is spatial
    - Scanning like a mental tape measure

Imagery & Perception: Similarities

Mental Scanning

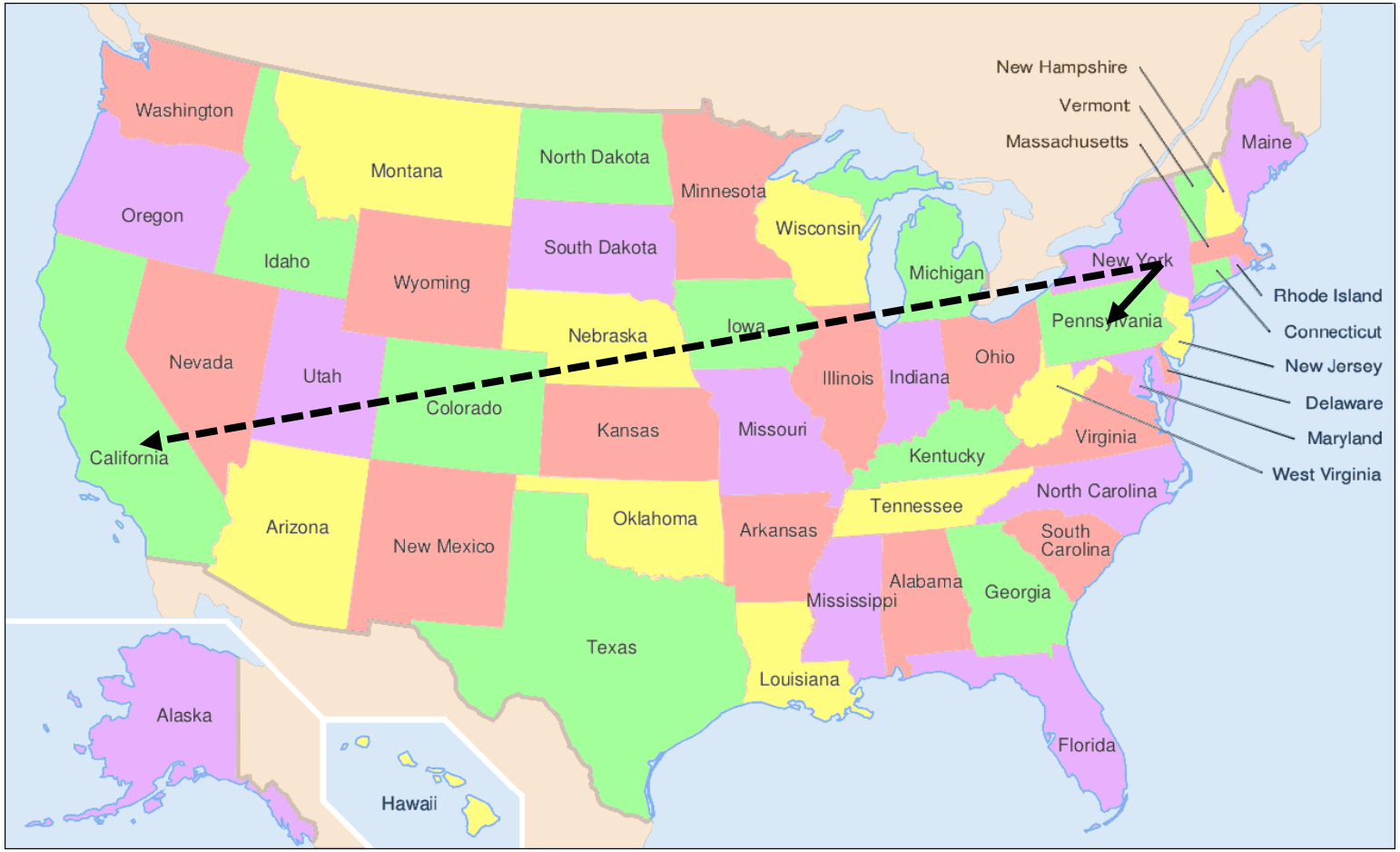
- Demo:

1. Imagine a map of the US
   - Concentrate on the locations of NY, CA, and PA

2. Imagine a dot moving from NY to PA
   - Raise hand when done
3. Imagine a dot moving from NY to CA
   - Raise hand when done

Imagery & Perception: Similarities

Mental Scanning



Imagery & Perception: Similarities

Mental Scanning

- Kosslyn (1973)
  - In image, move from one part of the picture to another
    - It took longer for participants to mentally move long distances than shorter distances

