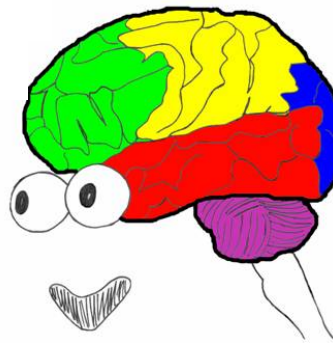


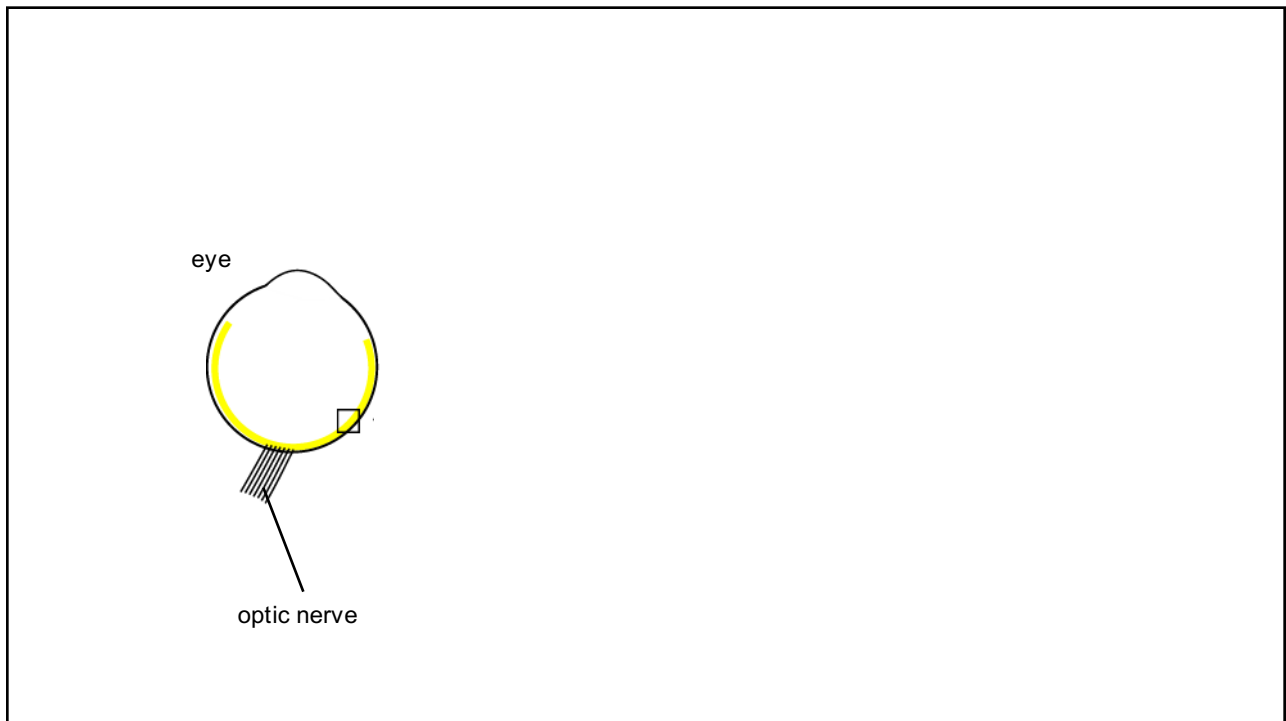
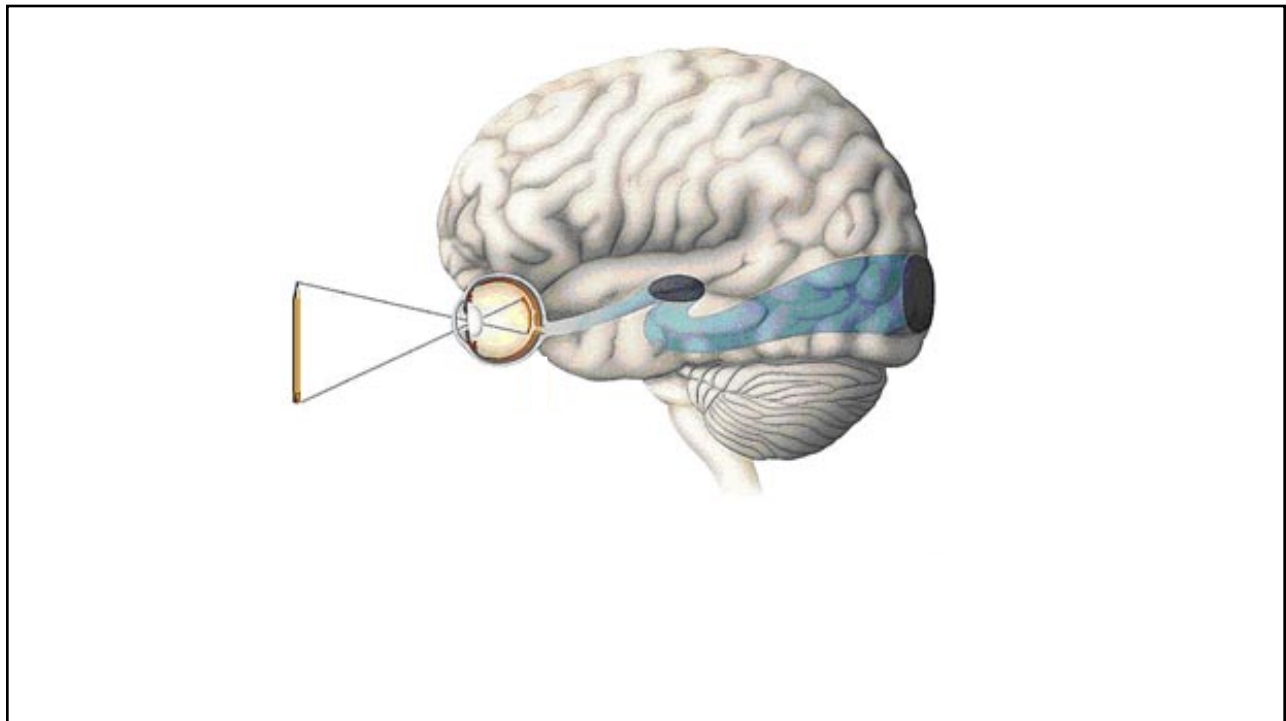
Hierarchical Visual processing and receptive fields (STAs and beyond)

