Receptive fields of Photoreceptors to Retinal-ganglion cells to LGN-neurons (Thalamus) to 1º Visual Cortex Neurons

1.) Many photoreceptors combine to make a receptive field of a ganglion cell!

2.) Receptive field of many Ganglion Cells

3.) ...Combine to make the receptive field of a signal LGN neuron.

4.) The receptive fields of many LGN neurons combine to make the receptive field of signal 1ºVisual cortex Neuron

Little White Dots indicate hypothetical Photoreceptors! Many photoreceptors are needed to combine to make a ganglion-cell receptive-field!
Light On the Surround  
Off Surround

Light On the Center  
ON Center

1.) Note in the figure above usually 1 to 1000s of photo-receptors are linked to a ganglion cell to make a “receptive field.” Some Ganglion cells respond to light (On-center above) and others are inhibited (Off-surround above). Remember Light = less Glutamate release from all Photoreceptors!

Thus, 1.) Light on photo-receptor = hyper polarization (always!) = less glutamate release (always!). This is the same for ON/Off surround and ON/OFF center configuration. 2.) Light on the Center field of an On-Center receptive field = more activation at the bipolar cell (Graded potentials only) = more activation of the Ganglion cell (Action potentials). This must mean that Glutamate at the synapse between the Photoreceptor and Bipolar cells (Blue circle) is inhibitory (meaning the receptor on the bipolar cell is inhibitory!), therefore, more light = less glutamate = more excitation.

2.) Light on the Surround field of an On-Center receptive field = less activation at the bipolar cell (Graded potentials only) = less activation of the Ganglion cell (Action potentials). This must mean that Glutamate at the synapse between the Photoreceptor and Bipolar cells (red circle) is excitatory (meaning the receptor on the bipolar cell is inhibitory!), therefore, more light = less = less excitation.

Processing of the ganglion (retina) cells: Each ganglion cell responds to the presence OR absence of light! In its receptive field. Keep in mind the receptive field in the retinal-ganglion cells and in the neurons of the LGN (thalamus) is concentric circle arrangement (see below).

This means that in On-Center arrangement, some retinal-ganglion cells respond to light in center and light passing on the surround photo receptors inhibits the same ganglion cells.
Off-Center Cells receptive field of Retina and LGN

**Light On the Center**

2.) Light on photo-receptor = hyper polarization (always!) = less glutamate release (always!). This is the same for ON/Off surround and ON/OFF center configuration.

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2.) Light on the **Center** field of an **OFF-Center** receptive field = less activation at the bipolar cell (Graded potentials only) = less activation of the Ganglion cell (Action potentials). This must mean that Glutamate at the synapse between the Photoreceptor and Bipolar cells (red circle) is excitatory (meaning the receptor on the bipolar cell is inhibitory!), therefore, more light = less Glu = less excitation.

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Sunday, March 4, 2012
Receptive field of 1\(^{\circ}\) Visual (V1 only) Cortex Neurons

(A) Horizontally aligned preferred orientation

No stimulus
Simple cell’s receptive field

Light

OFF
ON
OFF

Baseline response

Strong response
No response

Stimulation by light activates ganglion cells which excites LGN (not shown here) neurons, which excites one V1 neuron.

(B) Oblique preferred orientation

No stimulus

Light

OFF
ON
OFF

Baseline response

No response
Strong response

Stimulation by light in off surround leads to inhibition of one V1 neuron.

Each Circle = Ganglion receptive field

1\(^{\circ}\) Visual Cortex Neuron (V1)

Weak response

1\(^{\circ}\) Visual Cortex Neuron

V1 = Primary visual cortex
V2–V5 = Extrastriate cortex

Sunday, March 4, 2012
2. **Opponent process theory**:
- Ewald Hering (1874)
- Certain colors appear to be “linked together”
- 3 types of bipolar and ganglion cells:
  a. Red-Green opponents
  b. Blue-Yellow opponents
  c. Black-White opponents
  d. Color is due to the relative activity of these 3 kinds of opponents

N.B. This is true for: the rest of the visual system

**Example: RED (+) GREEN (-) OPPONENTS**

**GREEN LIGHT**
- Inhibits ganglion cell when in center field;
- Excites ganglion cell when in surround field.

**RED LIGHT**
- Excites ganglion cell when in center field;
- Inhibits ganglion cell when in surround field.

Use Figure 1. (Right) B and C to work through Below example

Red excites in center field
Green excites in surround field