

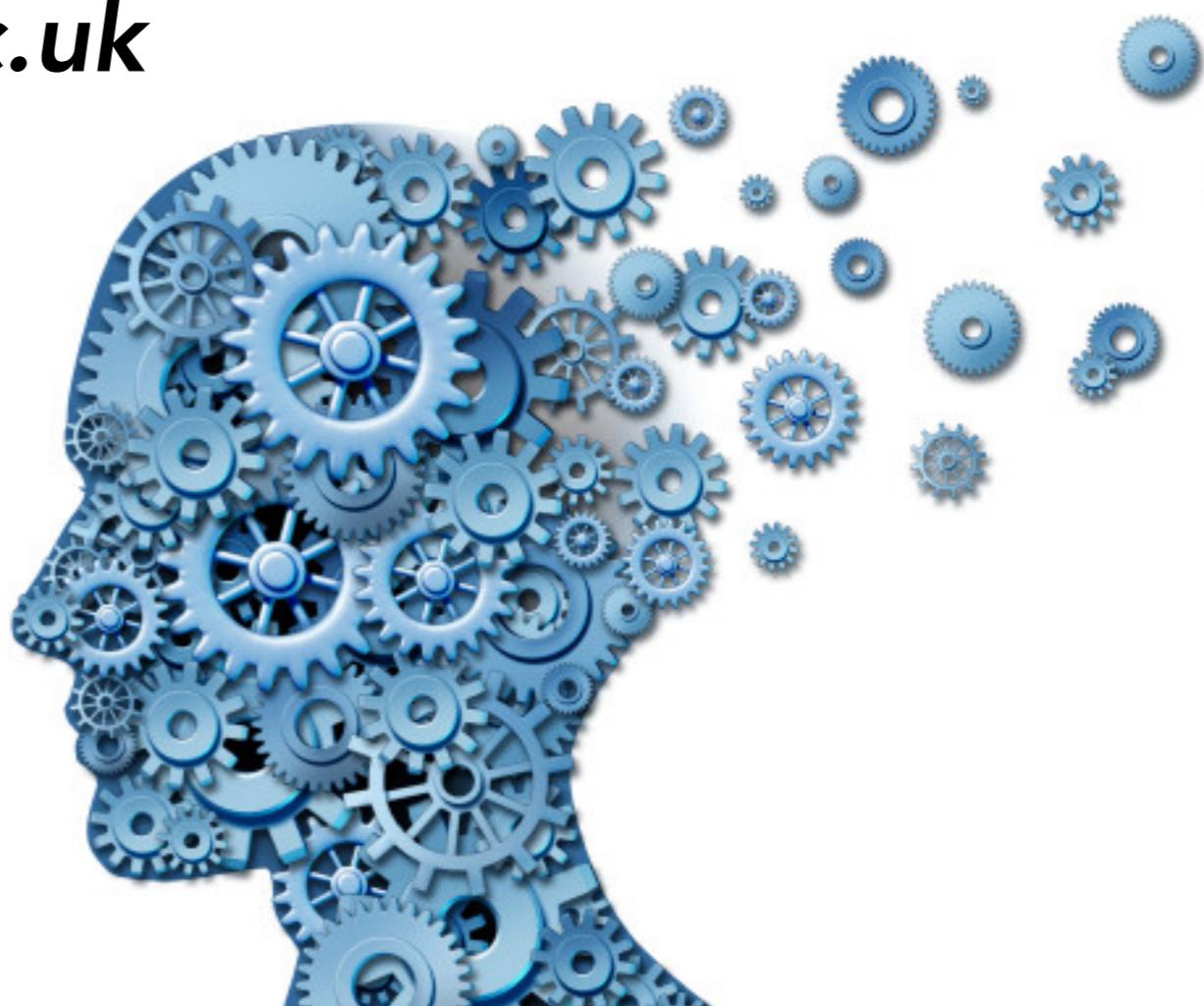
COMS30017

Computational Neuroscience

Week 6 / Video 2 / The visual pathway

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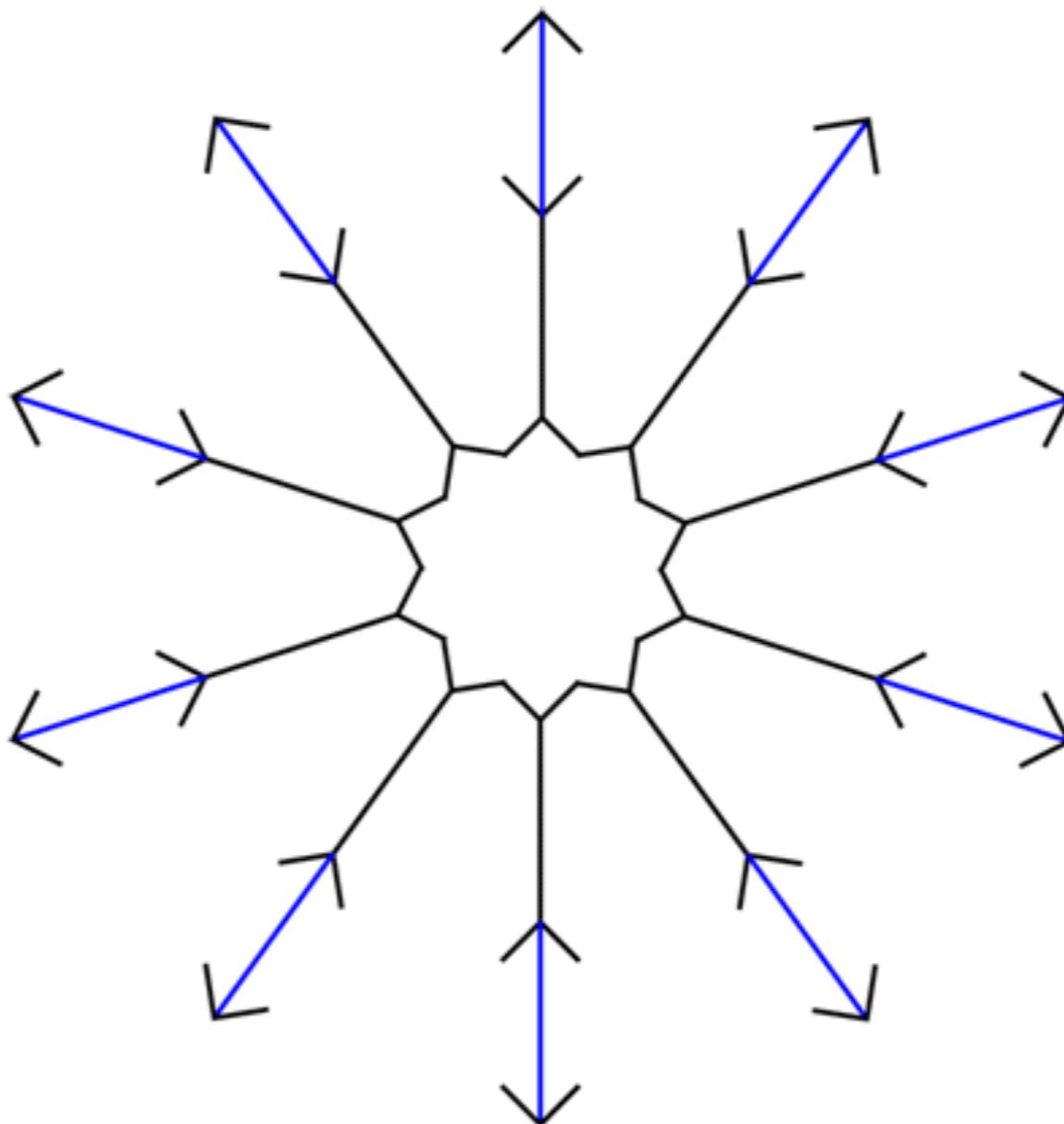
Intended Learning Outcomes

