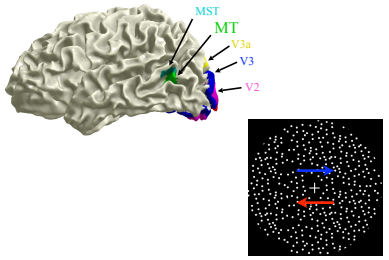
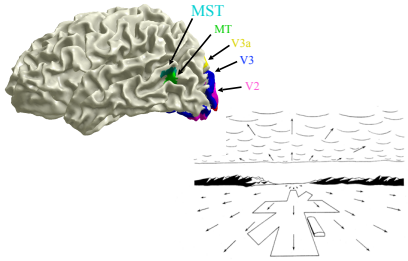
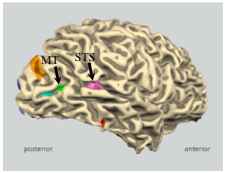
Visual area MT responds to local motion



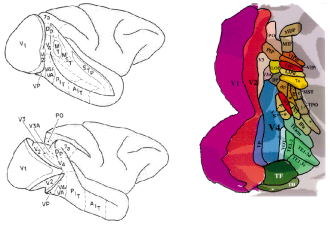
Visual area MST responds to optic flow



Visual area STS responds to biological motion



Macaque visual areas



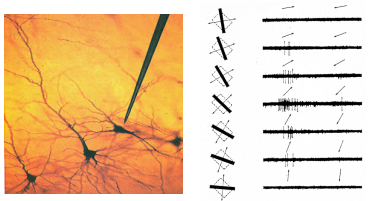
Flattening the brain

What is a visual area?

PhACT:

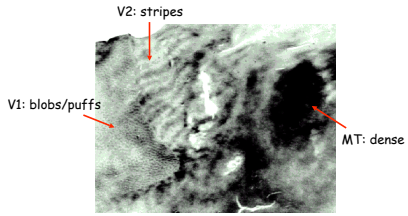
- Physiology
- Architecture
- Connections
- Topography

Physiology



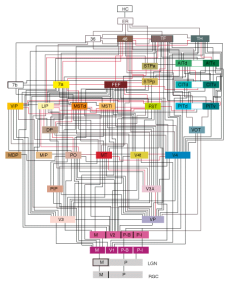
Example: direction selectivity in V1

Architecture



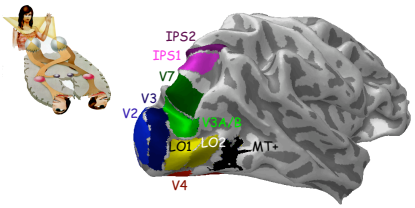
Example: cytochrome oxidase staining in human visual cortex

Connections



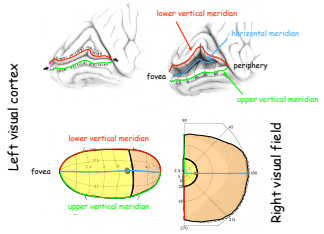
Example: connections in monkey visual cortex

Topography



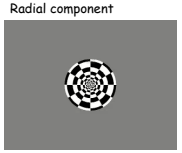
Each visual brain area contains a map of the visual world and performs a different function.

Topography (human V1)

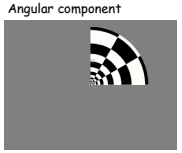


Measuring retinotopic maps

Radial component

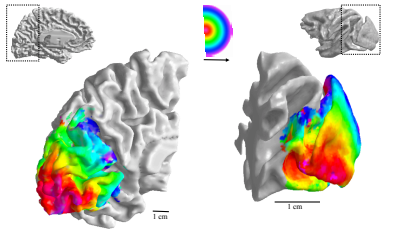


Angular component



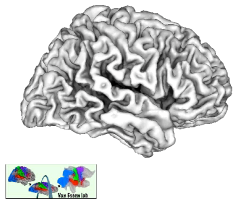
Engel et al (1994)

