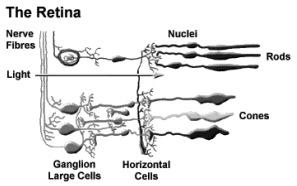
Photoreceptors

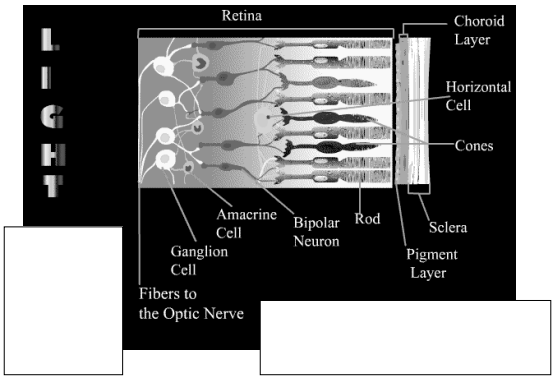
Rods

- 120 000 000
- Dim light
- Prefer wavelength of 505 nm
- Monochromatic
- Mainly in periphery of the eye

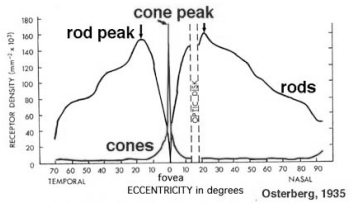
Cones

- 6 000 000
- More light
- Different spectral sensitivities
- Long-wave receptors (558 nm)
- Medium-wave receptors (531 nm)
- Short-wave receptors (419 nm)

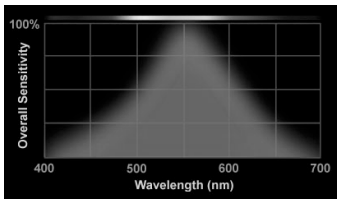




Distribution of rods and cones across the retina



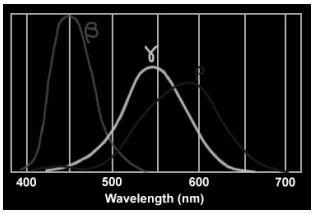
Rod sensitivity



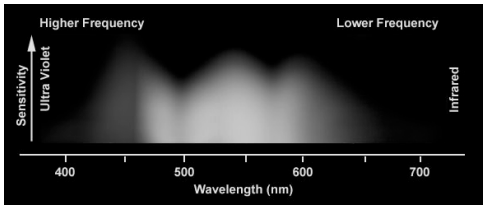
Prefer wavelength at around 505 nm

Cones sensitivity

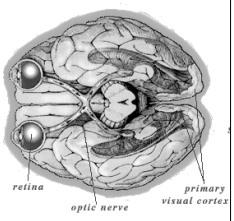
Different spectral sensitivities
Long-wave receptors (558 nm)
Medium-wave receptors (531 nm)
Short-wave receptors (419 nm)



