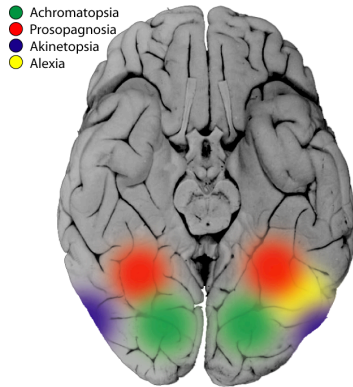


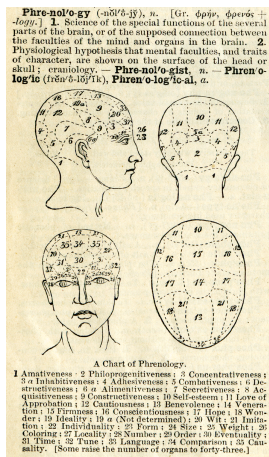
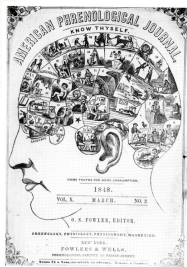
Functional specialization



Phrenology

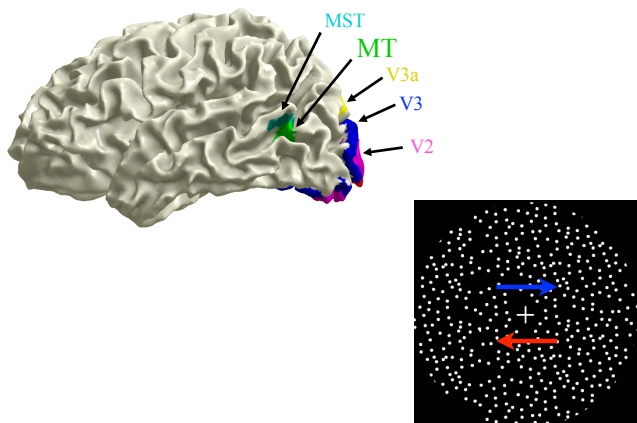


Franz Joseph Gall (1757-1828)



from Webster's Academic Dictionary, 1895

Visual area MT responds to local motion



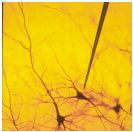
Flattening the brain



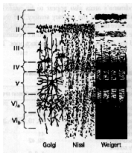
Defining visual cortical areas

PhACT

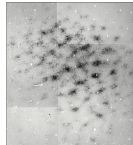
Physiology



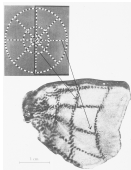
Architecture



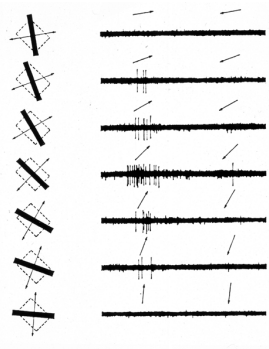
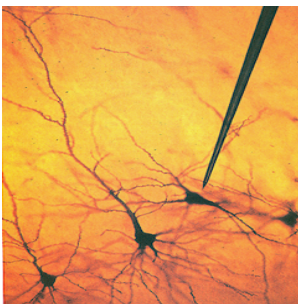
Connections



Topography



Physiology



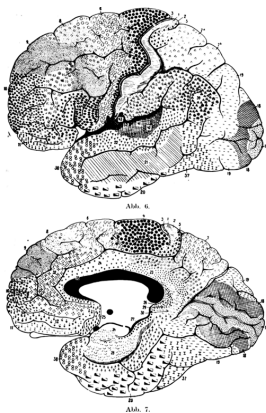
Example: direction selectivity in V1

Cytoarchitecture: Brodmann's areas



Korbinian Brodmann
(1868-1918)

~50 cytoarchitectural areas defined by cell size, cell density, number of layers, density of myelinated axons.

