kevin martin best scientist on connectivity

exam: mandatory rading: contents are part of exam even if did not appear in lecture

exam: 31st of may
1h MPC

Institute of Neuroinformatics
ETH/UNI Zurich

Computation in Neural Systems: Biological and Computational Vision

Lecture 1

Daniel Kiper

kiper@ini.ethz.ch

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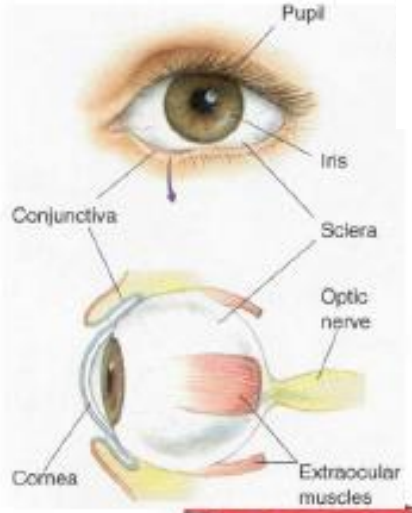
www.ini.unizh.ch/~kiper/comp_vis/index.html

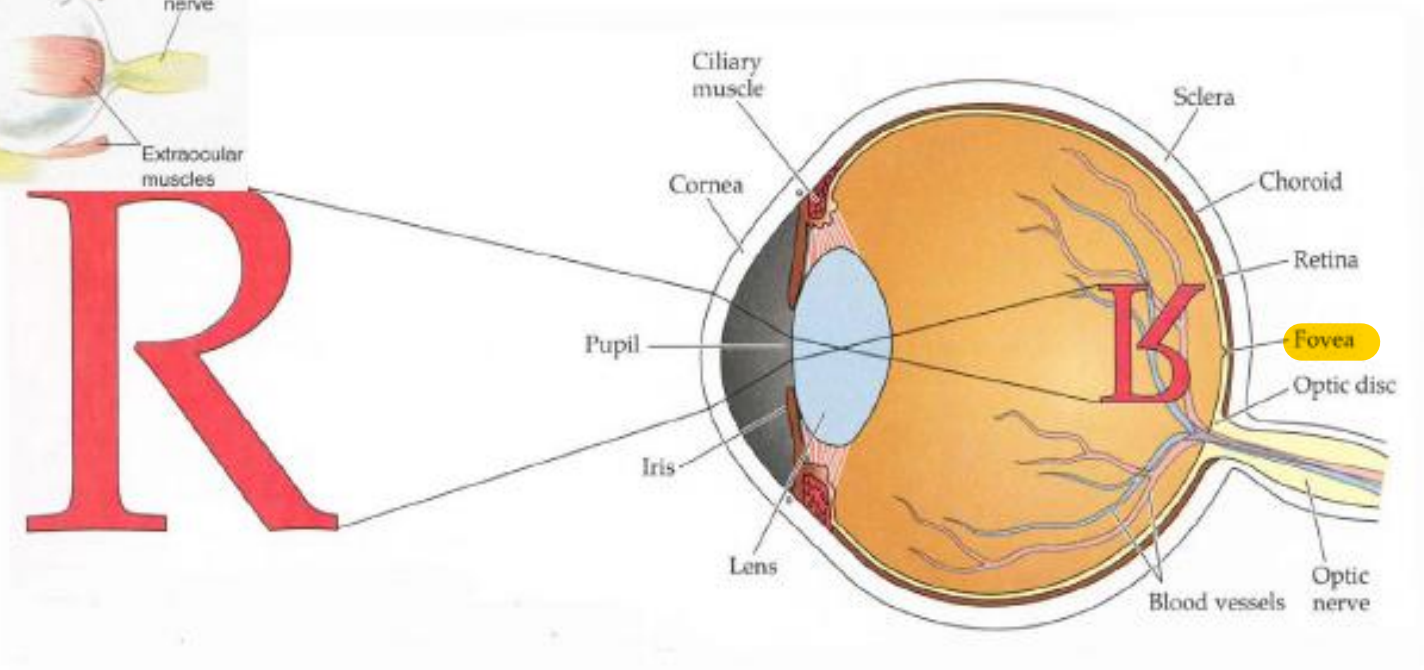
The visual pathways

humans and primates depend on viison a lot more than mice which is reflected in our brain

we have two eyes

Anatomy of the eye





fovea: very high density of photoreceptors: the aprt we use to look at something

optic disc: no photoreceptors, since we have all the nerves going there, so no place for photoreceptors

retina also compresses the info and works as a thinking organ

blood arteries are behind RT so they can get lots of energy and nutrients because the release lots of neurotransmitters

Basic retinal circuitry

photons are captured at RT that change memrbane potential and release and electrical signal etc.

inside
light goes all the way to here before it hits the photoreceptors.

Receptor terminals (**RT**)

Horizontal cells (**H**)

talk in chemical signals

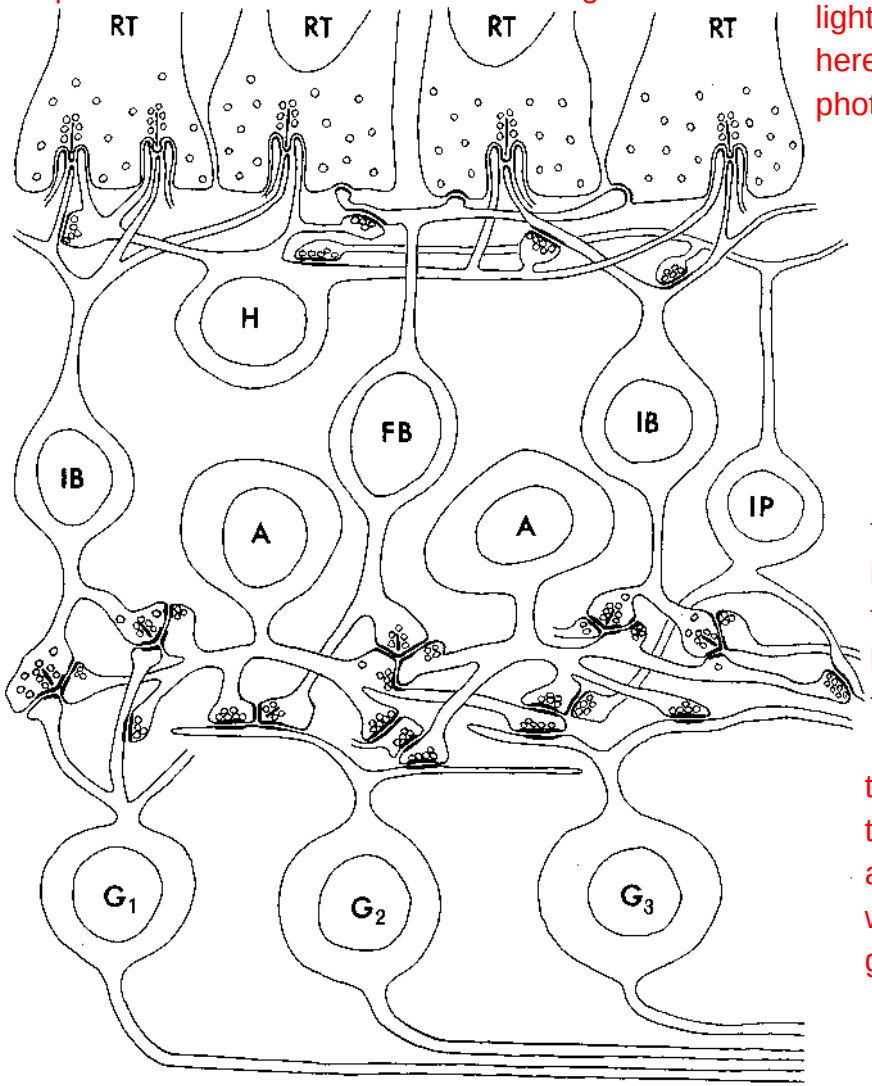
Bipolar cells (**B**)

Amacrine cells (**A**)

Ganglion cells (**G**)

here electric potential again

Optic nerve



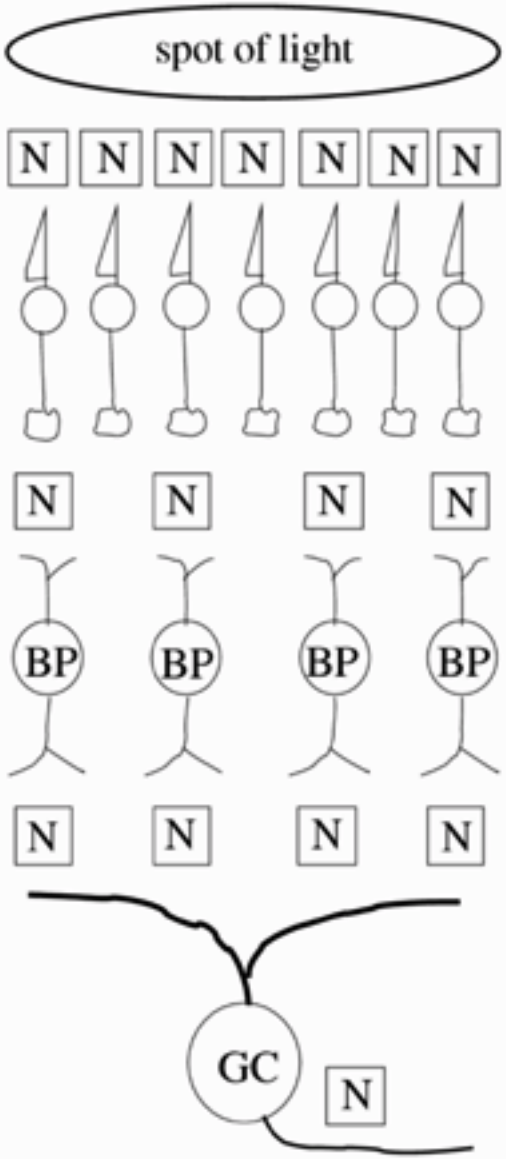
this inbetween tissue is transparent and lets the photon through but not perfectly though

the fovea is much thinner and has hardly any in between tissue which leads to really good vision

putside

outside world: here comes the world

Dowling, 1987 (Fig 3.17)



