

Color

SWEN-444

[Color Reference](#)

Color Perception - A Physics Review

- A **light source** emits **light waves** at **visible frequencies** that strike an object
 - The object **absorbs** and or **reflects** different **frequencies**
 - The object may be opaque, transparent, or translucent
- The **reflected frequencies determine the object's color**
 - **Black** if all frequencies **absorbed**
 - **White** if all frequencies **reflected**
 - Other combinations produce the color spectrum
- The **perceived color varies** based on **light source** properties and **viewing conditions**

Color Systems

- Primary colors – basic colors from which all other colors are derived
- Light – Red, Green, Blue (RGB)

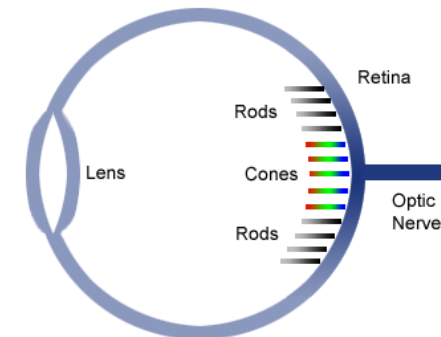


- Print – Cyan, Magenta, Yellow and (Black)



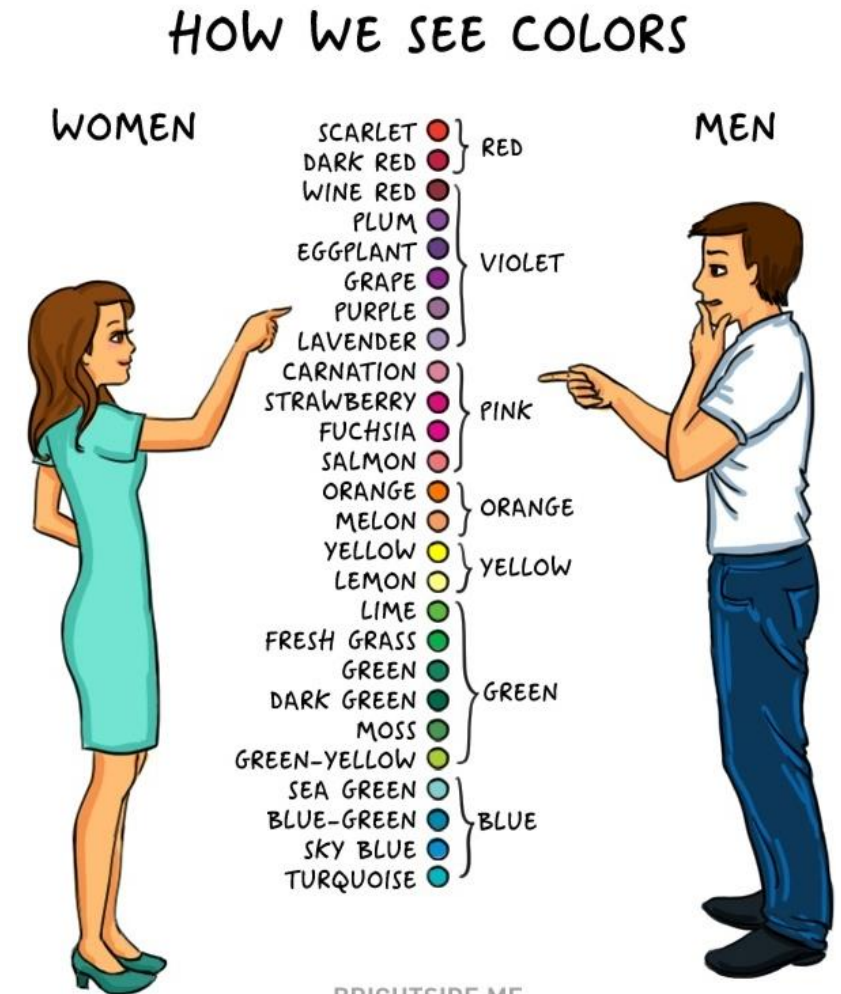
Color Perception

- The human visual system (rods and cones)
 - The **cones** prevalent in the central retina are **sensitive to color**
 - Sensitive to **red, green, and blue**
 - The **rods** prevalent on the retina periphery are **sensitive to motion and low-light environments**
- Visual limitations
 - Color **perception** is **weak** in our **peripheral** vision
 - **Eyes** are **most sensitive** to the middle frequencies, **green and yellow**



