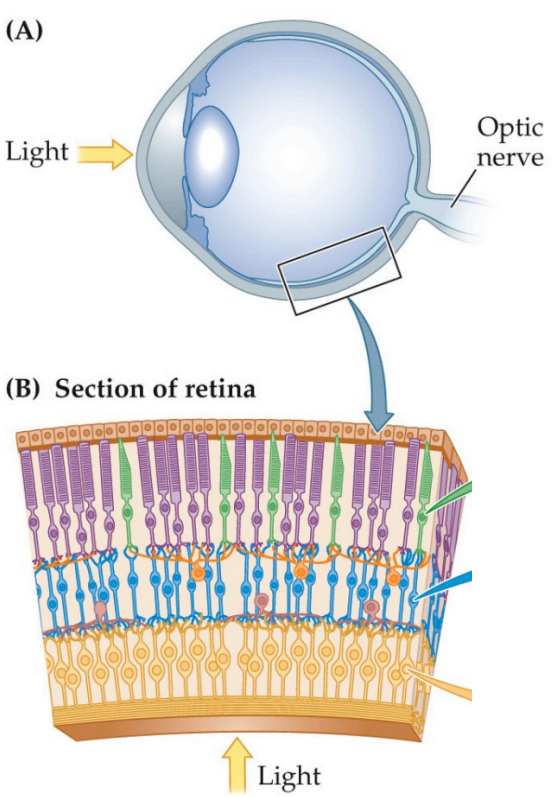
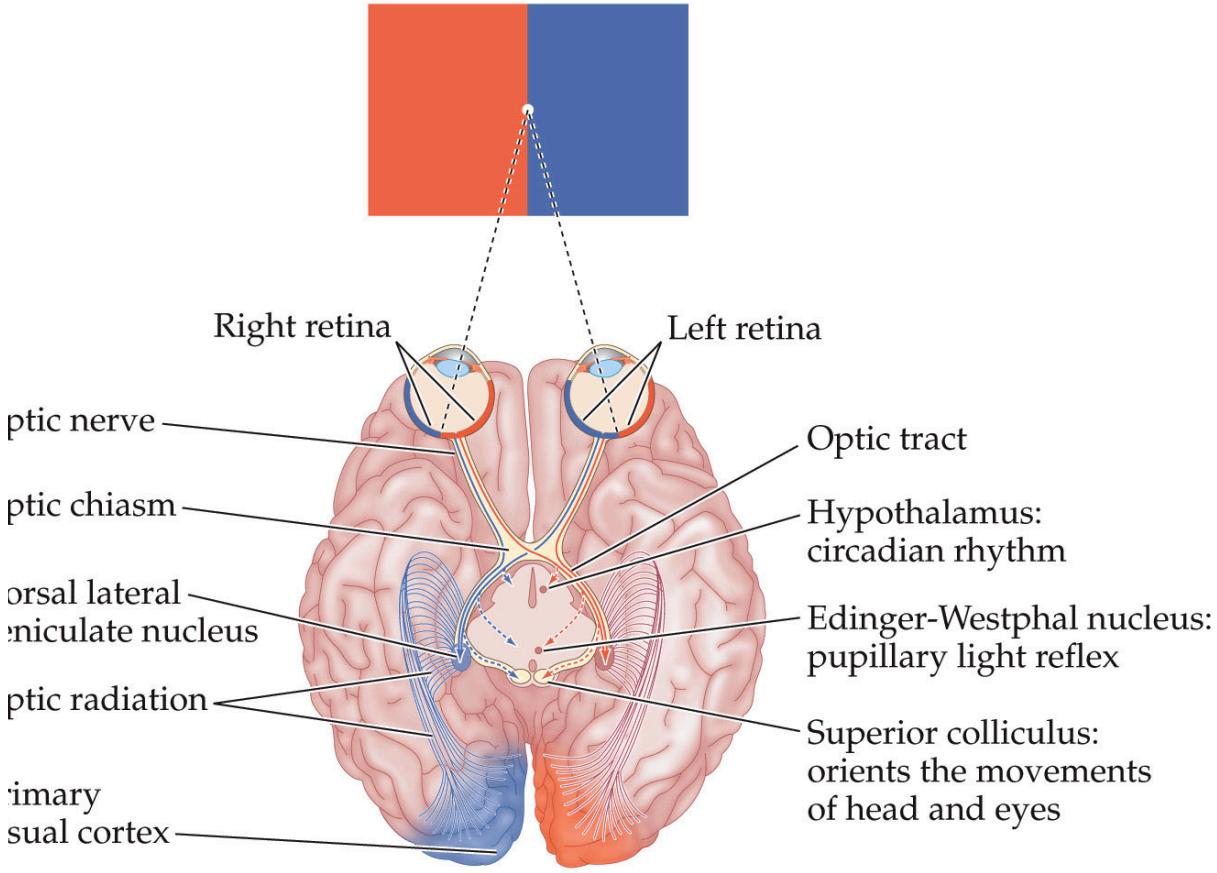
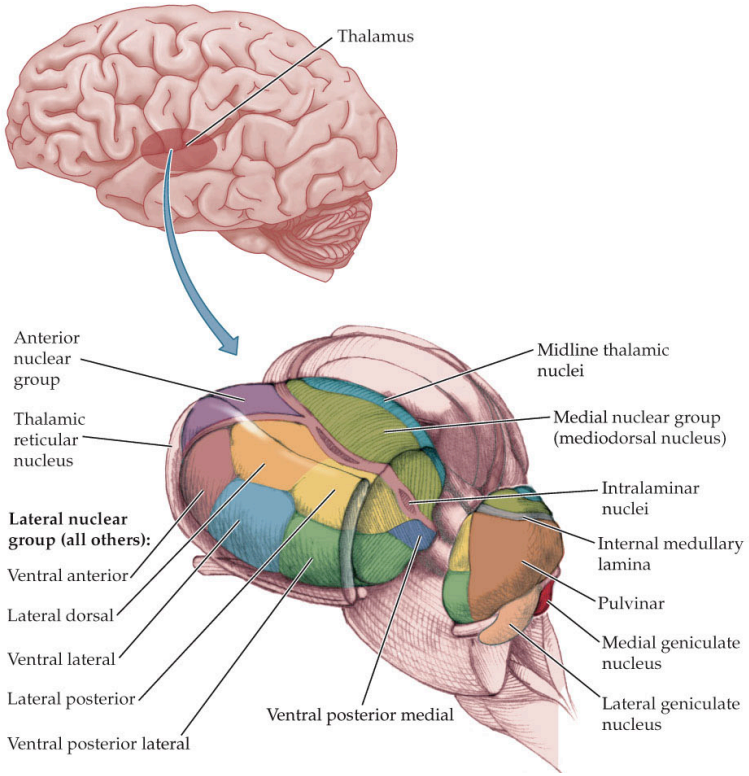
Short tutorial:
Visual Perception
&
Visual Neuroscience

