

Visual Cognition II

Visual Imagery

Solving problems through imagery

(意象)

- What shape are mickey mouse's ears?
- How many windows are there in your apartment?
- Which is a darker red – a cherry or an apple?
- What is the shortest path from RH104 to Phoenix Grill?

What is Imagery?

Study of Imagery

- Banned by behaviorists
- Possible subject of study in cognitive psychology
 - Cognitive psychology is distinguished from the earlier behaviorism by its claim that there are internal representations of knowledge on which the mind operates
- However, this is a difficult area of study
 - Mental images are subjective
 - How are they represented?



Stephen Kosslyn
(did much of the research on mental imagery)

Kosslyn and Thompson (2003, p. 723)

“Visual mental imagery occurs when a visual short-term memory (STM) representation is present but the stimulus is not actually being viewed; visual imagery is accompanied by the experience of ‘seeing with the mind’s eye’.”

Mental images are subjective; thus developing a cognitive understanding of Imagery has been fraught with difficulties.

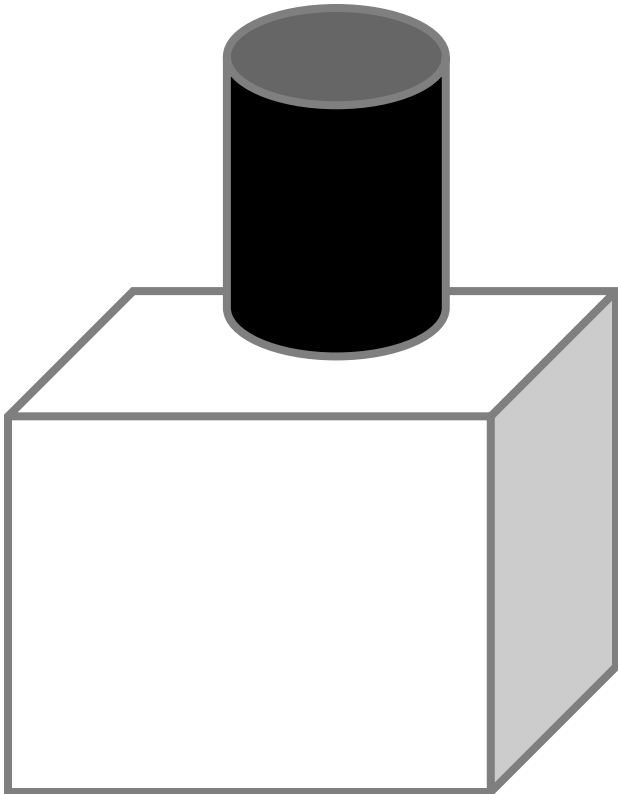
How are mental images represented?

- The analog vs. propositional debate
 - **Analog (模拟的)**: the representation has the same structure as the thing represented
 - **Propositional (命题的)**: a sentence-like description of the image, non-spatial
- Most studies mentioned seem to argue for analog representations (e.g., mental rotation, brain imaging studies). Yet mental images are not processed exactly the same as visual images