Photon Noise

Transduction Noise

Channel Noise

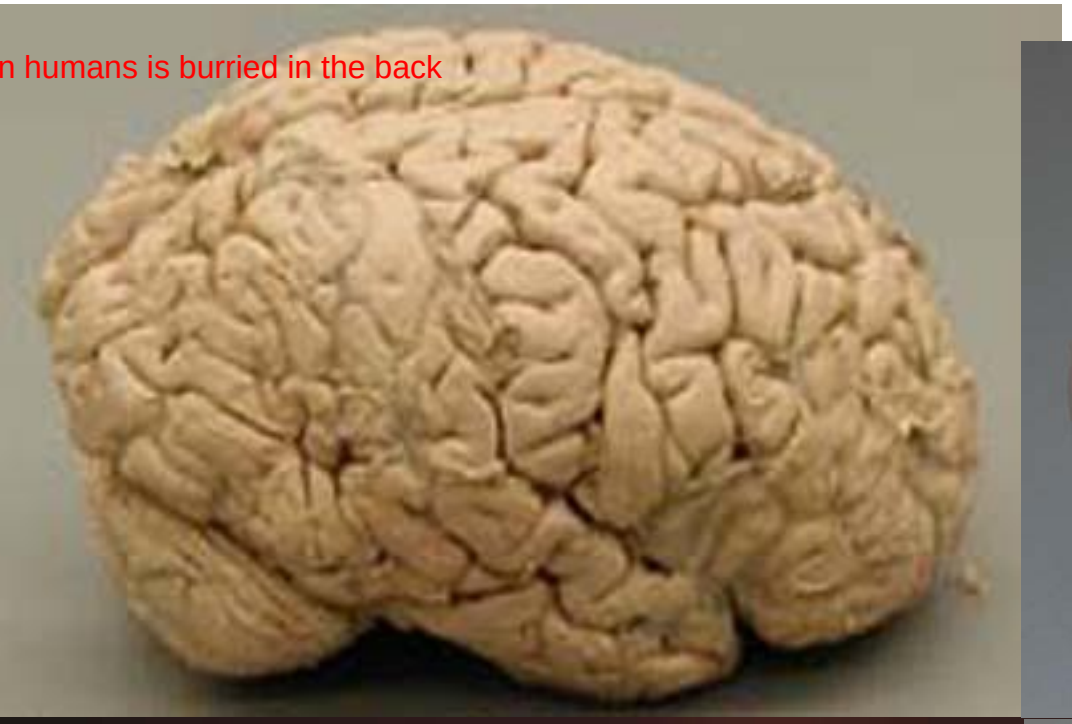
Synaptic Noise
(from Berntson & Taylor, 2003)

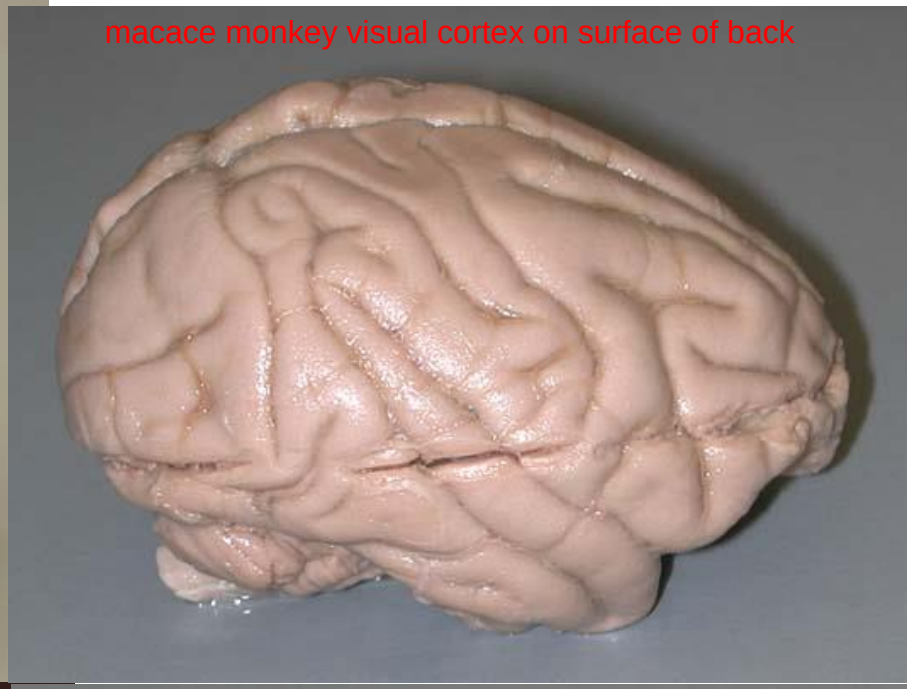
Channel Noise

Synaptic Noise

Dendritic Morphology
(from van Rossum et al, 2003)

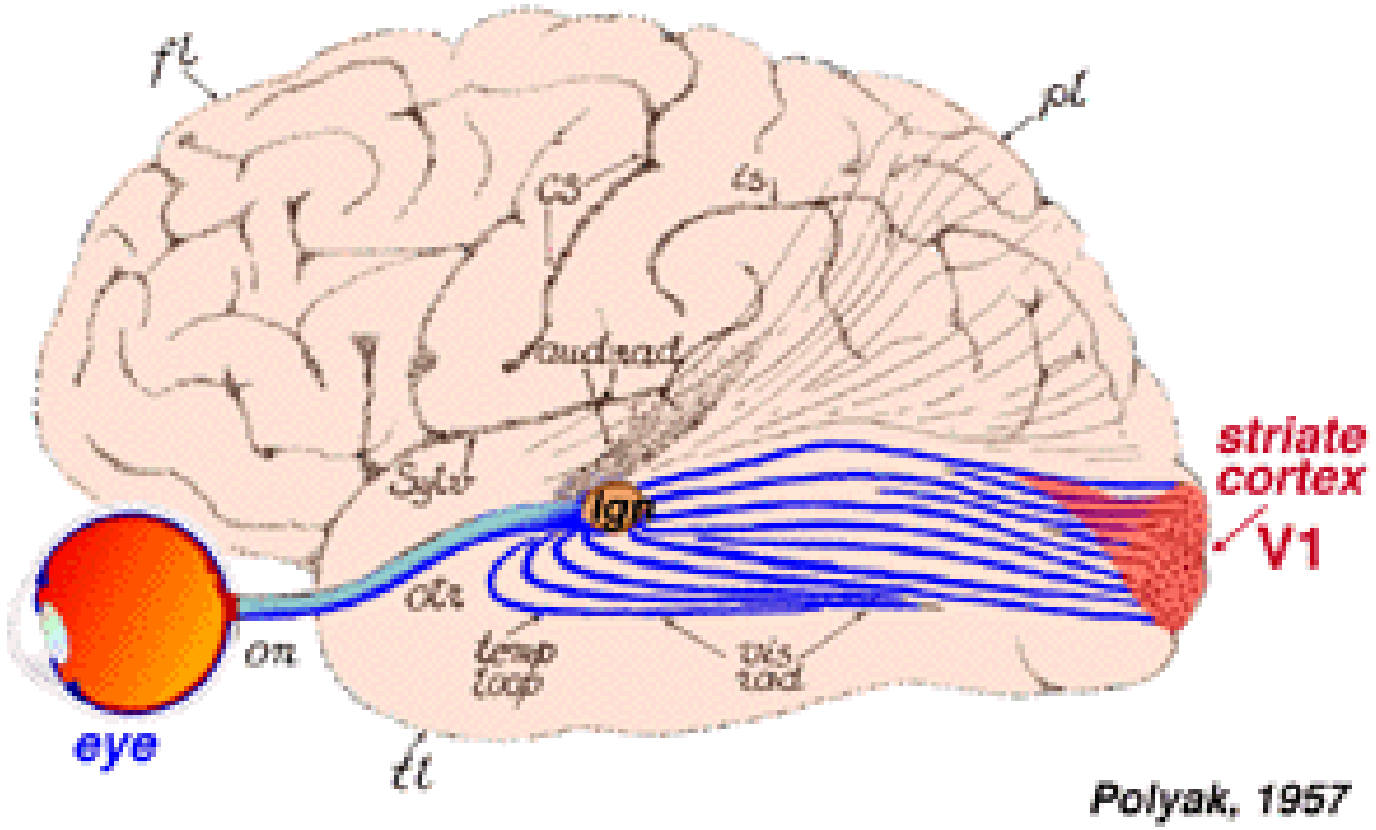
Spike Generator
(from Dhingra & Smith, 2004)