- Gross anatomy of the mammalian visual system.
- Receptive field properties along the visual hierarchy.

Müller-Lyer Pulsating Star

by Gianni A. Sarcone

Though the star seems to pulsate, the **blue** and **black** segments of the radial structure are always the **same length!**

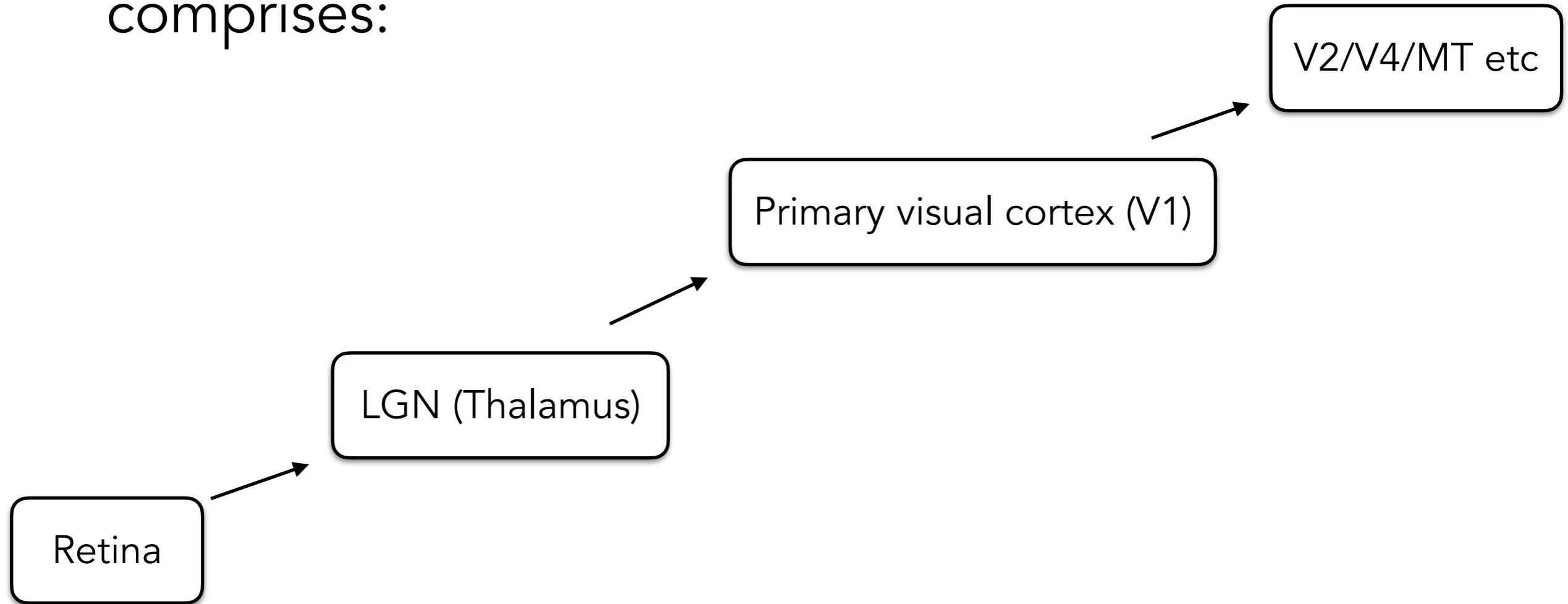


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https://www.giannisarcone.com/3-MEDIA_Images/Muller_lyer_star_OR2.gif

