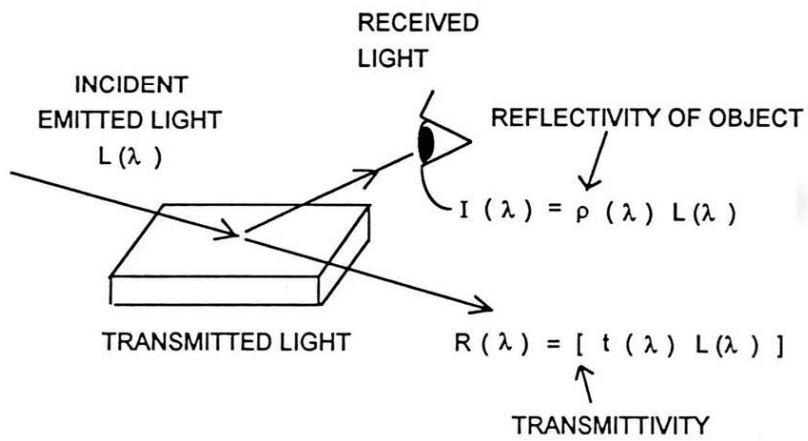


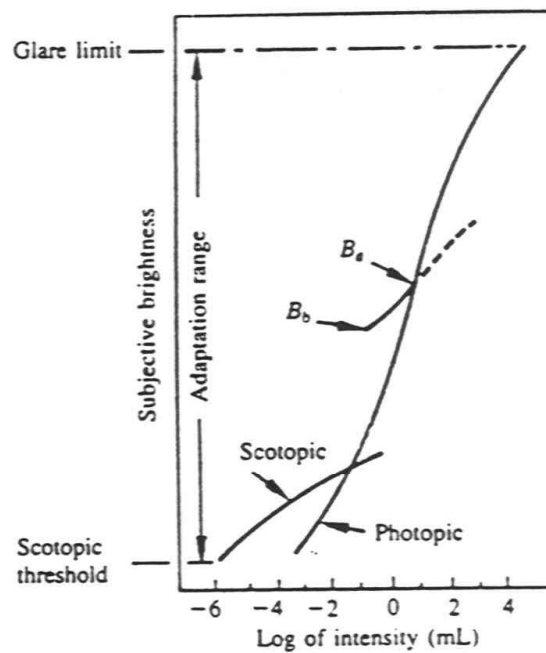
# I. Eye, Retina and Perception

## LIGHT:

- electromagnetic radiation.
- expressed as spectral energy distribution.  
 $L(\lambda)$  with  $\lambda \in [350\text{nm}, 780\text{nm}]$  on electromagnetic spectrum

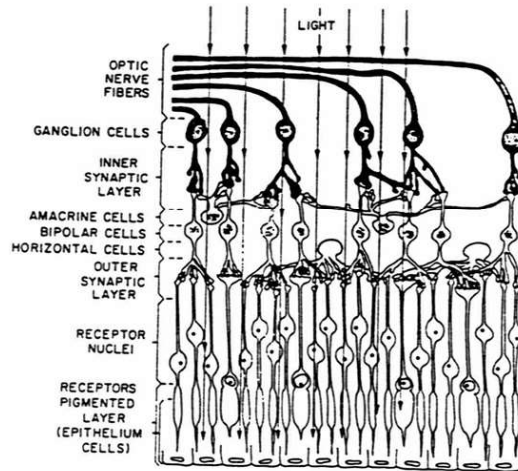
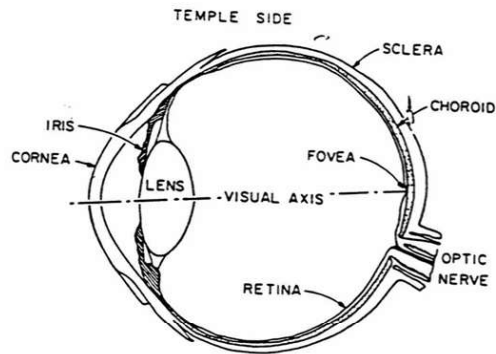


## Brillantez subjetiva. Nivel de adaptación



## RETINA:

- 5 kinds of cells



### Bipolar cells

- serial connections.
- between photoreceptors and ganglion cells.

