Shared mechanisms for visual imagery and perception?

• Functional equivalence in normals
  – Spatial distance, eccentricity etc. (Finke, Kosslyn et al.)

• Bidirectional connectivity
  – Same system in reverse direction

• Neuropsychology
  – agnosia & imagery deficit: same domain (faces, colors)
  – no perception/imagery in scotoma (Farah et al.)

• Neuroimaging
  – activation of same regions (V1 etc) for imagery and perception (Kosslyn et al.)
  – TMS (transcranial magnetic stimulation) and ERP (evoked response potential) confirmation
Kosslyn et al. Science, 1999

Imagery minus Baseline
(n=6)

Area 18/19

Area 17

Coronal View
AC - 87 mm

MGH PET

Visual system
Kanwisher and colleagues

Visual system
Shared mechanisms for object recognition and visual mental imagery

*IMAGERY*  

*OBJECT RECOGNITION*

*tightly coupled, exquisite parallelism*

Visual system
Consequences of lesion

Visual system

IMAGERY

OBJECT RECOGNITION
Dissociations between perception and imagery

• Neuropsychological double dissociation
  – loss of imagery but intact perception
    » (Charcot, 1883; Farah, 1988; Riddoch, 1990)
    » but imagery more difficult perhaps?
  – intact imagery and loss of perception
    » patient CK
    » several others as well

How to reconcile the association with double dissociation?
CK: object agnosia

• **Case study**
  – 33 year old, right handed, British
  – MVA in January 1988
  – bilateral thinning of occipital lobes

• **Behaviour**
  – normal intelligence
  – normal visual acuity
  – completed MA in History
  – employed in large organization
Visual agnosia

• failure to identify visually presented objects
• recognise from modalities other than vision
• no loss of semantics
• not attributable to an anomia

CK meets all these criteria
CK’s object recognition

“skewers on a kebab”

“fencer’s mask”

“feather duster”

“cockpit”
CK’s copying of geometric figure

Target

CK's copy

Visual system
CK fails to segment images
CK: Integrative agnosia

» Does more poorly on overlapping stimuli
» fail to segregate figure from ground
» fail to group lines into gestalt
» recognise by strategy of using local parts
But CK draws extremely well
Behrman et al. Nature

“map of England with London marked as well as place of birth”

“what kind of guitar shall I draw?”

Visual system
CK has intact visual imagery

• Imagery for object size:
  – thimble versus m & m?

• Imagery for object shape
  – ears up or down? tail long or short?
  – letters curve or straight?

• Imagery for object colour
  – inside of a cantaloupe?

• Sentence verification
  – letter ‘W’ has 4 strokes
CK can also perceive objects generated in internal image

- Reconstruct mental images of objects
  » Imagine the letter ‘B’. Rotate it 90 degrees to left. Put a triangle below it having the same width and pointing down. Remove the horizontal line. (Finke, Pinker & Farah, 1989)

- Reconstruct mental images of letters
  » Take two ‘C’s. Turn the right one backwards and make it touch the left one. Now add a small diagonal line to the bottom right edge. (Behrmann et al., 1994)
Summary

• CK
  – fails to recognise objects he can image
  – he can draw them; image them in detail
  – he can manipulate and recognise objects in mental image
Reconcile?

• Double dissociation but existing associations
  – system must diverge at some point
  – but mechanism essentially shared

• SAME SYSTEM BUT NOT ALL PARTS OF THE SYSTEM SHARED

Visual system
IMAGERY

GROUPING, BINDING NOT GENERALLY NECESSARY FOR IMAGERY; IMPORTANT FOR PERCEPTION

OBJECT RECOGNITION

VISUAL SYSTEM

ASSOCIATION BUT DIVERGENCE
Brain-behavior correspondence

• **Broad message:**
  – DD may exist
  – Explanation need not be straightforward

• **Functional specialization and optimization**
  – Motion
  – Depth
  – Color
  – But not exclusive dedication

• **Perception-imagery: coupled but differential reliance on subparts of system**

  Visual system
Some unresolved issues

• Imagery and other forms of internal representation:
  – Working memory studies?
    » See frontal not occipital activation
  – Visual search studies where target pre-specifed

• Why are images different from hallucinations
  – “The difference betwixt these (imagery/ideas and perception) consists in the degree of force and liveliness, with which they strike upon the mind. Perceptions enter with most force and violence. By ideas I mean the faint images of these in thinking and reasoning” (p311).
Single versus multiple codes

• All seem to agree on multiple codes but unclear what this means in a connectionist-type system.
  – Maybe there is only one code? Neither propositional nor spatial?