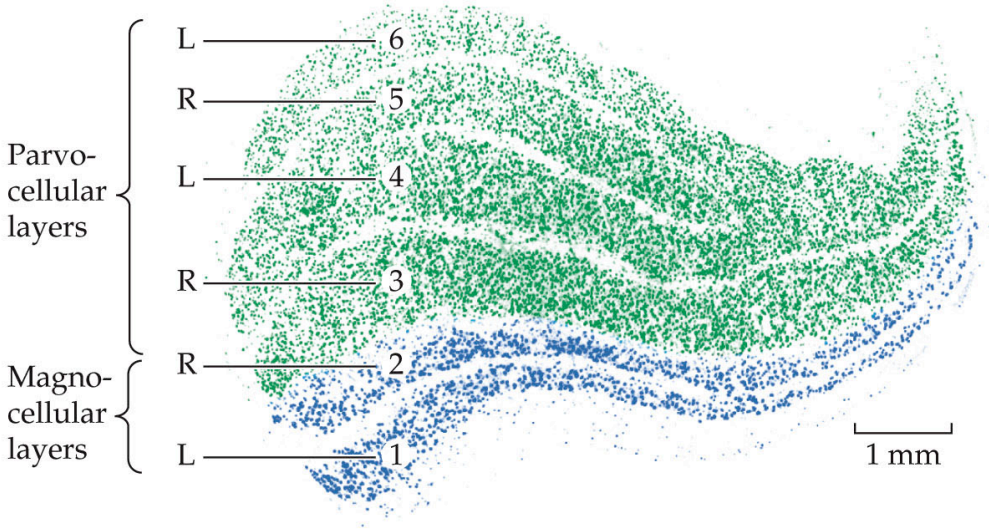
Organization of visual system





Organization: lateral geniculate nucleus



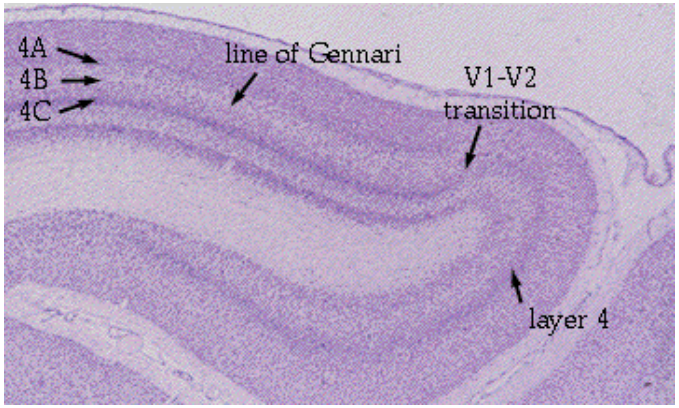


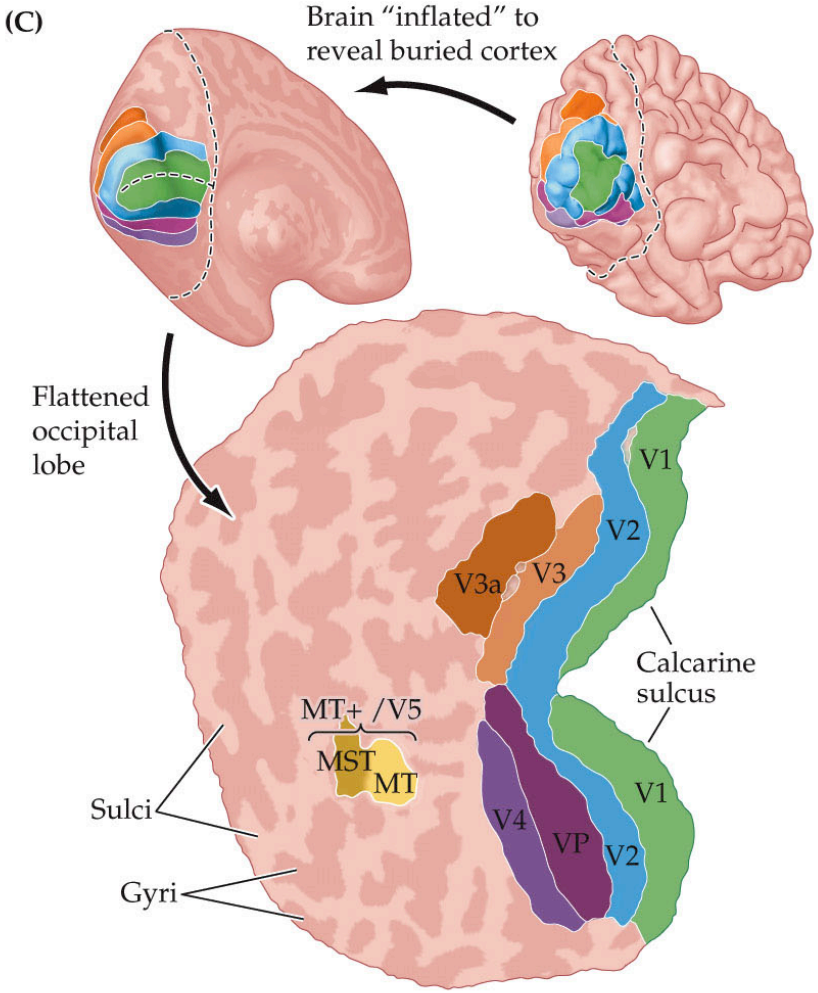
Ipsilateral: 2,3,5
Contralateral: 1,4,6

- Parvocellular: small cells, form
- Magnocellular: large cells, motion

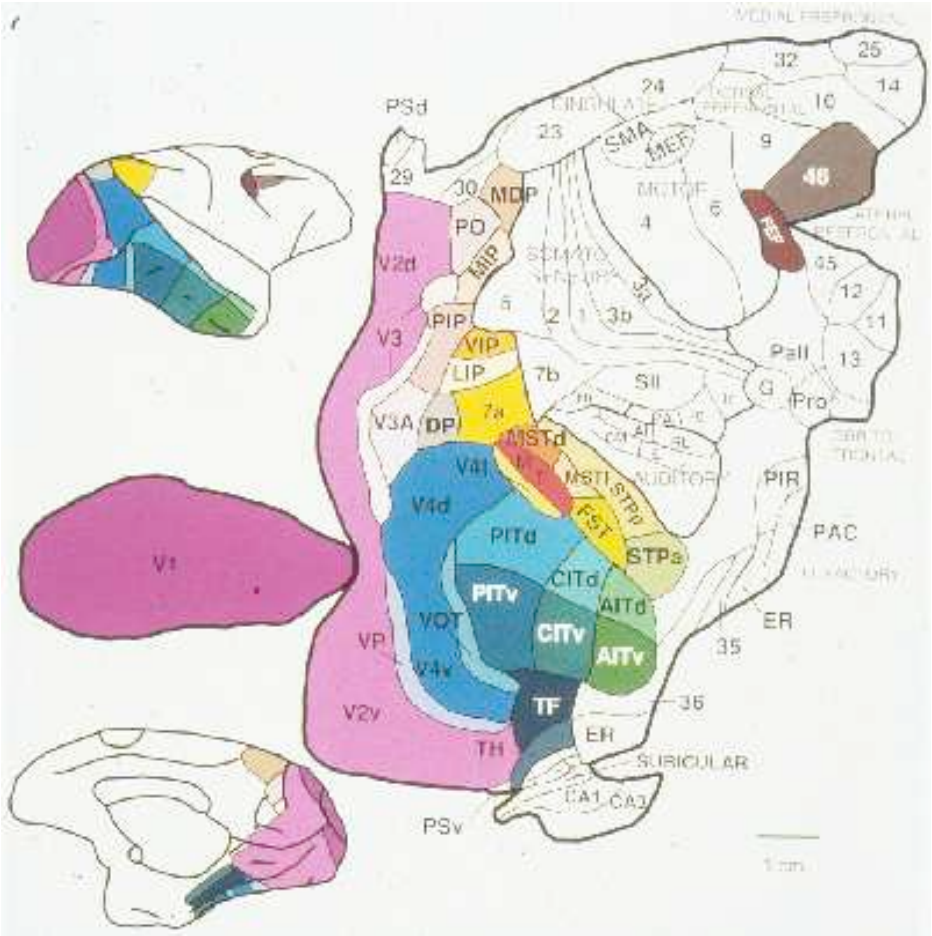
Visual cortex

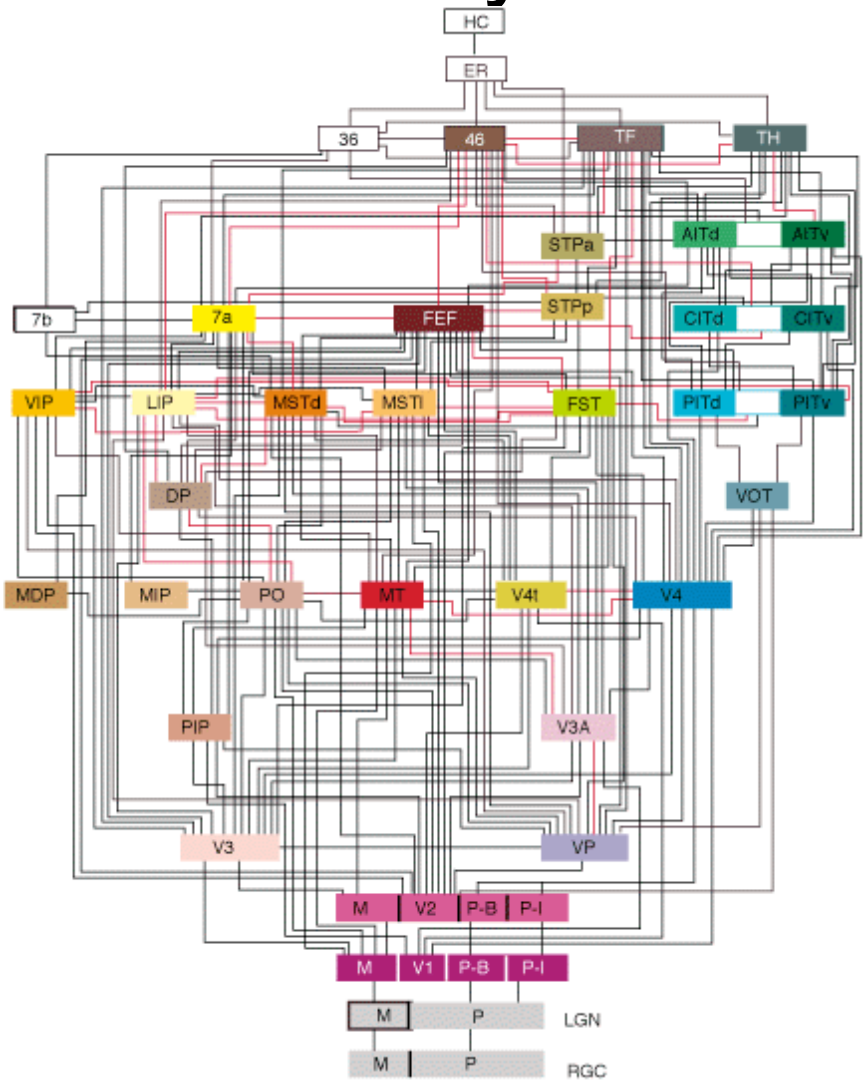
- Primary visual cortex (striate cortex, V1)
- Extrastriate visual areas
- Retinotopic mapping in humans with fMRI