- Possible Confound: More distance equals more (distracting) information

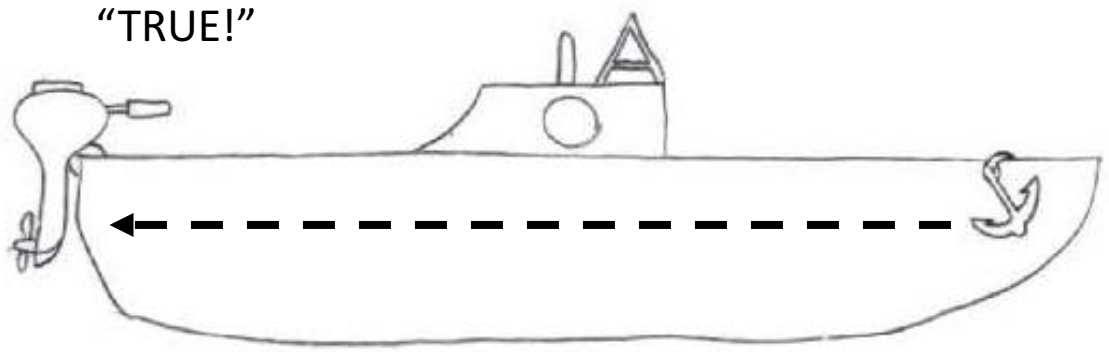
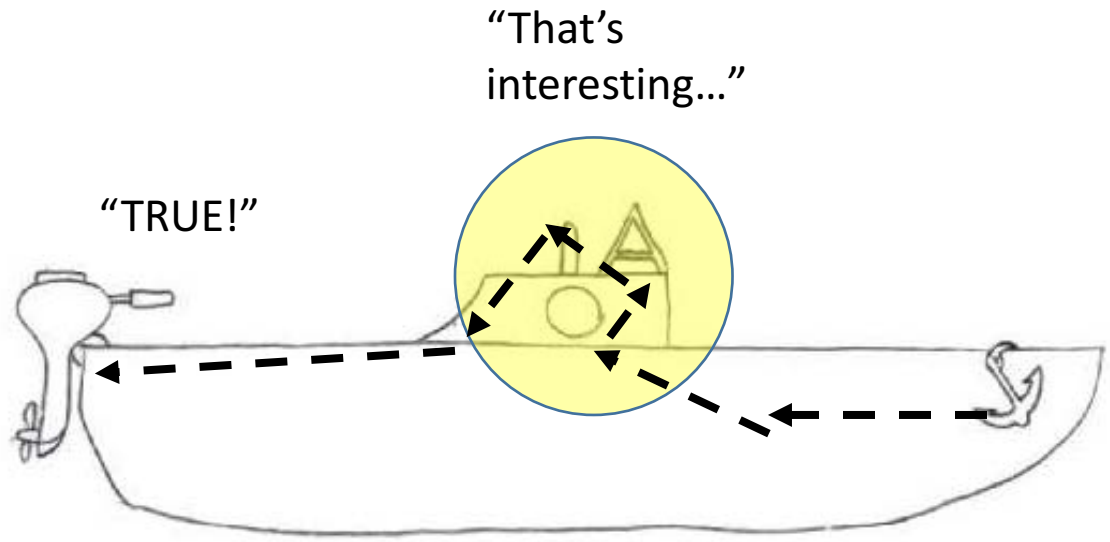


Figure 10.2 Stimulus for Kosslyn's (1973) image-scanning experiment. *(Source: S. M. Kosslyn, Scanning visual images: Some structural Implications,* Perception & Psychophysics, 14, *90–94, Figure 1. Copyright © 1973 The Psychonomic Society Publications. Reproduced with permission.)*

Imagery & Perception: Similarities

Mental Scanning

- Lea (1975)
  - More distractions when scanning longer distances may have increased reaction time
  - Interesting things encountered during the mental scan are responsible for these distractions



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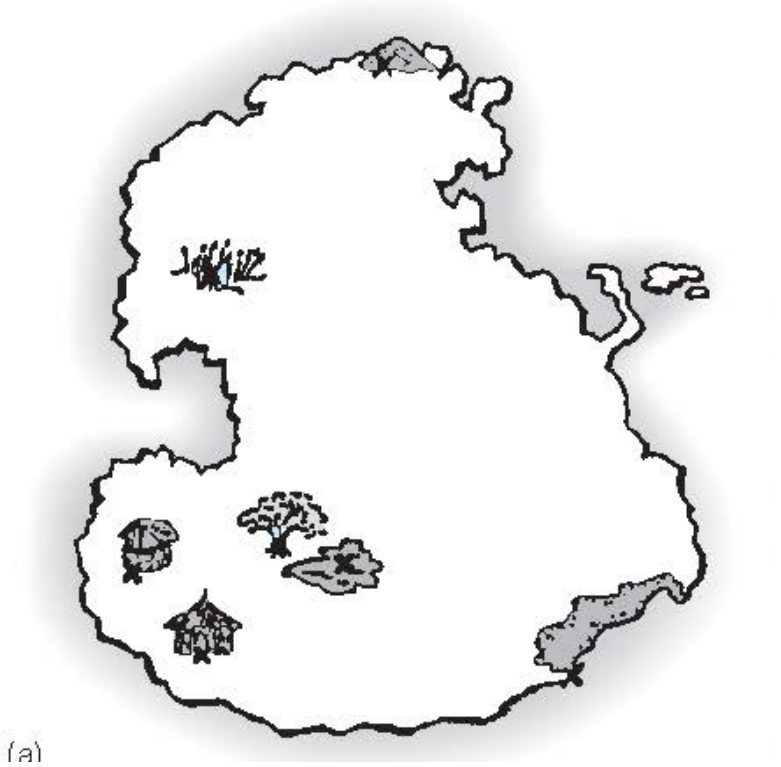
Imagery & Perception: Similarities

