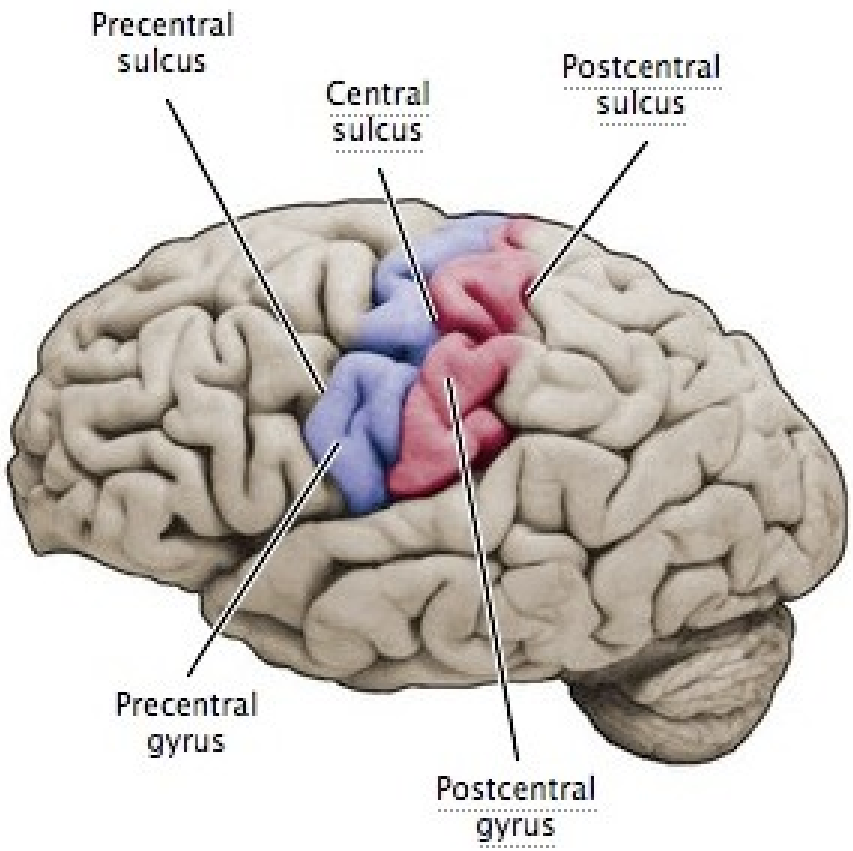
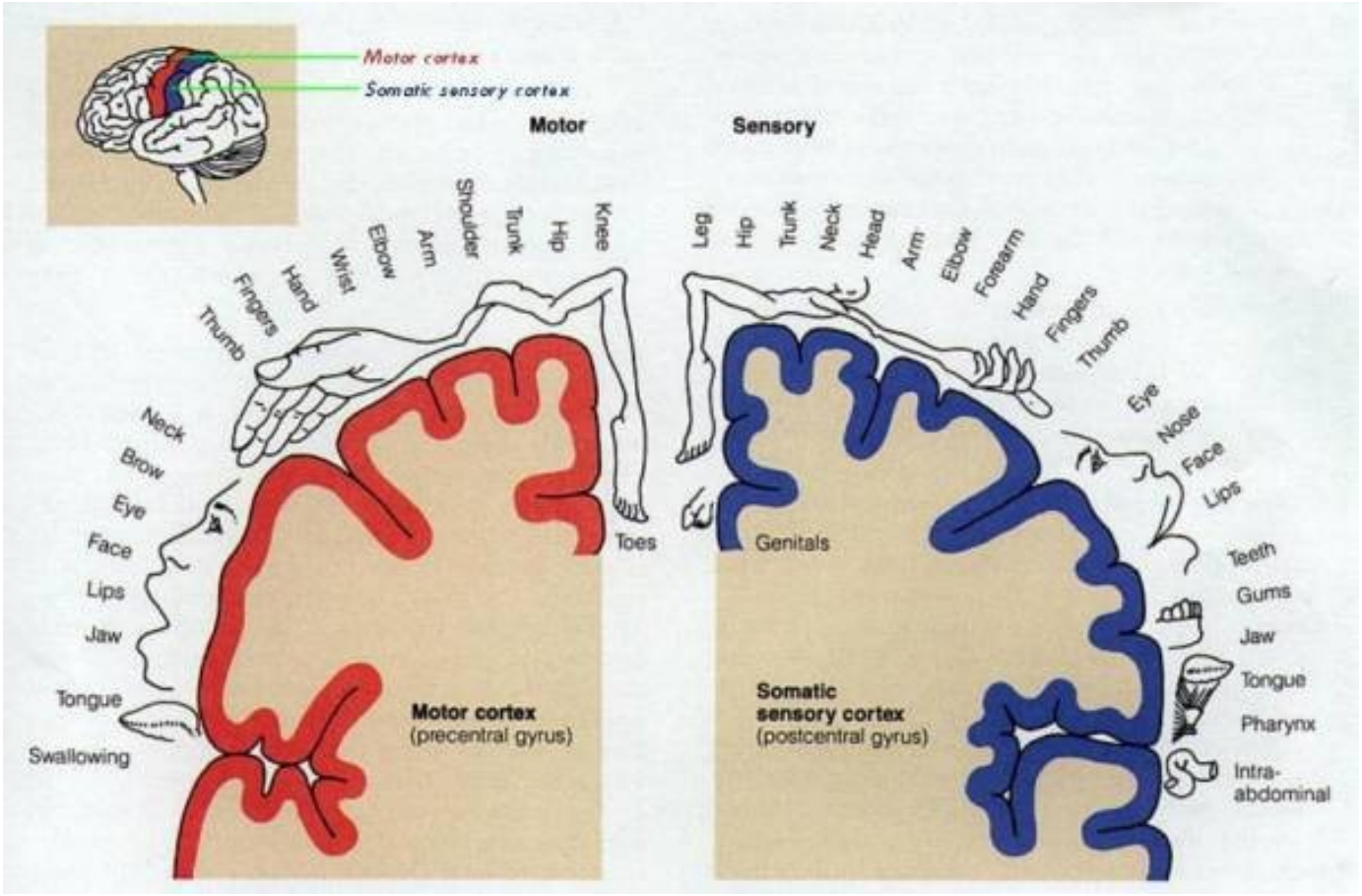
Overview

- Processing of sensory information in the brain:
  - Motor and sensory areas
  - Visual pathways
- Overview of senses

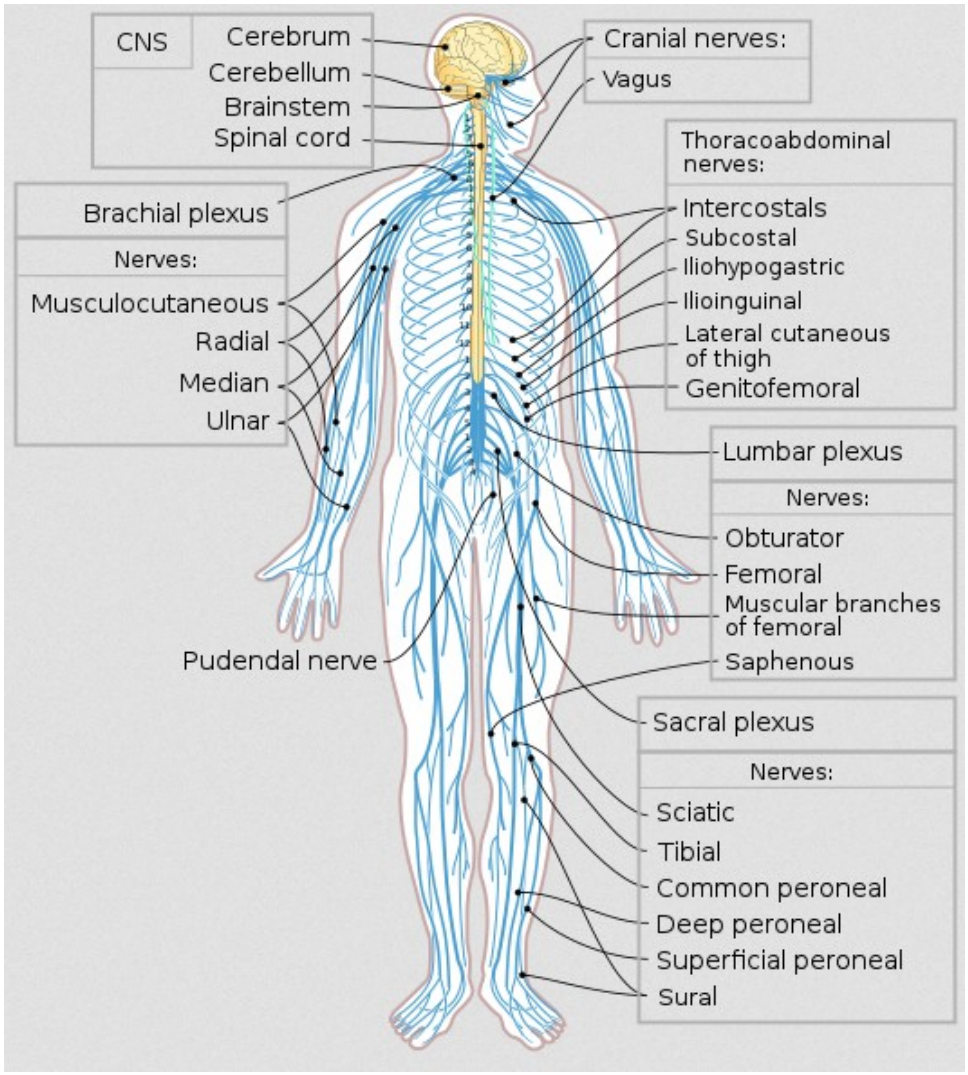
Primary motor and sensory areas

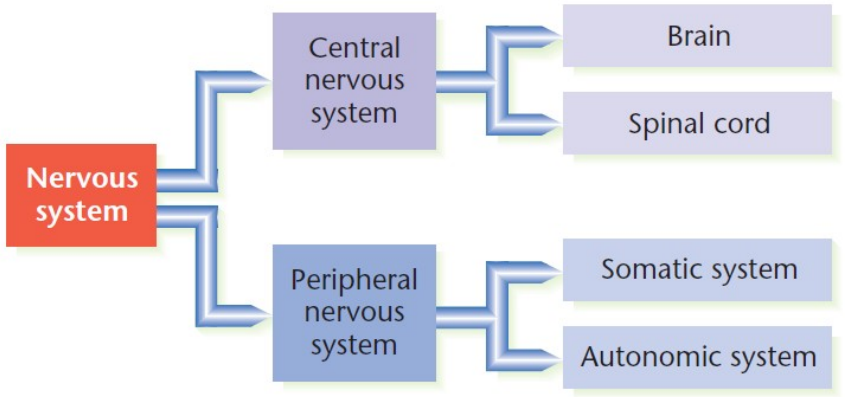


Organization of sensory and motor cortices



Nervous system



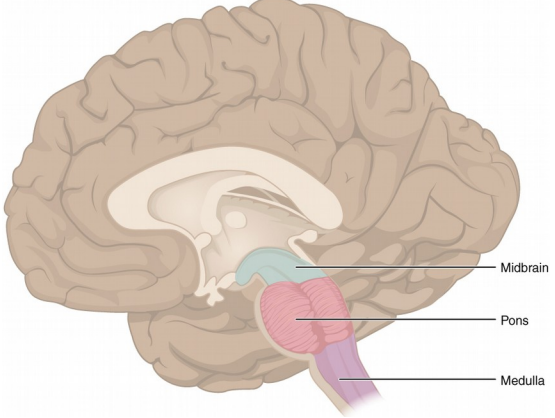


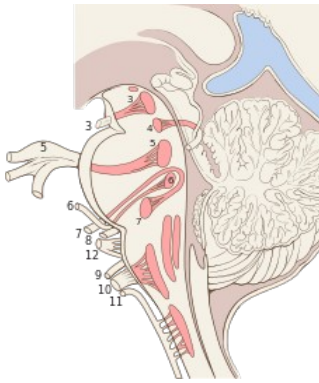
Somatic system: to/from the sense receptors, muscles, and surface of body – voluntary motor functions

