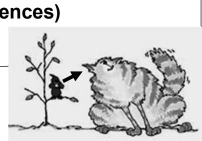
# Sensory Process

## Characteristics of Sensory Modalities

- **Sensitivity**
  - sensory modalities at the psychological level
  - To quantify the relation between "***intensity of physical stimulus***" and the "***psychological response"***
    - **Absolute Threshold**
    - **JND (Just Noticeable Differences)**



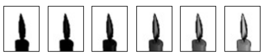
## Sensitivity

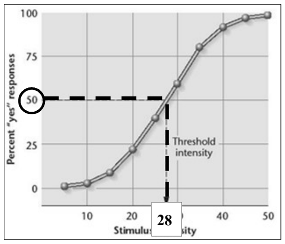
- **Absolute Threshold**
  - **The *minimum intensity* of a stimulus that can be reliably discriminated from NO stimulus at all.**
  - **Approximate minimum stimuli for various senses (Galanter, 1962)**

| Sense | Minimum Stimulus |
|---|---|
| Vision | A candle flame seen at 30 miles on a dark, clear night |
| Hearing | The tick of the clock at 20 feet under quiet condition |
| Taste | One teaspoon of sugar in 2 gallons of water |
| Smell | One drop of perfume diffused into the entire volume of six rooms |
| Touch | The wing of a fly falling on your cheek from a distance of 1 cm. |

# Sensitivity

- **Absolute Threshold**
  - Psychophysical Procedures (Detection Experiment)
  - Psychophysical function graph
  - The absolute threshold as the intensity of stimulus that is detected <u>50%</u> of the time






Psychophysical function from a detection experiment. Plotted on the vertical axis is the percentage of times the participant responds, "Yes, I detect the stimulus." On the horizontal axis is the measure of the magnitude of the physical stimulus. Such a graph may be obtained for any stimulus dimension to which an individual is sensitive.

# Sensitivity

- **JND (Just Noticeable Differences)**
  - The minimum difference in stimulus magnitude necessary to tell 2 stimuli apart
  - Detecting "changes" in intensity between 2 stimuli

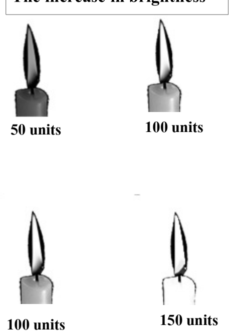
| Quality | JND (Weber fraction) |
|---|---|
| Light intensity | 8 % |
| Sound intensity | 5 % |
| Sound frequency | 1 % |
| Odor concentration | 15 % |
| Salt concentration | 20 % |
| Lifted weights | 2 % |
| Electrical shock | 1 % |

# Sensitivity

- **JND (Just Noticeable Differences)**

  **<u>Weber-Fechner Law</u>**
  - The intensity by which the standard must be increased to be noticed is proportional to the intensity of the standard.
  - When you switch a light bulb from 100 watts to 150 watts, the increase in brightness is not as great as when you switch the light bulb from 50 watts to 100 watts.

The increase in brightness



# Sensory Coding

- How stimuli are transmitted from the sensory receptors to the brain

## Transduction

- translation of physical energy into electrical signals that can make their way to the brain, accomplished by receptors
- Receptor = a specialized nerve cell (neuron) in the sense organs

# Transduction

| Sense Organ | Environmental Stimuli | Energy Transduced |
|---|---|---|
| Eye | Light | Radiant energy |
| Ear | Sound | Mechanical energy |
| Tongue | Taste | Recognition of molecular shape |
| Nose | Odor | Recognition of molecular shape |
| Skin | Touch | Mechanical energy |
| | Temperature | Thermal energy |
| | Vibration | Mechanical energy |
| | pain | Chemical reaction |
| Muscle | Stretch | Mechanical energy |
| Vestibular System | Tilt and rotation of head | Mechanical energy |

# Coding of Intensity and Quality Properties of any stimulus

- Intensity - How strong the stimulus is
  - Rate (Temporal pattern)
    - the spacing sequence of the electrical impulses- faster or slower rate
    - The greater the intensity of the stimuli, the faster the neural firing rate, the greater the perceived magnitude of the stimulus
  - Number of Neurons
    - The more intense the stimulus, the more neurons are activated

## Coding of Intensity and Quality Properties of any stimulus

- Quality - What the stimulus is like
  - Muller (1825) – "Specific nerve energy"
  - The brain can distinguish between information from different sensory modalities (e.g. light and sound) because they involve ***different sensory nerves***.
  - The brain codes the differences between sensory modalities according to the specific neural pathway, specific neurons, and specific firing pattern of the neurons.