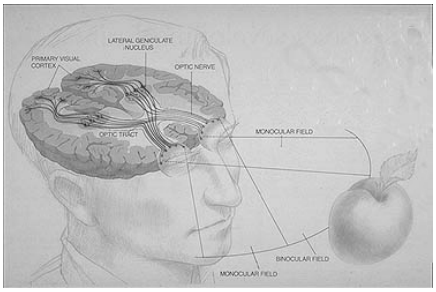
Cones sensitivity



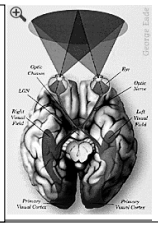
Visual Pathway

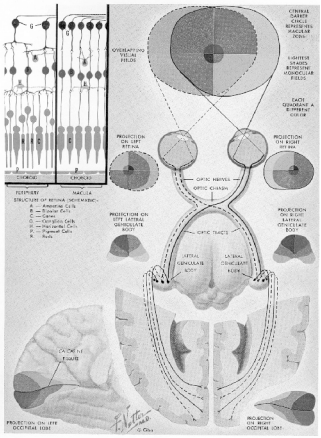


Visual Pathway

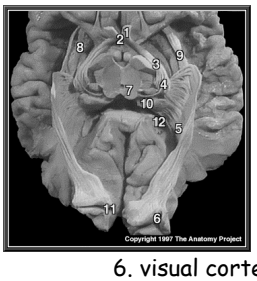


Visual Pathway

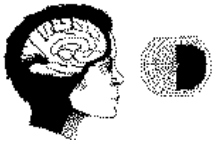


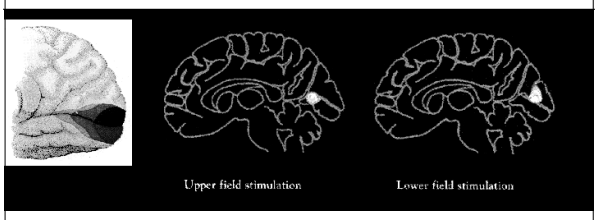


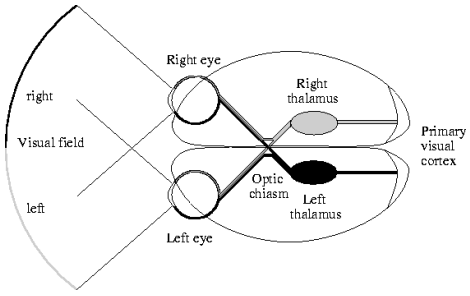
Visual Pathway



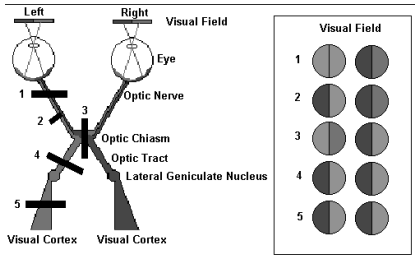
1. optic nerve
2. optic chiasma
3. optic tract
4. thalamus (LGN)
5. optic radiation
6. visual cortex of occipital lobe







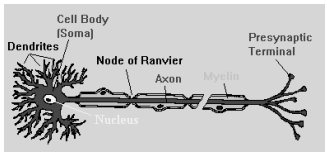
http://www2.prestel.co.uk/academy/pathway.htm

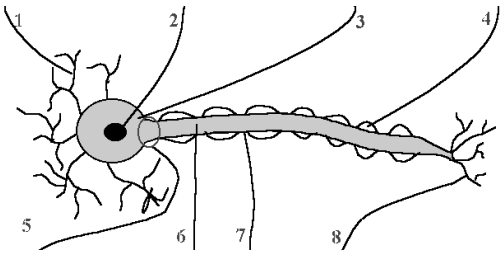


- great web page where you can simulate lesions along the pathway and see their effect on the visual field

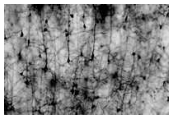
Neurons

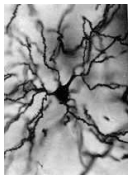
- Structure
- Electrical activity
- Action potential (nerve impulse)
  - EPSP:
    Excitatory post-synaptic potential)
  - IPSP:
    Inhibitory post synaptic potential)
- Neural circuits



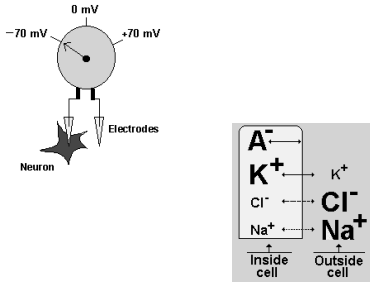


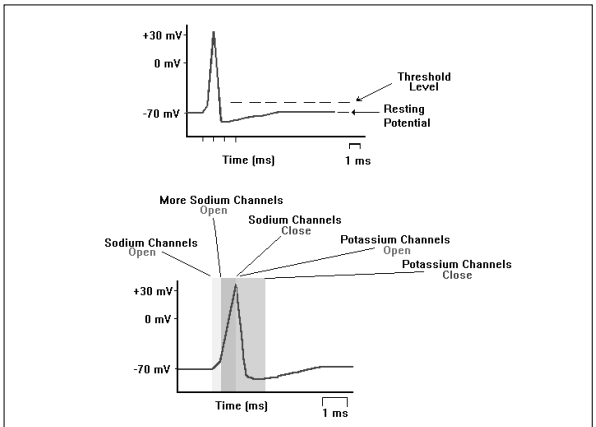
1. **Dendrite**
2. **Nucleus**
3. **Soma**
4. **Myelin**
5. **Axon Hillock**
6. **Axon**
7. **Node of Ranvier**
8. **Axon Terminal**

