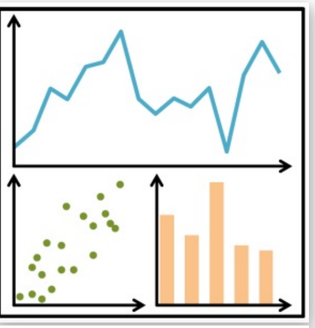
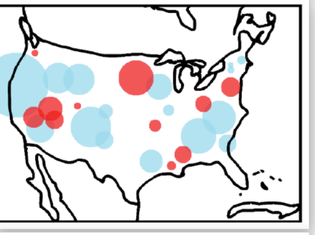
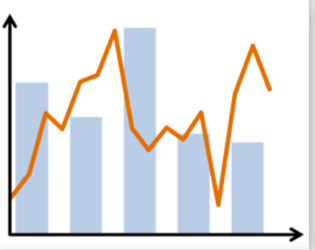
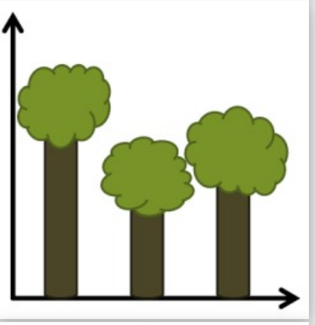
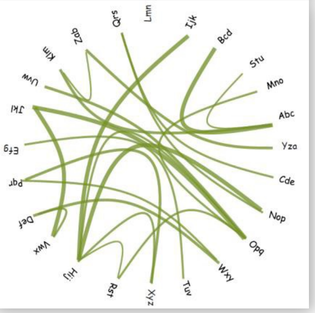






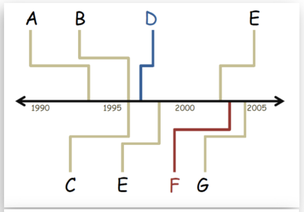
Lecture 6: Perception - Color

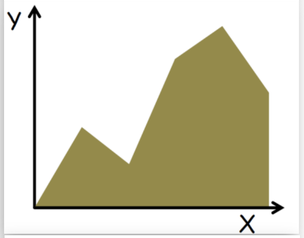
DS 4200

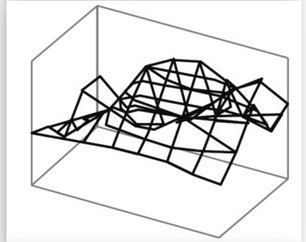
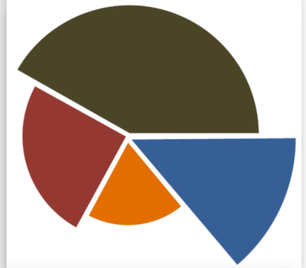
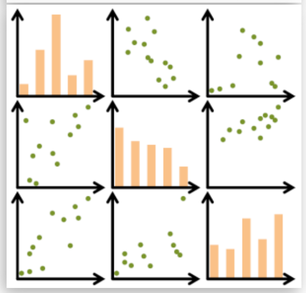
SPRING 2023

Prof. Ab Mosca (they/them)

NORTHEASTERN UNIVERSITY





Slides and inspiration from Cody Dunne, Dylan Cashman, Remco Chang, Lane Harrison, Connor Gramazio, Michelle Borkin, Krzysztof Gajos, Hanspeter Pfister, Miriah Meyer, Jonathan Schwabish, and David Sprague

Last Class

We:

- Reviewed marks and channels
- Reviewed decomposing graphics (ic-04)

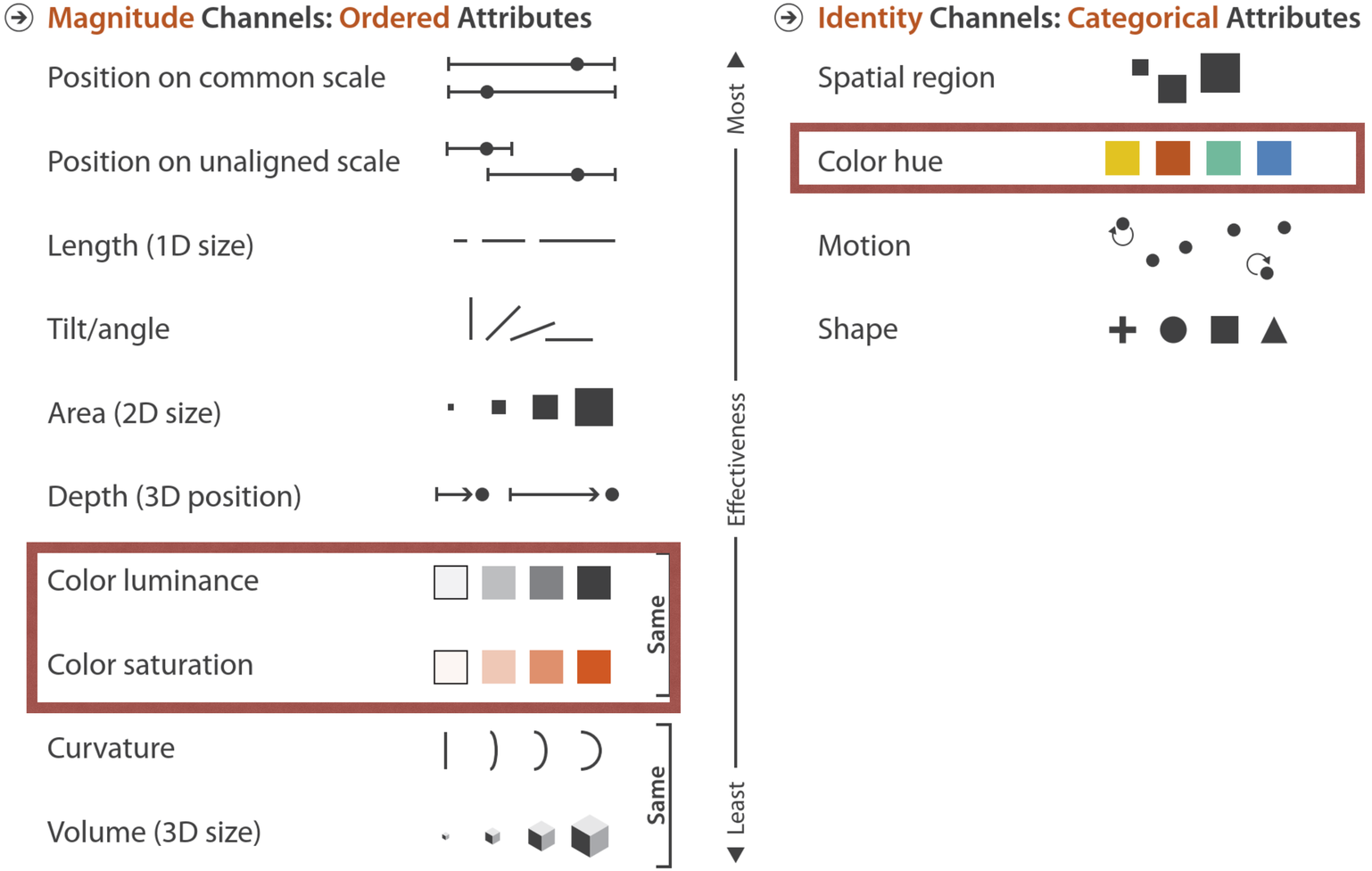
Any Questions?

Today

- High-level overview of color
- Intro to JavaScript

Expressiveness + Effectiveness

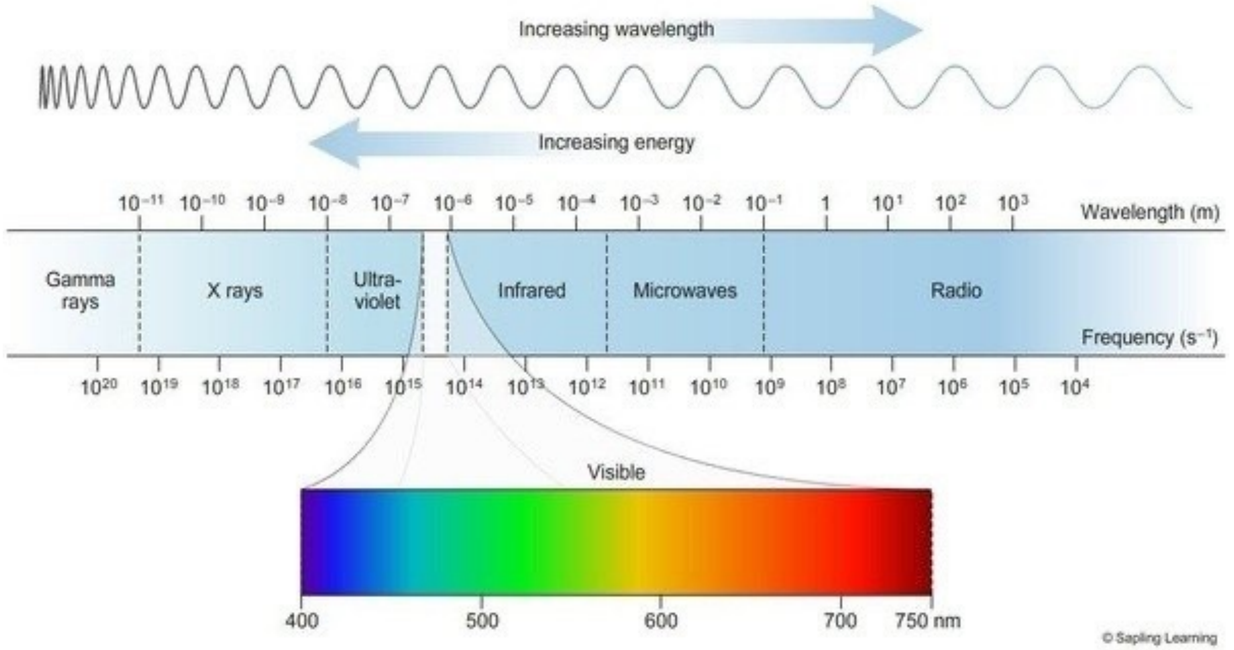
Channels: Expressiveness Types and Effectiveness Ranks