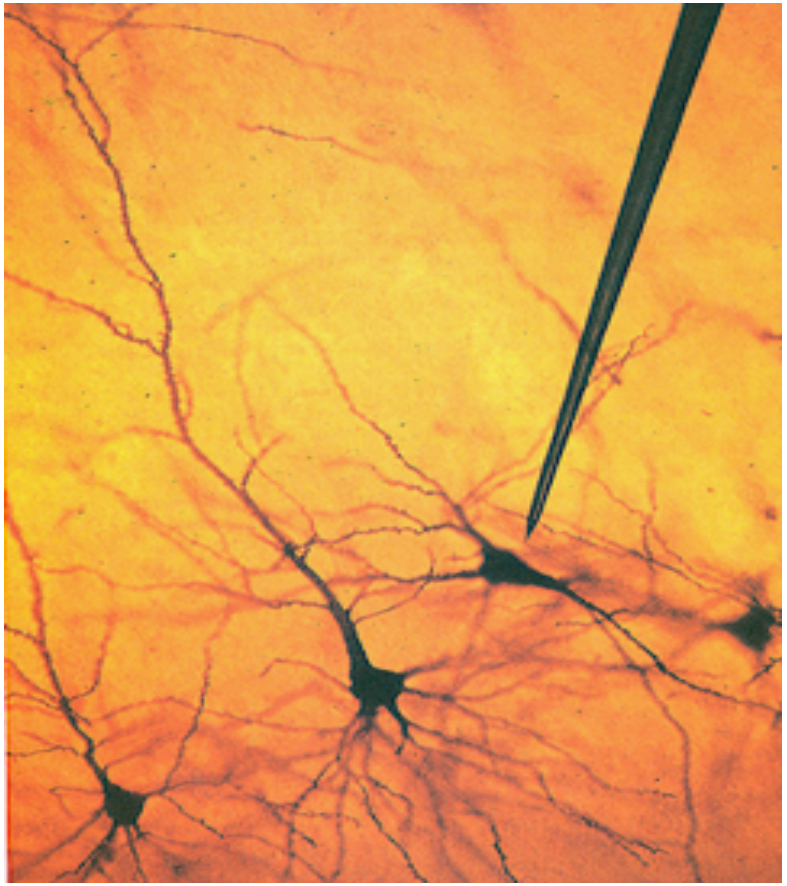
Multiple visual areas: reality

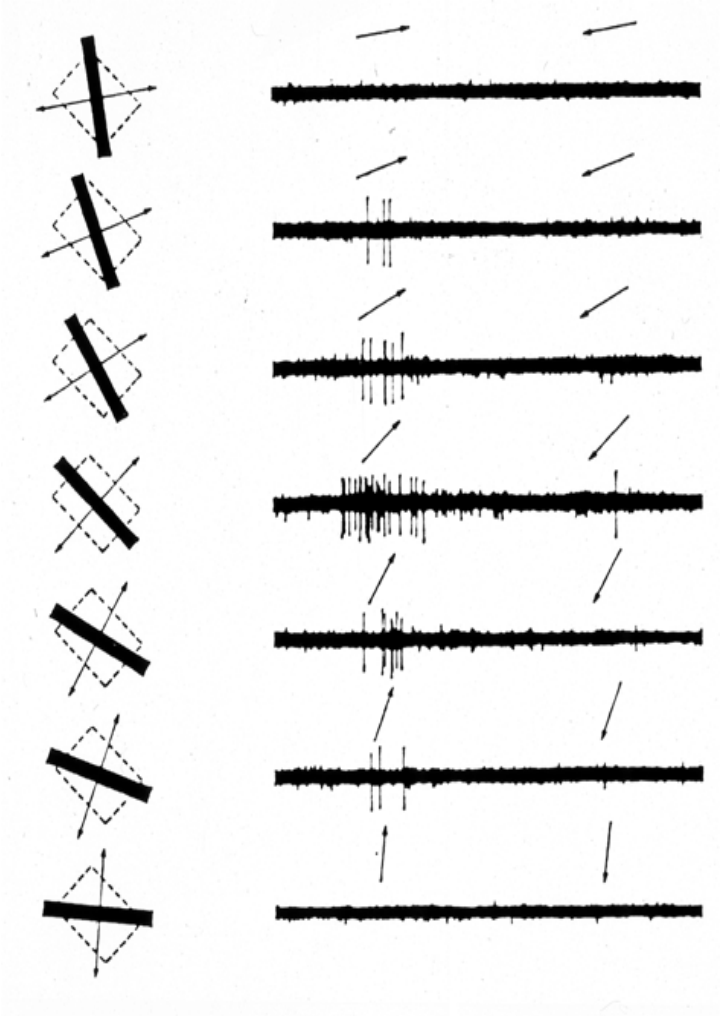




Macaque: about 50% of cortex is related to vision

Physiology





Example: direction selectivity in V1

V1 physiology

Simple cells:
- orientation selective
- some are direction selective
- some are disparity selective
- monocular or binocular
- separate ON and OFF subregions
- length summation

(best response to long bar)

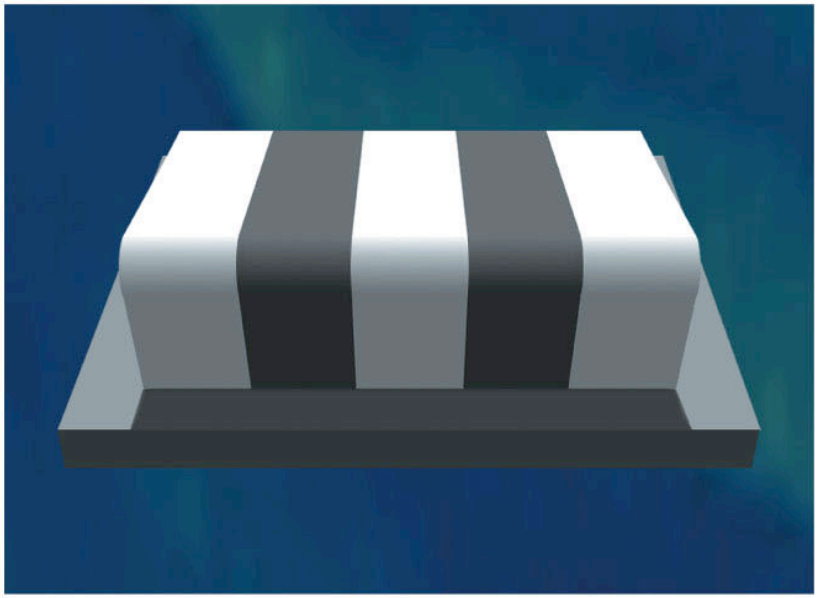
Complex cells:
- orientation selective
- some are direction selective
- some are disparity selective
- nearly all are binocular
- no separate ON and OFF subregions
- length summation

Hypercomplex cells:
end-stopping (best response to short bar)

Brightness perception

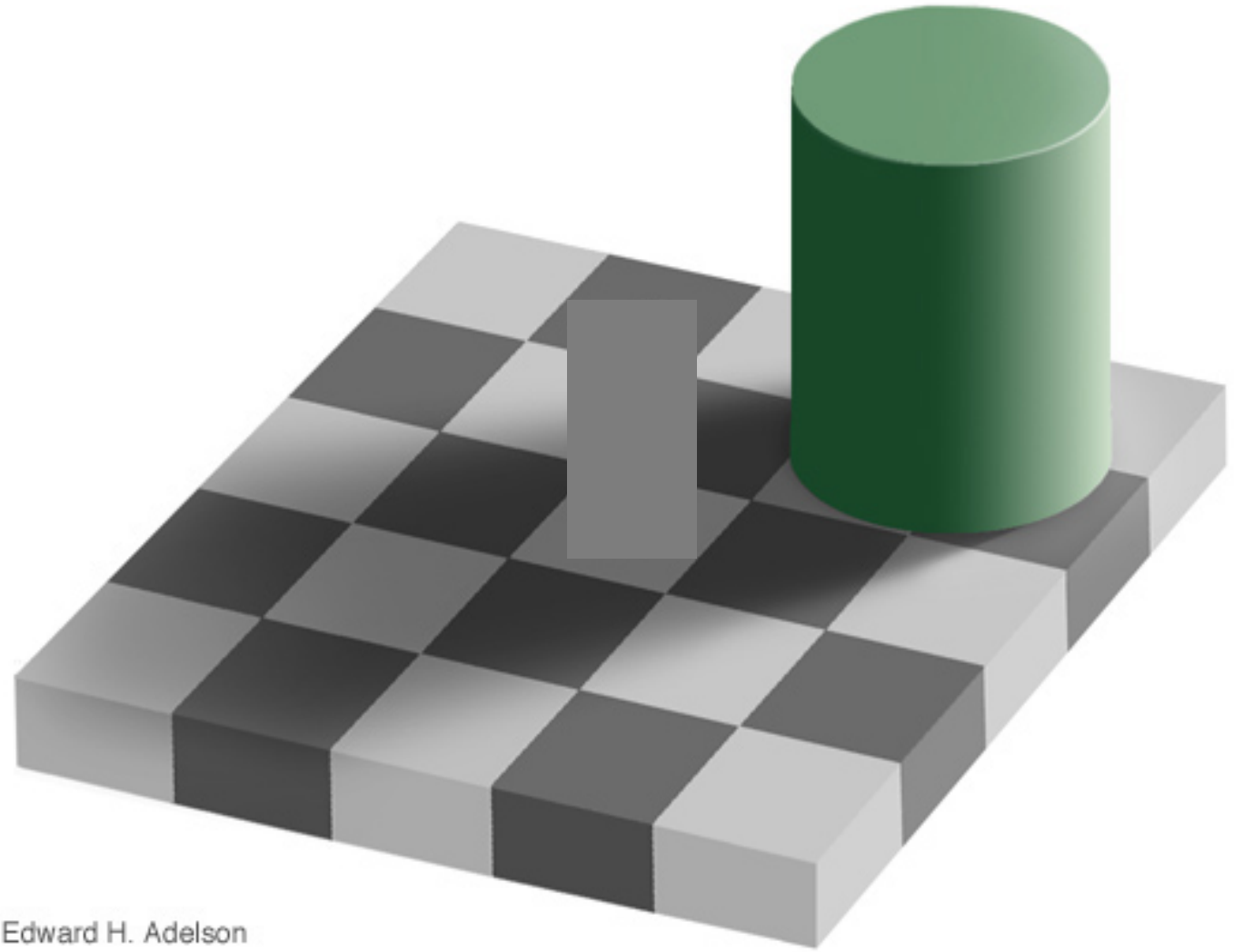
- Simultaneous brightness contrast

(B)



