

**Brief history**

- **Ancient Greeks**
  - Stoics spoke of 'impressions' in the mind, using the metaphor of a stamp being pressed into wax for how we perceive objects.
  - Aristotle: no thought without images.

- **Modern philosophers:**
  - Rationalists (e.g. Descartes) and empiricists (e.g. Locke) agreed that images are important for thinking.
  - Descartes argued that some thought was non-imagistic, distinguishing imaging and conceiving (chiliagon problem).
  - Berkeley also pointed out that it is difficult to image 'triangularity' (as opposed to some specific triangle).

- **In the 19th century (beginnings of psychology – Wundt and James)**
  - strong claims about the importance of imagery again became popular with the introspectionists.

- **Beginning of the 20th century**
  - Behaviorism: imagery was ignored, if not considered irrelevant (because it was exceedingly 'internal' in nature).
Modern views

1950s-60s (post-cognitive revolution)
- focus was on language-like, not picture-like processing for understanding cognition.
- the applicability of the computer metaphor to imagistic processing wasn’t immediately clear

1970s-Present
- No one has argued that imagery replaces verbal thought or accounts for all aspects of cognition.
- The question is whether there is anything special about mental images, or if/how we can/should talk about mental images at all.
- Most cognitive scientists take it that some processing is best understood in terms of mental images (though this is not unanimous).
- They are interested in understanding:
  1. the relation between images and perception; and
  2. the functional structure of images themselves
Perception/imagery shared mechanisms

- Some evidence
  - Interference effects
  - Brain damage effects (next slide)
  - ‘Weight-contrast’ illusion reproduced
  - ‘Pictures in the head’ (two slides)
  - Same areas ‘light up’ (Kosslyn, 1995) (three slides)
Case study

Case study: Farah, Beauvois and Saillant published a paper describing their intensive study of one patient (1985, 265-6). This patient had "verbal-visual disconnection syndrome"

- could not associate colour names with visual impressions of colours
- no problems working with colours purely visually (i.e. could see when two colour samples were identical)
- could use colour terms alone (e.g. answering "What colour is associated with envy?")
- when shown a black and white picture of object could select a colour sample that matches the object's actual colour
- if asked what colour a particular object was, relying only on his powers of mental imagery, failed.

Therefore, had the same problem with mental images that he had with visual perceptions: he could associate both with other visual perceptions, but he could associate neither with verbal representations.

The patient was injured in a brain area known to be active during visual perception, the study suggests that mental imagery and visual perception are controlled by the same brain areas.
Monkey VI staining from Tootel et al.
Figure 1 | **Auditory imagery.**  

a | A subject lying in a positron emission tomography (PET) scanner, listening to or imagining music.  

b | The patterns of activation detected in auditory imagery (Ima) and perception (Per), compared with a visual baseline (B). Left- and right-hemisphere sagittal slices are shown in both panels. The top panel shows activation in the superior temporal gyrus (STG). Although activation was stronger during perception than in imagery, it was located in similar regions of the temporal lobes in both conditions. In the bottom panel, similar areas of activation between imagery and perception were found in the supramarginal gyrus, and in the middle frontal (Mid F) and inferior frontal (Ant Inf F) cortices. PET data panel reprinted with permission from Ref. 23 © 1996 The MIT Press. Kosslyn et al. Nature.
Problems with V1 data: not replicated


Cortical activation evoked by visual mental imagery as measured by fMRI.
Knauff M, Kassubek J, Mulack T, Greenlee MW.

One of the major controversies in cognitive neuroscience is whether the primary visual cortex and nearby areas are involved in visual mental imagery. In an fMRI study we examined the brain activity of 10 healthy subjects under different task conditions: in the perception condition subjects saw complex geometrical shapes and had to decide whether other highlighted stimuli fell inside or outside the figure. In the imagery condition subjects saw only the highlighted stimuli and were instructed to imagine the previously studied geometrical shapes to solve the same task. Although the behavioral data show a distance effect that would be expected based on topographically organized mental images, the functional imaging data do not show increased activity in the primary visual cortex in the imagery condition. In the occipital cortex a slightly increased activity was found only in the visual association cortex (BA 19), whereas the highest activation was observed in the parietal cortex (BA 7 and 40). The results of the study do not support the assumption that the primary visual cortex is involved in visual mental imagery, but rather that a network of spatial subsystems and higher visual areas appears to be involved.