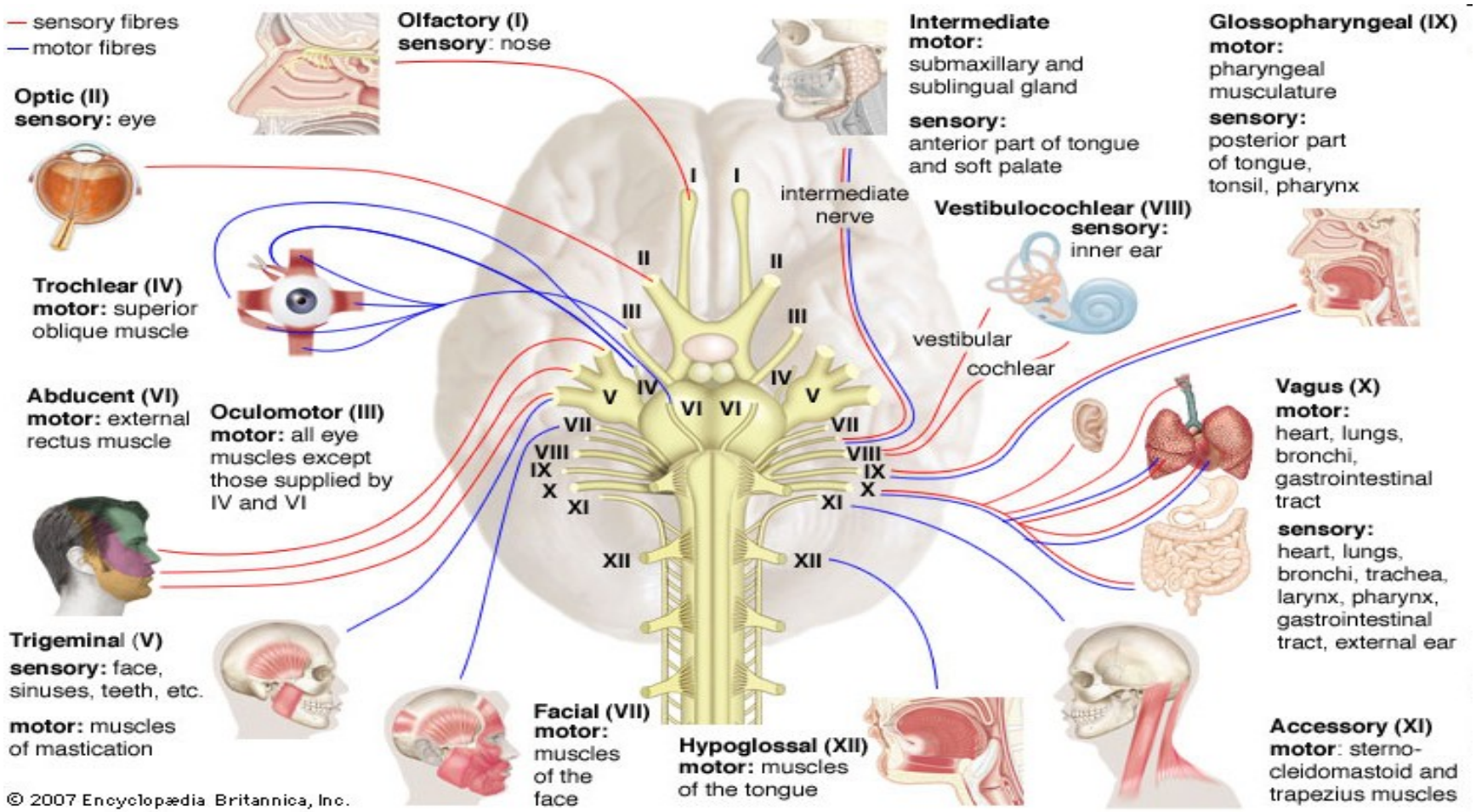
- Sensory nerves: transmit information about external stimulation from skin/muscles/joints, e.g. pain, pressure, temperature
- Motor nerves: from CNS to muscles

Autonomic: involuntary control system. internal organs and glands for automatic and involuntary actions such as beating of the heart. Respiration, heart rate, digestion

