The Use of Color in User Interfaces

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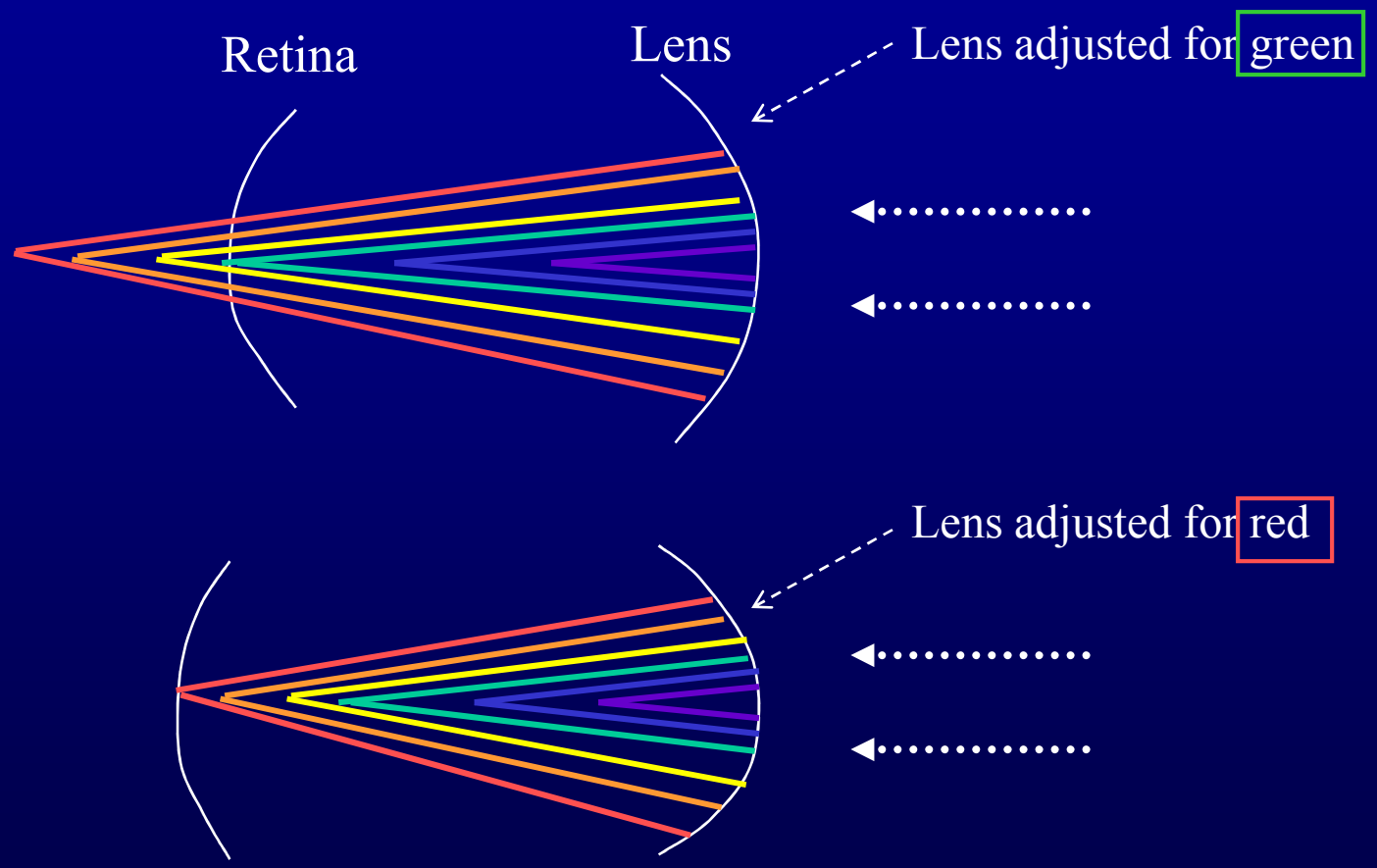
SWE 432
Design and Implementation of Software for the Web

