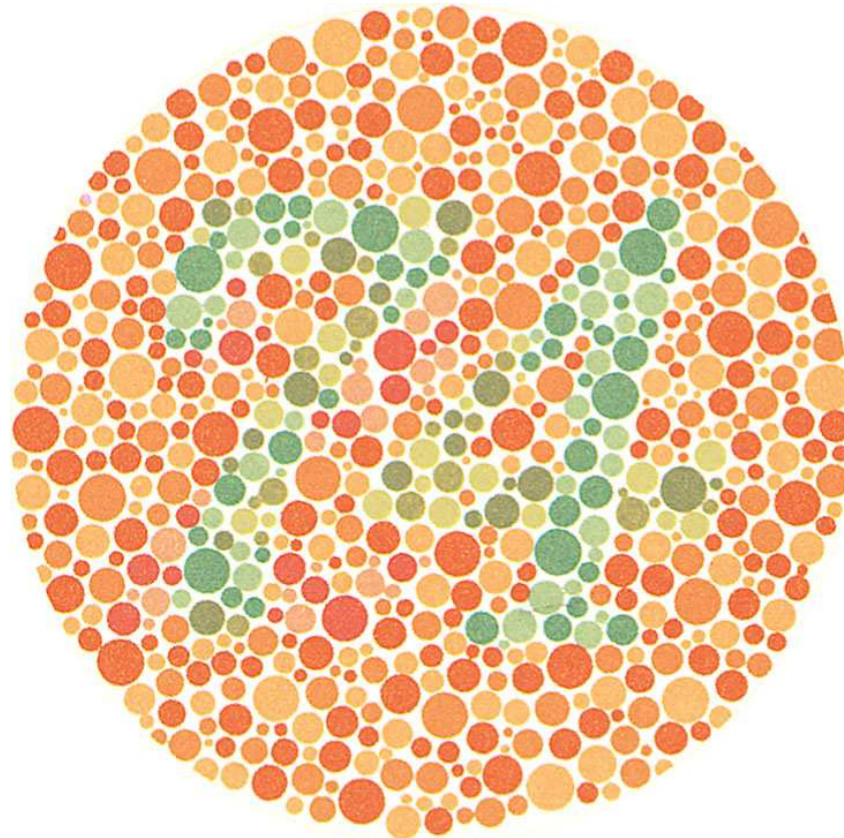


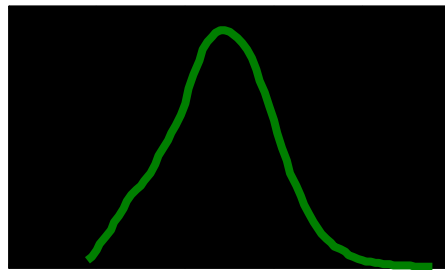
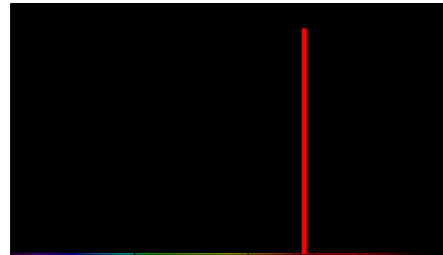
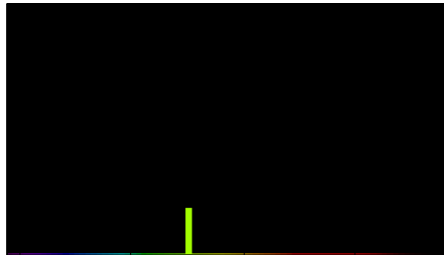
# Color Deficiency (“Color Blindness”)

- **Monochromat** - person who needs only one wavelength to match any color
- **Dichromat** - person who needs only two wavelengths to match any color
- **Anomalous trichromat** - needs three wavelengths in different proportions than normal trichromat
- **Unilateral dichromat** - trichromatic vision in one eye and dichromatic in other



# Color Experience for Monochromats

- **Monochromats** have:
  - A very rare hereditary condition
  - Only rods and no functioning cones
  - Ability to perceive only in white, gray, and black tones
    - Univariance
  - True color-blindness
  - Poor visual acuity
  - Very sensitive eyes to bright light