PMID: 11192609 [PubMed - indexed for MEDLINE]
Functional structure of mental images

- What characteristics do pictures/models and images share?
  - Mental rotation (Shepard and Metzler, 1971; next slide)
  - Mental folding (Shepard and Feng; two slides)
Rotation examples from Shepard and Metzler, 1971
Shepard and Feng mental folding experiment
Structure of mental images (cont.)

- Kosslyn claims we 'can manipulate these models much like we do actual objects' ('mental model').

- Scanning experiments (Kosslyn, et al., 1973, 1978):
  1) Imagined map (next slide)
  2) Focus on the front or back of an animal determine if the animal has a property.

- Mental resolution (Kosslyn, et al., 1978, 1980):
  1) Imagined animals at different relative sizes (two slides)
  2) Imagined animals at the same size.

- Mental screen size (Kosslyn, et al., 1983):
  Large objects ‘overflow’ screen at closer imagined dist.
Map from Kosslyn et al. scanning experiment
Mental Resolution: Participants imagine a certain animal (a rabbit) positioned next to either an elephant or a housefly. Time to answer simple questions ('does the rabbit have whiskers') depended on the context in which the rabbit was imaged.
Dennett’s Critique

Dennett’s introspective trap paper is a good summary of problems.

1. Mental 'images' are always hedged to be unlike images
   
   – Response: There are many different kinds of images, what is important is that images encode information in a spatial manner. (Dennett grants this: they are supposed to ‘resemble what they represent’).

1. An infinite regress of 'viewers'.
   
   – Response: Information encoded as image-like can be manipulated just as information encoded as text-like (no infinite regress of ‘hearers’). Mental images don't have to be interpreted any more than ‘mental text’ does.
Dennett's Critique (cont.)

3. Images have to specify a certain amount of detail. However, mental images don't specify certain things at all (e.g. whether or not a man is wearing a hat).
   - Response: Images can be fuzzy in such a way that it isn't clear whether certain properties are present or not (contra Dennett; e.g. hat picture).
   - Rejoinder: Also, the criticism is a two-edged sword: images do indeed have to specify certain properties (whether a (full) person is sitting or standing) that descriptions don't – maybe the information we actually use.

4. Pictures can be ambiguous but mental images can't be. (Recall the duck-rabbit (Chambers and Reisberg)).
   - Response: Good point, see below.

5. Also recall from the scanning experiments that the farther away the property, the longer it took to answer only if the property was rated as requiring imagery. So some information seems non-imagistic
   - Response: That's fine by us.
Descriptionalism

- Dennett proposes the 'descriptionalist' alternative to 'pictorialism'.
- Mental images are more like textual descriptions than pictures:
  - 'Spatiality is irrelevant to descriptions' (p. 56).
- Note:
  - Descriptionists think that perception is like a description too, so they can agree that the same mechanisms underlying perception underlie imagery.
Discussion

Anderson:
- formally descriptionalism is as representationally powerful as pictorialism. So, is there no way of determining which is really used by people?

Some differences:
- 1) Pictorialist accounts predict the results of novel experiments better than descriptionist accounts. (i.e. descriptionism is ad hoc).
- 2) Pictorialist accounts are better supported by neuroscientific evidence.
- 3) Explanations are simpler/more elegant (Ockham's razor) using pictorialism (related to 1).

Pictorialism seems to be the better candidate. But:
- the 'interpretation problem' still looms large.
- there have been suggestions of incorporating descriptions with pictorial representations (Chambers et al). However, it is not yet clear how this should be understood.
What two different kinds (categories) of evidence have been used to argue in favour of mental imagery?