Analog Images vs. Propositions

Imagine: *The can is on the box. The can is black*

Analog



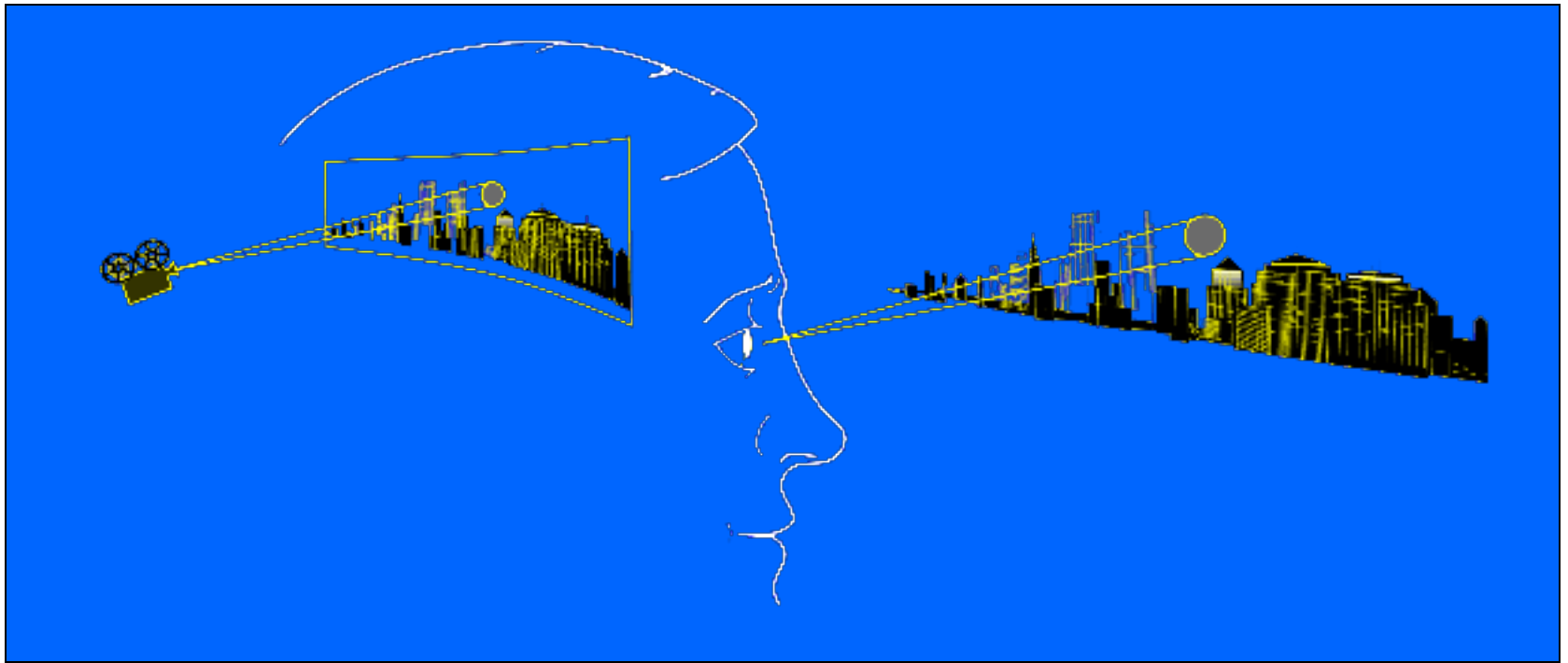
Propositions

on(can, box)
black(can)

Some Questions about Mental Images

- What is the relationship between imagery and perception?
(意象与知觉)
- How are mental images processed and transformed?

Imagery = perception in reverse?



Imagery in Neural Networks

- Mental images in neural networks can be produced by running the network “in reverse” -- activate class nodes (e.g. digit “3”) and running activation downwards to the input nodes

output (e.g. digit class)



hidden nodes



input



Imagery & Perception

- If the mechanisms used to perceive stimuli are also used to generate mental images, then we should predict:
 - Mental images should be quasi pictorial (类似图画的)
 - Mental images should activate some of the brain areas involved with visual processing

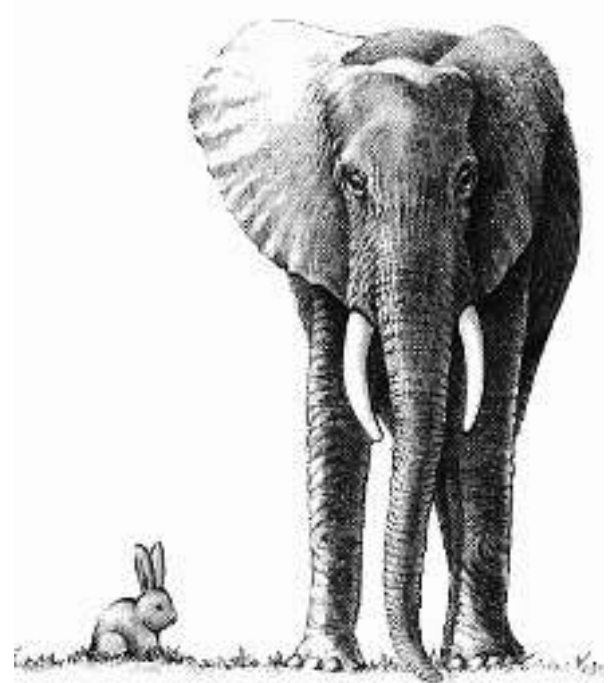
Just as in visual images, level of detail in mental images can vary