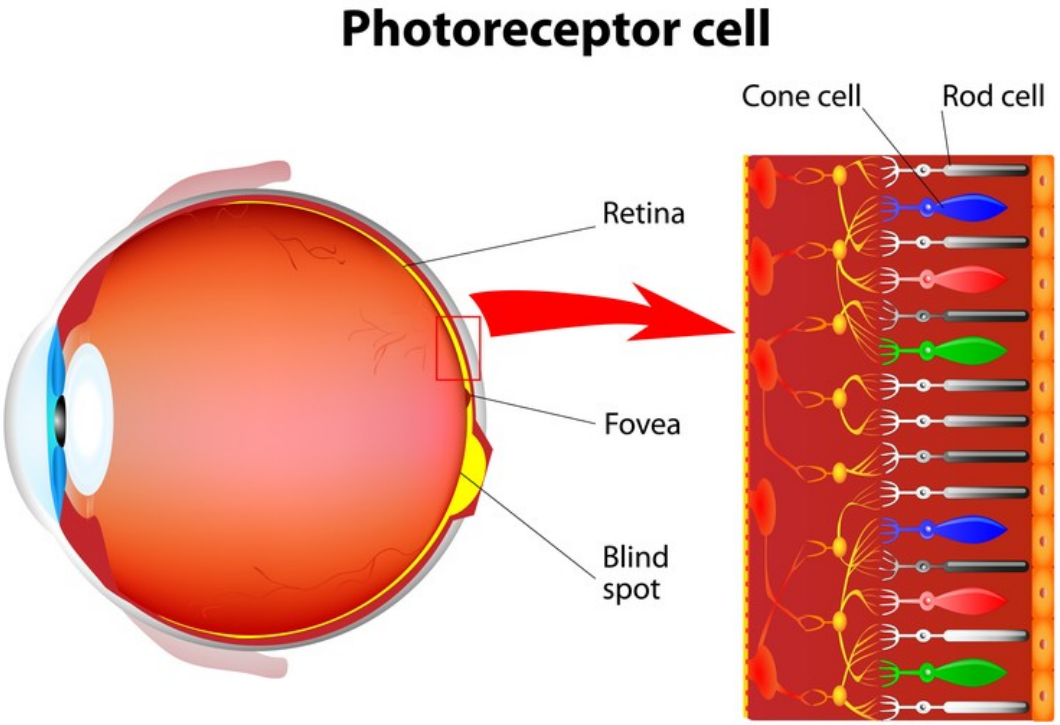
Cranial nerves

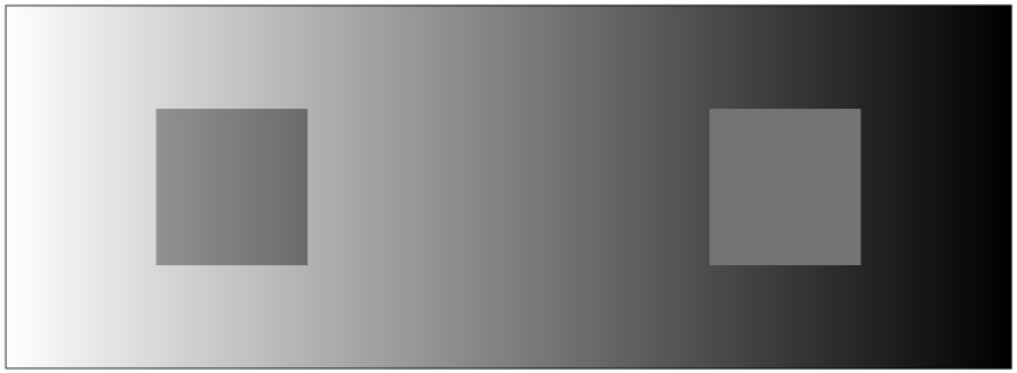




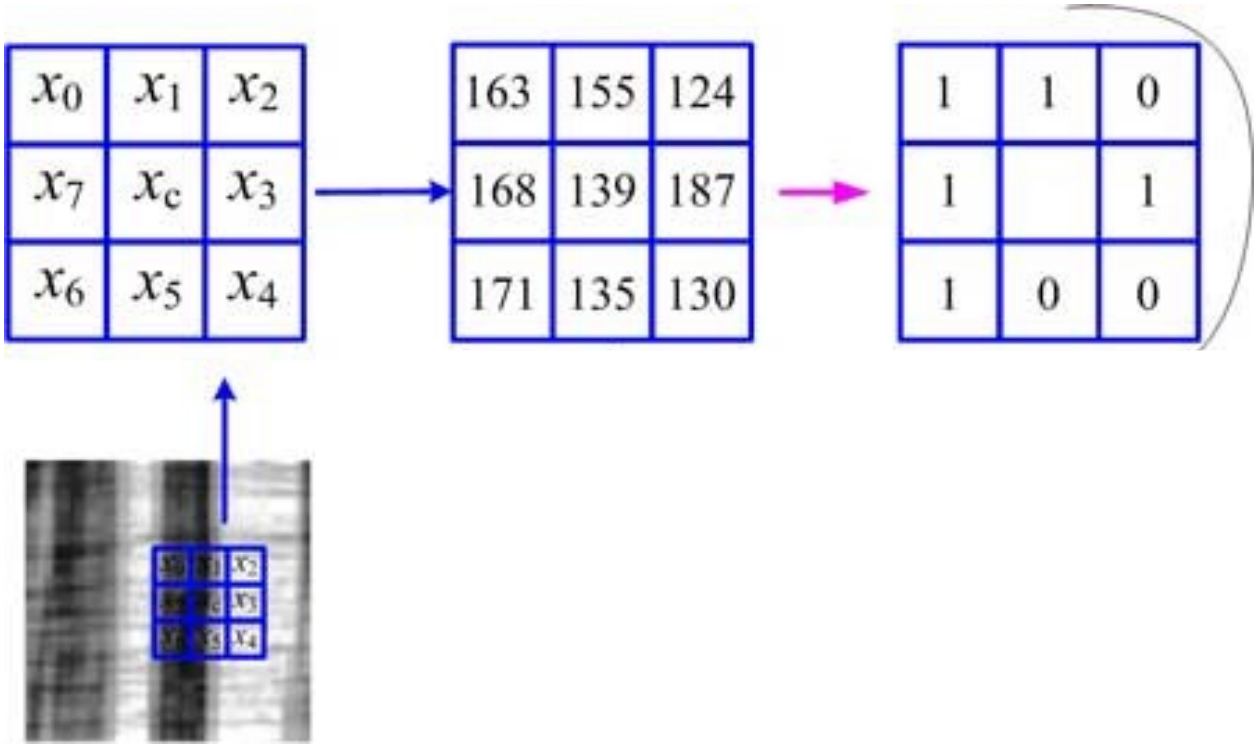


Eye and retina

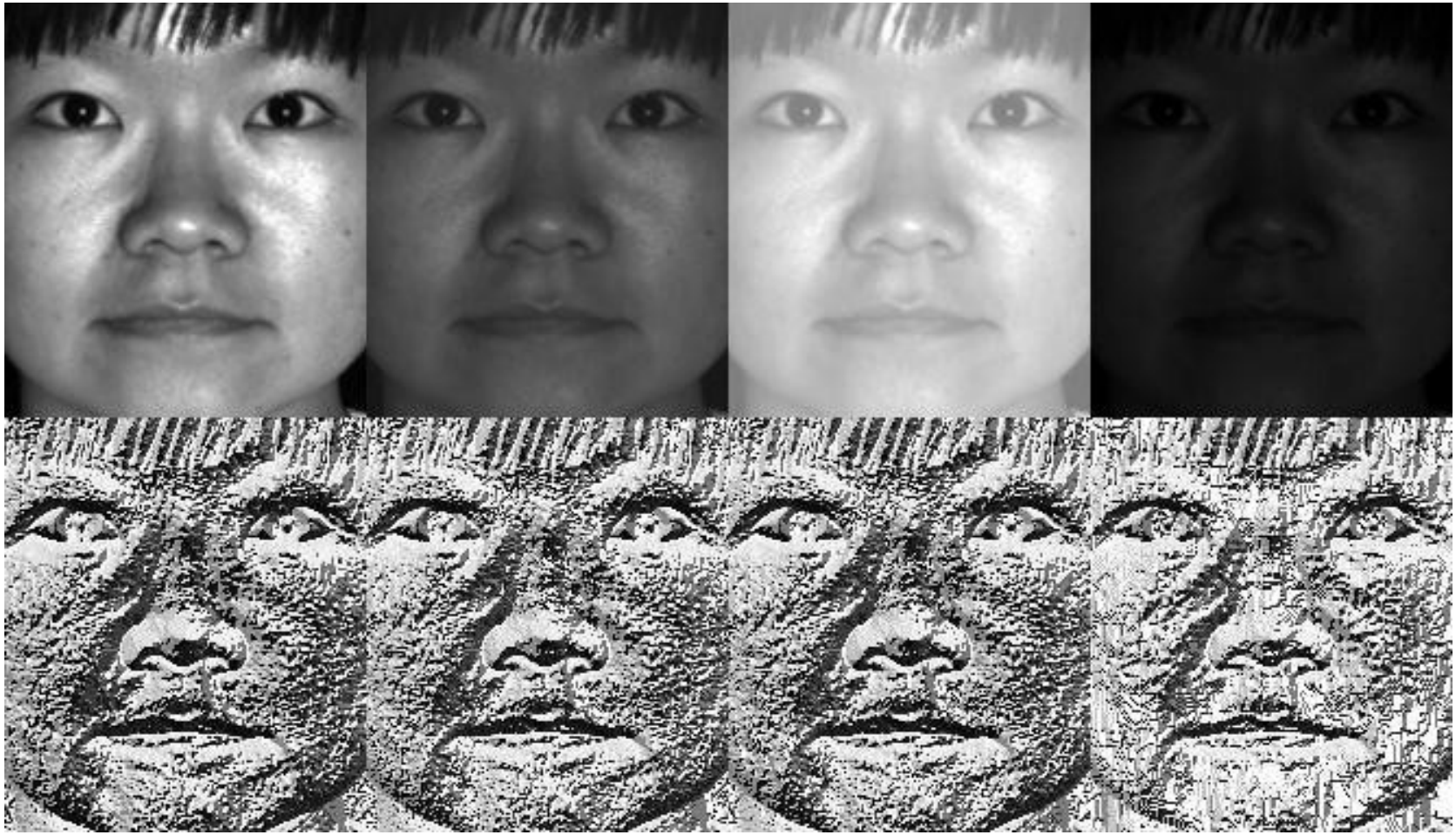




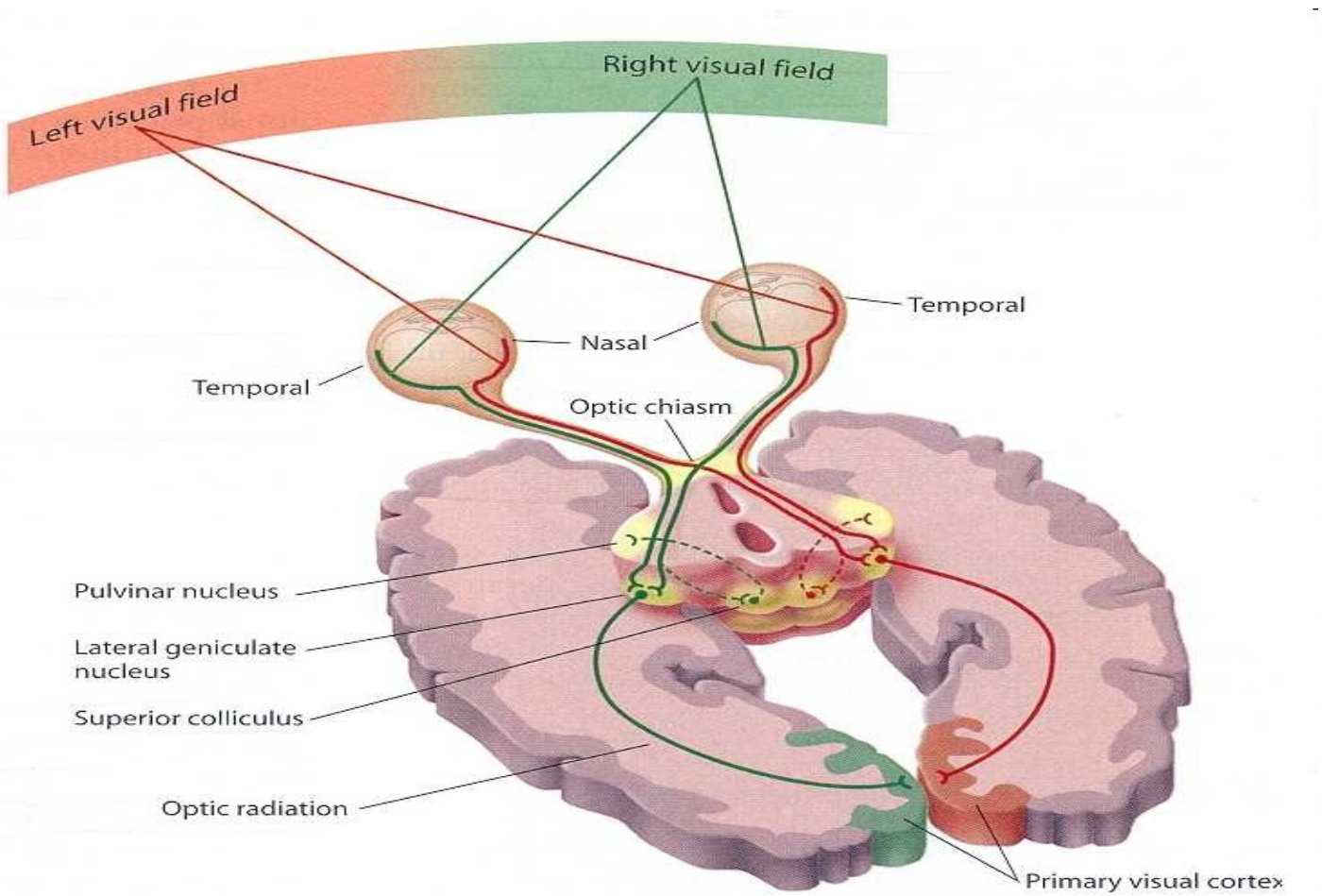
Local binary patterns



Illumination invariance



Visual pathways

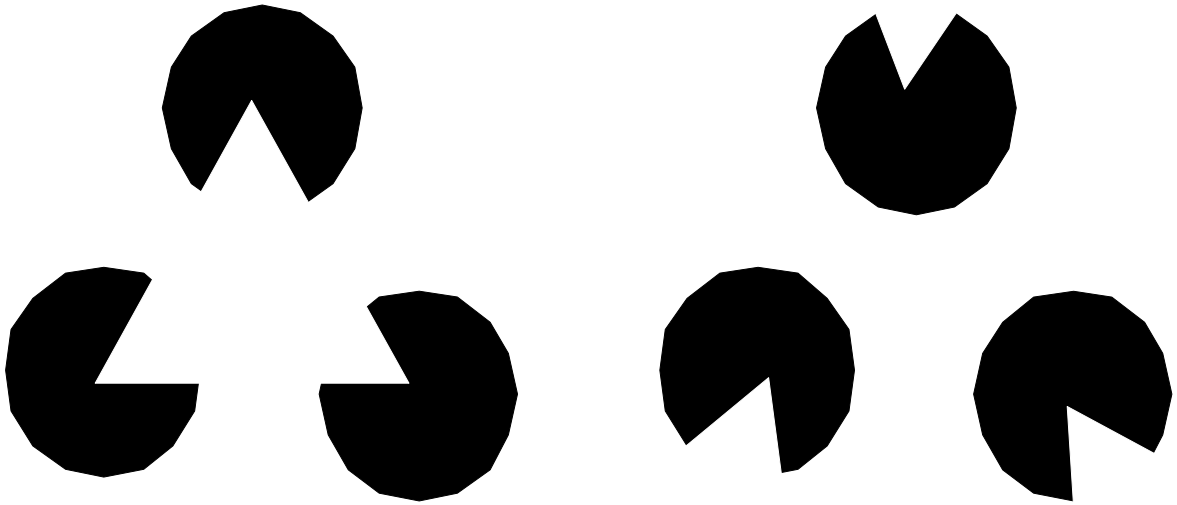


Senses

- How many senses do we have?
  - Five traditional senses: sight, touch, audition, taste, and smell
  - Proprioceptive senses: heat and cold, gravitation, acceleration, pain..
  - Sub-senses: motion, colour, form, brightness, texture, and contrast of objects.

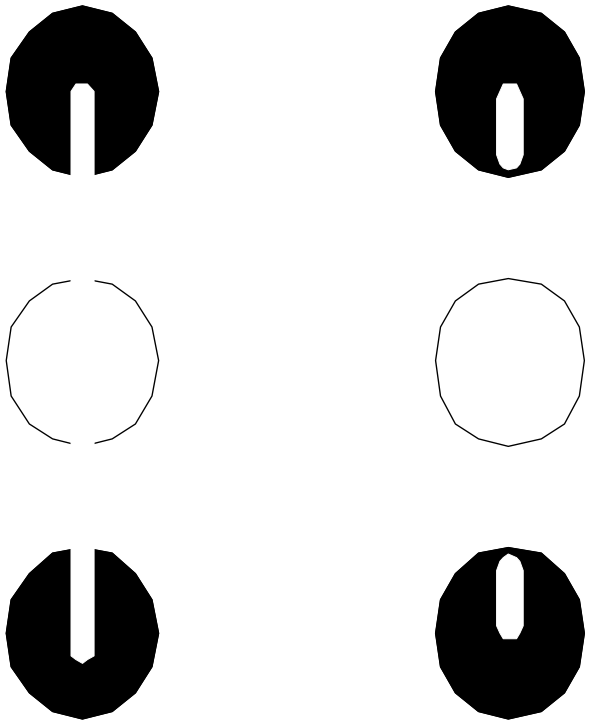
“Sensation is the body's detection of external or internal stimulation. Perception utilizes the brain to make sense of the stimulation.” wikipedia

See the triangle?



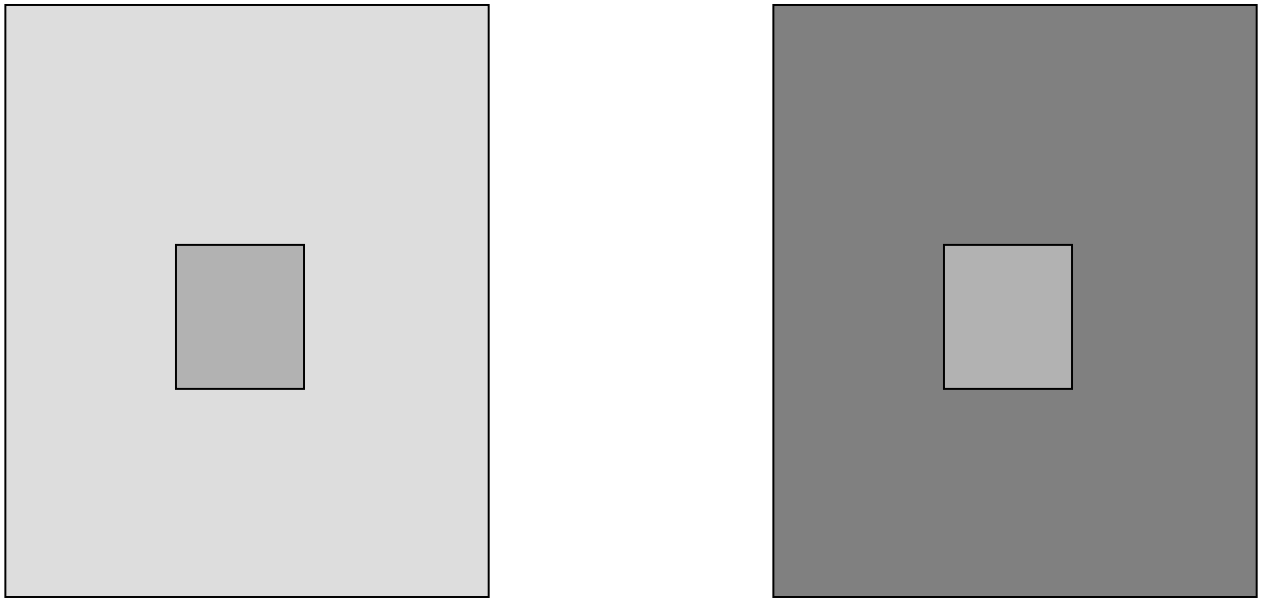
Adapted from Michael E. Goldberg, M.D.

See the white bar?



Adapted from Michael E. Goldberg, M.D.

Which small square is darker?



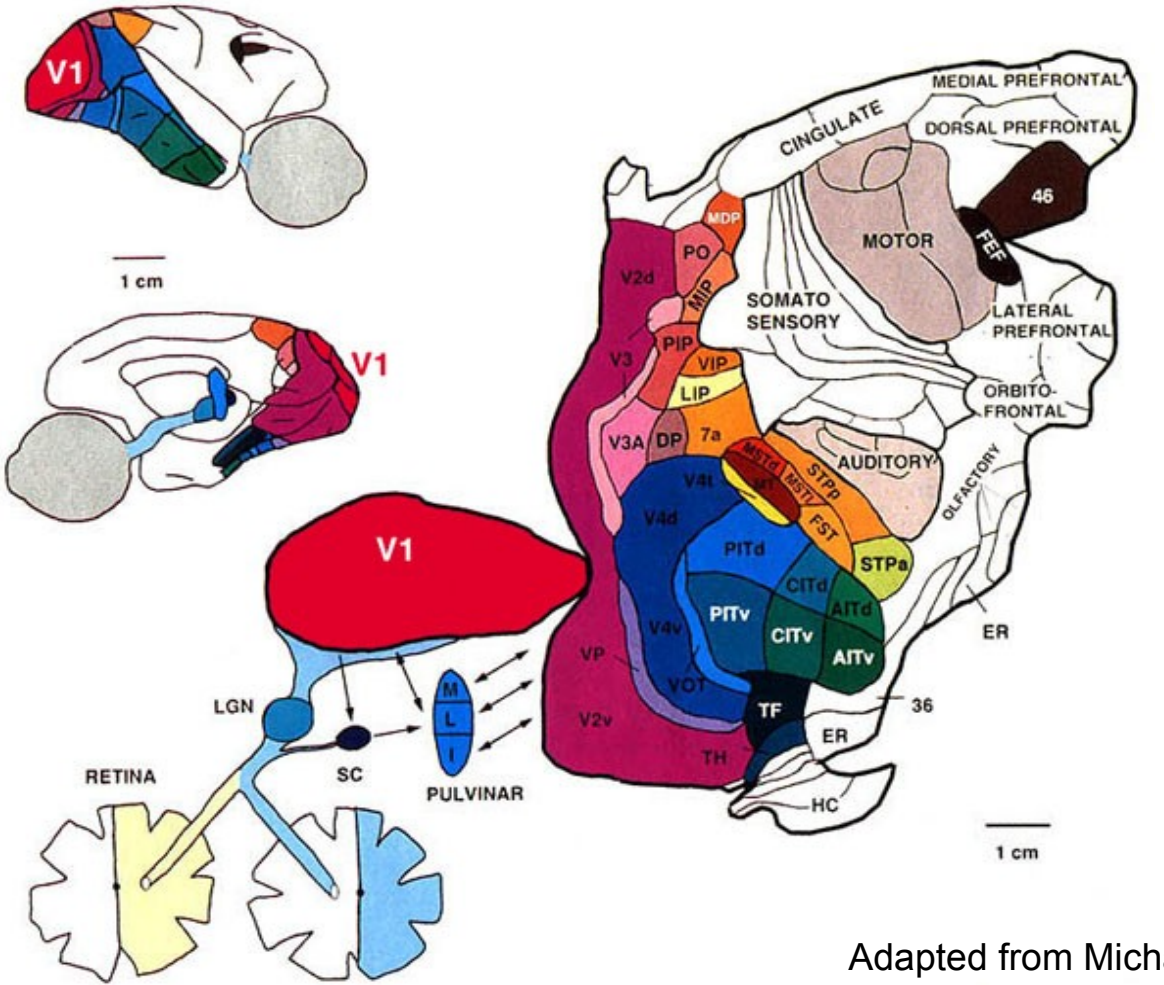
Adapted from Michael E. Goldberg, M.D.