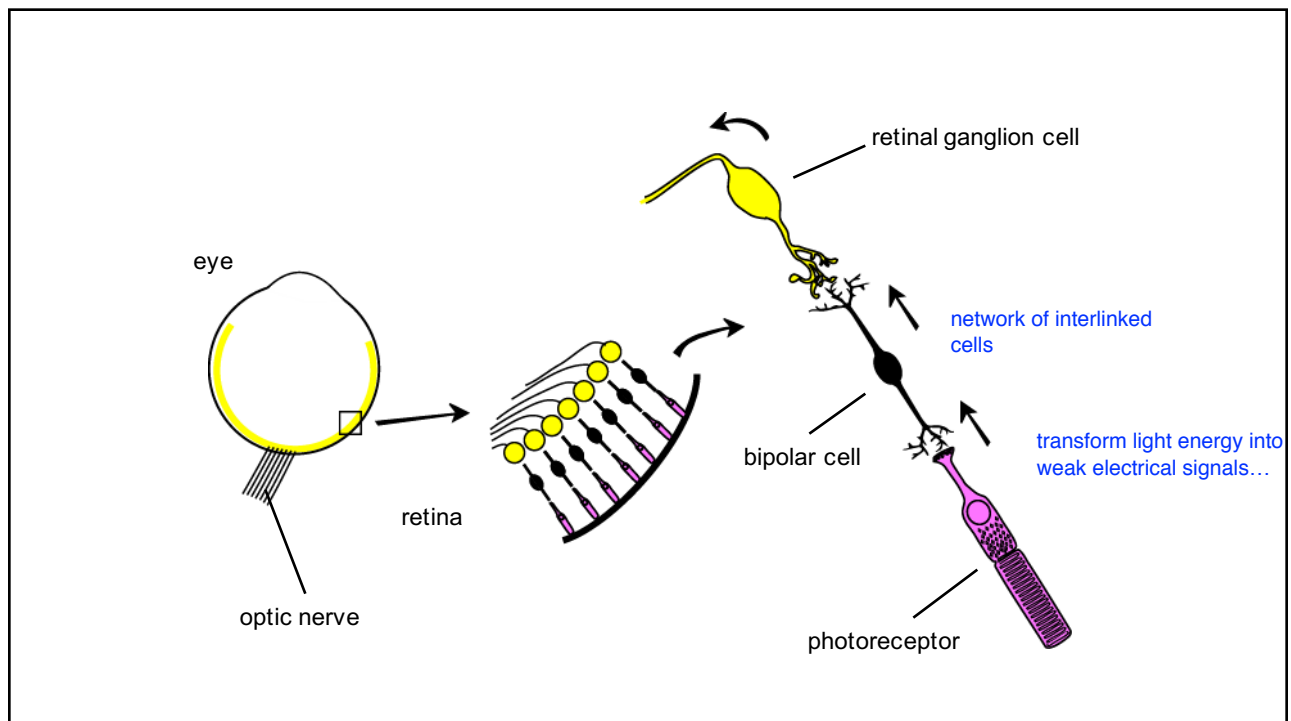
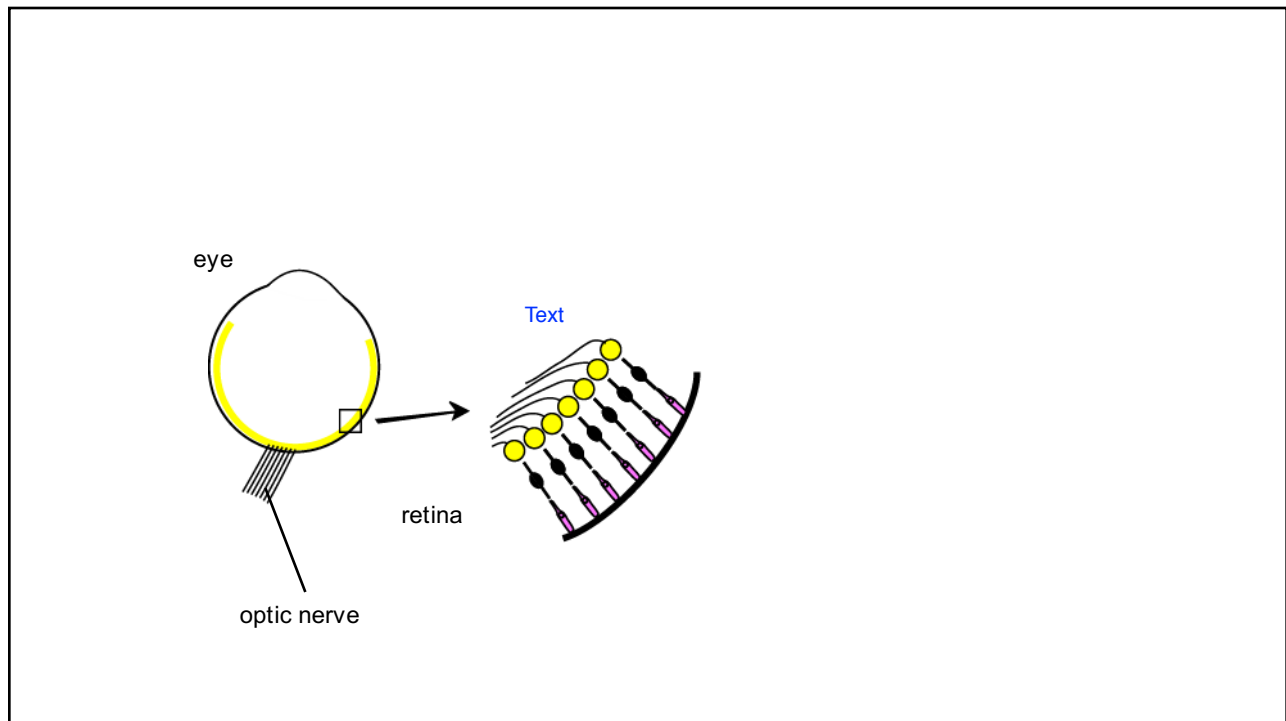
Spike Triggered Averages



AMATH 342

Many thanks to Dr. Yasmine El-Shamayleh,
Dr. Helen Sherk and Abishek De for slides and
images