## BEHAVIOR

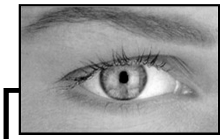
**The component of Behavior**


**Sensation**

Behavior

## Sensation

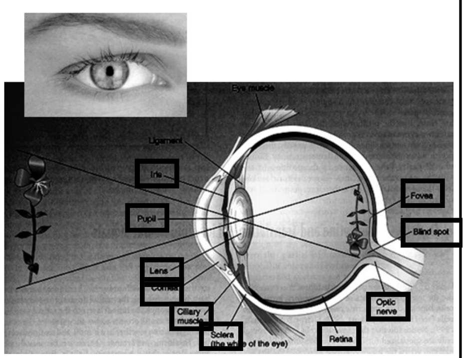
- **Vision**
- **Hearing**
- **Smell**
- **Taste**
- **Touch (Pressure, Temperature, Pain)**

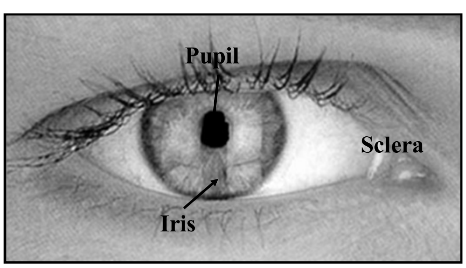


# Vision

## The Major Structures of the Eye

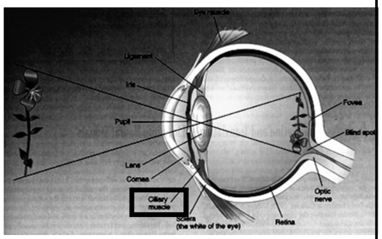
- **Iris**
- **Pupil**
- **Cornea**
- **Lens**
- **Ciliary muscle**
- **Sclera**
- **Retina**
- **Optic Nerve**
- **Optic disk**
- **Fovea**



# Accomodation

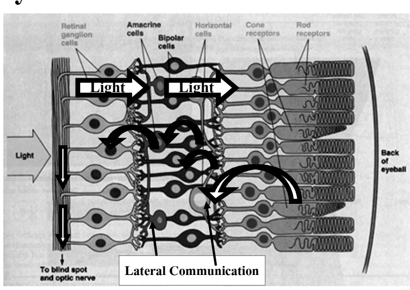
- **Ciliary muscle adjust the lenses to focus visual images sharply on each retina, regardless of the distance of the image from the eyes**
- **This process is Accomodation**




# The Retina

## 5 Different Layers of the cells

- **Receptors**
- ***<u>Horizontal Cells</u>***
- **Bipolar Cells**
- ***<u>Amacrine Cells</u>***
- **Retinal ganglion Cells**




- **Inside-out pattern**
- **Receptor Layer is the farthest from light (light distortion)**

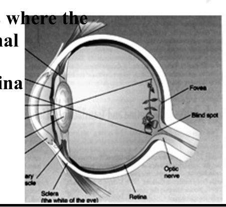
## <u>Structure of the Retina</u>

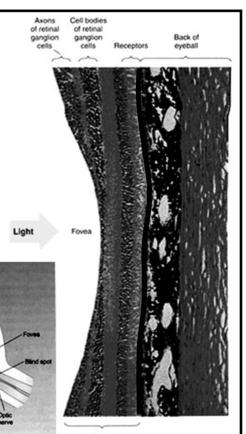
**Fovea is 330 micron (1 mm = 100 micron) at the center of retina – thinning of the retinal ganglion cell layer**

**That's why you hold the task that need high acuity (e.g., threading a needle) at the center of your visual field**

**The Optic Disk is where the <u>axons</u> of the retinal ganglion cells penetrate the retina and exit the eye.**

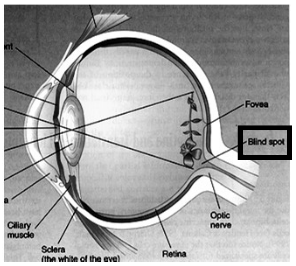
**NO RECEPTOR at optic disk = BLIND SPOT**



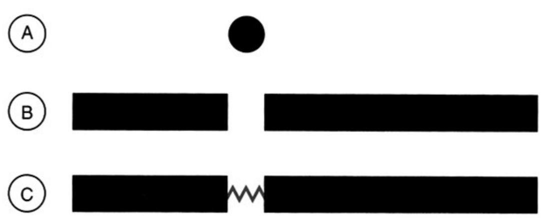
# Completion

- **Completion** = **the visual system use information provided by the receptors around blind spot to fill in the gaps in your retinal image**