Mental Scanning

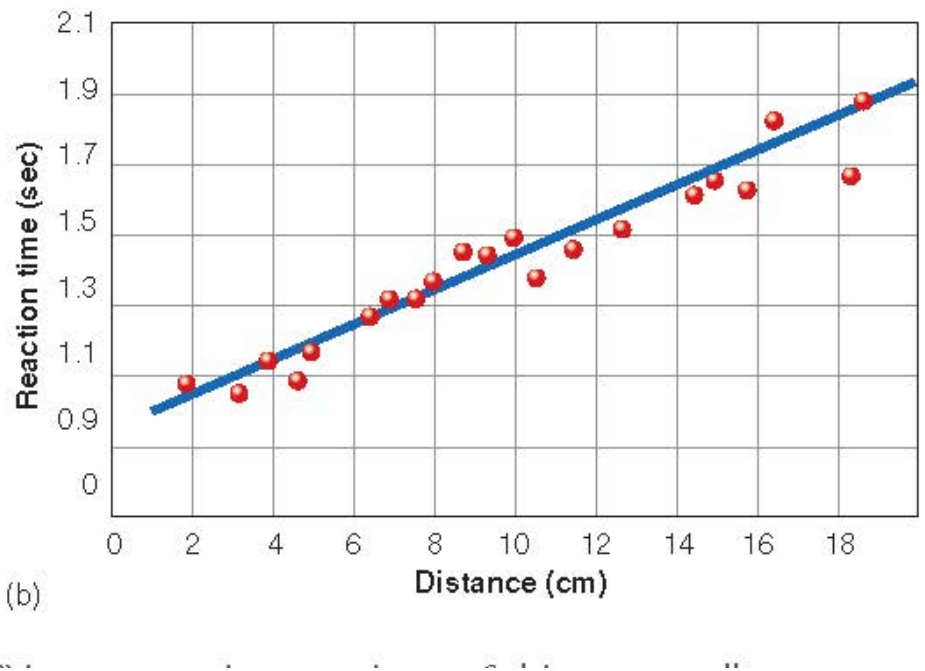
- Kosslyn et al. (1978)
  - Island with 7 locations, 21 trips



Imagery and Perception

Mental Scanning

- Kosslyn et al. (1978)
  - Island with 7 locations, 21 trips
  - It took longer to scan between greater distances
    - They made mental trips between *all* the pairs of locations
    - Can't just be distraction



Imagery & Perception: Similarities

Is there a shared system between imagery and perception?

- Spatial correspondence between imagery and perception
  - Mental scanning
- We act as if our mental images are physical entities
  - Scanning
  - Acuity

Imagery: Spatial or Propositional

- Pylyshyn (1973)

- Spatial representation is an epiphenomenon
  - Accompanies real mechanism but is not actually a part of it
- Proposed that imagery is propositional
  - Can be represented by abstract symbols

