Institute of Neuroinformatics
UNI/ETH Zurich

Biological and Computational Vision

Lecture 4

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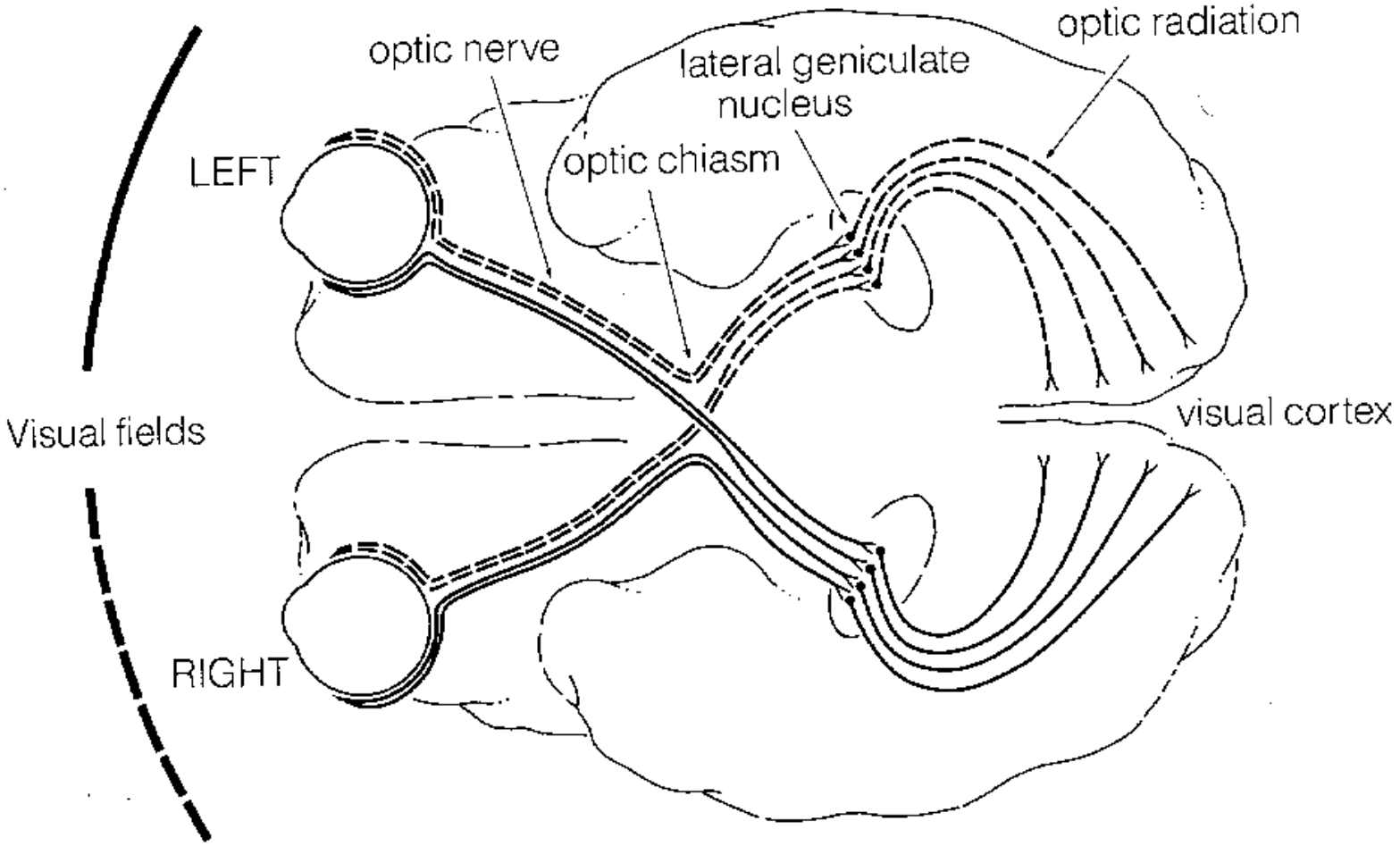
www.ini.unizh.ch/~kiper/comp_vis/index.html



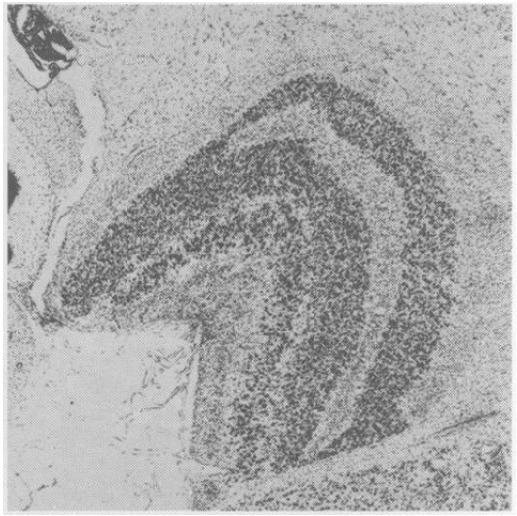
Dowling, 1987 (Fig 1.2)

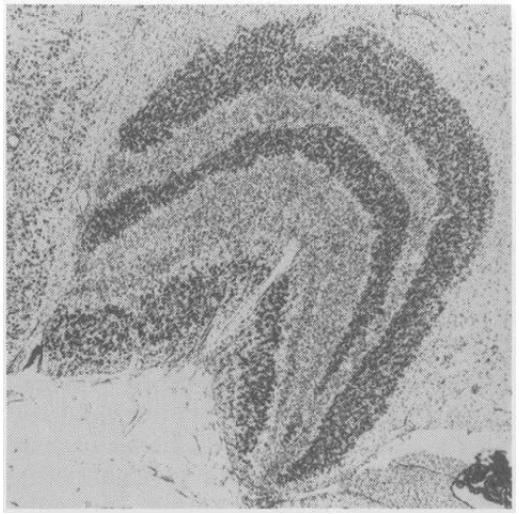
The lateral geniculate nucleus (LGN)

cells in magno layer are bigger than those in pavo (4 outer parvo, then 2 magno layer, organization: C,IPS,C,IPS,IPS,C)
there are also very tiny cells between the layers, called konio layers (anatomically very tiny cells). function: receive input from S cones