Color Perception

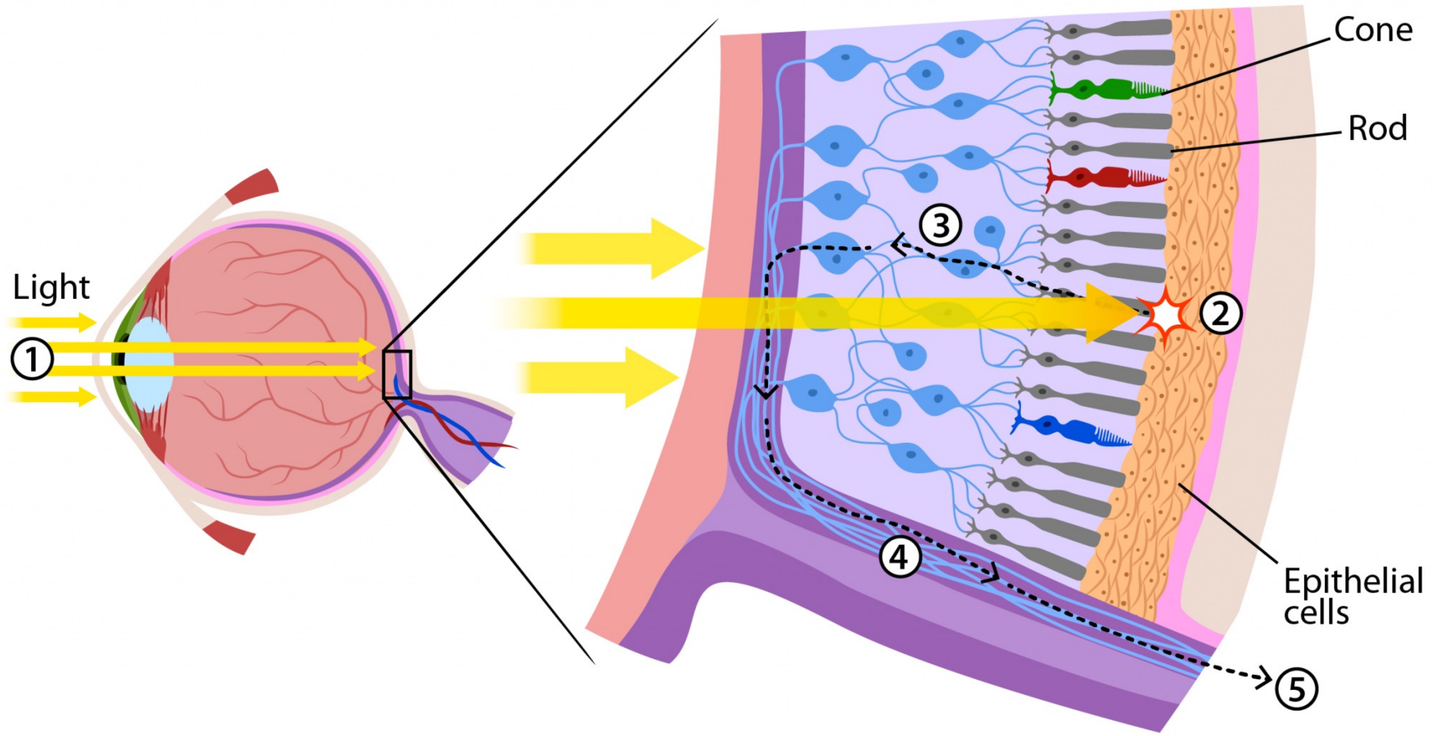
Color Perception

Color results from different wavelengths of light.



Color Perception

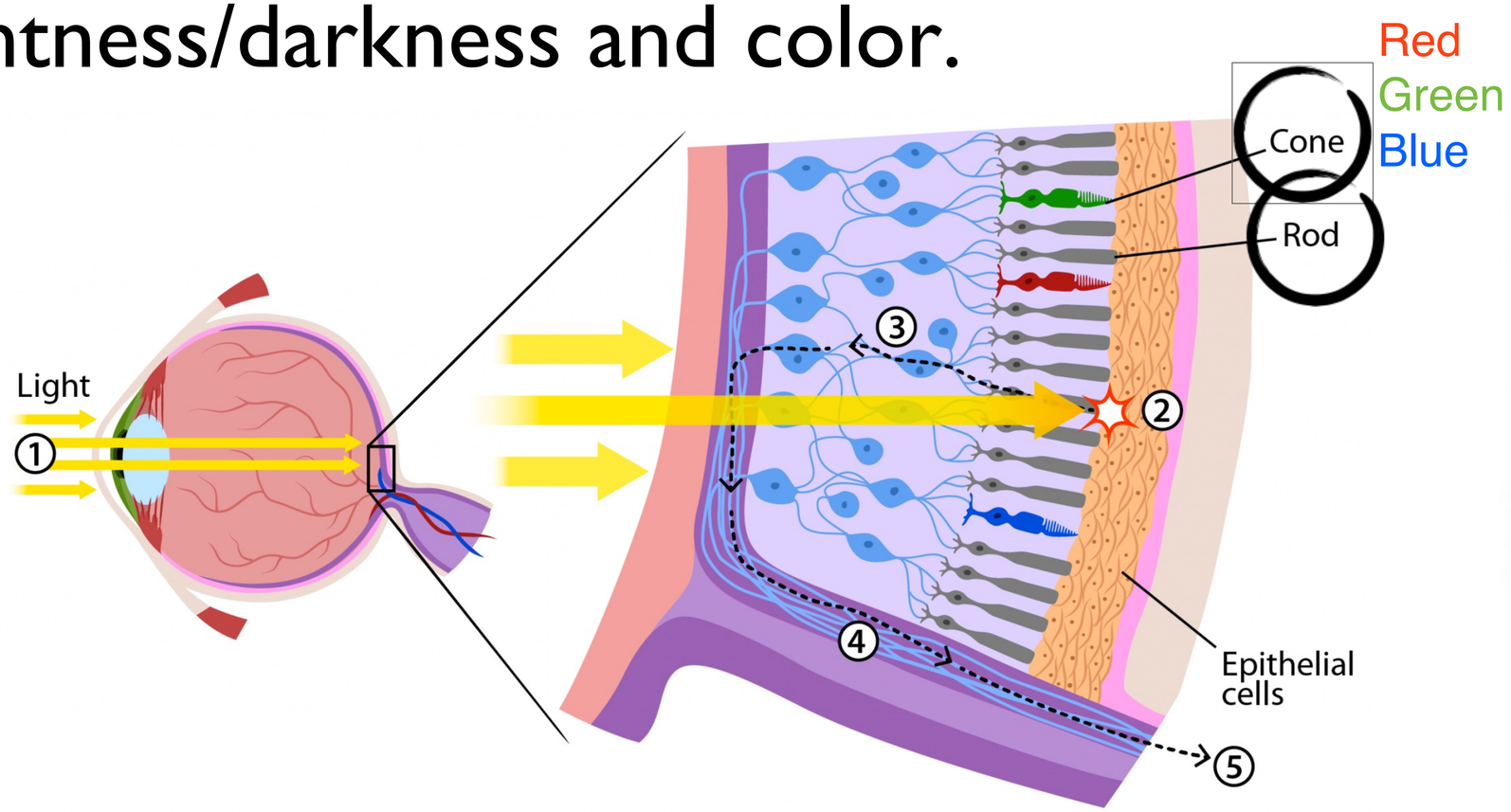
Your eye takes in light waves and translates them to lightness/darkness and color.