### Ganglion cells

- serial connections.
- its axons make up the optic nerve.

### Horizontal cells

- parallel connections.
- receive synapses from photoreceptors and may act on bipolar cells and photoreceptors.

### Amacrine cells

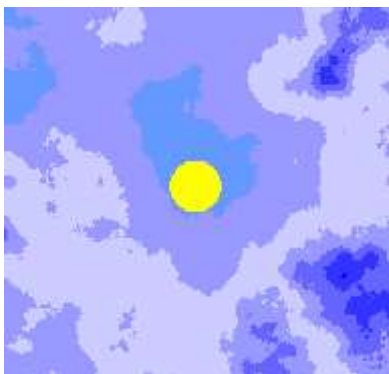
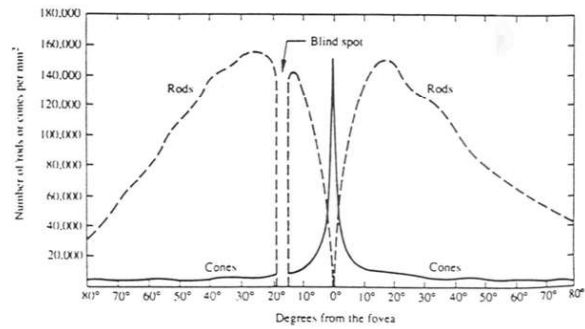
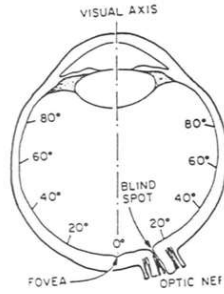
- parallel connections.
- receive synapses from bipolar cells and may act on ganglion cells.

◆ Crossing the retina, the number of cells decreases progressively. The information is concentrated more and more.

◆ Lateral correction made by horizontal and amacrine cells are responsible for amplitude companding and spatial frequency preemphasis by mediating the sensitivity of the ganglion cells to light => effect called *lateral inhibition*.

### Photocells

- RODS: 100 millions.  
Scotopic vision, lower order of magnitude illumination.
  
- CONES: 6.5 millions  
Photopic vision
  - higher orders [5 to 6] of magnitude illumination,
  - dense in fovea,
  - responsible for color vision.



1 2 3 4 5 6

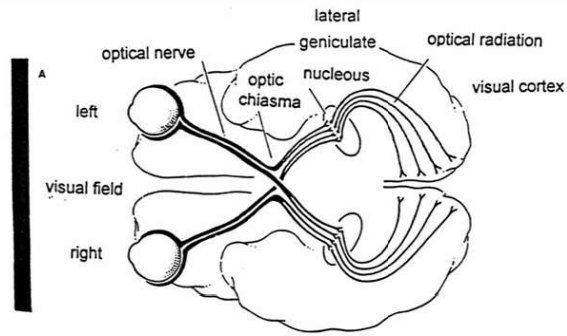
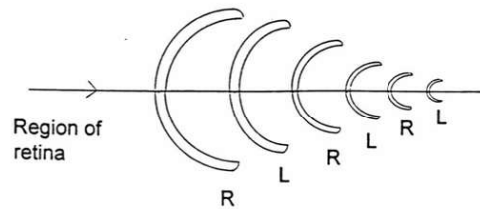


Fig. 1.5.  
Visual system transmission channels.

### LATERAL GENICULATE NUCLEOUS

- after division of information at optic chiasma. Layered organization of cells (1 layer for one eye).
- functionment similar to ganglion cells.
- independency from the orientation.
- information about a region of retina is on line across 6 superposed layers alternatively relative to eye Right, Left, ...