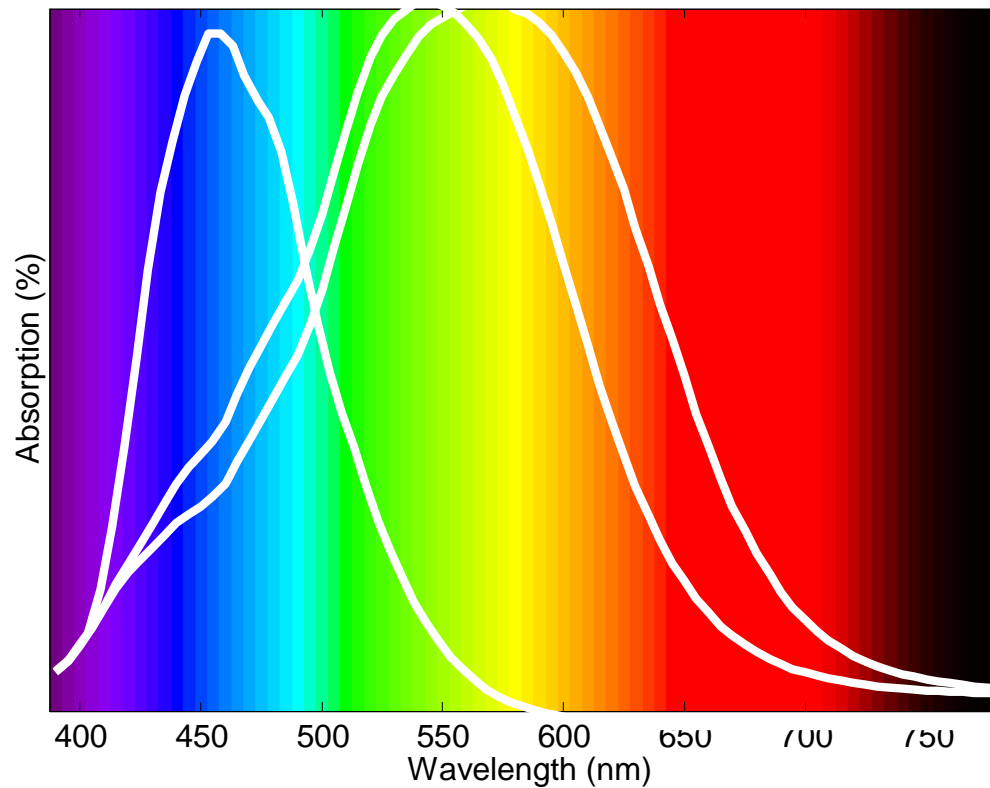
## Dichromats – only two cone types

**Dichromats** are missing one of the three cone systems, so there are three types of dichromats.

*Protanopes* – missing L cones

*Deuteranopes* – missing M cones

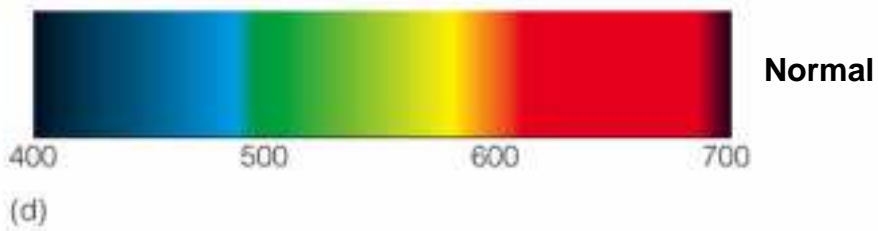
*Tritanopes* – missing S cones



# Dichromats – only two cone types

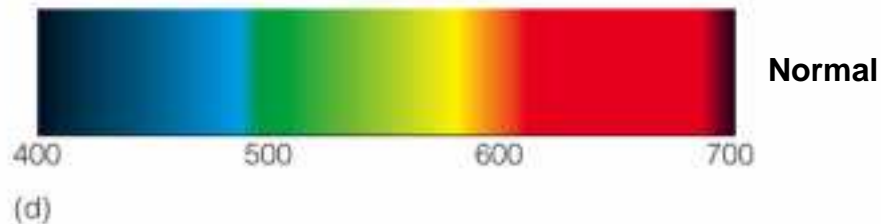
## 1. **Protanopia** affects 1% of males and .02% of females

- They are missing the long-wavelength pigment
- Individuals see short-wavelengths as blue
- Neutral point (gray) occurs at 492nm
- Above neutral point, they see yellow