n humans is burried in the back


macace monkey visual cortex on surface of back


mice brain


cat brain



lgn in thalamus

V1 = primary visual cortex = striate cortex = area 17

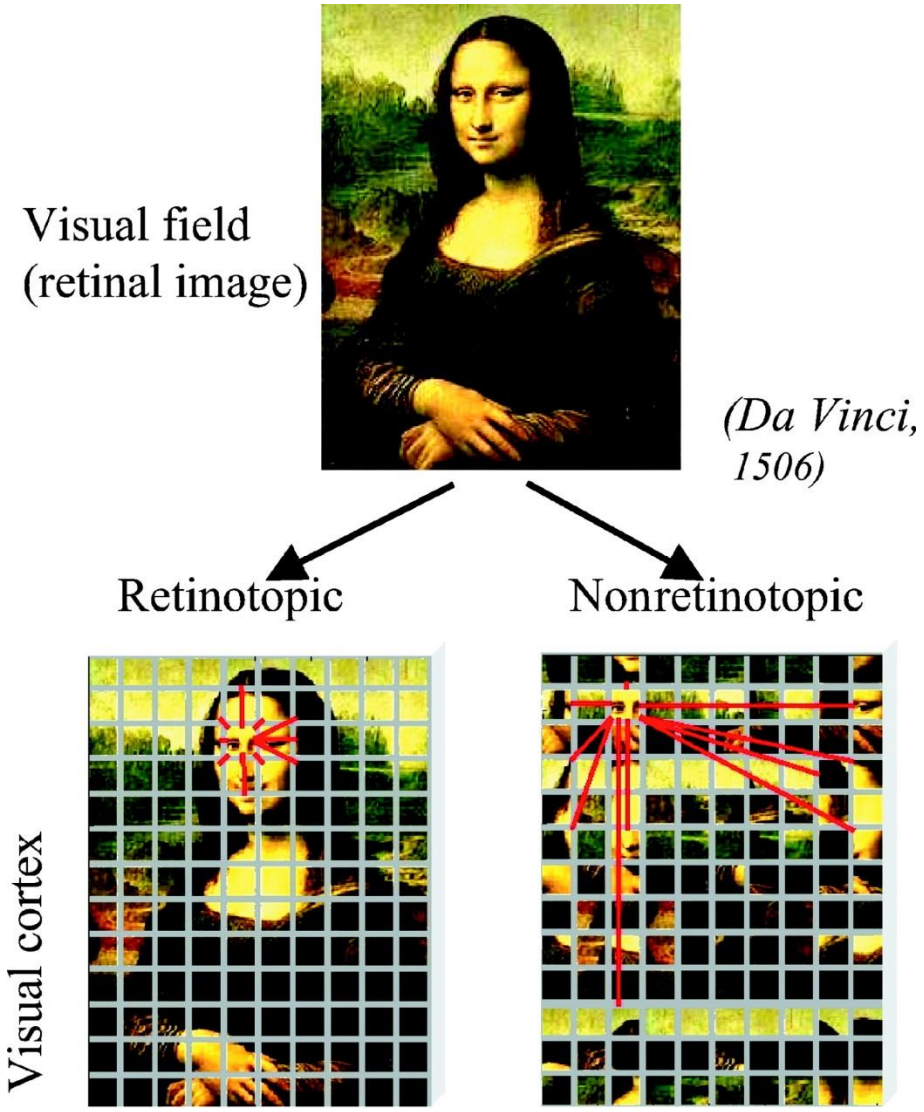
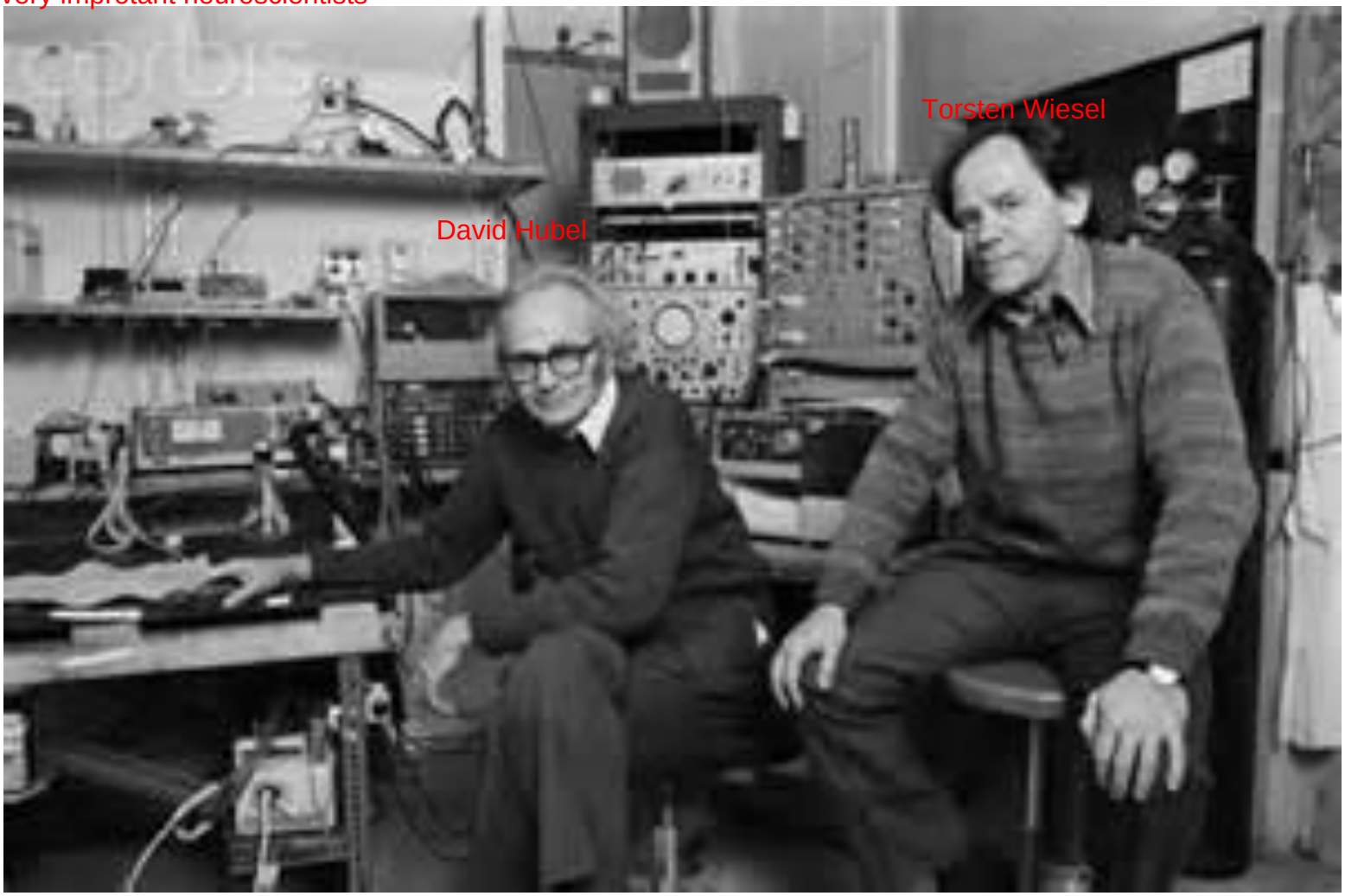


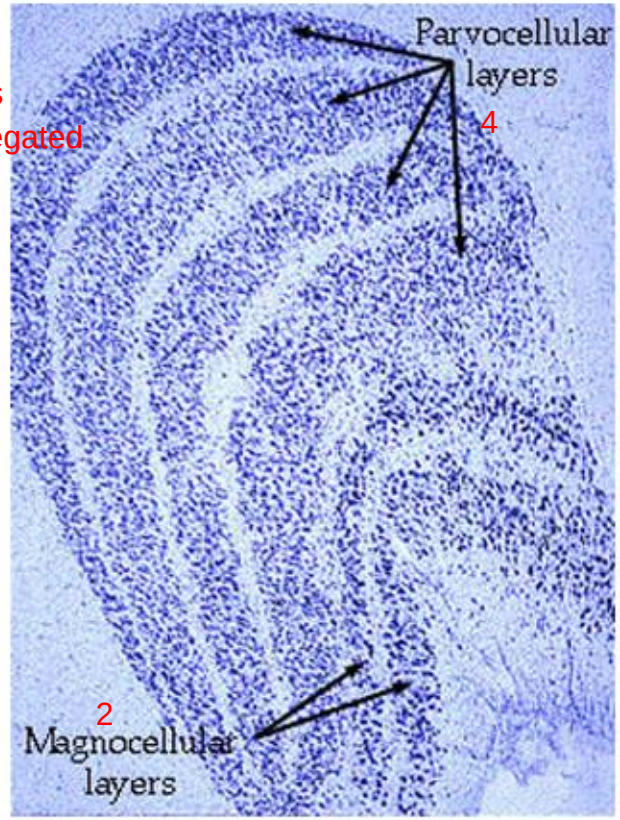
image preserved

very improtant neuroscientists



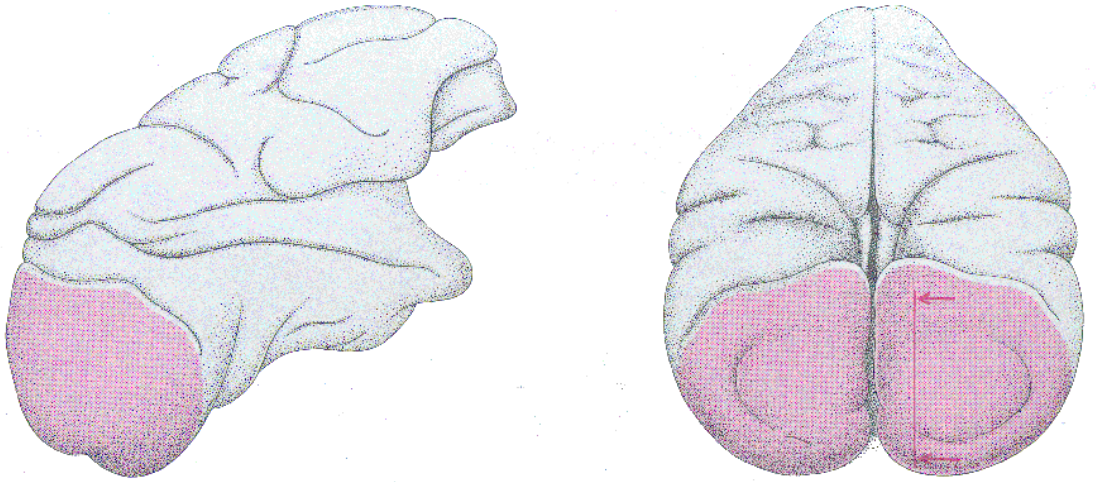
lgn of monkey, made of 6 main layers

the signals of the eyes
dont mix but are segregated



the other three layers are
contacted by the other eye then

the cell bodies in the lower two layers are bigger and start to segregate
the axons are monocular



