Visual Cortex: Thin stripes, Thick stripes & interstripes

10.10

V1-V4 = areas of visual cortex
MT = middle temporal (V5)
MST = medial superior temporal
IT = inferior temporal
Visual Cortex Organization

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Conceptual Organization: Intersection between psychology and biology

• Top-down processing: Global
  – Perceptual “whole” or gestalt of object or scene leading to object identification
  – Contextual influences related to integration of features, memory (e.g., recognition), etc.

• Question: How does the brain do this type of “top-down” processing?

• Bottom-up processing: Local
  – Stimulus features (contours, edges, movement, color)
  – Visual cell physiology
    • Receptor + receptive fields
    • Ganglion cells + receptive fields
    • LGN cells + receptive fields
    • Cortical cells + receptive fields

• Question: How does the brain create an integrated perception – a “perceptual whole” or “gestalt”, from local processes. This is the Binding Problem.

Answer MAY be in the HIERARCHICAL organization of cortical functioning. That is, this may occur as parallel pathways:
1) “integrate” information from earlier stages of processing within serial pathway.
2) “shares” information with other structures in other pathways.
Each subsequent level processes information that comes closer to integrating (all?) “salient” stimulus features passed on/”up” to that level.
Simple Feature Detection Cells

- Simple Feature Detection Cells
  - Rectangular receptive field – On Center
  - Specific Orientation
  - Spot
  - Bars best

- V1 and some V2 +
Hypercomplex Feature Detection Cells

- **Receptive fields**
  - Selected stimulus features - Inhibitory at specific location, rest excitatory
  - Likes bars/lines
  - Orientation
  - Movement

- **V2 +, especially along ventral stream**
Visual Cortex: Form or complex shape (again)

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Cortical Color Responsive Cells: Double Opponent

[A diagram illustrating double-opponent color-responsive cells in the cortex.]

B Double-opponent red-green contrast cell
Cortical Color Responsive Cells: Color Contrast

• V4 cortical damage
  – Achromatopsia: vision without color
  – Cannot imagine color
  – Cannot remember color of object seen before injury.
  – Can state names of colors
  – Deficits restricted to ½ visual field if damage is unilateral.

• V4 cells (Color contrast cells)
  – Input from Thin stripes
  – Large receptive fields
    • Large surround around primary area
    • No response in secondary if it alone is stimulated.
  – Stimulation of primary area of receptive field
    • Specific color
    • Bar shape
    • Specific orientation
  • Respond to narrow range of wavelengths, e.g., 550-570 nm
Cortical Color Responsive Cells: Color Contrast

- Cells respond to narrow range of wavelengths, e.g., 550-570 nm

- But better if the stimulus light has some small amount of different wavelength.

- Different wavelength is in the surround.

- Comparison wavelengths for **color contrast**

![Graph showing action potentials for different wavelengths](image-url)
Visual Cortex: Color (again)

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Non-M and non-P (from koniocellular layers directly to blobs)
Visual Cortex (area MT): Motion

- Cells in MT cortex respond best when small object moves relative to background either when –
  - object’s image moves on the retina and background remains stationary or
  - object remains on the same portion of the retina (stationary) while the background moves
Visual Cortex: Motion and electrical stimulation of MT

- Cells in MT – Action potential responses to visual stimulation
  - Columnar organization
  - Sensitive to motion in specific direction
  - Stronger the signal, stronger the AP response of cells
    - 0% = random, no response,
    - 100% moving same direction, strongest response of cells “tuned” to that direction.

- Monkeys trained to identify pattern of movement of circles.

- Only single column needs to be responding for monkey to make accurate judgment.
Visual Cortex: Motion and electrical stimulation of MT

• Behavioral response to electrical stimulation of cells in column of MT

• Design 1
  – Random visual pattern (A)
  – Electrical stimulation of single column of cells preferring 225°
  – Makes judgement that circles are moving 225°

• Design 2
  – If visual pattern is weak (25% = red dotted line),
  – Stimulate another column more (red dot).
  – Judgement biased towards stronger activation (red solid line).

• Estimated that in MT, only 200 cells in a column are needed to perceive motion.
Visual Cortex: Motion (again)

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