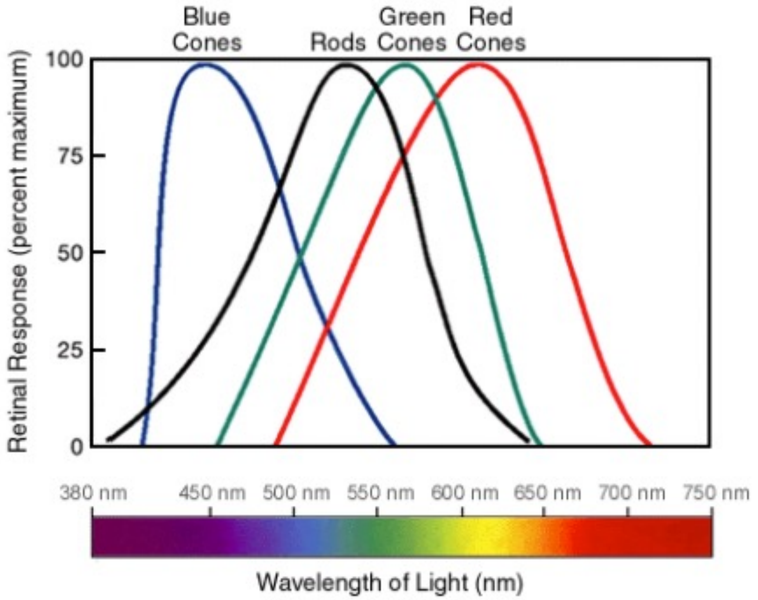


https://askabiologist.asu.edu/rods-and-cones

Color Perception

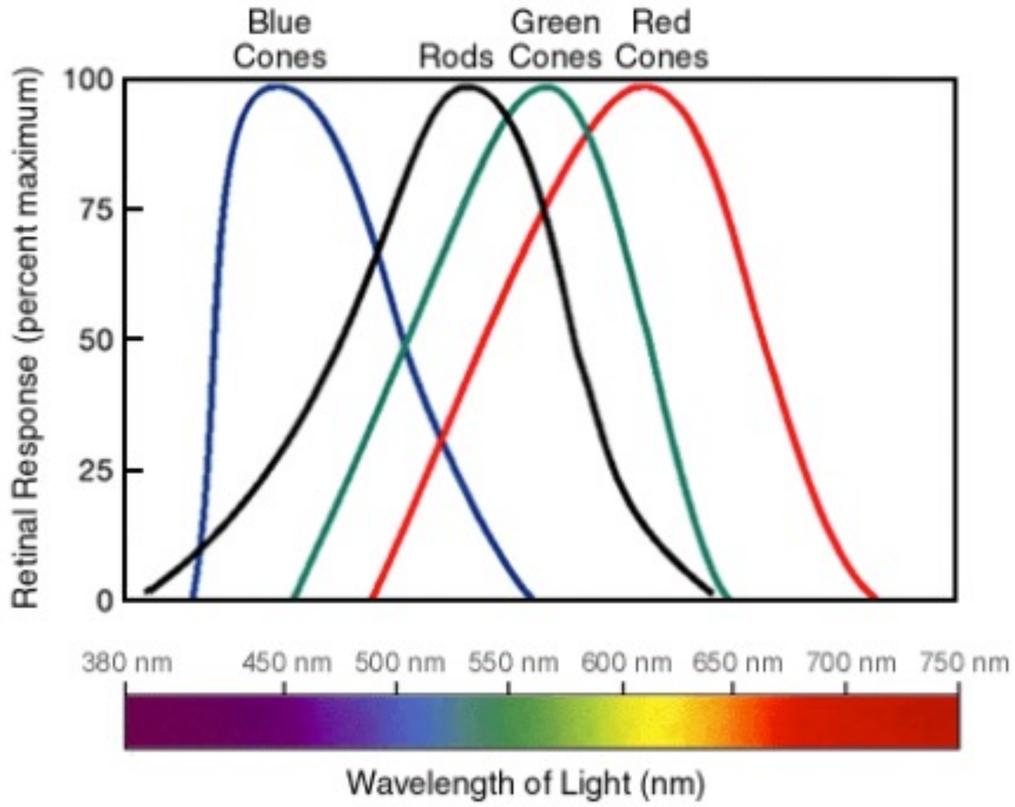
Your eye takes in light waves and translates them to lightness/darkness and color.





https://askabiologist.asu.edu/rods-and-cones

Color Perception



This is why lightness/darkness is an effective encoding channel!

Rods: 120 million

Cones: 5-6 million

This is why we are so sensitive to red!

Cones:

64% red-sensitive

32% green-sensitive

2% blue-sensitive.

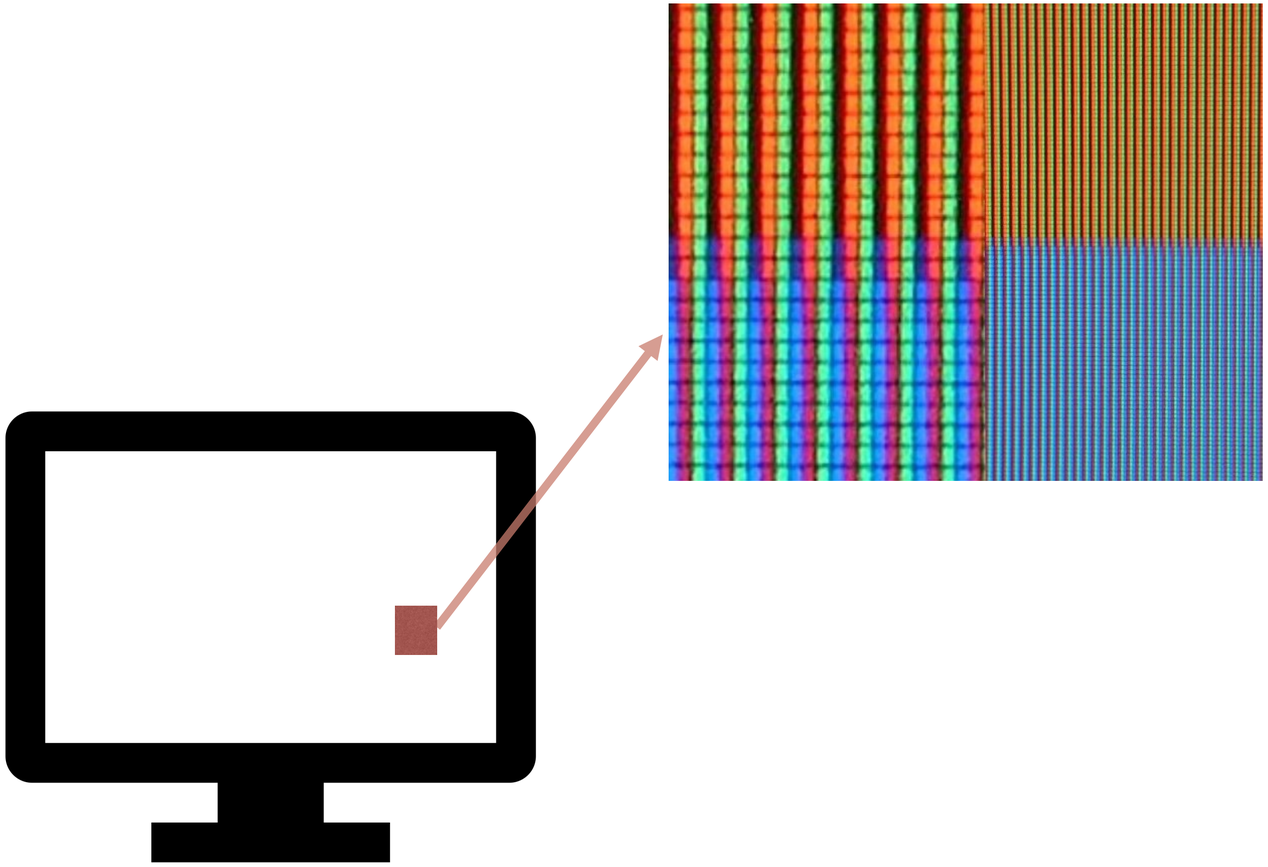
https://askabiologist.asu.edu/rods-and-cones

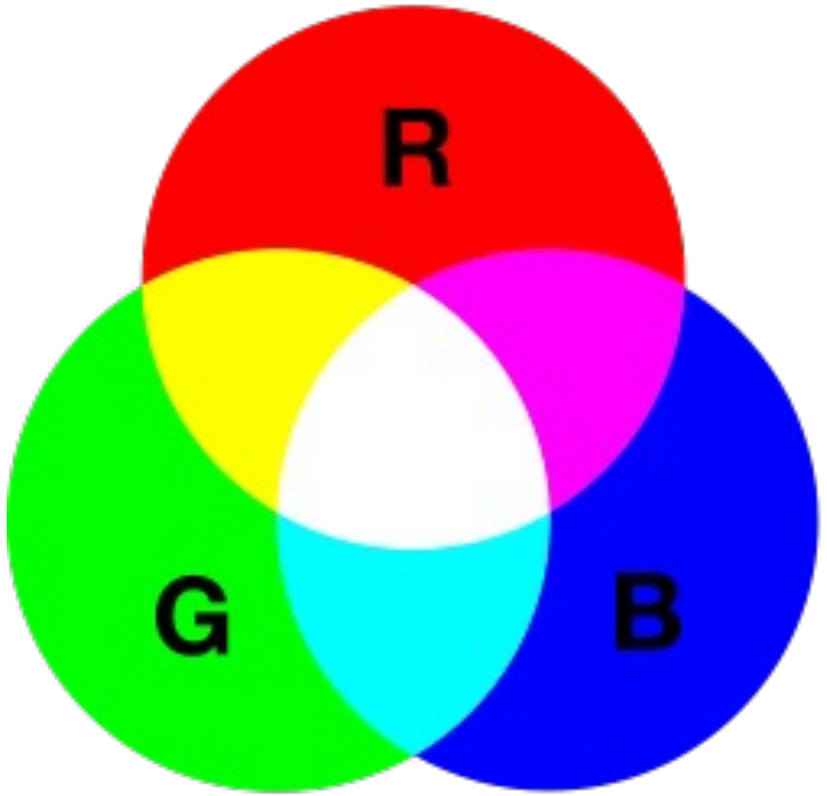
Color Models and Spaces

COLOR MODEL \ SPACE = Mathematical model describing the way colors can be represented.