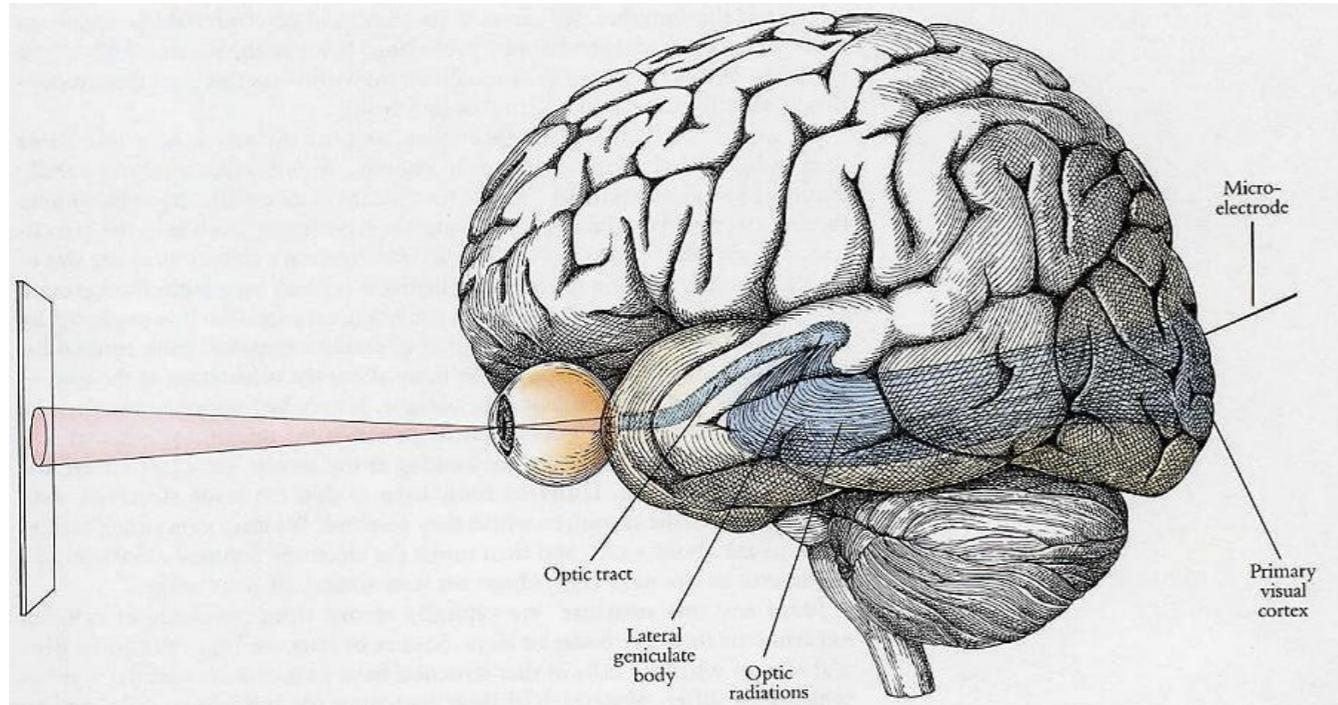
The visual system

- As a first approximation, the visual system comprises:

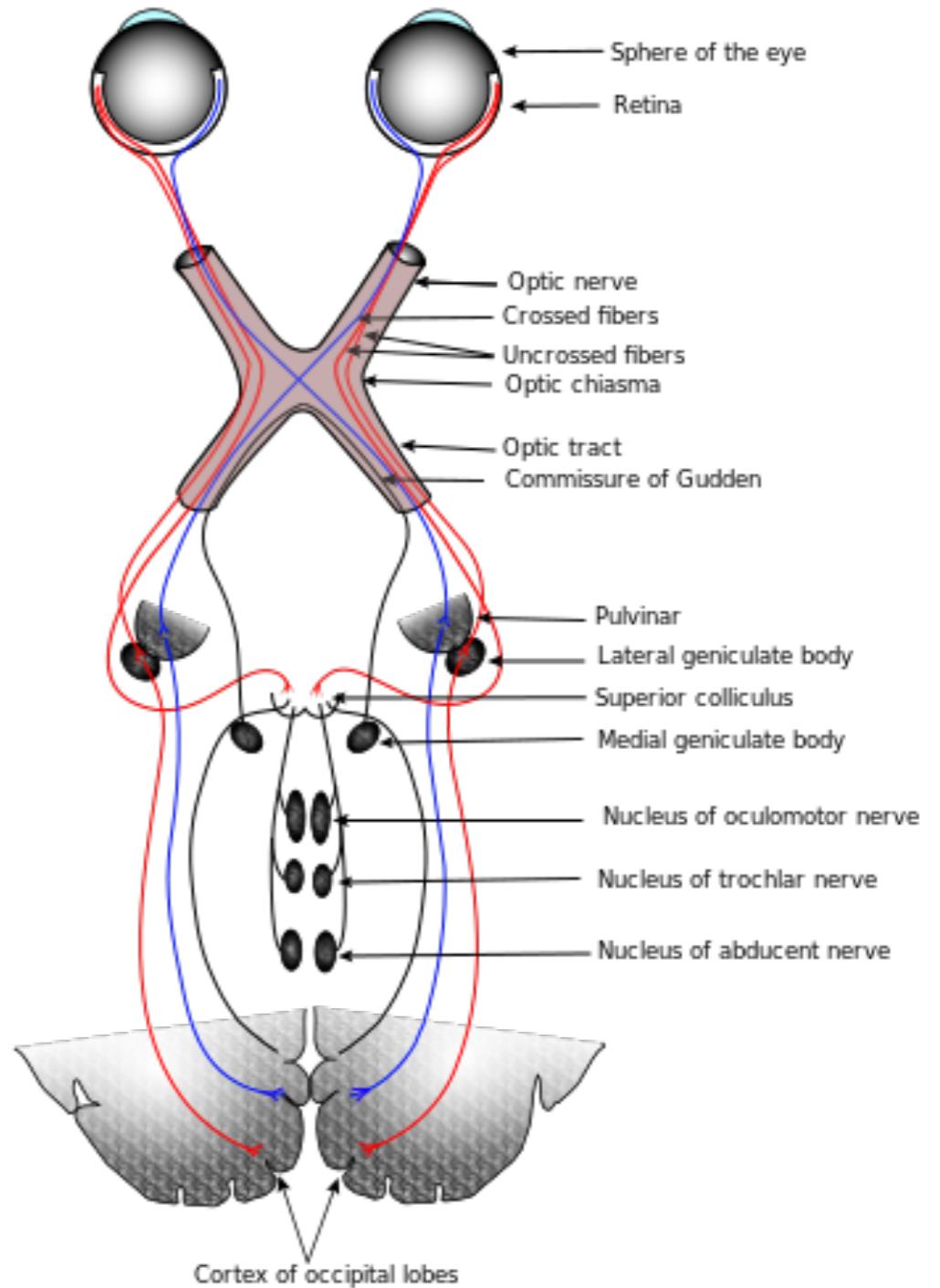


- However, reality is much more complicated (tens of visual regions, heterogeneity within regions, feedback connections down the hierarchy)

