Visual Imagery
Chapter 10

Imagery Demonstration

- Answer these questions...
  - How many windows are there in your house/apartment?
  - Which is bigger, a carpenter ant or a ladybug?
  - How do you get from here to the UMC?
  - How did you answer these questions?
  - Mental imagery

What is Imagery?

- Visual imagery = perceiving in the absence of a physical stimulus
- Motor imagery = mental movement in the absence of overt action
- There is also imagery for audition, taste, smell, and touch
  - Listen to the “Happy Birthday” song in your head
  - Think about what a lemon tastes like
  - Think about what peppermint smells like
  - Think about touching sandpaper
Imagery

- Questions about imagery
  - How does imagery work in the brain?
  - Is visual imagery like visual perception?
  - Is motor imagery like physical action?
  - Can imagery improve learning and memory?

A Brief History of Imagery

- Wundt studied imagery in the late 1800’s
  - Claimed that because images accompany thought, you can study thought by studying imagery
  - Is thought possible without imagery? (Aristotle)
  - Imageless though debate
  - Behaviorism rejected the study of imagery (Watson)
  - Too subjective, mental states cannot be proven

How to Study Imagery

- Mental rotation studies
- Scanning and distance
- Mental walk experiments
- Report on mental image (introspection)
- Mental practice (motor imagery)
Today’s Plan

- Classic research
- What is the imagery debate?
  - Pictures versus propositions
  - Tacit knowledge explanation
- Behavioral evidence linking vision to visual imagery
- Neuroscientific evidence linking imagery and vision

Imagery and the Cognitive Revolution

- Developed ways to measure behavior that could be used to infer cognitive processes
- Paired-associate learning
- Paivio (1963, 1965)
  - Memory for words that evoke concrete mental images (usually nouns) is better than those that do not (Chapter 7)
- Conceptual-peg hypothesis
  - e.g., boat–hat; monkey–bicycle

Imagery and the Cognitive Revolution

- Shepard and Meltzer (1971)
  - Mental rotation / mental chronometry
  - Participants mentally rotated one object to see if it matched another object
Mental Rotation

• Shepard & Metzler (1971)
  - Rotation also in 2 dimensions
• RT increased linearly as the degree of rotation increased

Imagery and Visual Perception

• How similar is imagery to perception?
• The mental rotation experiments provide evidence that imagery is like perception
• However, unlike perception, imagery relies solely on top-down processing
Imagery and Perception

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

Image Scanning (Kosslyn, 1973)

- Memorize a picture
- Then imagine it and focus on one part. Answer true/false:
  - Where is the motor?
  - Where is the flag?
  - Where is the anchor?

Image Scanning (Kosslyn, 1973)

- Takes longer to “find” parts farther away from start location
- What’s another explanation for longer times?
  - Experimenter expectancy
Imagery and Perception

- 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
  - Took this as evidence showing that like perception, imagery is spatial

Imagery and Perception

- Kosslyn et al. (1978)
  - Island with 7 locations, 21 trips
  - It took longer to scan between greater distances
  - Visual imagery is spatial

Kosslyn (1978)
Perception & Imagery: Image Scaling

- Imagine a rabbit next to an elephant.
- Does the rabbit have whiskers?
- Imagine a rabbit next to a fly.
- Does the rabbit have whiskers?

Comparing Imagery and Perception

- Mental-walk task results
- Move closer to small animals than to large animals
- Images are spatial, like perception
Spatial vs Propositional Representations

- Spatial/analog (pictorial representation)
- Propositional (language-like representation)
- Imagery Debate: Kosslyn vs Pylyshyn

Is 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 (sentence, equation, etc)

Epiphenomenon

- A secondary phenomenon that occurs alongside a primary phenomenon
- In medicine, side-effect is a specific kind of epiphenomenon
- In philosophy of mind, epiphenomenalism is the view that mental phenomena are caused by physical phenomena and cannot cause anything themselves (Huxley, 1874)
Propositional vs Spatial

Propositional Representations (Pylyshyn)

How to apply propositional representations to the boat example?

Motor to porthole: 3 links
Motor to anchor: 4 links

Is Imagery Spatial or Propositional?

- Pylyshyn (2003)
- Kosslyn's results can be explained by using real-word knowledge unconsciously
  - Tacit-knowledge explanation
- e.g.: People know that in the real world it takes longer to move from the back of the boat to the front vs to the middle.
Tacit Knowledge

- **Tacit-knowledge** explanation
  - Apply knowledge of how things work in the world
  - Not conscious of using knowledge
  - But can also have demand characteristics
    - Expectations of experiment
  - How does this apply to mental scanning?
  - We know what usually happens when looking at real scene

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Tacit Knowledge

- Finke & Pinker (1982) dot and arrow
  - Hard to use tacit knowledge
  - See dot pattern, then arrow
    - Is arrow pointing to one of the dots?

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Demo: Finke & Pinker (1982)
Finke & Pinker (1982) Results

- Participants took longer to respond when the arrow was farther away from the dot
- In their mental image, they were scanning from the arrow to the dot
- Couldn't use tacit knowledge: no time to memorize dot and arrow distance
- Supports spatial representations

Pylyshyn's Response

- The tacit knowledge claim is simply the claim that when subjects are asked to “imagine x” they use their knowledge of what “seeing x” would be like and they simulate as many of these effects as they can.
- Whether a subject has this sort of tacit knowledge cannot always be determined by asking them
- When the arrow is further from the dot, the task is more difficult. Longer times could reflect difficulty retrieving tacit knowledge

Imagery so far

- Classic research
  - Imageless thought debate
  - Wundt
  - Behaviorism
  - Shepard & Meltzer
- What is the imagery debate?
  - Pictures versus propositions
  - Tacit knowledge explanation
  - Kosslyn
  - Pylyshyn
Interactions between Imagery and Perception

Cheves Perky (1910)

Imagery, Size, & Anorexia Nervosa

- Smeets & Kosslyn study
- Leotard image, distorted: fatter or thinner
- Results: anorexic women judge “fatter” image as close to their own body
Imagery and the Brain

- Category-specific neurons
- *Imagery neurons* (Kreiman et al., 2000) respond to both perceiving and imagining an object
- Overlap in brain activation
- Visual cortex

Imagery neurons

Kreiman et al. (2000)

W: “Wider than tall?”

