Kognitív idegtudomány

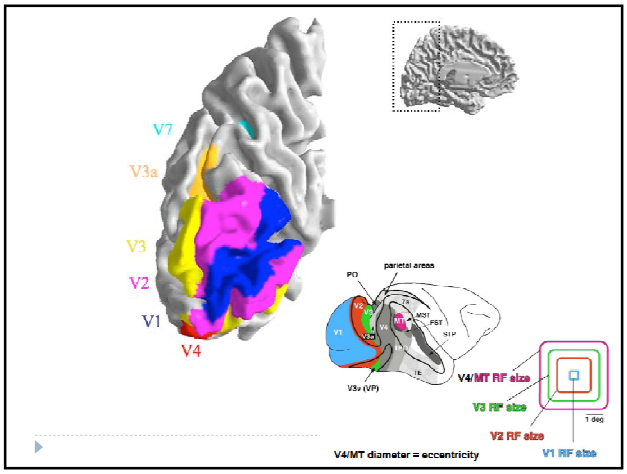
Introduction to neurosciences for MAs.

Látás 5.

Ventral and Dorsal pathways

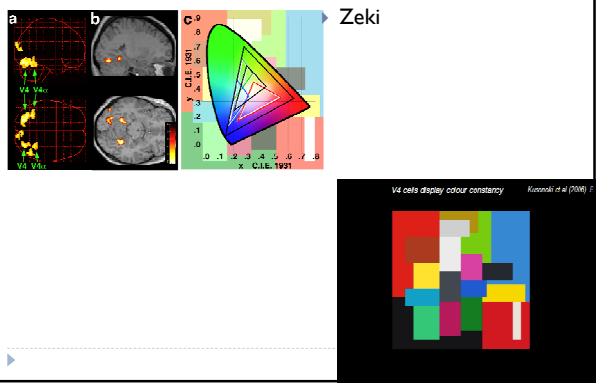
Ventral pathway

V4



V4

- Zeki

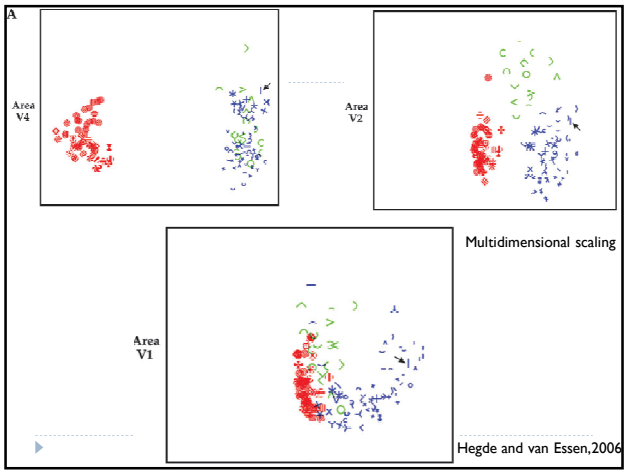


Area V4

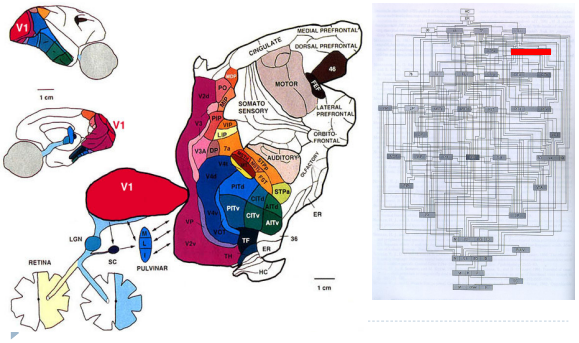
- Colour recognition
- Individual neurones in V4 respond to a variety of wavelengths
- Also some coding for orientation (may be colour specific)

- PET studies show
  - more activation in V4 to coloured pattern than to grey tone
  - no difference if coloured pattern is stationary or moving

- Achromatopsia
  - damage to V4 causes an inability to perceive colour
  - patients "see the world in black and white"
  - also an inability to imagine or remember colour

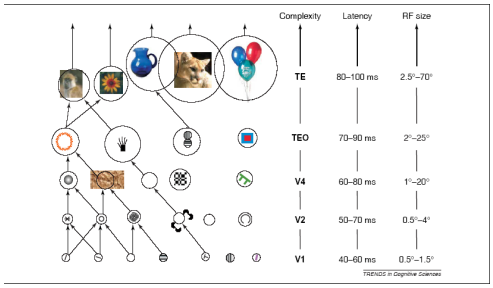


The inferotemporal cortex



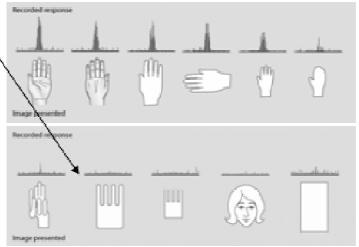
Computational Problems in Object Recognition

- Hierarchical coding hypothesis
  - Object defined by *Gnostic* (or grandmother) cell? single neuron that represents "granny" activated by outputs from increasingly more complex detectors. NO!



Ventral "What" pathway characteristics

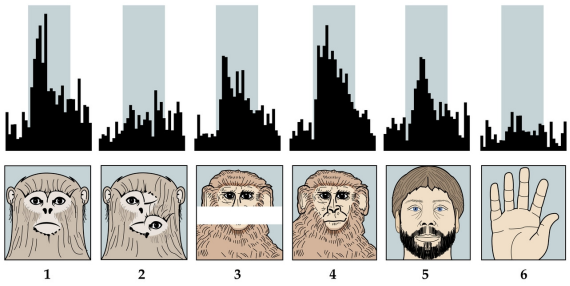
- Complex response profile
  - Dissimilar to V1
  - Not simple orientation
  - Selectivity
    - Hands, faces etc



