# Sensory Experience

Lecture 12

# Recap:
# Defining the Modality of Sensation

- Proximal Stimulus
- Receptor Organ
- Afferent Tract
- Projection Area

# Defining a Sensory Modality by Proximal Stimulation

| | |
|---|---|
| • Vision | Rods, Cones in Retina |
| • Audition | Hair Cells in Cochlea |
| • Olfaction | Olfactory Epithelium |
| • Gustation | Taste Buds |
| • Touch | Cutaneous Receptors |
| • Temperature | Krause bulbs, Ruffini organs |
| • Pain | A-delta, C fibers |
| • Kinesthesis | Spindles, Golgi Organs |
| • Equilibrium | Hair Cells in Inner Ear |

# Problems for the Traditional View

- Non-Normative Stimulation
- Electrical Stimulation
  - Sensory Receptors
  - Sensory Nerves

# The Doctrine of Specific Nerve Energies

Muller (1826)

- The Modality of Sensation is not Determined by the Proximal Stimulus.
- Each Sensory Nerve Reacts Differently to Stimulation.
- The Modality of Sensation is Determined by the Specific Nerve Activated by the Stimulus

# Problems with the Original Doctrine

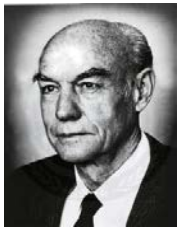
- No Specific “Nerve Energies”
  - Adrian (1915)

- Electrical Stimulation of Projection Areas
  - Penfield (1945)

# The Doctrine of Specific Nerve Energies

Muller (1826), modified by Sperry (1945)

- Modality of sensation not determined by the proximal stimulus or the sensory receptor.
- Each sensory nerve reacts differently to stimulation.
  - *Muller*: Modality of sensation is determined by the activation of modality-specific nerves
  - *Sperry:* Modality of sensation is determined by the projection area to which the sensory impulse is delivered



# Defining a Sensory Modality by Projection Area

| | |
|---|---|
| • Vision | Primary Visual Area |
| • Audition | Primary Auditory Area |
| • Olfaction | Primary Olfactory Cortex |
| • Gustation | Primary Gustatory Cortex |
| • Touch | Primary Somatosensory Cortex |
| • Temperature | Somatosensory Cortex |
| • Pain | Somatosensory Cortex |
| • Kinesthesis | Somatosensory Cortex |
| • Equilibrium | Cerebellum |

# Qualities of Sensation

Boring (1953)

## Intensity

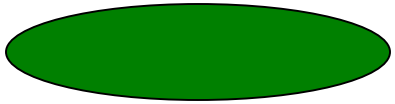
- Vision
  - Brightness, Hue, Saturation
- Audition
  - Loudness, Pitch, Timbre
- Olfaction, Gustation
  - Flavor, Odor
- Touch
  - Roughness, Wetness (Pressure, Pain, Warmth)

# The Psychophysical Principle

Every Psychological Quality
of a Sensory Experience
is Related to
Some Physical Property
of the Corresponding Stimulus