So

- Your visual system does not measure and report the exact physical nature of the visual world.
- It collects some data, and makes guesses.
- Optical illusions take advantage of the guessing strategies.

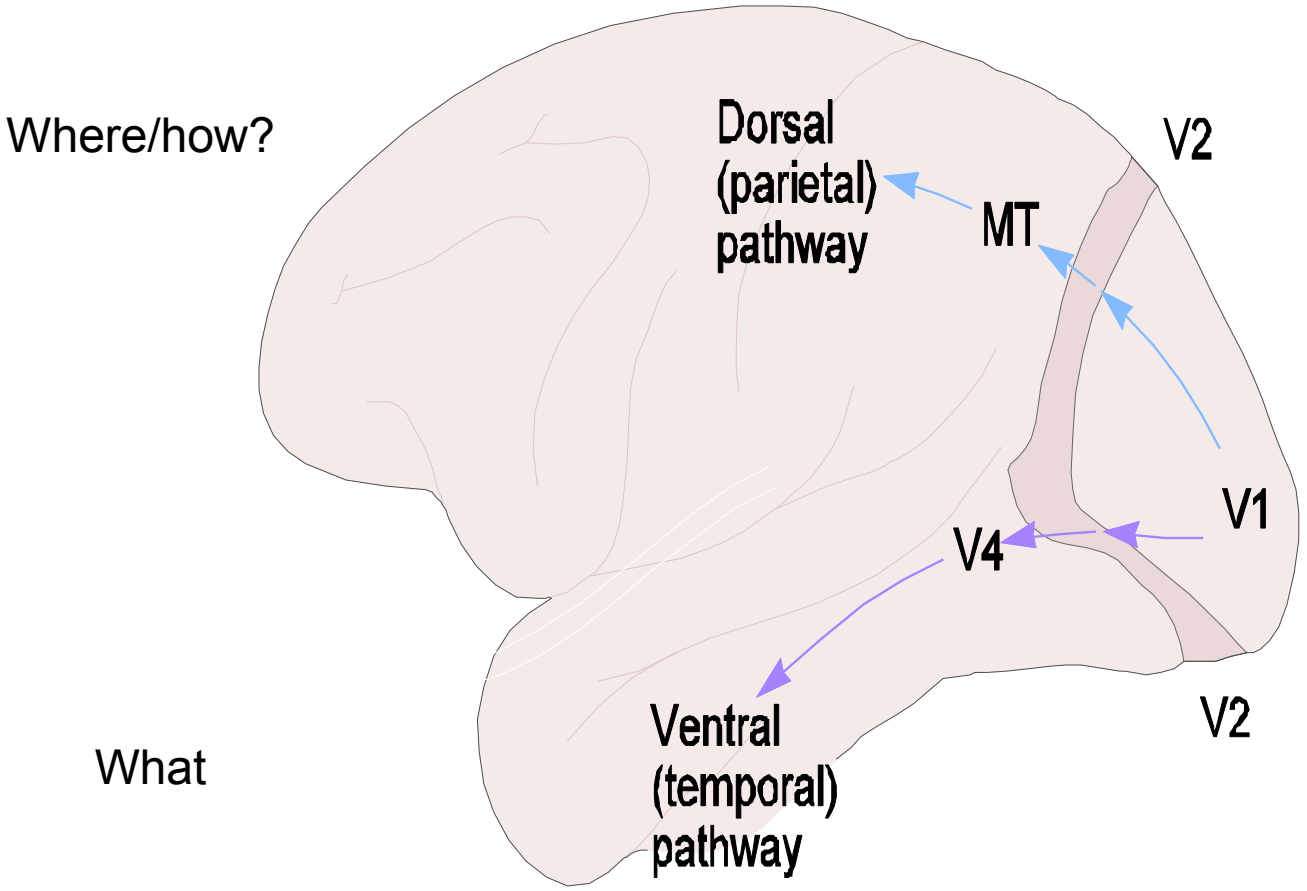
Adapted from Michael E. Goldberg, M.D.

Roughly 40% of cerebral cortex is involved in vision



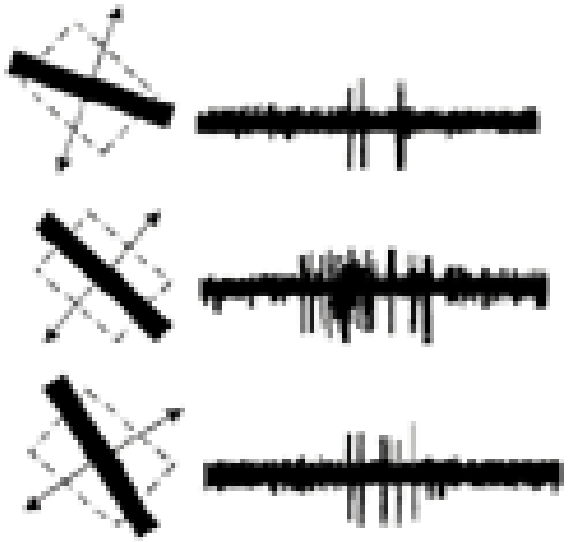
Adapted from Michael E. Goldberg, M.D.

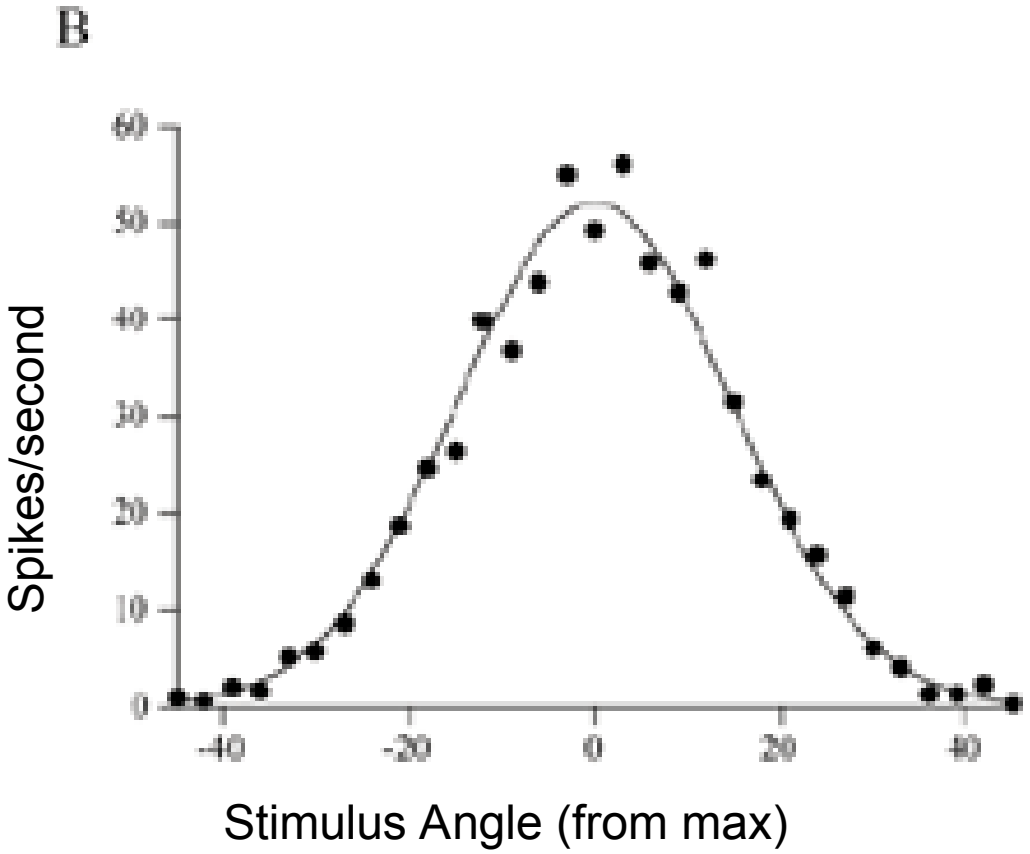
Two cortical visual streams subserve two different visual functions.



Adapted from Michael E. Goldberg, M.D.

Orientation tuning in a V1 simple cell





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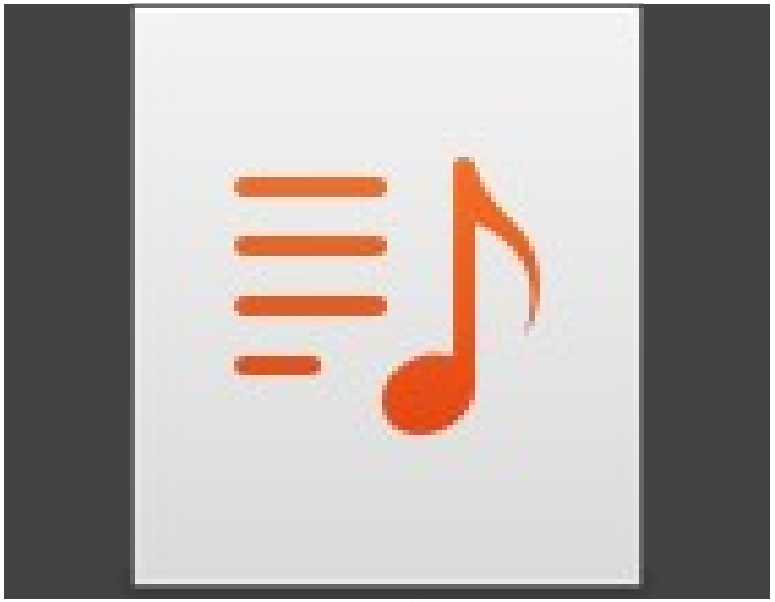
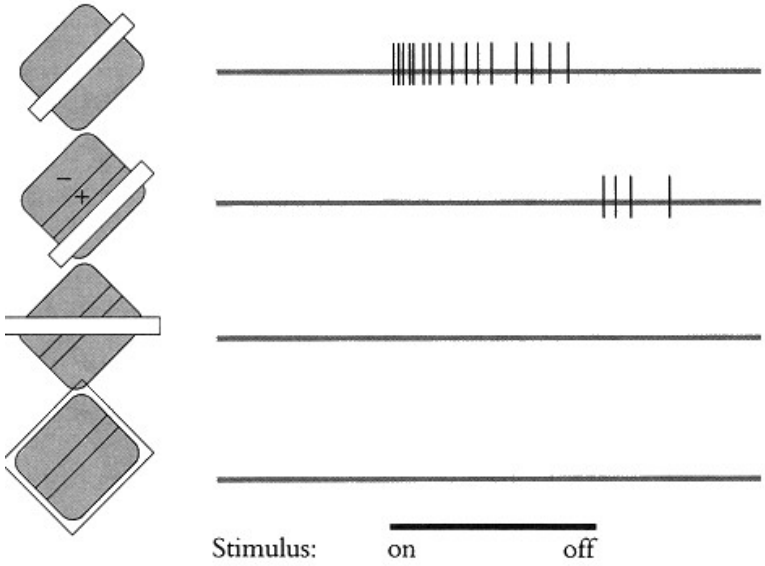
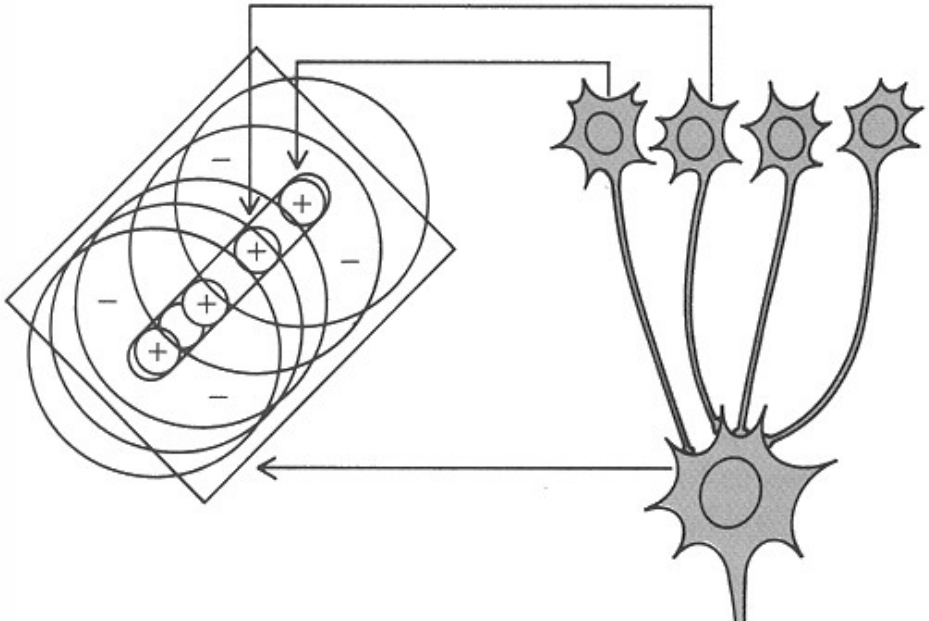
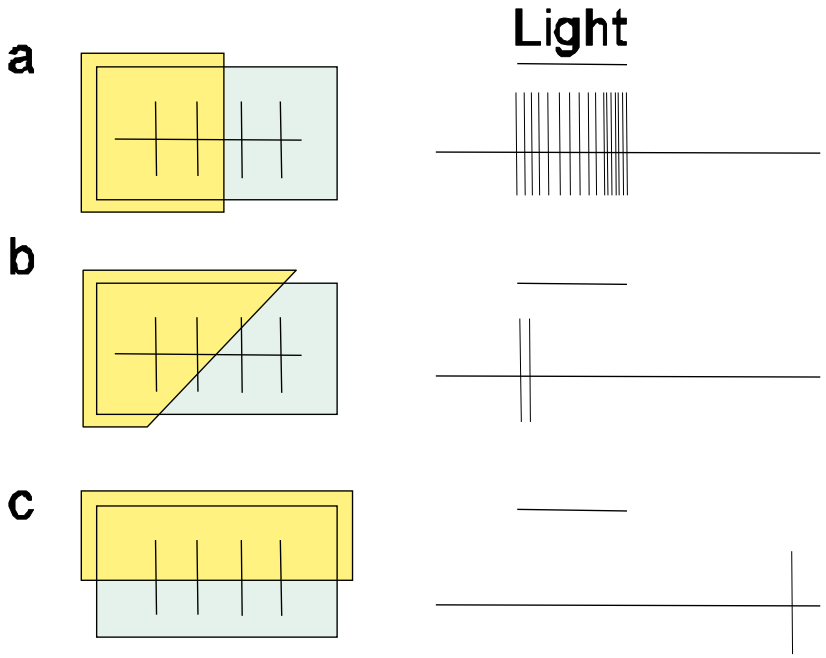
Orientation tuning in a V1 simple cell