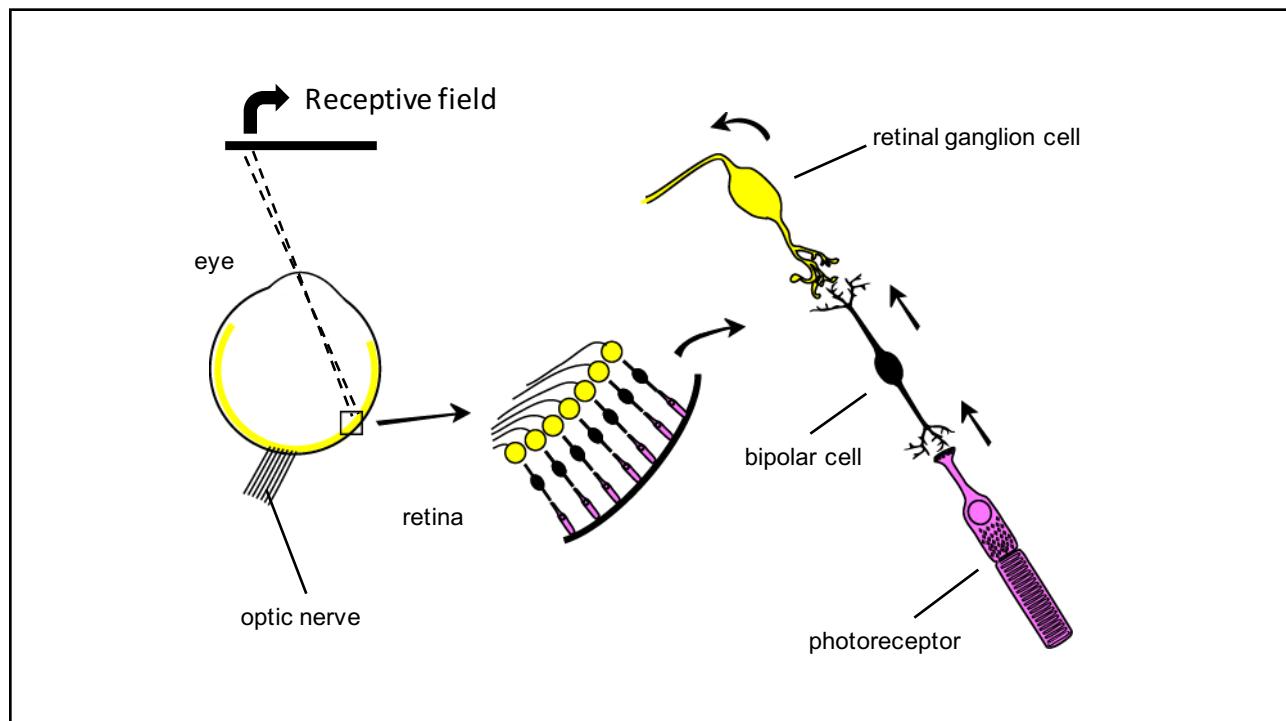


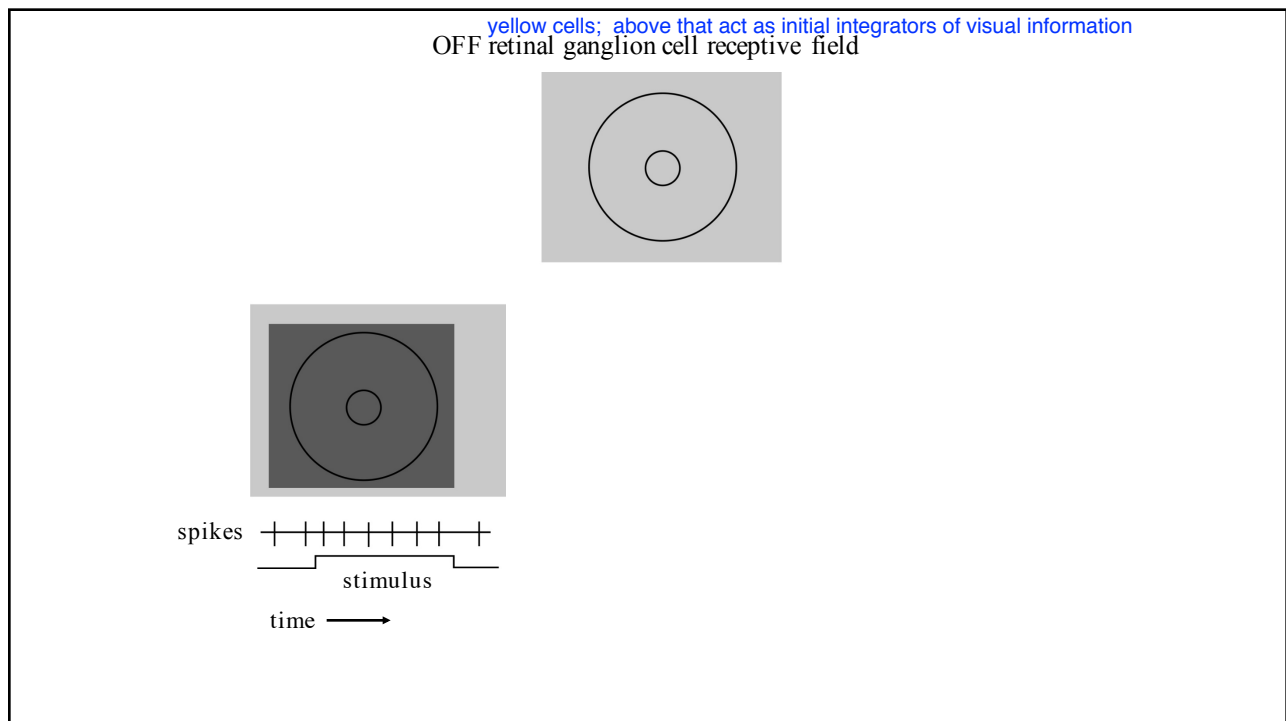
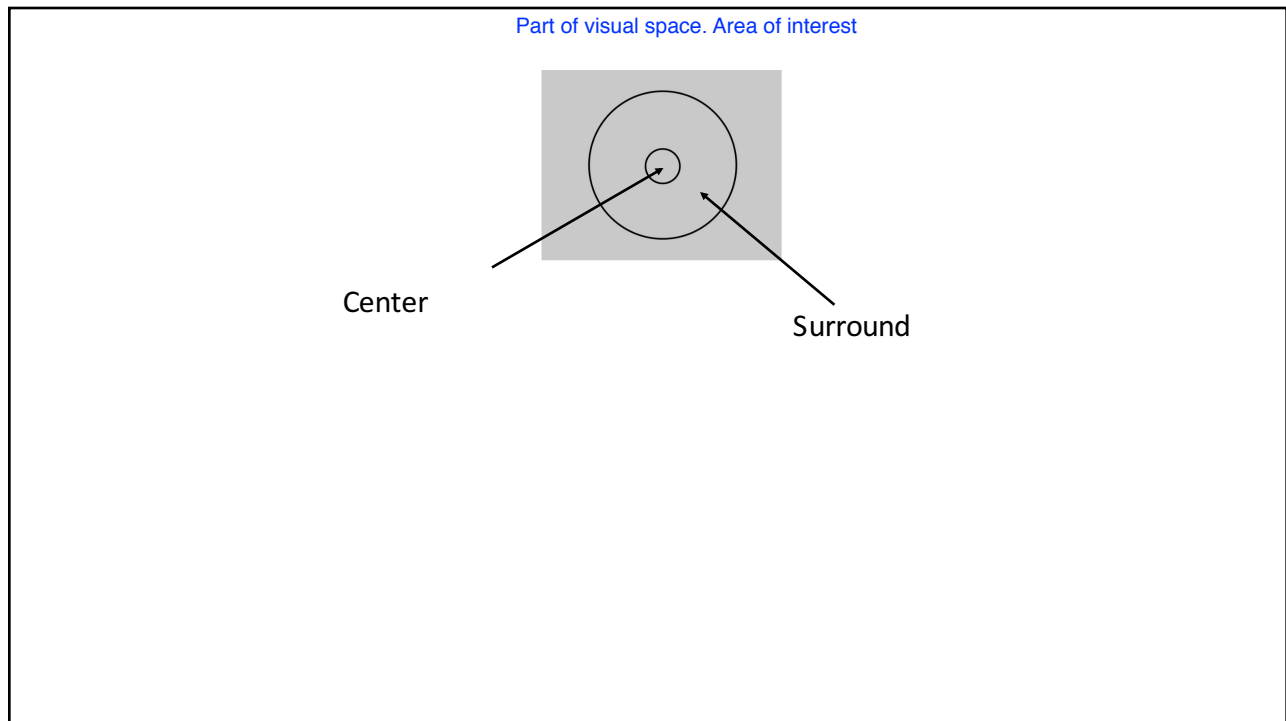


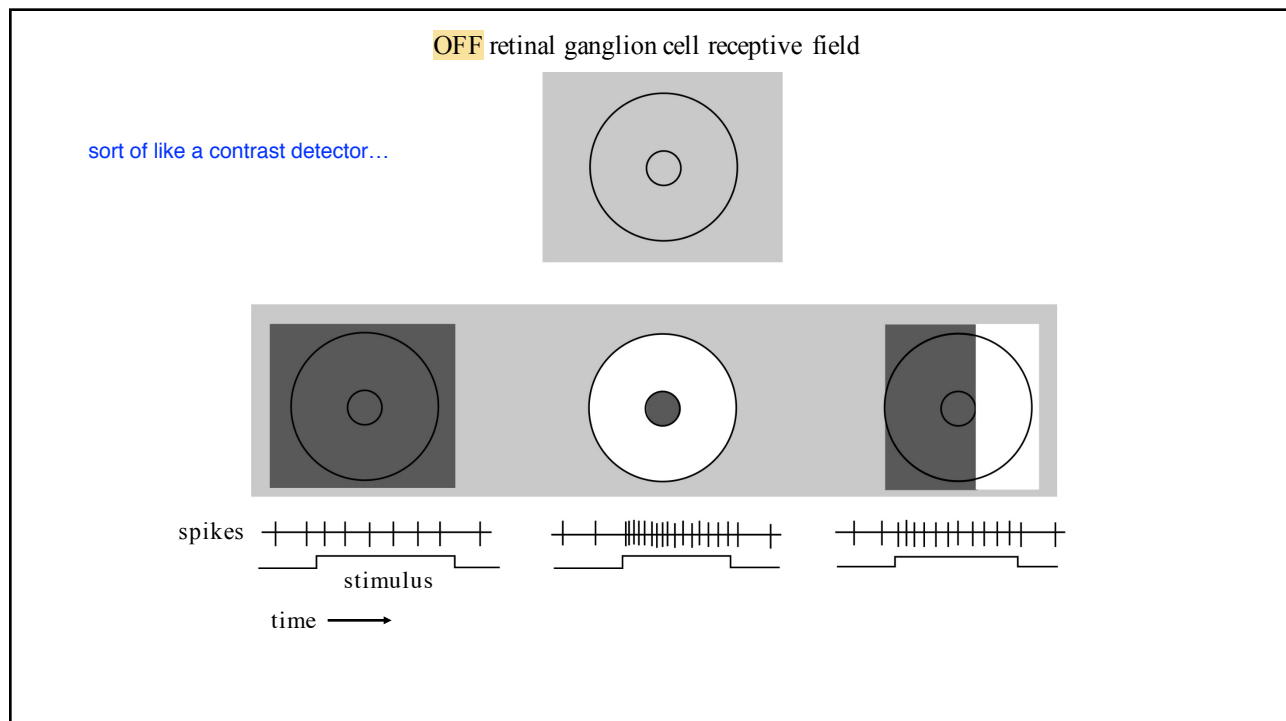
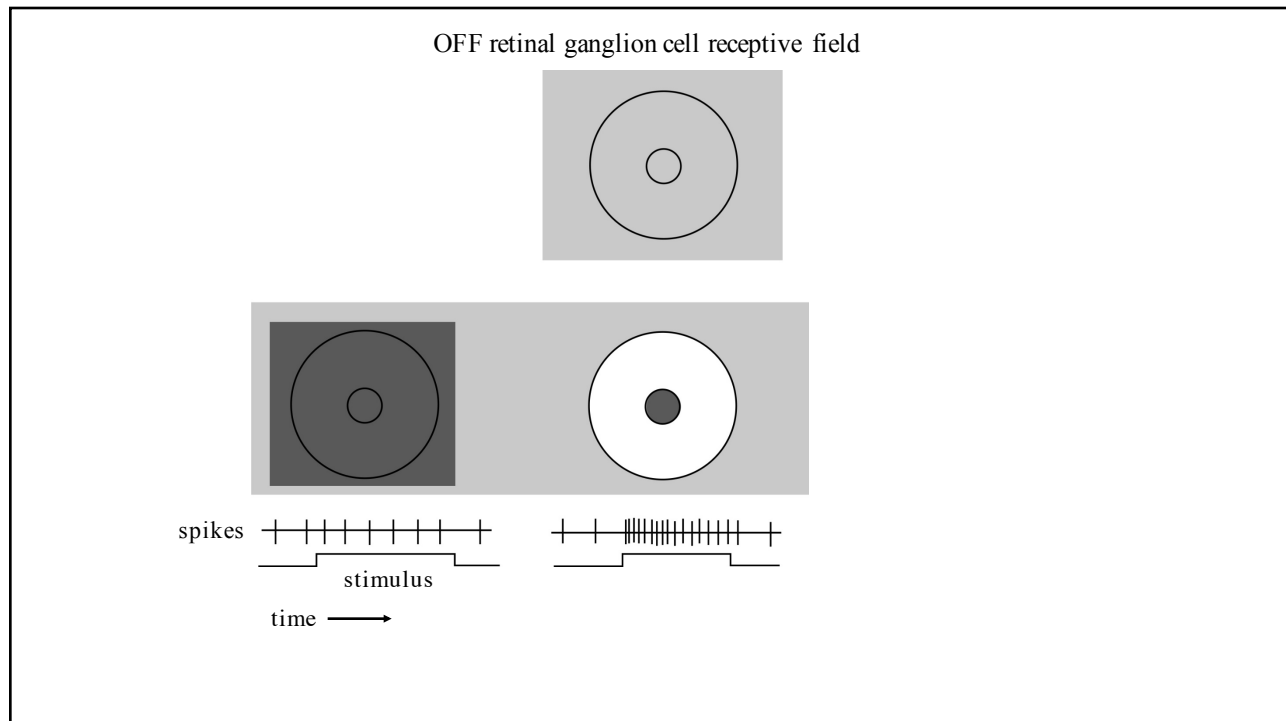
What is a “receptive” field?