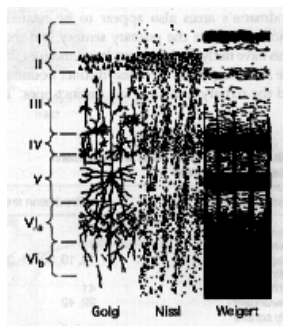


Different stains for different features

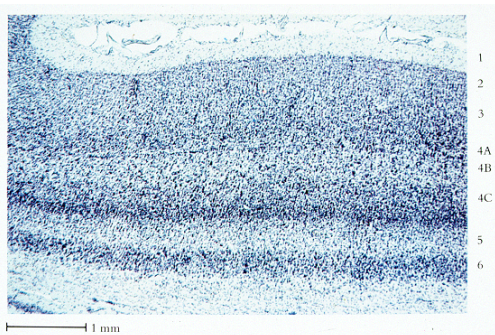
Golgi stain: small fraction of cell bodies and dendrites

Nissl stain: only cell bodies

Weigert myelin stain for axons

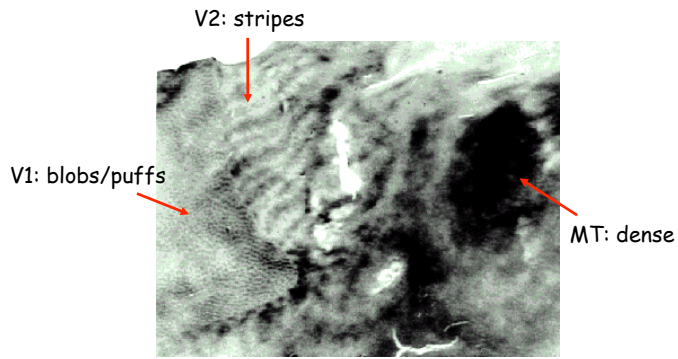


Cortical layers



Primary visual cortex slice (Nissl stain)

Architecture



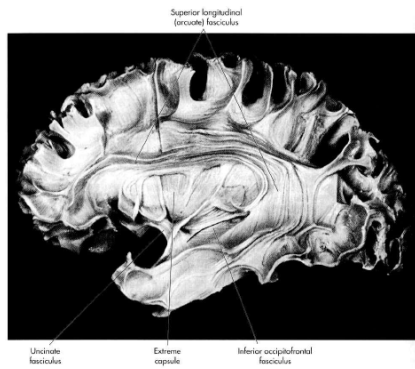
Example: cytochrome oxidase staining in human visual cortex

Connections: white matter bundles

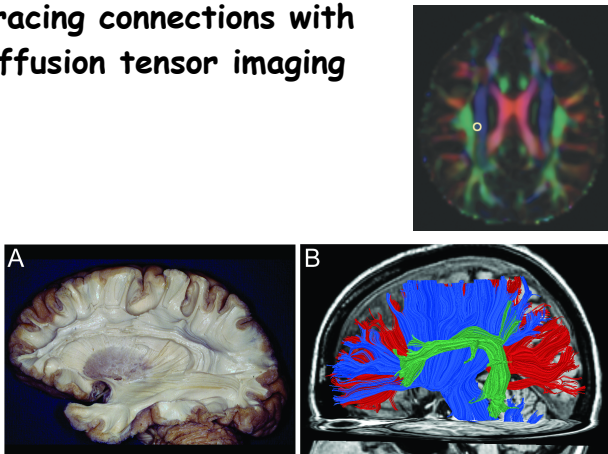
Superior longitudinal (arcuate): connects language centers (Broca's, Wernicke's).

Superior occipitofrontal: dorsal (where) visual pathway.

Inferior occipitofrontal: ventral (what) visual pathway.

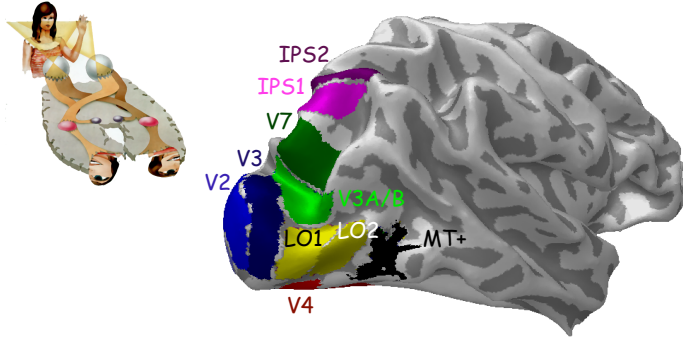


Tracing connections with diffusion tensor imaging



Ben-Shachar, Dougherty, Wandell (2007)

Topography



Each visual brain area contains a map of the visual world and performs a different function.