Color Blindness

- Photoreceptors vary greatly from person to person
- People with photoreceptors that do not respond to certain frequencies do not perceive those colors in the same way that other people do; “color blindness”
 - 8% of male individuals
 - 0.4% of female individuals

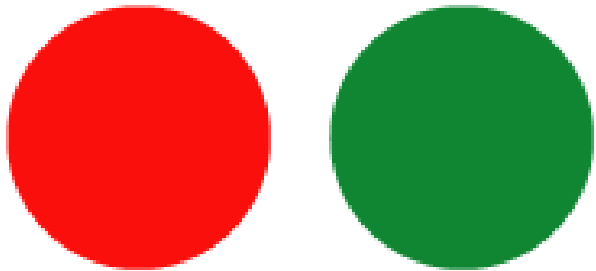


<http://www.colourblindawareness.org/>

Types of Color Blindness



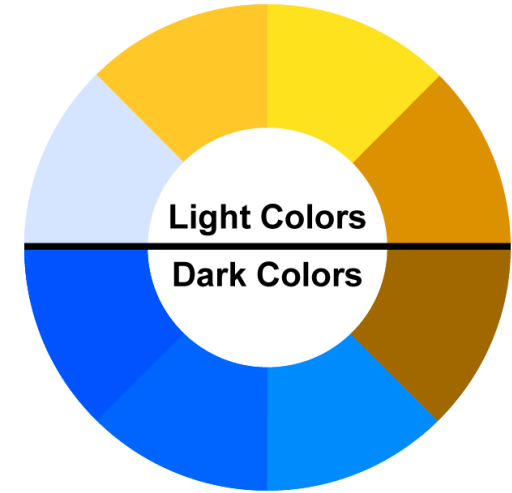
Protanopic color vision,
no ability to perceive red



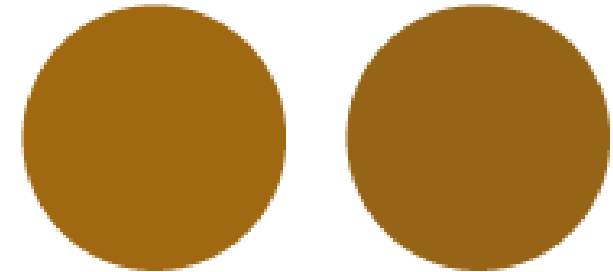
Normal



Normal trichromatic
color vision



Deuteranopic color vision,
no ability to perceive green



Deuteranopic (most common)

[Color Blindness Simulator](#)



Gregg Rosenthal ✓

@greggroenthal

Follow

This matchup is a color blind person's nightmare. Teams are blending together.

8:28 PM - 12 Nov 2015

67 114



Michael A. Giarrusso ✓

@MichaelG1

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ent of men, about 13 million Americans, are colorblind, red/green. This is torture to us.#BUFvsNYJ

l - 12 Nov 2015



Color Perception

- Factors affecting color perception:

- Culture
- Age
- Fatigue
- Emotions
- Ambient light
- Light sources
- Blood oxygen levels



Walk

Don't Walk

- Color can evoke:

- An **expectation, preferences**
- **Emotion** – aesthetic appeal – “**warm**” versus “**cold**” colors
- **Localization** – differences by culture or commercial context (logo color) in the meaning and emotion of color

Using Color in Interaction Design

- Clarification, Relation, and Differentiation
- Searching
- Comprehension, Retention, and Recall
- Task Performance
- Redundant Coding
- Color Concerns for Interaction Design

Clarification, Relation, and Differentiation

- Color can be used to **clarify differences** and **similarities** and **communicate relationships**
- Color codes can be used to support a logical information structure; e.g., multi-variable graph