Range of stimuli that triggers firing of neuron

- Particular region in sensory space that triggers the firing of a neuron
- Sensory space has an associated template which the cell responds to
- Exists for sensory modality like visual, auditory and somatosensory system
- Term coined by Sherrington to describe the area of a skin that elicits a scratch reflex in a dog
- Visual system => receptive field ----- visual space







- Firing rate of an ON-center RGC decreases as the diameter of the illumination spot increases.
- Firing rate of an OFF-center RGC increases as the diameter of the illumination spot increases.

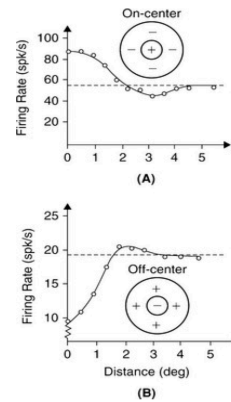
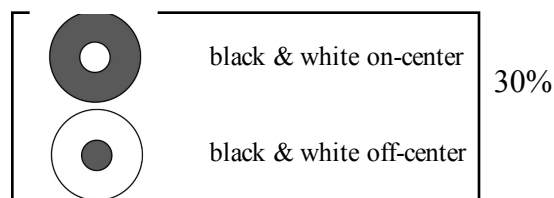
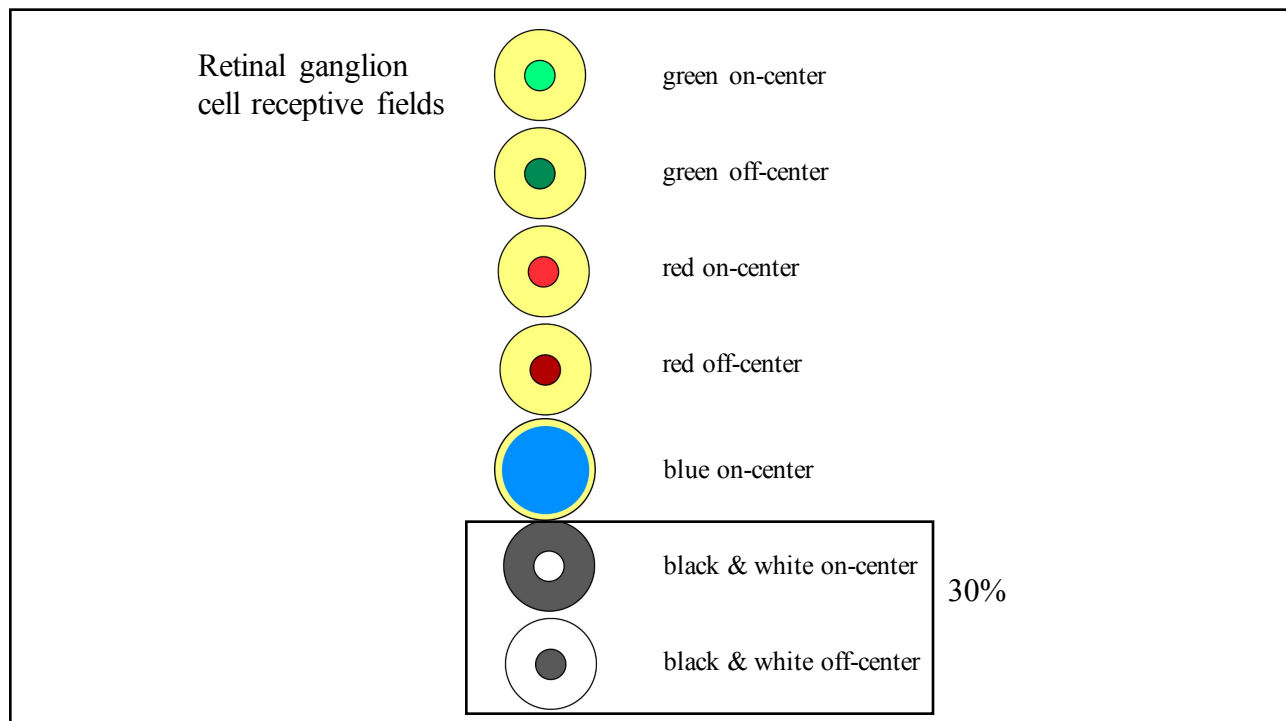
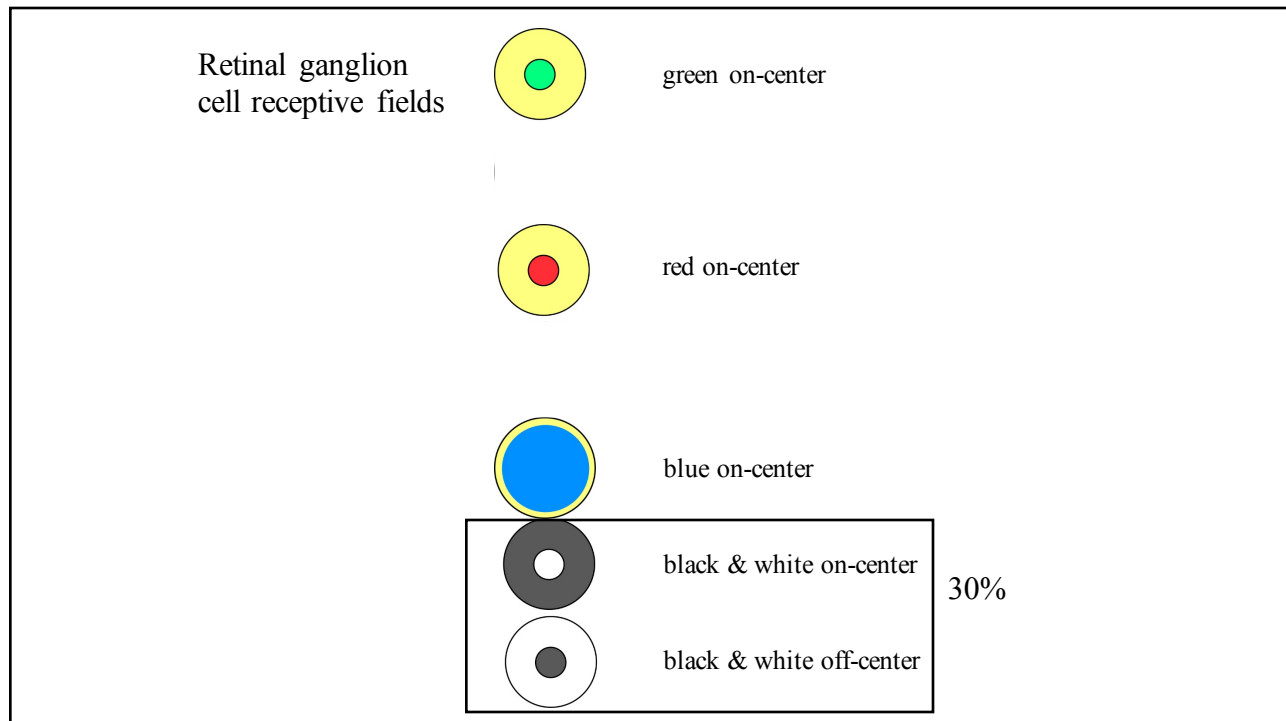
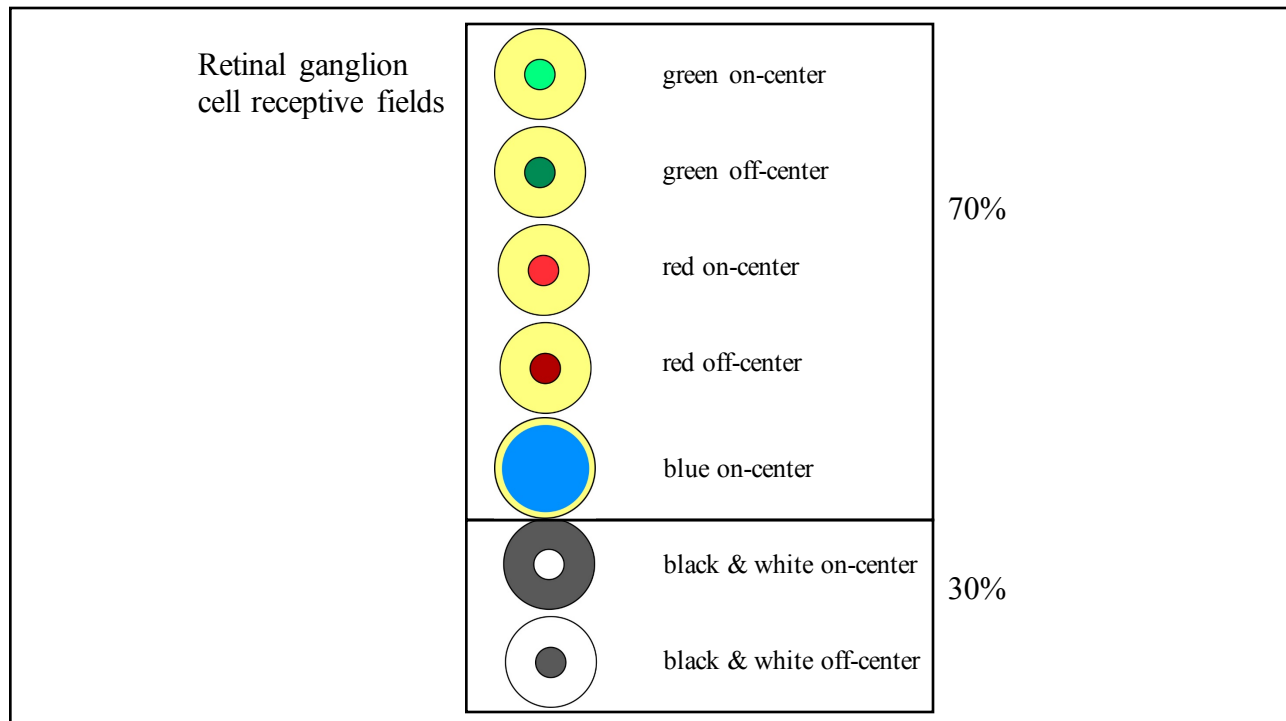