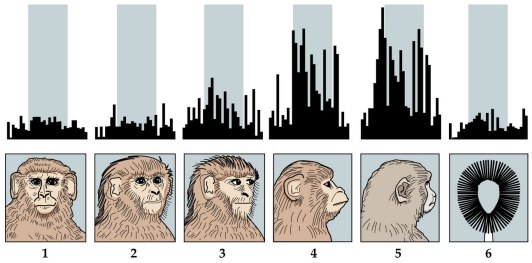
Complex shapes

Tamura and Tanaka, 2001

Face Selective Cells

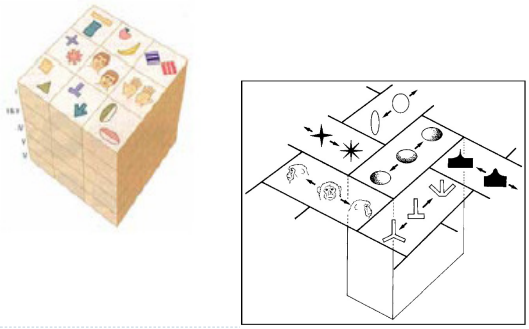


Face sensitive cells are often view dependent



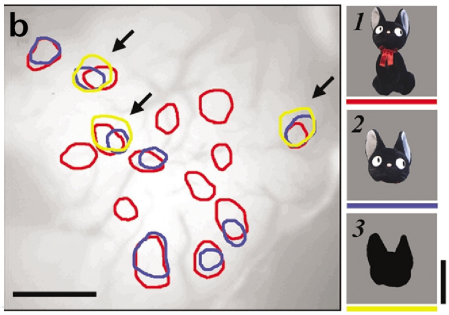
Tanaka

-clustering of similar cells
-Columnar organization



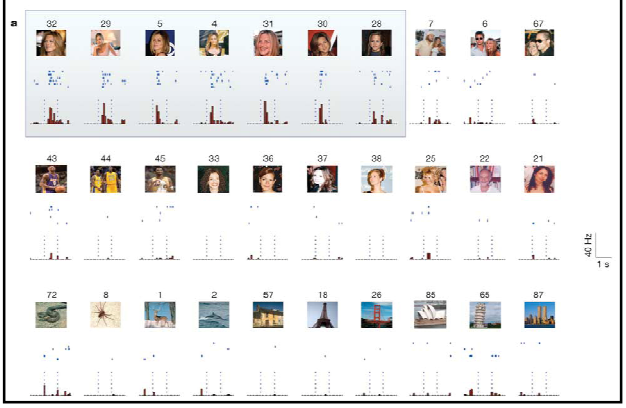
Tsunoda et al, 2001

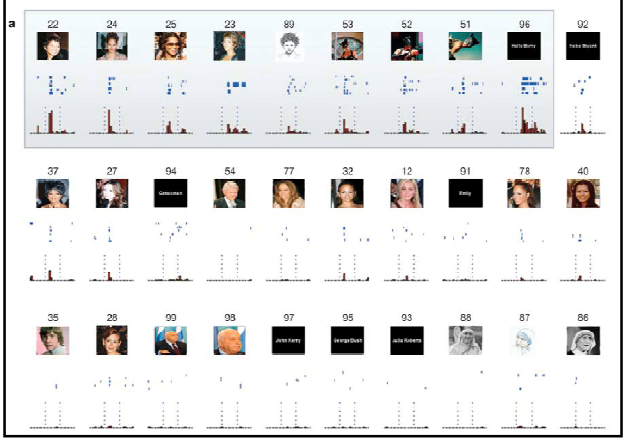
-Different, but related features activate overlapping columns



-Coding

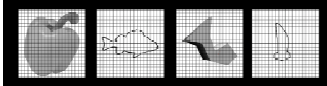
Quiroga et al, 2005





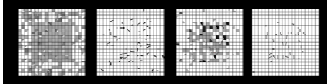
fMRI studies of Object Recognition

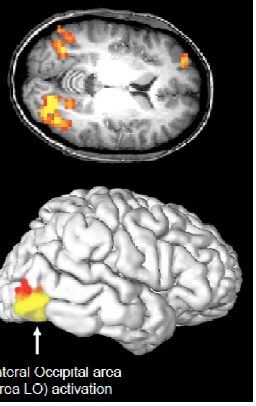
Intact Objects

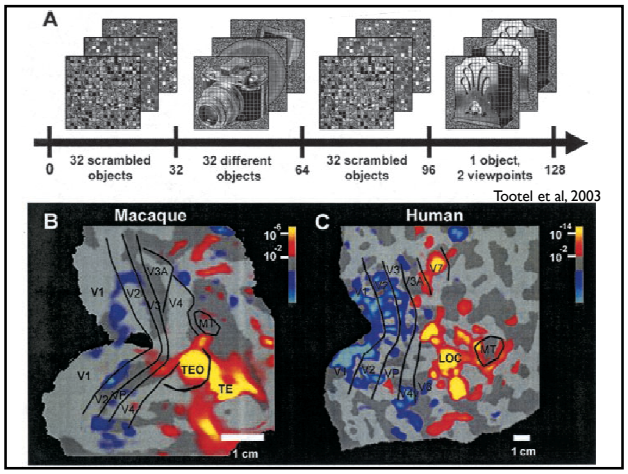


minus

Scrambled Objects







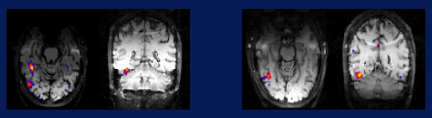
Human ventral areas

- LO- Lateral occipital cortex
- FFA- fusiform face area
- OFA- occipital face area
- EBA – extrastriate body area
- FBA- fusiform body area
- PPA- parahippocampal place area

FFA - human

The Fusiform Face Area (FFA)

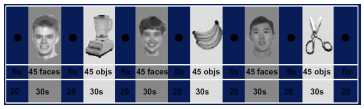
Kanwisher, McDermott, & Chun (1997)



- 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.