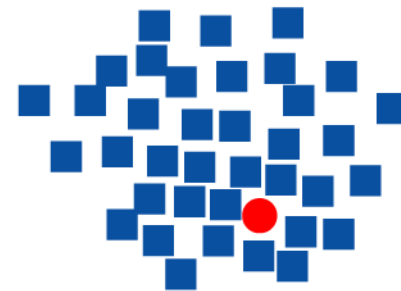
Searching

- Color can be used to **catch the attention** of the user
 - Keywords, string types

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style="text-align:left; width:100%;">  
<tbody>  
<tr>  
<td style="vertical-align:top; text-align:center;">
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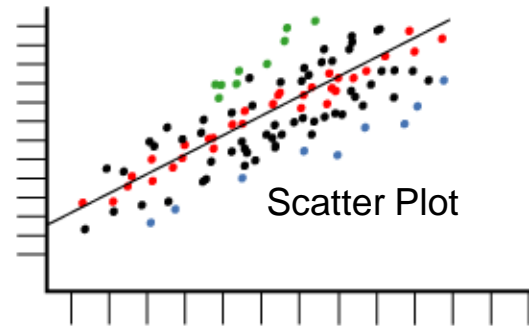
` `` `; When Netscape Navigator 7.1 displays the source code of a web page, it colors the element names purple, the attribute names black, the attribute values blue, the comments green and character entities orange.

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</td>  
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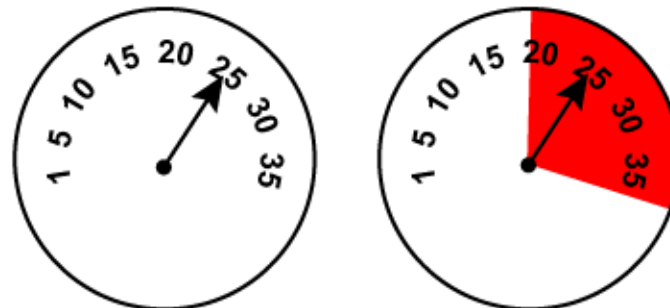


Comprehension, Retention, and Recall

- Color can enable us to **comprehend patterns** in complex data structures



- Color can aid in **remembering and recalling** information

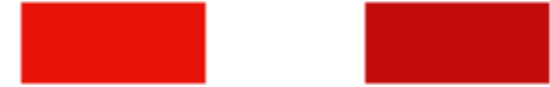


Task Performance and Redundancy

- Studies show **color** improves task **performance** for:
 - Recall
 - Search-and-locate
 - Retention
 - Decision judgment
- Redundancy – **color alone is not enough**
 - A clear **HCI structure and presentation** must **already be present** before color is introduced
 - Use **multiple sensory cues** (e.g. color and shape)
 - Don't use color to delineate shapes – contrast issues

Color Concerns for Interaction Design

- **Limitations** in the perception of **subtle color differences**
- Number and choice of colors
 - To aid in color recognition and recall, **use only a few distinct colors**
 - Red, green, blue, and yellow are best
 - Five to nine colors for coding information
 - Don't **distract** the **user** or **compete** with **content**
 - Keep color **perception limitations** in mind
 - E.g., we see green and yellow best, so avoid small blue objects
 - **Avoid saturated colors** – can cause visual fatigue



Color Concerns - Contrast

- **Incompatible differences**
 - some specific color combinations cause unique problems:
 - **Colors at opposing ends of the spectrum** such as red and blue
 - **Positive contrast** makes characters appear to glow (Halation)

Saturated yellow and green	Saturated yellow on green
Yellow on white	Yellow on white
Blue on black	Blue on black
Green on white	Green on white
Saturated red on blue	Saturated red on blue
Saturated red on green	Saturated red on green
Magenta on green	Magenta on green
Saturated blue on green	Saturated blue on green
Yellow on purple	Yellow on purple
Red on black	Red on black
Magenta on black	Magenta on black

Foreground-Background Color Contrast

- **Color Backgrounds**

- An object's **perceived color** is affected by the **background color**