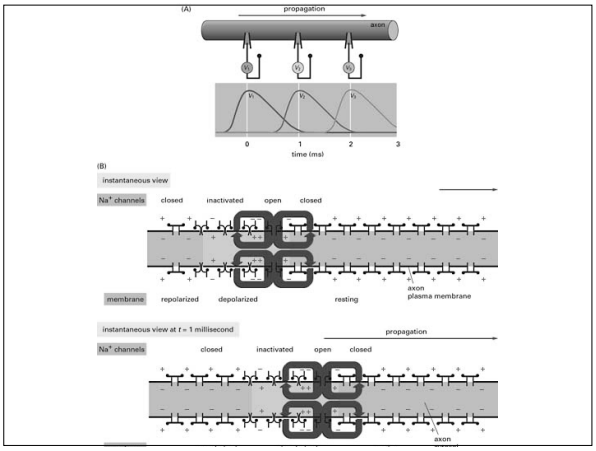


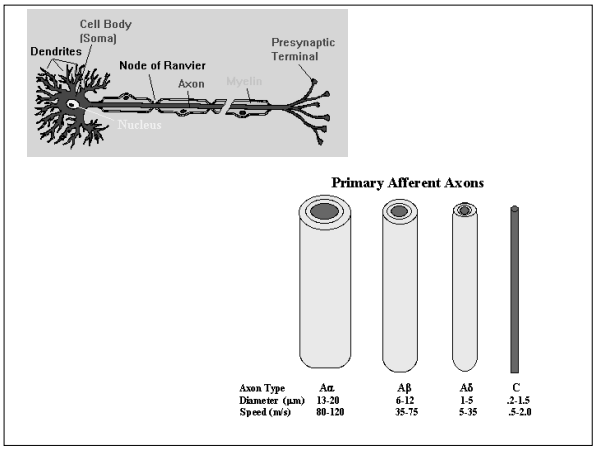


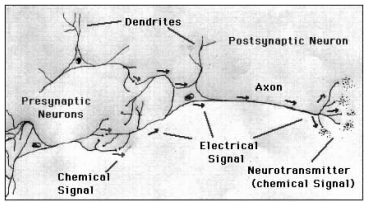
Neuron located in the cerebral cortex of the hamster. Golgi stain. (Image courtesy of Dr. James Crandall, Eunice Kennedy Shriver Center)

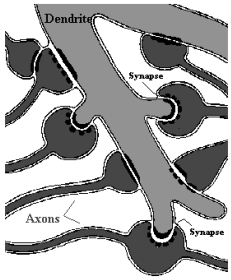

0 mV
−70 mV
+70 mV
Electrodes
Neuron
A⁻
K⁺
Cl⁻
Na⁺
K⁺
Cl⁻
Na⁺
Inside cell
Outside cell


+30 mV
0 mV
-70 mV
Threshold Level
Resting Potential
Time (ms)
1 ms
More Sodium Channels Open
Sodium Channels Close
Sodium Channels Open
Potassium Channels Open
Potassium Channels Close
+30 mV
0 mV
-70 mV
Time (ms)
1 ms


(A)
propagation
axon
time (ms)
(B)
instantaneous view
Na+ channels
closed
inactivated
open
closed
membrane
repolarized
depolarized
resting
axon plasma membrane
instantaneous view at t = 1 millisecond
propagation
Na+ channels
closed
inactivated
open
closed
axon


Cell Body (Soma)
Dendrites
Node of Ranvier
Axon
Myelin
Presynaptic Terminal
Nucleus
Primary Afferent Axons
Axon Type Aα Aβ Aδ C
Diameter (μm) 13-20 6-12 1-5 .2-1.5
Speed (m/s) 80-120 35-75 5-35 .5-2.0





Excitatory Post-Synaptic Potential

EPSP

Depolarization of the post-synaptic membrane

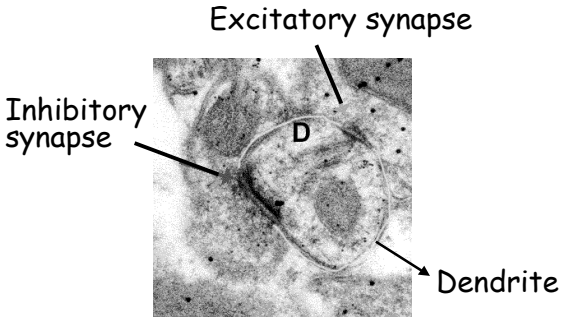
Increase the probability of nerve firing