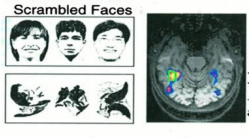
fMRI: FFA- fusiform face area

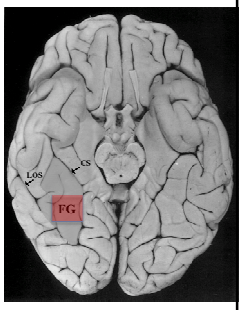
We contrast the activations obtained during presentation of faces with that of other Objects or scrambled faces



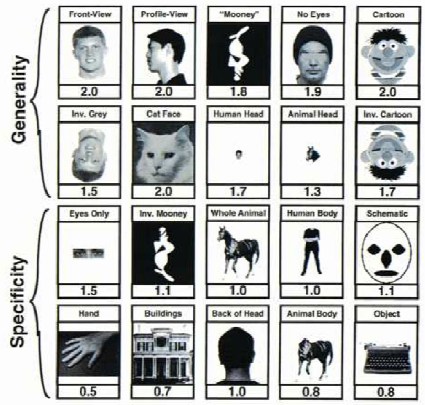
- Nancy Kanwisher (MIT)

3b. Intact Faces > Scrambled Faces



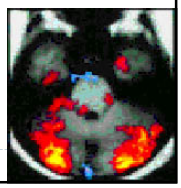


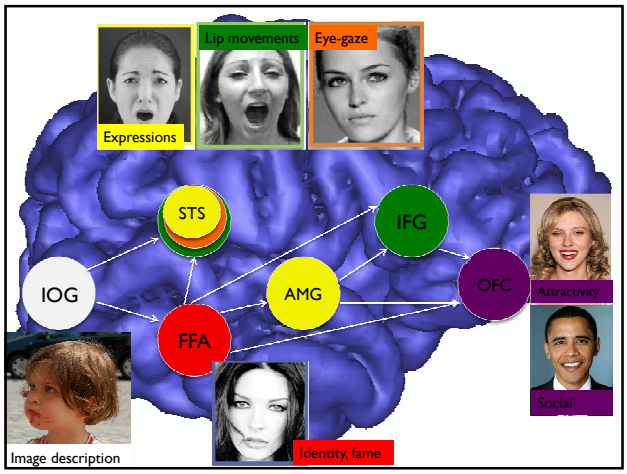
Fusiform Face Area



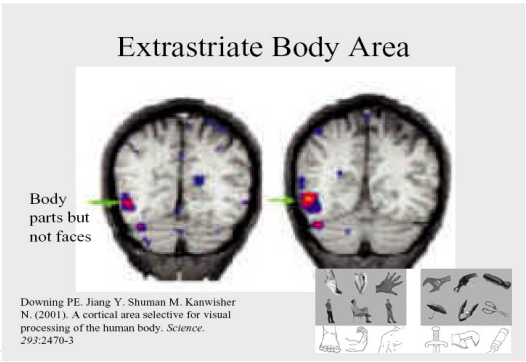
What activates the FFA?

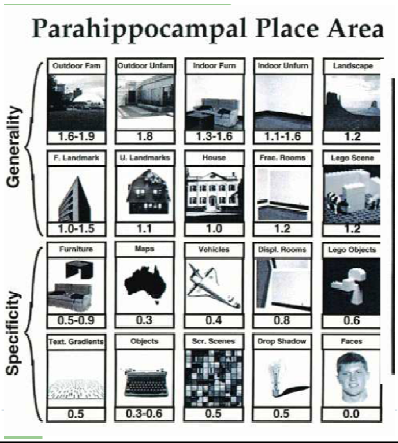
- Kanwisher & her colleagues have probed the type of stimuli that activate this region
- Strong response: Frontal shots, profiles, cartoon faces, inverted faces?!, inverted cartoon faces, cat faces, faces with no eyes, & eyes alone.
- Weak response: Schematic faces, animal bodies, houses, back of head.
- FFA appears broadly tuned to face like stimuli