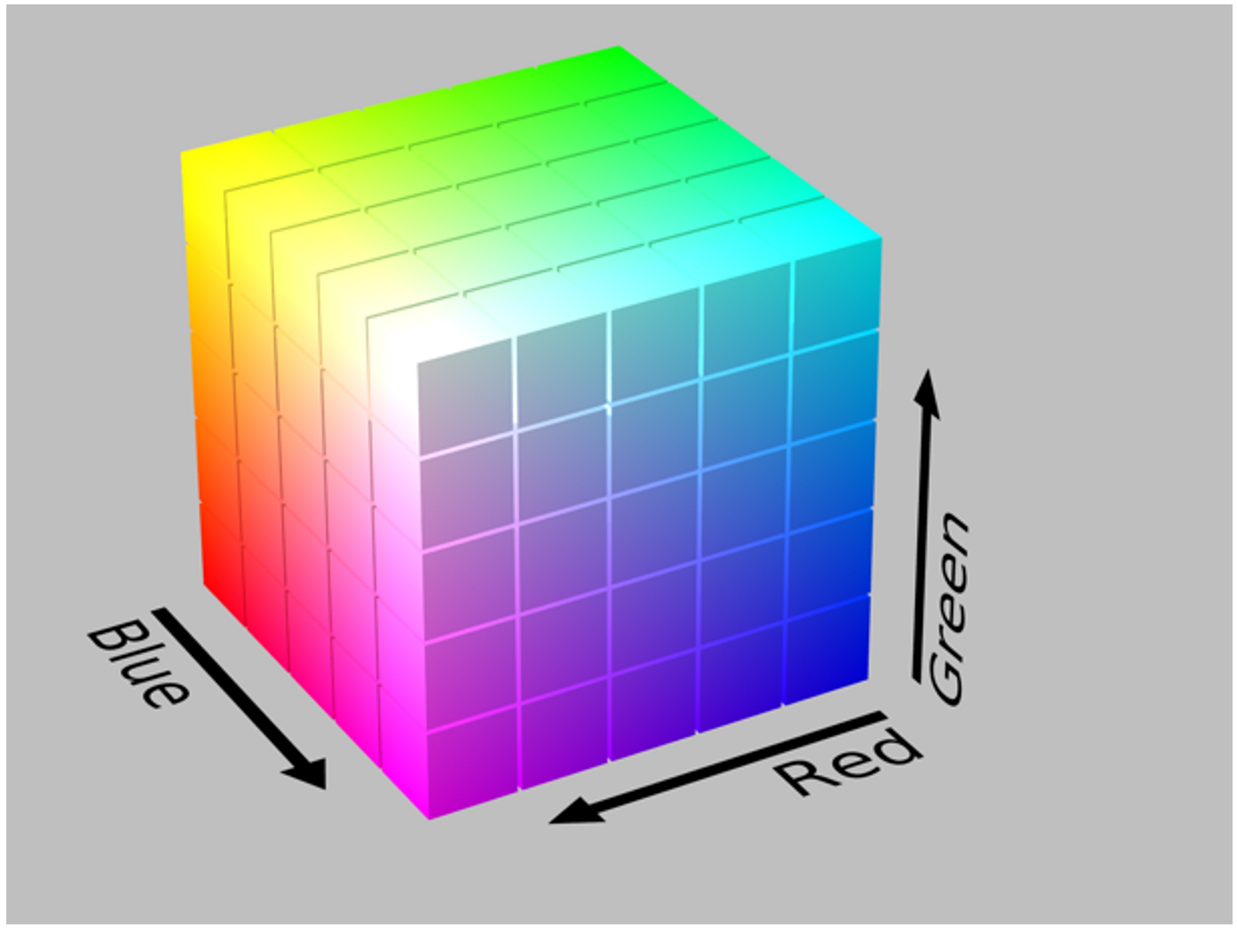
https://www.photoreview.com.au/tips/outputting/colour-spaces-explained/#:~:text=Colour%20spaces%20are%20mathematical%20models,%3A%20red%2C%20green%20and%20blue.

RGB (Red, Green, Blue)



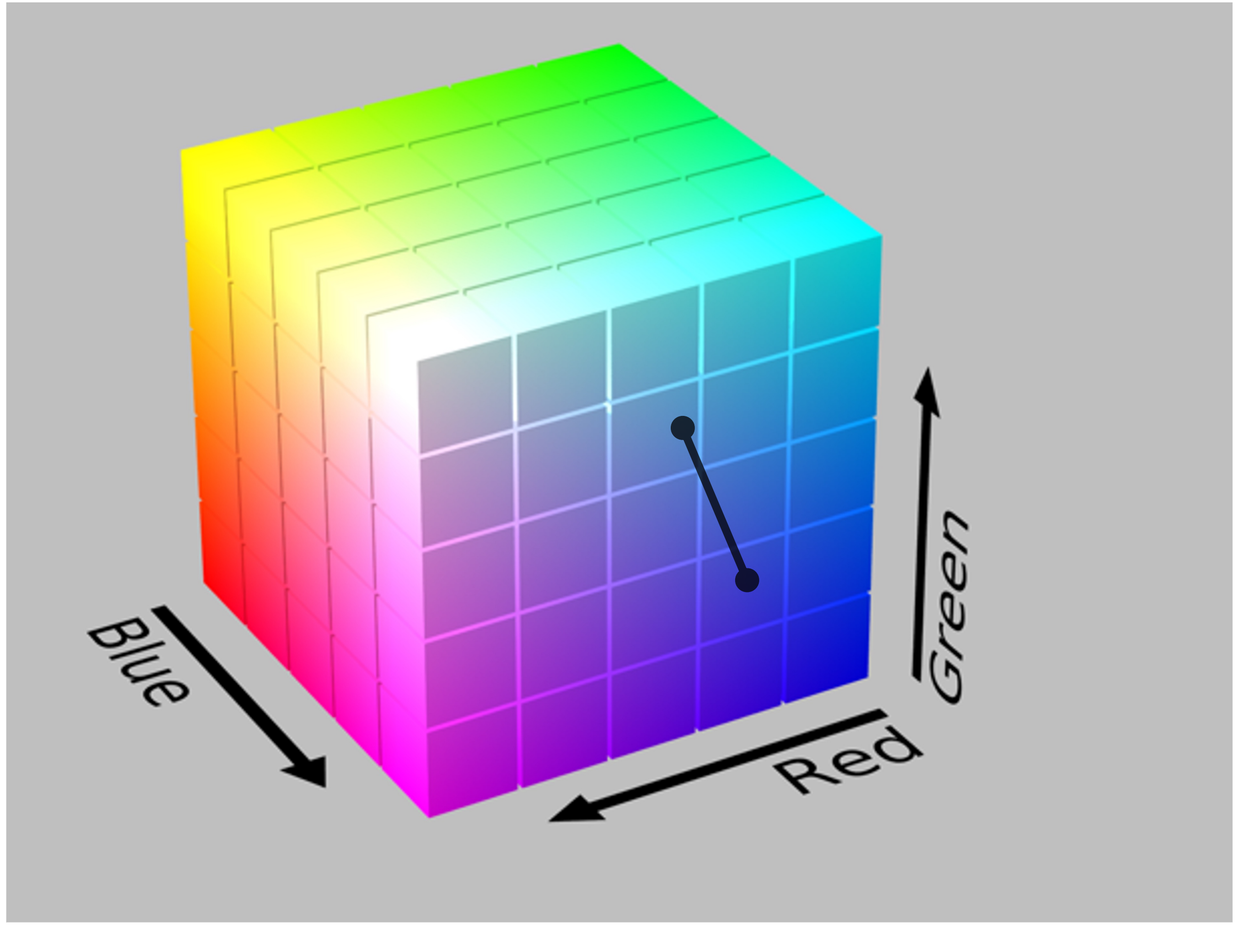


RGB



Colors exist in a cube space and are mixtures of Red, Green, and Blue

RGB



Issues

- Distance between colors nowhere near how we perceive differences

A: (5, 7, 15)

rgb(0, 128, 0)

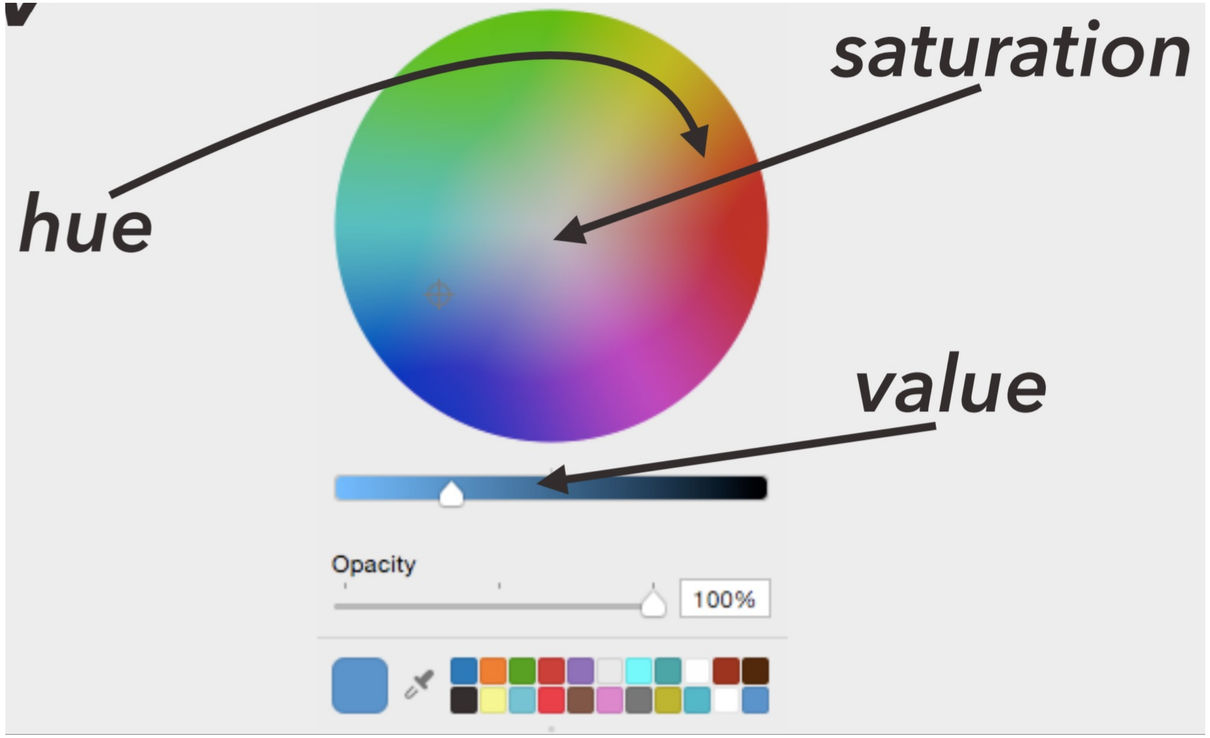
rgb(128, 0, 0)

