



color

Color is...

*Complex*

Color is...

*Confusing*

Color is...

*Important*

Color helps you

*Explore*

3	3	0	3	0	1	8	7	6	8	2	1	4	0	3	8	3	7	7	2	0	5	2	3	2	7	0	2	0	
7	1	4	6	0	2	1	3	2	7	6	0	2	5	6	3	2	5	7	6	3	3	3	0	2	0	3	0	7	2
8	7	5	7	2	8	3	8	7	7	8	2	0	7	7	5	2	3	1	1	5	6	3	8	4	7	8	2	0	
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1	0	2	2	7	6	3	3	0	8	8	0	3	1	8	8	1	2	1	7	5	2	9	3	5	8	3	2	5	

Color helps you

*Measure*



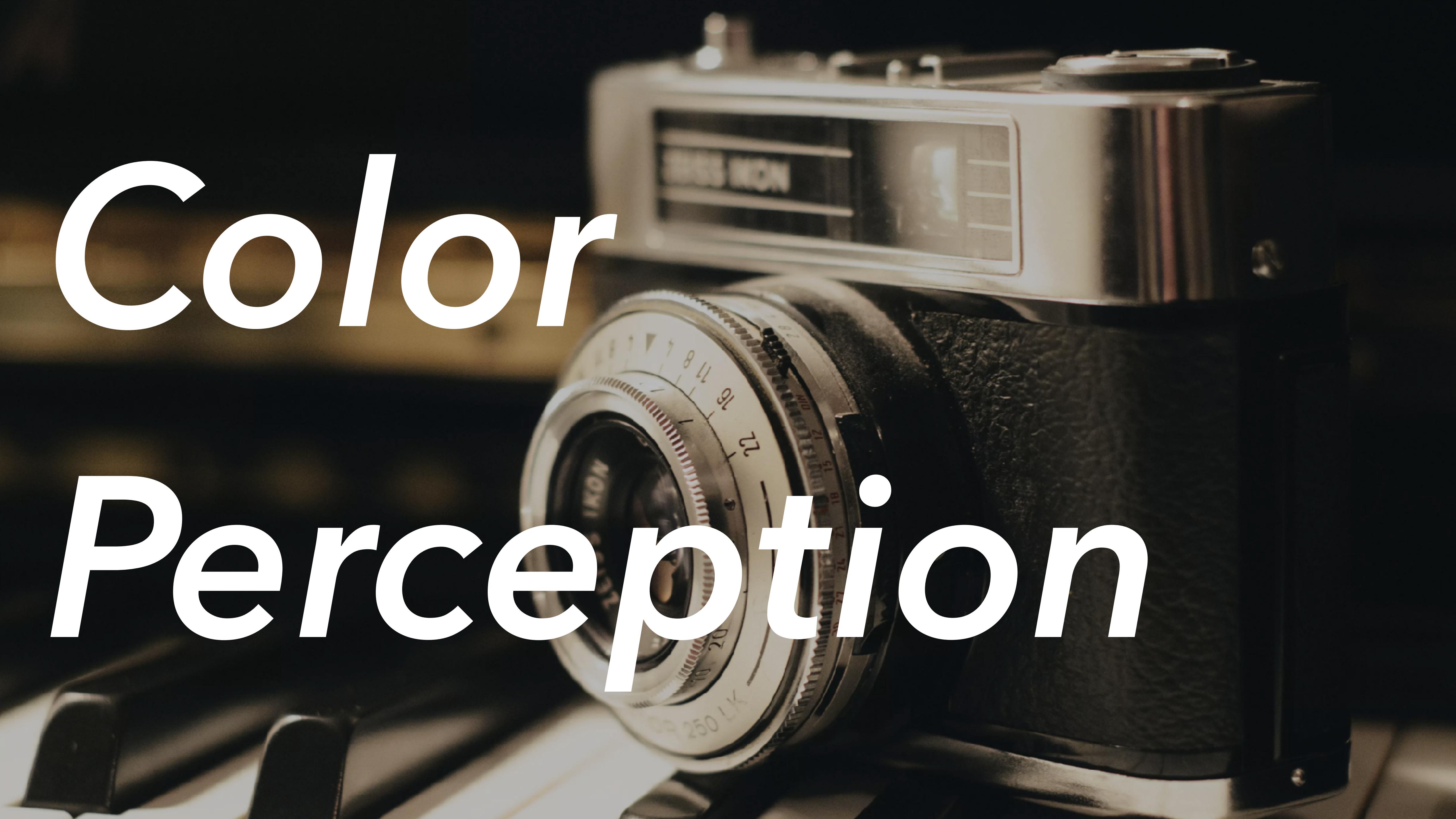
Color helps you