### VISUAL CORTEX

- 4 types of neurons.
  - simple cells - orientation and position in visual field.
  - complex cells - orientation.
  - hypercomplex cells - orientation and discontinuity (corner, end of line).
  - higher and hypercomplex cells ...
- organization into columns:

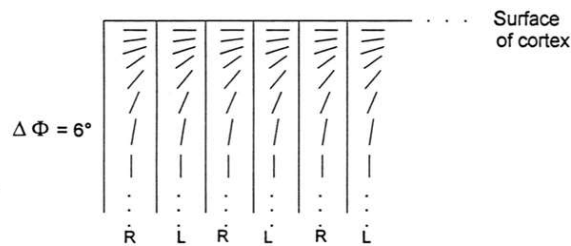


Fig. 1.7.  
Typical relative luminous efficiency function.

### LUMINANCE OR INTENSITY:

- for a spatially distributed object with light distribution  $I(x,y,\lambda)$ , luminance or intensity is defined as:

$$f(x,y) = \int_0^{\infty} I(x,y,\lambda) V(\lambda) d\lambda$$

where  $V(\lambda)$  is called *relative luminous efficiency function* of the visual system.

- measured in lumens (lm): amount of energy an observer perceives.

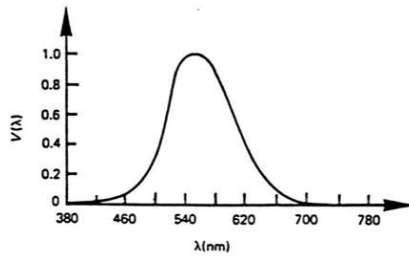


Fig. 1.8.

*Typical relative luminous efficiency function.*

Luminance of an object is independent of the luminance of the surrounding objects.

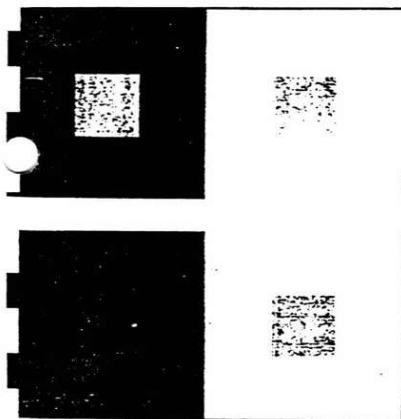
**BRIGHTNESS:** *also called apparent brightness*

- it is the perceived luminance,
- it depends on the luminance surround. Two objects with different surroundings could have identical luminances but different brightnesses,
- cannot be measured.

## II. Spatial Visual Phenomena

*Simultaneous contrast*

Fig. II.1.  
Simultaneous contrast:

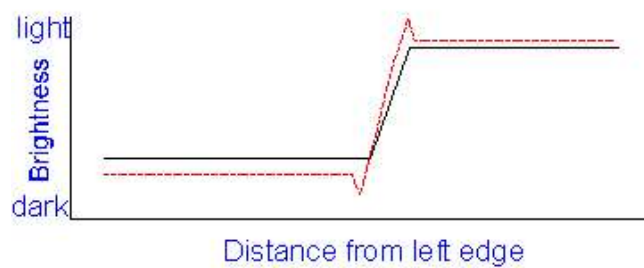
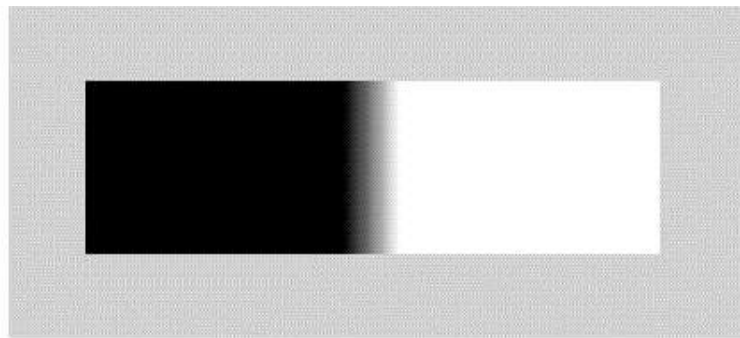


a) *Small squares in the middle have equal luminances but do not appear equally bright.*