The striate cortex (V1)

the border is very clear to other cortical regions

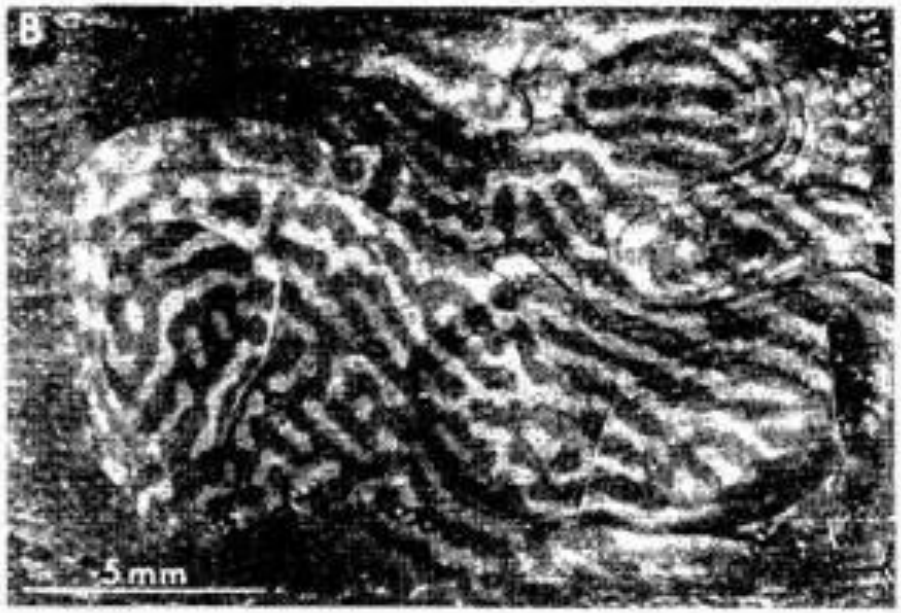
primary visual cortex

since the brain is also folded, V1 is also present inside the brain so to say

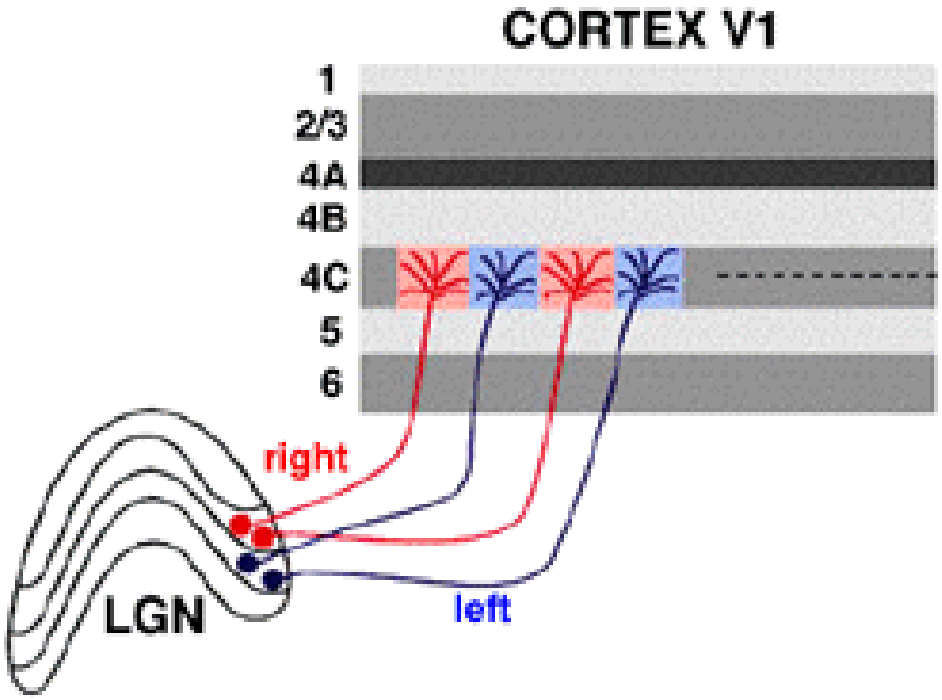
cells in the cortex receive singals binocularly:
LGN to V1 is biocular