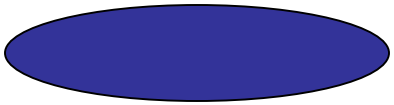
# Qualities of Visual Sensation

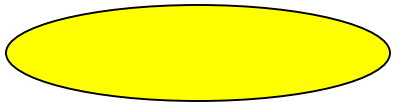
- Hue
  - Wavelength



495 nm

465 nm

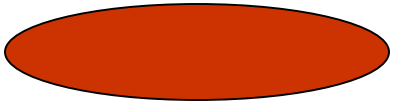


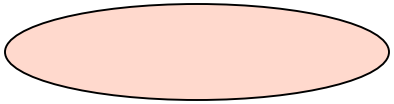


570 nm

- Saturation
  - Amount of Gray

700 nm

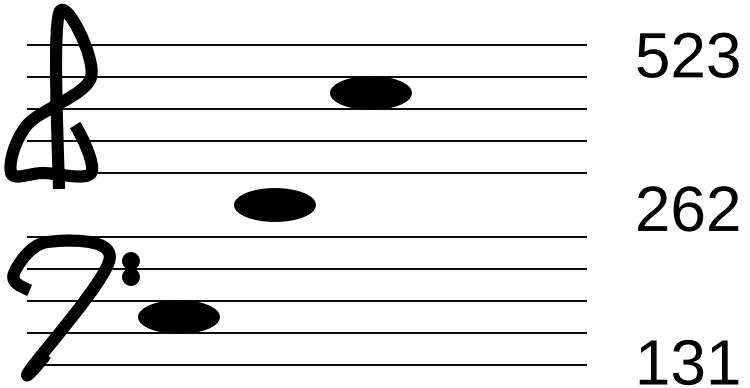


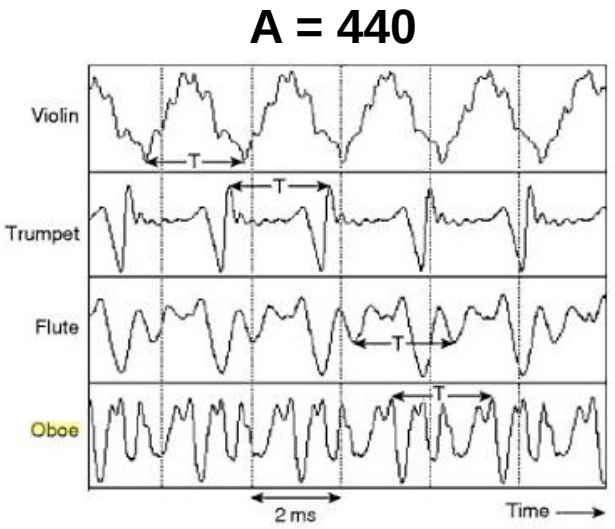


# Qualities of Auditory Sensation

Seashore 1938; Howard & Angus (2006)

- Pitch
  - Frequency
- Timbre
  - Shape of Wave
    - Fundamental Frequency
    - Distribution of Harmonics
      - Flute, sine wave
        - » Pure fundamental
      - Oboe, square wave
        - » Fundamental + Odd harmonic



# The Doctrine of Specific Fiber Energies

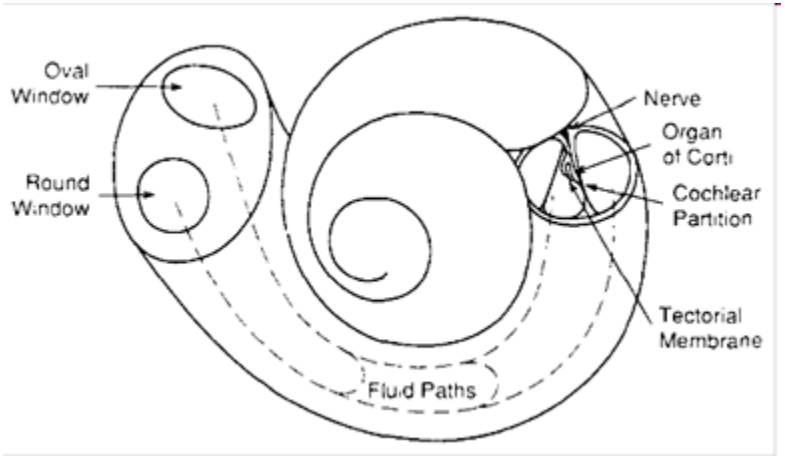
Helmholtz (1863, 1866), after Muller (1826)

Just as Every Modality of Sensation is Mediated by a Specific Neural System, so…

Within each Modality, Every Quality of Sensation is Mediated by a Specific Neural System