*Engage*





# Color Perception



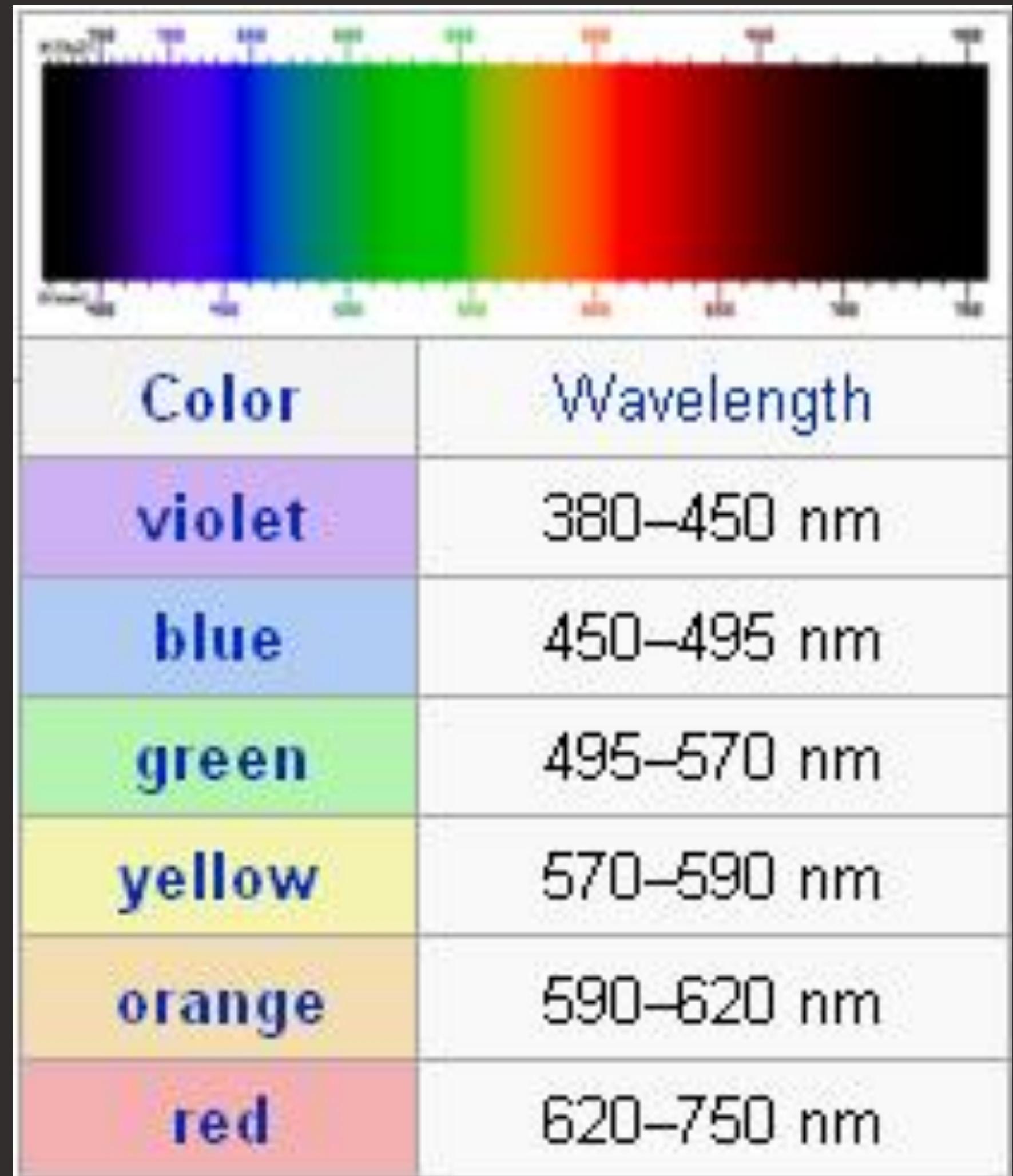
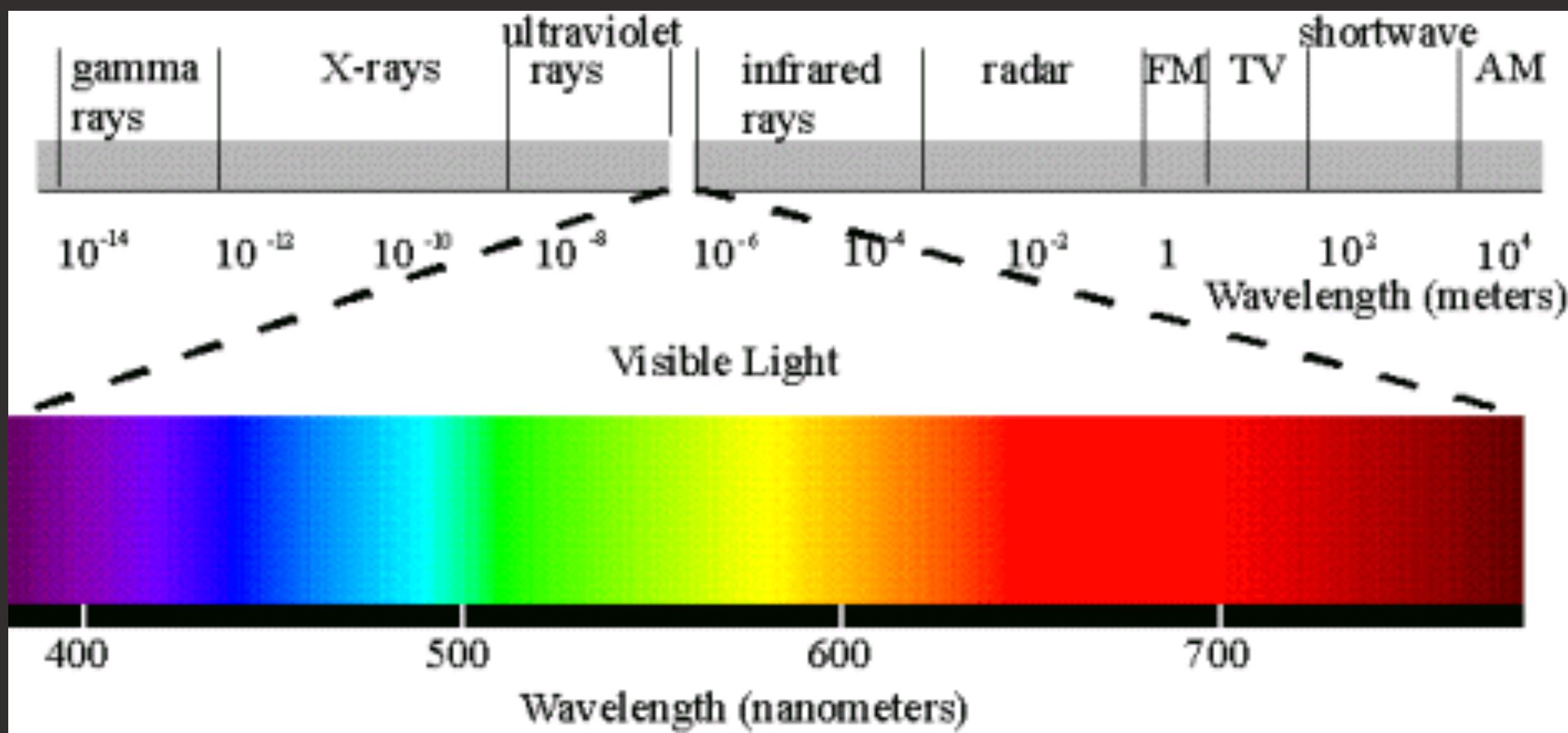
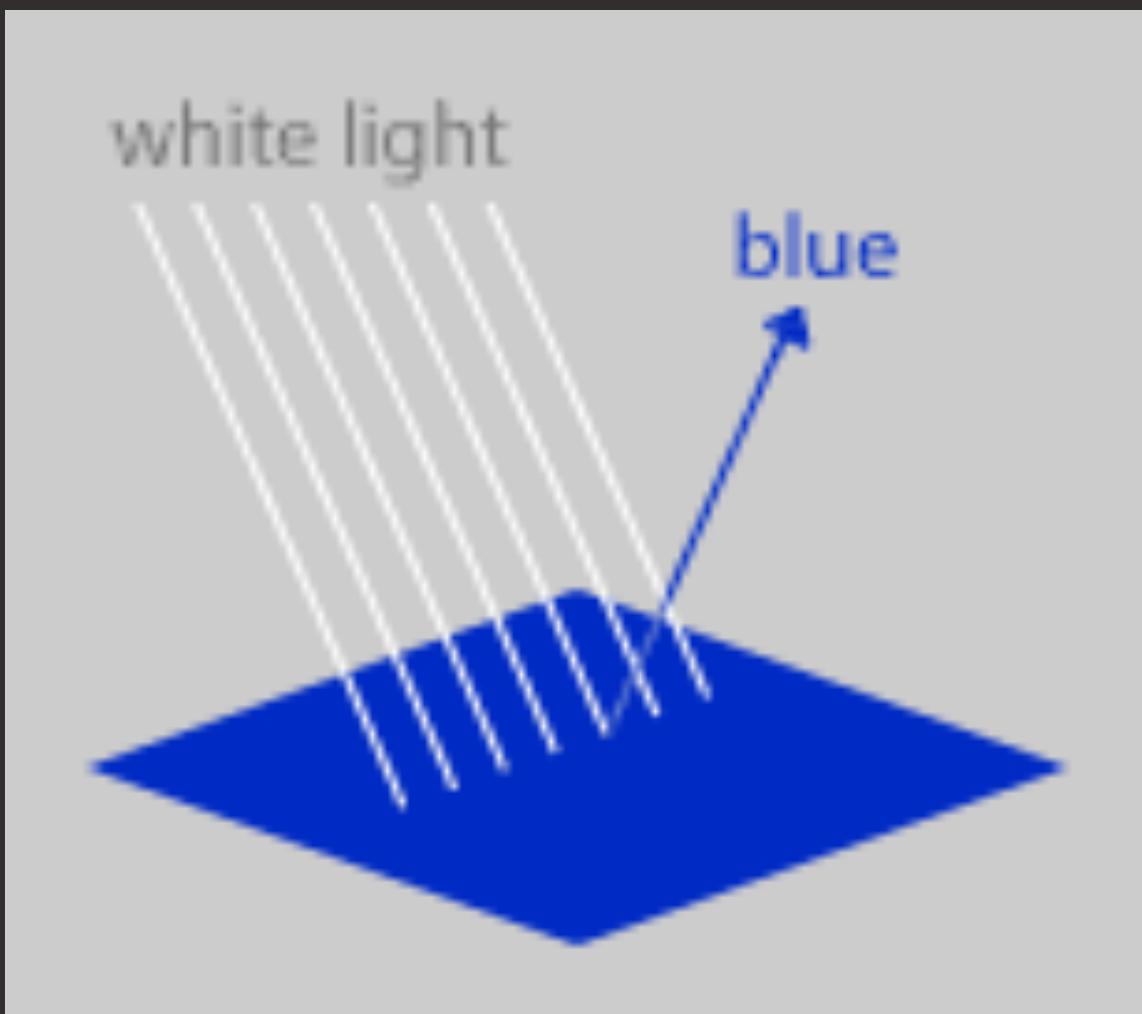
*Light*