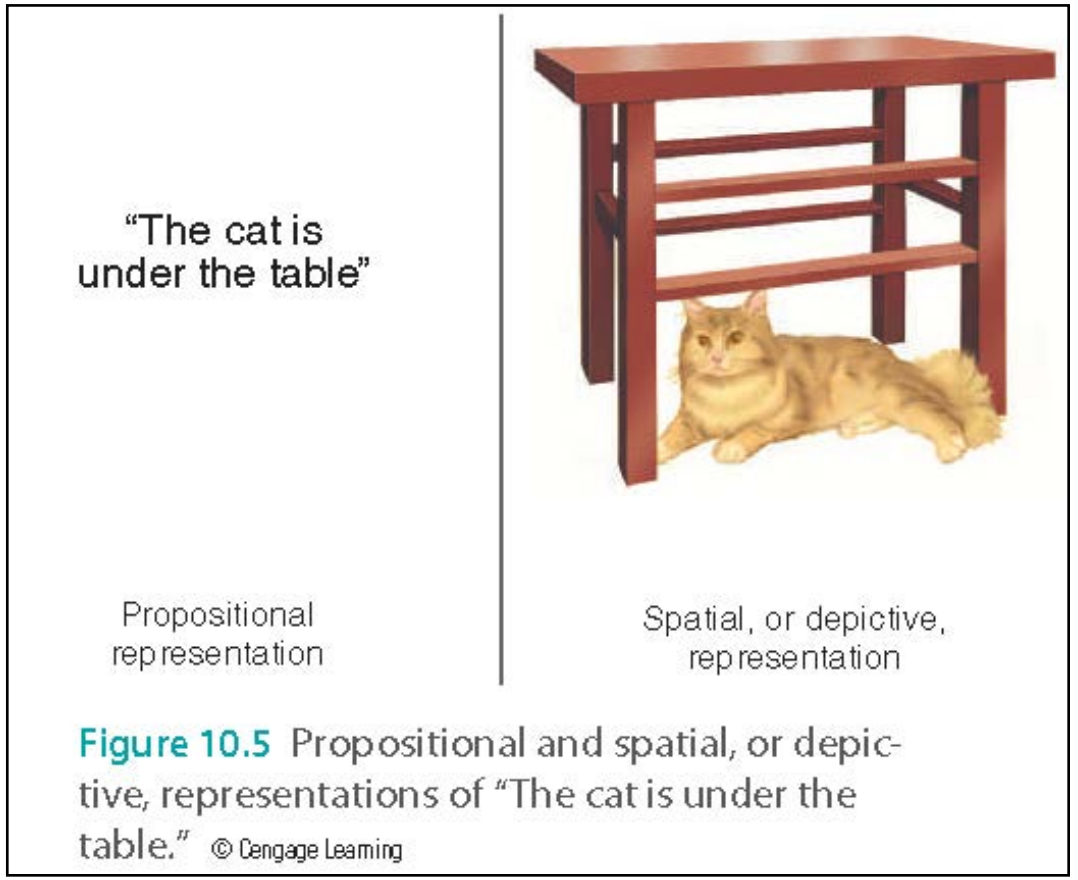


Figure 10.5 Propositional and spatial, or depictive, representations of "The cat is under the table." © Cengage Learning

Imagery: Spatial or Propositional?

Is Imagery Spatial or Propositional?

- Proposition representation: symbols, language
- Depictive representation: similar to realistic pictures

Propositional	Depictive
Bite {action} (mouse [agent of action], cat[object])	
[external surface characteristic] (furry [attribute], mouse [object])	

Imagery: Spatial or Propositional?

- Pylyshyn (2003)
  - Kosslyn's results can be explained without assuming visual or spatial representations

E.g., mental scanning: the boat

- Propositional representations work like semantic networks

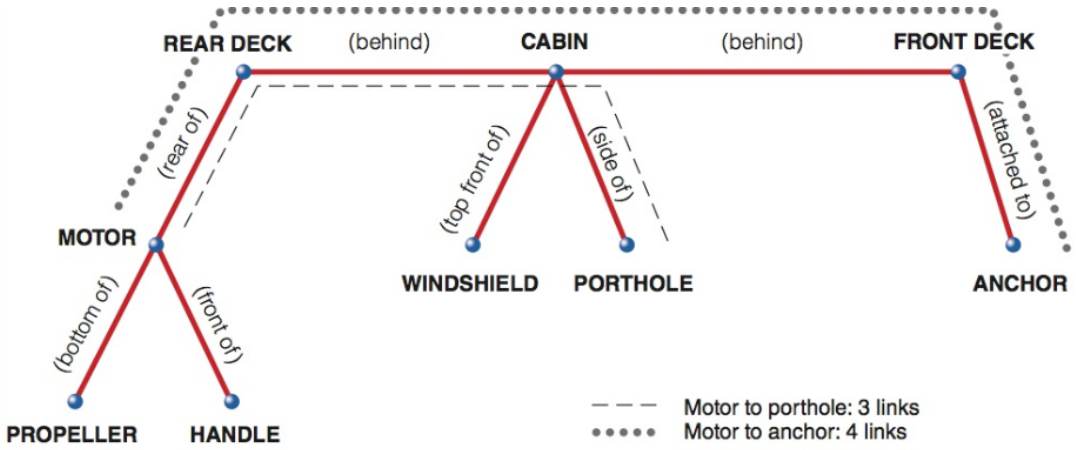


Figure 10.6 How the visual appearance of the boat in Figure 10.2 can be represented propositionally. Paths between motor and porthole (dashed line) and motor and anchor (dotted line) indicate the number of nodes that would be traversed between these parts of the boat. *(Source: Reprinted from S. M. Kosslyn, Mental imagery, in S. M. Kosslyn & D. N. Osherson,* An invitation to cognitive science, *2nd ed., vol. 2:* Visual cognition, *pp. 267–296, Figure 7.6, Copyright © 1995 MIT Press.)*

Imagery: Spatial or Propositional?

- Pylyshyn (2003)
  - Kosslyn's results can be explained without assuming visual or spatial representations

E.g., mental scanning: the island

- The island example cannot be explained by the propositional network
- However, Pylyshyn argues that the task causes people to simulate the "staged event" as best they can, making use of implicit or tacit knowledge about the world
  - **Tacit Knowledge Explanation**
    - We unconsciously use knowledge to make our judgments
    - We implicitly know it takes longer to scan from NY to CA, then NY to PA, therefore take longer when simulating

Imagery: Spatial or Propositional?