Imagine a bee next to a rabbit



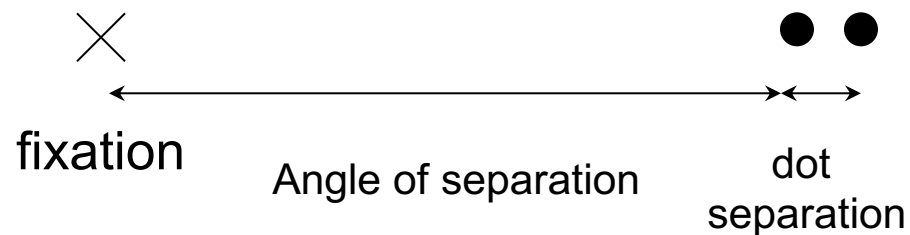
Does a rabbit have eyebrows?

Imagine an elephant standing next to a rabbit



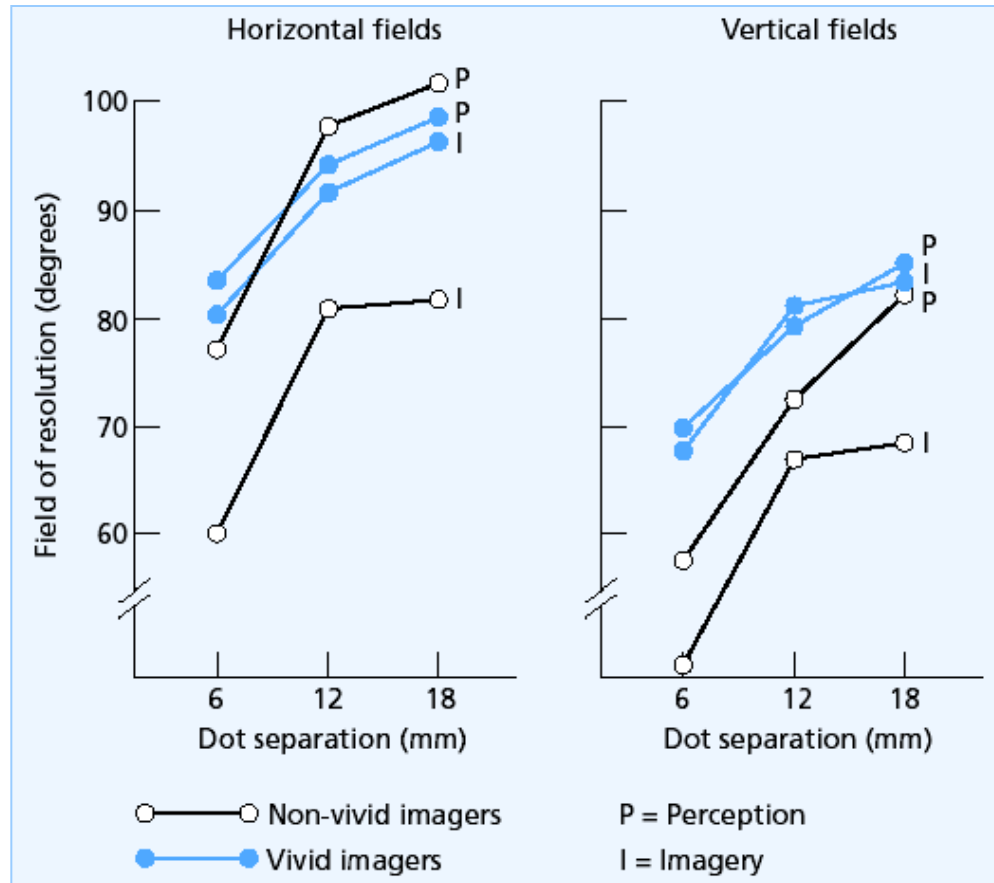
Does a rabbit have eyebrows?