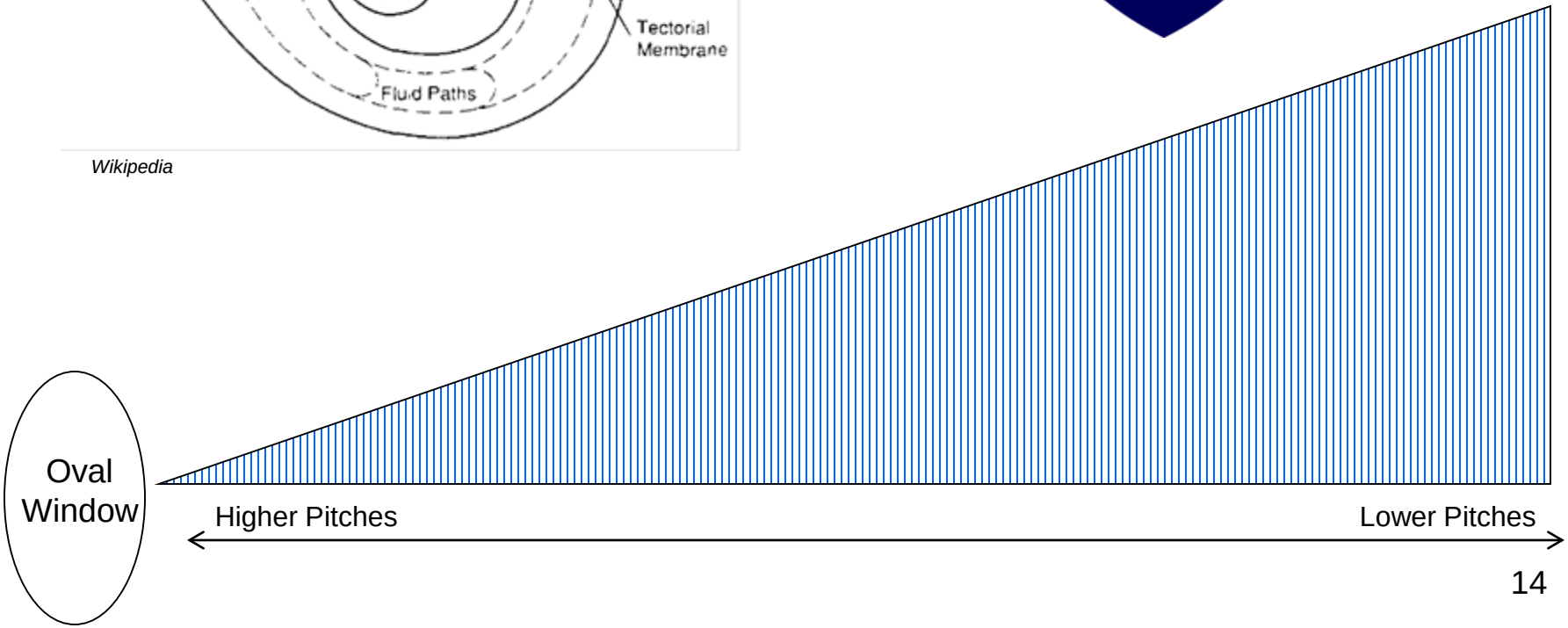
# The Place Theory of Pitch

Helmholtz (1863); Bekesy (1960)




*Wikipedia*

Coat of Arms
Republic of Ireland



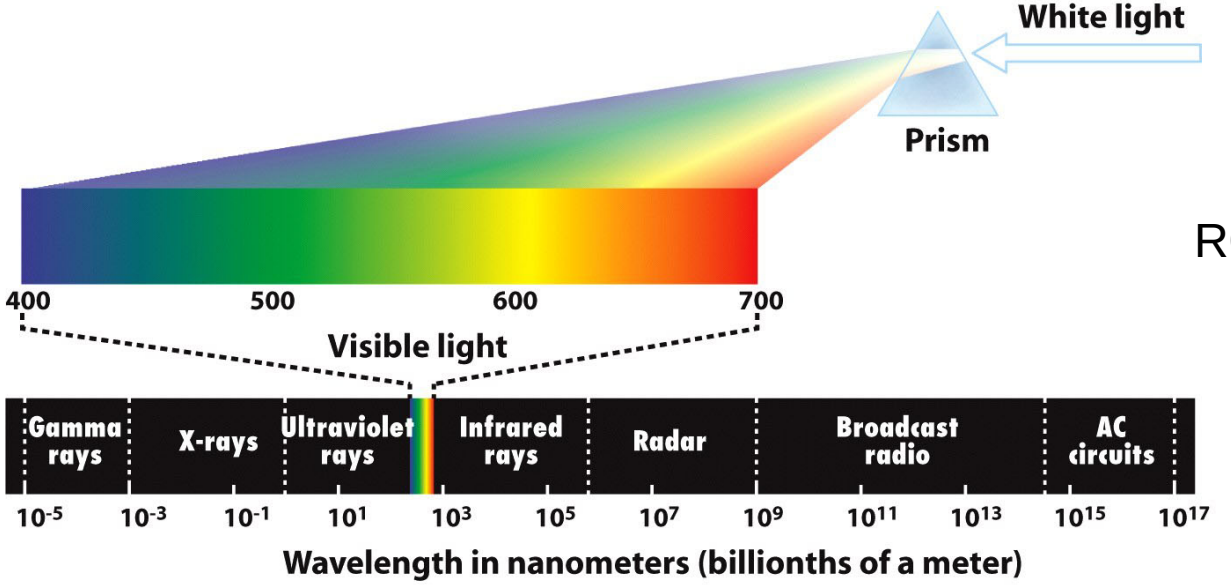
# Duplex Theory of Pitch Perception

Wever & Bray (1930)