- Attempting to rule out propositional
- Finke and Pinker (1982)
  - Participants judge whether arrow points to dots previously seen
  - Longer reaction time when greater distance between arrow and dot (as if they were mentally "traveling")
  - Not instructed to use visual imagery
  - No time to memorize, no tacit knowledge

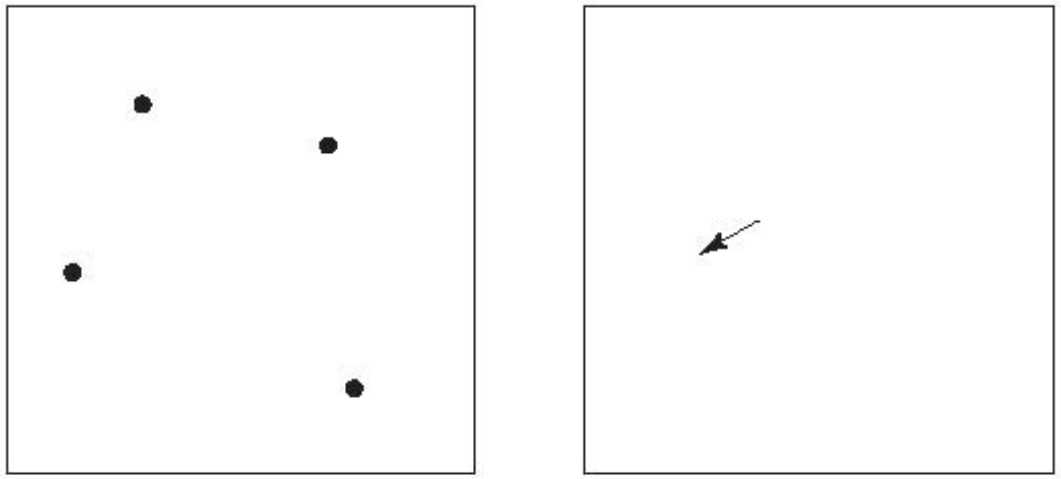


Figure 10.7 Stimuli for Finke and Pinker's (1982) experiment. The display in (a) was presented first, followed, after a 2-second delay, by the arrow in (b). The subjects' task was to determine whether the arrow pointed to any of the dots that had been presented in the first display. *(Source: From R. A. Finke & S. Pinker, Spontaneous imagery scanning in mental extrapolation,* Journal of Experimental Psychology: Learning, Memory and Cognition, *8, 2, 142–147, Figure 1, 1982.)*

Imagery & the Brain

- Resolving the debate by looking at physiological evidence

Evidence for similar mechanism:

- Imagery neurons respond to both perceiving and imagining an object
  - Overlap in brain activation
  - Visual cortex

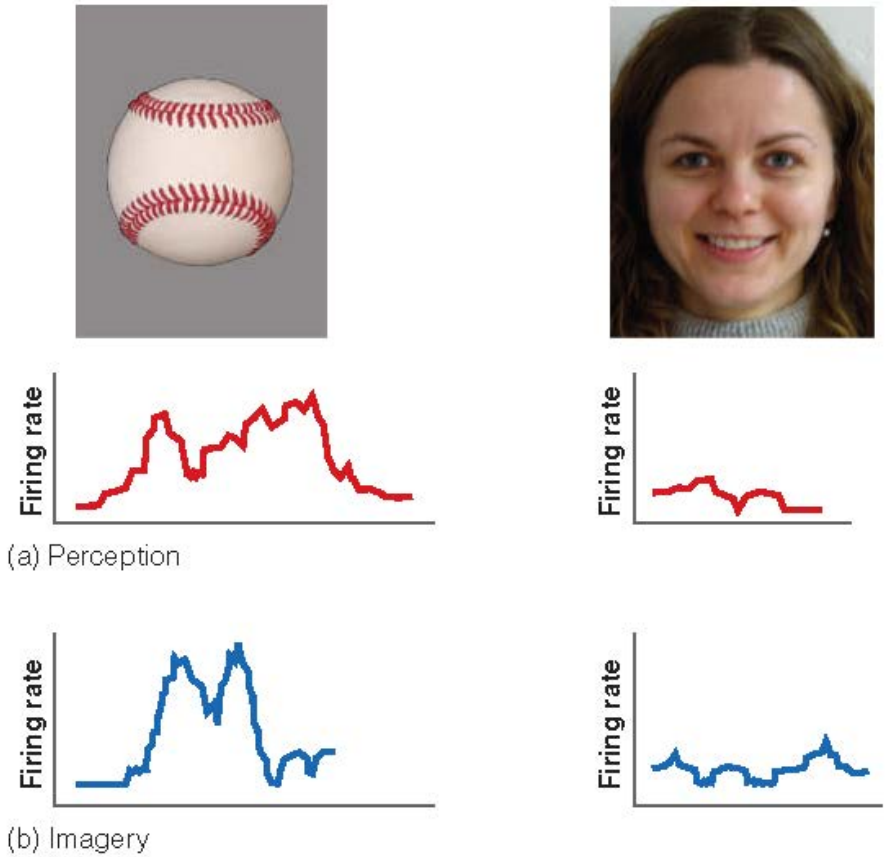


Figure 10.12 Responses of single neurons in a person's medial temporal lobe that (a) respond to perception of a baseball but not of a face, and (b) respond to imagining a baseball but not to imagining a face. *(Source: Based on G. Kreiman, C. Koch, & I. Fried, Imagery neurons in the human brain,* Nature *408, 357–361, November 16, 2000. Photos by Bruce Goldstein.)*