Retinotopy: radial component

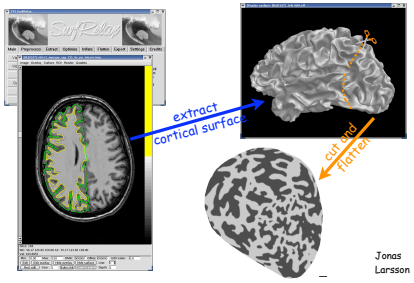


Brewer, Wandell, & Logothetis

Flattening the human brain

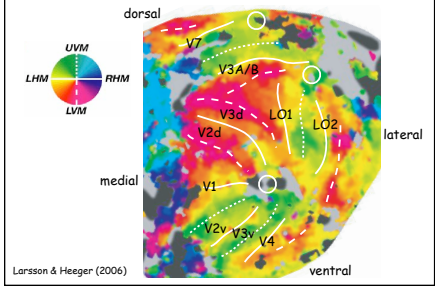


Cortical segmentation & flattening



Jonas
Larsson

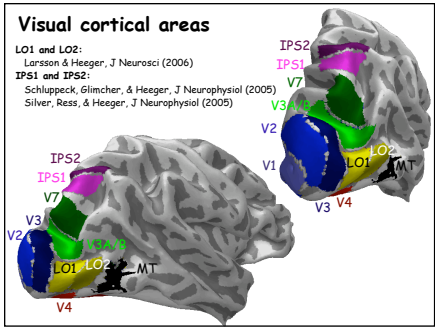
Retinotopy: angular component



Larsson & Heeger (2006)

Visual cortical areas

LO1 and LO2:
Larsson & Heeger, J Neurosci (2006)
IPS1 and IPS2:
Schluppeck, Glimcher, & Heeger, J Neurophysiol (2005)
Silver, Ress, & Heeger, J Neurophysiol (2005)

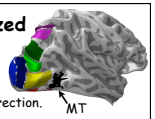


Functional specialization

Match each cortical area to its corresponding function:

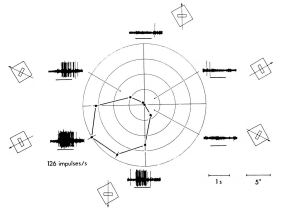
V1	Motion
V2	Stereo
V3	Color
V3A	Texture
V3B	Segmentation, grouping
V4	Recognition
V5	Attention
V7	Working memory
LO1	Mental imagery
IPS1	Decision-making
IPS2	Sensorimotor integration
Etc.	Etc.

Cortical area MT is specialized for visual motion perception



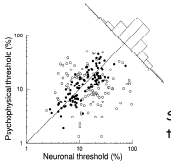
- Neurons in MT are **selective** for motion direction.
- Neural responses in MT are **correlated** with the perception of motion.
- Damage to MT or temporary inactivation **causes** deficits in visual motion perception.
- Electrical stimulation in MT **causes** changes in visual motion perception.
- Computational **theory** quantitatively explains both the responses of MT neurons and the perception of visual motion.
- Well-defined **pathway** of brain areas (cascade of neural computations) underlying motion specialization in MT.

Neurons in MT are selective for motion direction



Maunsell and Van Essen, 1983

MT responses correlated with motion perception



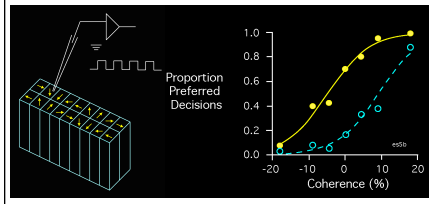
See signal detection theory lecture

Britten, Shadlen, Newsome & Movshon (1992)

Damage to MT causes deficits in motion perception

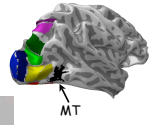
(Akinetopsia: motion blindness)

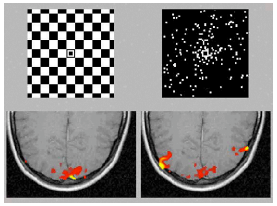
Microstimulation in MT changes motion perception



Salzman, Britten, Newsome (1990)

Human MT



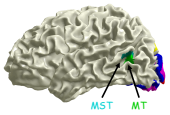


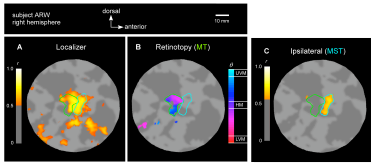
Beware of circular reasoning in brain mapping

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 then low demand trials.

What can you conclude from this?

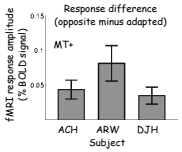
Topography in human MT





Huk, Dougherty, & Heeger (2002)

Direction-selective adaptation in human MT



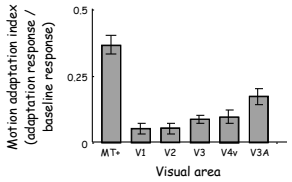
Adaptation improves speed discrimination thresholds

Subject	ACH	ARW	DJH
Adapted	4.3	7.3	6.6
Opposite	6.9	9.1	9.3

(% speed increment)

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.