Finke and Kosslyn (1980) experiment



Experiment measures **field of resolution**: the angle of separation into the visual periphery where you cannot distinguish dots any longer

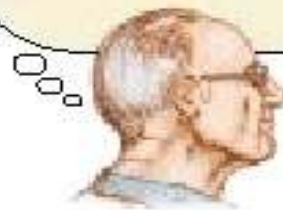
Fields of resolution are similar in perception and imagery



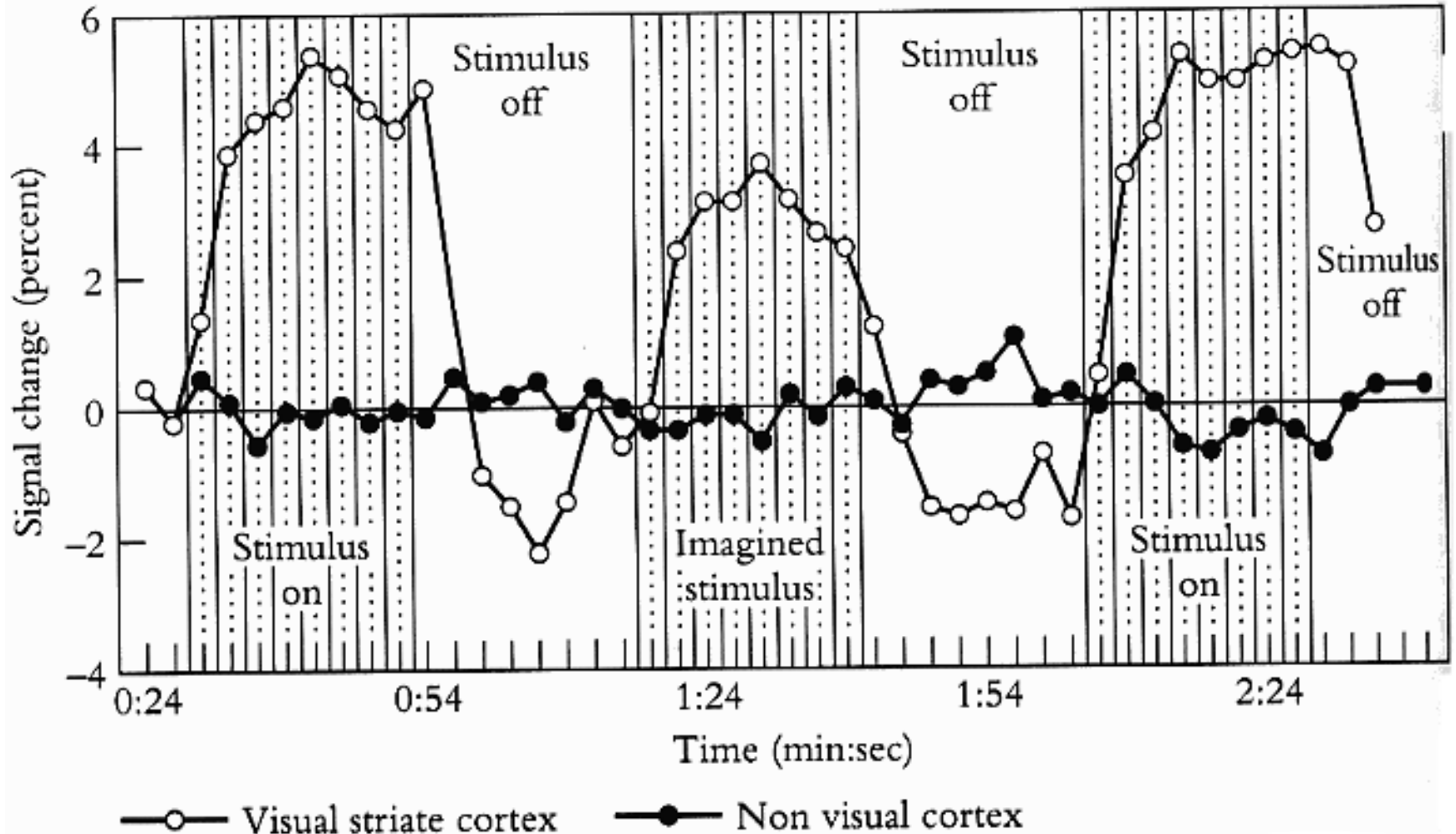
Horizontal and vertical fields of resolution in perception and imagery as a function of dot separation and vividness of imagery. Data from Finke and Kosslyn (1980).