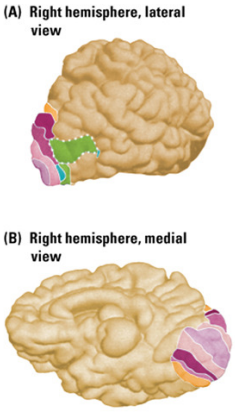


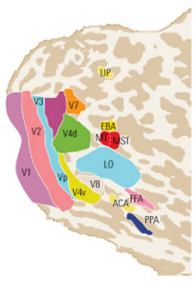


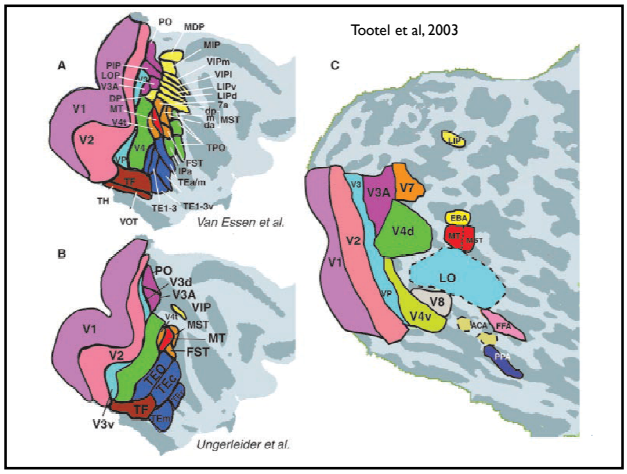
EBA- human



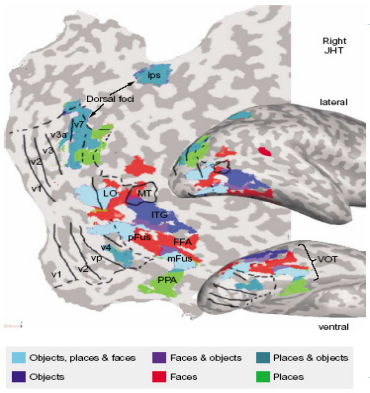






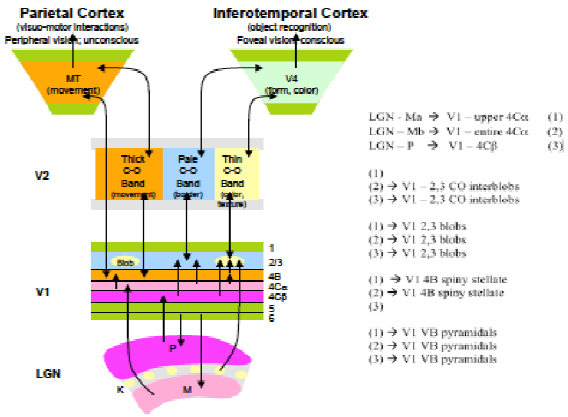


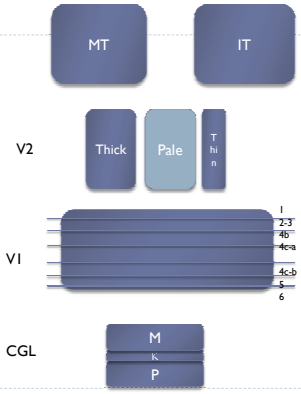
LOC-



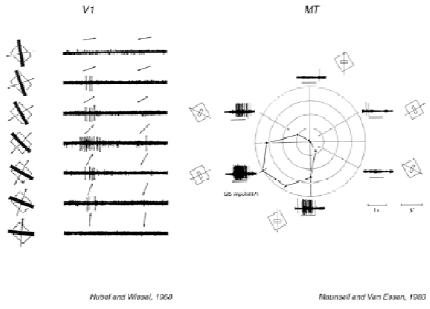
Dorsal pathway

MT





Motion selectivity in V1 and MT

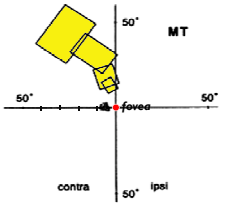


Receptive Fields in Area MT

MT neurons have medium-sized receptive fields (5-10 fold larger than in V1) which increase with eccentricity.

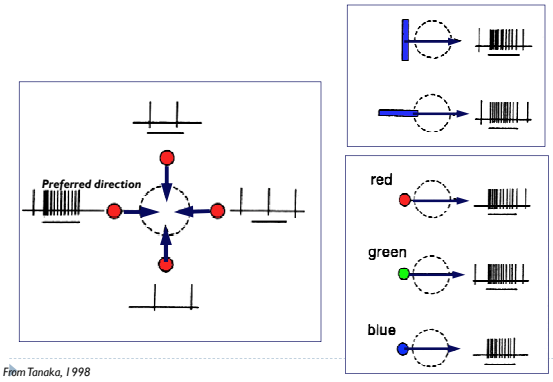
Contains a coarse retinotopic map of the contralateral visual field.

Most MT neurons are not selective for form but are tuned to:
- direction of motion
- speed of motion
- binocular disparity (depth)



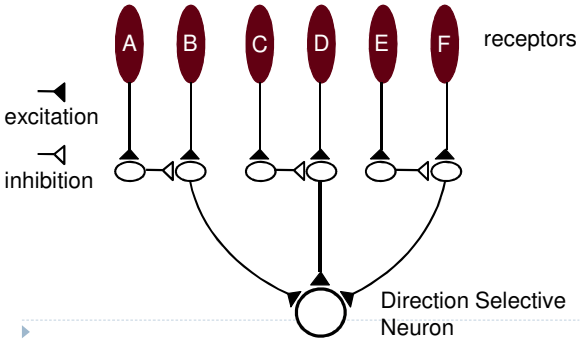
from Tanaka, 1998

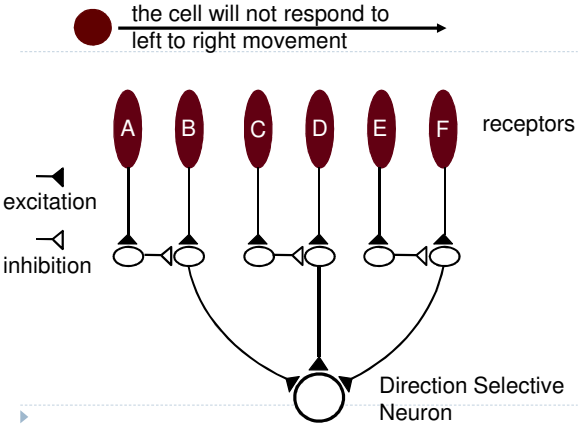
MT Neurons Are Selective for the Direction of Motion but not Color and Orientation

