

PSYC 441

Cognitive Psychology II

Session 13 – Empirical Investigations of Imagery

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Session Overview

- In this last section we discuss some of the empirical studies of imagery. Do images function like mental pictures and if so, do the kind of mental operations and transformations of images also function in ways similar to those of corresponding physical operations and transformations?

Session Objectives

- At the end of the session, the student will be able to
- Describe some of the experiments conducted in the area of mental imagery
- Determine if the mental operations and transformations on visual imagery are similar to physical operations and transformations.
- Discuss the fundamental nature and properties of visual images
- Discuss some of the neuropsychological findings

Session Outline

The key topics to be covered in the session are as follows:

- Topic One: Experiments in Mental Imagery
- Topic Two : Imagery and Size
- Topic Three: Principles of Visual Imagery
- Topic Four: Critique of Mental Imagery



Reading List

- Ashcraft, M. H. (2013). *Cognition* (6th edn.), London: Pearson Education Int.
- Eysenck, M. W. (2012). *Fundamentals of Cognition* (2ed). Psychology Press, Sussex.
- Galotti, K. M. (2017). *Cognitive Psychology: In and out of the laboratory* (6th edn.). Belmont, CA: Wadsworth.
- Glictman, H. (2011). *Psychology* (8ed). Norton, New York.
- Hunt, R. R. & Ellis, H. C. (2004). *Fundamentals of Cognitive Psychology* (7th edn.), New York: McGraw-Hill.
- Willingham, D, B. (2013). *Cognition: The thinking animal* (International edn. NJ: Prentice-Hall).

Topic One

EXPERIMENTS IN MENTAL IMAGERY



Experiments in Mental Imagery

- Do images function like mental pictures and if so, are the kinds of mental operations and transformations of images also function in ways similar to those of corresponding physical operations and transformations?
- Several experiments have been done on imagery. Studies by Lee Brooks (1968) are widely regarded as the best evidence that images are distinct from verbal materials or that they use different processes.
- In one of such experiments (Figure 6.2), he asked subjects to imagine a letter such as capital **F** and to move clockwise mentally from a particular corner marked with asterisk.

Experiments in Mental Imagery

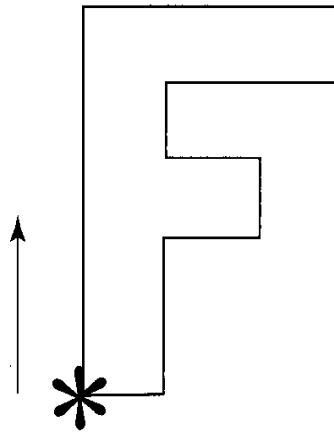


Figure 6.2. Sample figure from Brooks (1968) study

- Subjects were to start at the corner marked with an asterisk, and indicate whether or not each corner is at the extreme top or bottom.
- In this example, the correct responses are “**yes, yes, yes, no, no, no, no, no, no, yes**”. Subjects responded in two different ways.

Experiments in Mental Imagery

- One was verbal – responding either **yes** or **no** as above.
- The other was spatial (subjects were given a response sheet on which letters **Y** and **N** were printed and they were told to point to either **Y** or an **N** in each row to indicate their responses.
- Brooks found that subjects took almost 2½ times longer when they responded by pointing than they did by responding verbally.



Experiments in Mental Imagery

- One explanation is that the task required the formation of visual image of an **F** and it is assumed that this visual image of an **F** is picturelike. Therefore, a spatial or visually guided response would be interfered with to a greater extent than a verbal response, because with imagery, an image must be produced and visually scanned before a response is given.
- Brook's (1968) work supports the idea that images and words make use of different kinds of internal codes (as the dual-coding hypothesis suggests).
- Now think about this, if you are asked “Which is larger, a pineapple or a coconut?” You are likely to construct a visual image of a coconut next to a pineapple and “read” the answer from your image. You would hardly look at word length or word structure, suggesting that recall of information should be different for images and words.

Mental Rotation of Images

Mental Rotation of Images

- Studies reviewed above show that people create and use visual images to answer certain questions and perform certain tasks. It also suggests that the images created in these exercises are in some ways picturelike.
- Other studies have shown that people could do even more than simply create images; they could also apparently, mentally transform and rotate images.
- One of the most profound studies of this type was performed by Shepard and Metzler (1971) and later by Vandenberg and Kuse (1978).
- Stimuli from Vandenberg and Kuse (1978) are shown in Figure 6.3.