- Place Principle
  - Above 500-20,000 cps
- Pure Frequency Principle
  - Below 1,000 cps
- Volley Principle
  - 1,000 – 4,000 cps

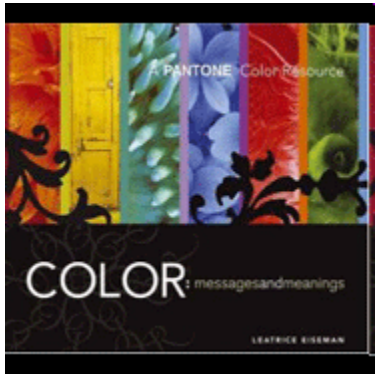
# The Problem of Color Vision

Newton (1704); Young (1802)



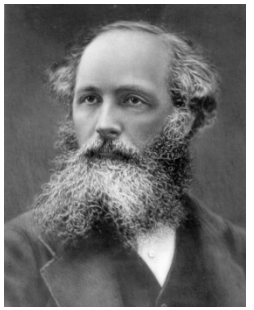

ROY G BIV

- 7 Million Shades of Color
  - Hue, Brightness, Saturation
    - Pantone: 3,039 Specific Colors
      - 300 Shades of Blue

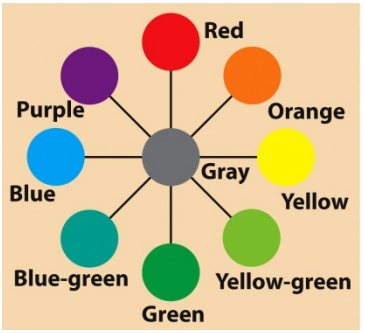


# The Search for Primary Colors

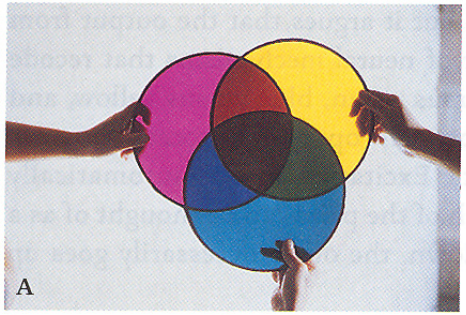
Young (1802); Maxwell (1855)

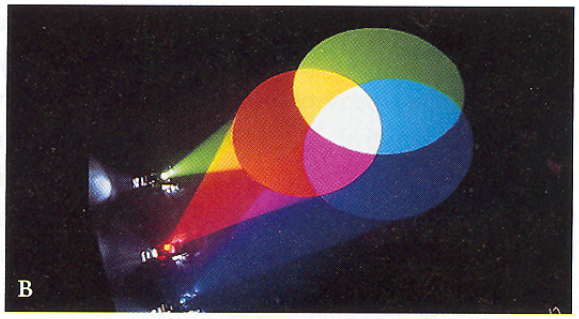


- 7 Primaries?
  - 4 Primaries?
  - 3 Primaries!
- Additive Mixture Adds Colors to Black
  - Subtractive Mixture Eliminates Colors from White