*Eyes*

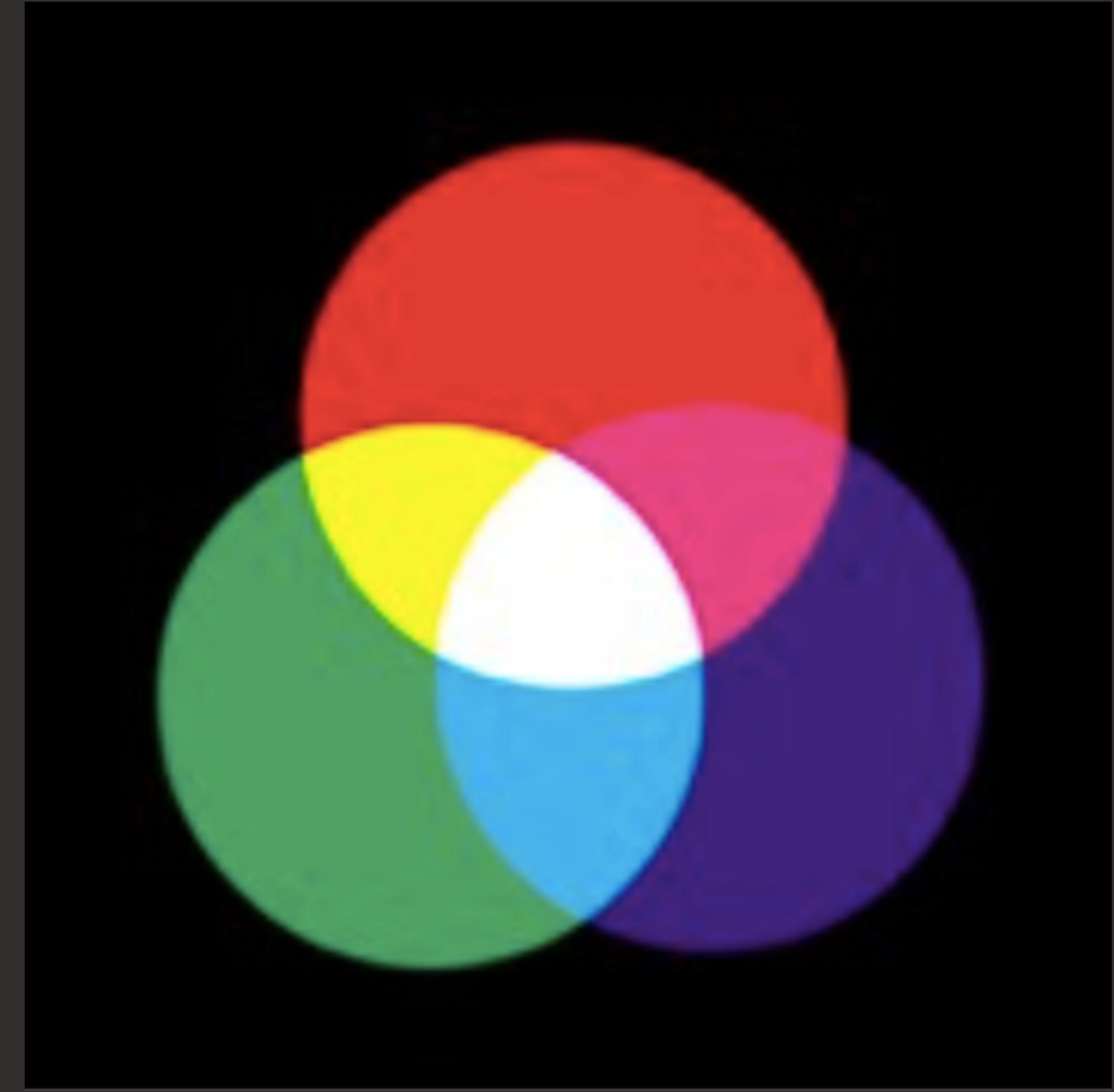
*Mind*

# *Light*

# Light



# Light + color “types”



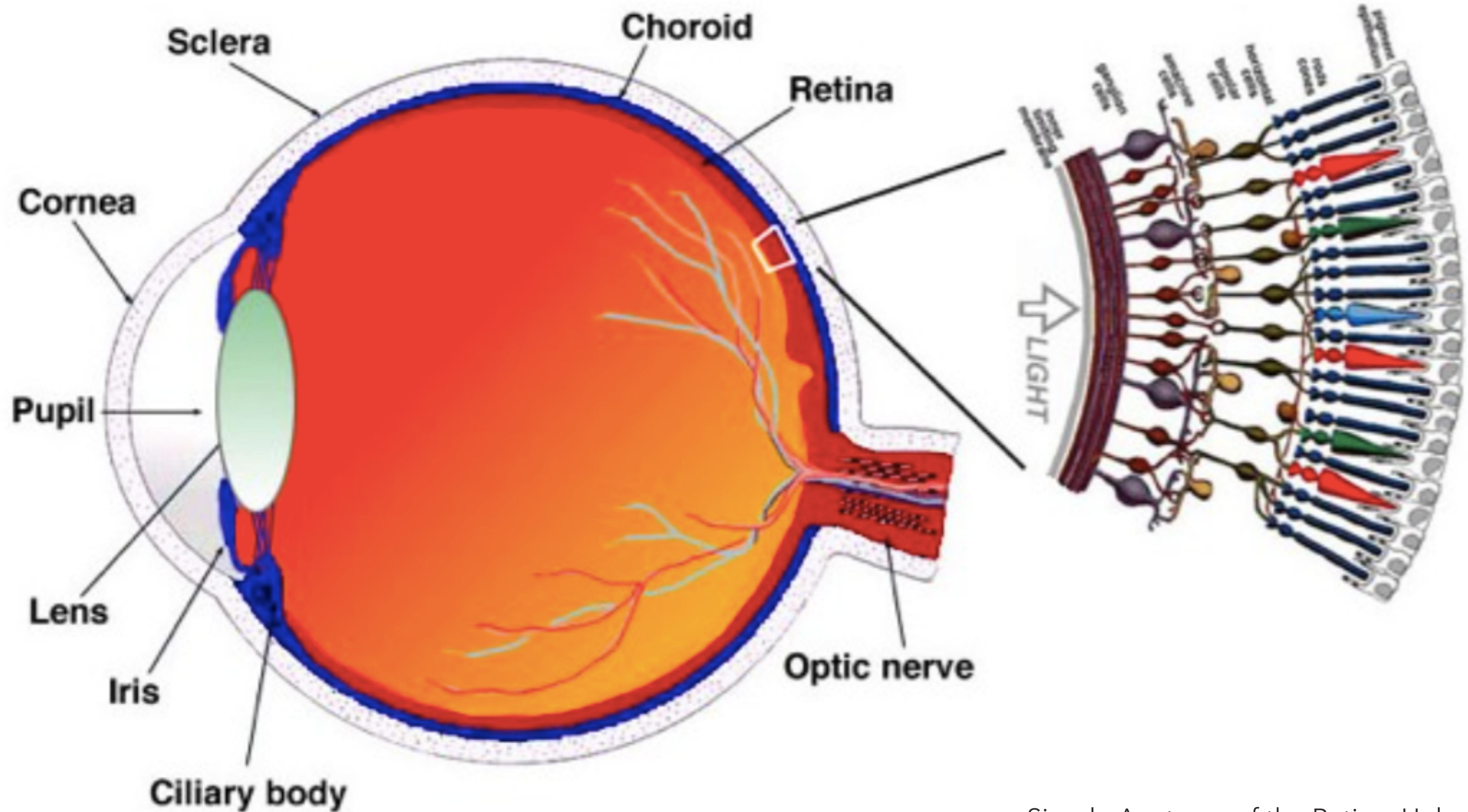
# Subtractive



# Additive



*Eyes*