Visual Imagery and Hemispatial Neglect

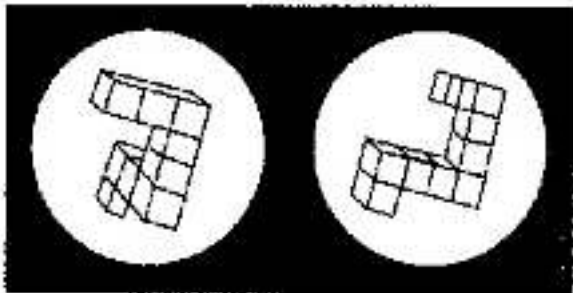
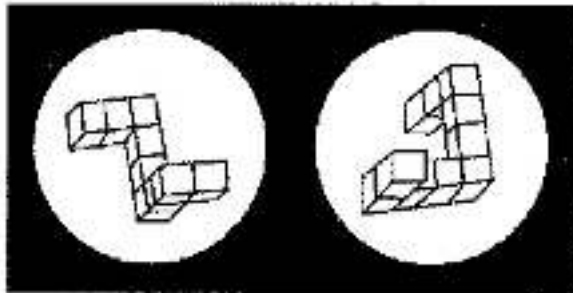
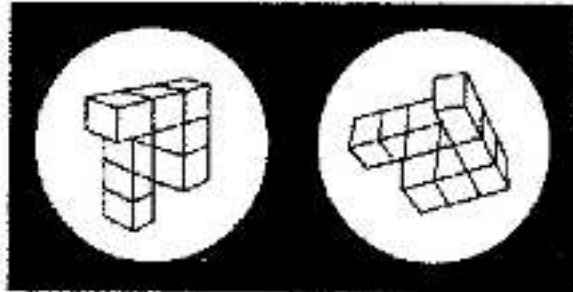
Mental images from opposite sides of an imagined public landmark



Evidence from brain imaging (fMRI) for involvement of visual processing areas during visual imagery

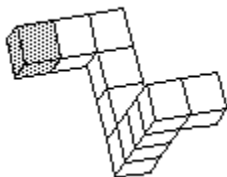
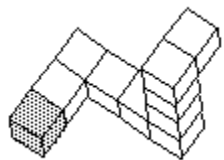


Mental Rotation

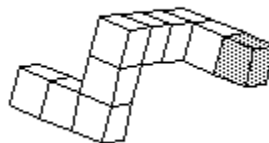


- Can mental images be transformed in a way analagous to physical objects? How could we tell?
- Mental rotation task: look at the time it takes to rotate two shapes into correspondence
- Demo experiment:
<http://bjornson.inhb.de/?p=55>

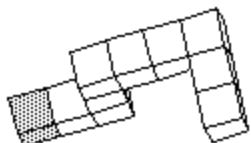
Example Trials



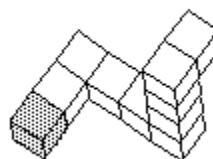
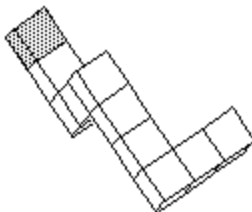
same