FIGURE 20.3 Average firing rate in response to a spot of light for an ON-center (A) and OFF-center (B) retinal ganglion cell of the cat as a function of the distance from the center of the receptive field. The dashed line represents the spontaneous activity level. Note that inhibitory regions do not exactly counterbalance excitatory ones. Therefore these neurons convey some information about the average luminance of stimuli in their receptive fields, in addition to their spatial contrast.

Retinal ganglion
cell receptive fields





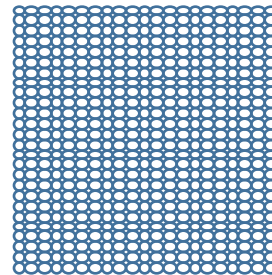


“What” are the RGCs doing ?

Input image
(cornea)



Input image
(cornea)

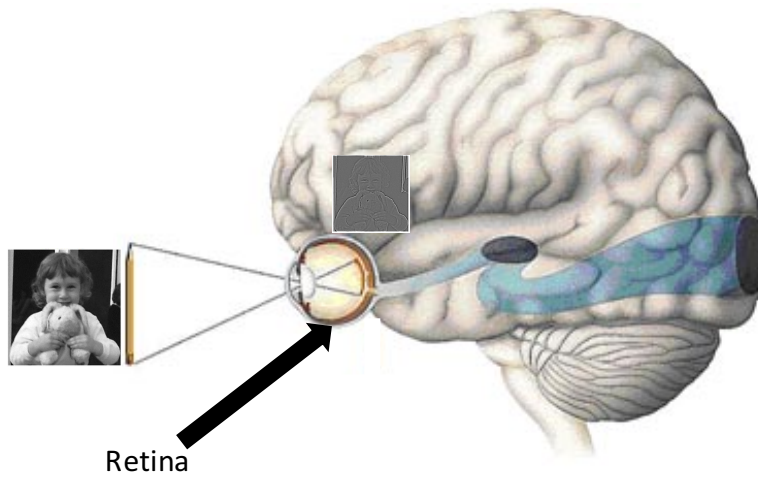
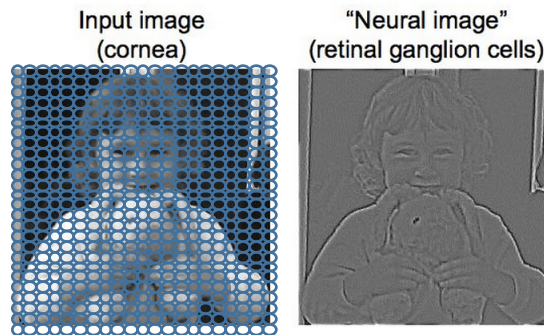


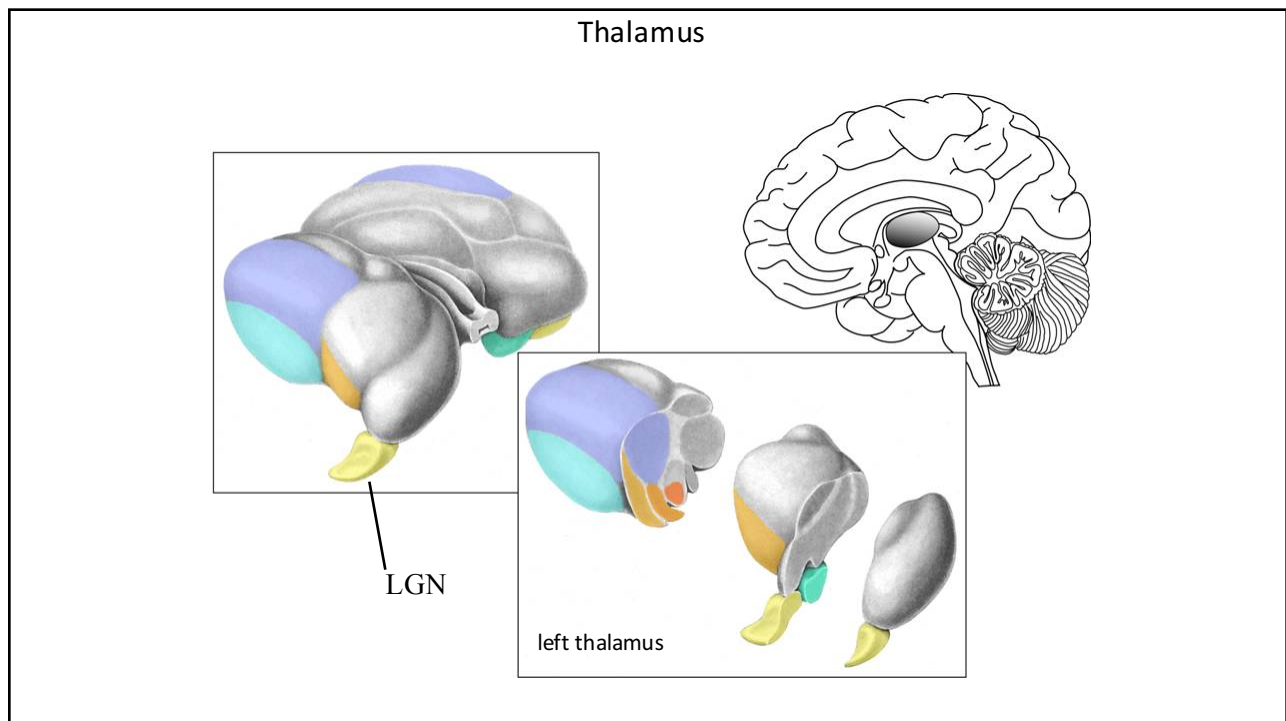
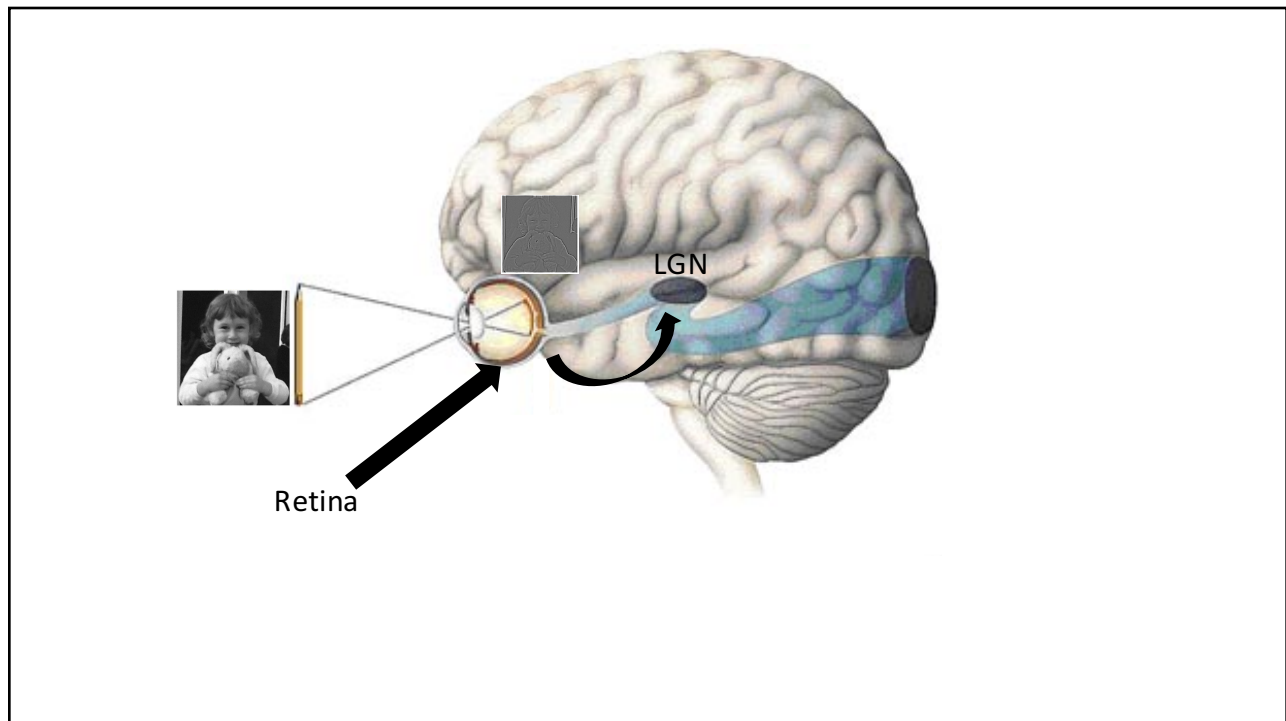
RETINA