**The Color Circle**

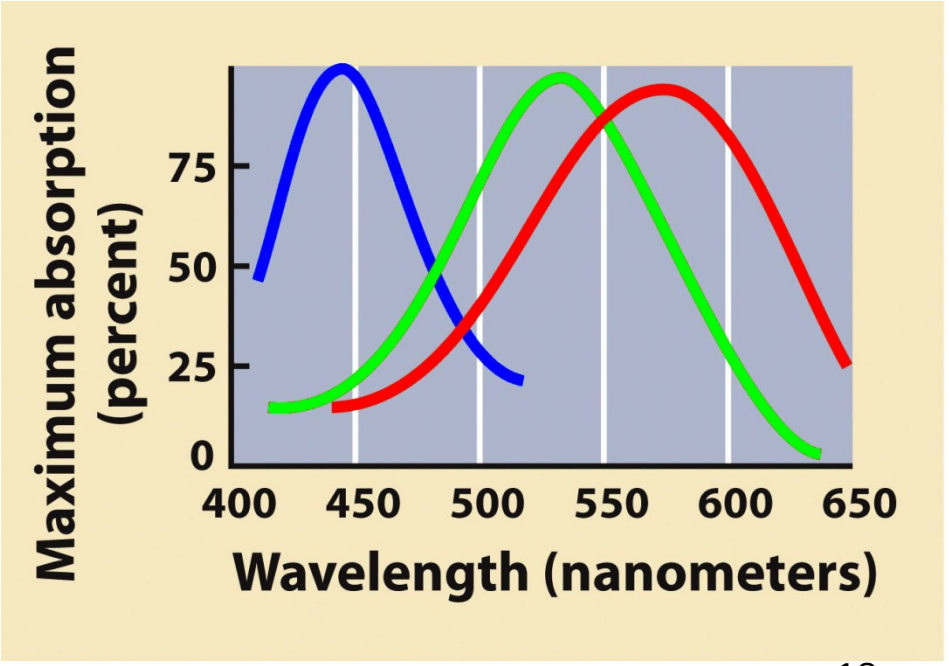


# Trichromatic Theory of Color Vision

Helmholtz (1856-1867), after Young (1802) and Maxwell (1855)

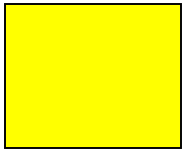
- Any Visible Color can be Produced by Mixing Three Primary Colors
- Three Kinds of Cones
  - "Red"
    - Long Wavelengths
  - "Green"
    - Medium Wavelengths
  - "Blue"
    - Short Wavelengths



Georges Seurat,
“Sunday Afternoon on the Island of La Grande Jatte” (1884-1886)
Art Institute of Chicago