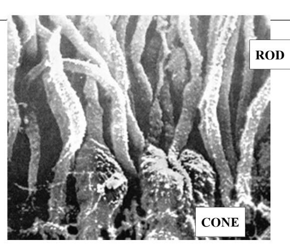

## Lab Vision
## Blind Spot &Completion

First, prove to yourself that you do have areas of blindness that correspond to your retinal blind spots. Close your left eye and stare directly at the A below, trying as hard as you can to not shift your gaze. While keeping the gaze of your right eye fixed on the A, hold the book at different distances from you until the black dot to the right of the A becomes focused on your blind spot and disappears (at about 20 centimeters, or 8 inches).



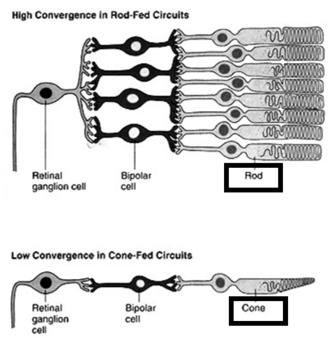

# Cone & Rod

- **Two different types of receptors in retina ─ Rod & Cone (1866)**
- **The Duplexity Theory of Vision ─ Cones and Rods mediate different kinds of vision**



## The Duplexity Theory of Vision

- **<u>Scotopic Vision</u>**
  - **rod**
  - **dim light**
  - **high convergence (many ---> one)**
  - **high sensitivity**
  - **Low acuity**
- **<u>Photopic Vision</u>**
  - **cone**
  - **good lighting**
  - **high acuity**
  - **low sensitivity**
  - **color perception**
  - **low convergence (one to one)**



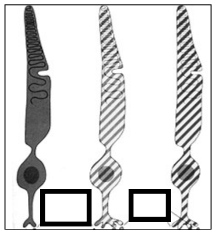

## Seeing Color

## Seeing Color

- **Seeing color = the perception of mixture of wavelengths reflecting from the object**
- **<u>Achromatic Color</u>**
  - **Black = no light**
  - **white = intense mixture of wavelengths with equal proportion**
  - **gray = low intense mixture of wavelengths**
- **<u>Chromatic Color</u> – colors**

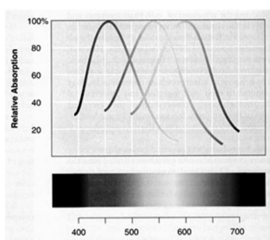
# Seeing Color

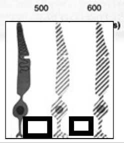
- **Component Theory** **(Trichromatic Theory)**
  - **proposed in 1802 by Thomas Young, refined by Helmholtz in 1852**
  - **3 different kinds of cone**



# Seeing Color

- **Component Theory**
  **(Trichromatic Theory)**
  - **New research and technologty (microspectrophotometer) can confirm Young's theory for 3 different kinds of cone**
    - **Blue**
    - **Yellow-green**
    - **yellow-red**



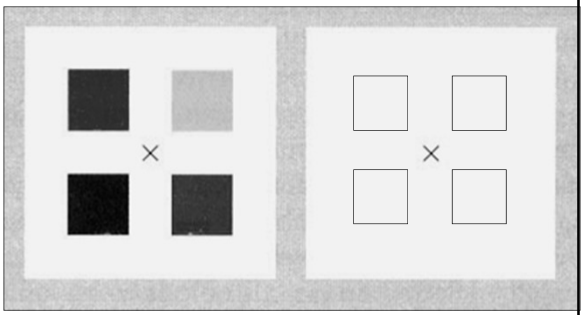
# Seeing Color

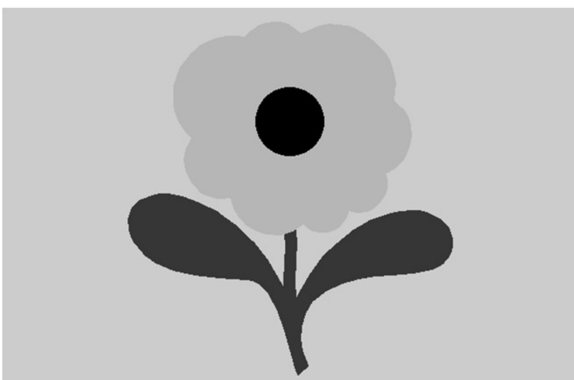
- **Opponent Theory**
  - **proposed by Hering in 1878**
  - **Three classes of cells in the visual system**