Inhibitory Post-Synaptic Potential

IPSP

Hyperpolarization of the post-synaptic membrane

Decrease the probability of nerve firing



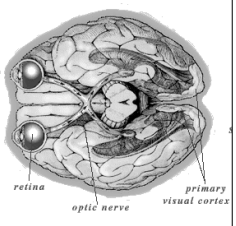
VISUAL PATHWAYS

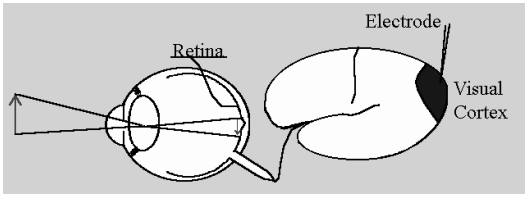
Hubel and Wiesel:
****Receptive fields
- Retina: ganglion cells
- Lateral Geniculate Nucleus
- Visual cortex

Receptive fields

The regions of receptors on the retina which when stimulated make a neuron fires

Visual Pathway

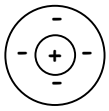




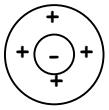
Receptive fields in the Retina and Lateral Geniculate Nucleus (LGN)

Center-Surround or concentric cells

Center-ON
Surround-OFF

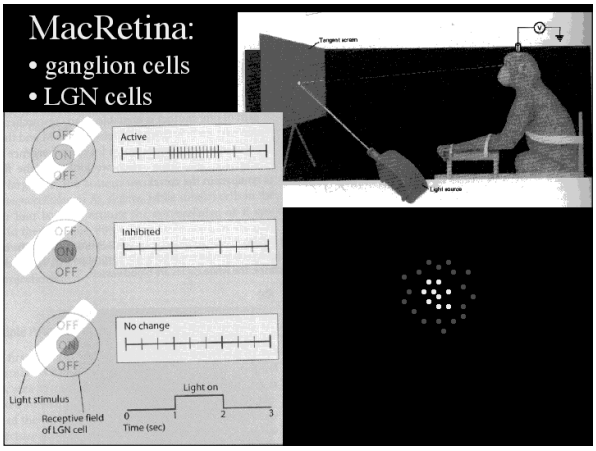


Center-OFF
Surround-ON



MacRetina:

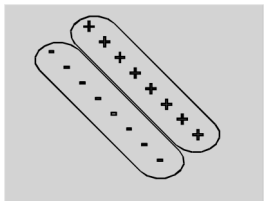
- ganglion cells
- LGN cells

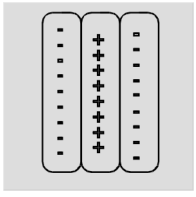


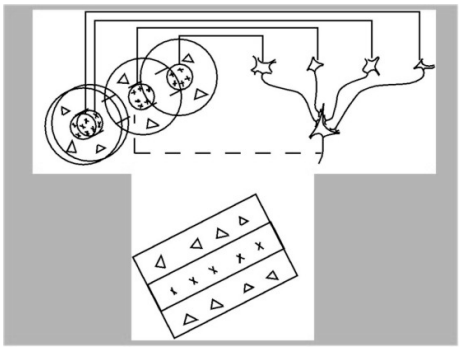
Receptive fields in the first visual area: V1, Striate Cortex, Area 17

Simple cells

Orientation selective
(Linear)

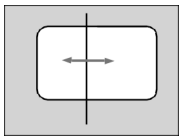






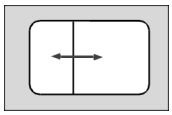
Receptive fields in the first visual area:
V1, Striate Cortex, Area 17

Complex cells



Orientation selective
Motion selective
Not position

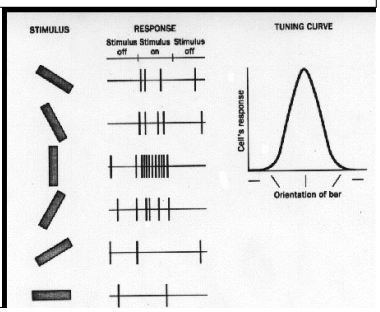
Hypercomplex cells

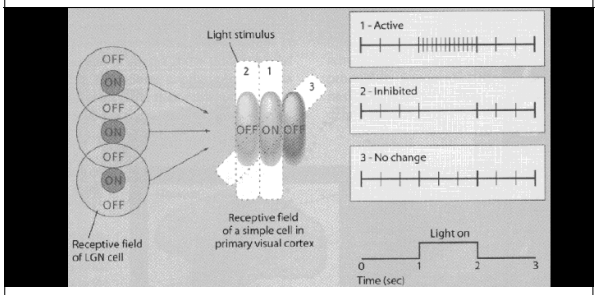


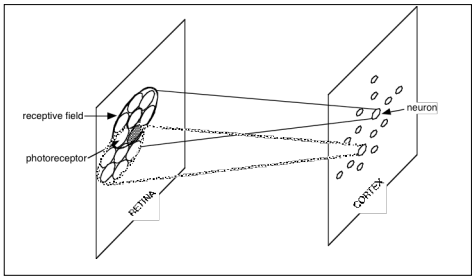
END STOPPED
Orientation selective
Motion selective
Not position