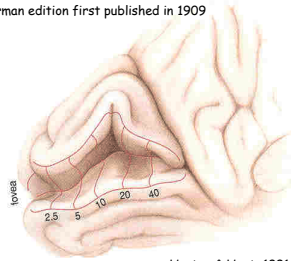
Retinotopy (human V1)



Tatsuji Inouye
(1880-1976)

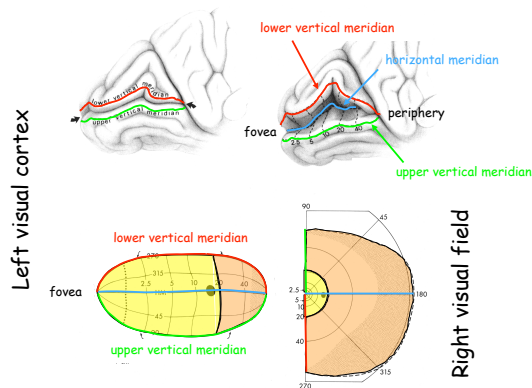
Visual Disturbances Following Gunshot Wounds of the Cortical Visual Area

Based on observations of the wounded in
the recent Japanese wars
German edition first published in 1909



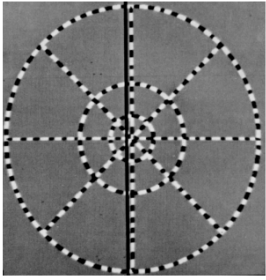
Horton & Hoyt, 1991

Topography (human V1)

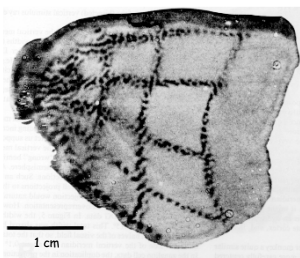


Retinotopy (monkey V1)

stimulus



flattened left hemisphere

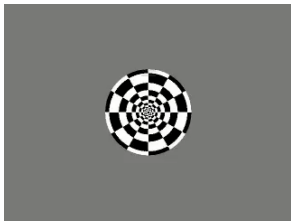


2-deoxyglucose

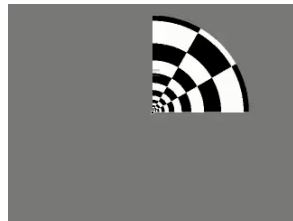
Tootell, Silverman, Switkes, & DeValois (1982)

Measuring retinotopic maps

Radial component

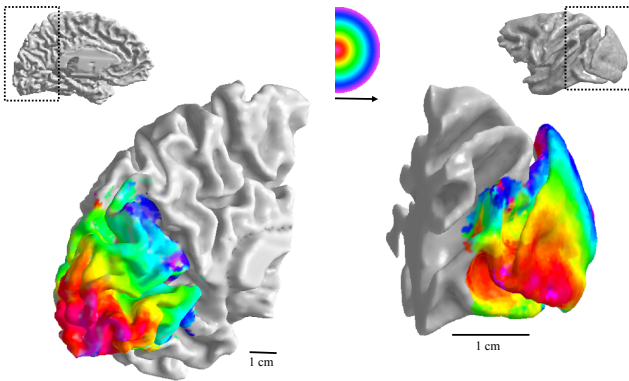


Angular component



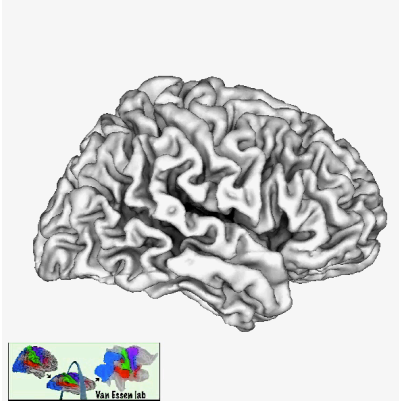
Engel et al (1994)