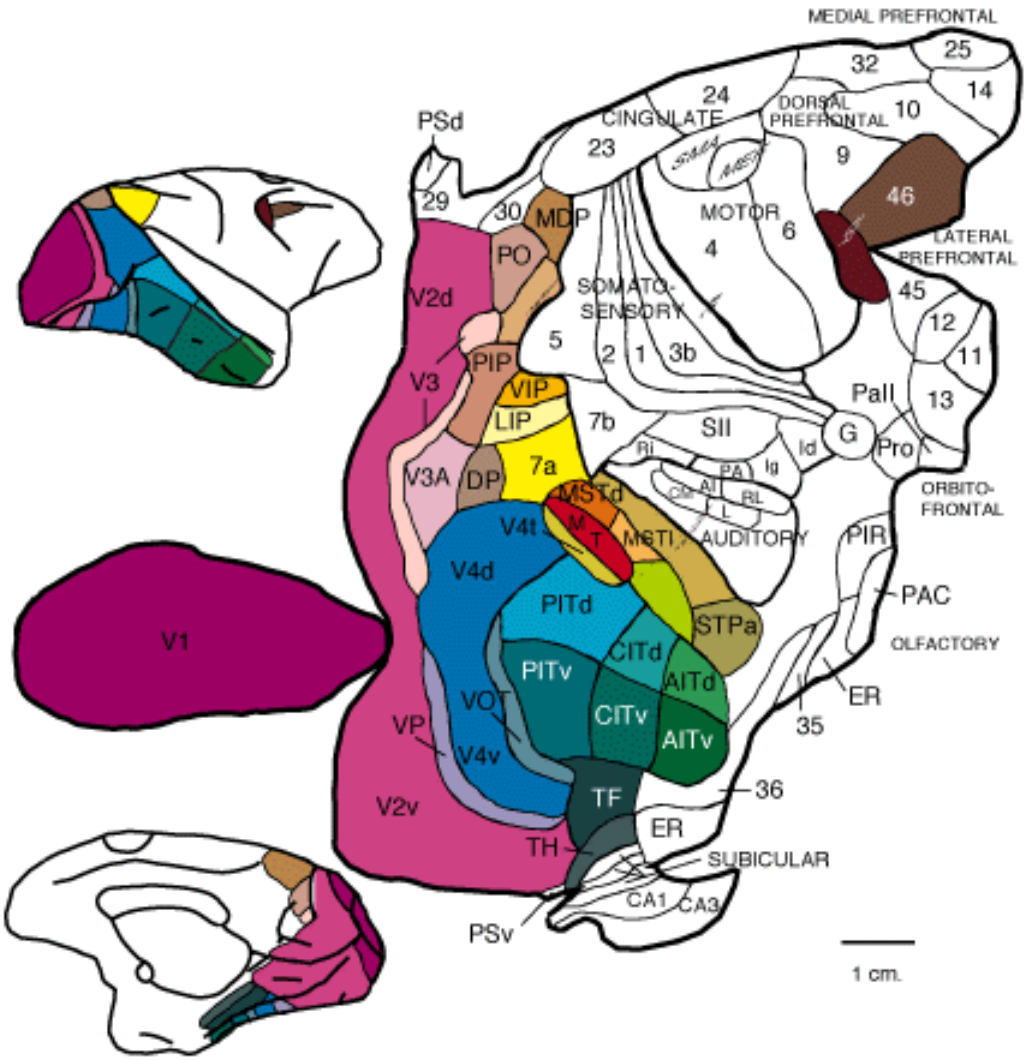
Hubel and Wiesel, 1979


1 mm

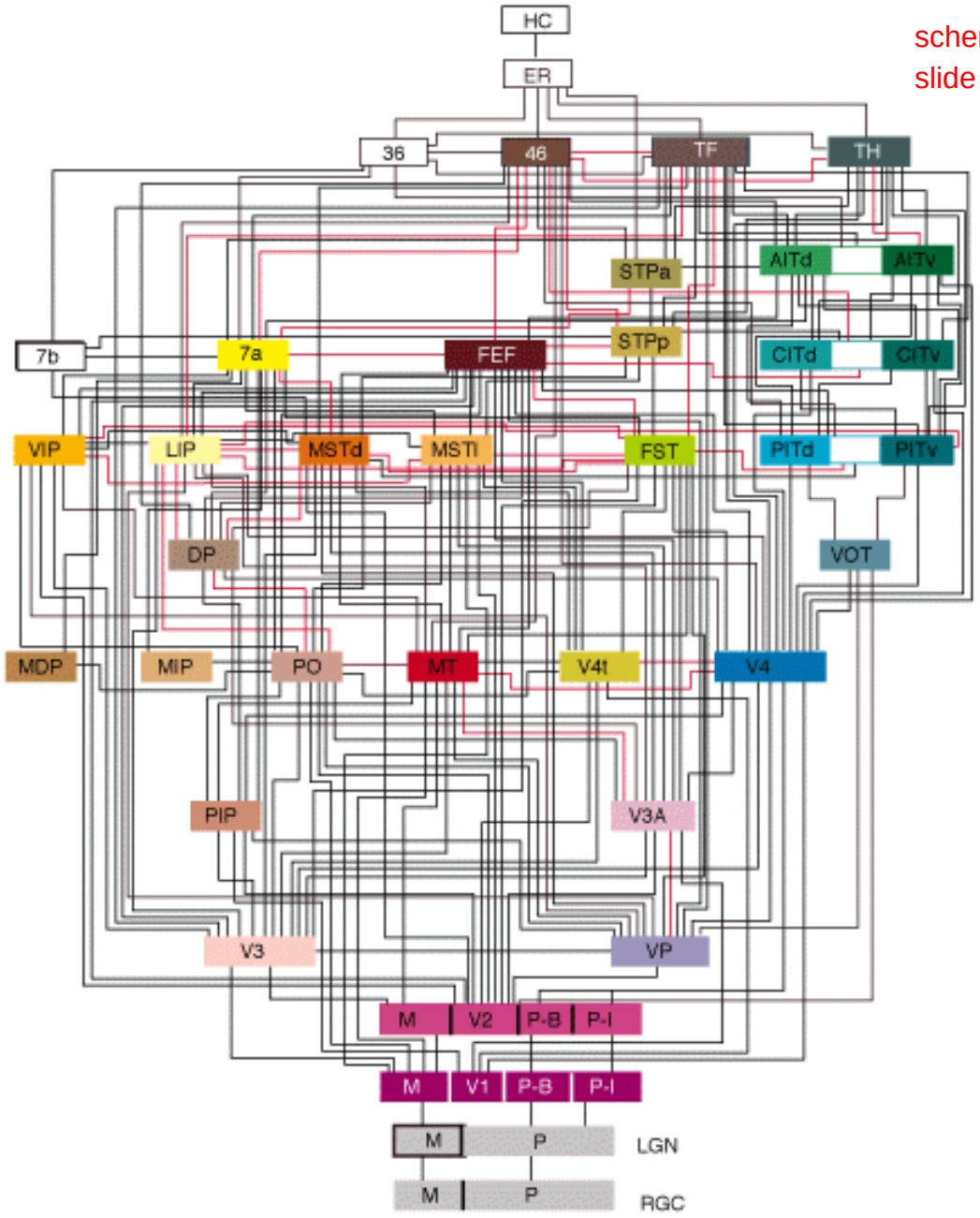

B
5 mm

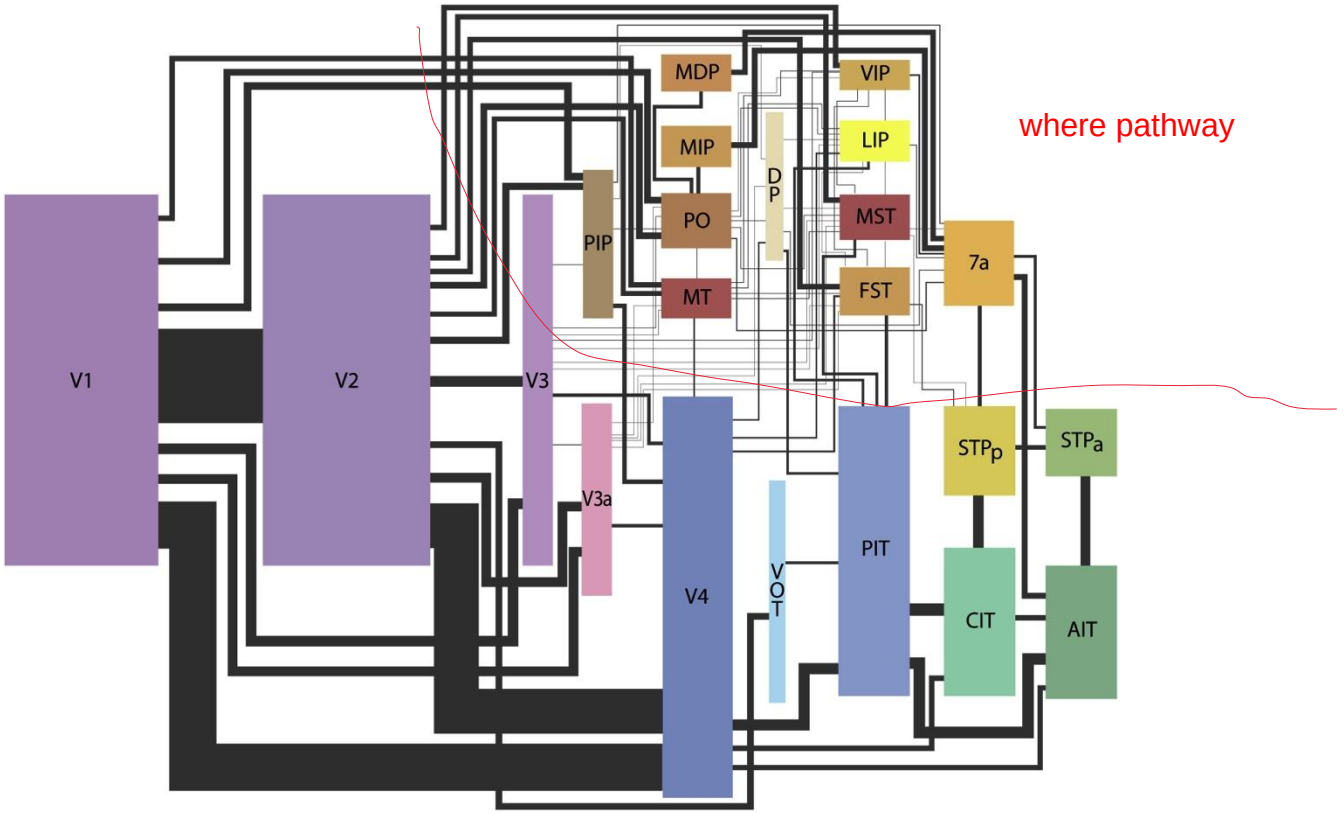

ocular
dominance
stripes


CORTEX V1
1
2/3
4A
4B
4C
5
6
right
left
LGN

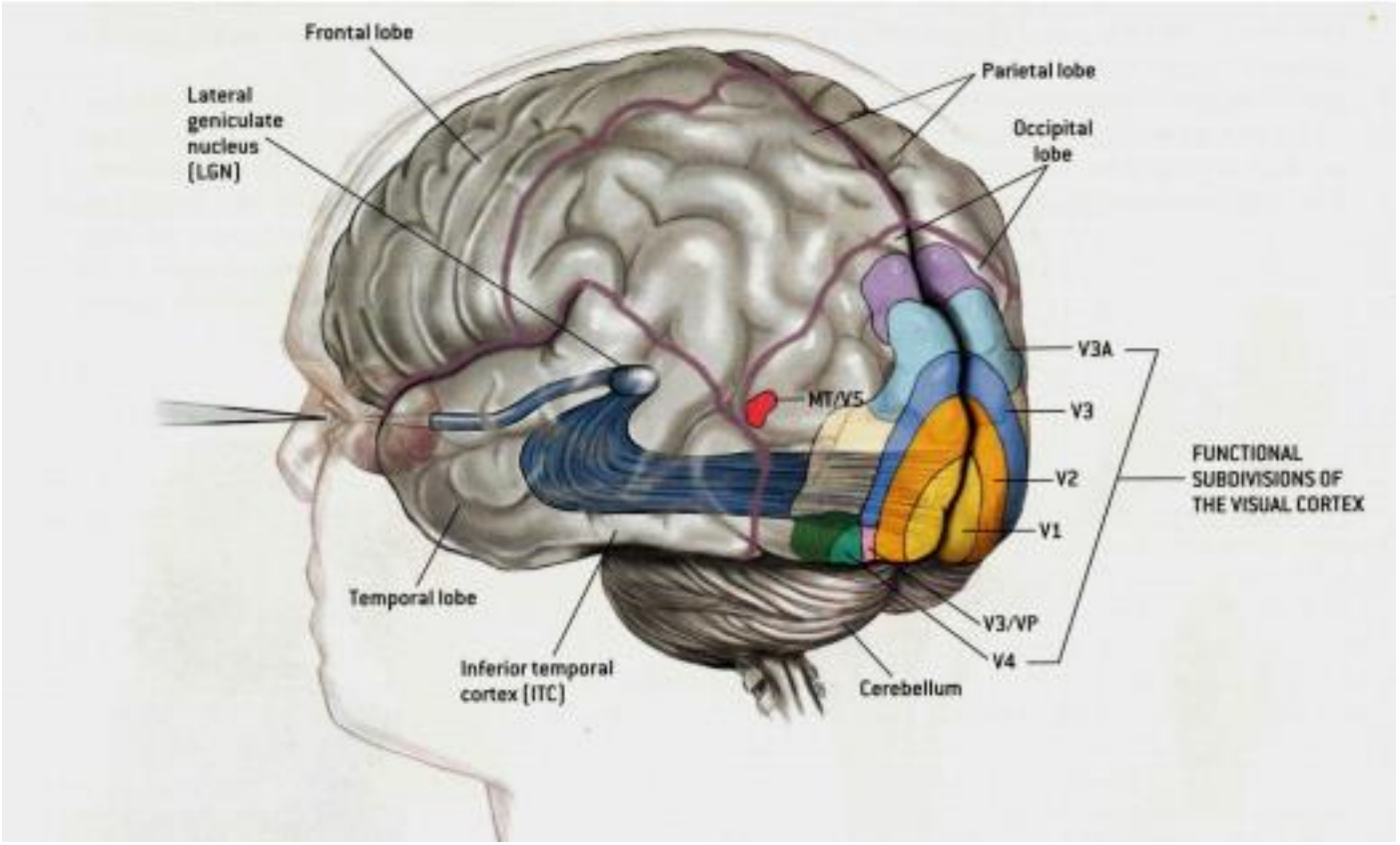

MEDIAL PREFRONTAL
32
25
14
24
CINGULATE
DORSAL PREFRONTAL
10
PSd
23
9
46
29
30
MDP
MOTOR
6
4
LATERAL PREFRONTAL
PO
V2d
SOMATO-SENSORY
45
12
5
2
1
3b
11
V3
PIP
VIP
PaII
13
LIP
7b
SII
G
Pro
V3A
DP
7a
MSTd
V4t
MT
MSTl
AUDITORY
ORBITO-FRONTAL
PIR
V4d
PITd
PAC
V1
STPa
OLFACTORY
CITd
PITv
AITd
VOT
ER
VP
CITv
35
AITv
V4v
36
TF
V2v
ER
TH
SUBICULAR
CA1
CA3
PSv
1 cm.