    **2 types for encoding color (opponent color)**
    - **Red-green cells**
    - **Blue-yellow cells**

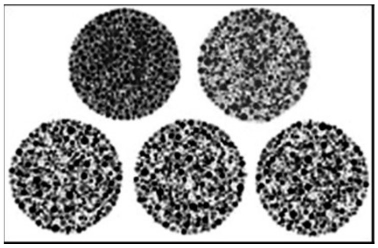
    **1 type for encoding brightness**
    - **Black-white cells**

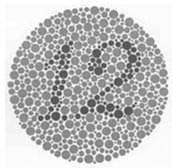
**Complementary Afterimage Test – DO IT IN YOUR BOOK**





## Opponent Process Theory






Color Blindness Test

## Which Theory is right, Component or Opponent ?

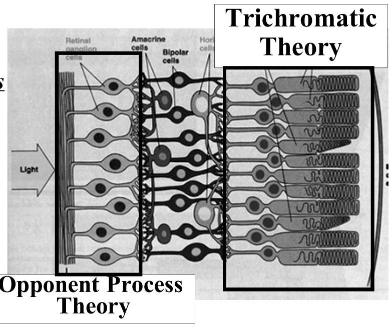
**Trichromatic Theory** (Component)

**Opponent Process Theory**

# BOTH

# Retina – 5 layers of different cells

- Receptors (Rod + Cone)
- ***Horizontal Cells***
- Bipolar Cells
- ***Amacrine Cells***
- Retinal ganglion Cells



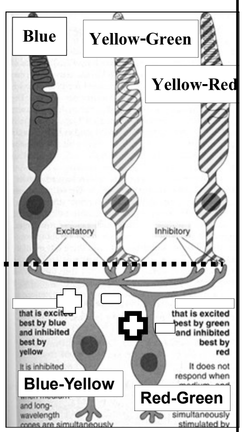

## Component Theory

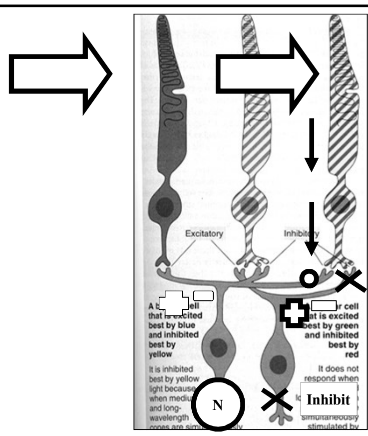
3 types of **cone**

## Opponent Theory

2 types of **retinal ganglion cells** (Carlson et al, 2007)

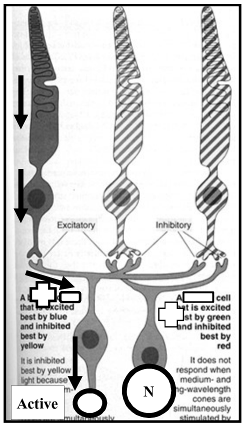
**Or cells in Thalamus** (Smith et al., 2003)



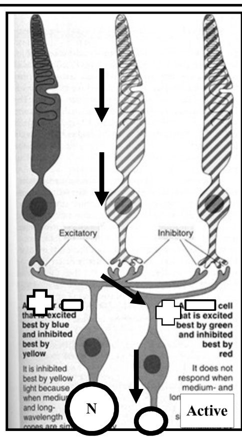

O / -

**RED**



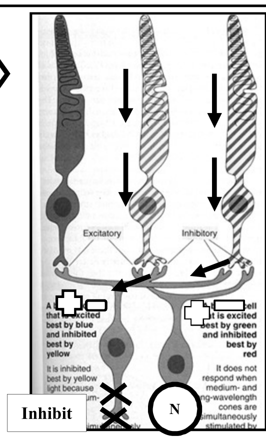

+ / O

BLUE




O / +

GREEN

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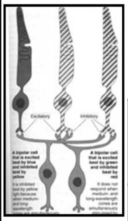
Yellow



| | Cone Cell | | | Retinal Ganglion Cell | |
|---|---|---|---|---|---|
| | Red | Blue | Green | Blue-Yellow | Red-Green |
| RED | + | | | 0 | - |
| BLUE | | + | | + | 0 |
| GREEN | | | + | 0 | + |
| YELLOW | + | | + | - | 0 |