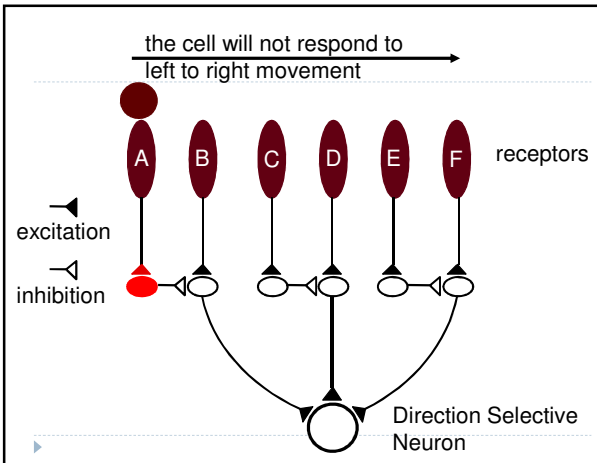


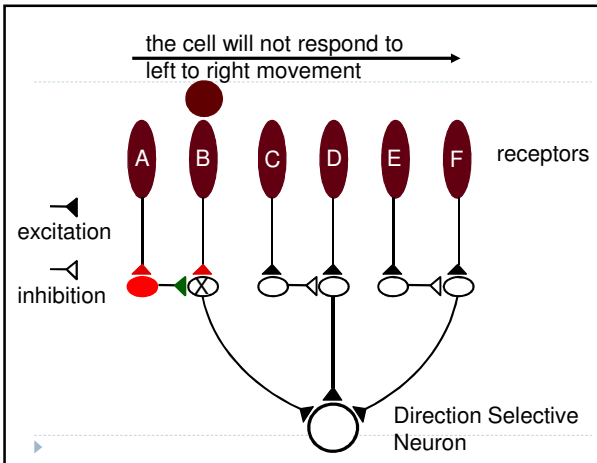
From Tanaka, 1998

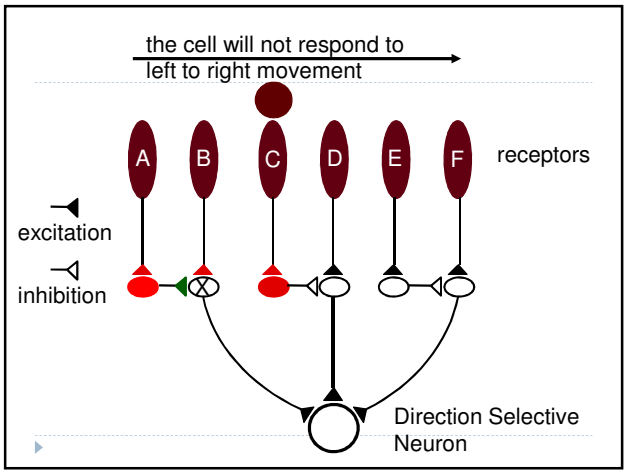
A neural model for motion detection

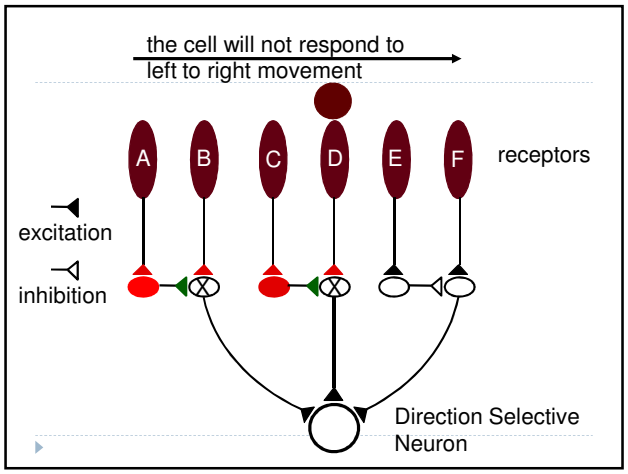









the cell will not respond to
left to right movement
A
B
C
D
E
F
receptors
excitation
inhibition
Direction Selective
Neuron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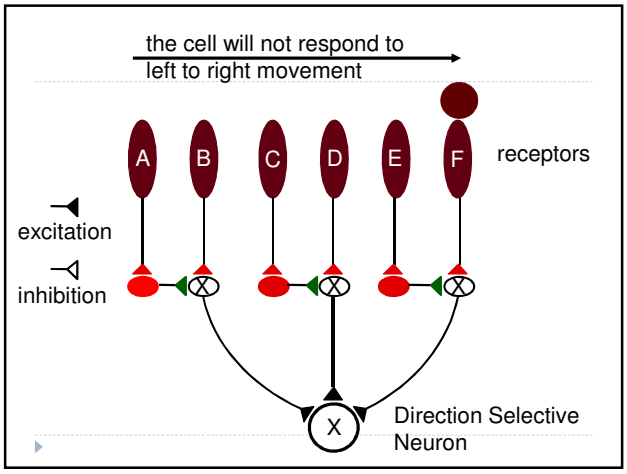
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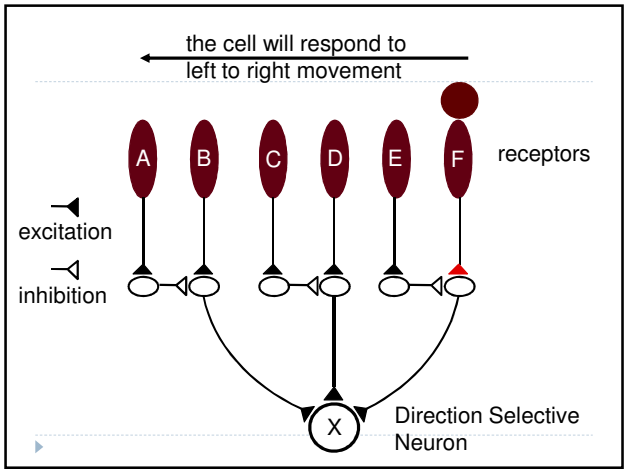
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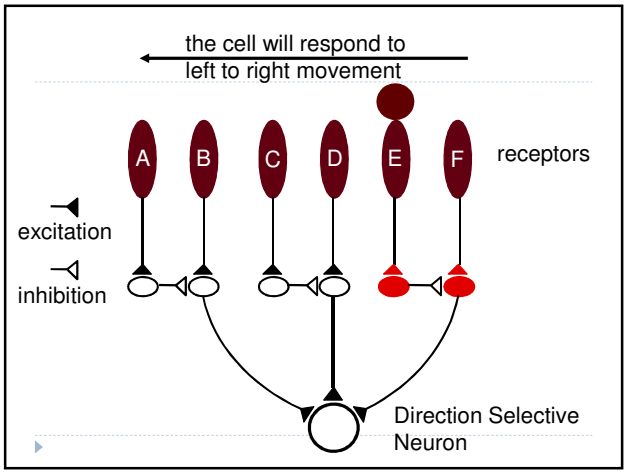
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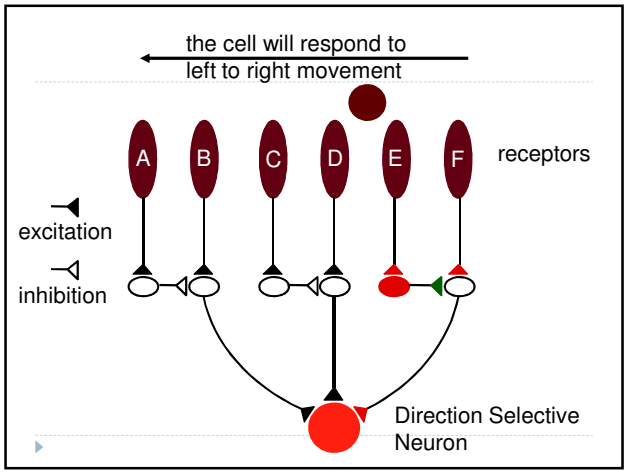
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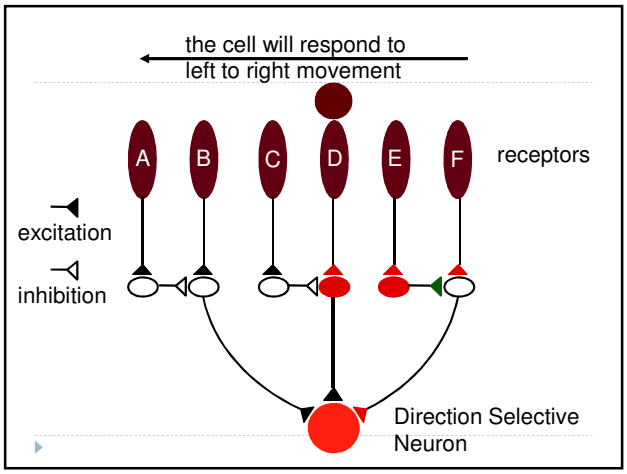