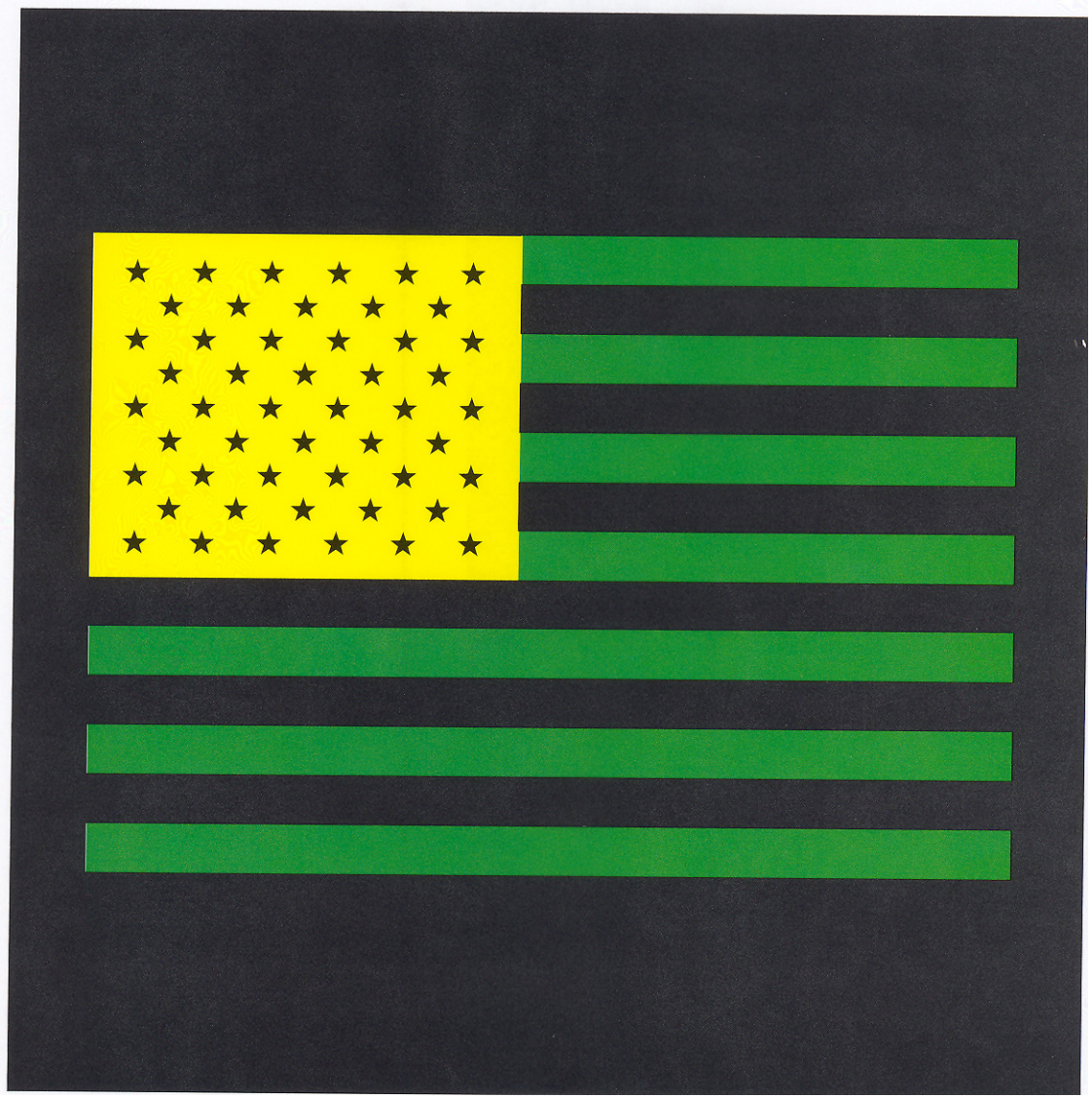
# Problems with the Trichromatic Theory

- Yellow as Pure Color
  - Not Mix of Red and Green



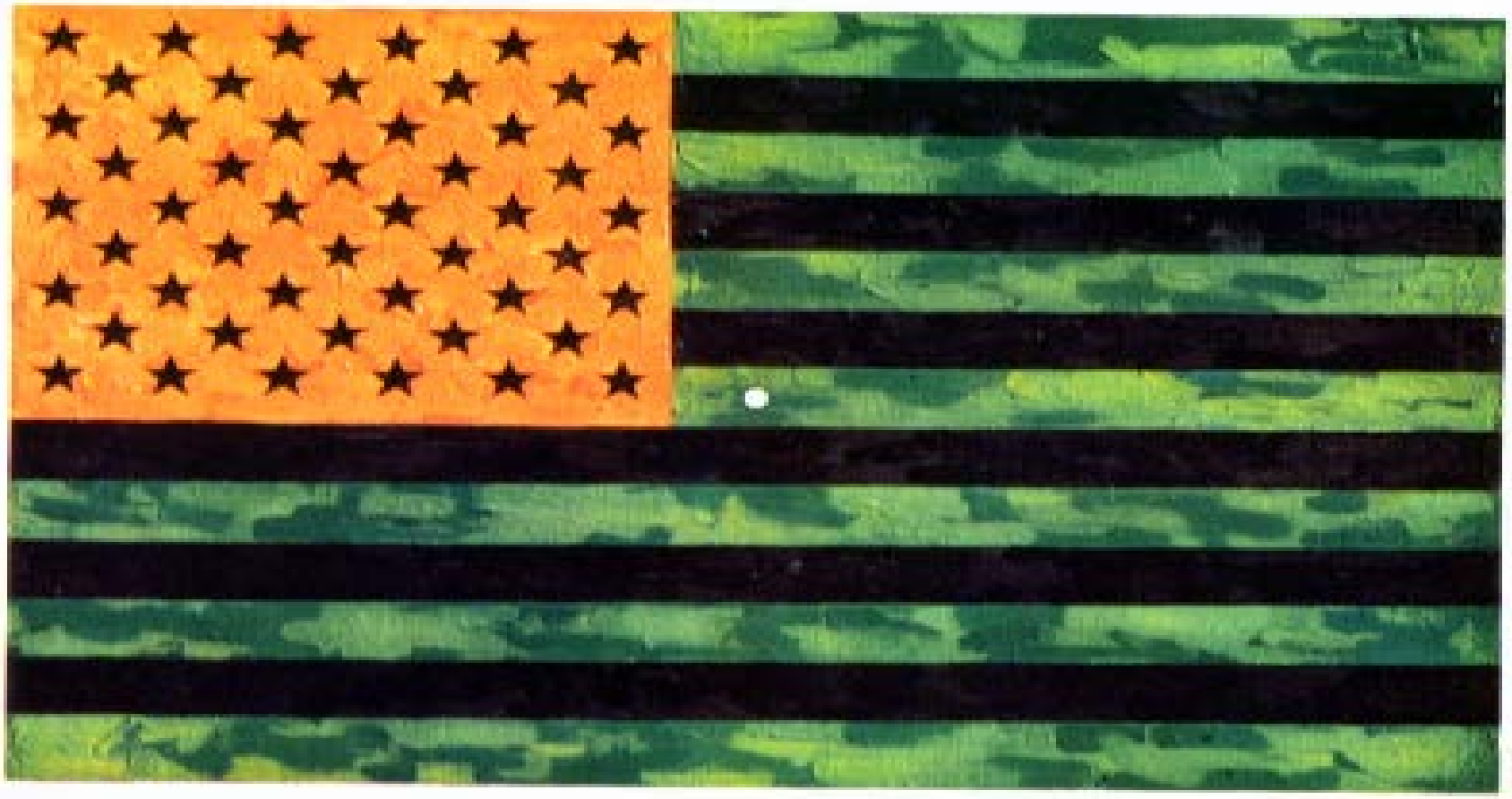
- Two Forms of Color Blindness
  - Monochromacy
    - Loss of All Color Sensitivity
  - Dichromacy
    - Protanopia
      - Loss of “Red” Receptors
    - Deuteranopia
      - Loss of “Green” Receptors
- Negative Afterimages