schematic representation of the slide before

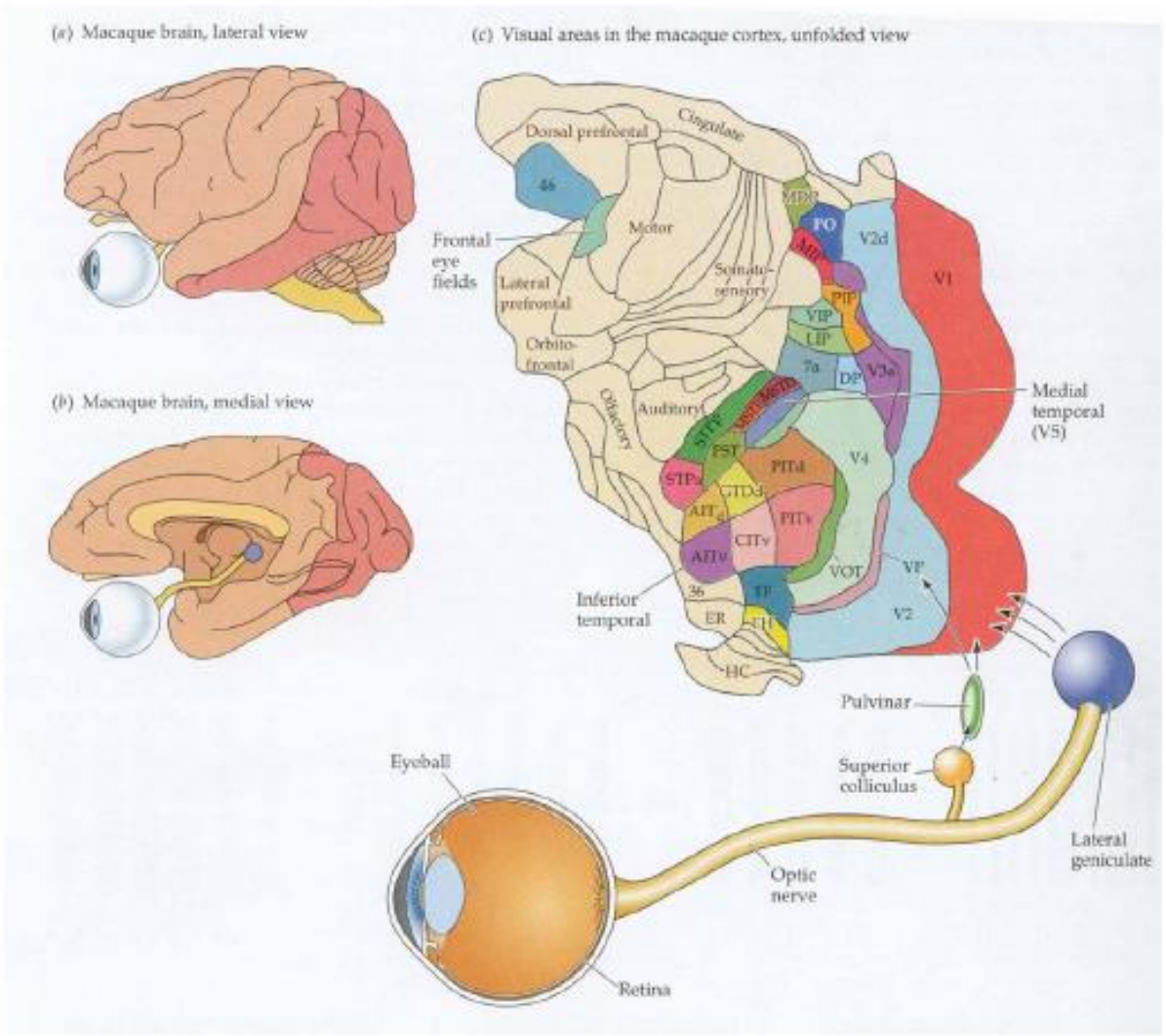



MDP
VIP
where pathway
MIP
LIP
D
P
PIP
PO
MST
7a
MT
FST
V1
V2
V3
STPp
STPa
V3a
V4
PIT
V
O
T
CIT
AIT
what pathway

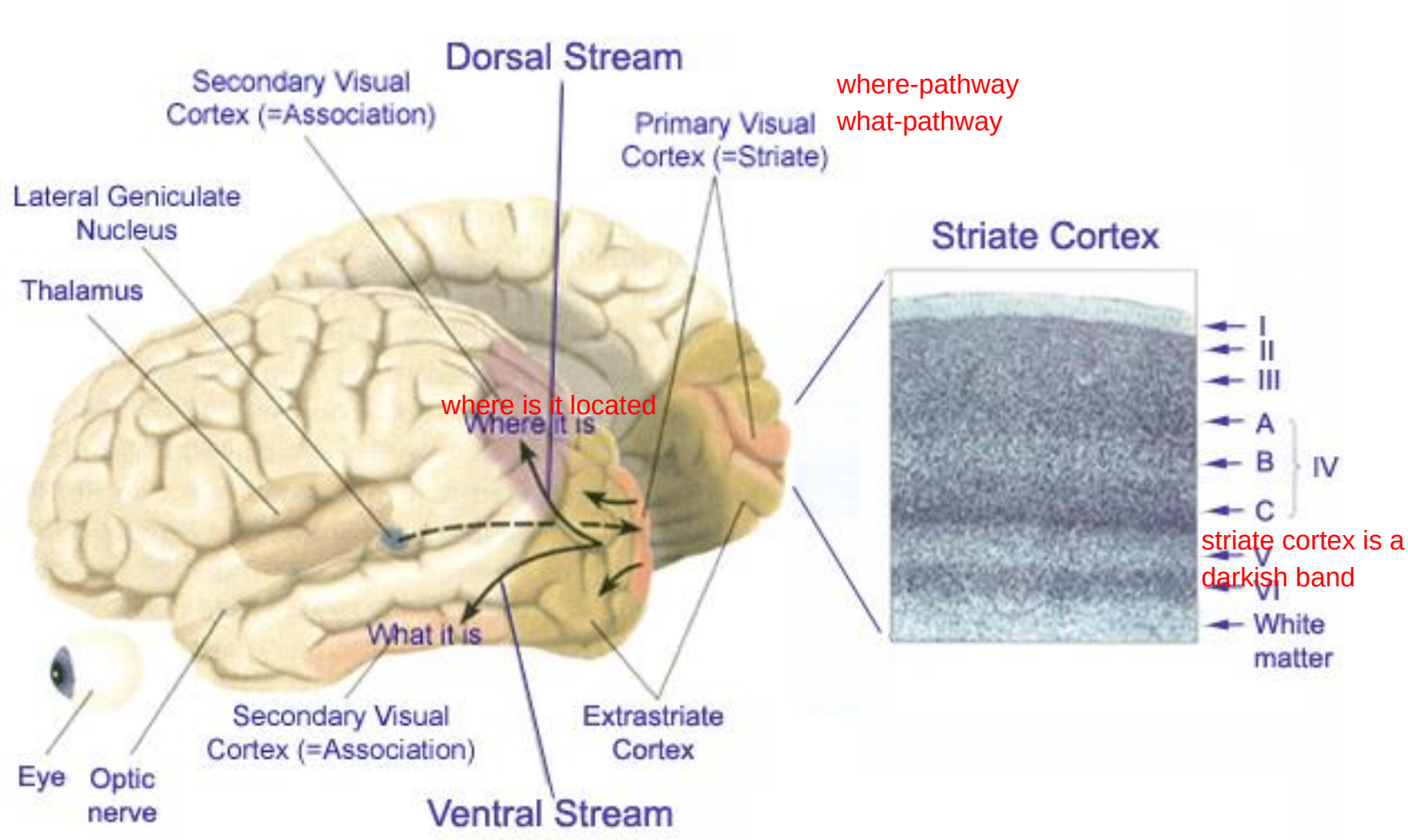
the visual is isnide embedded in the calcarian sulcus (so it's like folded inside)