The visual system



<http://hubel.med.harvard.edu/book/b3.htm>



[https://en.wikipedia.org/wiki/Visual_system#/media/File:Gray722-
svg.svg](https://en.wikipedia.org/wiki/Visual_system#/media/File:Gray722-svg.svg)

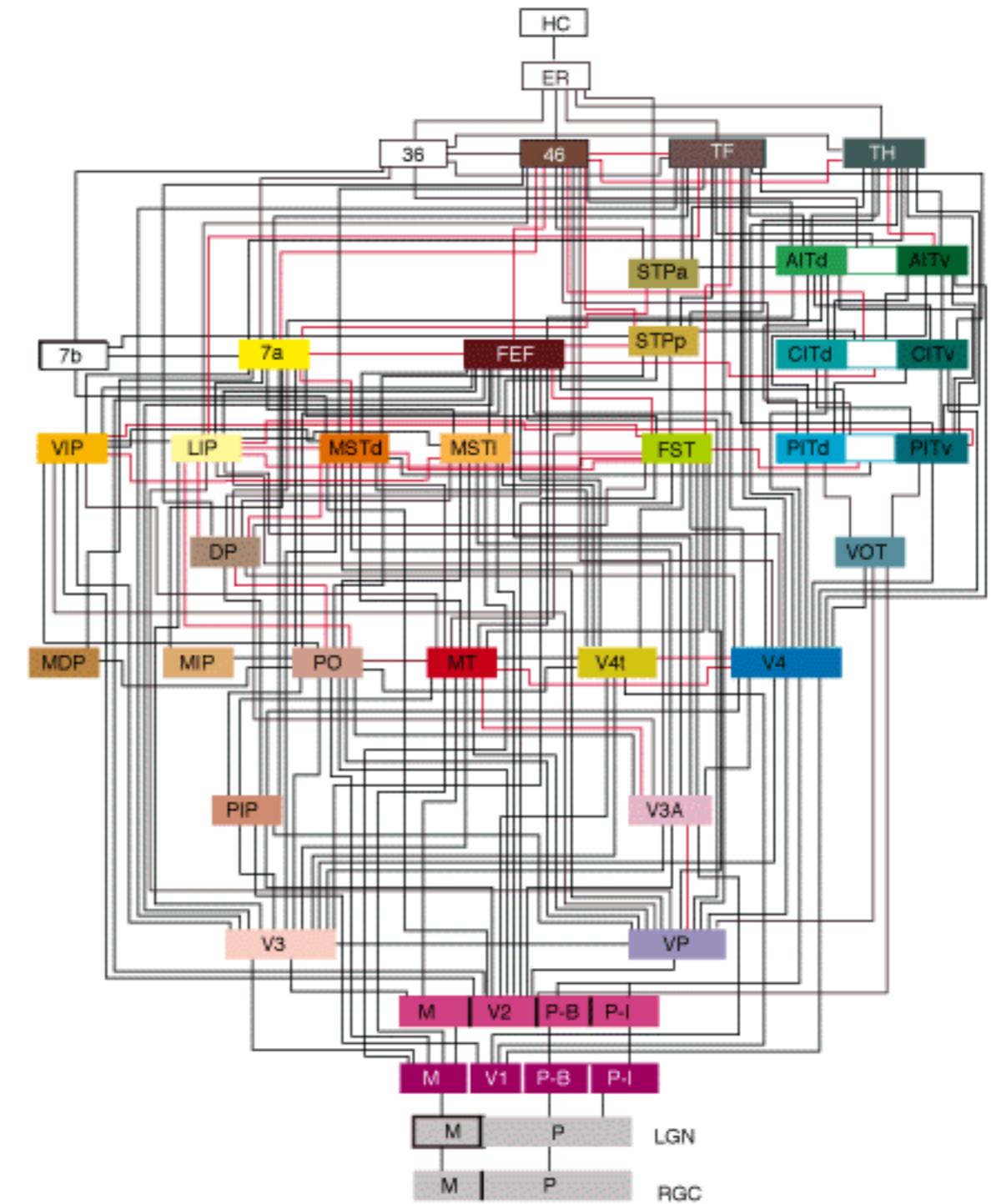
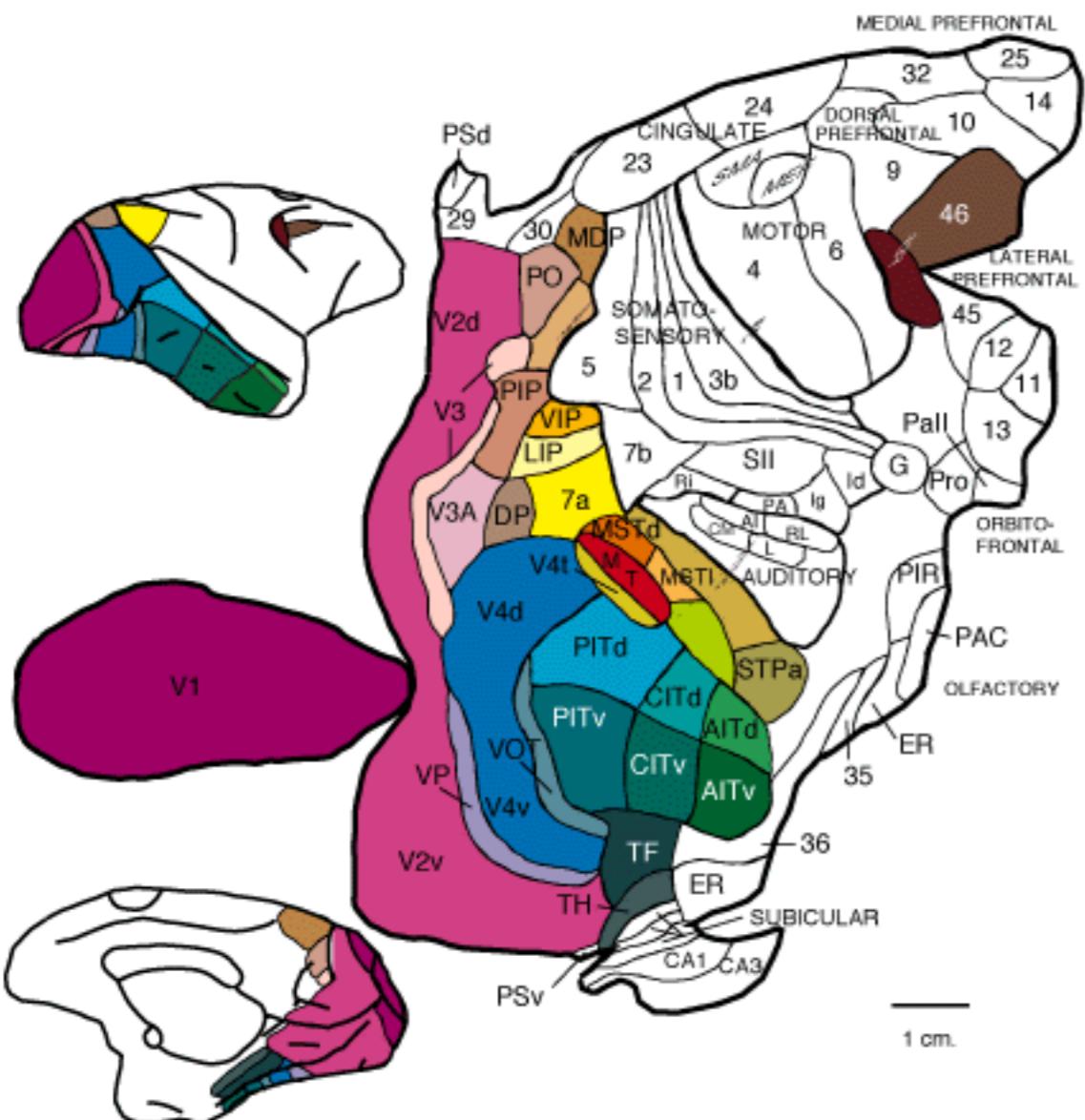
The visual system