Contralateral eye

Ipsilateral eye



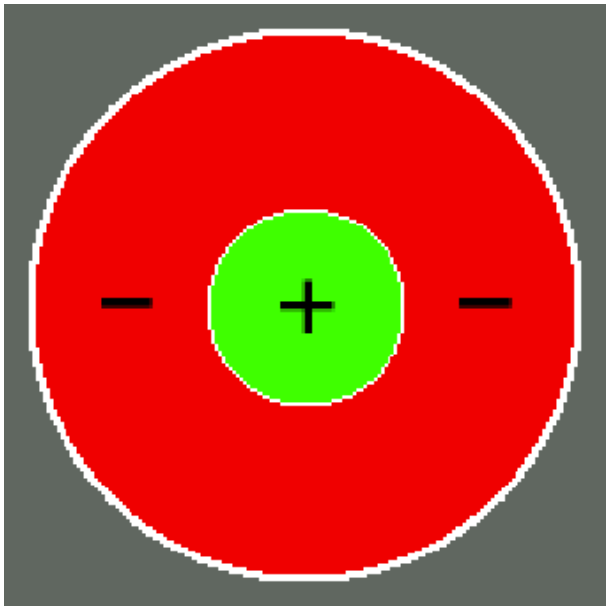


Hubel and Wiesel, *Scientific American*, 1979

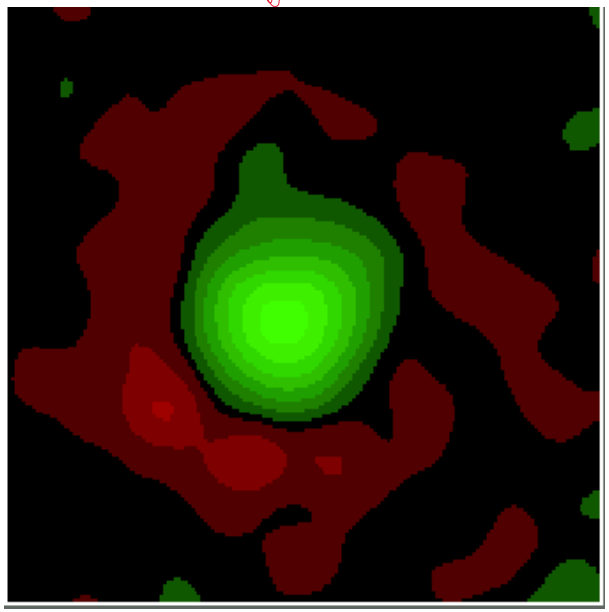
The receptive fields of LGN neurons are similar to those of retinal ganglion cells

the RF of parvo, magno and konio looks just about those of ganglion cells

real measurement of a RF



Schematic of the receptive field

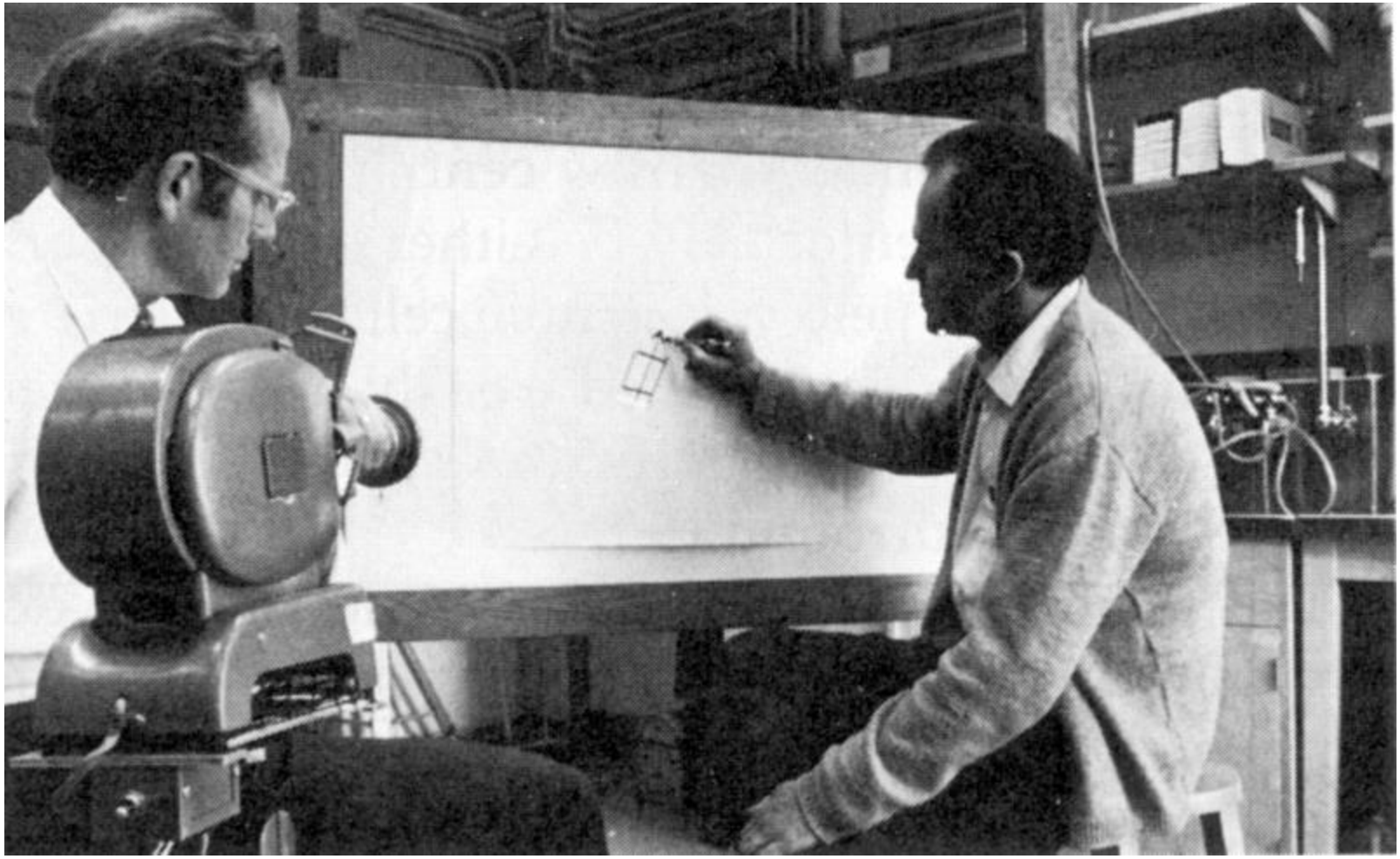


Responses to white dots - responses to black dots

DeAngelis, Ohzawa & Freeman (1995)