## Dichromats – only two cone types

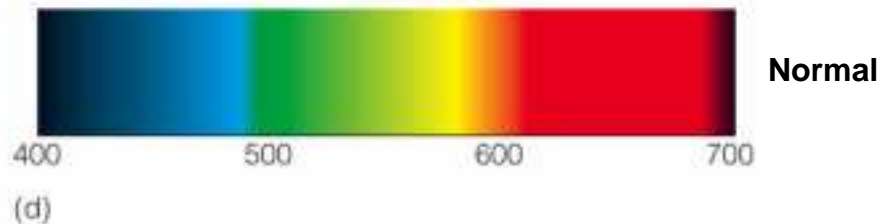
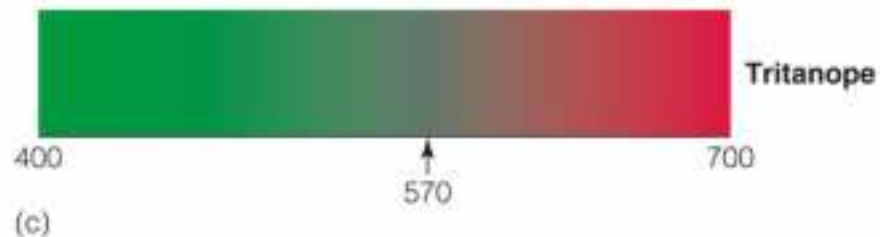
2. **Deuteranopia** affects 1% of males and .01% of females
- They are missing the medium wavelength pigment
  - Individuals see short-wavelengths as blue
  - Neutral point (gray) occurs at 498nm
  - Above neutral point, they see yellow

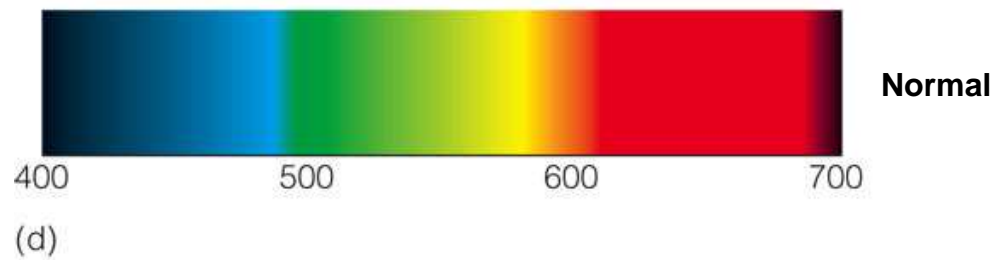
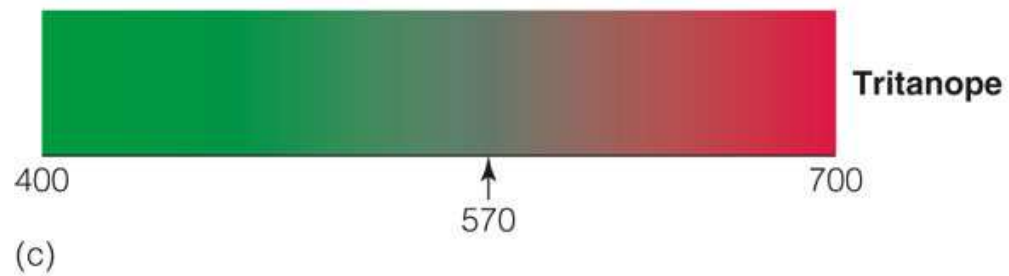


## Dichromats – only two cone types

### 3. **Tritanopia** affects .002% of males and .001% of females

- They are almost always missing the short wavelength pigment
- Individuals see short wavelengths as green
- Neutral point (gray) occurs at 570nm
- Above neutral point, they see red