Mental Rotation of Images

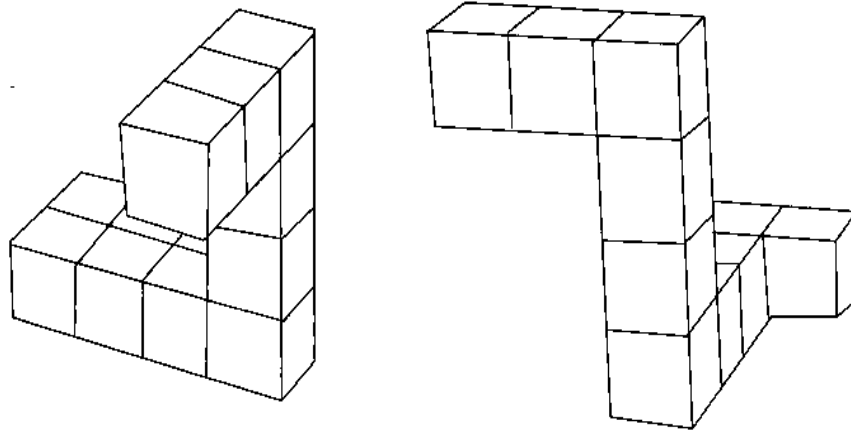


Figure 6.3. Figures similar to those used by Shepherd and Metzler (1971)

- Participants were asked to evaluate whether the two pictures were of the same object but at a different angles or whether the objects were different. The amount of rotation was varied. Sometimes they were rotated in the picture plane and other times they were rotated in depth.

Mental Rotation of Images

- *Two findings of the study were obvious.*
- First, the amount of time it took participants to make their decision was a very orderly function of the degree of rotation between the two pictures. In other words, a small degree of rotation of the second stimulus was quickly judged, while a large degree of rotation required more time.
- Second, response time was the same whether the rotation was in the picture plane or in depth.
- These experiments suggest that people construct and transform visual images. The transformations performed on the images seem to correspond to similar transformations on pictures.

Topic Two

IMAGERY AND SIZE



Imagery and Size

- The studies we have discussed so far suggest that people can construct and transform their visual images, which also suggest that images are in many ways like pictures.
- Images contain visual information, including the kinds of transformations performed on them, which seem to suggest a close correspondence similar to transformations on pictures.
- Another series of studies carried out by **Kosslyn** (1975) investigated imagery and size determination. Now consider the following questions:

- Imagine an elephant standing next to a rabbit. **Now answer this question: (a) Does a rabbit have eyelashes?**
- Imagine a fly standing next to a rabbit. Now answer this question: (b) **Does a rabbit have eyebrows?**
- Look at the illustration in Figure 6.6.

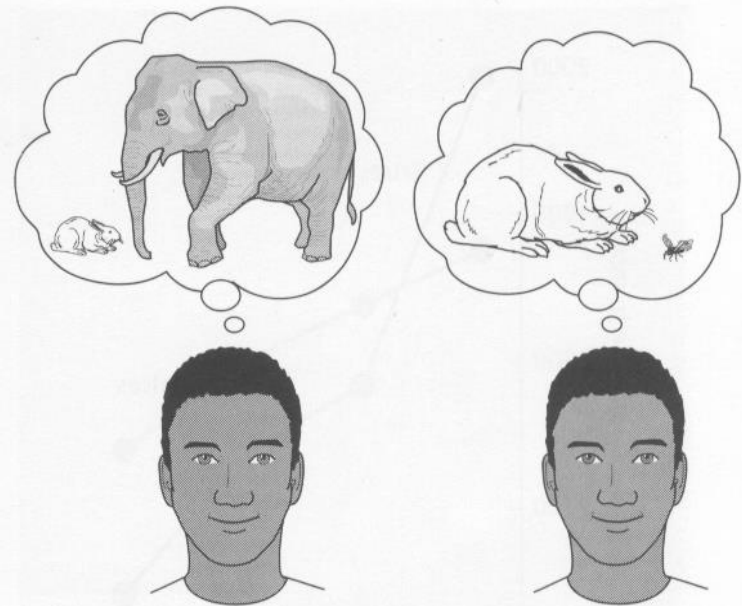


Figure 6.6. Typical relationships imagined by participants in Kosslyn's experiment

Imagery and Size

- Try the questions A and B before you read further.
- Kosslyn wanted to find out whether people would make faster judgments about large images than about small images. The problem with this research is about how to control the size of someone's mental image.
- Kosslyn believed that a mental image of an elephant next to a rabbit would force people to imagine a relatively a small rabbit. In contrast, a mental image of a fly next to a rabbit would produce a relatively large rabbit.
- In real life pictures of animals, we see details clearly on a picture. However, when you look at a small picture, the details are squeezed and it is difficult to make judgment about them.

