Brain Mechanisms of Memory and Cognition – 2

Motion processing; spatial cognition; parietal cortex

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Monday 17, 24, 31 Jan; 7, 14, 28 Feb 2005; 10 am
Physiology Main Lecture Theatre
Slides will be at pobox.com/~rudolf/psychology
Two visual streams

from Zigmond et al (1999)
Concurrent (parallel) processing begins at the retina

Information flow in the visual streams

High-level visual tasks

Intermediate Visual Tasks

Intermediate cortical analyses

Early cortical analyses

Retina, LGN

van Essen & DeYoe (1995)
Colour (V4) and motion (V5)

colour (versus monochrome)
moving dot image (versus still)

Zeki (1993)
V1/V2 active in all conditions
Blindsight: residual visual function after V1 lesions
Blindsight: detection of visual stimuli without perception

Perimeter, for measuring visual fields in monkeys

Cowey & Weiskrantz (1963)
Fig. 15 The bilaterally destricated monkey Helen roamed freely among the objects in the test arena. She would, however, bump into the obstacle made of transparent perspex, as shown, revealing that her navigation was not based on non-visual cues. (Photographs taken from a film by N. Humphrey, and published with his kind permission.)
Blindsight: patient D.B. in a forced-choice discrimination

Weiskrantz (1986)

Percentage correct

<table>
<thead>
<tr>
<th>Discrimination task</th>
<th>X versus O</th>
<th>□ versus □</th>
<th>□ versus □</th>
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<tr>
<td>Percentage correct</td>
<td>75</td>
<td>75</td>
<td>50</td>
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chance
Blindsight: motion discrimination following V1 lesions

... whereas hemispherectomized patients perform at chance (on their bad side)

Perenin (1991)
Effects of parietal cortex lesions.
Bálint’s syndrome; neglect
Optic ataxia: impaired visual guidance of movement

figure from Zigmond et al. (1999)
Simultanagnosia

‘Are there circles of two different colours?’

Random

‘No.’

Single

‘No.’

Mixed

‘Yes.’

Humphreys & Riddoch (1993)
Neglect: line cancellation task

Kartsounis & Warrington, 1989
Neglect: drawings from memory

Beschin et al. (2000)
Sensory extinction following partial recovery from neglect

from Rafal & Robertson (1995)
Neglect is attentional: the Piazza del Duomo, Milan (1)

Bisiach & Luzzatti (1978)
Neglect is attentional: the Piazza del Duomo, Milan (2)

Bisiach & Luzzatti (1978)
Object-centred neglect

A  Model  Patient's copy

B  Model  Patient's copy
Cortical regions damaged in neglect

TPJ = temporo-parietal junction
IPL = inferior parietal lobule (ang = angular gyrus; smg = supramarginal gyrus)
IPS = intraparietal sulcus
STG = superior temporal gyrus
MFG = middle frontal gyrus
IFG = inferior frontal gyrus

Left/right asymmetry of function in the TPJ

<table>
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<tr>
<th>Stimulus</th>
<th>Right Damage</th>
<th>Left Damage</th>
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<tbody>
<tr>
<td><img src="image" alt="Stimulus" /></td>
<td><img src="image" alt="Right Damage" /></td>
<td><img src="image" alt="Left Damage" /></td>
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Rey-Osterreith figure

**FIGURE 44.9** Examples of drawings of a stimulus by patients with left or right hemisphere damage. (Adapted from Robertson and Lamb, 1991.)
Parietal cortex: anatomy and electrophysiology
Parietal cortex (with the intraparietal sulcus ‘unfolded’)

(a) Macaque monkey

(b) Human

Culham & Kanwisher (2001)
There are multiple monocular cues for depth, such as texture gradient, in addition to stereopsis (binocular disparity and convergence information).

(Above: stereo pair of satellite images. Left: ‘Rue de Paris, temps de pluie’ by Gustave Caillebotte, 1877.)
Caudal intraparietal sulcus (cIPS) and 3D spatial processing

Tsutsui et al. (2002)
Science 298: 409
LIP neuronal responses: updated based on planned motor acts

Duhamel et al. (1992) Science 255: 90
VIP neuronal responses: polymodal, ‘head-centred’

Duhamel et al. (1991)
‘Head-centred’ receptive fields in VIP

monkey looking straight ahead (at F); grey = receptive field

monkey looking 30° to left (at F)
Electrophysiology - 7a, 7b, AIP: visuomotor control

- **7a:** Similar to LIP. Visual receptive fields; also respond to position of eyes in orbits; thus may e.g. respond best to stimulus in RF when eye in a certain position.

- **7a:** Activity related to saccades, visual pursuit, and also movement of arm towards a target (N.B. relevance to optic ataxia) and manipulation of an object. *Visuomotor.*

- **7b:** Response to somatosensory as well as visual input.

- **AIP:** involved in visual guidance of precise hand movements. *Visuomotor.* Receives info about 3D properties of objects from other parietal regions. Active during all phases of grasping activity.

Electrophysiology - 5: somatomotor control (‘active touch’)?

- **5:** Predominantly somatosensory and proprioceptive input (N.B. is adjacent to primary somatosensory cortex). Responds e.g. to active touching, but not to passive visual or cutaneous stimulation.
The dorsal stream: visuomotor control
Perception of object size \textit{versus} grasping

\textit{Milner} (1998)
Impaired perception of object size, but normal actions


Impaired perception of orientation, but normal actions

Patient D.F.; ventral stream lesion (due to anoxia secondary to carbon monoxide poisoning); esp. areas 18/19

Milner et al. (1991) Brain 114: 405
Object constancy in the ventral stream (1 - shadow)

Weiskrantz & Saunders (1984) - impaired by TE (inferotemporal) lesions, not parietal lesions
Object constancy in the ventral stream (2 - size, orientation)

Fig. 3. Photographs of all stimulus objects with size and orientation transforms. View of object in the centre of each panel is of the standard training object. The forward views are of the two size transforms, and the back views are of the two orientation transforms. The label for each panel indicates the order in which the problem was presented to each group (see Appendix).

Weiskrantz & Saunders (1984) - impaired by TE (inferotemporal) lesions, not parietal lesions
Summary

- **Ventral stream is object-centred.** Object detection largely irrespective of position, sometimes independent of viewpoint, etc. Required for visual awareness?

- **Dorsal stream is visuomotor.** High spatial precision for guidance of action. Unconscious?

- The posterior parietal cortex maintains multiple maps of space with which it can control actions; some approximate allocentric maps (independent of eye/body position to a degree).

- The posterior parietal cortex has *attentional* functions, separate from its visuomotor functions. To be continued...