<https://youtu.be/aCv4K5aStdU?t=83>

Split-brain patients without a corpus callosum (typically cut to treat epilepsy) tend to separately process sensory stimuli from each side of the world.

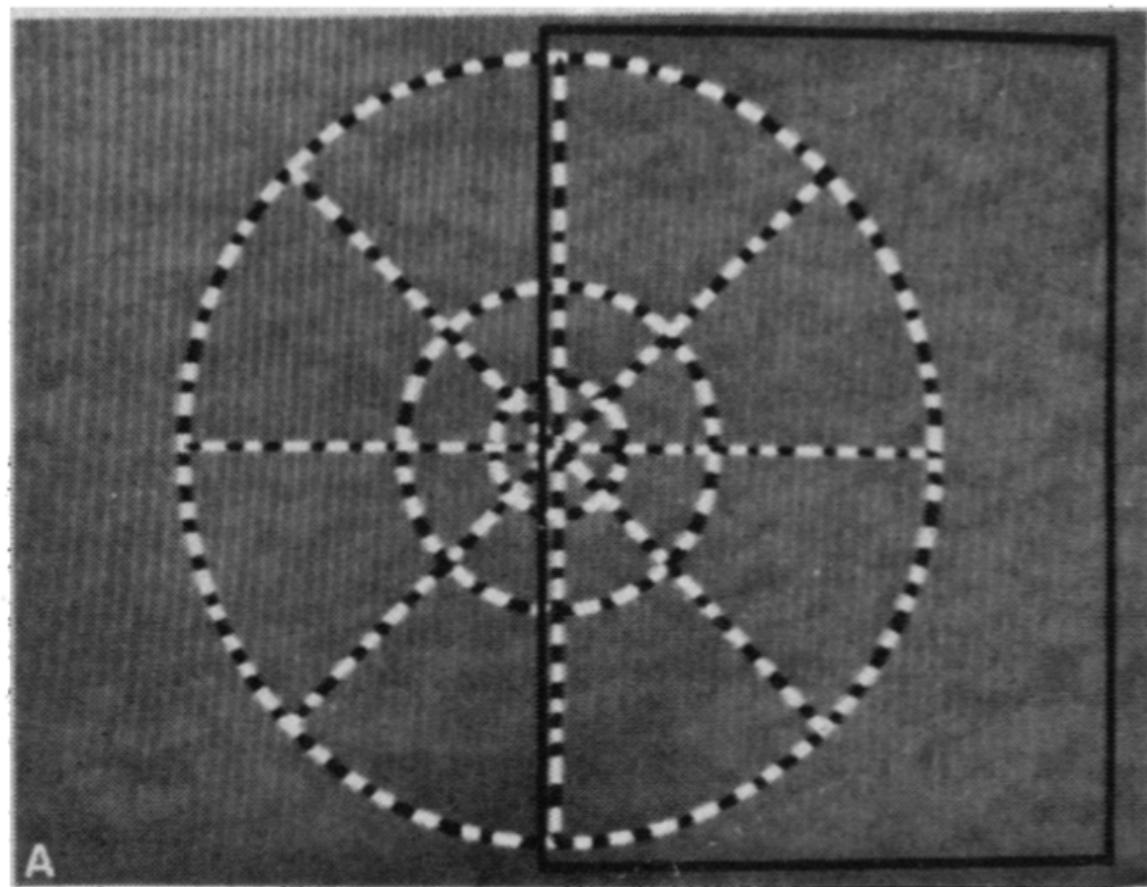
Visual hierarchy (macaque)