Orientation selective

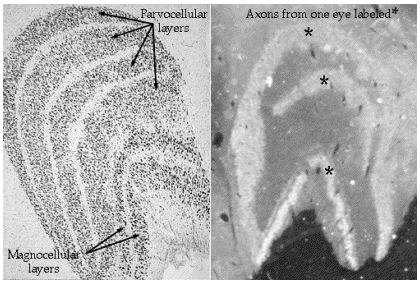
Tuning curve







Lateral Geniculate Nucleus



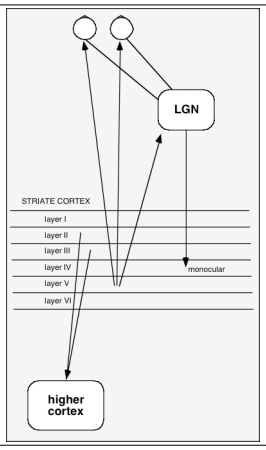
ORGANIZATION OF THE VISUAL CORTEX

- Laminar organization
- Retinotopic
- Ocular dominance
- Orientation preference
- Color blob (in V4)

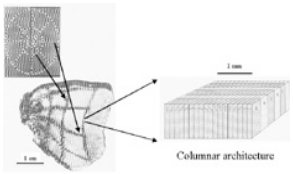
Primary Visual Cortex
(V1, Brodmann area 17, striate cortex)

Laminar organization

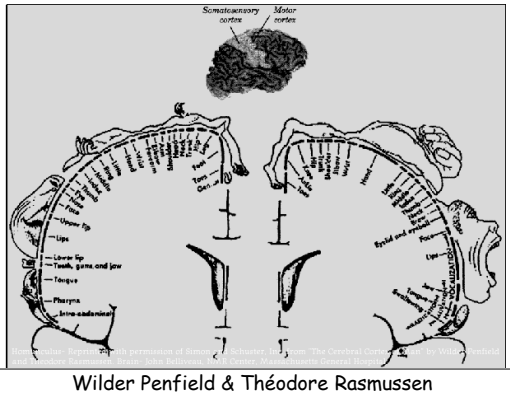
layer 4: input layer
layers 2+3: output to other cortical areas
layer 5: output to the superior colliculus
layer 6: output to the LGN



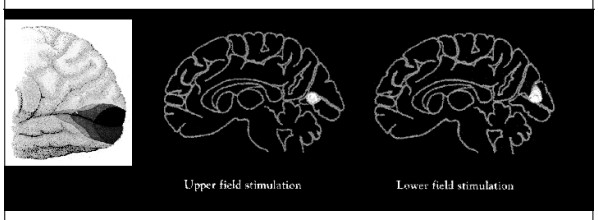
Tootel

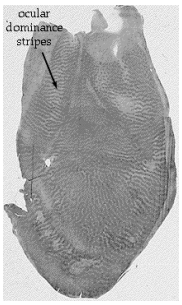


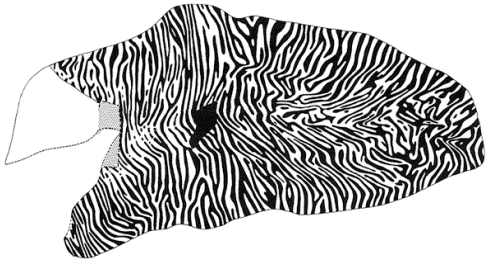
Retinotopic map



Wilder Penfield & Théodore Rasmussen
(Centre de recherche en neurophysiologie du Royal Victoria Hospital de Montréal, 1950)







Simon LeVay, The Journal of Neuroscience, Vol. 5, No. 2, Feb. 1985

LeVay, S., Hubel, D. H., and Wiesel, T. N. (1975).
The pattern of ocular dominance dominance columns in macaque visual cortex revealed by a reduced silver
J. Comp. Neurol., 159:559-576.