Keep Your Eyes Focused On This Image for 60-90 Seconds,
Then Advance to the Next Slide



Jasper Johns,
“Target” (1974)
Walker Art Center, Minneapolis

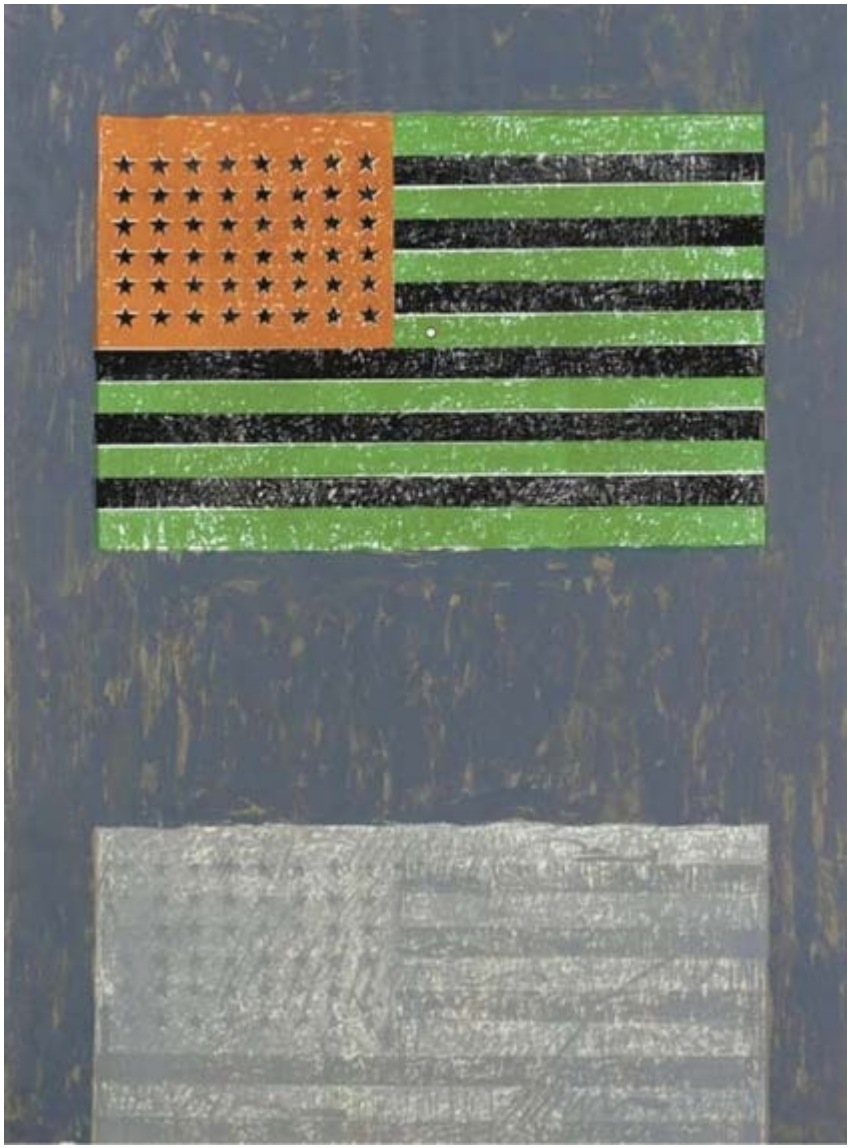
Jasper Johns,
“Target”