Retinal ganglion cells respond to edges

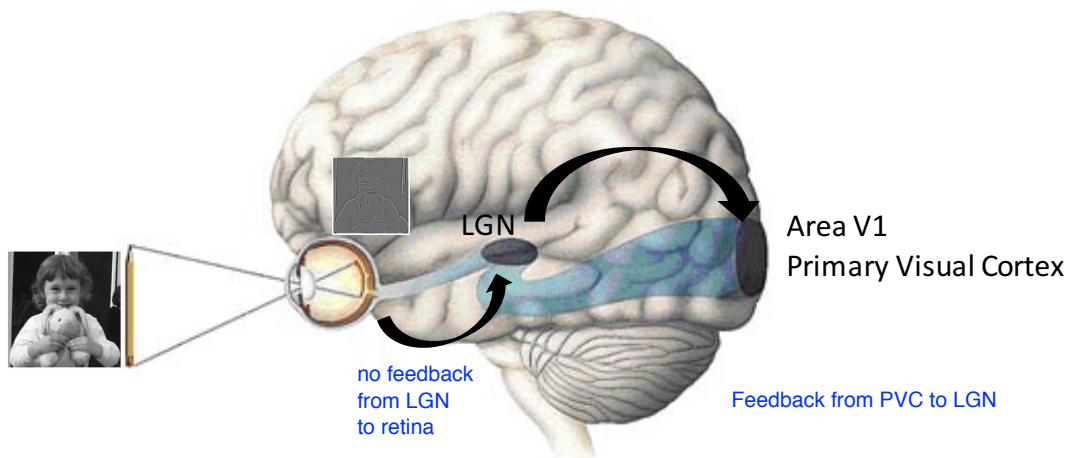
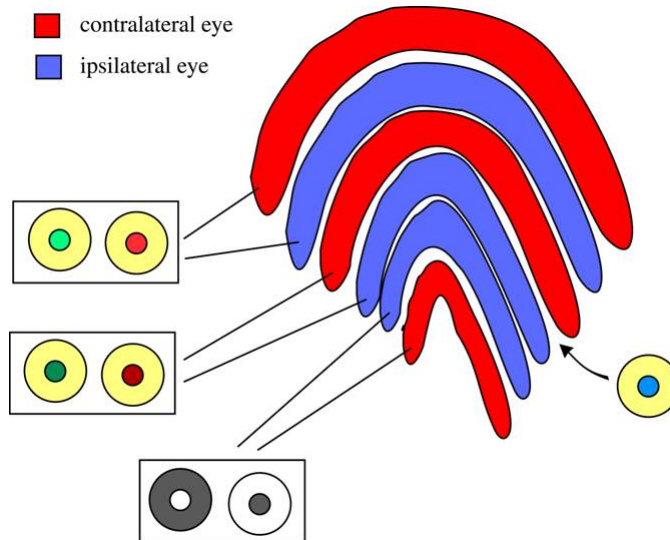
By measuring the contrast,
high firing cells correspond
to high firing rates.
Can show some aspects of edges



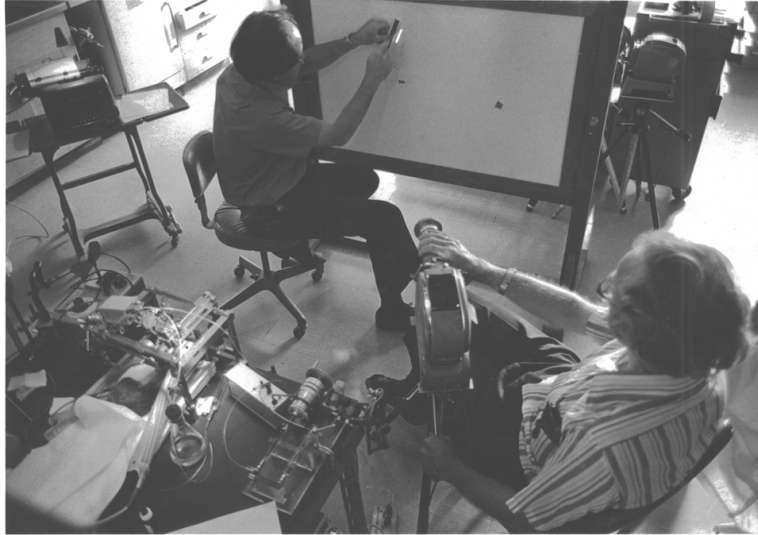


Major integrator of information before sending it out to the rest of brain (visual cortex) for more complex processing

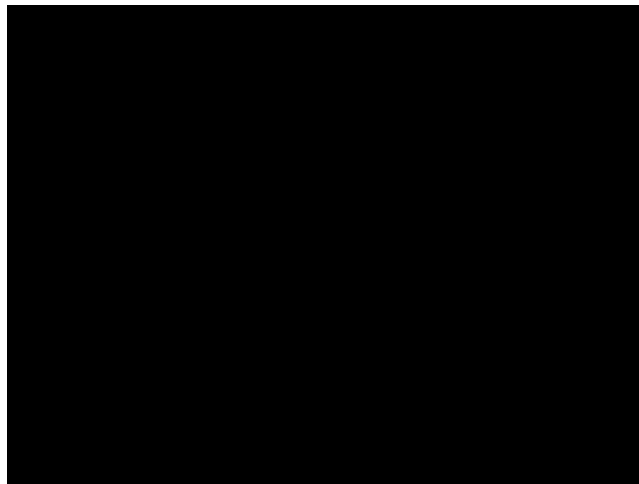
LGN has similar receptive field structure as retinal ganglion cells



Earliest attempt to find the receptive field template of V1 cells



Hubel and Weisel V1 Video

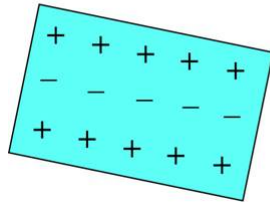


<https://www.youtube.com/watch?v=8VdFf3egwfg>

Area V1 has two different kinds of cells based on their response properties

simple cell

small region in which there is a response

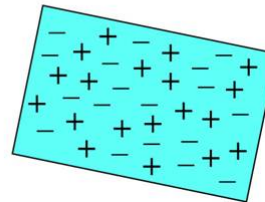


very specific; orientation and in space

can be obtained via spike triggered averages...

complex cell

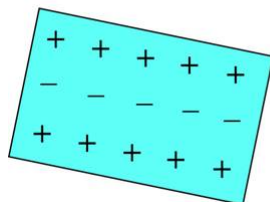
large area of response...



very specific in orientation, but location in space not as important
Invariance!