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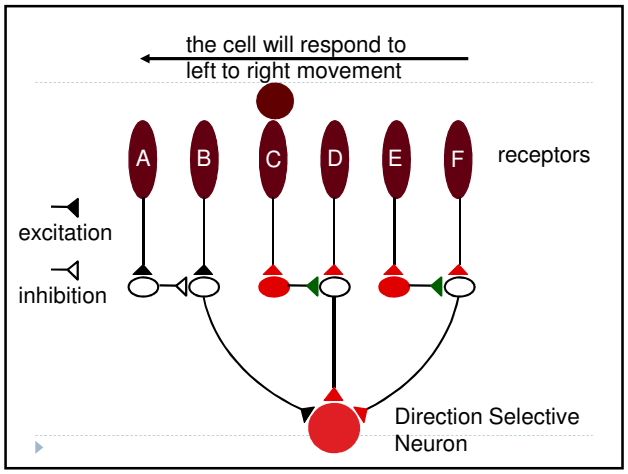
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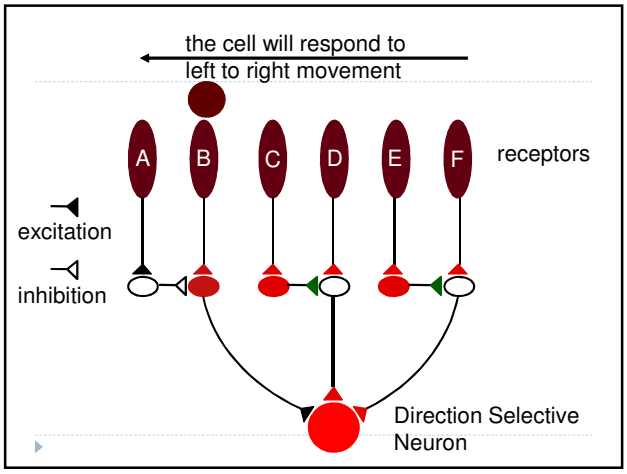
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left to right movement
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B
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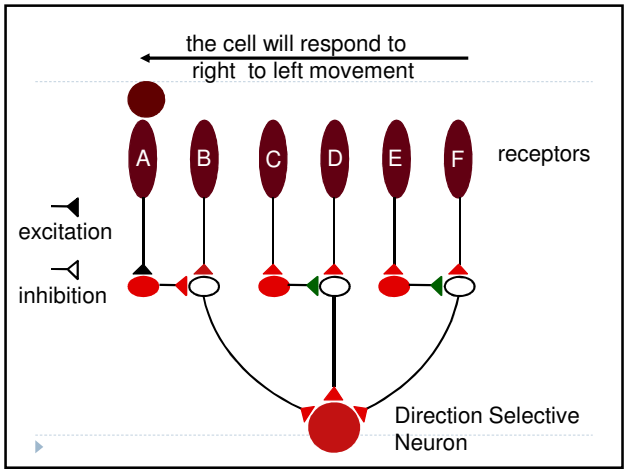
D
E
F
receptors
excitation
inhibition
Direction Selective
Neuron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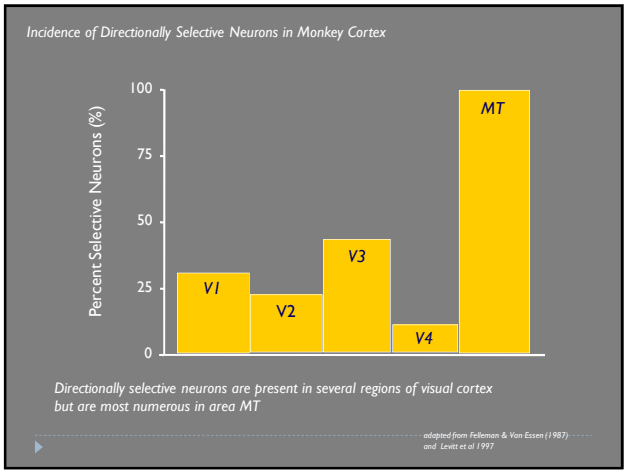
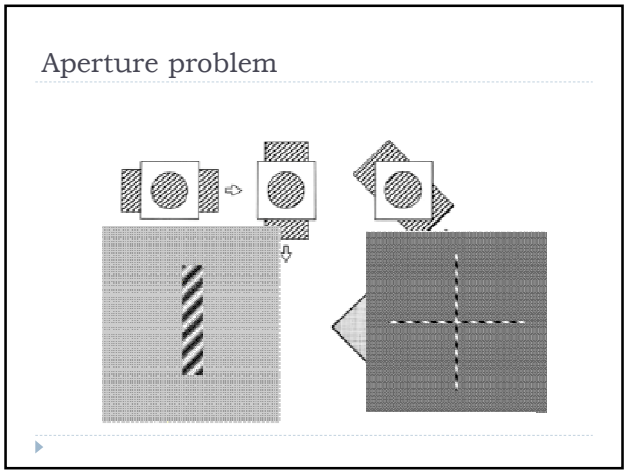
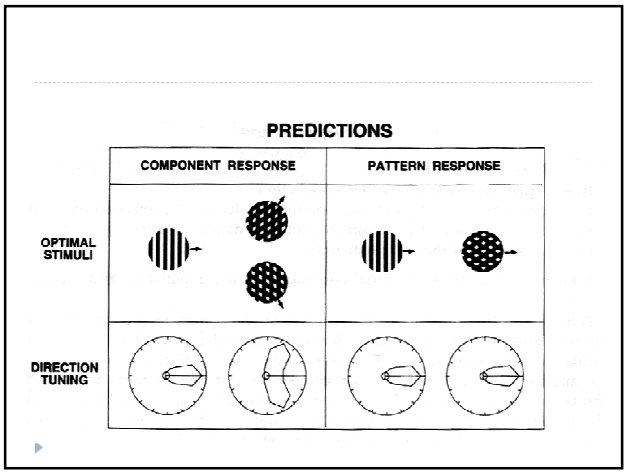
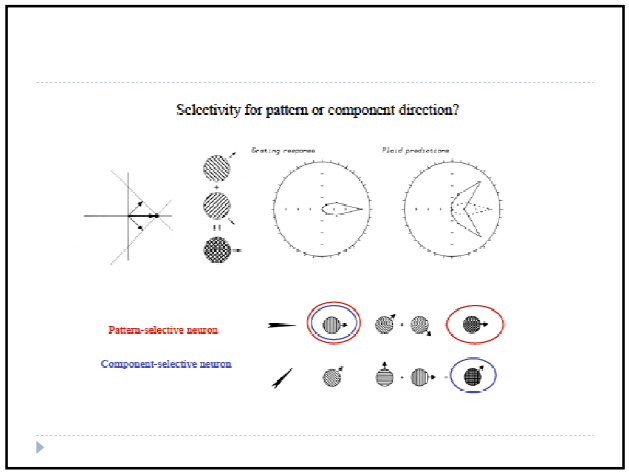
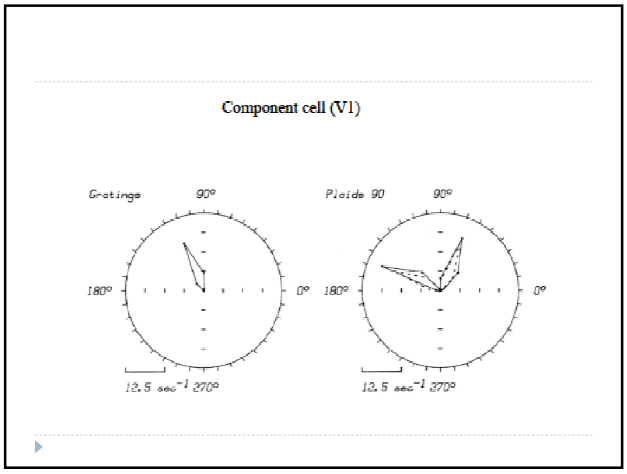
B
C
D
E
F
receptors
excitation
inhibition
Direction Selective
Neuron