V1 cells and receptive fields

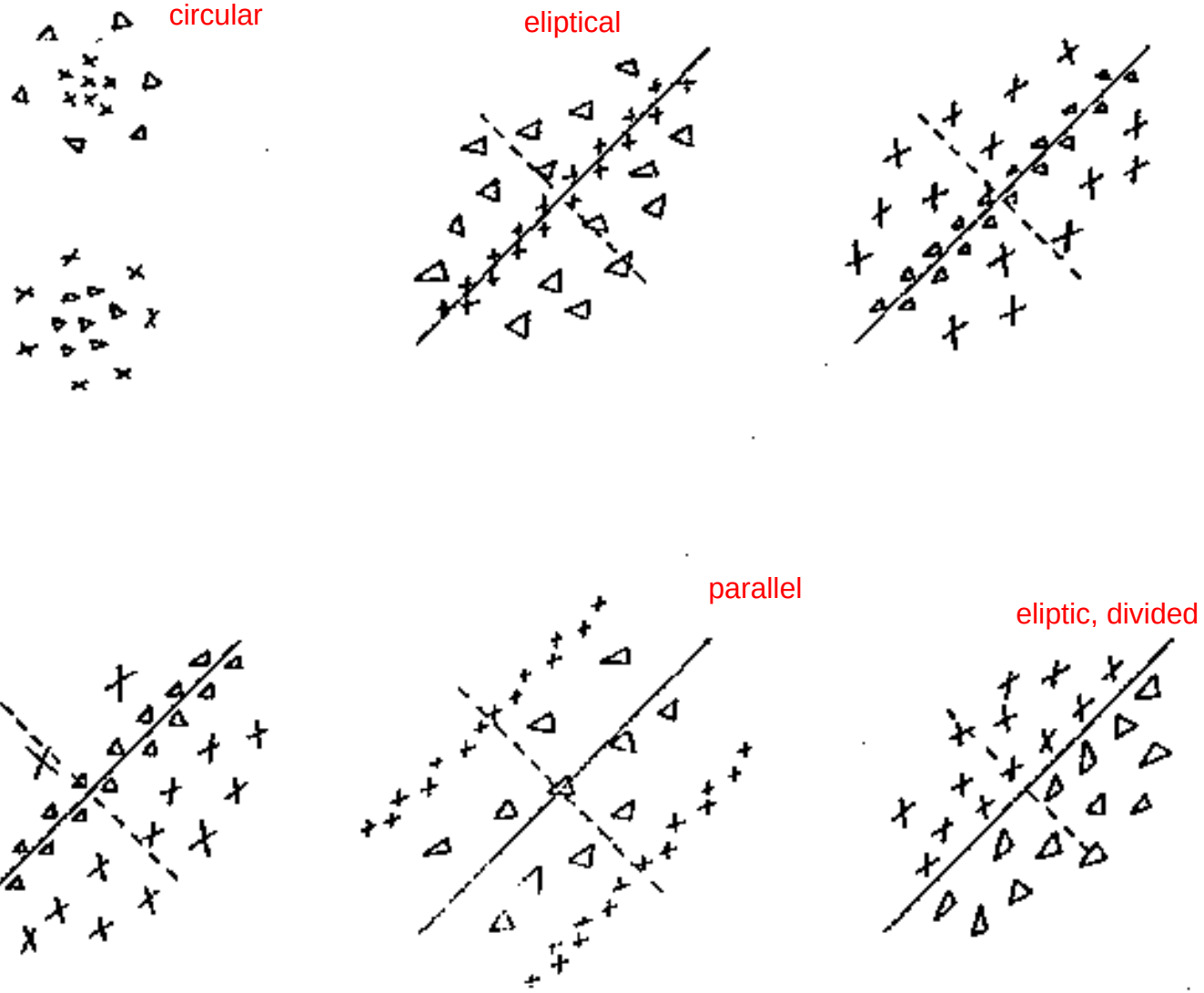
Hubel and Wiesel, circa 1969



in Nicholls et al. (1992)

Receptive fields of LGN and V1 simple cells

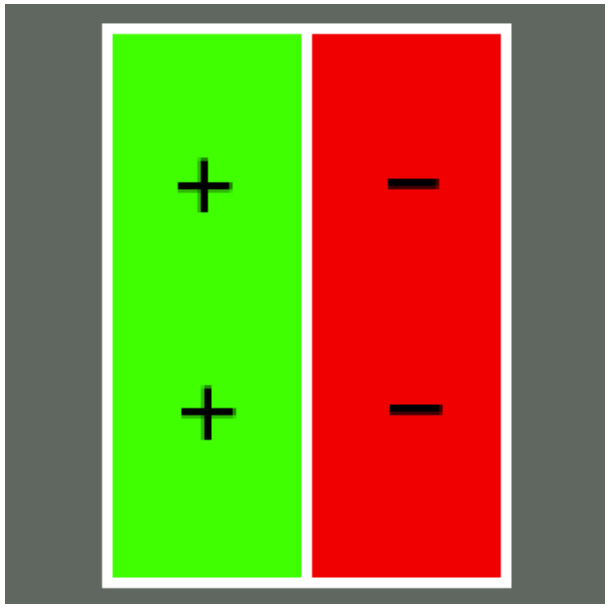
schematic repres of RF of V1 -



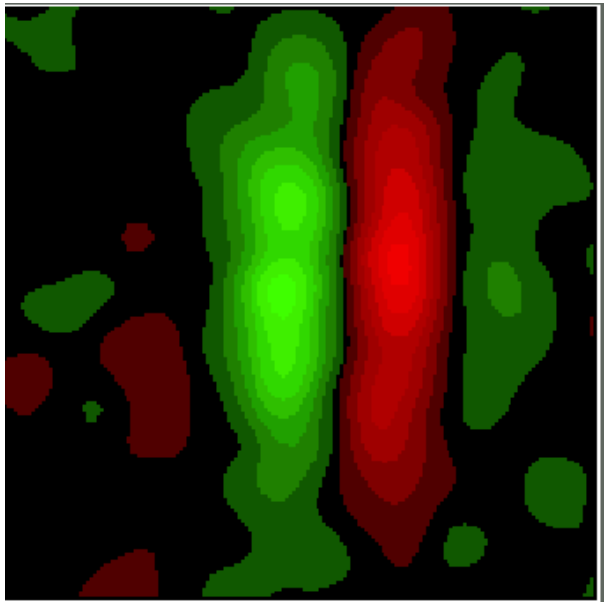
Hubel & Wiesel (1963)

Receptive field of a simple cell

best way to stimulate is to present edges/bars to produce strong responses



Schematic of the receptive field



Responses to white dots - responses to black dots

cells in V1 are amongst others line/edge detectors
there are different kinds of orientations of RF in V1

DeAngelis, Ohzawa & Freeman (1995)

Two types of cells in V1:

- Simple cells have separated ON and OFF regions

- Complex cells have overlapping ON and OFF regions

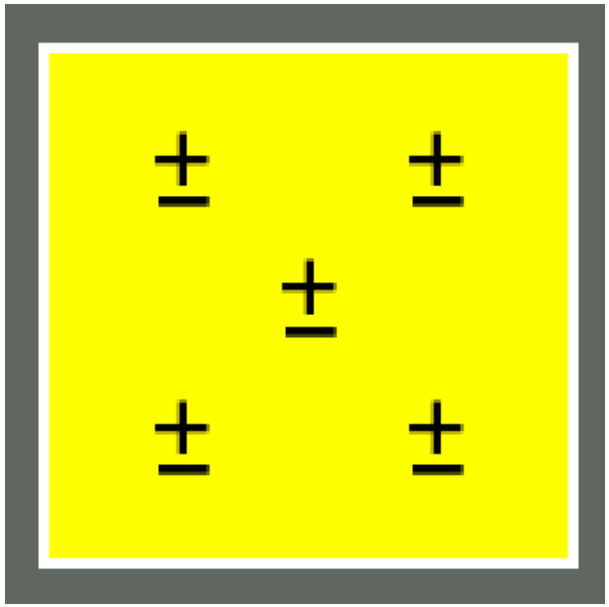
  imagine graph with two curves, where one means ON and other OFF and they literally overlap (during turning light on or off, there are two AP (spikes))

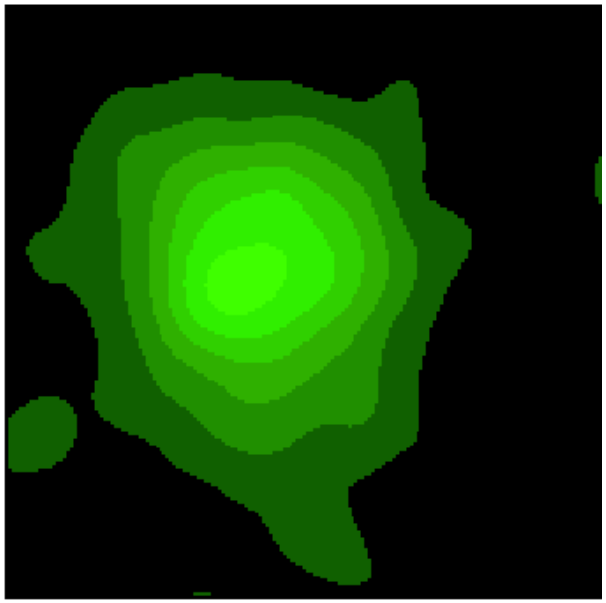
(both types of cells are selective for orientation)

a complex cell cannot distinguish if light switched on then off or the other way around, but we have simple cells that also feed brain with information