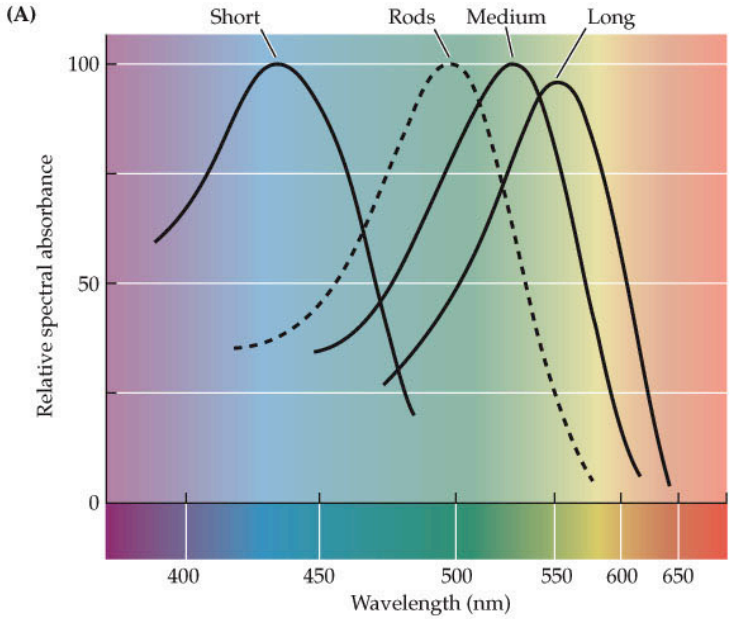
  - Effect of center-surround RF in the retina?

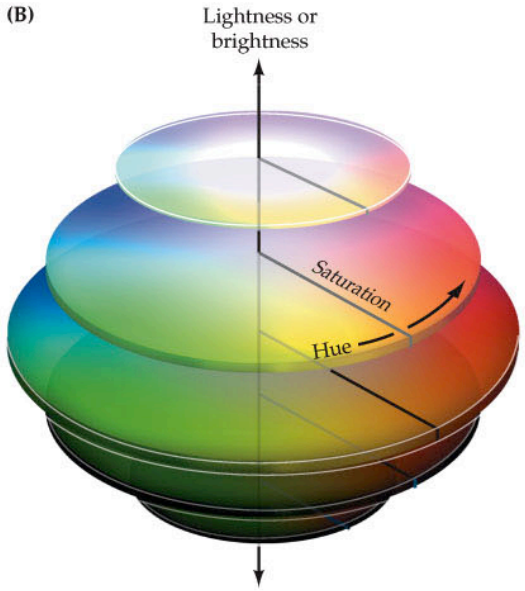
Adelson's checker shadow illusion
See http://web.mit.edu/persci/people/adelson/checkershadow_illusion.html



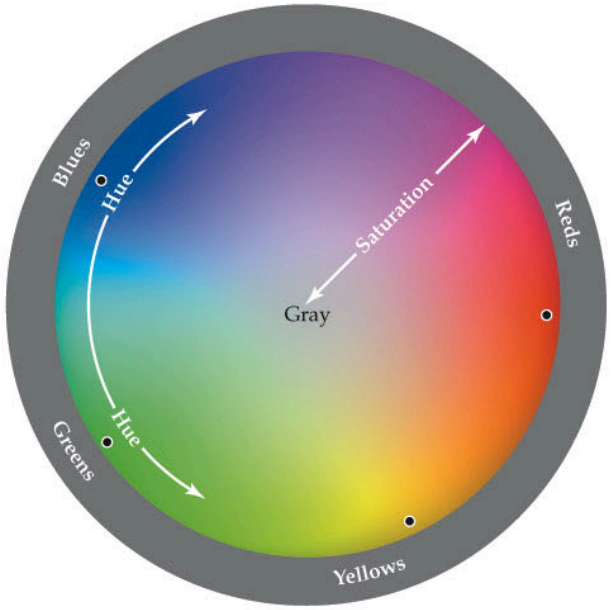
Edward H. Adelson

Color perception





- Trichromacy
- Opponent processes
  - R-G, B-Y, B-W
  - Opponent cells (center-surround opponency)

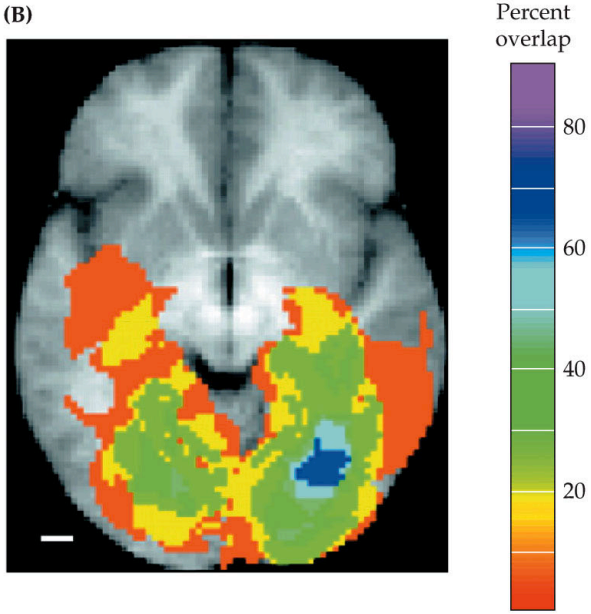


Cortical basis of color perception

- Evidence of a dedicated ‘color module’ in the human brain
  - Cerebral achromatopsia

Mr. I. could hardly bear the changed appearances of people ("like animated gray statues") any more than he could bear his own changed appearance in the mirror: he shunned social intercourse and found sexual intercourse impossible. He saw people's flesh, his wife's flesh, his own flesh, as an abhorrent gray; "flesh-colored" now appeared "rat-colored" to him. This was so even when he closed his eyes, for his preternaturally vivid ("eidetic") visual imagery was preserved but now without color, and forced on him images, forced him to "see" but see internally with the wrongness of his achromatopsia. He found foods disgusting in their grayish, dead appearance and had to close his eyes to eat. But this did not help very much, for the mental image of a tomato was as black as its appearance.