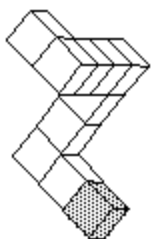
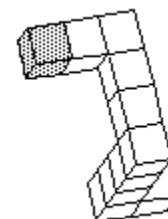
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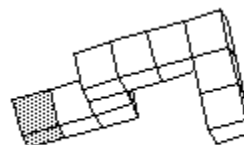
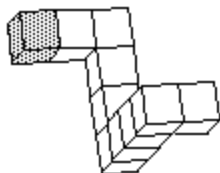
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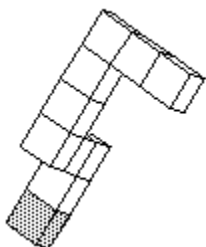
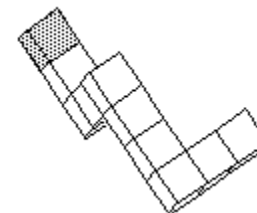
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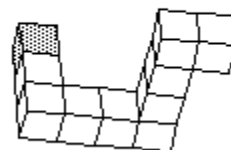
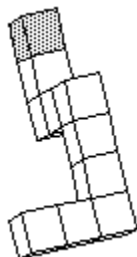
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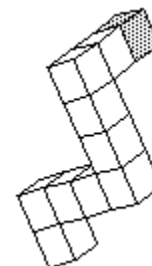
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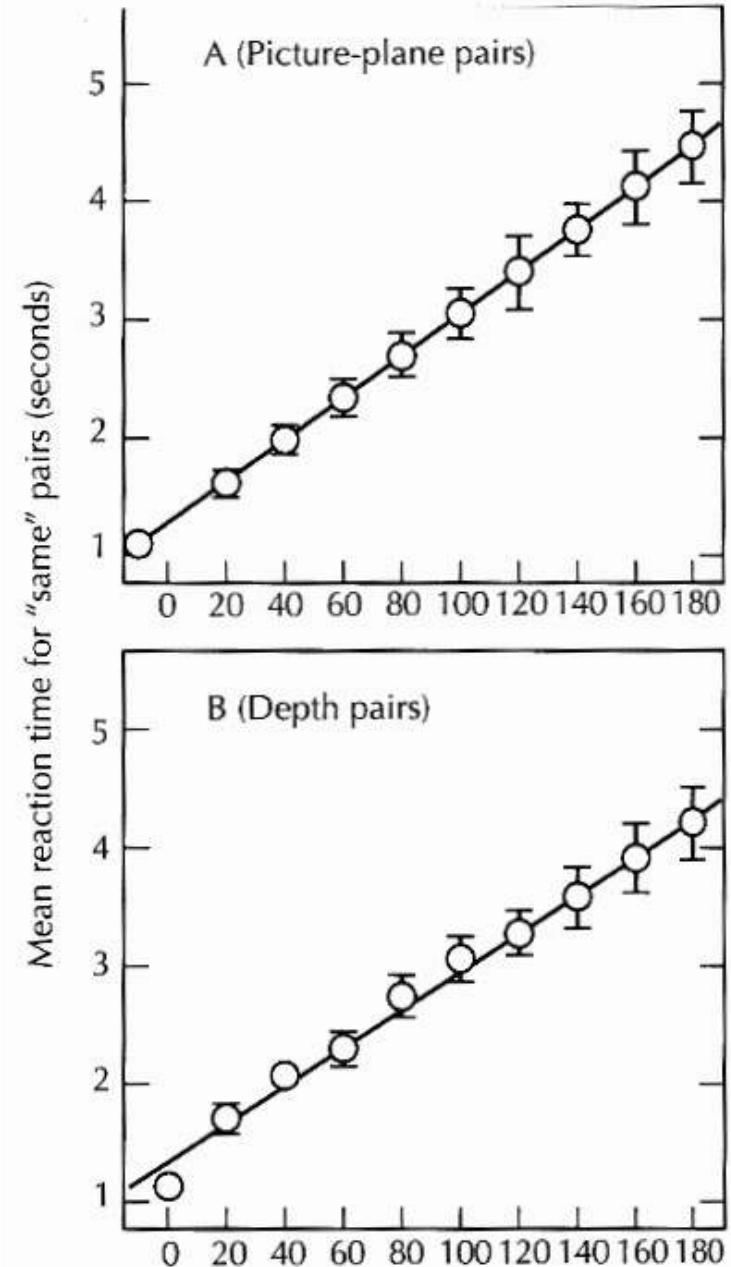


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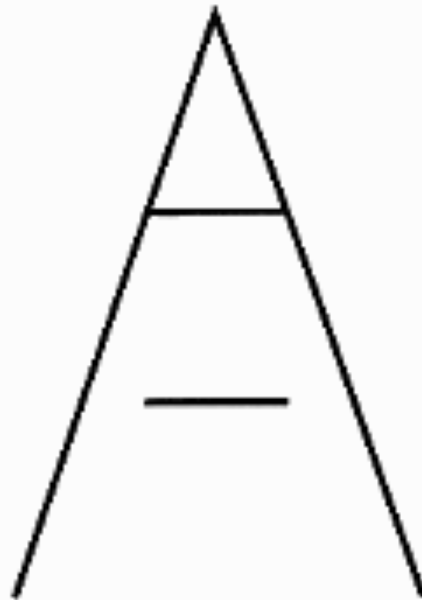
Results

- Linear relationship between angle of rotation and reaction time in object comparison
- The mental process seems to be analogous to the physical process of rotation.