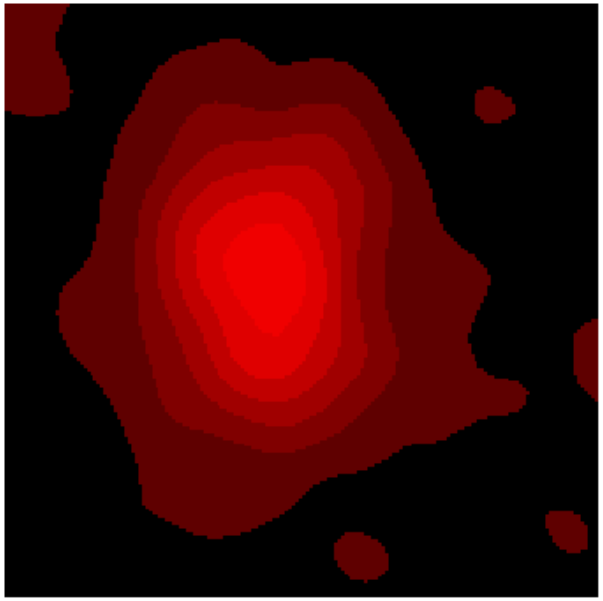
Receptive field of a complex cell

ganglion cells do not know orientaiton of bar, since their RF is circular, so they dont know about orientation of bar. also same case as in LGN. not so in V1





Responses to white dots

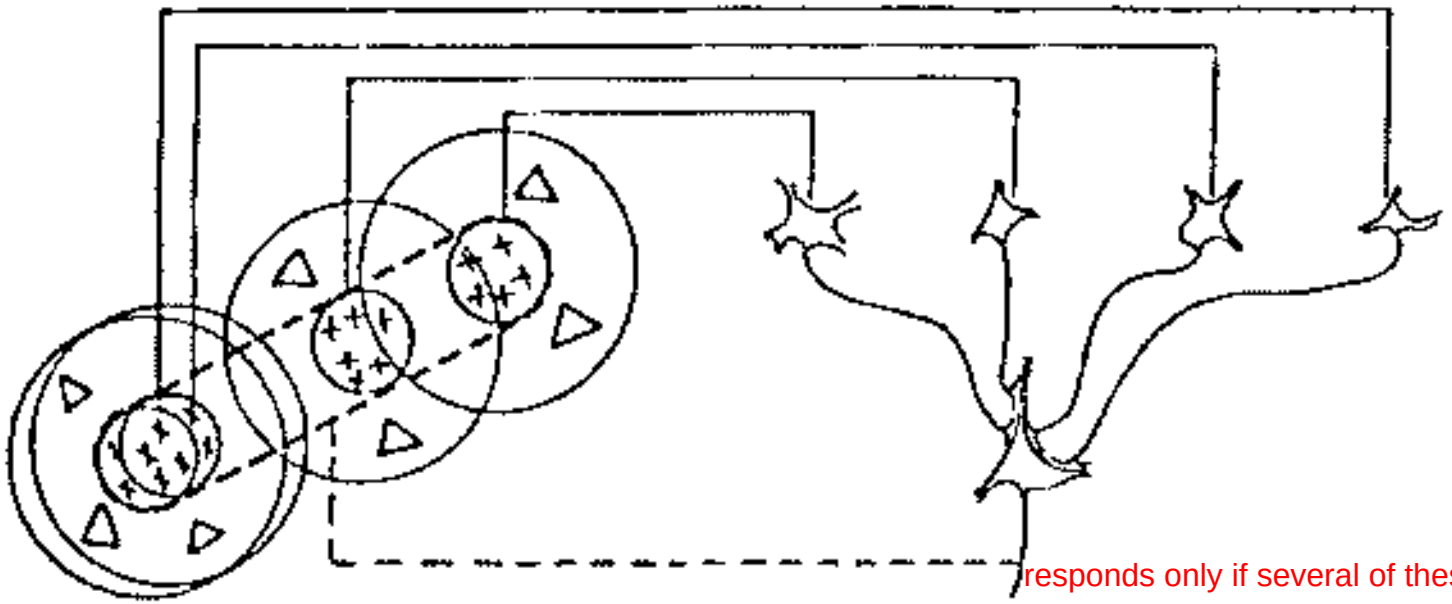


Responses to black dots

DeAngelis, Ohzawa & Freeman (1995)

Hubel & Wiesel's feedforward model of simple cells

in simple cells, strength of ON or OFF center is equally strong



LGN cells

Simple cell

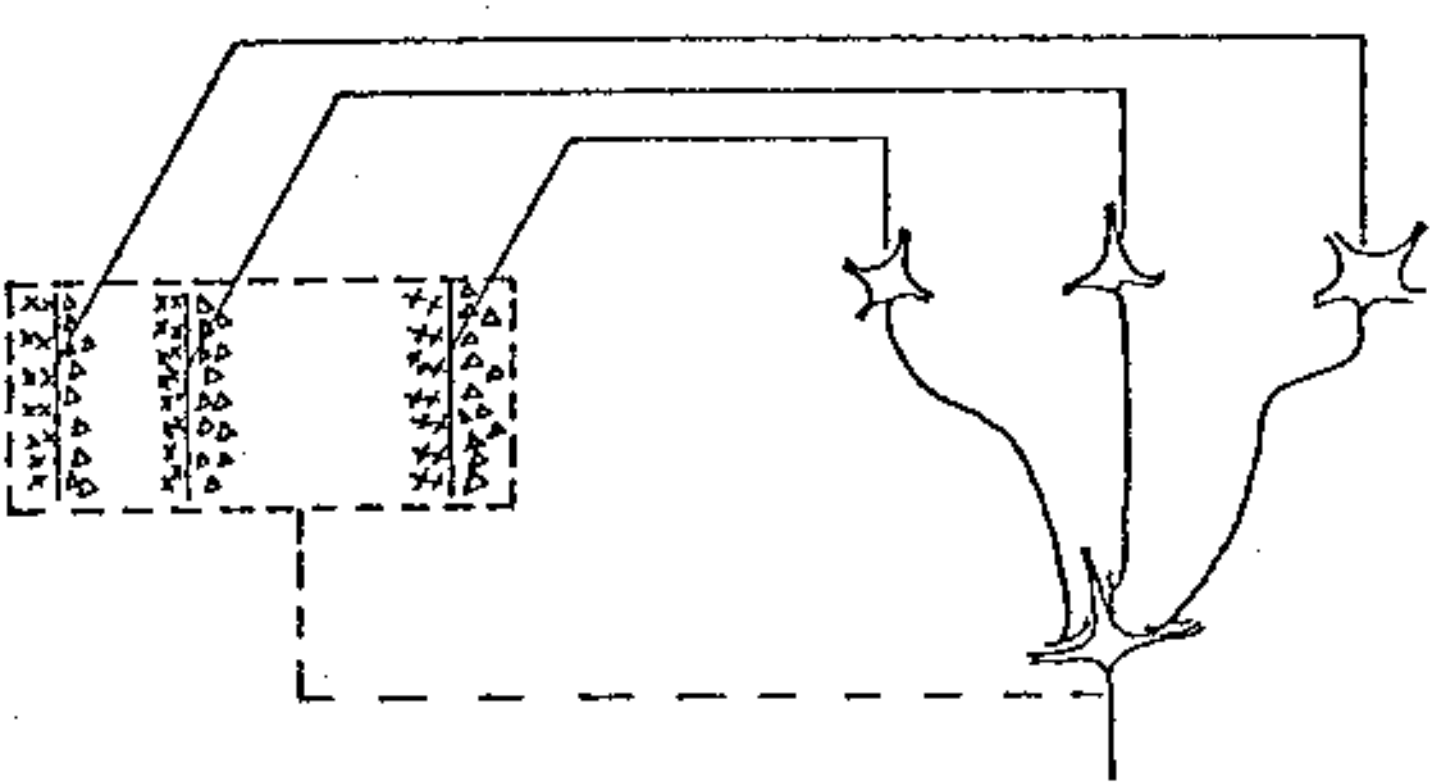
responds only if several of these upper cells make an AP