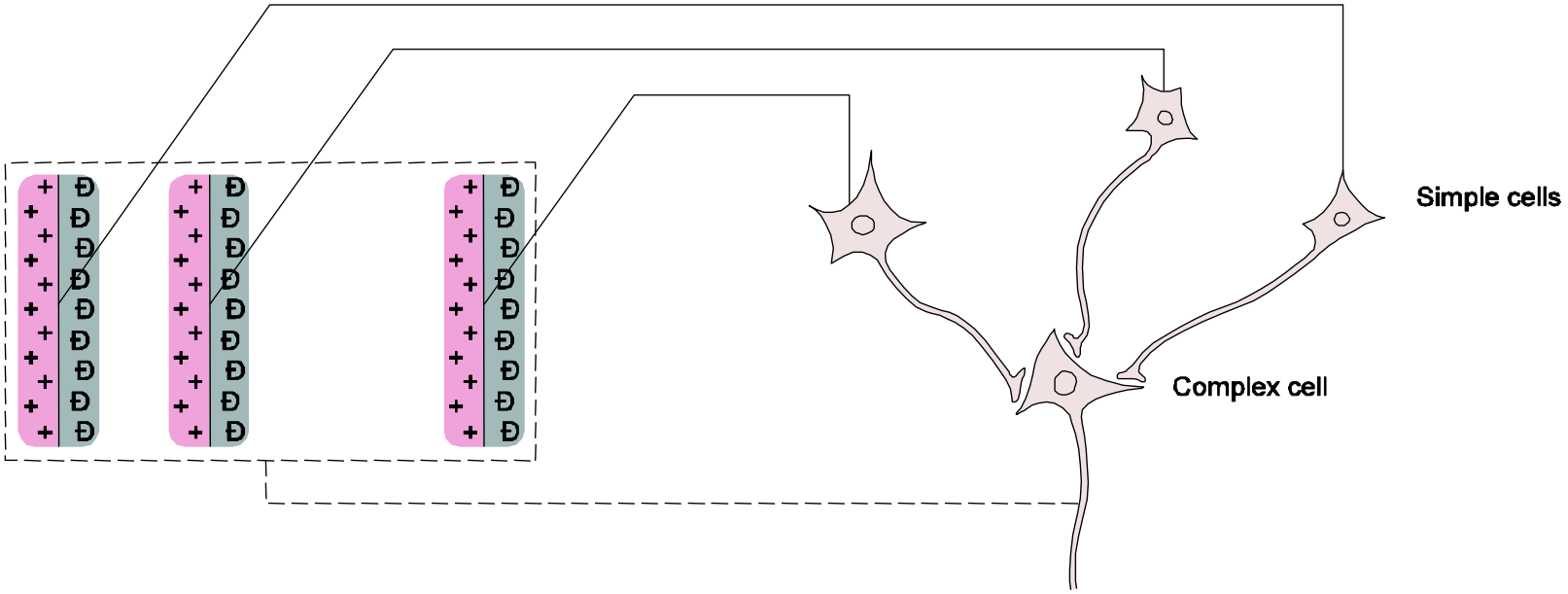


V1 complex cells are sensitive to orientation of stimuli



Adapted from Michael E. Goldberg, M.D.

Complex cells can be constructed from an array of similarly oriented simple cells



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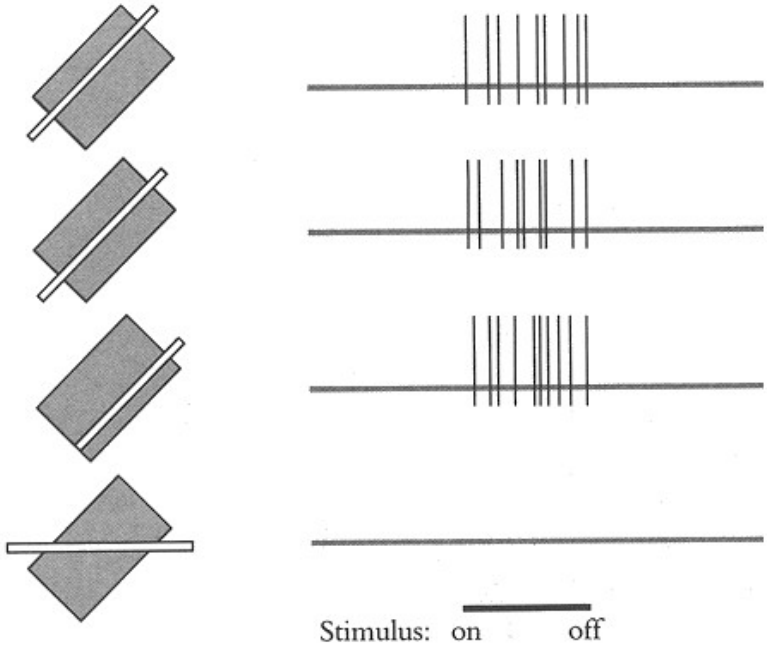
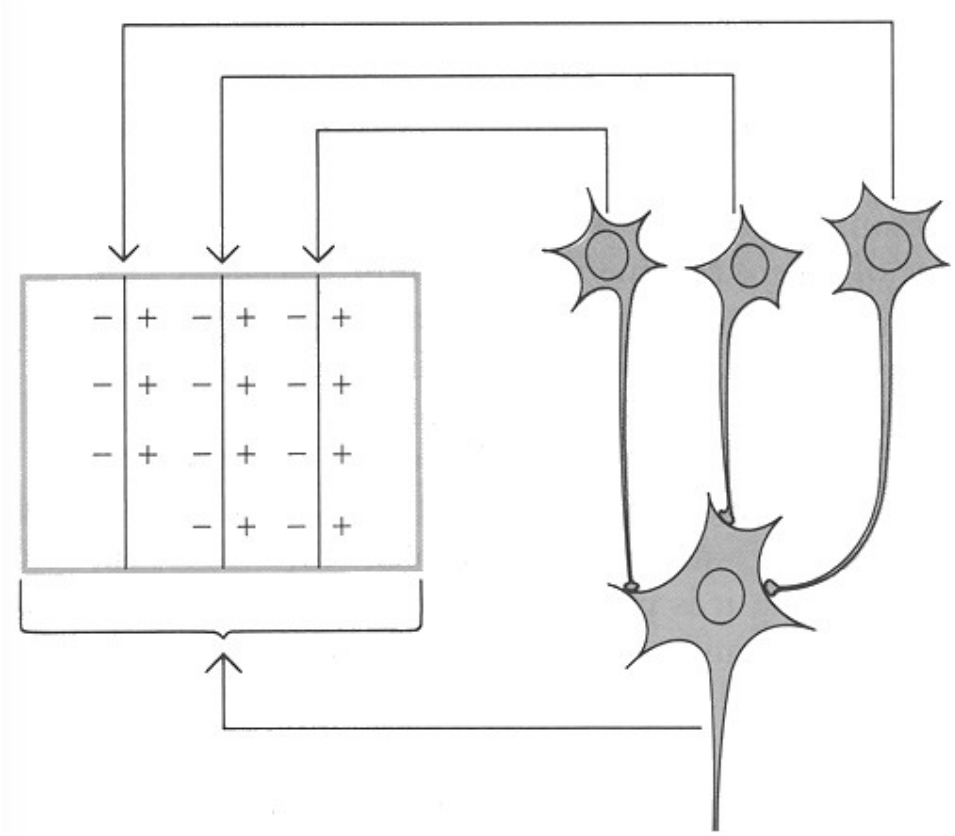
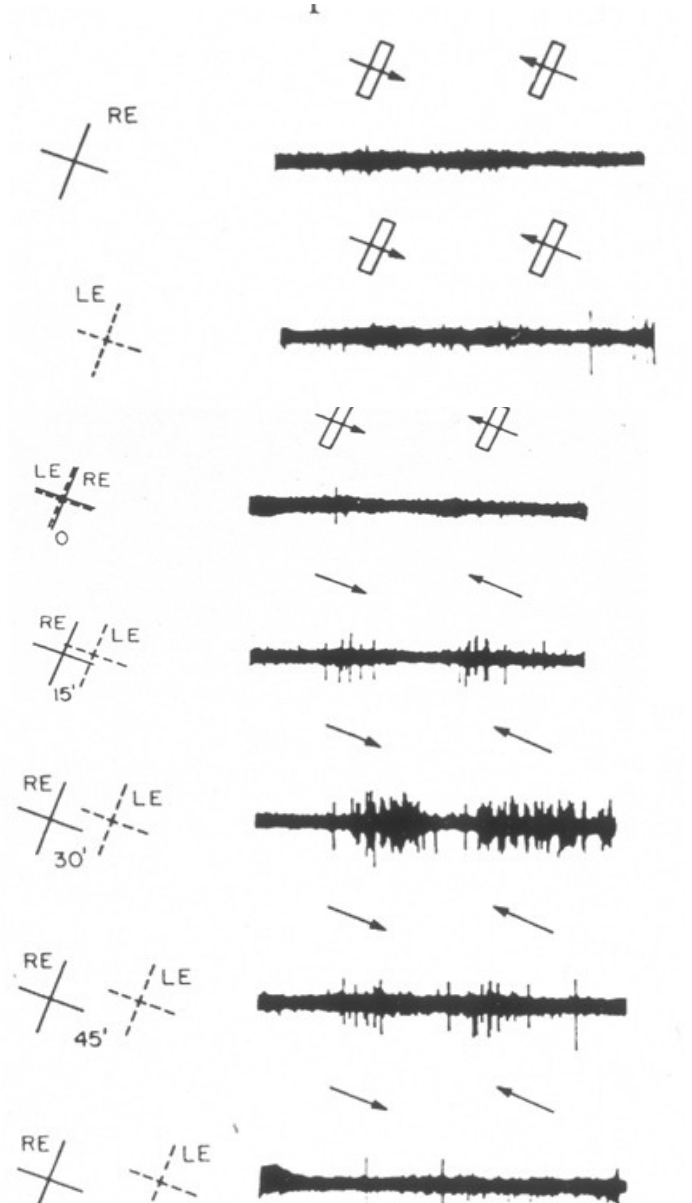
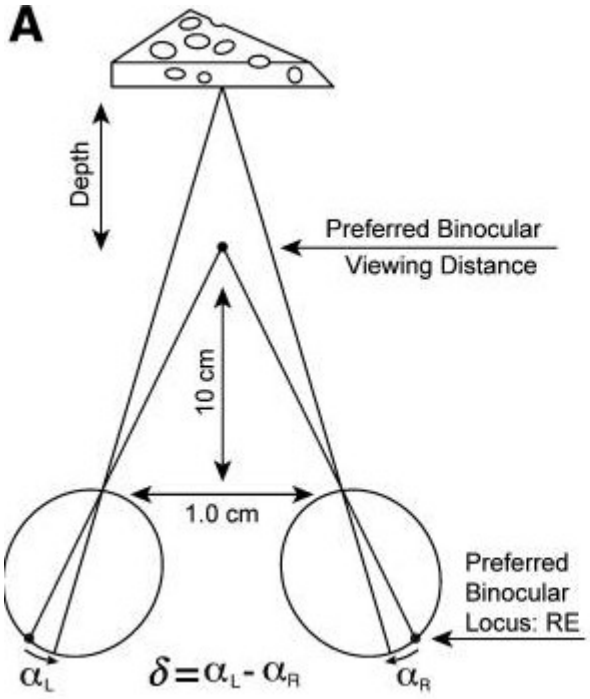
V1 complex cells are sensitive to orientation of stimuli