Retinotopy: radial component

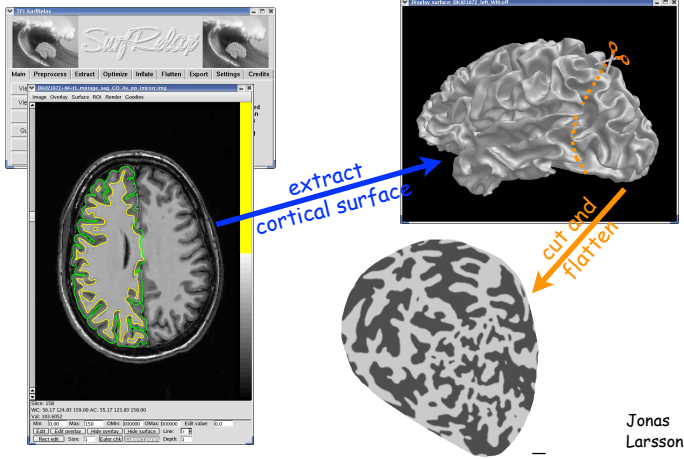


Brewer, Wandell, & Logothetis

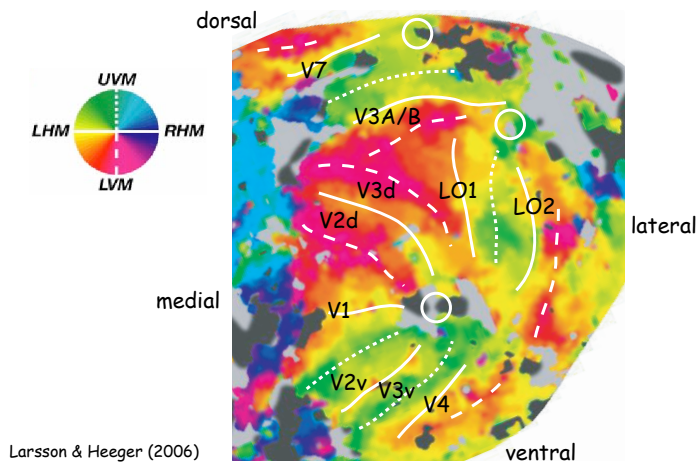
Flattening the human brain



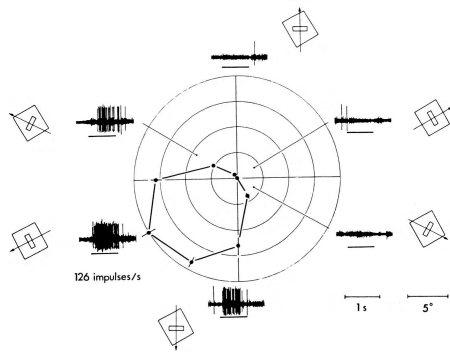
Cortical segmentation & flattening



Retinotopy: angular component

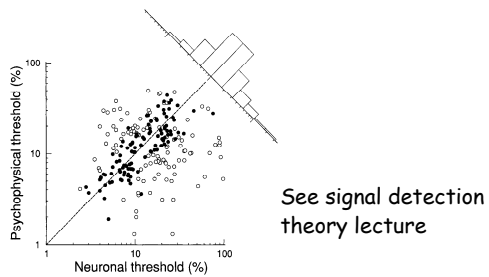


Neurons in MT are selective for motion direction



Maunsell and Van Essen, 1983

MT responses correlated with motion perception



Britten, Shadlen, Newsome & Movshon (1992)

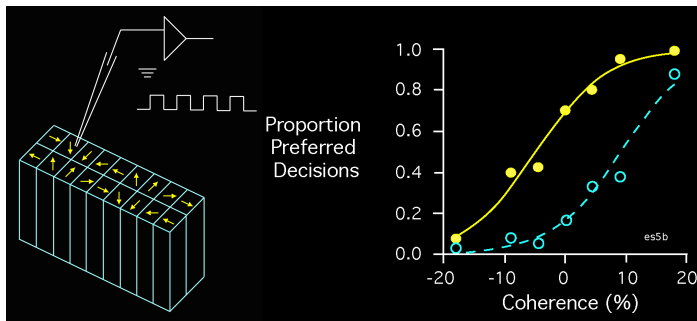
Damage to MT causes deficits in motion perception

(Akinetopsia: motion blindness)



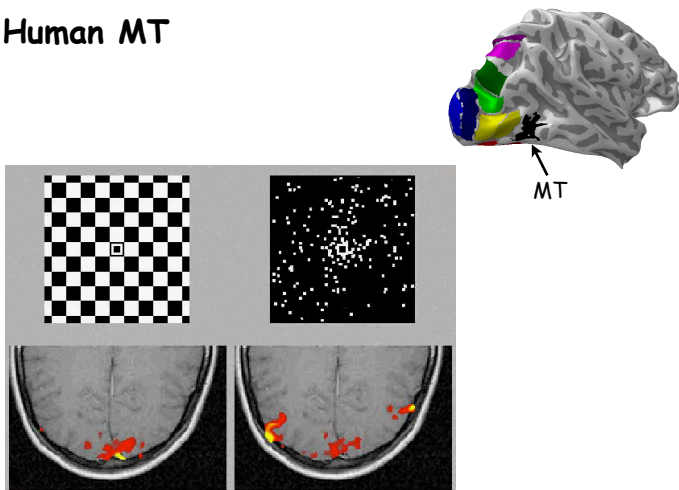
SENSITIVITY TO RANDOM
DOT MOTION STRENGTH