Receptive fields

Brain

Hubel & Wiesel (1963)

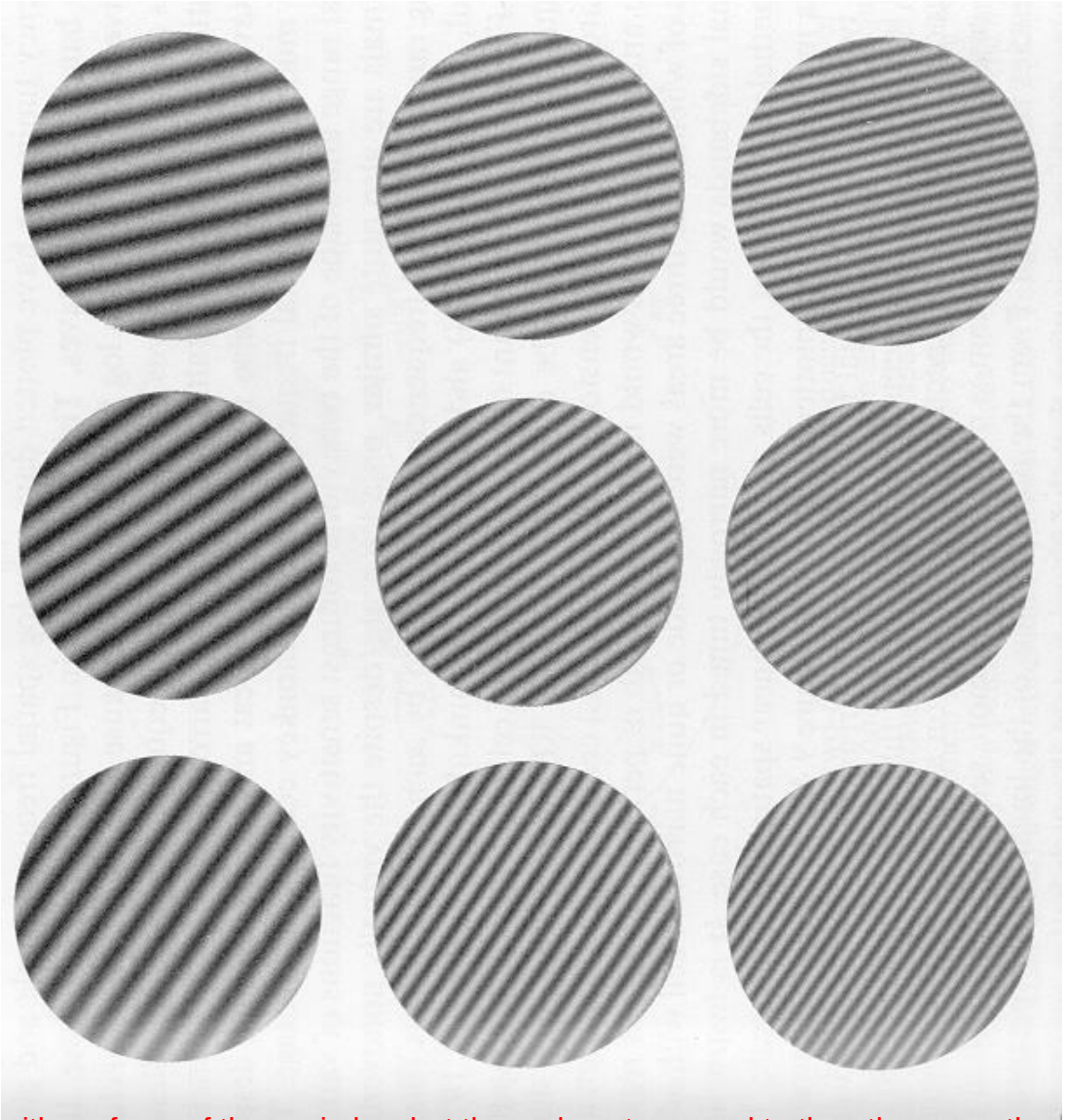
Hubel & Wiesel's feedforward model of complex cells



what they meant is that the RF overlap, but in inverted ways, to the complex cell inherits both RF (which are like the opposite of each other actually). Also, complex cells receive input from LGN cells directly and not only from simple cells

Hubel & Wiesel (1963)