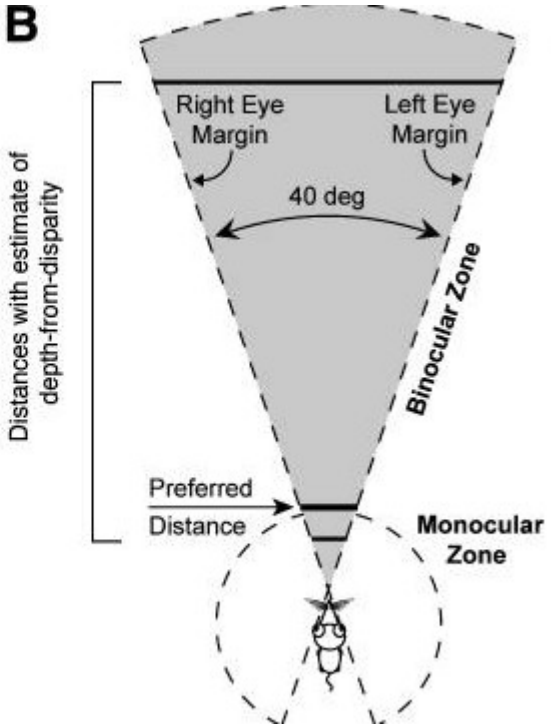




Disparity selectivity in a V1 neuron

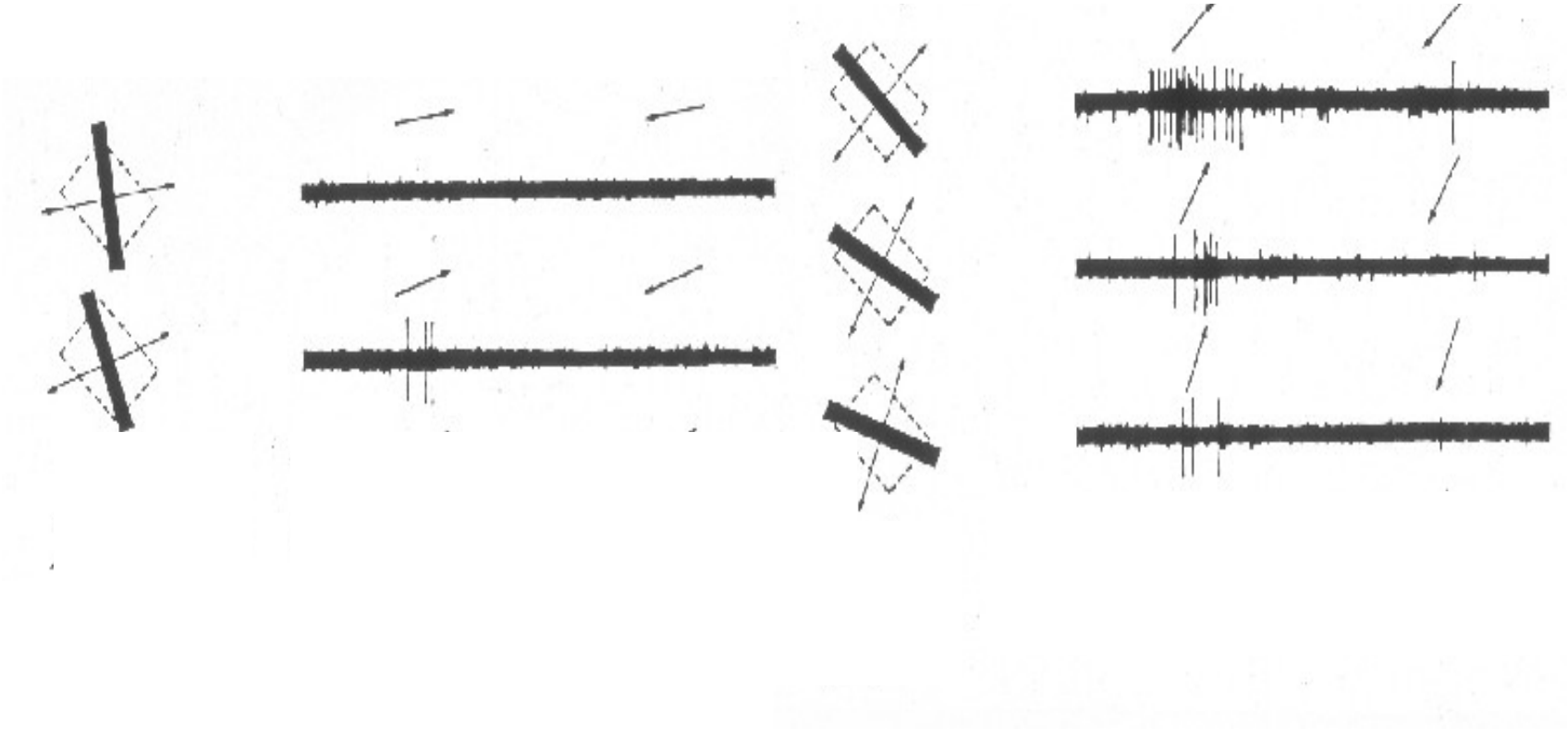






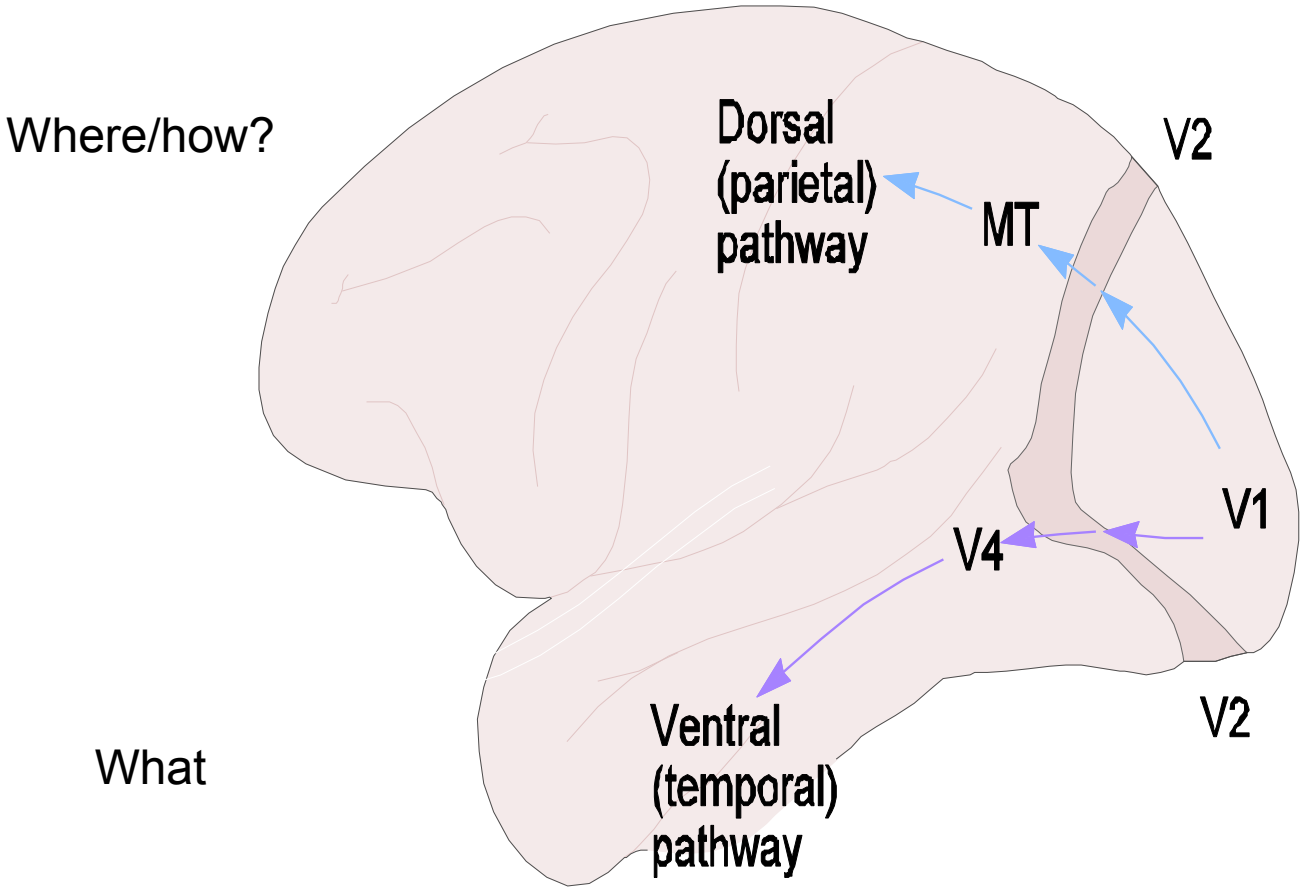
Adapted from Michael E. Goldberg, M.D.

Motion selectivity in a V1 neuron



Adapted from Michael E. Goldberg, M.D.

Two cortical visual streams subserve two different visual functions.



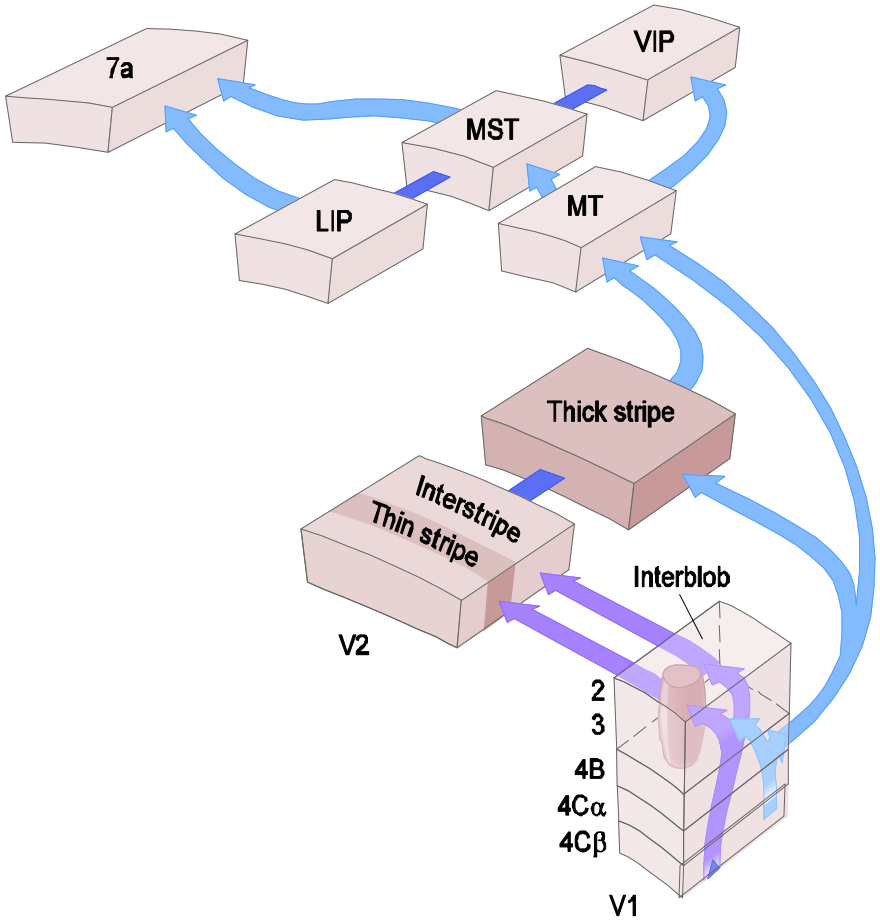
Adapted from Michael E. Goldberg, M.D.