Imagery & the Brain

Evidence for similar mechanism:

- Le Bihan et al. (1993)
  - Overlap in brain activation
  - Visual cortex
- Kossylyn (1995)
  - Imagined objects at different sizes
  - Found similar activity for perceiving and imaging different sizes

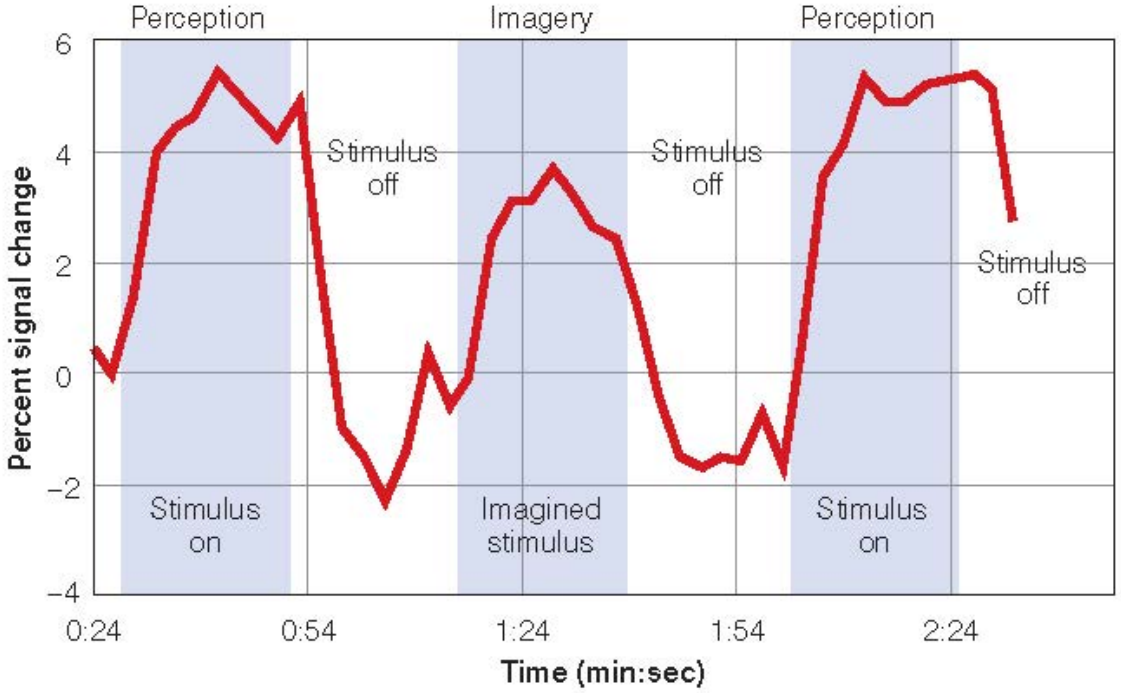


Figure 10.13 Results of Le Bihan et al.'s (1993) study measuring brain activity using fMRI. Activity increases to presentation of a visual stimulus (shaded area marked "Stimulus on") and also increases when subjects are imagining the stimulus (area marked "Imagined stimulus"). In contrast, activity is low when there is no actual or imagined stimulus. *(Source: D. Le Bihan et al., Activation of human primary visual cortex during visual recall: A magnetic resonance imaging study,* Proceedings of the National Academy of Sciences, USA, 90, *11802–11805, 1993.)*

Imagery & the Brain

- **Although there is overlap in activity, there are also differences**
- Ganis and coworkers (2004)
  - Complete overlap of activation by perception and imagery in front of the brain
  - Differences near back of the brain
- Amedi and coworkers (2005)
  - Again, overlap
  - However, during imaging there was deactivation of non-visual areas of brain
    - Hearing
    - Touch
  - They argued that mental images more fragile, less activation keeps other things from interfering