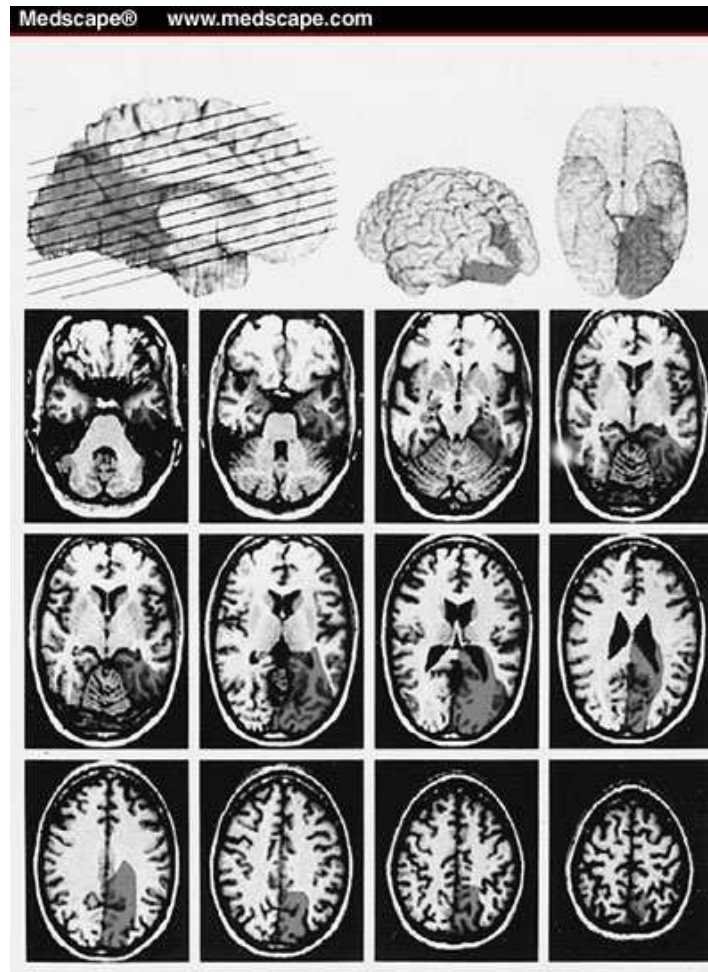
# Color Processing in the Cortex

- There is no single module for color perception
  - Cortical cells in V1, V2, and V4 respond to some wavelengths or have opponent responses

fMRI experiments on color vision show responses to color all over the visual cortex, but particularly strong responses in area V4.



V4 seems to be necessary for color vision. Damage to V4 leads to **cerebral achromatopsia** – complete color blindness, even though the cones are normal.



## Chapter 8: Perceiving Depth and Size



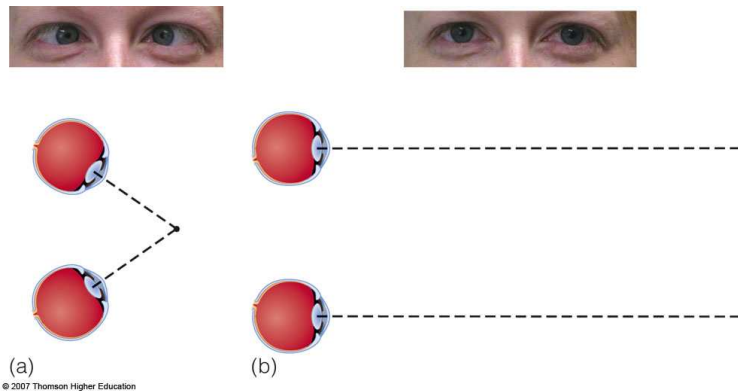
# Cues to Depth Perception

- **Oculomotor** - cues based on sensing the position of the eyes and muscle tension
- **Monocular** - cues that rely on only one eye.
- **Binocular** – cues that rely on both eyes.

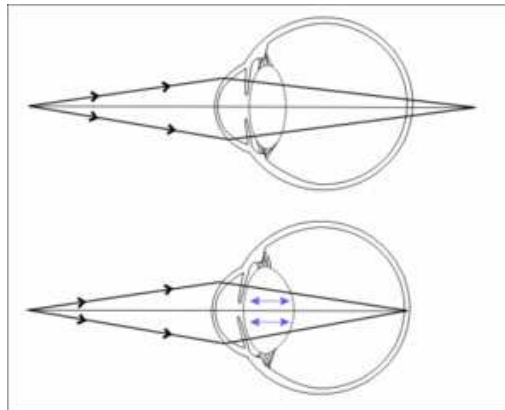
# Cues to Depth Perception

- **Oculomotor** - cues based on sensing the position of the eyes and muscle tension

1. **Convergence** – knowing the inward movement of the eyes when we focus on nearby objects



2. **Accommodation** – feedback from changing the focus of lens.



# Cues to Depth Perception

- **Monocular** - cues that come from one eye. Two categories:
  1. **Pictorial cues** - sources of depth information that come from 2-D images, such as pictures
  2. **Movement-produced cues**

# Pictorial Cues

**Occlusion** - when one object partially covers another

**Relative height** - objects that are higher in the field of vision are more distant



# Pictorial Cues

- **Relative size** - when objects are equal size, the closer one will take up more of your visual field
- **Familiar size** - distance information based on our knowledge of object size
- **Perspective convergence** - parallel lines (in real world) appear to come together in the distance



# Pictorial Cues

- **Atmospheric perspective**
  - distant objects have lower contrast and have a blue tint





# Pictorial Cues

**Texture gradient** - equally spaced elements are more closely packed as distance increases



# Pictorial Cues

**Shadows** – can help indicate distance



(a)