Are visual images also subject to visual illusions? Ponzos Illusion

Which horizontal line is longer?



(a)

Imagine an inverted “V” over these lines.

Which horizontal line is longer?



(b)

Differences between pictures and mental images

- Mental images are more difficult to be reinterpreted
 - Mental image = perception + interpretation
- Strong influence of conceptual knowledge on imagery
 - Simplification of object models
 - Distortions in cognitive maps

Imagery and Ambiguous Figures

*What would this
object look like when
rotated 90 degrees?*

Imagery and Ambiguous Figures

- If you see one interpretation, it is very difficult to then imagine the other interpretation (unless you are trained in this task)
- One difference between imagery and visual perception: visual images, unlike mental images, can be easily reinterpreted

Mental Images might miss important aspects of object being imagined

- Imagine you have a cube between your thumb and index finger. One corner of the cube touches your thumb, and the diagonally opposite corner touches your index finger. Now, point to the locations of the rest of the corners in space.

Imagine this object

Mental distortions in Cognitive Maps

Which is further east?

a) Reno

b) San Diego

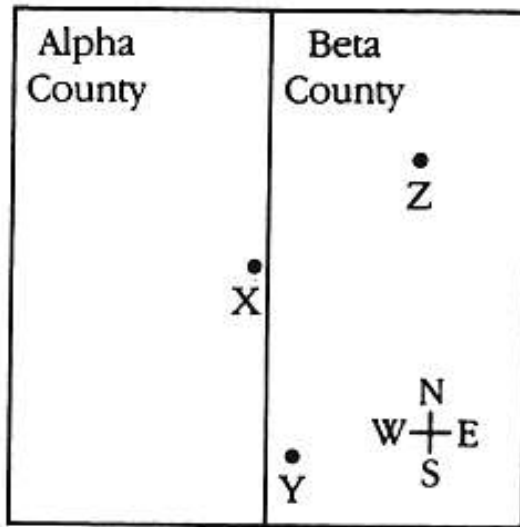
Cognitive maps are affected by conceptual knowledge

- Relative locations of small regions is determined by a conceptualization of larger regions.
- Line of reasoning:
 - Nevada is east of California
 - Reno is in Nevada, San Diego in California,
 - Therefore, Reno must be east of San Diego

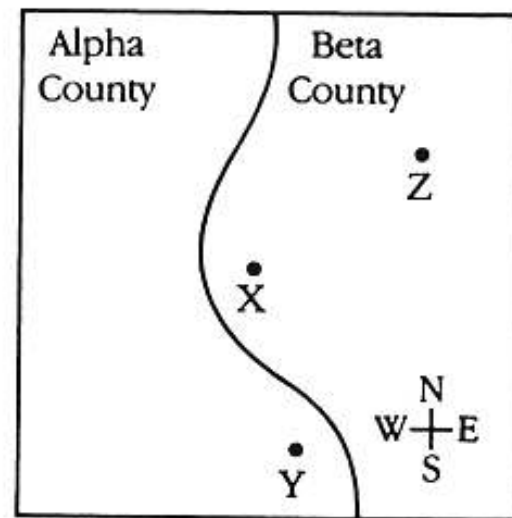
Experimental evidence for hierarchical organization in cognitive maps

- Ss. study maps. Later, from memory, they judge relative position of locations x and y
- Performance was better when superordinate information was congruent with question

Congruent



Incongruent



Summary

- Imagined information is processed in similar ways to perceptual information
 - Neuroscience evidence (fMRI)
 - Neuropsychological evidence
 - Behavioral evidence:
 - ✓ Kosslyn studies/ Scanning studies
 - ✓ Mental rotation
 - ✓ Some visual illusions
- But there are also differences:
 - Mental images are difficult to reinterpret
 - Cognitive distortions in mental maps