Imagery & the Brain

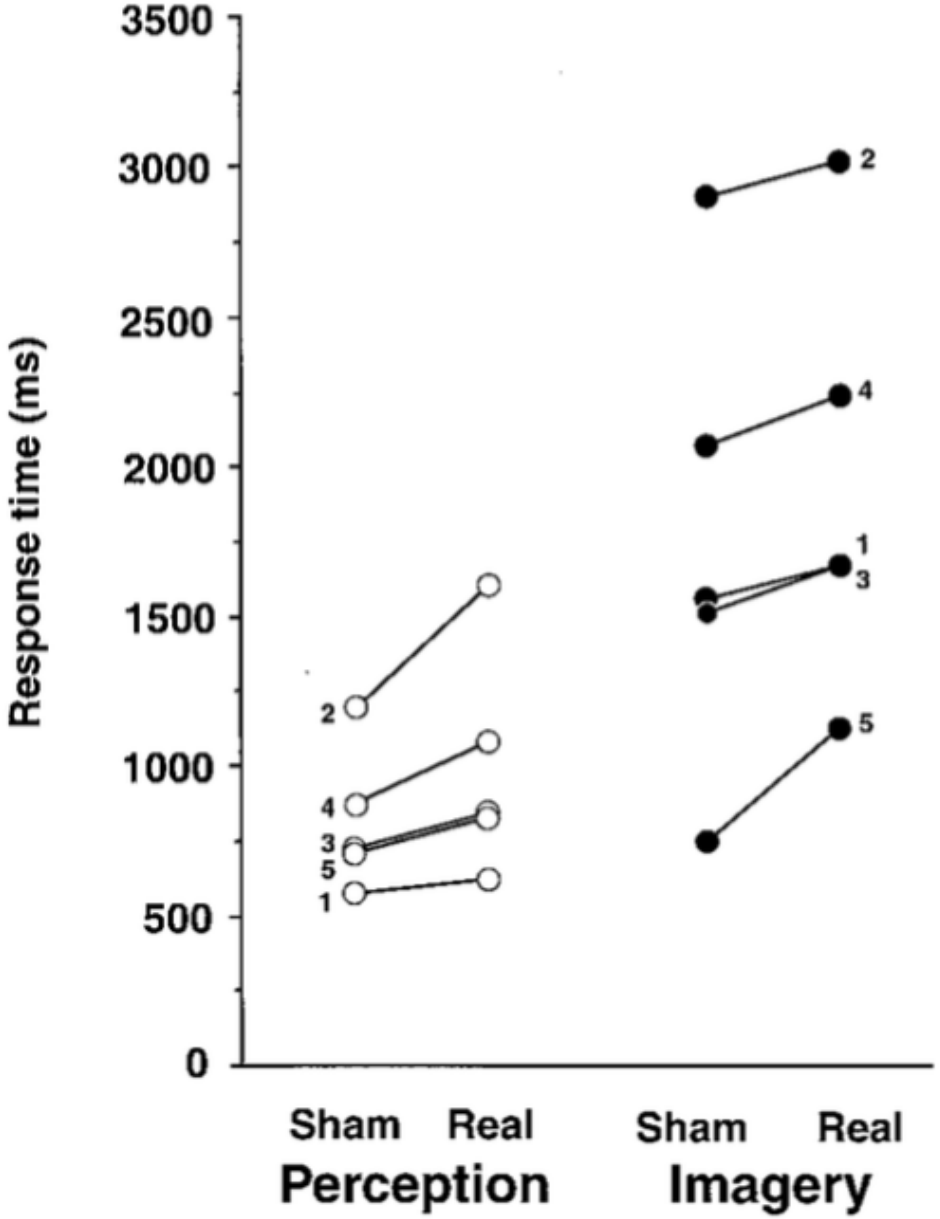
- Large overlap = some shared mechanisms
- Criticism:
  - Brain activity in response to imagery
    - May indicate something is happening
    - May not cause imagery

Imagery & the Brain

- Transcranial Magnetic Stimulation (TMS)
  - Decreases brain functioning in a particular area of the brain for a short time
  - If behavior is disrupted, the deactivated part of the brain is causing that behavior

Imagery & the Brain

- Kosslyn and coworkers (1999)
  - TMS to visual area of brain during perception and imagery task
  - Response time slower for both
  - Brain activity in visual area of brain plays a causal role for both perception and imagery