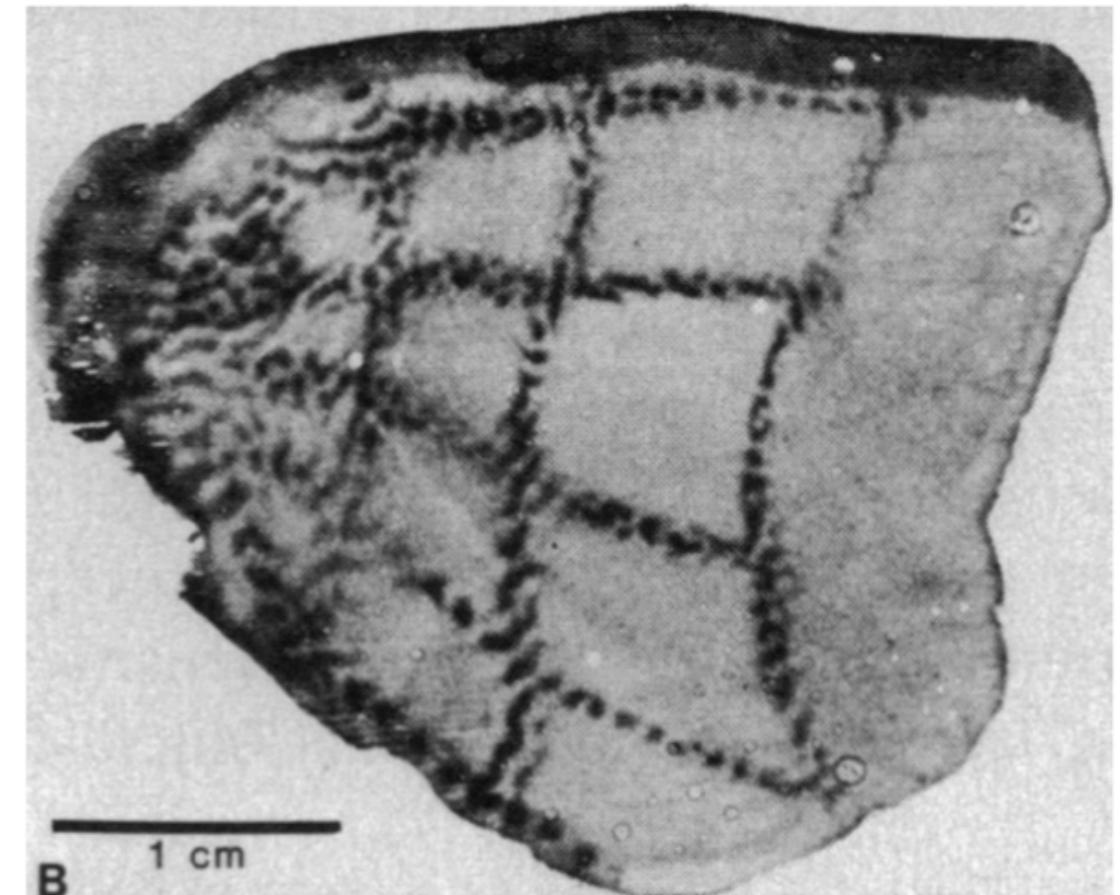
[Felleman and van Essen, *Cerebral Cortex* (1991)]

Retinotopy

- Anatomically neighbouring neurons tend to respond to neighbouring parts of the visual field.
- This retinotopy is preserved along the visual hierarchy.



Stimulus



Visual cortex response pattern

Coding along the visual hierarchy

Receptive fields tend to change from level to level up the visual processing hierarchy.

They:

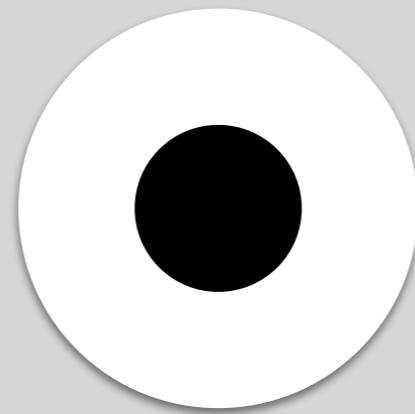
- Become larger.
- Become sensitive to complicated aspects of the visual stimulus.
- Become more multimodal (i.e. also depend on non-visual sensory signals).
- Become more sensitive to top-down, contextual information (e.g. task context, animal's behavioural state, attention)

Coding along the visual hierarchy: retinal ganglion cells/LGN



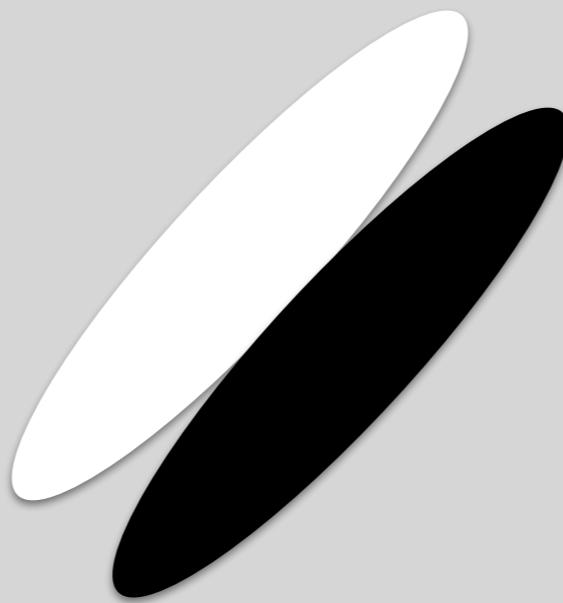
“ON centre”