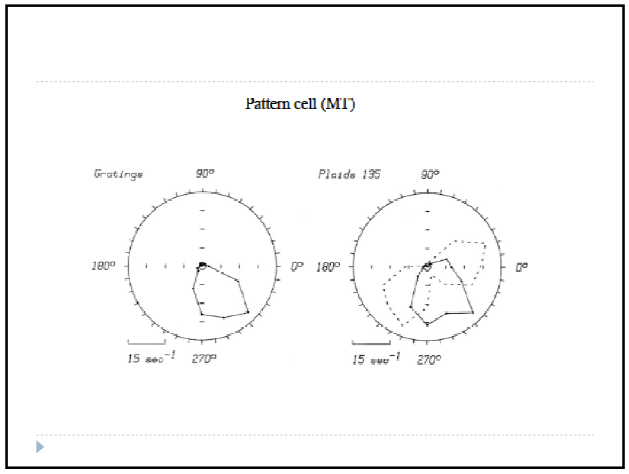

Incidence of Directionally Selective Neurons in Monkey Cortex
Percent Selective Neurons (%)
100
75
50
25
0
V1
V2
V3
V4
MT
Directionally selective neurons are present in several regions of visual cortex
but are most numerous in area MT
adapted from Felleman & Van Essen (1987)
and Levitt et al 1997