Color Topics

- The Eyes
- Color
- Guidelines
  - Physiological
  - Perceptual
  - Cognitive

The Eyes



The Eyes: Lens and Retina

- Lens: Use muscles to change shape to focus on colors
- Retina: Absorbs longer wavelengths better
- Rods: See shades of gray
- Cones: See color and detail
- Chromostereopsis: Cannot focus on different colors at the same time

Color

- Hue: What we usually see as color
- Luminance: Amount of light entering eye
- Brightness: Perceived amount of light
  (blue appears brighter than white)
- Saturation: Purity of color
- Lightness: Amount of light an object reflects

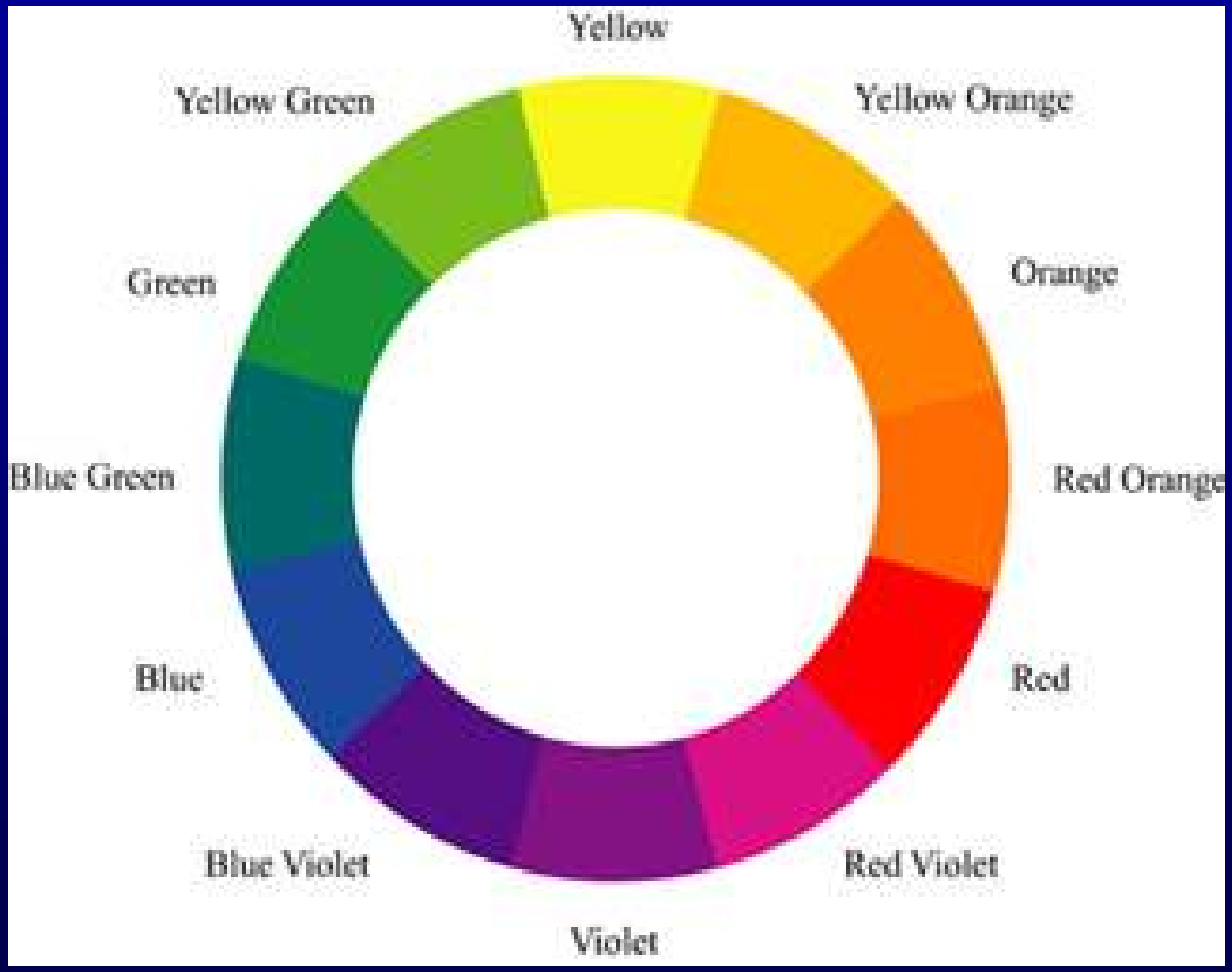
Color Spectrum

Color	Wavelength
Purple	< 430 nm
Blue	450 – 480 nm
Green	500 – 550 nm
Yellow	570 – 590 nm
Orange	610 – 630 nm
Red	> 640 nm

See the Java Applet color wheel at:

http://www.ficml.org/jemimap/style/color/wheel.html

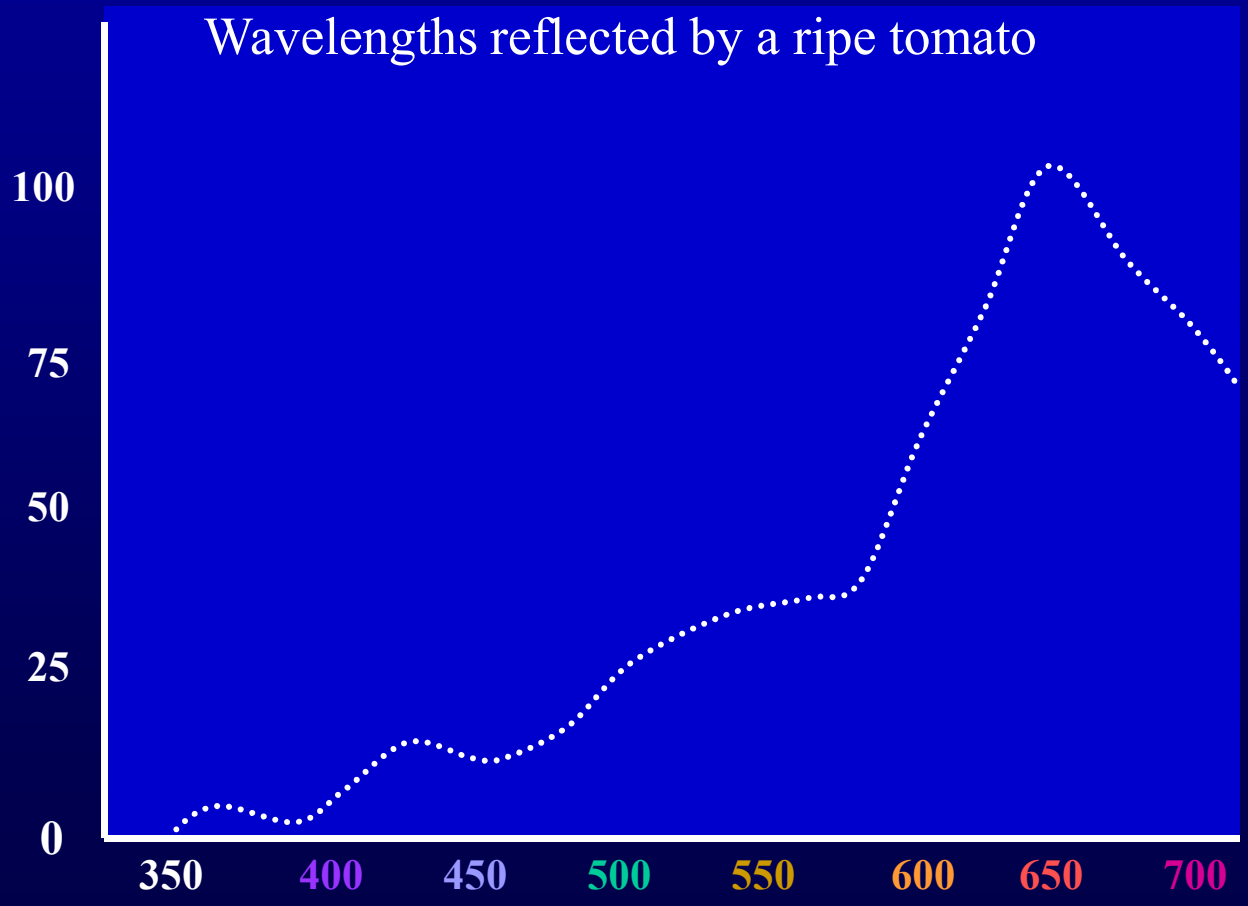
Color Wheel – Opposites



Notes on Human Eyes

- Lens are adjusted for green when relaxed
- Reds are easiest to discriminate
- Blues are hardest to discriminate
- The number of hues we can perceive shrinks as we age

Color Lightness



Color Contrast

- Relative brightness of signal over background
- Greater contrast – better perception
- Opponent colors yield better contrast – but may be ugly

  (yellow:blue, red:green)

- Dark on light yields better contrast than light on dark
  - This is true on paper and on screens
  - The effect is reversed when *projecting*

Color Contrast

- Relative brightness of signal over background
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- Opponent colors yield better contrast

  (yellow:blue, red:green)
- Dark on light has better contrast than light on dark
  - This is true on paper and on computer screens
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Color Guidelines

- Physiological
- Conceptual
- Cognitive

Physiological Guidelines (1)

1. Avoid using highly saturated opponent colors at the same time (except as BG / FG)
2. Do not use blue for text, thin lines, and small shapes
3. Do not use adjacent colors that only differ in the amount of blue
4. Older users need higher brightness levels
5. Use dark on light when printing and on-screen, and light on dark when projecting

Physiological Guidelines (2)

6. As light levels change, color perception changes
7. The amount of detectable change in color is different with different colors
8. Try not to put red and green on the sides of large displays (those cones are centered in our eyes)
9. Opponent colors give strong contrast
10. Adjacent colors should have different levels of brightness

Perceptual Guidelines (1)

1. Hue changes perceived brightness
2. Different hues have different saturation levels
