The visual cortex
V1

Anatomical Layout
V1
Receptive Field Organization
Receptive field plots of cat V1 cells using small spots

Figure by MIT OCW.
Asessing orientation and direction specificity of a V1 cell
Assessing spatial frequency selectivity of a V1 cell
Responses of a simple and complex cell to gratings of different spatial frequencies

Figure by MIT OCW.
Transforms in V1

Orientation
Direction
Spatial Frequency
Binocularity
ON/OFF Convergence
Midget/Parasol Convergence
V1

Cytoarchitecture
Original Hubel-Wiesel "Ice-Cube" Model

Ocular Dominance Columns

Left Eye

Right Eye

4cα

4cβ

5

6

L parasol midget

R parasol midget

Orientation Columns

500 μ
Cytochrome oxidase patches in monkey V1

Figure by MIT OCW.
Radial Model

Orientation Columns

Ocular Dominance Columns

Left Eye

Right Eye

L parasol midget

R parasol midget
Three models of columnar organization in V1

Original Hubel-Wiesel "Ice-Cube" Model

Radical Model

Swirl Model

Figure by MIT OCW.
Extrastriate cortex
Methods for delineating extrastriate areas

architectonics
connections
topographic mapping
physiological characterization
lesions and behavioral testing
cerebral accidents and behavioral testing
imaging
Visual functions studied
Basic visual capacities

- color
- brightness
- pattern
- texture
- motion
- depth

Intermediate visual capacities

- constancy
- selection
- recognition
- transposition
- comparison
- location
Layout of visual areas
## Major cortical visual areas:

<table>
<thead>
<tr>
<th>Location</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occipital</td>
<td>V1, V2, V3, V4, MT (medial temporal)</td>
</tr>
<tr>
<td>Temporal</td>
<td>IT (inferotemporal)</td>
</tr>
<tr>
<td>Parietal</td>
<td>LIP (lateral intraparietal), VIP (ventral intraparietal), MST (medial superior temporal)</td>
</tr>
<tr>
<td>Frontal</td>
<td>FEF (frontal eye fields)</td>
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</tbody>
</table>
Connections among adjacent visual areas

Receptive field locations and sizes at successive penetrations in V1 and V2.
Area V2
# Functional Segregation in Area V2

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Percent of cells</th>
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<tbody>
<tr>
<td></td>
<td>Thin</td>
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<tr>
<td>Stripes</td>
<td></td>
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<tr>
<td>Orientation</td>
<td>48</td>
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<tr>
<td>End stopping</td>
<td>22</td>
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<tr>
<td>Color</td>
<td>63</td>
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<tr>
<td>Direction</td>
<td>10</td>
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<tr>
<td>Disparity</td>
<td>21</td>
</tr>
</tbody>
</table>

Source: Peterhans, in Cerebral Cortex, Vol 12, 1997, sum of five studies
Area V4
Central Sulcus
V1
Lunate
V2
LIP
V4
Figure by MIT OCW.
Area V4 attributes:

1. Large receptive fields
2. Complex receptive field properties
3. Responses are task and intent modulated
4. Response can also be modulated by eye movements
5. Not just a color area
Area MT and MST
Direction specificity as a function of track distance in MT

Figure by MIT OCW.
Layout of directions in MT

Figure by MIT OCW.
Inferotemporal cortex
Summary:

1. The contralateral visual hemifield is laid out topographically in V1 of each hemisphere.

2. V1 transforms are: orientation, direction, spatial frequency, binocularity, ON/OFF convergence and midget/parasol convergence.

3. V1 is organized in a modular fashion. Three models of the layout of the modules are the ice cube, radial and swirl models.

4. There are more than 30 visual areas that make more than 300 interconnections.

5. Extrastriate areas do not specialize in any single function.

6. The receptive field size of neurons increases greatly in progressively higher visual areas.

7. Area MT is involved in the analysis of motion, depth, and flicker.

8. Area V4 engages in many aspects of analysis; neurons have dynamic properties.

9. In inferotemporal cortex high level analysis takes place that includes object recognition.

10. Single cells in cortex are multifunctional.