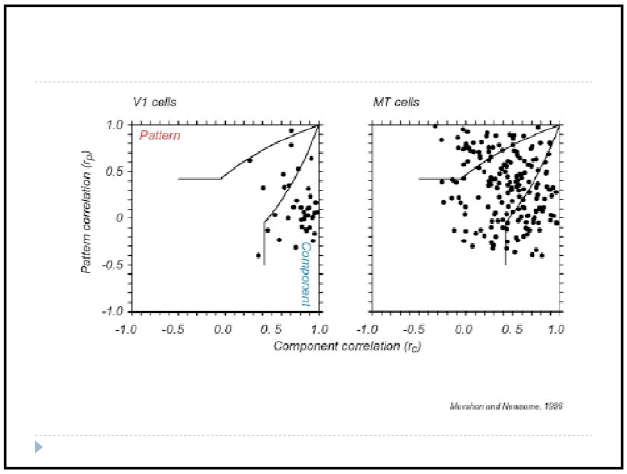

Aperture problem



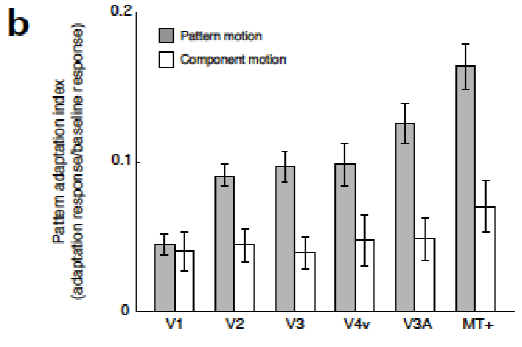




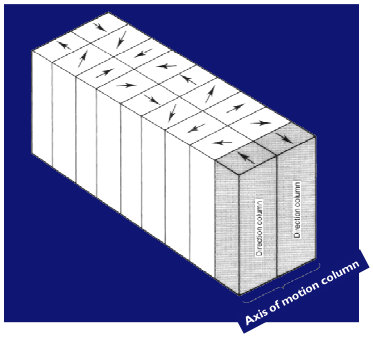




Huk and Heeger, 2006



MT is columnar

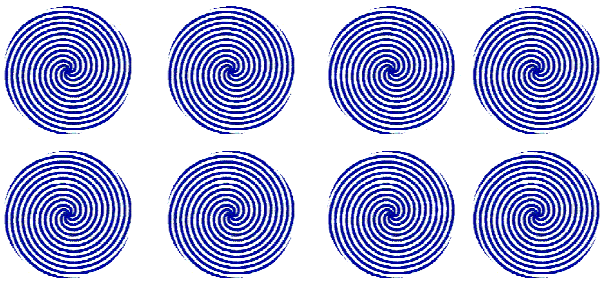


from Albright et al 1984

Motion aftereffect

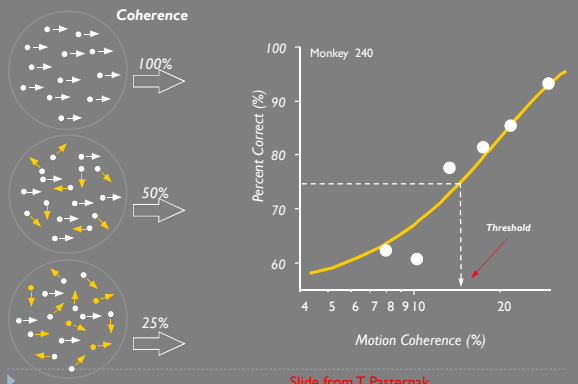
- http://www.lifesci.sussex.ac.uk/home/George_Mather/Motion/MAE.HTML

Motion aftereffect



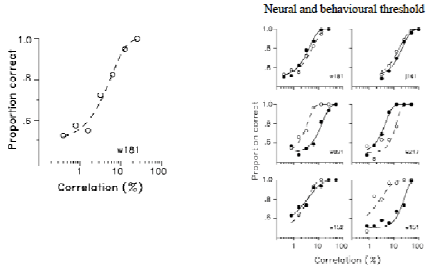
Aristotheles b(cca. 350 BC) *Parva Naturalia.*
Addams, R. (1834).
An account of a peculiar optical phenomenon seen after having looked at a moving body. *London and Edinburgh Philosophical Magazine and Journal of Science, 5,* 373–374

Measuring Complex Motion Perception



Slide from T. Pasternak

- Behaviour
- Neural response

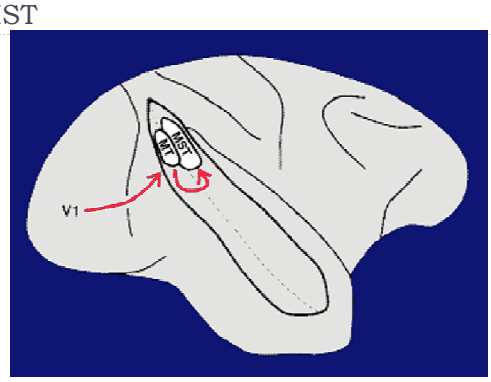


Slide from T. Pasternak

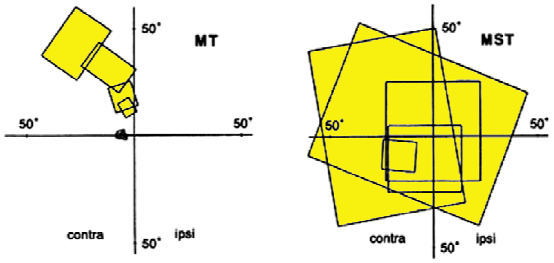
Properties of MT neurons

- *MT contains representation of the contralateral receptive field*
  - *receptive fields are localized and increase with eccentricity*
- *Most MT neurons are selective for direction & speed of stimulus motion*
- *Directionally selective neurons are organized in columns*
- *Responses of MT neurons are strongly modulated by stimuli placed in the surround (relative motion)*
- MT neurons respond to relatively low spatial frequency, have high contrast sensitivity and are broadly tuned to temporal frequency
- Spatial limits of MT receptive fields increase with eccentricity
- MT neurons are capable of integrating local motion vectors
- Many properties of MT neurons parallel perceptual phenomena
- Signals provided by MT neurons are used in the performance of motion tasks

MST



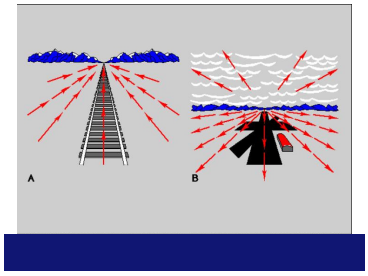
Receptive Fields in Area MST



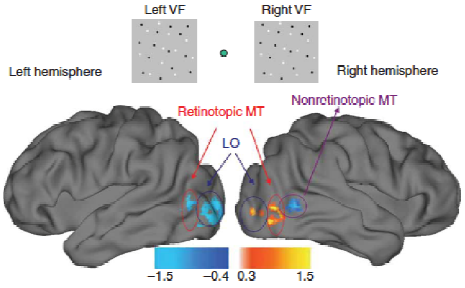
Receptive fields in MST are larger than those in MT and include the fovea

Optic flow

- MST is sensitive to optic flow



Human MT (hMT+)



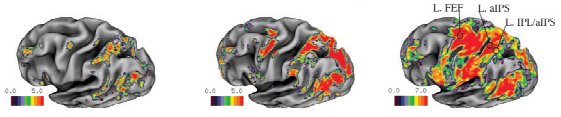
dAvossa et al, 2007

Akinetopsia and prosopagnosia

Akinetopsia J. Zihl. (LMU)
prosopagnosia

Posterior parietal cortex

- Attention
- Coordinate transformation
- Multimodal
- Intentions



G. Attention + detection **H.** Saccade + detection **I.** Pointing + detection

Astafiev et al, 2003

Did you want to study vision?