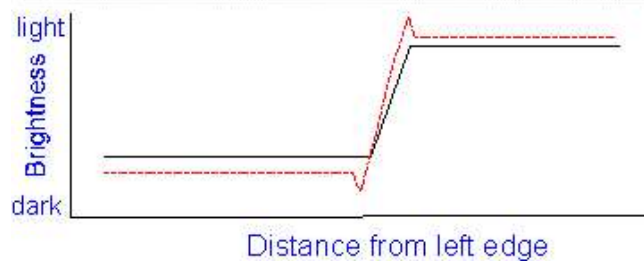
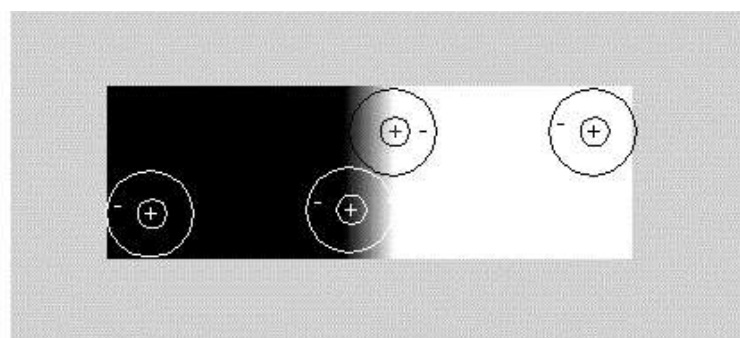
b) *Small squares in the middle appear almost equally bright, but their luminances are different.*

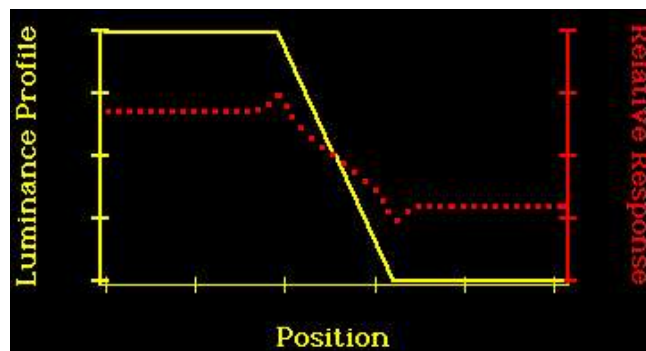
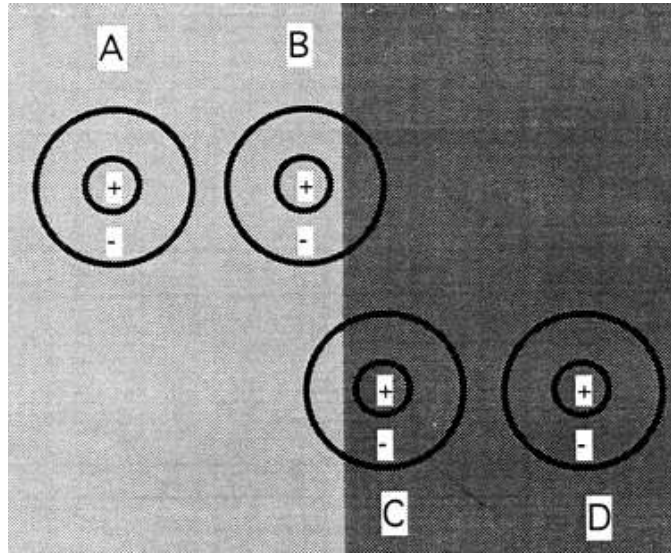
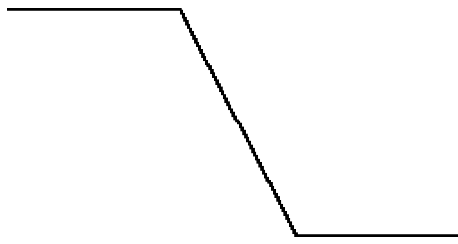
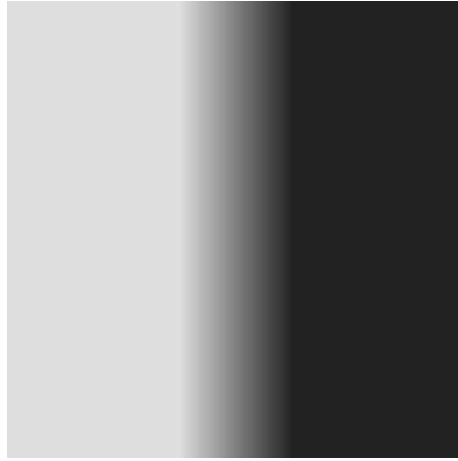
Our perception is sensitive to luminance contrast rather than the luminance values.