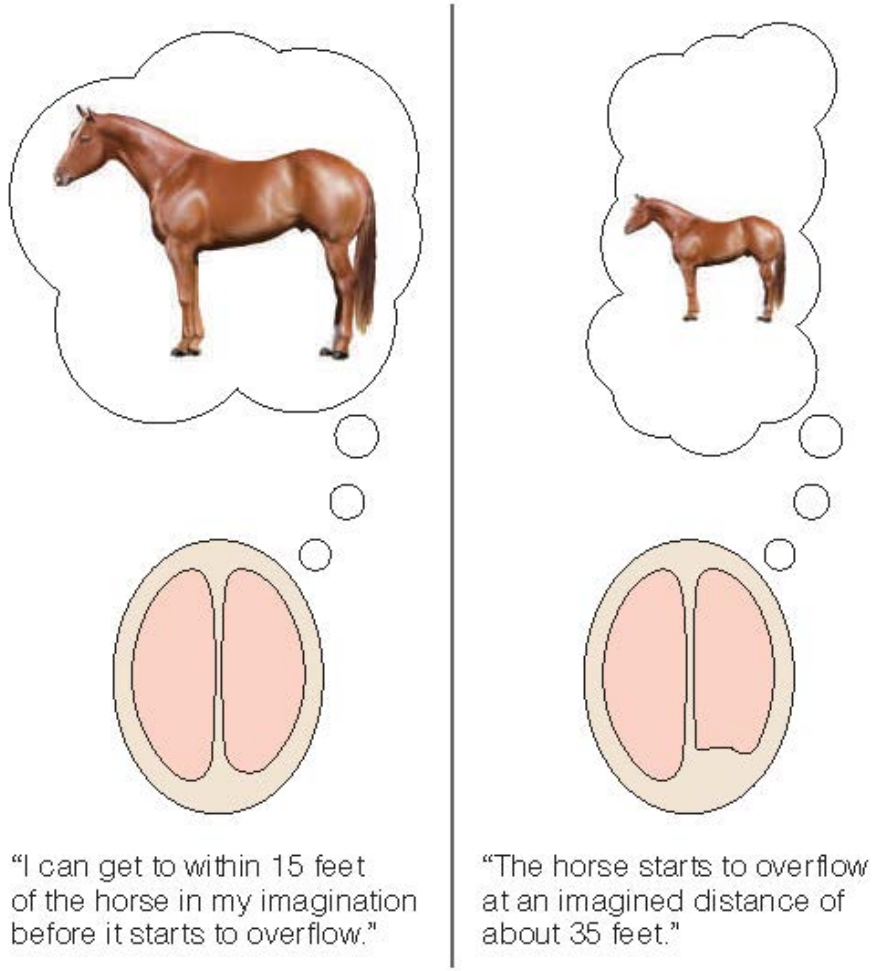


Imagery & the Brain

Neuropsychological Case Studies

Similarities between perception & imagery

- Removing part of the visual cortex reduces image size (right)
  - Patient M.G.S.
- Unilateral neglect
  - Patient ignores objects in one half of visual field in perception and imagery



"I can get to within 15 feet of the horse in my imagination before it starts to overflow."

"The horse starts to overflow at an imagined distance of about 35 feet."

Imagery & the Brain

Neuropsychological Case Studies

- However, some evidence for double dissociation
  - R.M.
    - Damage to occipital and parietal lobes
    - Could draw accurate pictures of objects in front of him
    - Could not draw accurate pictures of objects from memory (using imagery)
  - C.K.
    - Inability to name pictures of objects, even his own drawings, in front of him
    - Could draw objects in great detail from memory (using imagery)

Imagery & the Brain

How to make sense of the mixed evidence?

- Behrmann and coworkers (1994)
  - **Mechanisms partially overlap**
  - Visual perception involves bottom-up processing
    - lower and higher visual centers
  - Imagery is a top-down process
    - Located only at higher visual centers
  - Explains C.K. and R.M. but not M.G.S.
    - Mental walk impairment

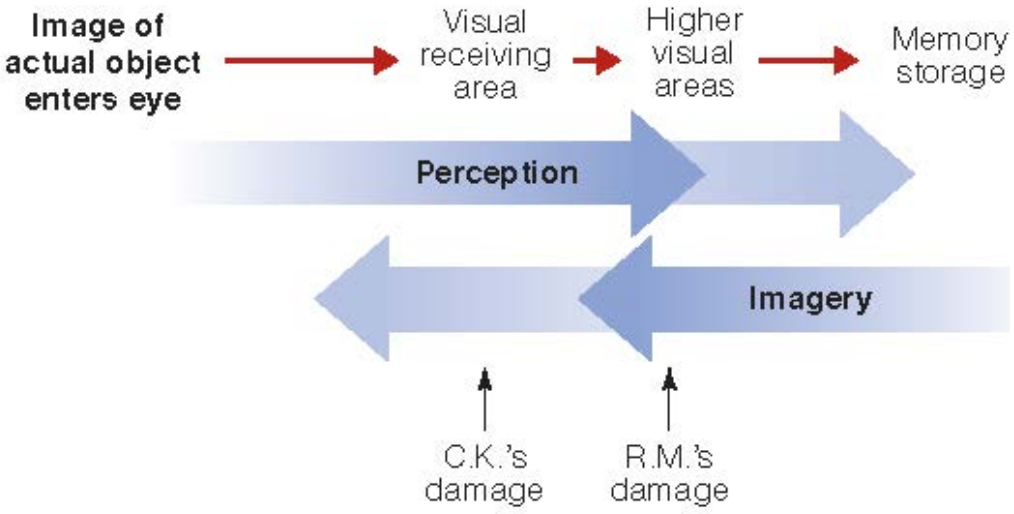
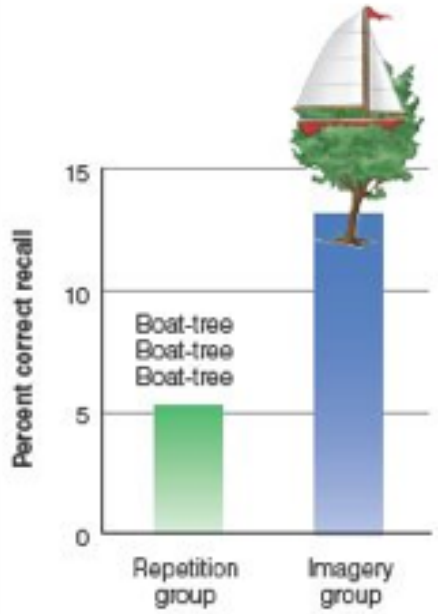


Figure 10.21 Depiction of the idea that mechanisms serv-

Imagery can help memory

- **Pegword technique**
  - Conceptual peg hypothesis (Paivio, 1963)
  - Associate to-be-remembered item with a visual image



Imagery can help memory

- **Method of loci**
  - Create organized locations where to-be-remembered items can be “placed”
  - Imagine yourself walking around the location, visualizing the items placed in each location