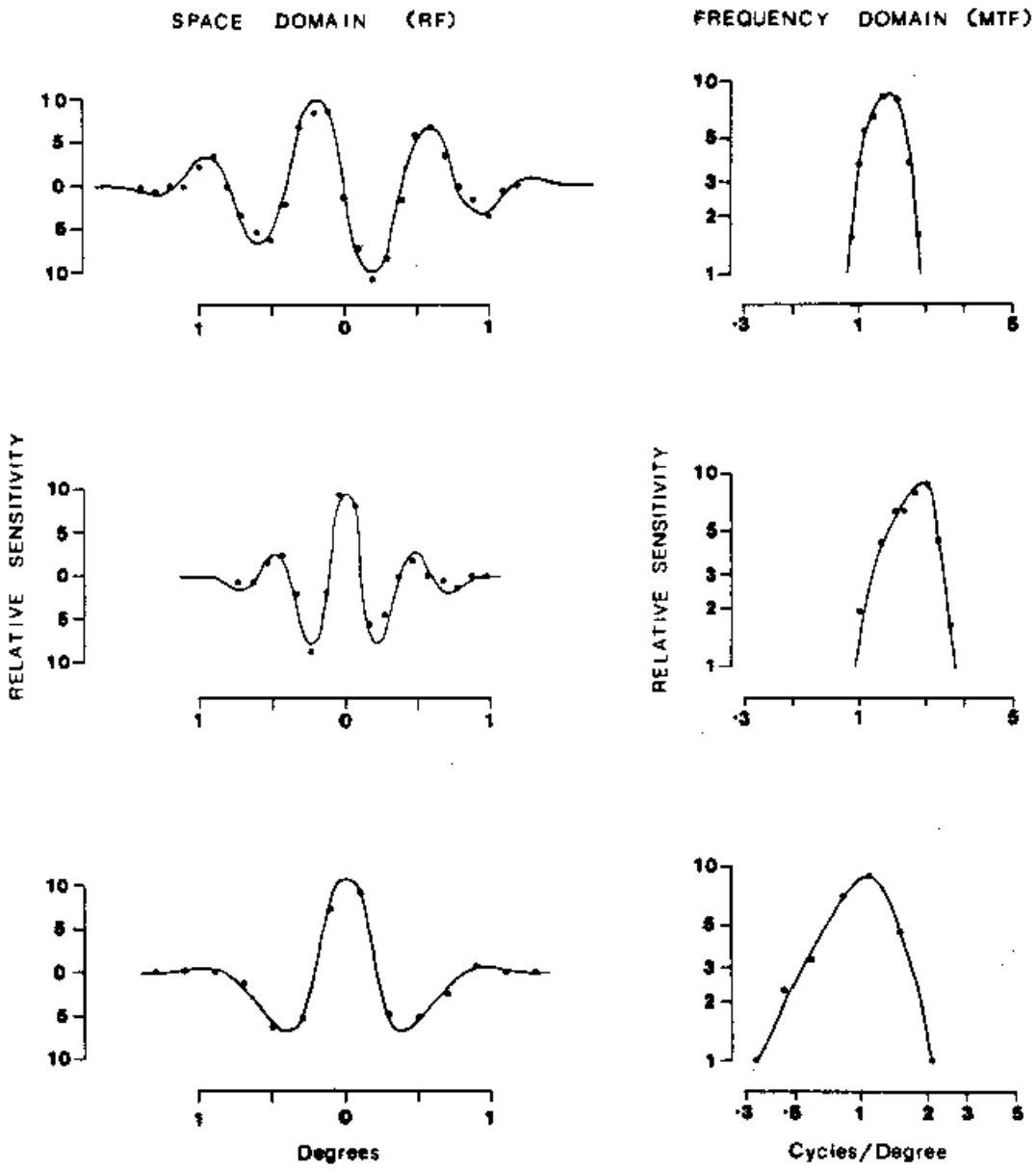
Selectivity in V1 is extremely sharp



we have cells that respond to either of any of these circles, but those do not respond to the other ones then due to very high specificity

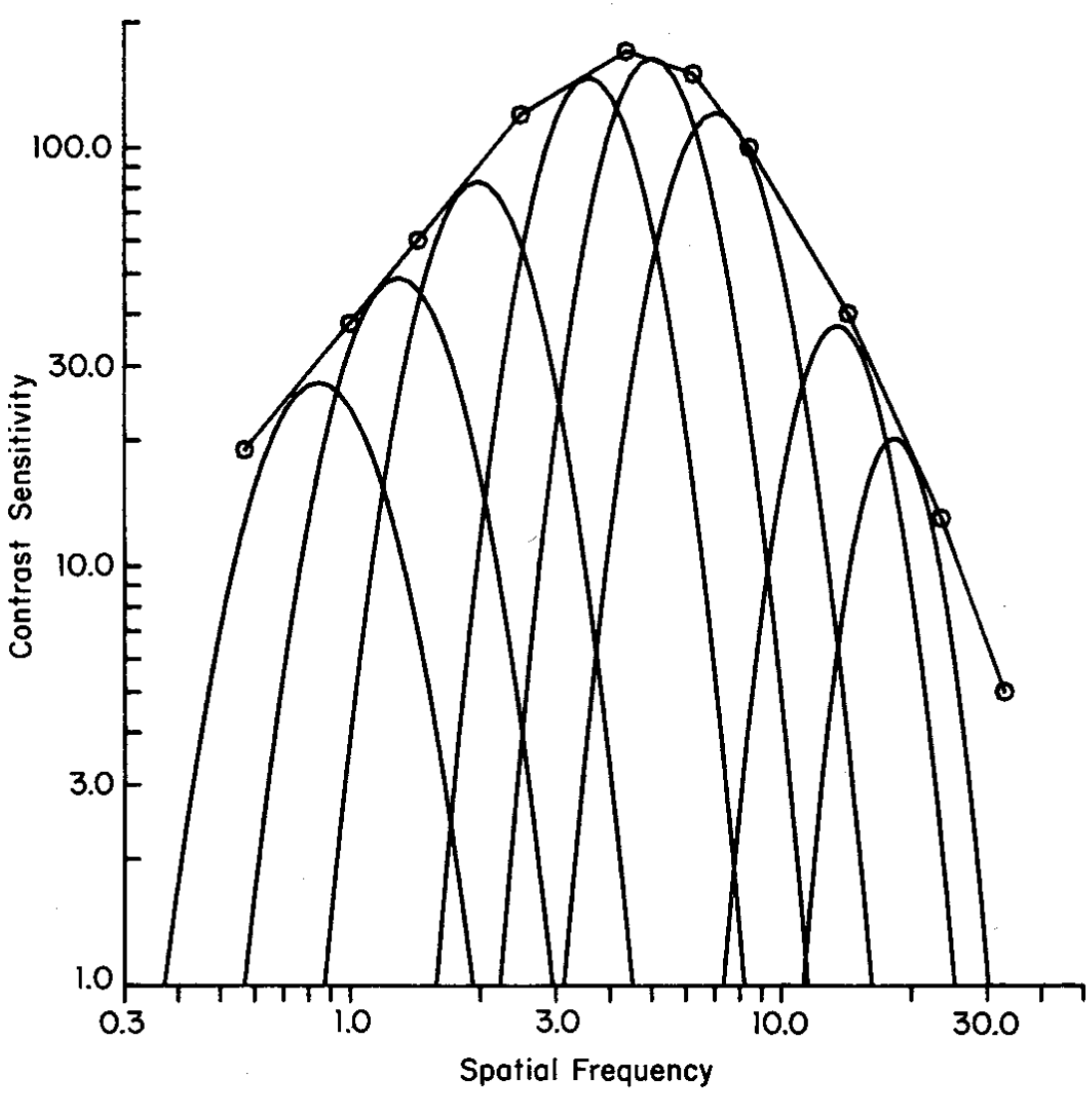
De Valois & De Valois (1990)