# Mach bands



## Mach bands, explicación





# Mach Bands

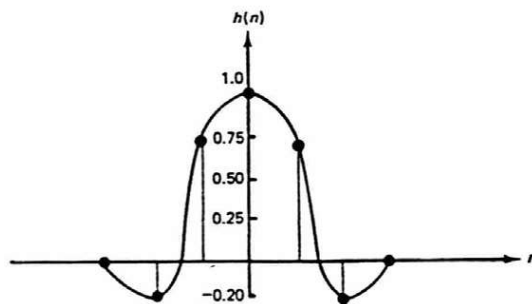
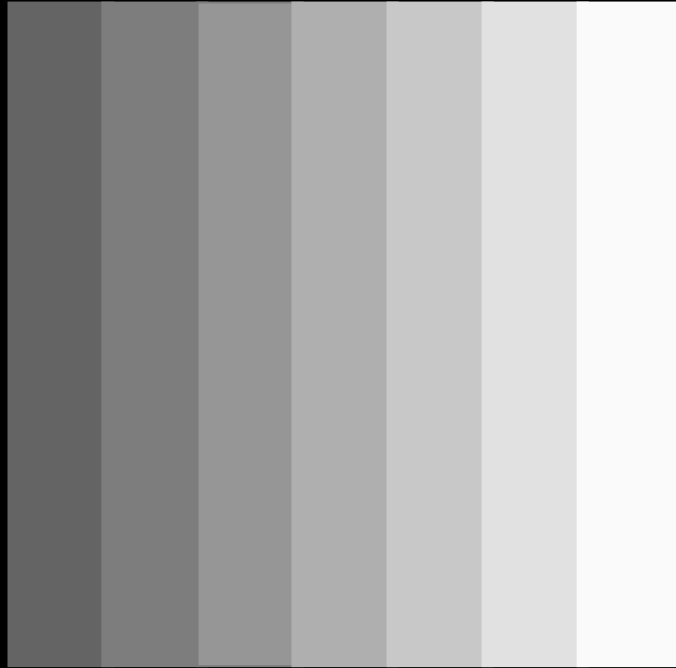
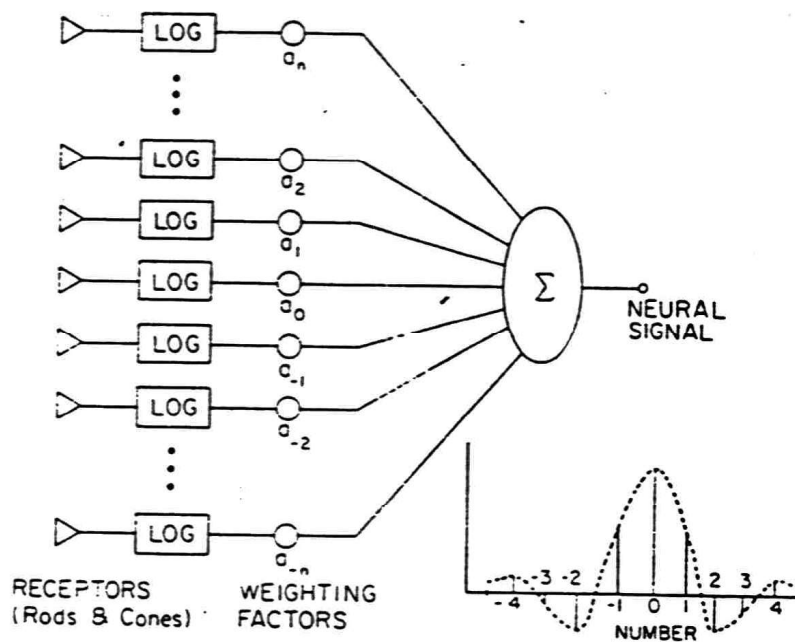
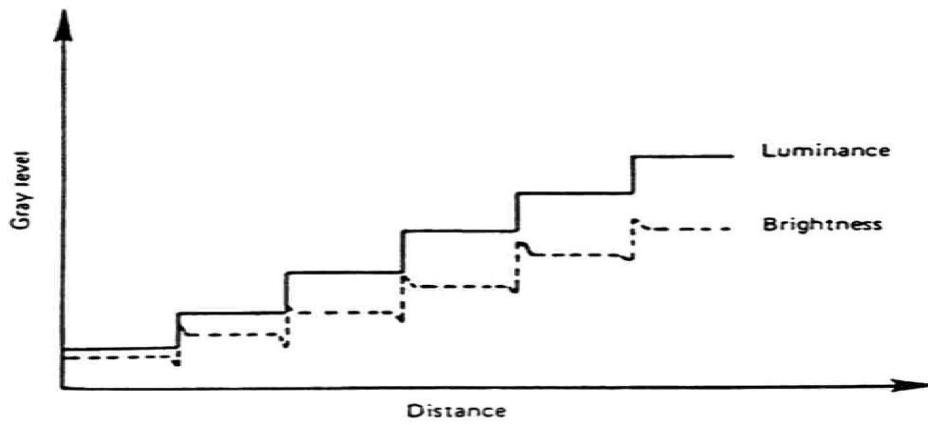