Coding along the visual hierarchy: retinal ganglion cells/LGN



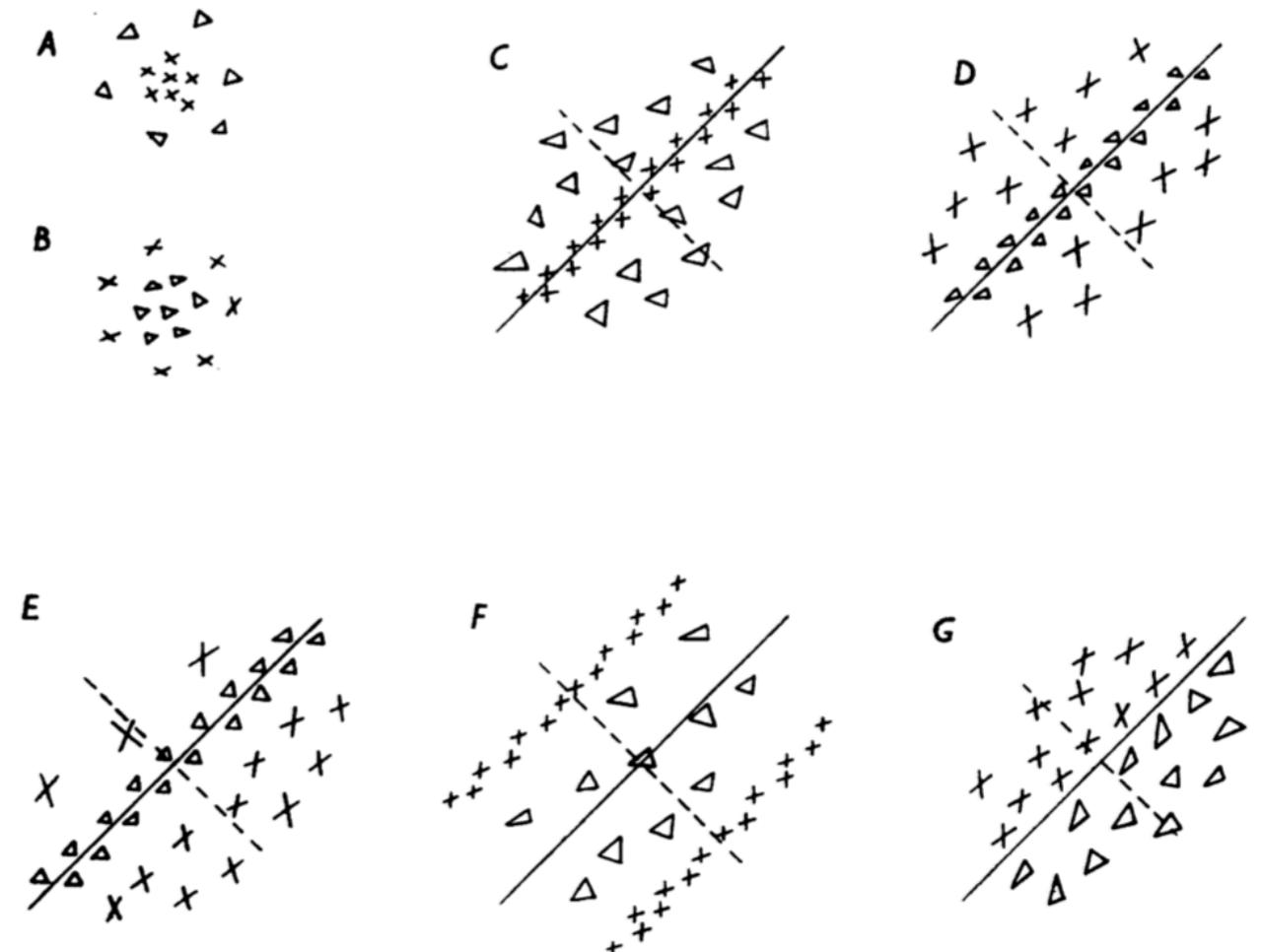
“OFF centre”

Coding along the visual hierarchy: V1



Orientation tuning,
Gabor-like.