Sharpness of tuning depends on number of subfields



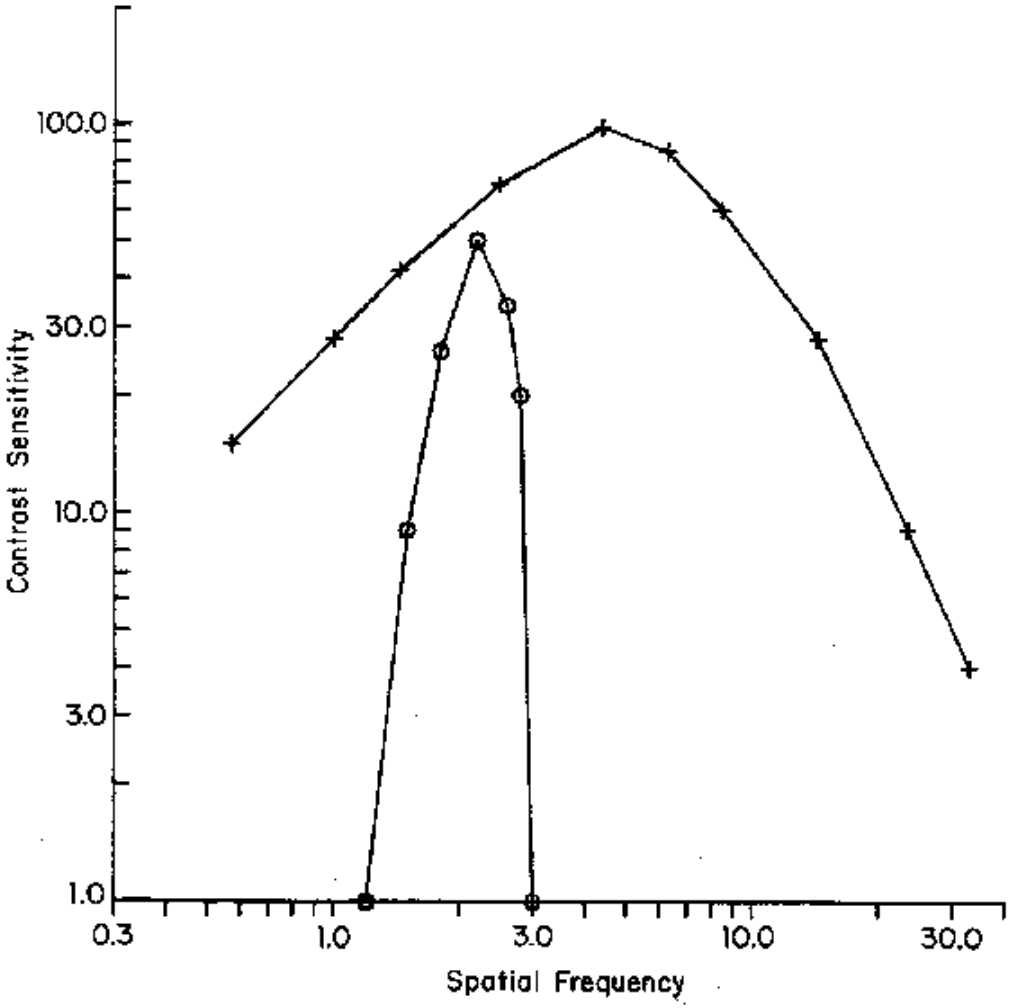
De Valois & De Valois (1990)
Albrecht (1978)

Back to the model of perceptual sensitivity



De Valois & De Valois (1990)

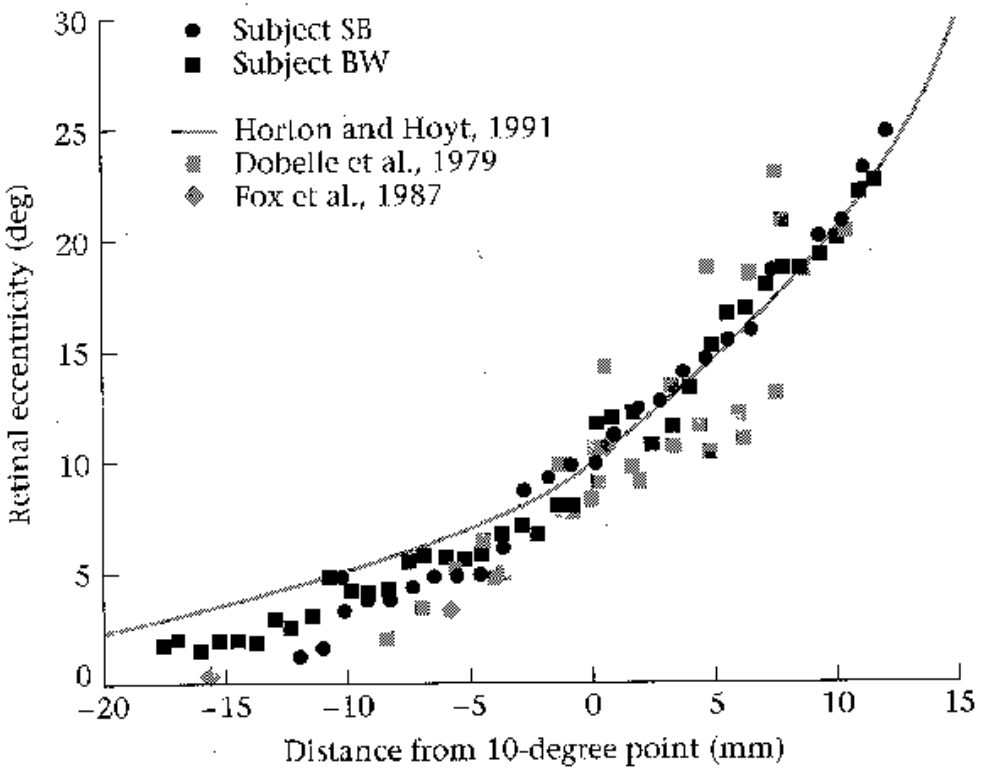
Perceptual and neural sensitivity: data from a monkey



De Valois & De Valois (1990)