Fig. II.5. Mach bands.

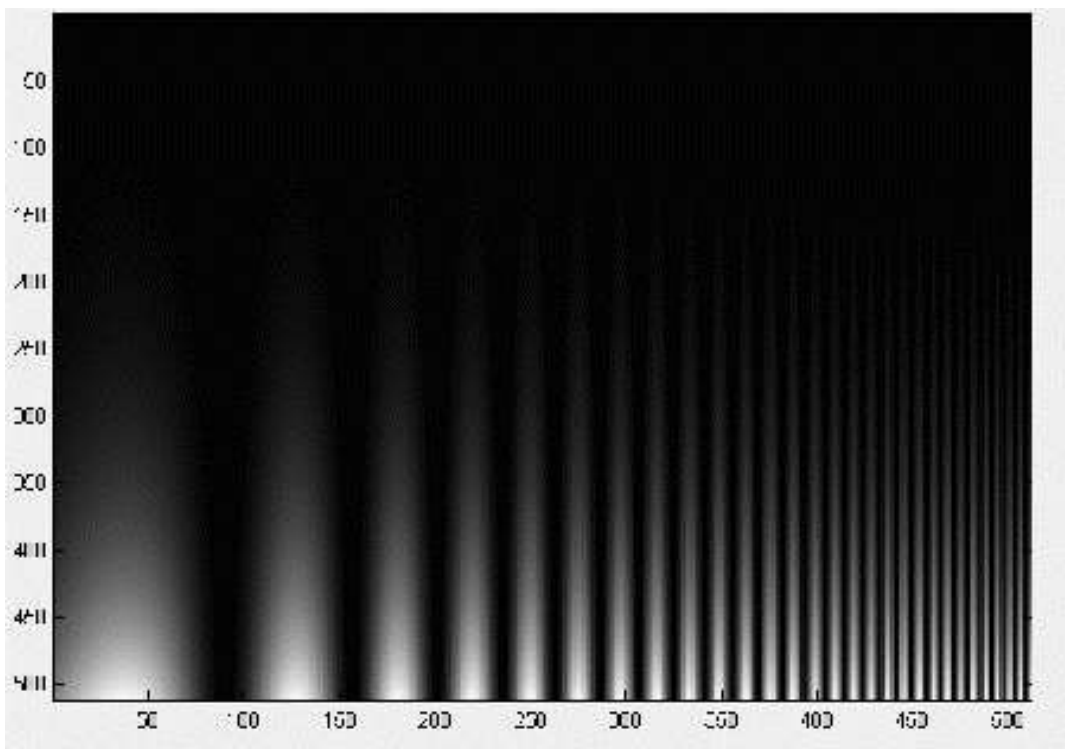
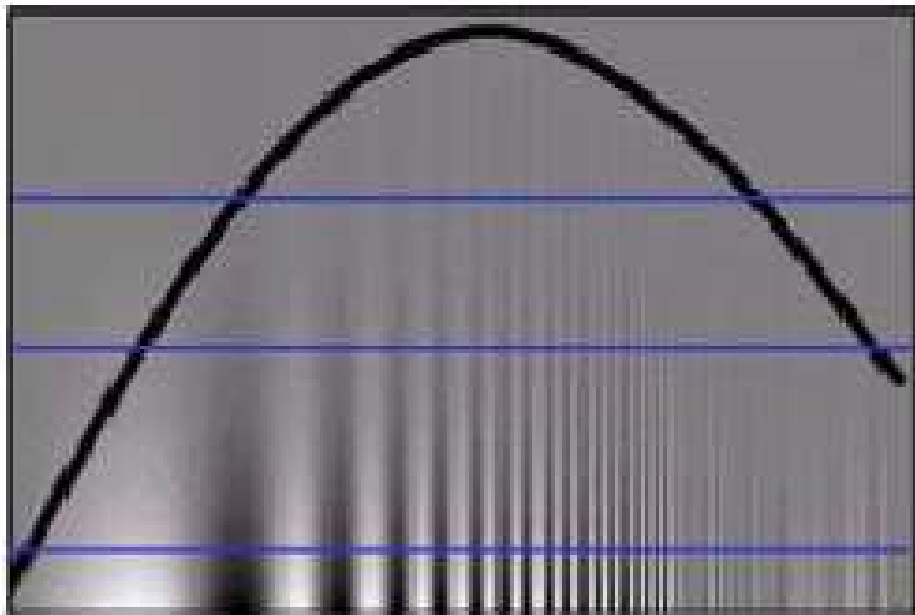
(c) Nature of the visual system impulse response.

The negative lobes manifest a phenomenon called lateral inhibition. Signal at a location is inhibited by some of the laterally located receptors.