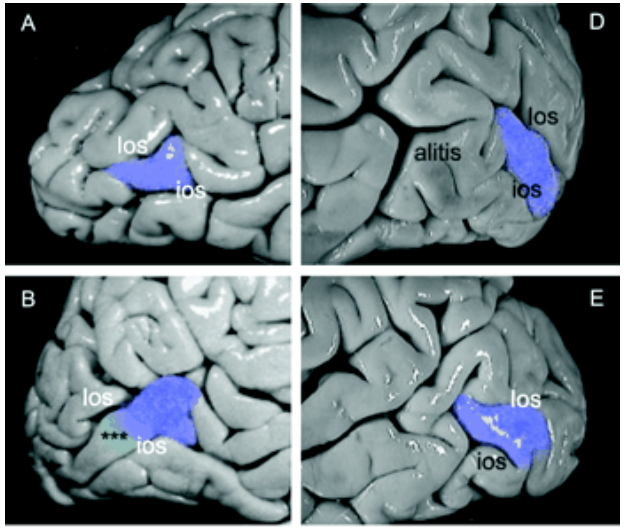
--Oliver Sacks in “The case of the colorblind painter”

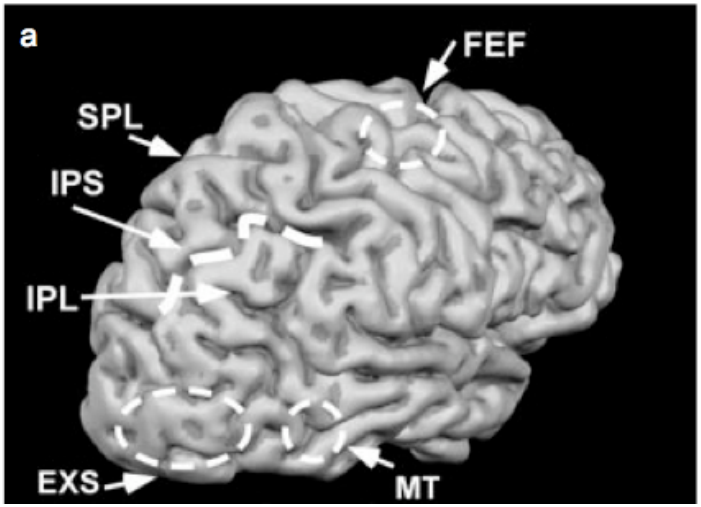


  - fMRI evidence
    - Human V4, ventral visual cortex
    - Still controversial

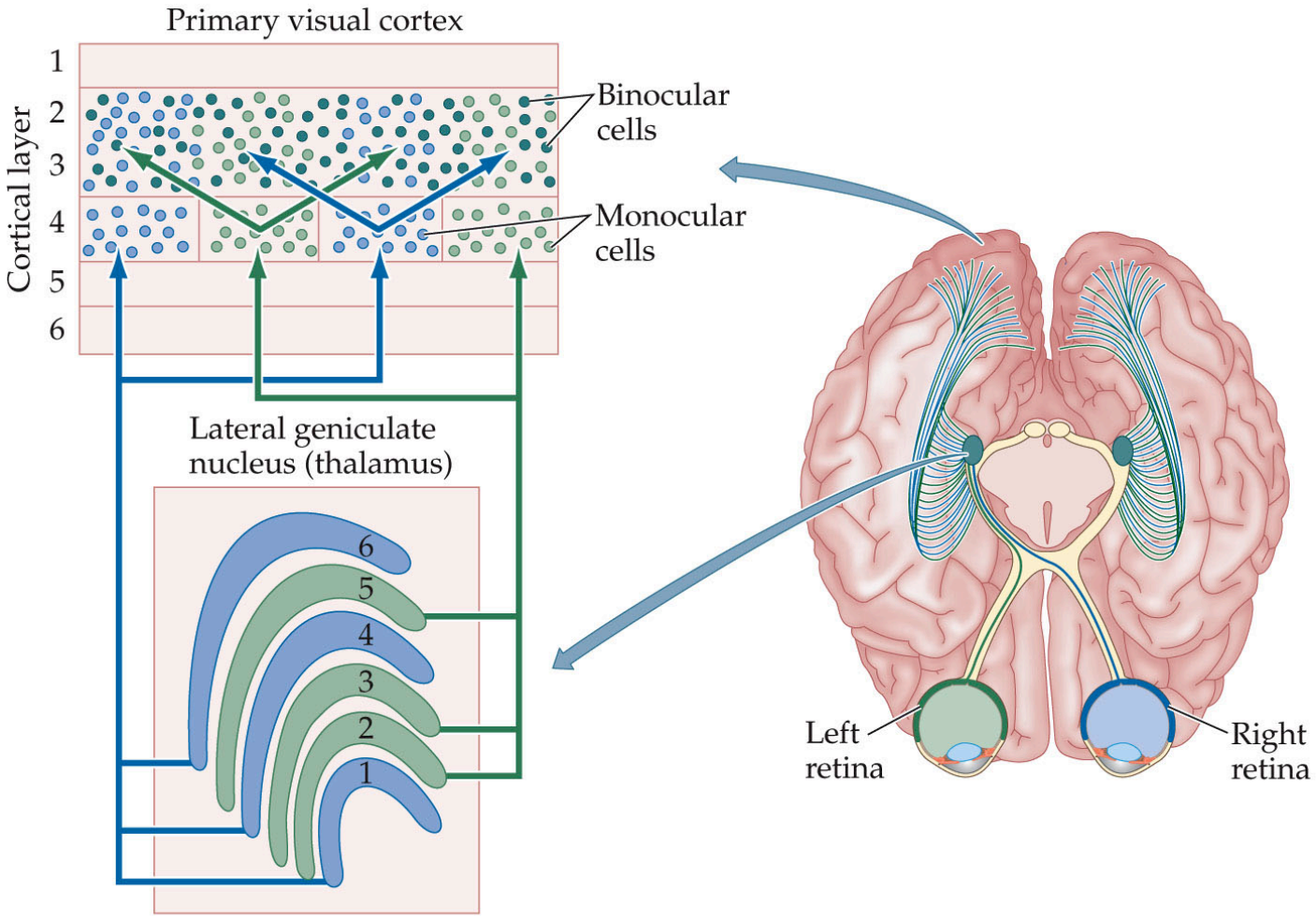
Motion perception

- MT/MST: dedicated motion processing in the brain
  - Monkey: direction selective responses (single-unit recording)
  - Human: fMRI studies
  - Monkey: directed lesion studies
  - Human: neurological case studies
  - Linking neural activity to behavior (neural coding)
  - Microstimulation studies (show movie)