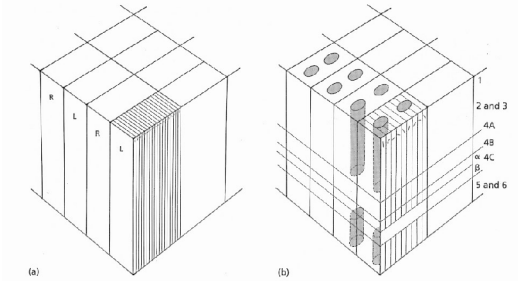
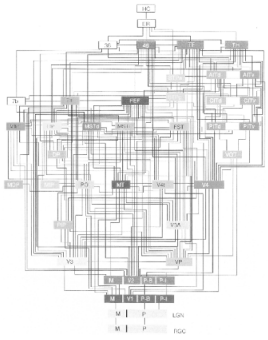


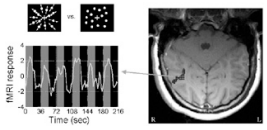
Fig. 19.2 (a) The model of the organization of area V1 proposed by Hubel and Wiesel and (b) its later modification by Livingstone and Hubel. (Redrawn from Hubel, D.H. & Wiesel, T.N. (1977). *Proc. R. Soc. Lond.* B **198**, 1–59 and Livingstone, M.S. & Hubel, D.H. (1984). *J. Neurosci.* 4, 309–356.)

Visual hierarchy

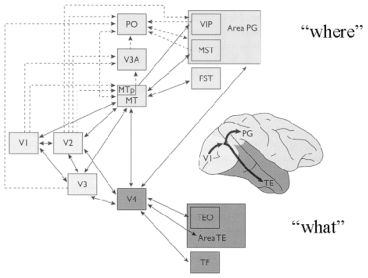


Cortical areas of macaque

Motion sensitivity in Middle Temporal Area (MT)



Dorsal and ventral streams



What & How systems
Goodale

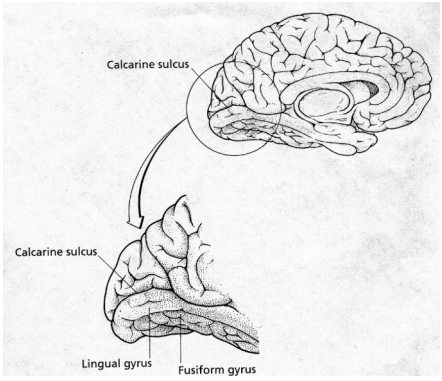
Double dissociation

	Visuo-motor orientation	Judging Visual orientation
Ventral Stream Damage	√	X
Dorsal Stream Damage	X	√

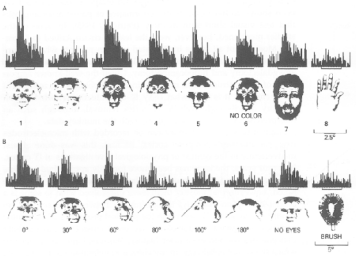
Ventral Stream

Properties of Infero-Temporal (IT) neurons

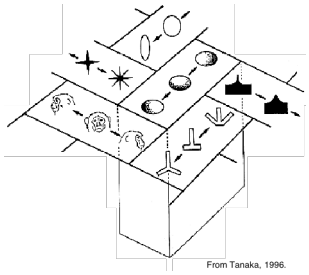
- receptive field size
- stimulus selectivity
- "attribute" invariance
- position invariance
- size invariance
- viewpoint invariance
- columnar organization



"Face cells"

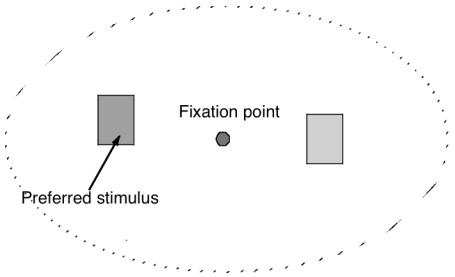


Columnar organisation in IT

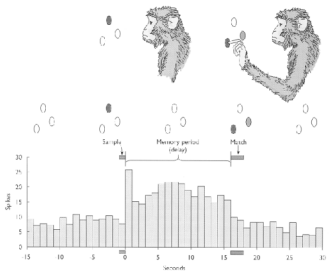


From Tanaka, 1996.

Attention in the ventral stream
Moran & Desimone (1985)



Delayed-match-to-sample task



Is cell firing related to perception?

- Logothetis et al.
- Newsome et al.