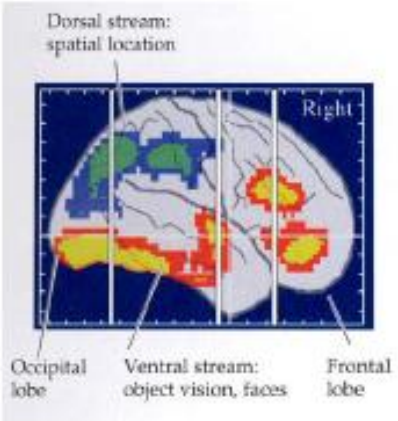
Extrastriate cortex



Human extrastriate cortex



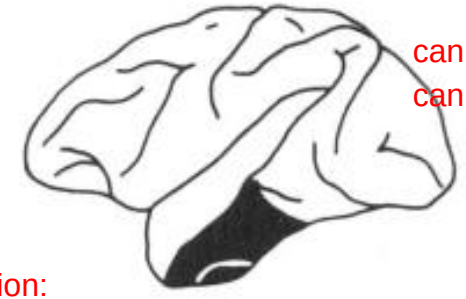
capgvas syndrome - emotional connection to sensory input disconnected



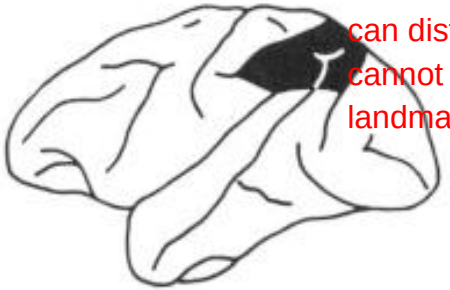
What and Where

depending where the lesion was, they had different probelms and couldnt deal with the specific task properly

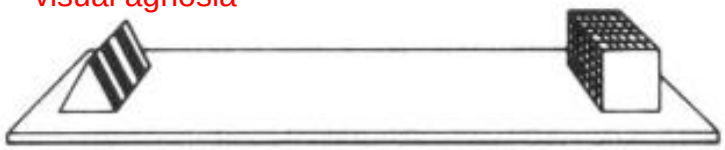
cannot distinguish objects
can distinguish with landmarks

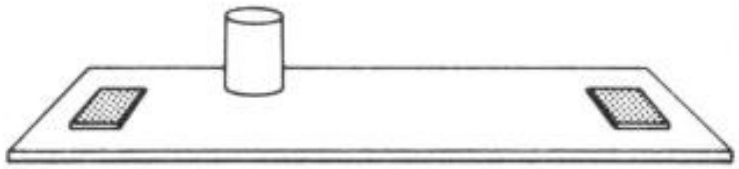


can distinguish objects
cannot distinguish with landmarks



condition:
visual agnosia





Object Discrimination

Landmark Discrimination

condition: neglect: cannot make sense of spatial (own body or external) organization of hemifield (visual field) or other parts of the body

((prosopagnosia: cannot recognize faces)

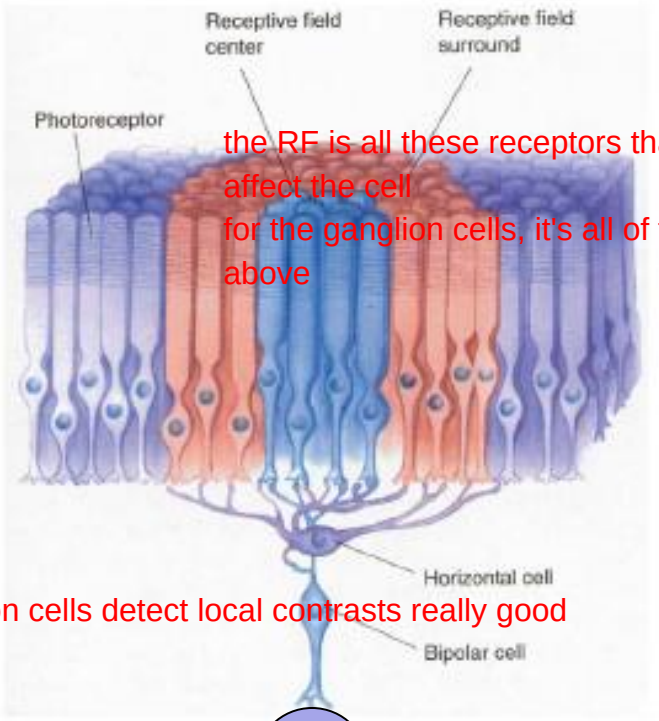
Ungerleider and Mishkin, 1982

A very important concept: The receptive field (RF)

The RF of a cell is the region of visual space in which light can affect (increase or decrease) the cell's firing frequency. resp its activity or is state

extremely important slide to be understood (will occur for the rest of course all the time)

The Receptive Field

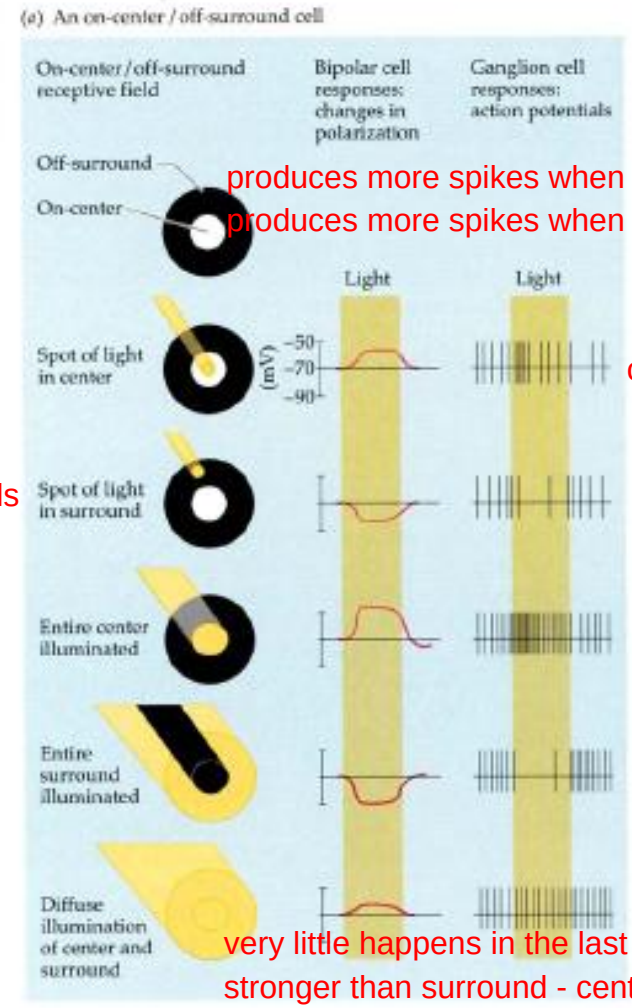


Ganglion cell

the RF is all these receptors that affect the cell

for the ganglion cells, it's all of the cells above

ganglion cells detect local contrasts really good



produces more spikes when light turned off (periph)

produces more spikes when light turned on (center)

center - depolarization

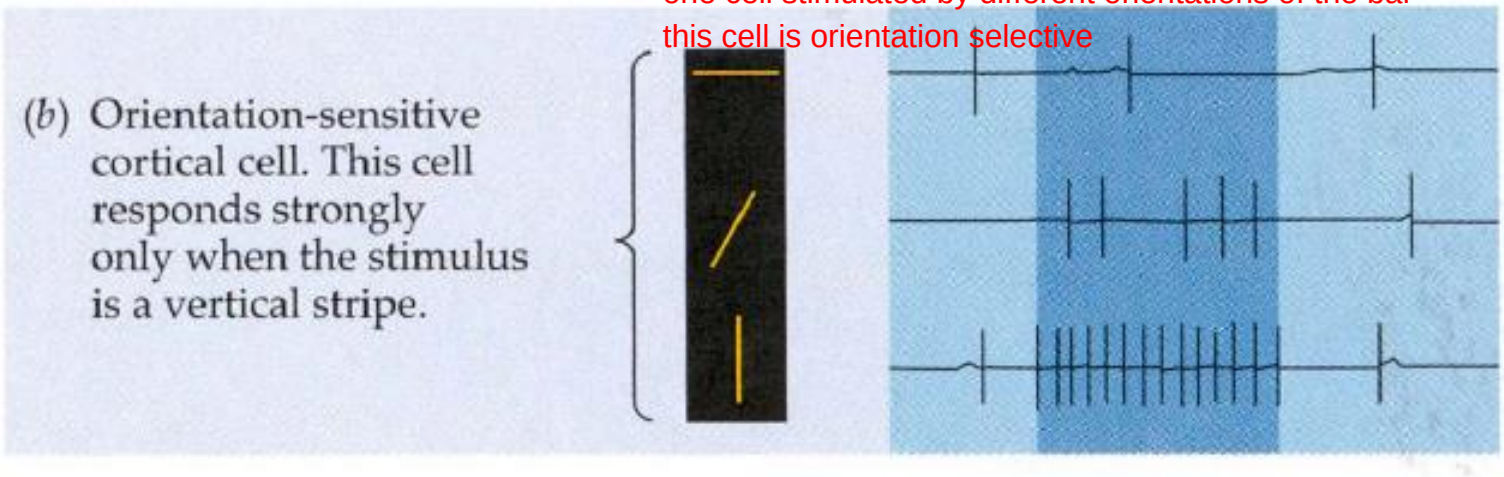
peripheral - hyperpola

very little happens in the last case - the center stronger than surround - center dominates