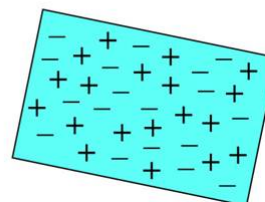
Area V1 has two different kinds of cells based on their response properties

simple cell



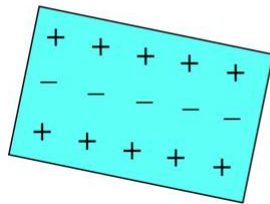
Selective

complex cell



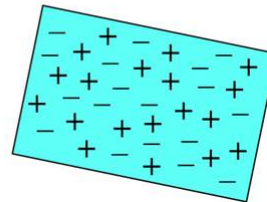
Area V1 has two different kinds of cells based on their response properties

simple cell



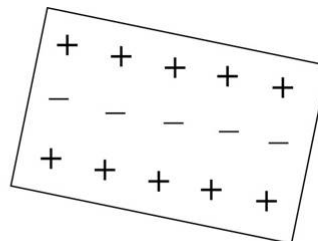
Selective

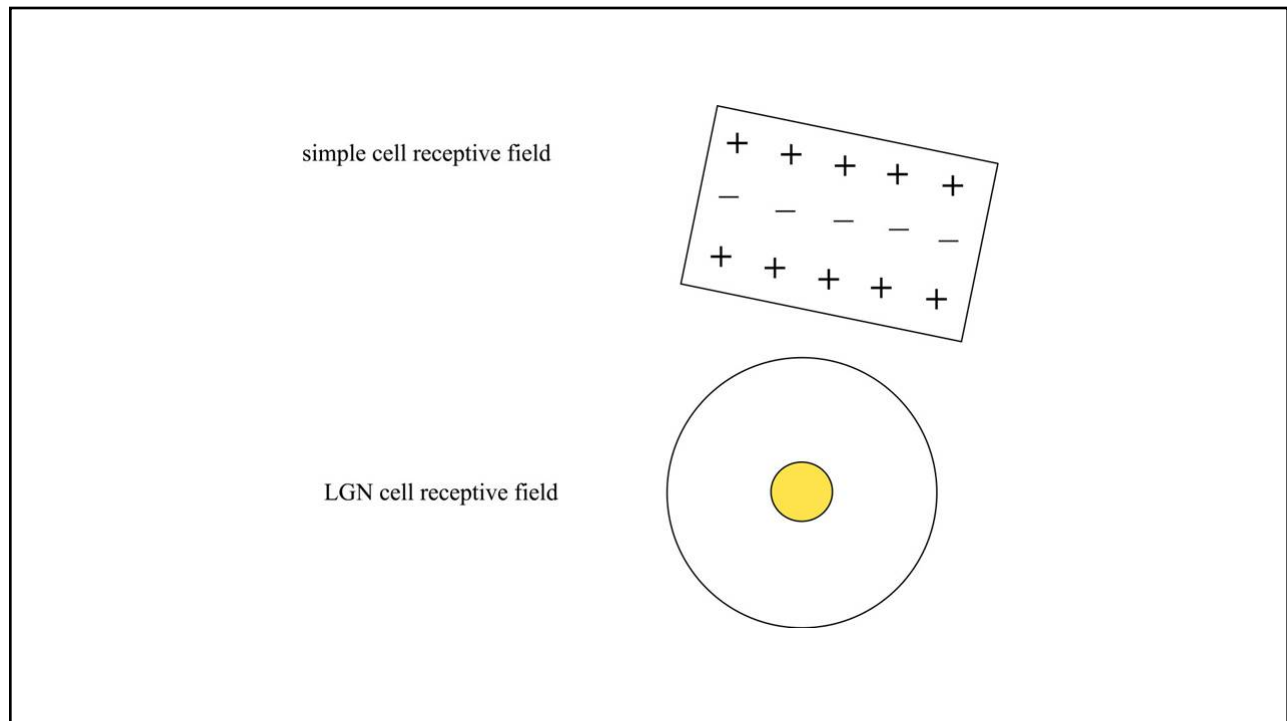
complex cell



Invariant

simple cell receptive field



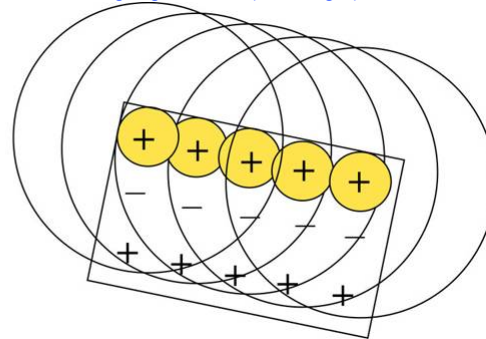


How is receptive field structure of simple cell derived from LGN cells?

Many LGN cells project to a simple cell to form elongated receptive field structure

Yellow circles = ON ganglion cells (fire in light)

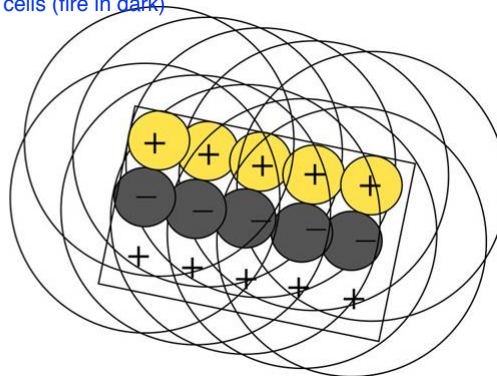
simple cell receptive field



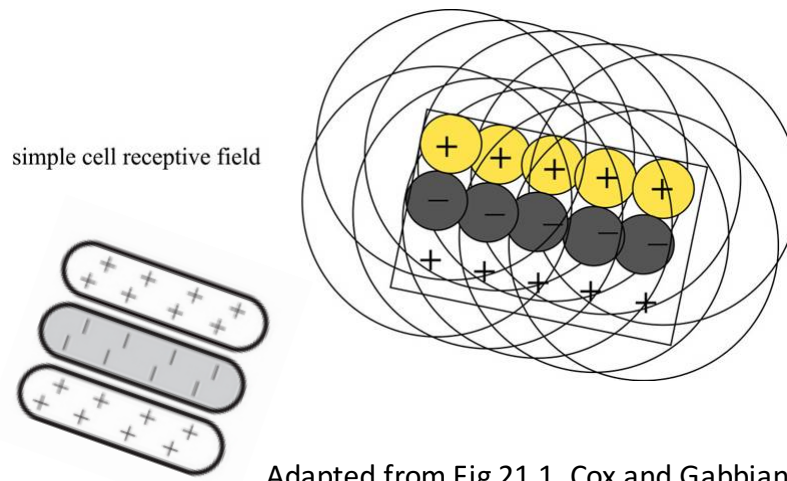
Many LGN cells project to a simple cell to form elongated receptive field structure

BLACK dots = OFF Ganglion cells (fire in dark)