Microstimulation in MT changes motion perception



Salzman, Britten, Newsome (1990)

Human MT

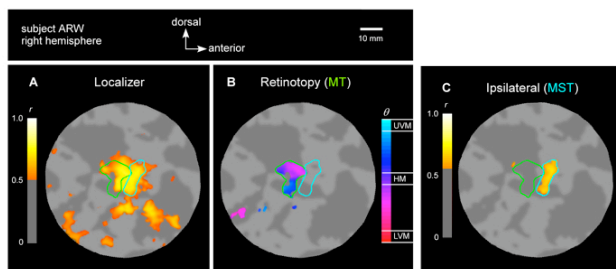
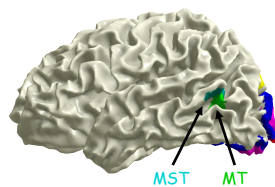


Beware of circular reasoning in brain mapping

1. Hypothesize that there is a particular visual/cognitive process that is localized to a functionally specialized brain area.
2. Design an experiment with two stimuli/tasks, one of which you believe imposes a greater demands on that cognitive process.
3. Run the experiment and find sure enough that there is a brain area that responds more strongly during trials with high demand on that visual/cognitive process than low demand trials.

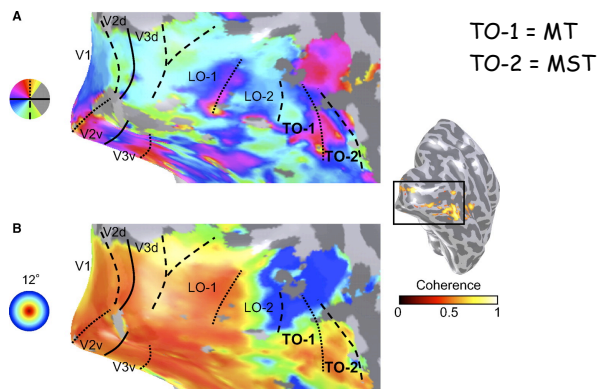
What can you conclude from this?

Topography in human MT



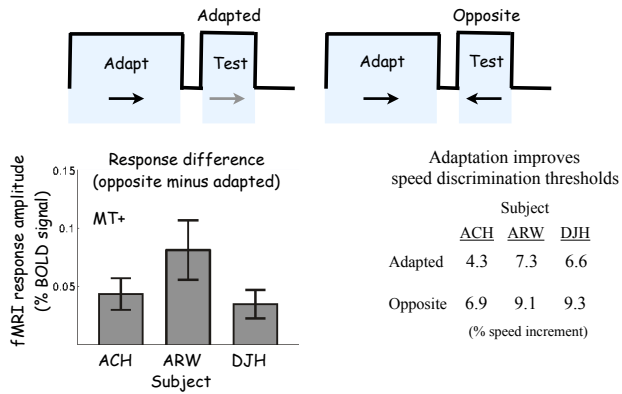
Huk, Dougherty, & Heeger (2002)

Topography in human MT/MST



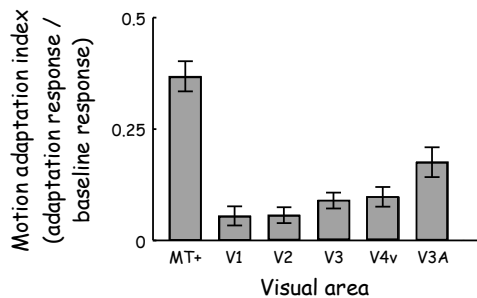
Amano, Dumoulin, & Wandell, J Neurophysiol (2009)

Direction-selective adaptation in human MT



Huk, Ress, & Heeger (2001)

Direction-selectivity across visual areas



Huk, Ress, & Heeger (2001)

Is MT specialized for only visual motion perception?

- Neurons in MT are also selective for binocular disparity.
- Neural responses in MT are also correlated with the perception of depth.
- Motion discrimination performance mostly recovers following carefully circumscribed lesions to MT in monkeys.
- Electrical stimulation in MT causes changes in stereo depth perception.

Even so... **computational theory** quantitatively explains the responses of MT neurons.