Patients demonstrate this functional segregation

- Patients with V1 lesions generally have total visual field deficits in the affected field.
- Patients with dorsal stream lesions have deficits in sensory location (and attention), motion perception, color perception, and the performance of visually-guided movements.
- Patients with ventral stream lesions have visual agnosia, the inability to associate a visual stimulus with a name or function.

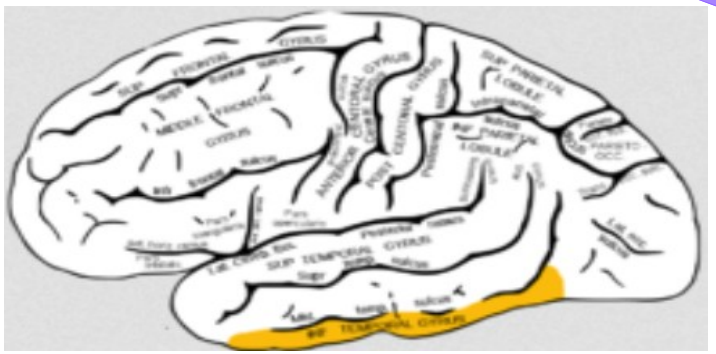
Adapted from Michael E. Goldberg, M.D.

After V2, different functions are performed by anatomically different areas:
The dorsal stream provides vision for action –"where and how"



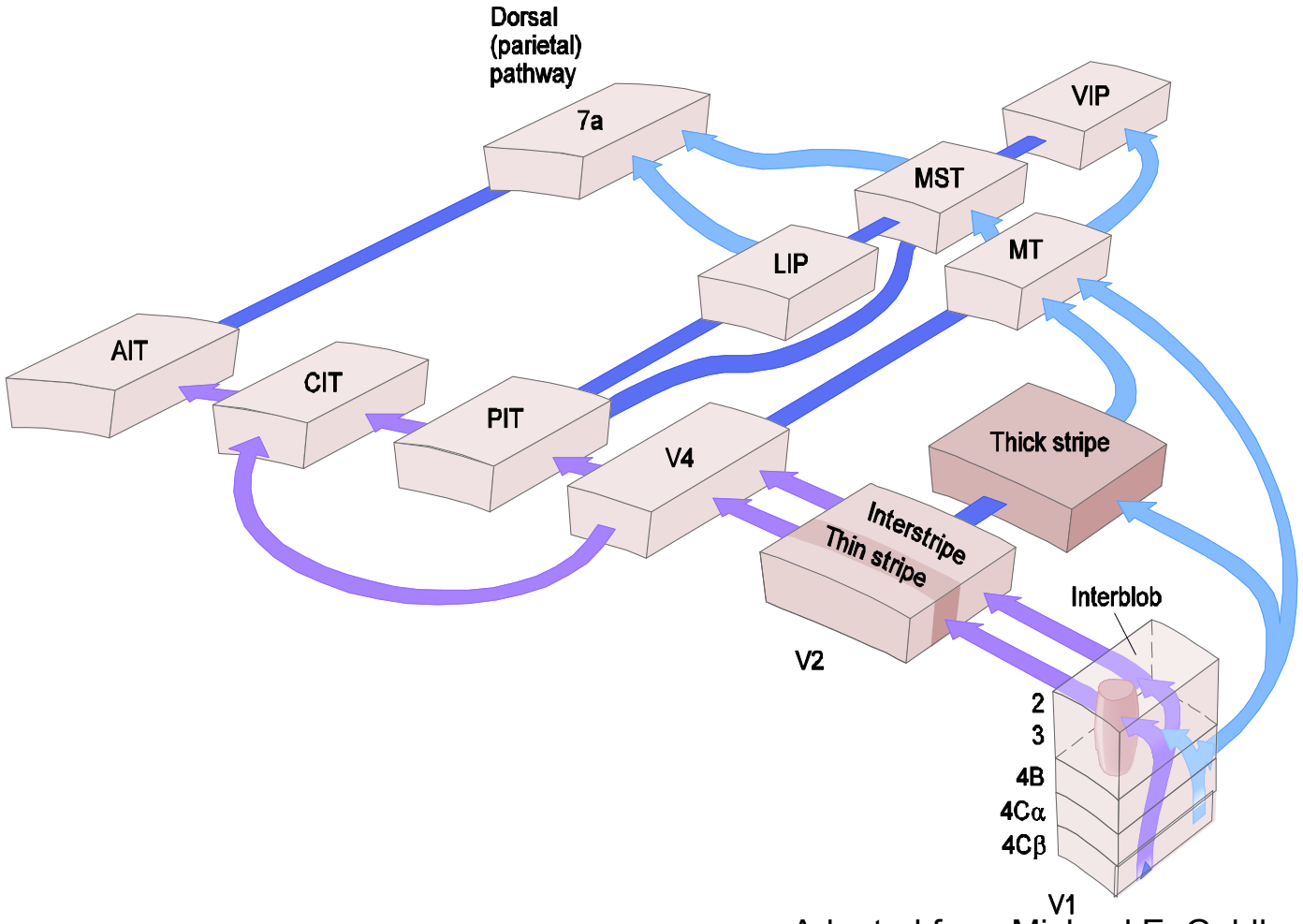
Adapted from Michael E. Goldberg, M.D.

After V2, different functions are performed by anatomically different areas:
The ventral stream provides vision for object identification



Adapted from Michael E. Goldberg, M.D.

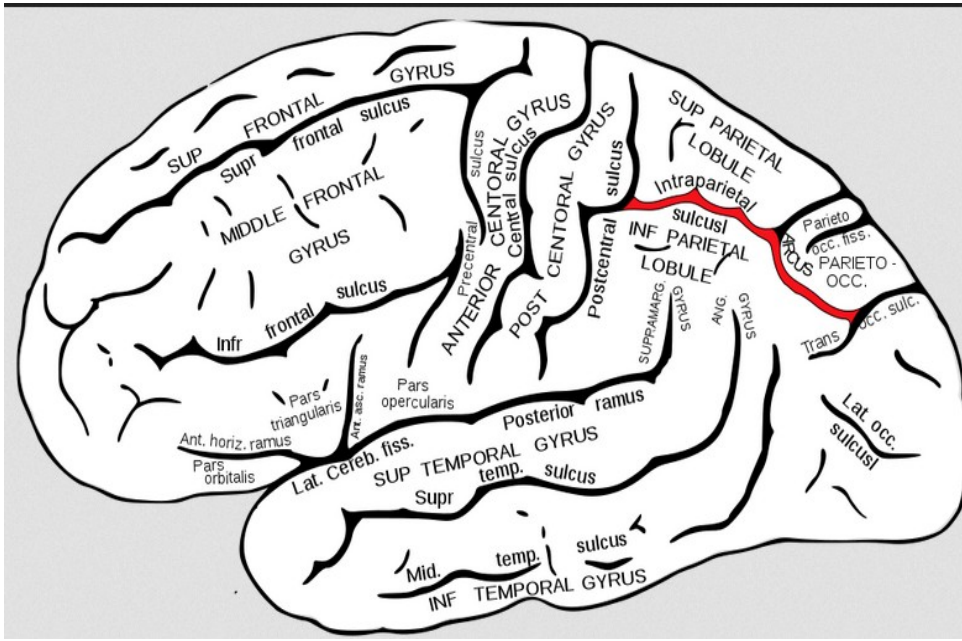
After V2, different functions are performed by anatomically different areas:
But the areas are interconnected

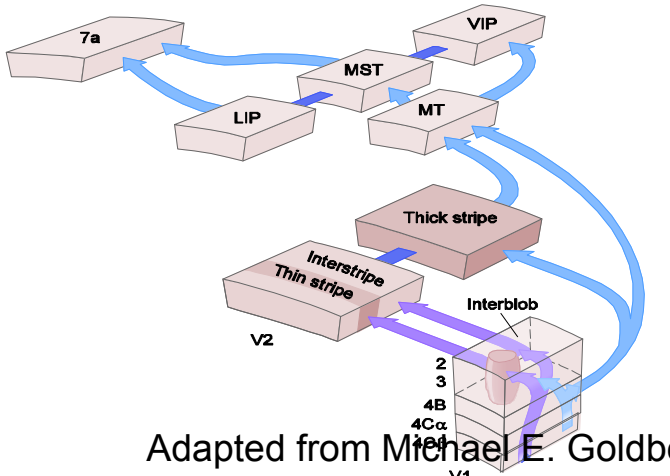


Adapted from Michael E. Goldberg, M.D.

Within the dorsal stream there is further functional segregation –

- MT is specialized for depth and motion.
- LIP is specialized for attention in far space.
- MIP is specialized for providing visual. information for reaching.
- AIP is specialized for providing visual. information for grasping.
- VIP is specialized for providing visual. information for mouth and head movements.





Adapted from Michael E. Goldberg, M.D.

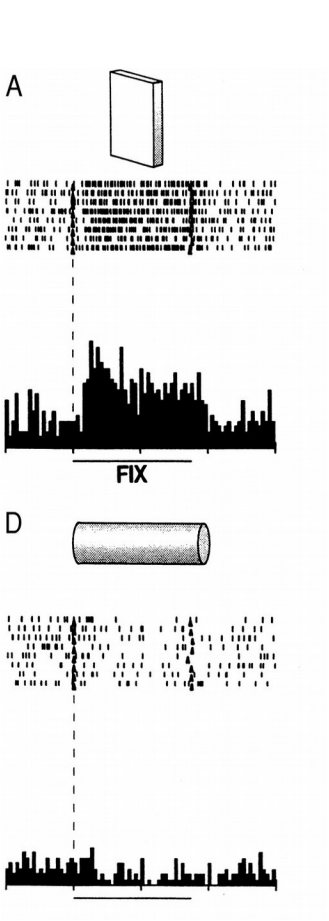
An example of a dorsal stream function

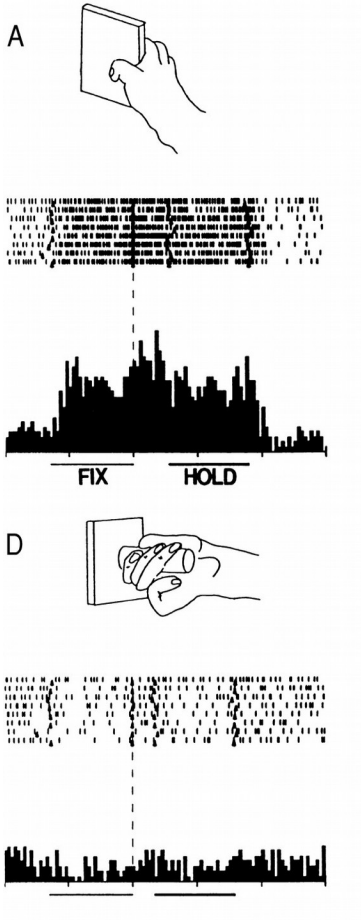
- When you reach for something, your grip opens to accommodate the size of your target.
- Patients with dorsal stream lesions can’t do this.
- They can, however, describe the size of the object.

Adapted from Michael E. Goldberg, M.D.

Neurons in AIP specialized for grip

Look at the object



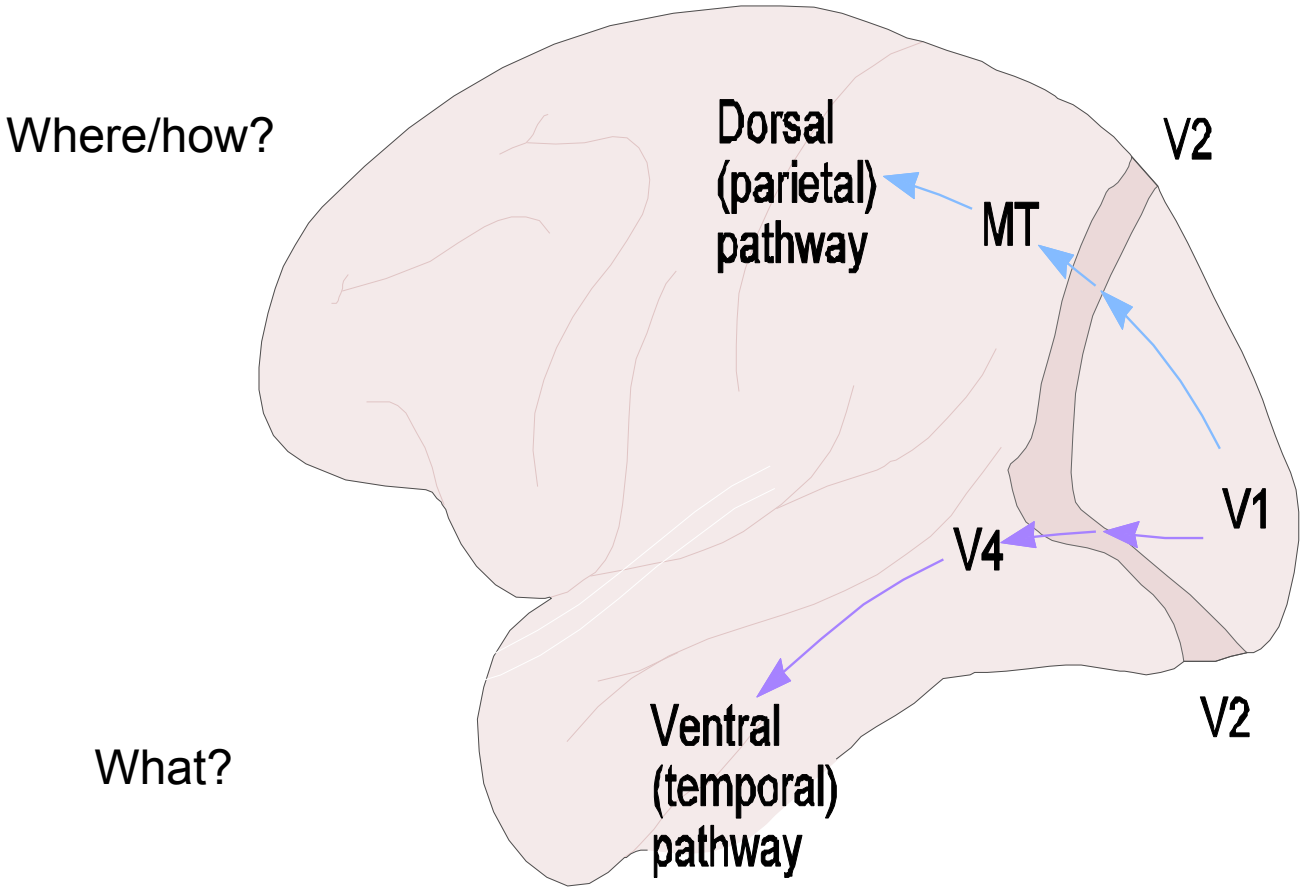


Reach for the object

Dorsal visual pathway is concerned with the aspect of form, orientation, and/or size perception that is relevant for the visual control of movements.