Ganis et al. (2004)
Imagery and the Brain

- Ganis and coworkers (2004)
  - Complete overlap of activation by perception and imagery in front of the brain
  - Differences near back of the brain
    - Perception > Imagery
    - Bottom-up vs top-down difference

- Amedi and coworkers (2005)
  - Again, overlap
  - Also deactivation of non-visual areas of brain during imagery
    - Hearing
    - Touch
  - Mental images more fragile, less activation keeps other things from interfering

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**fMRI**

LeBihan et al. (1993)
Correlation vs. Causation

- Brain activity can also be an epiphenomenon. Just correlated with behavior in fMRI, etc.
- Using TMS, can (temporarily) disrupt a brain region. Impaired function means that region was important.
  - Kosslyn et al. (1999)
  - TMS to visual areas caused slower response for both perception and imagery
    - Visual areas are important for both.
Neuropsychological Studies

- MGS: epilepsy, right occipital lobe
- Mental walk task before and after surgery
  - Before: 15 feet from imaginary horse
  - After: 35 feet
  - Visual field reduced after surgery
- Conclusion: Visual cortex is important for imagery

Neuropsychological Studies

- **Double Dissociation** between Perception and Imagery
- OK perception, bad imagery (R.M.)
  - Can copy pictures, but can’t draw from memory
- OK imagery, bad perception (C.K.)
  - Visual agnosia (can’t recognize objects)
- Can draw objects from memory, but can’t copy pictures

C.K.’s results

Naming problems

Drawing OK
• Earlier we said perception and imagery are related, but what about the double dissociation?

• Mechanisms only partially overlap

• Perception: bottom-up and top-down

• Imagery: top-down only

Motor Imagery versus Action

• Imagery alone can be used to learn a new motor task

• Imagery can be used to maintain performance in the absence of physical practice for at least 3 months

• The same brain regions active during physical practice are also active during motor imagery

• Supplementary motor areas, premotor areas, primary motor cortex

• Research at CU: Alice Healy

Motor Imagery

Test period: Old (trained) and new (untrained) numbers

Execution Time (in s)

Mental-Same Mental-Switch Physical-Same Physical-Switch

Generalization via mental practice!

Wohldmann et al. (2008)
Improving Memory with Imagery

- The pegword method
- The method of loci
- The keyword method

The Pegword Method

- One is “bun”
- Two is “shoe”
- Three is “tree”
- Four is “door”
- Five is “hive”
- Six is “sticks”
- Seven is “heaven”
- Eight is “gate”
- Nine is “wine”
- Ten is “hen”
<table>
<thead>
<tr>
<th>1. Top of your head</th>
<th>1. Stapler</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Forehead</td>
<td>2. Bacon</td>
</tr>
<tr>
<td>3. Eyes</td>
<td>3. Light bulb</td>
</tr>
<tr>
<td>4. Nose</td>
<td>4. Ballpoint pen</td>
</tr>
<tr>
<td>5. Mouth</td>
<td>5. Spatula</td>
</tr>
<tr>
<td>7. Neck</td>
<td>7. Dental floss</td>
</tr>
<tr>
<td>8. Shoulder</td>
<td>8. Sour cream</td>
</tr>
<tr>
<td>10. Stomach</td>
<td>10. Watermelon</td>
</tr>
<tr>
<td>12. Thigh</td>
<td>12. Peanut butter</td>
</tr>
<tr>
<td>15. Ankle</td>
<td>15. Paper towel</td>
</tr>
</tbody>
</table>

- ALMANAC
- ENVELOPE
- BASSOON
- HYACINTH
- PLATFORM
- BROCCOLI
- UMBRELLA
- CHIMNEY
- AARDVARK
- MEDICINE
- VERANDA
- SURGERY
- CUPCAKE
- ESPRESSO
- PLANKTON
- HORIZON
- WARRANTY
- ADVENTURE
- LETTUCE
- MONOGRAM
- SAPPHIRE
- OUTSIDER
- KNAPSACK
- PARADIGM
- MIGRAINE
- BACHELOR
- UNIVERS
- YOGHURT
- RAINBOW
- HYDRANT
- STALLION
- TRICYCLE
- JUDGMENT
- COCONUT
- NOCTURNE
- TOOTHACHE
- VAGABOND
- MICROSCOPE
- VIOLENCE

**The Keyword Method**

Useful for learning new foreign vocabulary

Example: *rodilla*

“rodilla” sounds like “rodeo” (the keyword: “rodeo”)

rodilla --- rodeo --- knee
More Imagery Mnemonics

- For imagery-based mnemonics to work, the images you create have to be integrated.
- Evidence: Bower & Winzenz (1970)
- Three mnemonic conditions
  - **Overt rote rehearsal**
    - 30% recall
  - **Noninteracting imagery**
    - 27% recall
  - **Interacting imagery**
    - 53% recall
- Interacting images do NOT have to be bizarre to be effective

“piano, cigar, piano, cigar…”