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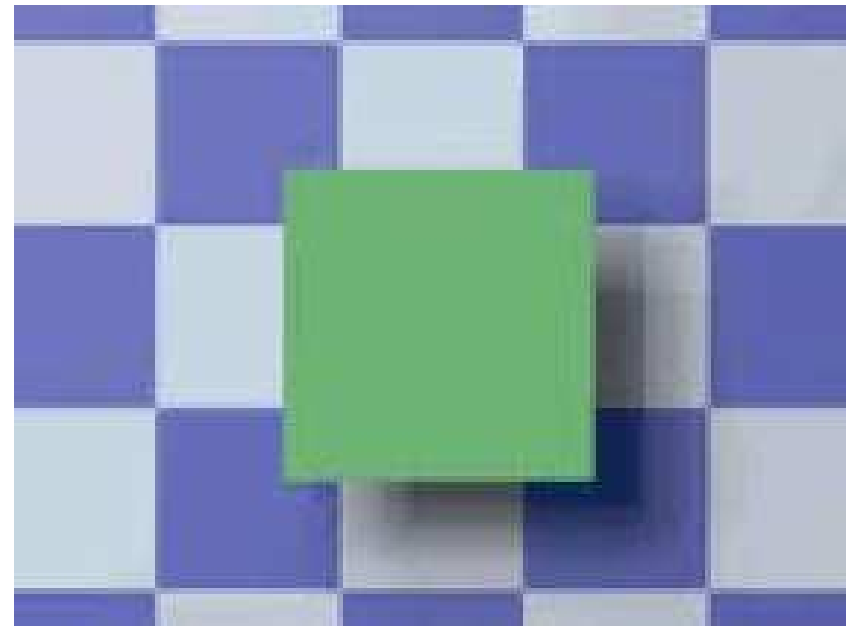
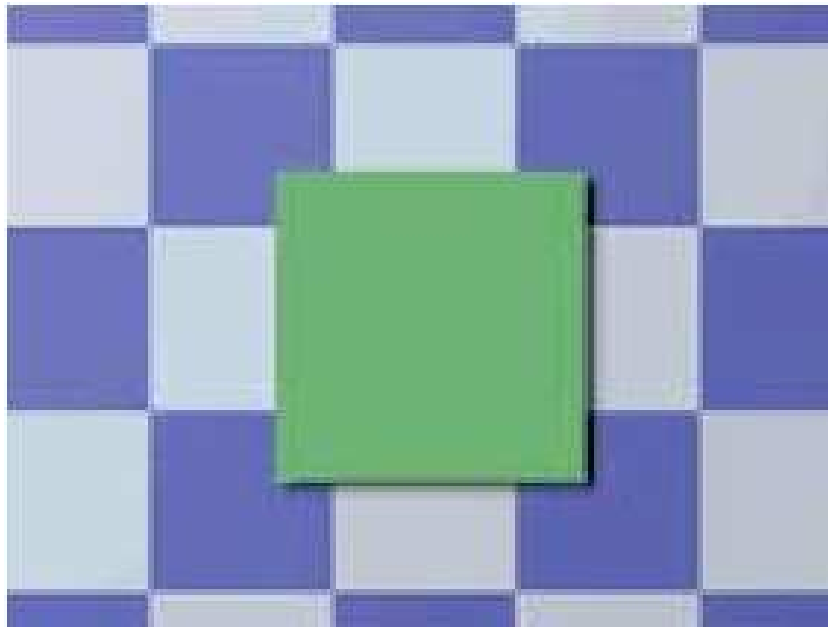
(b)



(c)

# Pictorial Cues

**Shadows** – can help indicate distance



## Name the pictorial cues in this scene

atmospheric perspective

texture gradient

shadows



# Name the pictorial cues in this scene



1. Occlusion
2. Relative height
3. Relative size (familiar size)
4. Cast shadows
5. Atmospheric perspective
6. Perspective convergence
7. Texture gradient

*Cestello Annunciation* by Sandro Botticelli, circa 1489-1490.

# Motion-Produced Cues

- **Motion parallax** - close objects in direction of movement glide rapidly past but objects in the distance appear to move slowly
- **Deletion and accretion** - objects are covered or uncovered as we move relative to them
  - Also called occlusion-in-motion



**Table 8.1** ■ *Range of effectiveness of different depth cues*

Depth Information	0–2 Meters	2–20 Meters	Above 30 Meters
Occlusion	✓	✓	✓
Relative size	✓	✓	✓
Accommodation and convergence	✓		
Movement	✓	✓	
Relative height		✓	✓
Atmospheric perspective			✓

Source: Based on Cutting & Vishton, 1995.