B: (15, 17, 25)

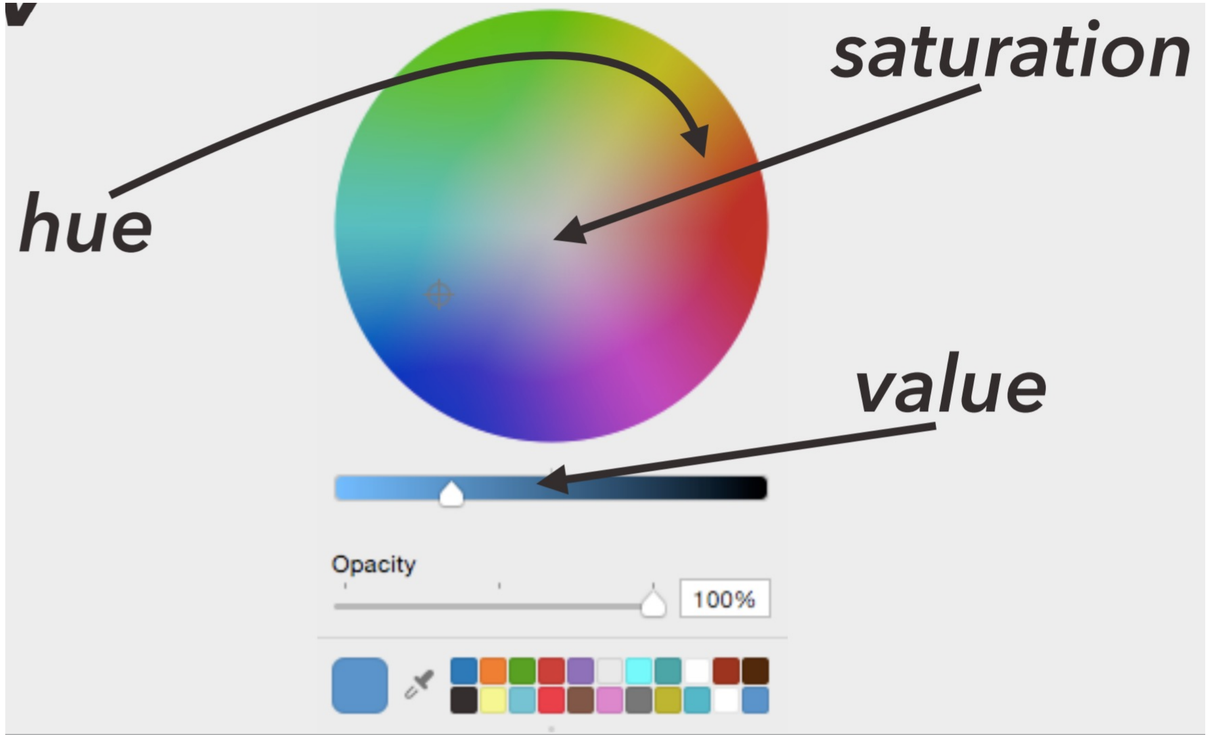
rgb(10, 138, 10)

rgb(138, 10, 10)

HSV/L (Hue-Saturation-Value/Lightness)



HSV/L (Hue-Saturation-Value/Lightness)

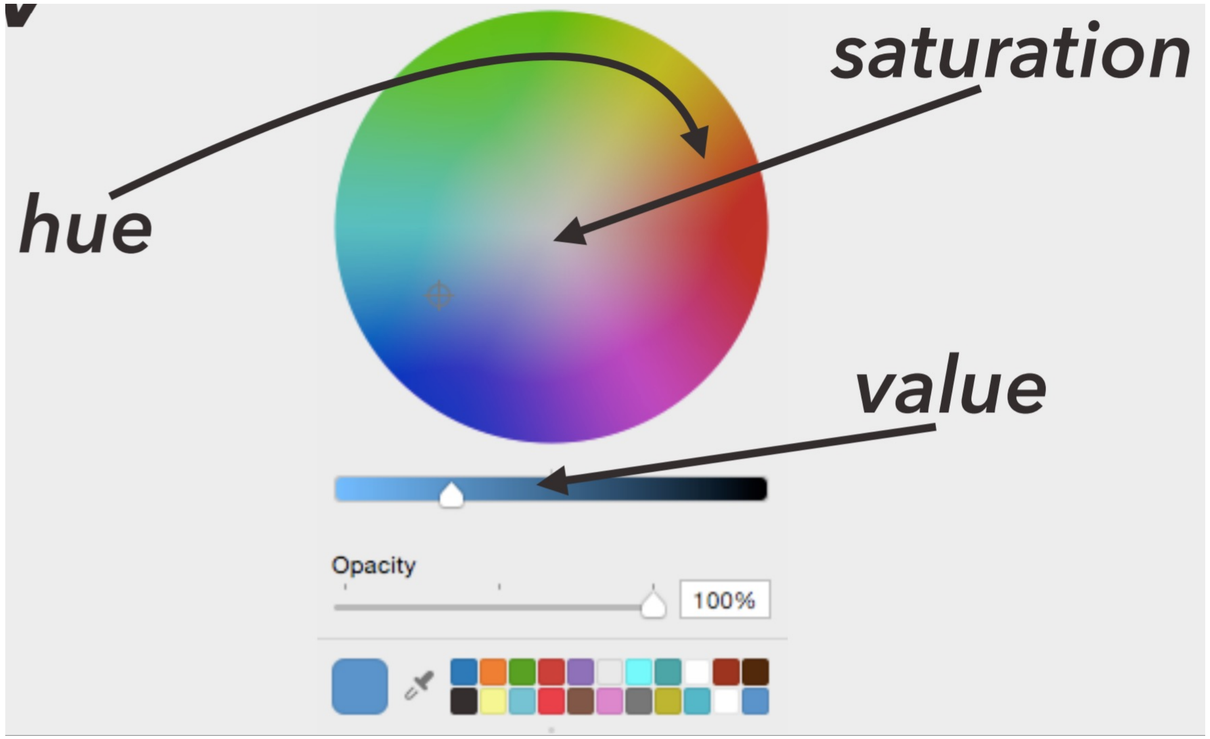


HUE = Pure colors (not mixed with white or black)

SATURATION = Amount of white mixed with pure color

VALUE/LIGHTNESS = Amount of black mixed with pure color

HSV/L (Hue-Saturation-Value/Lightness)



Distance between colors is closer, but not identical to how we perceive differences

A: (5, 7, 15)

hsv(120, 100, 50)

hsv(0, 100, 50)

B: (15, 17, 25)

hsv(130, 110, 60)

hsv(10, 110, 60)

Colormaps

Colormaps

Help us choose the correct colors to represent different attribute types

Categorical

Sequential

Divergent

Categorical

- Different color = different category
- Protip: choose colors that are perceptually distant
- Protip: choose colors that are roughly the same saturation and value

Sequential

- Saturation indicates difference in the amount of the phenomenon
- Protip: people interpret darker as meaning more

Divergent

- Two colors used to indicate extremes of a range
- Protip: neutral color in the middle
- Protip: differentiate between “average” or midpoint and “no data”