- If this holds true for pictures in our heads, then people should make judgments more quickly with a large mental image (as in a rabbit next to a fly) than with a small mental image (as in a rabbit next to an elephant).
- In the experiment, subjects made judgments about objects – for example, whether a rabbit had legs or a rabbit has a pink nose.
- Kosslyn's results support his prediction; judgments were 0.29 seconds faster when they judged a large mental image than when they judged a small mental image.

Topic Three

PRINCIPLES OF VISUAL IMAGERY



Principles of Visual Imagery

- Converging evidence from research suggest that images share some properties with pictures. People report their experience of images as looking at mental pictures and the kinds of mental transformations done on images seem very similar to transformations done on pictures.
- Now the questions we need to ask are: **Just what are images?** What kinds of properties do images have, and how are these similar or dissimilar to the properties that real pictures have?
- Answers to these questions have implications for the way information is stored, retrieved and used. Research on visual imagery, then, can potentially tell us a great deal about how information is mentally represented and organized in our memories.

Principles of Visual Imagery

- Controversy over the nature of visual images has been intense in cognitive psychology, so let us review the controversy by taking a closer look **at the image-as-mental-picture metaphor.**
- Let us review the **Principles of Visual Imagery** as suggested by **Ronald Finke (1989)**. He describes the fundamental nature and properties of visual images in five principles. ▲
- Each covers a different characteristic of imagery.

Principles of Visual Imagery

1. Implicit Encoding

- According to Finke, the first principle of visual imagery state that “mental imagery is instrumental in retrieving information about the physical properties of objects, or about physical relationships among objects, that were not explicitly encoded at any previous time”.
- This means that images are places from which some information can be obtained, even if that information was never stored intentionally.

Principles of Visual Imagery

2. Perceptual Equivalence

- This principle of visual imagery has to do with the similarities between the construction of visual images and the perception of real objects and events. It states that “imagery is functionally equivalent to perception to the extent that similar mechanisms in the visual system are activated when objects or events are imagined as when the same objects or events are actually perceived”.
- In other words, many of the same kinds of internal processes used in mental visualization are used in visual perception as well.

Principles of Visual Imagery

- In a related group of studies with more experimental controls, Matha Farah (1985) asked subjects to form an image of a certain letter (e.g., **H** or **T**). Soon after, they were sometimes presented with one of these letters, but at a low contrast, making the letters very difficult to see.
- The results showed that those who imagined a letter first were more accurate at detecting the actual presented letter than they were at detecting another letter.
- These results suggest that imagery can “prime” the visual pathway used in detecting an actual stimulus.
- Neisser (1976) for example, regard visual imagery as perceptual “anticipation” – the visual system “getting ready” to actually see something.

• Neisser, U. (1976). *Cognition and reality: Principles and implications of cognitive psychology*: San Francisco: W. H. Freeman.



Principles of Visual Imagery

3. Spatial Equivalence

- This has to do with the way spatial information, such as location, distance and size is represented in visual imagery. The principle states that “spatial arrangement of the elements of a mental image corresponds to the way objects or their parts are arranged on actual physical surfaces or in an actual physical space”.
- The general finding is that the amount of time that it takes people to scan from one element of a visual image to another corresponds to the distance between the elements in a physical representation. Thus, spatial relationships among elements (relative locations, distances, sizes) all seem to be preserved in the visual image of the drawing or object.

Principles of Visual Imagery

- In one experiment, Nancy Kerr (1983) in a map-scan study used congenitally blind and normal participants. The blind learned the “map” by feeling the objects (each of which had a distinct shape) placed on a flat surface. After learning the locations, the experimenter named a pair of objects and the subjects were asked to focus mentally on one and to imagine moving a raised dot from that object to the second.
- She found that the greater the distance between objects, the longer it took both blind and sighted participants to scan.
- Her results suggest that visual imagery has spatial properties. In other words, spatial properties of images are similar to visual representations. It also suggests that congenitally blind people – without vision – apparently are able to make use of visual images.

Principles of Visual Imagery

4. Transformational Equivalence

- The fourth principle of visual imagery has to do with the way images are mentally transformed. It states that “imagined transformations and physical transformations exhibit corresponding dynamics and are governed by the same laws of motion”.
- Best evidence comes from the studies of mental rotation (see Figure 6.3). Such studies suggest that mental rotation apparently works in the same way that physical rotation does. The time it takes to perform mental rotation depends on how much rotation is to be done as with physical rotation.