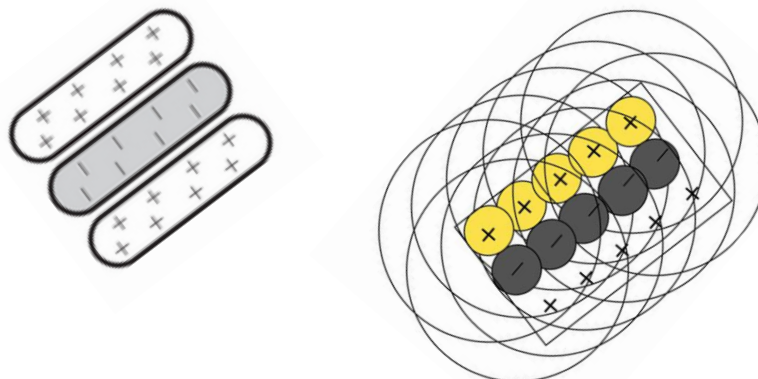
simple cell receptive field



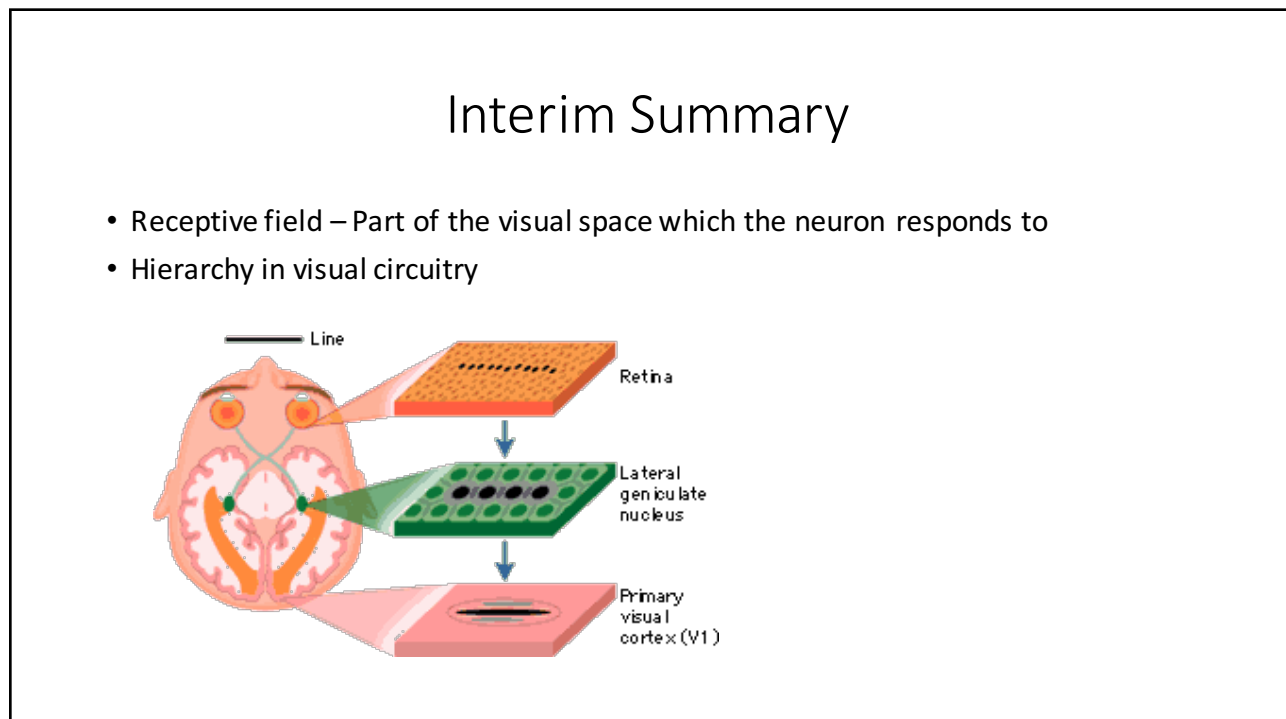
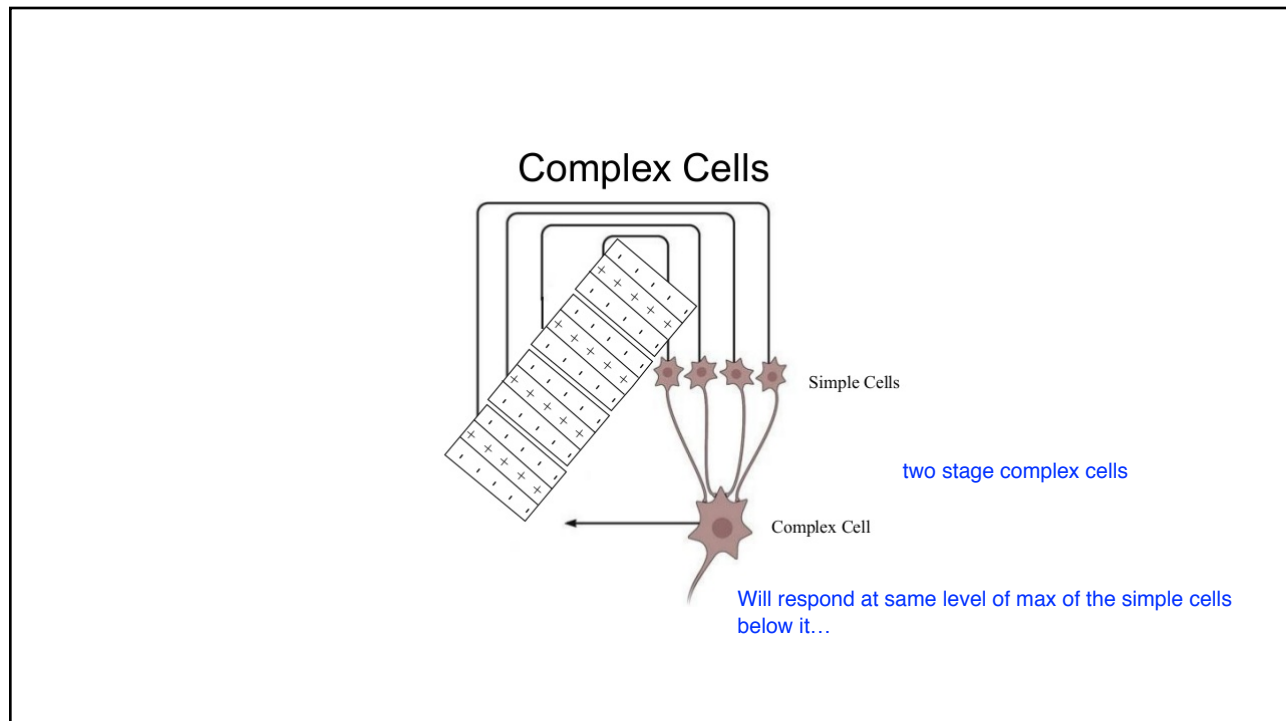
Many LGN cells project to a simple cell to form elongated receptive field structure



Many LGN cells project to a simple cell to form elongated receptive field structure

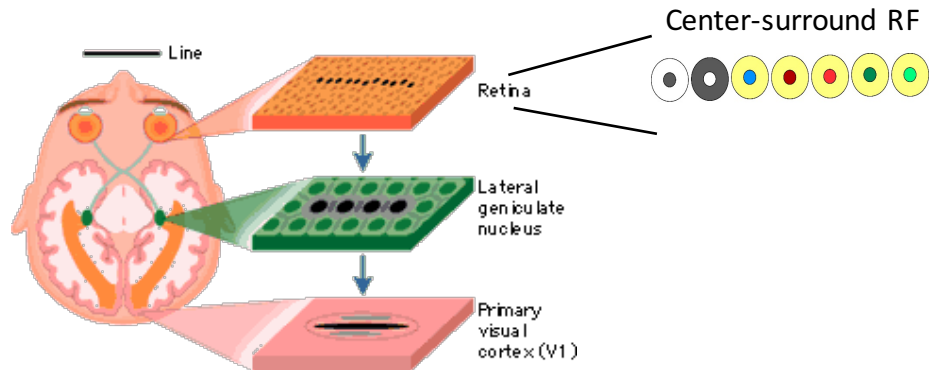


Adapted from Fig 21.1, Cox and Gabbiani



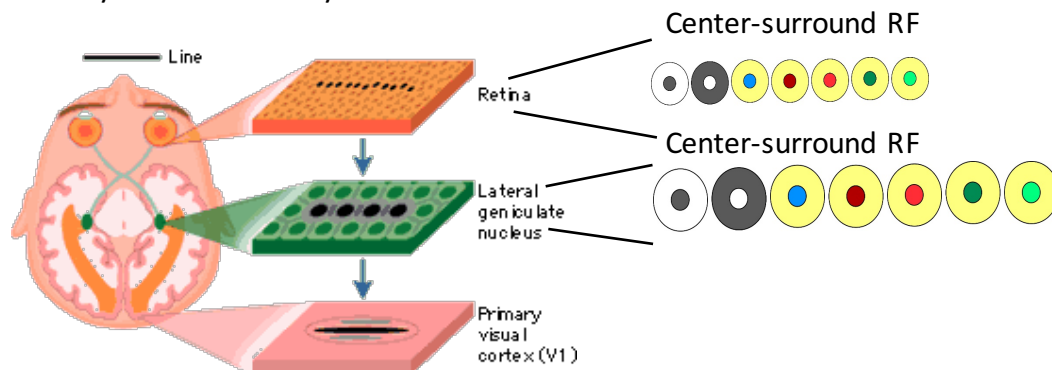
Interim Summary

- Receptive field – Part of the visual space which the neuron responds to
- Hierarchy in visual circuitry



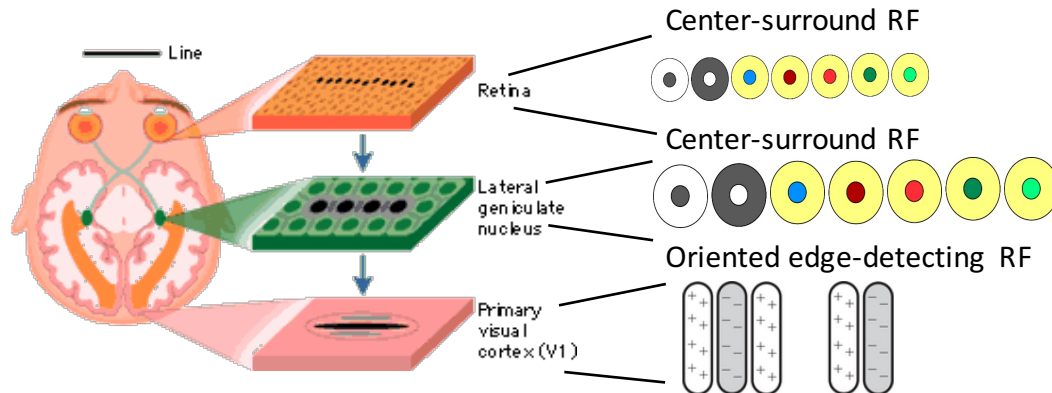
Interim Summary

- Receptive field – Part of the visual space which the neuron responds to
- Hierarchy in visual circuitry



Interim Summary

- Receptive field – Part of the visual space which the neuron responds to
- Hierarchy in visual circuitry



What about feedback from PVC to LGN?

Interim Summary

- Receptive field – Part of the visual space which the neuron responds to
- Hierarchy in visual circuitry

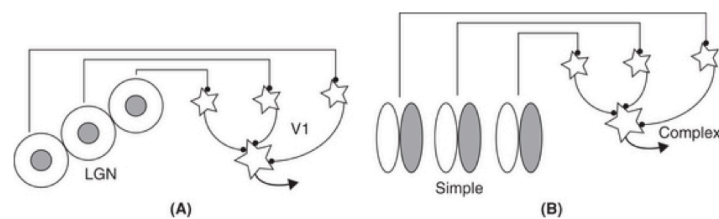


FIGURE 21.13 A. Hubel and Wiesel model describing