Expressiveness + Effectiveness

- **Magnitude Channels: Ordered Attributes**
  - Ordered
    - *Ordinal*

    - *Quantitative*

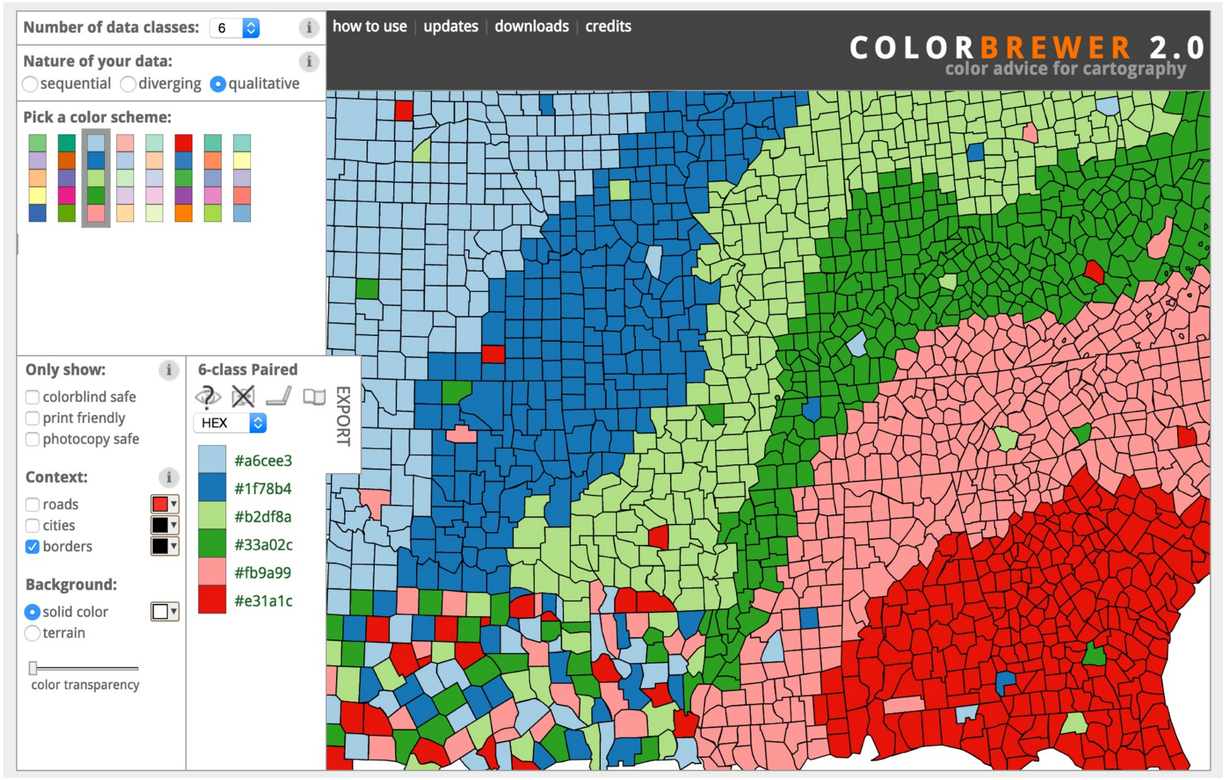
- **Identity Channels: Categorical Attributes**
  - Categorical

Divergent

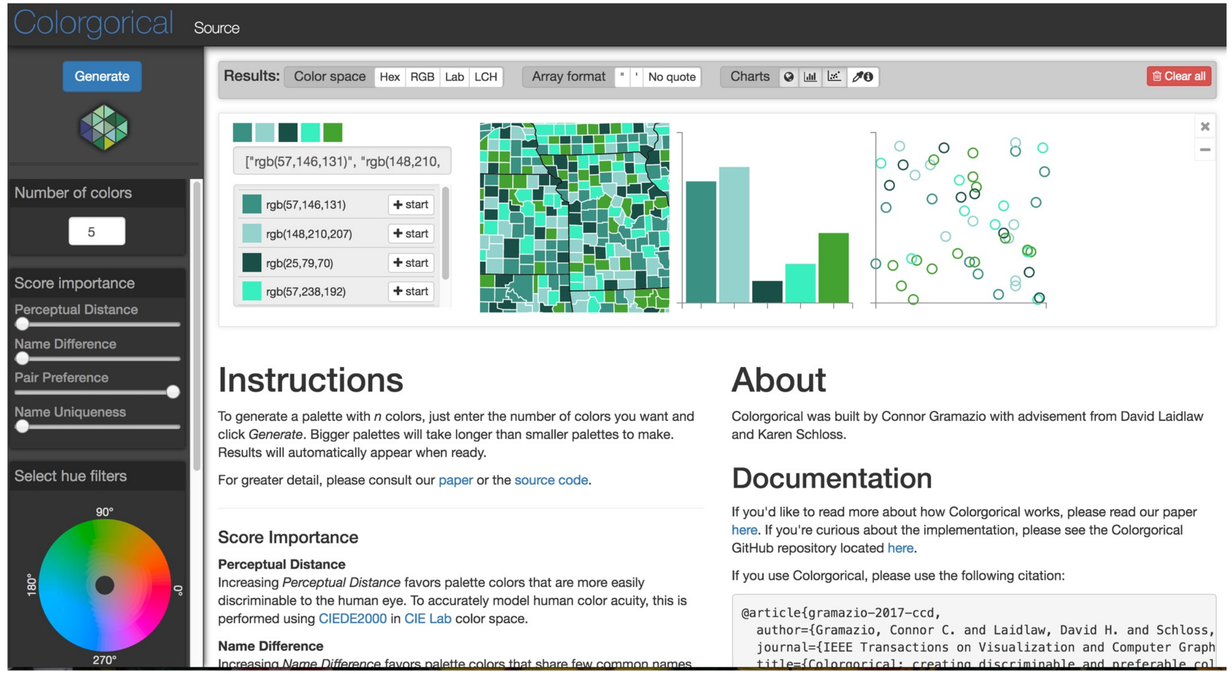
Sequential

Categorical

Picking a Colormap



http://colorbrewer2.org/



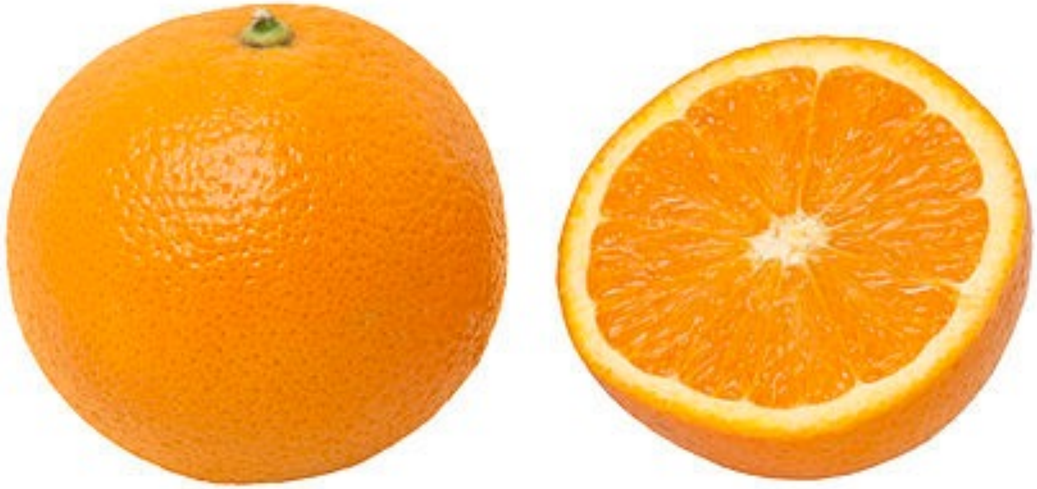
http://vrl.cs.brown.edu/color

Color Considerations

Colors - Beware

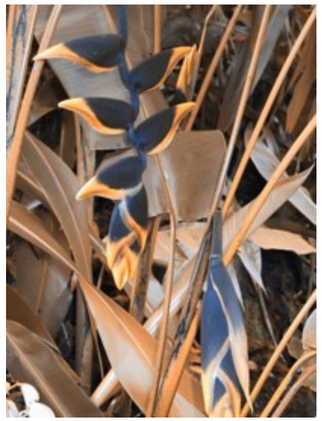
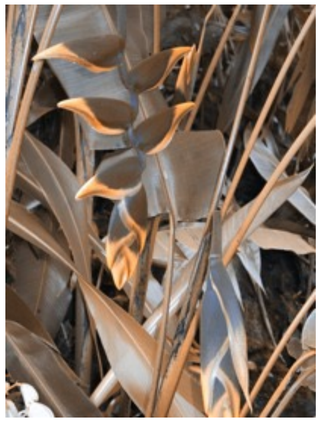
- When possible, use semantically meaningful colors
  (ex. red=hot, blue=cold)

- Be aware of cultural differences
  (ex. red in Chinese Culture vs Red in US culture)



Colors - Beware

- Use colorblind safe pallets.