Principles of Visual Imagery

5. Structural Equivalence

- The final principle of visual imagery has to do with the ways that images are organized and assembled. It states that “the structure of mental images corresponds to that of actual perceived objects, in the sense that the structure is coherent, well organized and can be reorganized and reinterpreted”.
- If you are asked to draw a picture of an object that you need to look at carefully, what properties of the object will influence the difficulty of the task?
- Generally, the larger the object, the more time it would take to draw it.

Principles of Visual Imagery

- Also the more complicated the object (that is, the more different parts it had) the harder it would be (and the longer it will take) to draw it.
- Construction of visual images works the same way. Images are formed, not all at once, but in pieces that are assembled into a final rendition.
- Kosslyn et al. (1983) studied image generation as it relates to the complexity of the object to be imagined. Subjects were asked to form images of pictures that differed in amount of detail (See Figure 6.7A below).

Principles of Visual Imagery

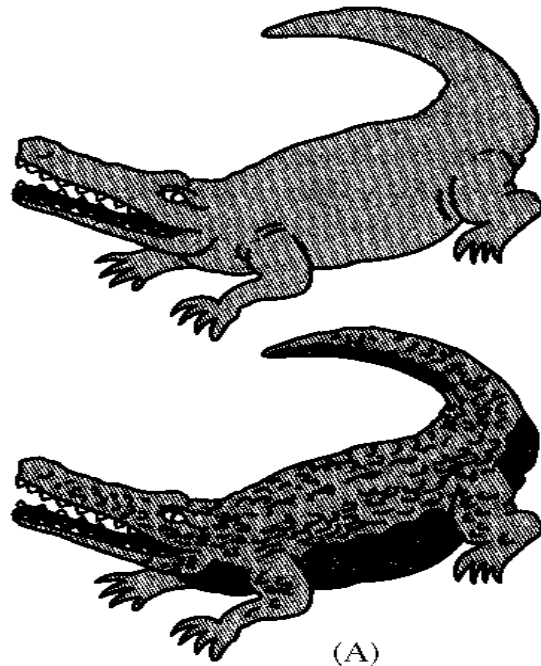


Figure 6.7. Stimuli from the Kosslyn et al. (1983) study.

Principles of Visual Imagery

- It took the subjects about one and a third times as long to form an image of the detailed pictures as compared to the image of the outline drawing.
- With images then, the greater the complexity of the conceived structure of the object, the longer it takes to assemble an image of it.

Topic Four

CRITIQUE OF MENTAL IMAGERY



Critique of Mental Imagery

- Study of imagery in psychology has been overly controversial. We will look at three themes.

Tacit knowledge and Demand Characteristics

- The experimental design may give enough “hints” either explicitly or implicitly, for subjects to rely on their beliefs and knowledge rather than on the imagery task (manipulation and construction) they are to perform.
- Again in imagery task, subjects may “pause mentally” when they are performing an image-scanning task because of their beliefs and expectations of the experiments. If you assume, for example, that the amount of time to lift a cup from one location to another will be proportional to the distance the two objects in an imagery experiment, this could be flawed because subjects in performing such tasks may pause mentally, depending on their expectations.

Critique of Mental Imagery

- Generally, demand characteristics especially experimenter expectancy effects may influence some investigations of imagery.

The Picture Metaphor

- The second critique questions the metaphor between images and pictures. Some psychologists consider visual images as mental pictures. The question is how far does the analogy go?

Critique of Mental Imagery

- Visual images may differ in several ways from pictures. There are situations where you can look physically at pictures and not knowing what it is and may ask “what is this?” but its impossible to “look” at images unless you know what they represent. This is because images are mental constructions formed with some intention in the mind.
- Pictures and images may be disrupted in different ways. You can cut pictures and remove arbitrary parts but images are organized more meaningfully, when they fade it is only the meaningful parts that disappear (Finke, 1989).
- Lastly images may be easily distorted by the viewer’s interpretations than are pictures or photographs. Pictures may be objectively assessed but images may be subjective.

Critique of Mental Imagery

Propositional Theory

- Contrary to dual-code hypothesis, propositional theorists believe that information is mentally represented in a single code (neither visual nor verbal) but propositional in nature (Anderson & Bower, 1973).
- Propositions specify relationships between different concepts and they (propositions) can be linked together in networks, with two very related ideas joined by virtue of sharing a number of propositions (associative strength). [cats and claws; birds and feathers.
- Propositional theory would predict that the higher the association value, the more propositions relating the two items, and thus the faster the verification time than reaction times for imagery.

Sample Questions

1. Describe and discuss Finke's five principles of imagery.
2. What are some of the criticisms of visual imagery?
3. What were the key results from the Shepard and Metzler study on mental rotation and why were they so important?



References

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- Finke, R. A. (1989). *Principles of imagery*. Cambridge, MA: MIT Press.
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