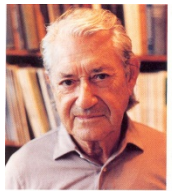
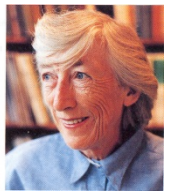
Jasper Johns, Moratorium (1969)

Fogg Art Museum, Harvard

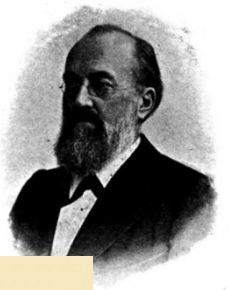
Jasper Johns
*Flags* (1967-1968)
Metropolitan Museum of Art



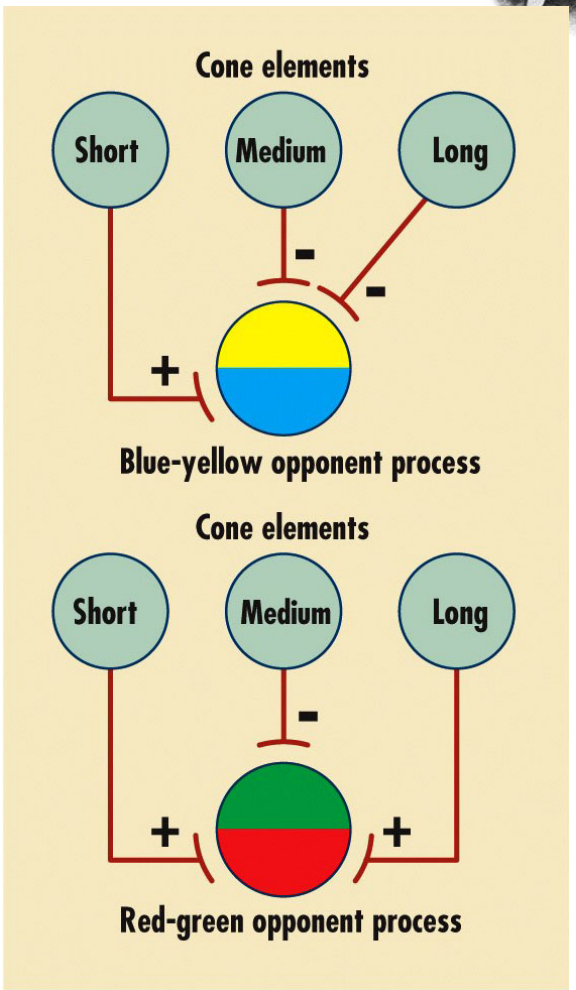
# The Opponent-Process Theory of Color Vision

Hurvich & Jameson (1957), after Hering (1878)



- On the Retina
  - Three Types of Cones
    - “Blue”, “Green”, “Red”
  - One Type of Rod
    - Light
- Antagonistic Pairs
  - Red-Green
  - Yellow-Blue
  - Black-White



# Cortical Determinants of Sensory Quality

- Auditory Pitch
  - Tonotopic Organization of A1

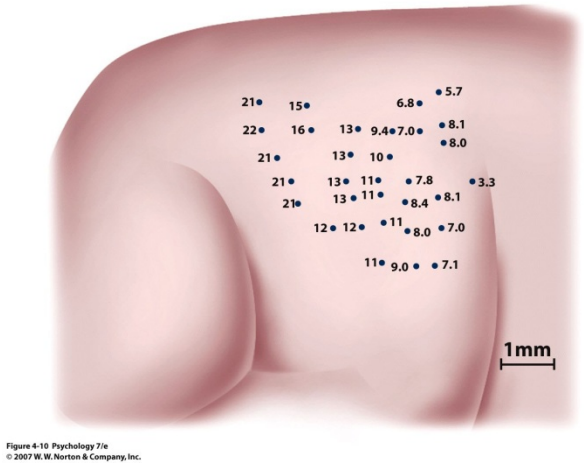



Figure 4-10 Psychology 7/e
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- Visual Hue
  - Lateral Geniculate Nucleus
  - Area V8