3. Not all colors are as readable as others
4. Use brighter, spectrum-centered colors for text
5. Hues will look different with different intensity and background color

Perceptual Guidelines (2)

6. Do not require color discrimination in small areas
7. Avoid using hue to indicate numeric information
8. Use greater intensity for hues that indicate larger amounts
9. Use two different background colors to split screen

Cognitive Guidelines (1)

1. Do not use too much color
2. Group related elements by using a common background color
   - Use color to indicate “regions” in web sites
3. Use similar colors to imply similar meanings
4. Brightness and saturation draw attention

Cognitive Guidelines (2)

5. Warm and cold colors can indicate action levels
6. The same color may have different meanings in different cultures
7. Use redundant coding of shape and color

Color in HTML

Color is defined as #RRGGBB

Some predefined colors:

Color Name	*Hex Value*	*Color Name*	*Hex Value*
Aqua	#00FFFF	Navy	#000080
Black	#000000	Olive	#808000
Blue	#0000FF	Purple	#800080
Fuchsia	#FF00FF	Red	#FF0000
Gray	#808080	Silver	#C0C0C0
Green	#008000	Teal	#008080
Lime	#00FF00	White	#FFFFFF
Maroon	#800000	Yellow	#FFFF00

Usable Color Combinations

Background	*Best Colors*	*Worst Colors*
White	Black, Blue	Cyan, Yellow
Black	Yellow, White	Blue
Red	Black	Blue, Magenta
Green	Black, Red	Cyan
Blue	Red, White, Yellow	Black
Cyan	Blue, Red	Green, White, Yellow
Magenta	Black, Blue	Cyan, Green
Yellow	Black, Blue, Red	Cyan, White

An Effective Use of Colors

Borland C++ 3.1 used six colors to categorize textual content:

1. Reserved words – white
2. Identifiers – yellow
3. Macros – green
4. Literals – cyan
5. Comments – gray
6. Syntax errors – red

Conclusions

- Color can greatly enhance the usability of interfaces
- Color can (and often is!) greatly over-used
- When using color:
  - be gentle
  - be thoughtful