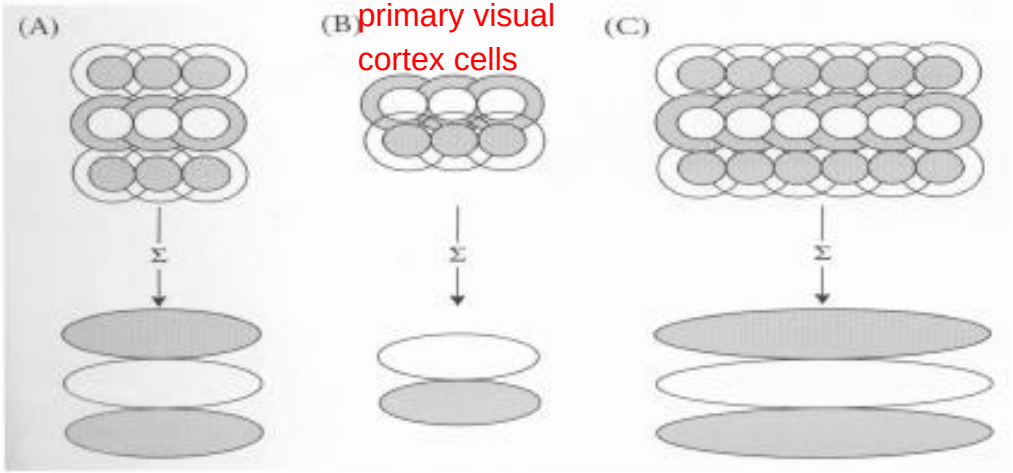
fire's strongly when light is turned off

Cortical receptive fields

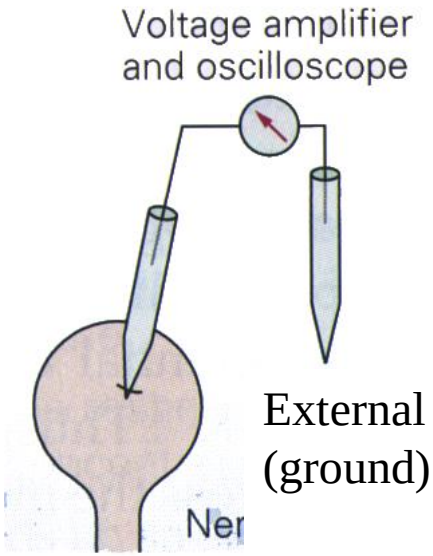
one cell stimulated by different orientations of the bar
this cell is orientation selective



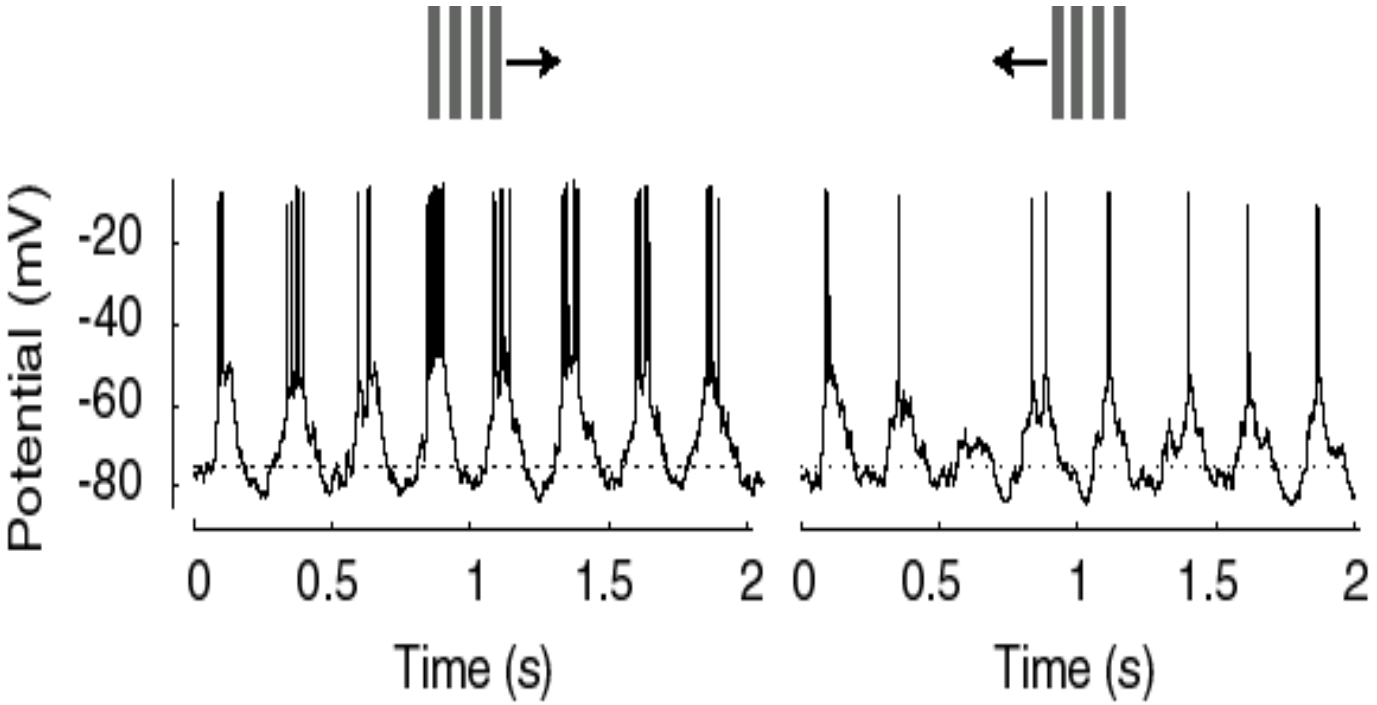
primary visual cortex cells



Intracellular recordings



External reference
(ground)

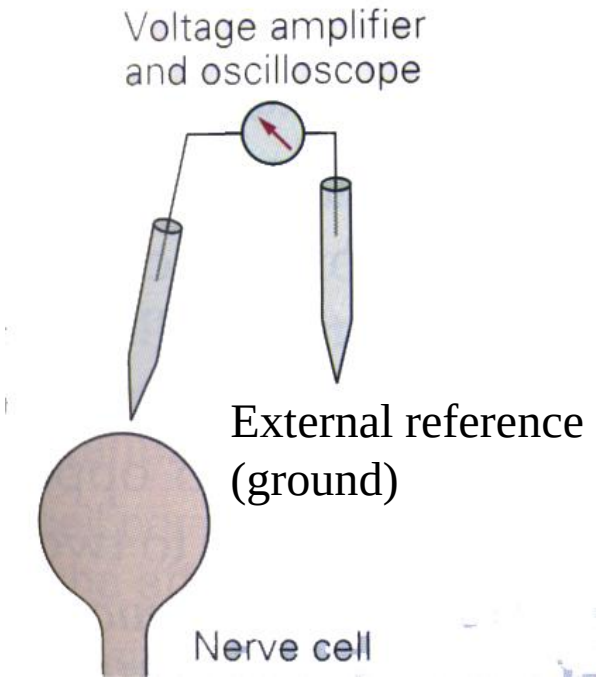


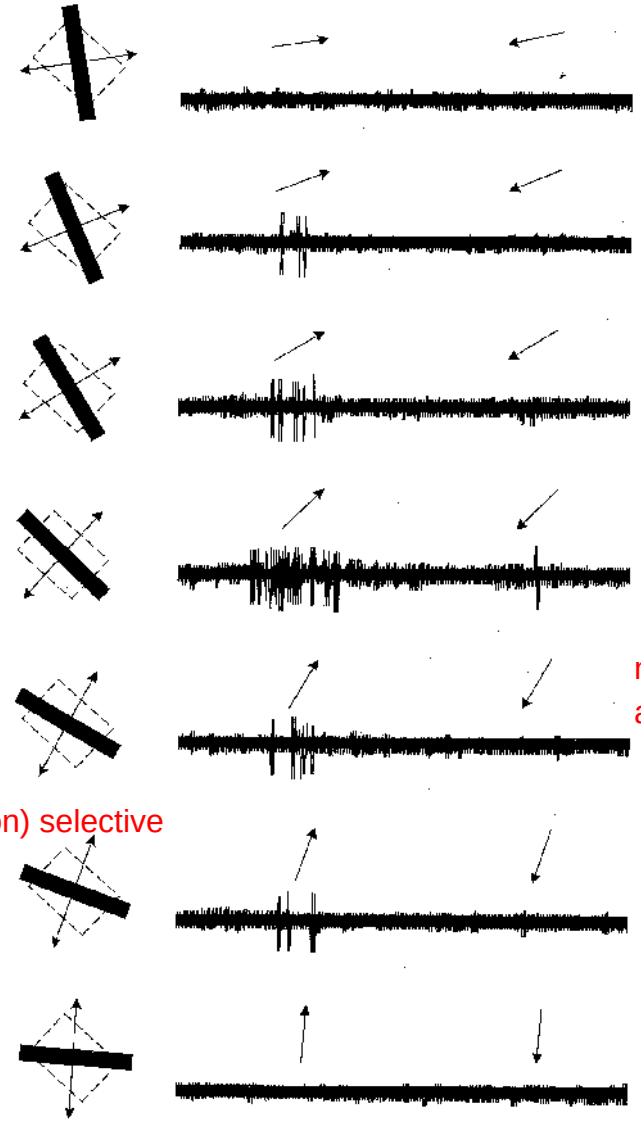
Carandini & Ferster (1999)

in V1 vast majority of cells is orientation selective
only around 20% also respond to direction of motion in a particular case
80% does not care which direction object moves
in other cortical areas, this can change:
in parietal cortex, many cells are direction selective

Extracellular recordings

Selectivity for stimulus orientation and direction in area V1:





cells responses

best respond here

not only angle of the bar but also the direction of motion

this one is cell is oritentation (angle) and direction (of motion) selective

(Sihl's patient - look up on internet
she saw the world as a series of static images
had no information of motion - couldnt cross street, pour water in glass)

Hubel and Wiesel (1968)
in Wandell (1995)