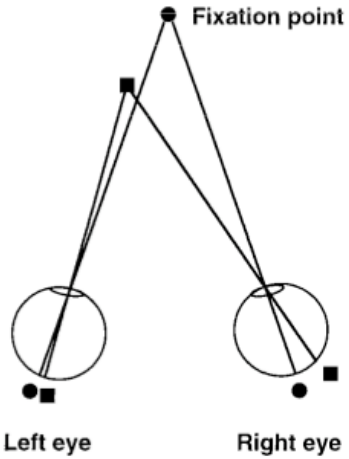


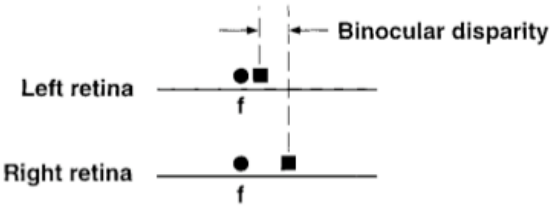
Binocular vision

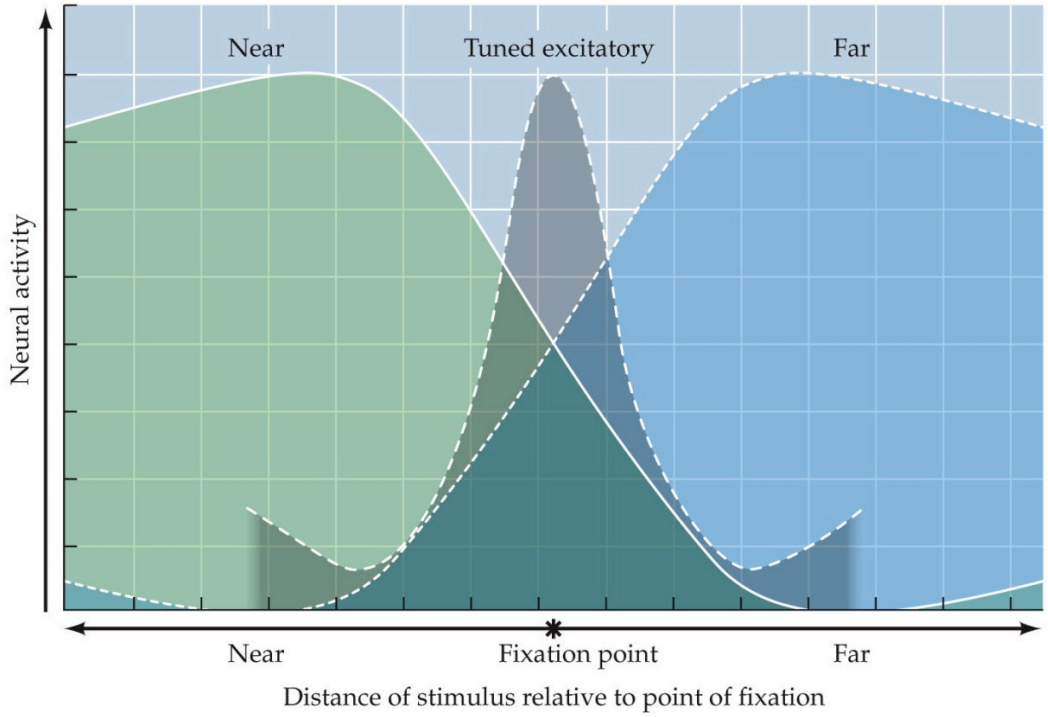


Binocular vision

- Binocular depth perception
  - Binocular disparity
  - Disparity tuned neuronal responses