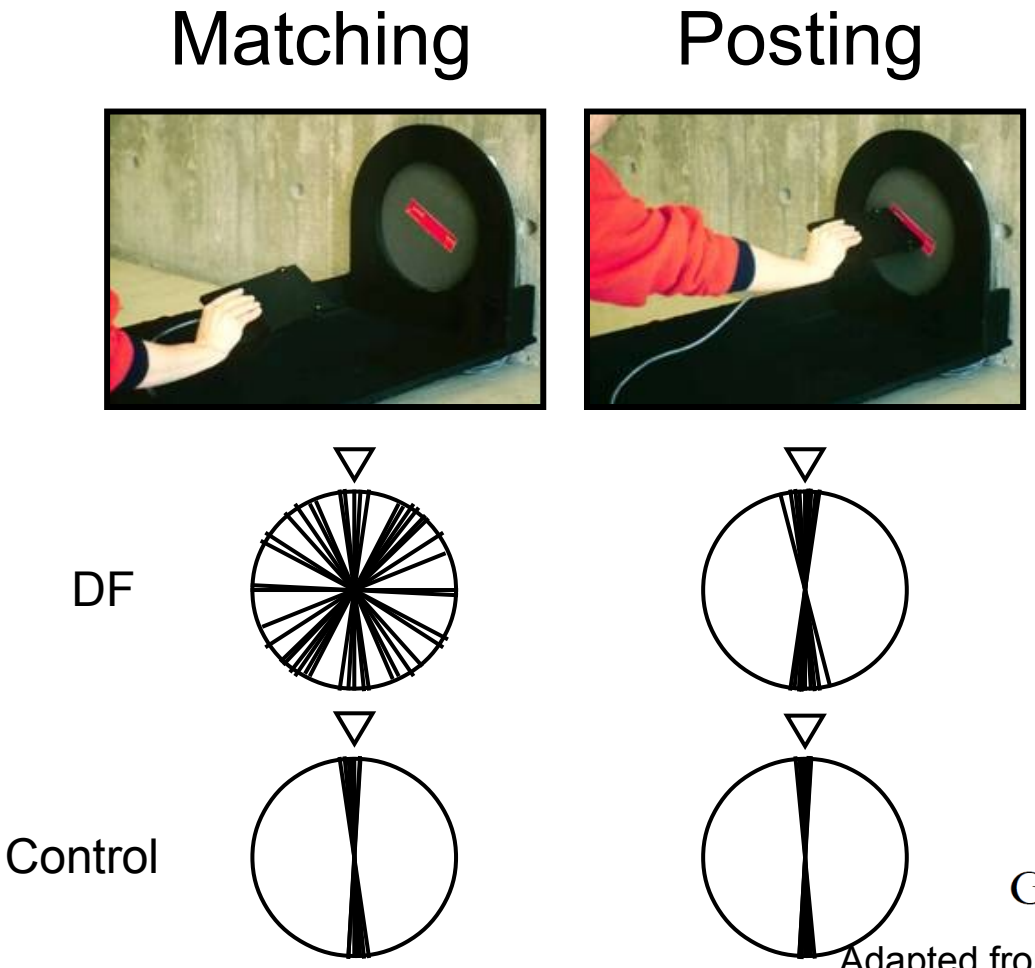
Selectivity for the Shape, Size, and Orientation of Objects for Grasping in Neurons of Monkey Parietal Area AIP Akira Murata, Vittorio Gallese, Giuseppe Luppino, Masakazu Kaseda, Hideo Sakata Journal of Neurophysiology Published 1 May 2000 Vol. 83 no. 5, 2580-2601

The inferior temporal lobe describes the visual world for object recognition



Adapted from Michael E. Goldberg, M.D.

A patient with a ventral stream lesion can move her hand to a slot, but can't match the position or can't report the orientation



Goodale, et al., (1991)

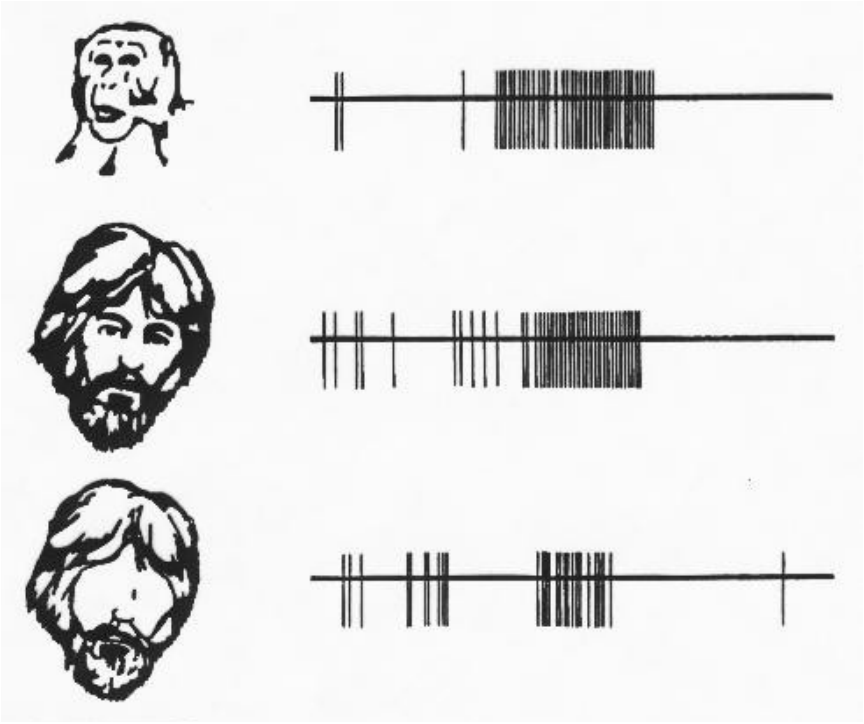
Adapted from Michael E. Goldberg, M.D.

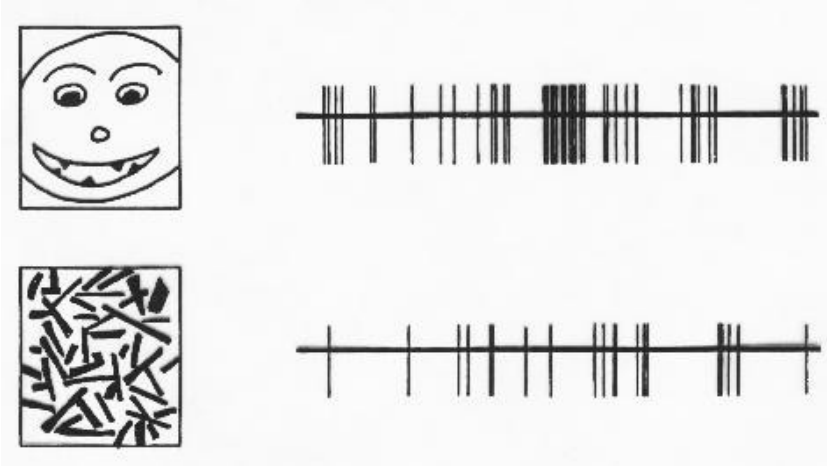
Ventral stream patients

- Cannot identify objects
- But they can make appropriate visually-guided movements.
- The patient who could not set her grip can still tell you which cylinder is thicker.
- The patient who cannot tell you which cylinder is thicker can set still her grip.

Adapted from Michael E. Goldberg, M.D.

Neurons in inferior temporal cortex are selective for complex patterns like faces

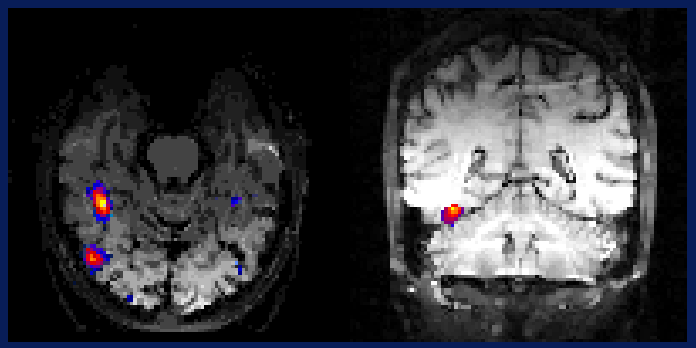


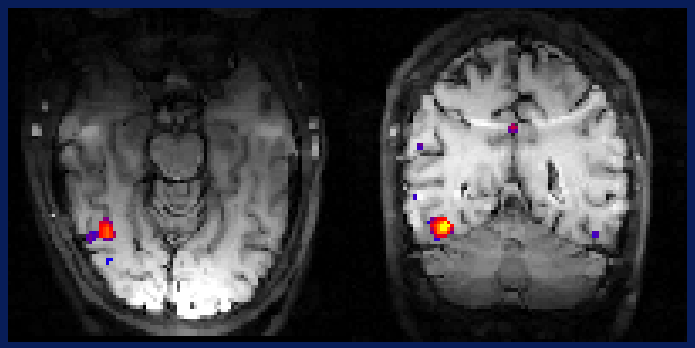


Adapted from Michael E. Goldberg, M.D.

The Fusiform Face Area (FFA)

Kanwisher, McDermott, & Chun (1997)





- Responds during passive viewing of faces > objects.
- Cannot be explained in terms of
  - differences in low-level features
  - attentional confounds
  - subordinate - level categorization of any stimulus class
  - generalized response to anything animate/human
- Is selectively involved in perception of faces.

Adapted from Michael E. Goldberg, M.D.

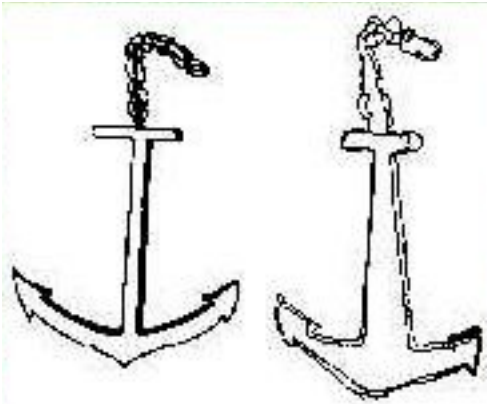
Prosopagnosia "face blindness" is the most dramatic ventral stream deficit

- Term first used by Bodamer, 1947
- Inability to recognize familiar faces
- Visual acuity is normal
- Caused by lesion to right inferior temporal lobe
- May be congenital ("developmental prosopagnosia")
- Patients compensate by using other recognition cues: clothing, gait, voice, etc.

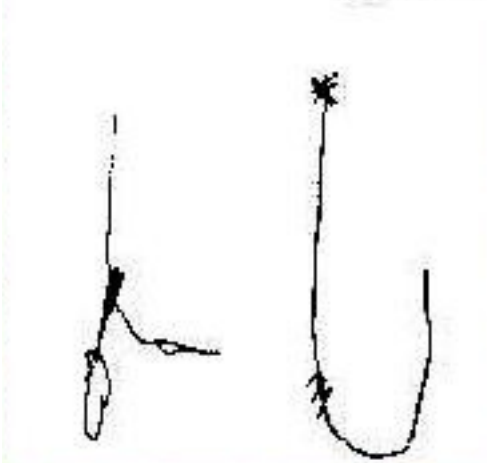
Adapted from Michael E. Goldberg, M.D.

Patients with inferior temporal lesions have visual agnosia

Copy the drawing
Visuomotor function
Intact – but patient
can't name the object



Draw an anchor.
Patient cannot
conceptualize the
anchor



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