Hubel and Wiesel cat vision experiments

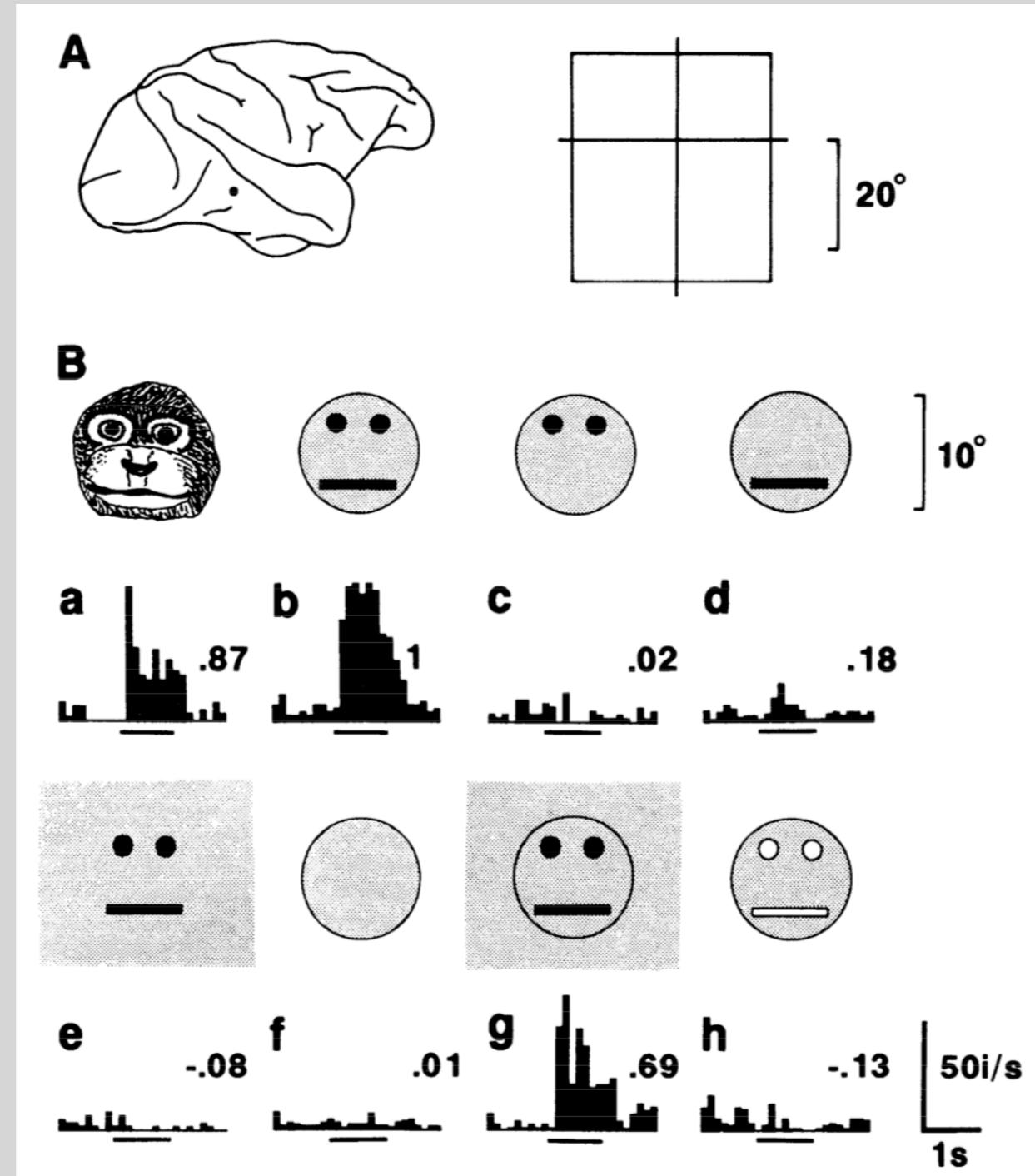


Text-fig. 2. Common arrangements of lateral geniculate and cortical receptive fields. A. 'On'-centre geniculate receptive field. B. 'Off'-centre geniculate receptive field. C-G. Various arrangements of simple cortical receptive fields. \times , areas giving excitatory responses ('on' responses); Δ , areas giving inhibitory responses ('off' responses). Receptive-field axes are shown by continuous lines through field centres; in the figure these are all oblique, but each arrangement occurs in all orientations.

<https://youtu.be/8VdFf3egwfg>

[Hubel and Wiesel, *J Physiol* (1962)]

Coding along the visual hierarchy: higher visual areas

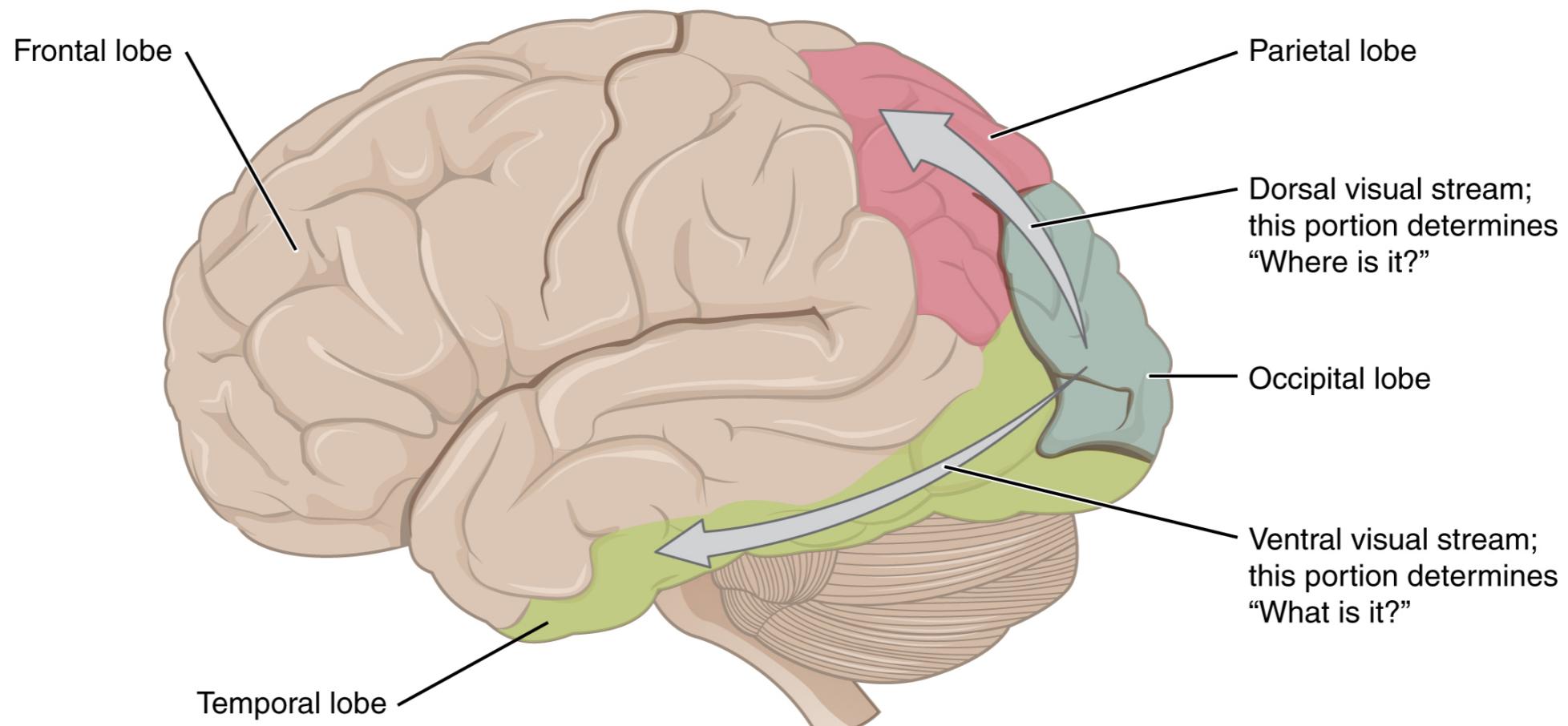


Objects, e.g. faces

[Kobatake and Tanaka, *J Neurophysiol* (1994)]

“What” vs “where” pathways

- The “two-streams” hypothesis suggests that the human brain splits visual information into two anatomically separate pathways.
- The “what” or ventral stream codes for object identity.
- The “where” or dorsal stream codes variables useful for action guidance.



End