Colors - Beware

- Saturation can cause illusions

High Saturation

→ Participants reported more red than green

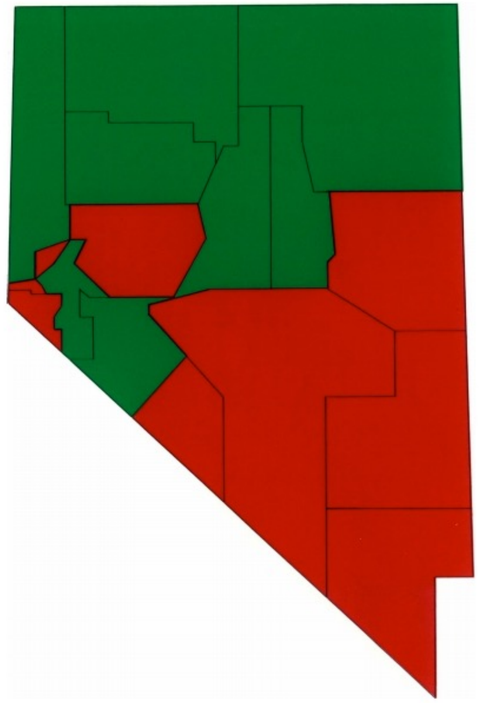


Figure 1. Stimulus From the High-Saturation Group

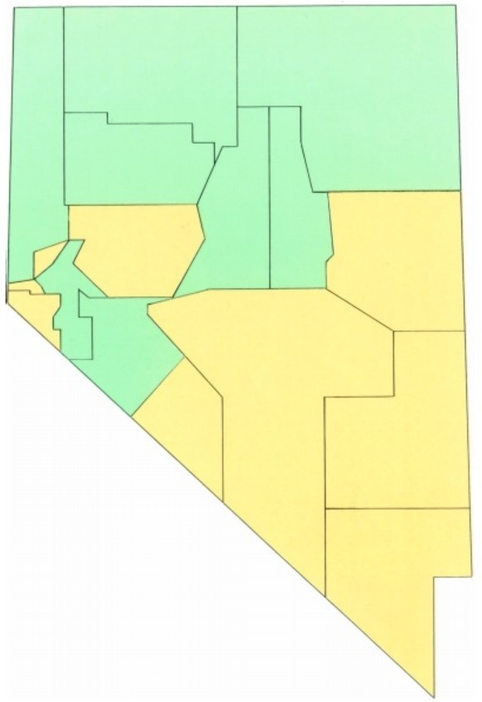


Figure 2. Stimulus From the Low-Saturation Group

Low Saturation

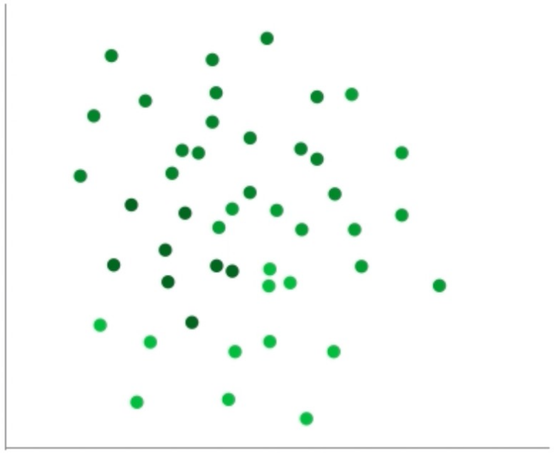
→ Participants reported equal proportions (which is correct)

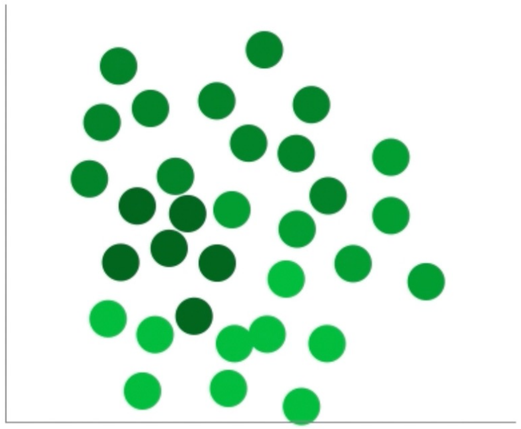
Cleveland & McGill, "A Color-Caused Optical Illusion on a Statistical Graph", 1983

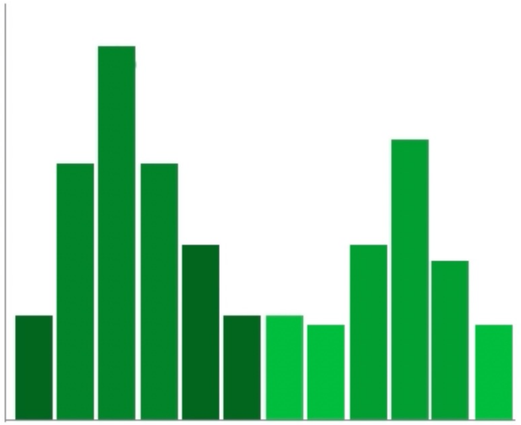
Colors - Beware

- Mark type and size effects how we perceive color

How many categories?







Szafir. Modeling Color Differences for Visualization Design

Colors - Beware

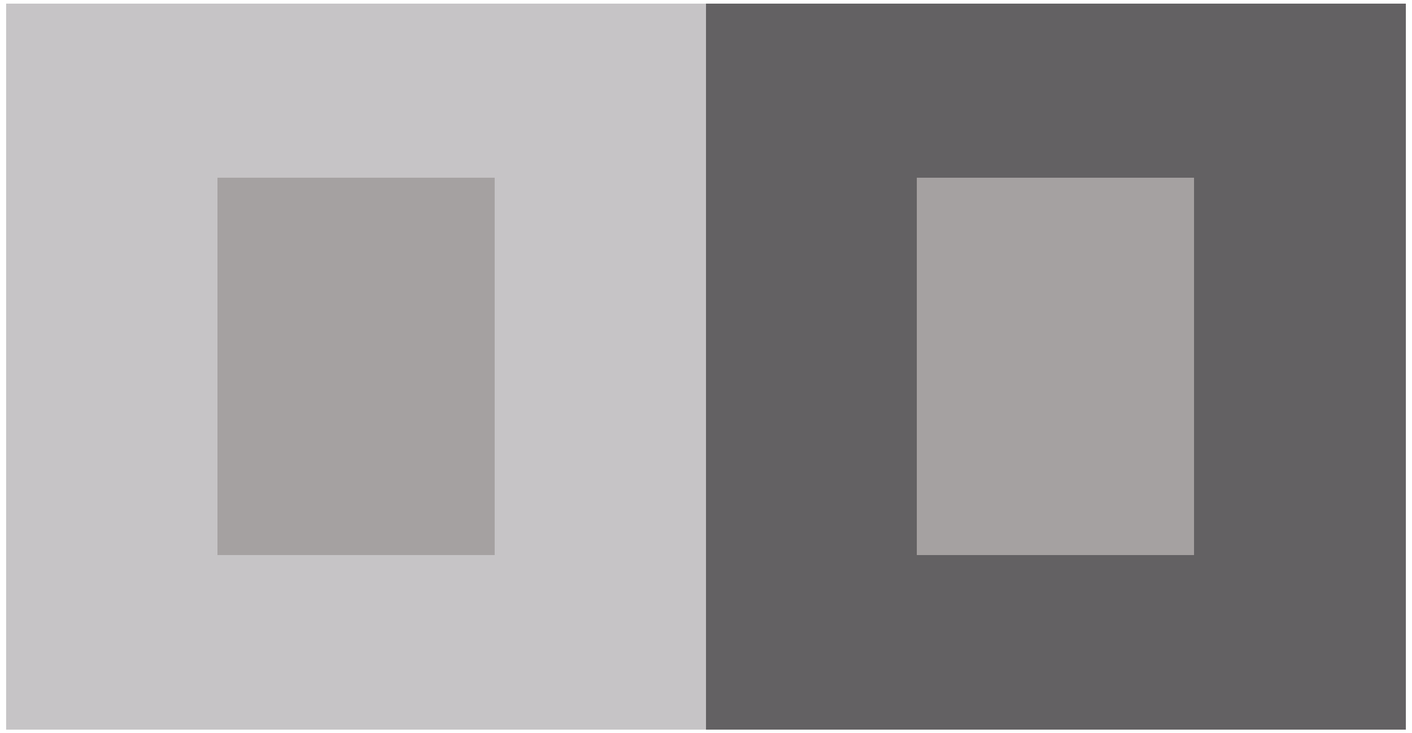
Is the smaller rectangle a solid color or gradient?

Colors - Beware

- SIMULTANEOUS CONTRAST – using a gradient as a background can distort how we see the foreground

  → Avoid using gradients as backgrounds

Colors - Beware



Are the smaller rectangles the same color or different colors?