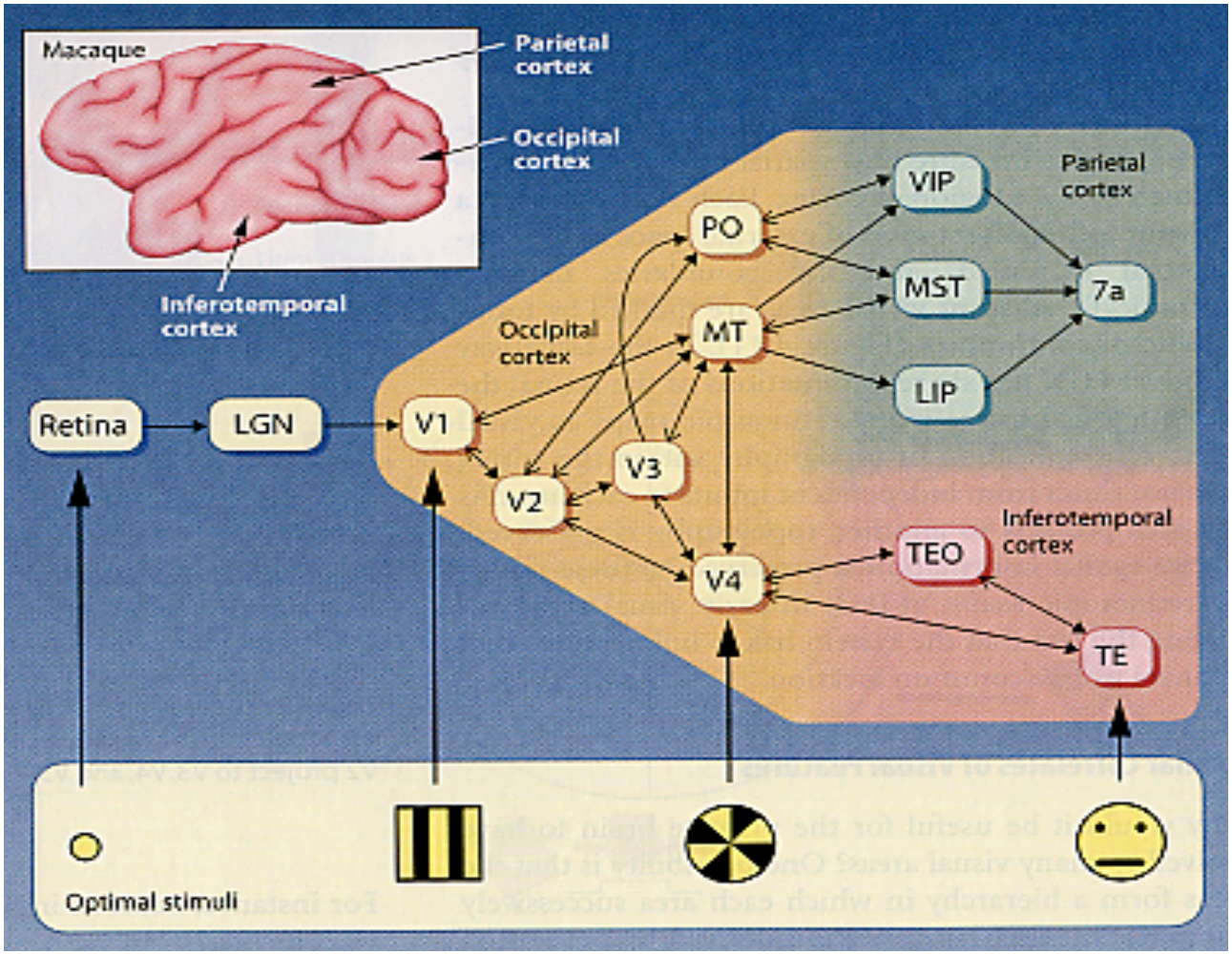




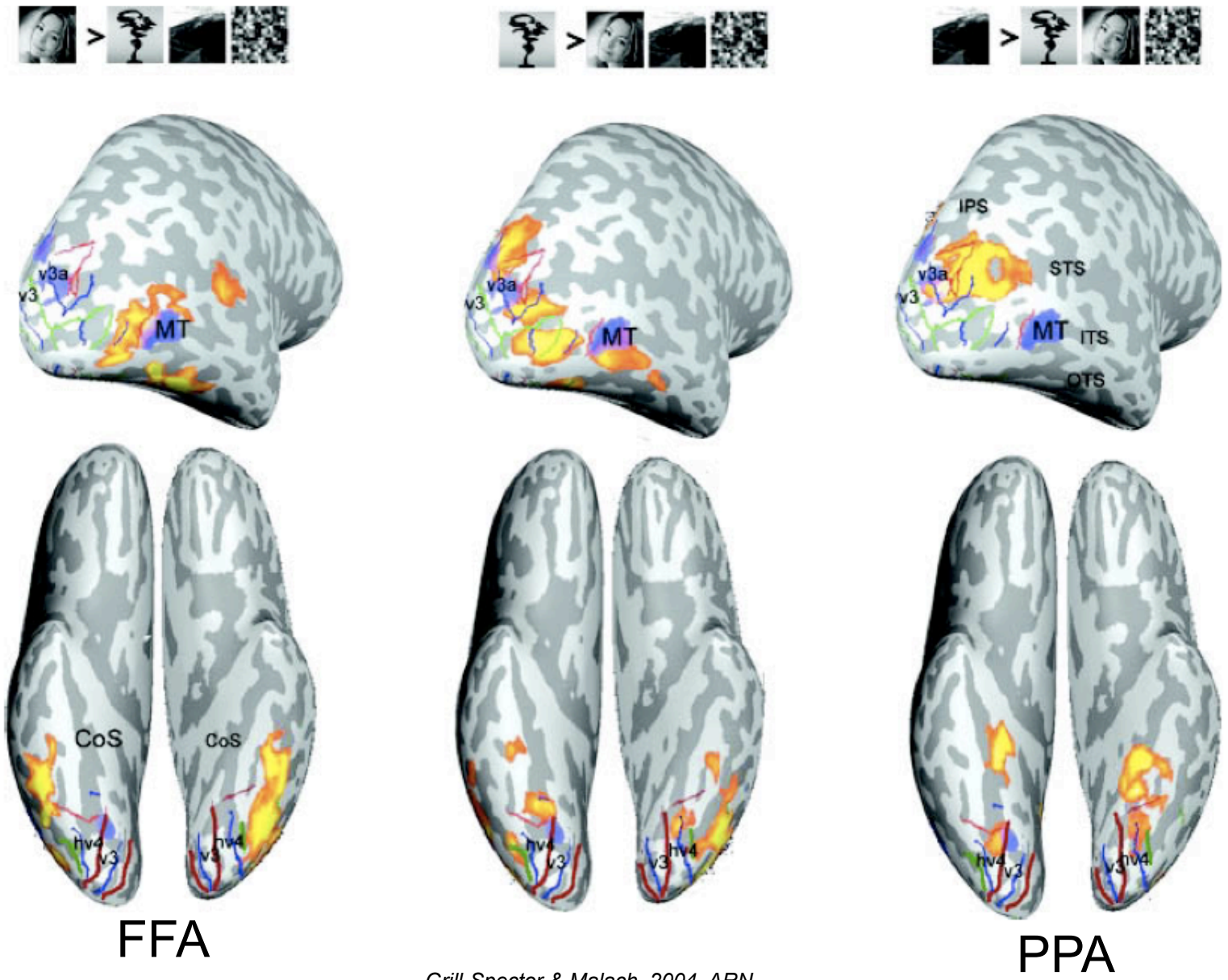


Perception of objects

- Ventral visual stream



Category-specific areas in ventral visual cortex



FFA

PPA

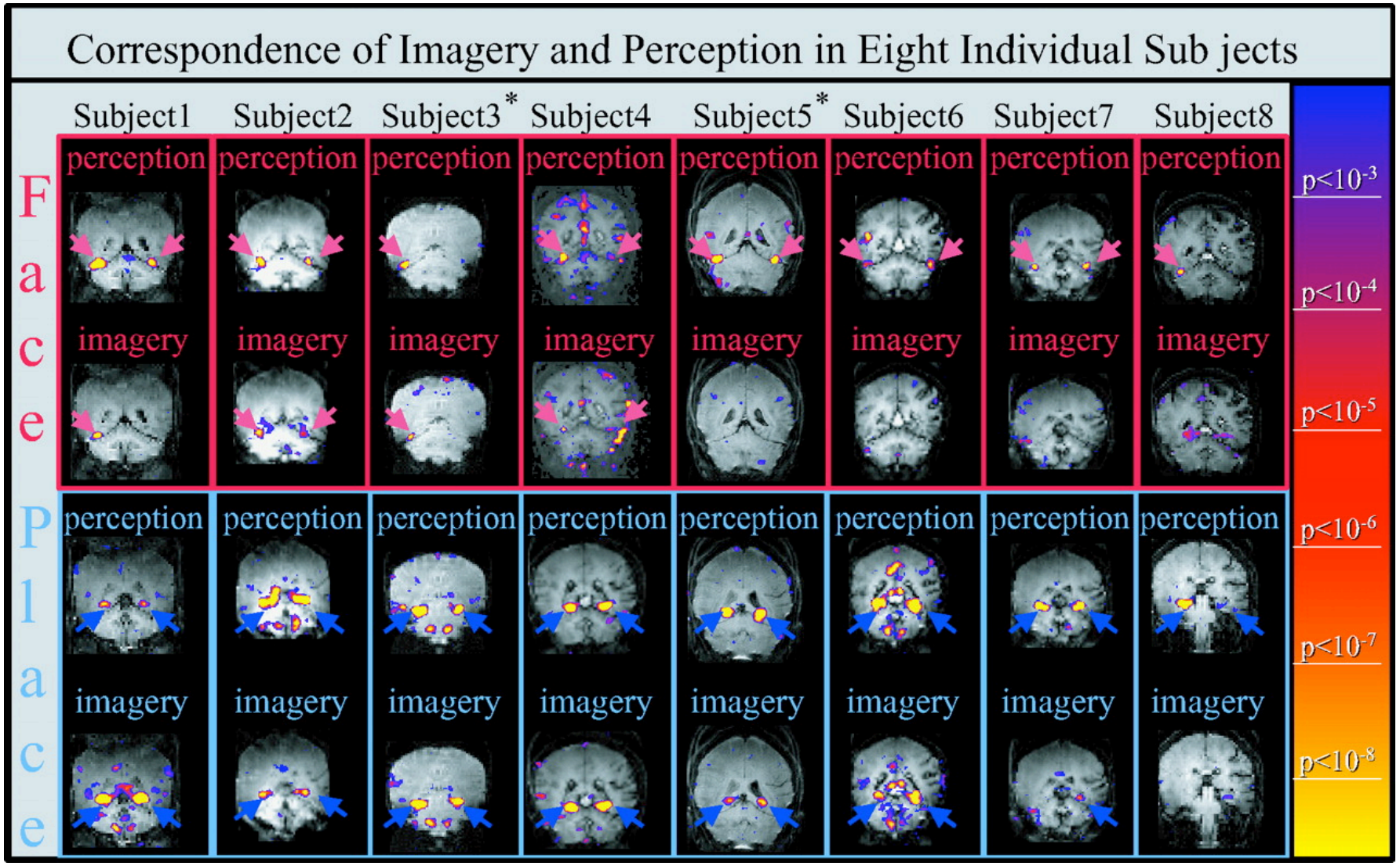
Grill-Spector & Malach, 2004, ARN

Dedicated face processing module?

- Is FFA a true module for face processing?
  - modular vs distributed processing of categorical information (Kanwisher vs. Haxby)
- For
  - Prosopagnosia (http://www.faceblind.org)
    - "The man who mistook his wife for a hat" Oliver Sacks
  - Response selectivity of FFA
- Against-- consistent **pattern** of responses for categories
  - Faces elicit consistent activity pattern outside FFA
  - Pattern of activity in FFA also discriminates other categories

Mental Imagery

- Imagery activates similar areas as perception



O'Craven & Kanwisher, 2000, JOCN