Retinotopy

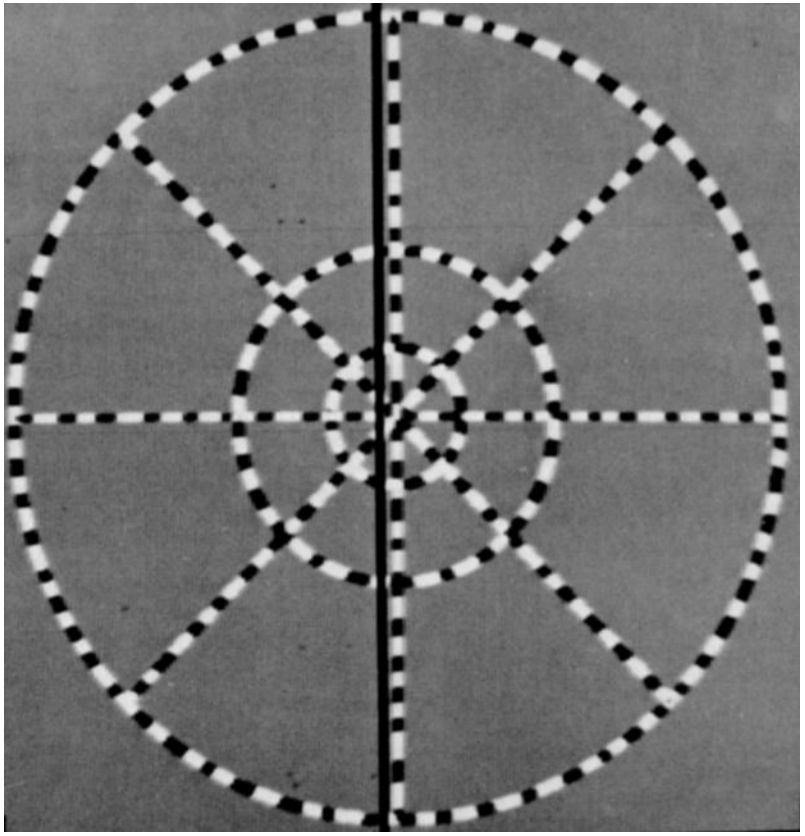
Cortical magnification

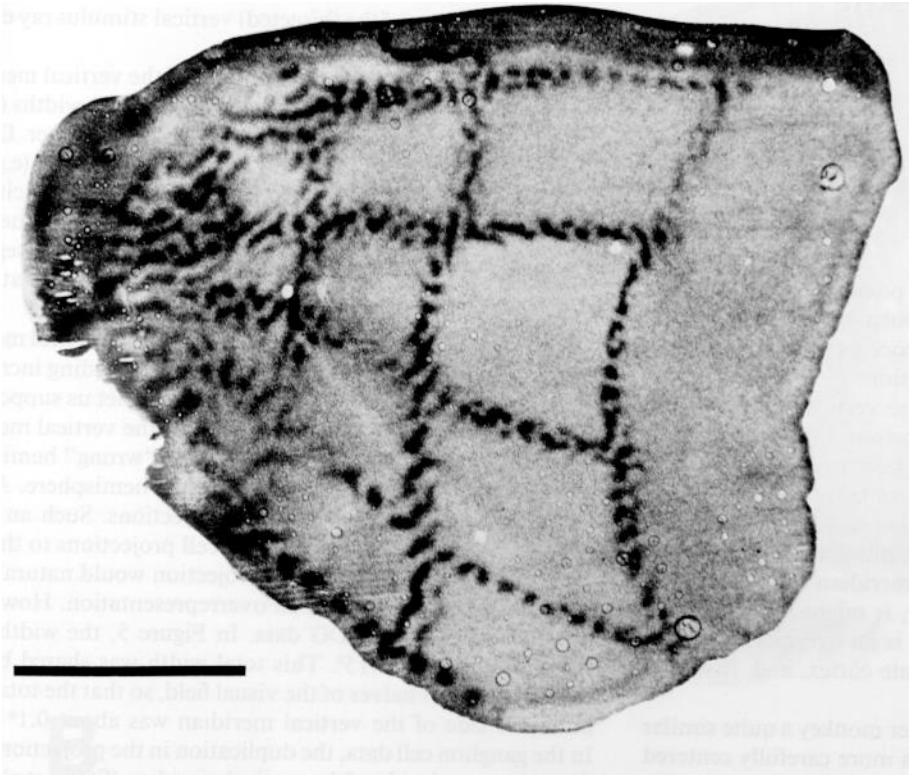


Methods:
- fMRI
- estimate from strokes + primate cells
- microstimulation in a blind volunteer
- PET in 5 observers

Engel et al. (1994)
in Wandell (1995)

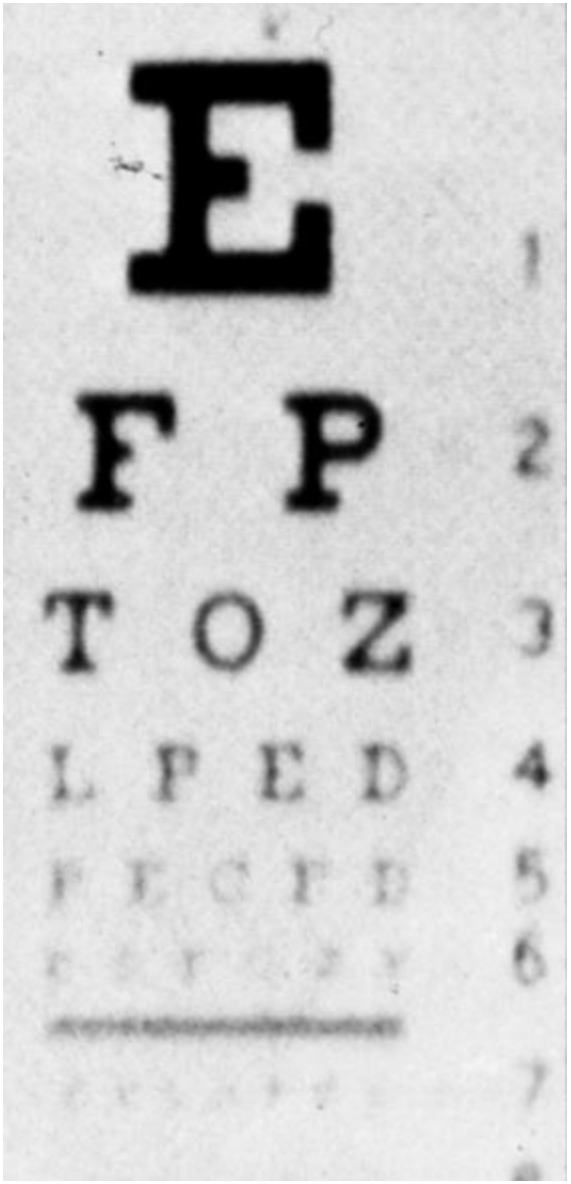
Cortical representation measured with 2-deoxy-glucose



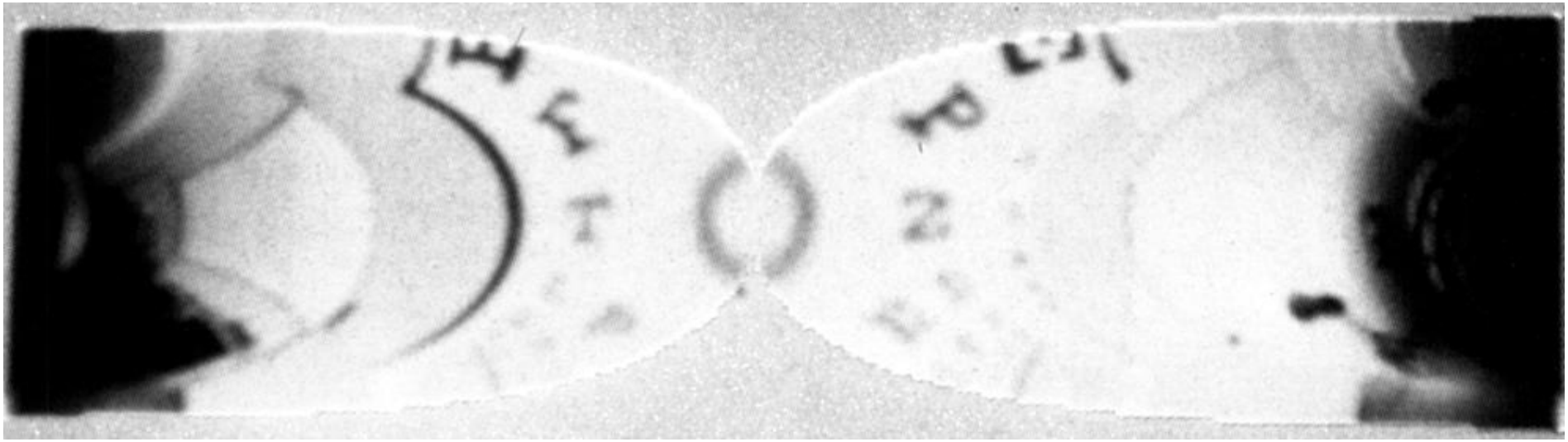


Tootell et al. (1988)

Schwartz et al. (1988)



Schwartz et al. (1988)



Schwartz et al. (1988)
Frederick and Schwartz (1990)

Questions for Next week :

1) Consider Hubel and Wiesel's model of simple cells. Why does it respond more to one orientation than to the orthogonal one?

2) How does Hubel and Wiesel's model of complex cells explain the receptive field properties of complex cells?

3) Imagine a simple cell whose receptive field fills the whole retina, and thus has a very large number of equally spaced long subfields (it is an example! there are no cells like that!). Would such a cell be very selective for orientation and spatial frequency? Explain why.