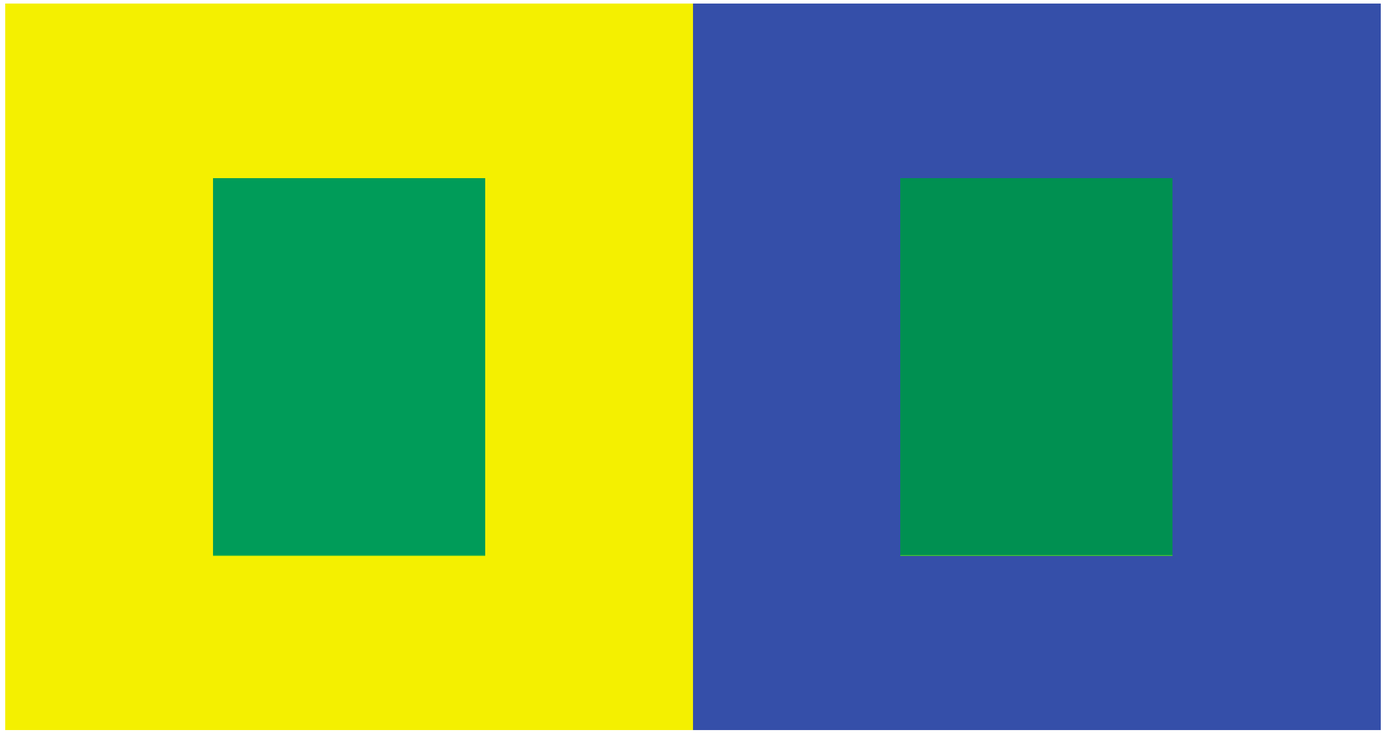
Colors - Beware

- SIMULTANEOUS CONTRAST – solid backgrounds can distort how we see foreground shapes

Colors - Beware

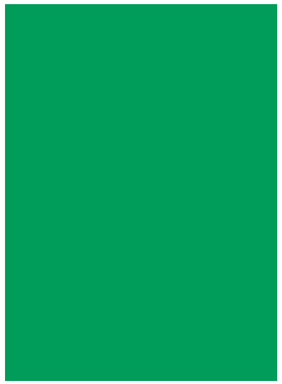
- SIMULTANEOUS CONTRAST – solid backgrounds can distort how we see foreground shapes

Colors - Beware



Are the smaller rectangles the same color or different colors?

Colors - Beware

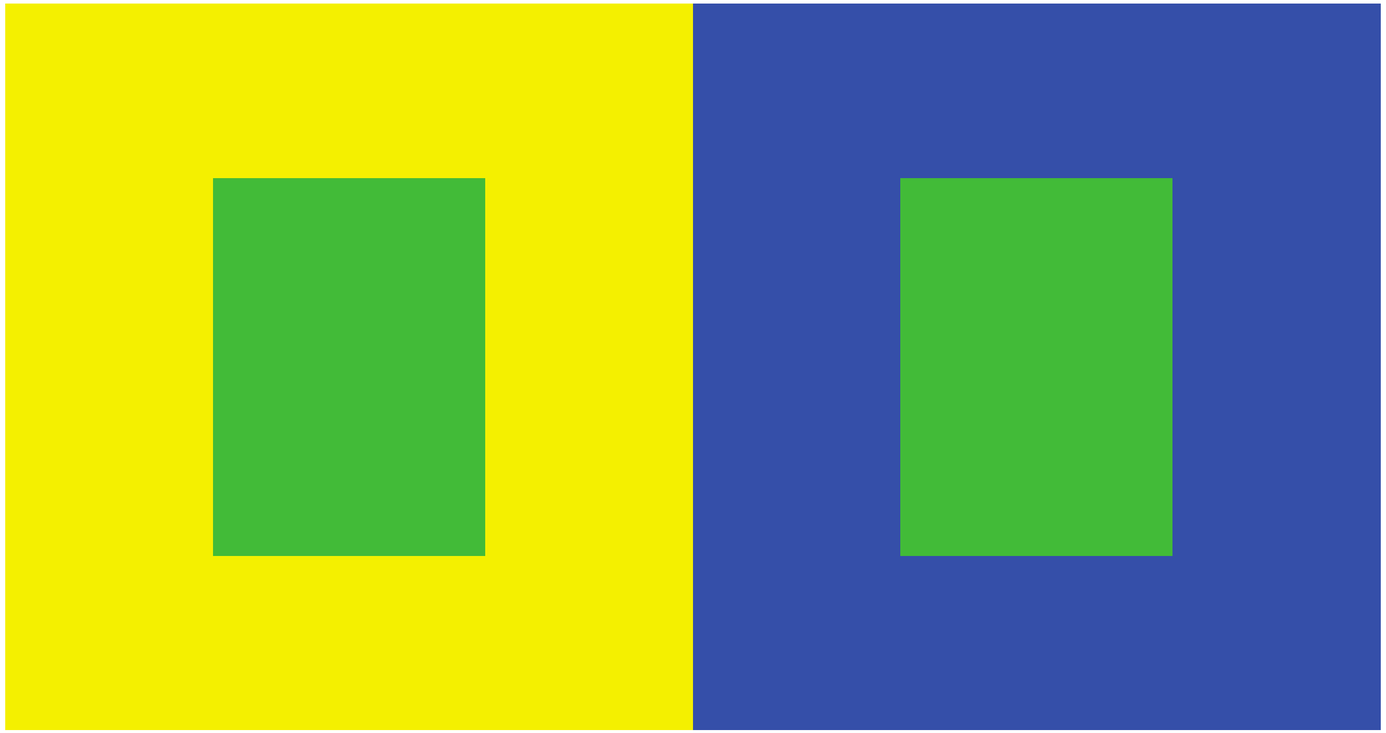


#009C59

#009051

Different!

Colors - Beware



Are the smaller rectangles the same color or different colors?

Colors - Beware

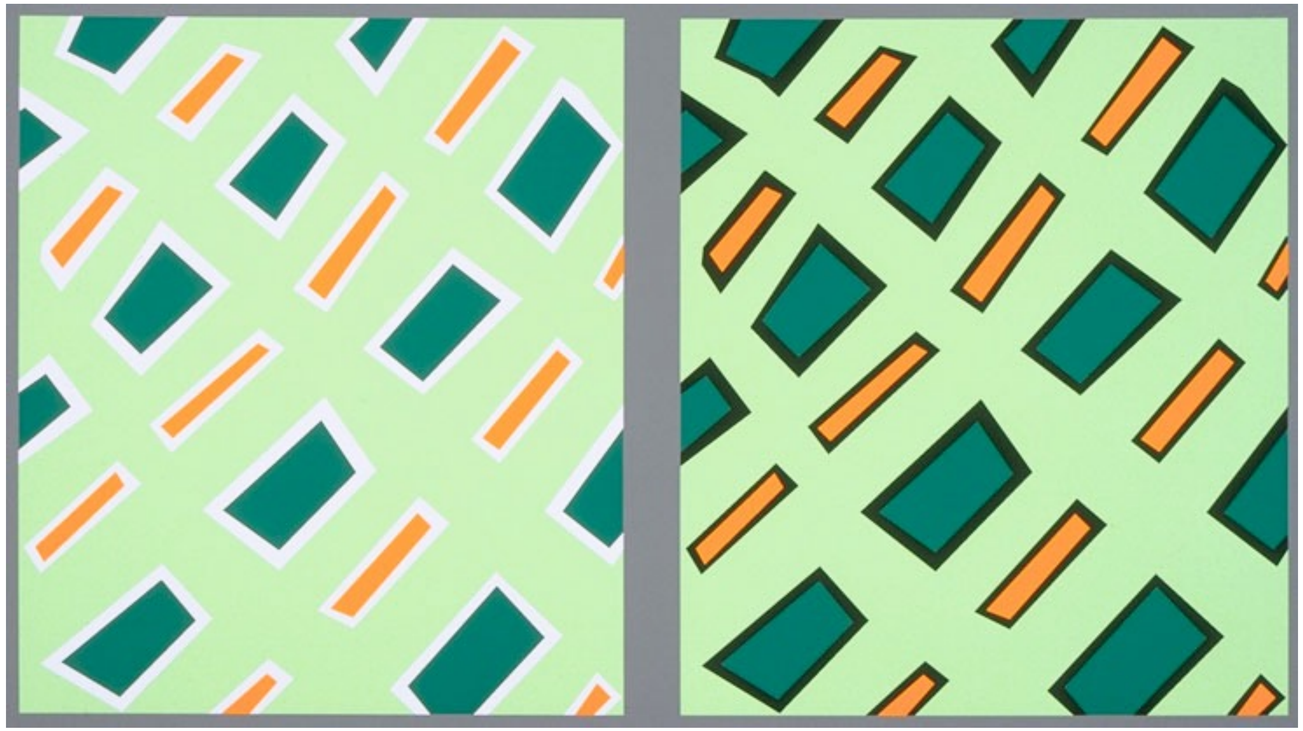
- SIMULTANEOUS CONTRAST – solid backgrounds can distort how we see foreground shapes

Colors - Beware

- SIMULTANEOUS CONTRAST – solid backgrounds can distort how we see foreground shapes

Colors - Beware

- VON BEZOLD SPREADING EFFECT – borders can change the appearance of shape's colors



Let’s take a break! Stretch, go for a walk, be social ☺
Be back here in 10 mins.

JavaScript

IC-05: JavaScript Pt. 1

Summary

Today we:

- Reviewed color at a high-level
- Practiced JavaScript (ic-05)

pm-01 is DUE before next class.
ic-05 is DUE today.