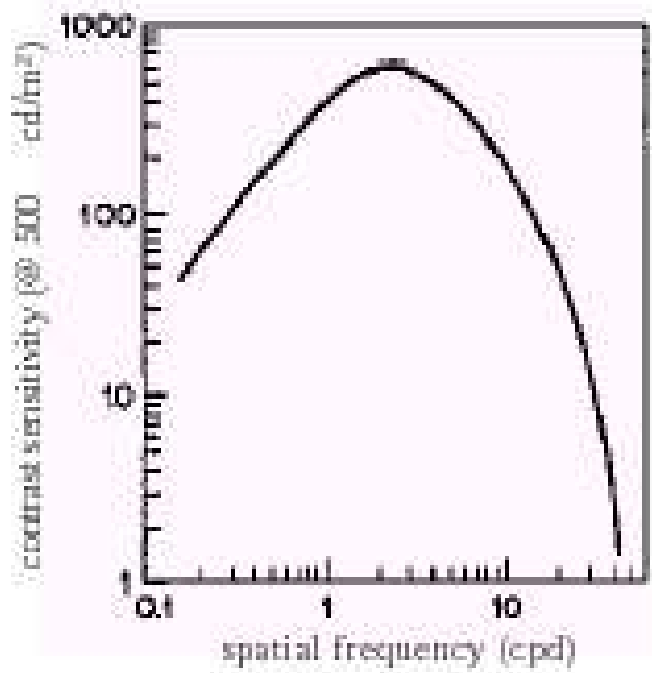




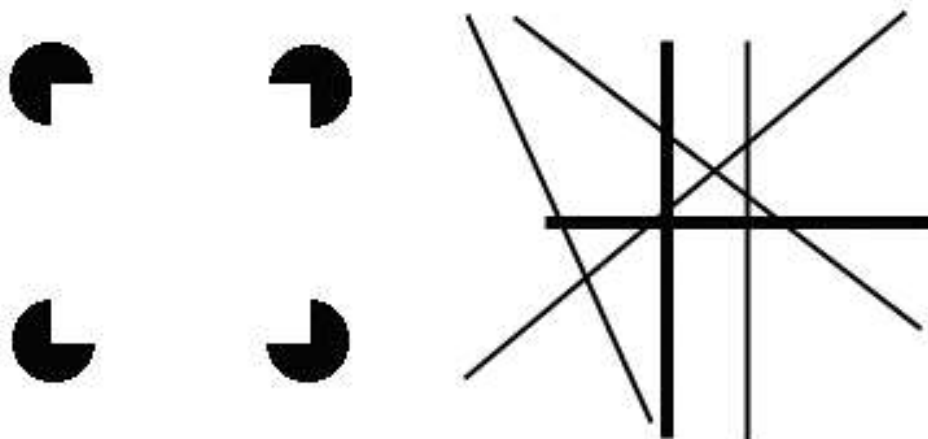
# MTF del sistema de visión humano



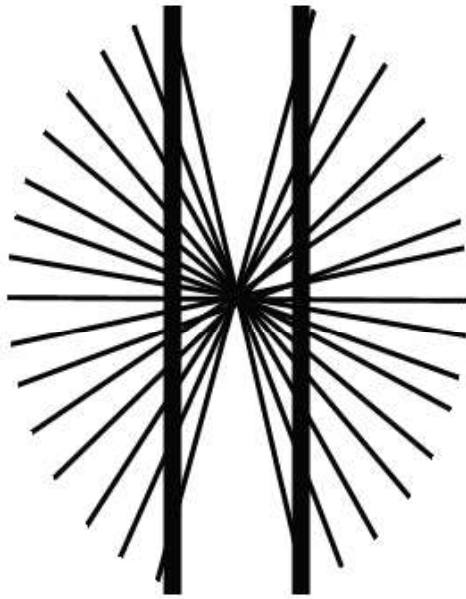
# Función de sensibilidad de contraste



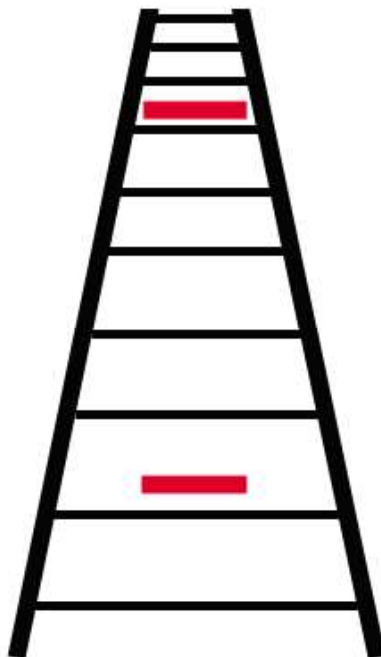
## Contornos falsos



## Distorsión de línea



## Distorsión de profundidad



# Sitios interesantes

- <http://www.purveslab.net/>
- <http://www.yorku.ca/eye/>
- <http://wisebytes.net/illusions/>
- <http://www.stanford.edu/class/ee368b/handouts.html>