Simple Anatomy of the Retina, Helga Kolb

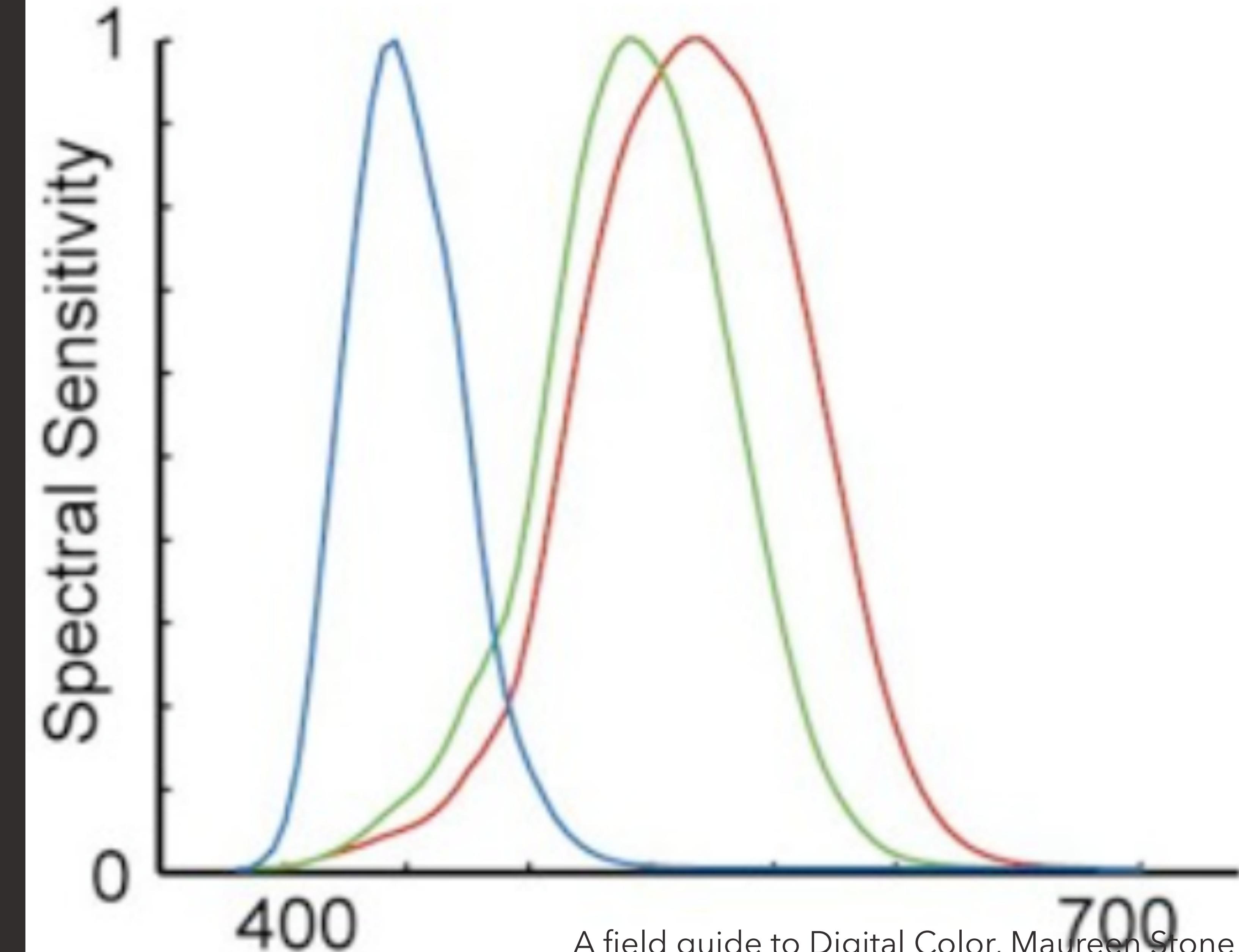
# Cones

Long

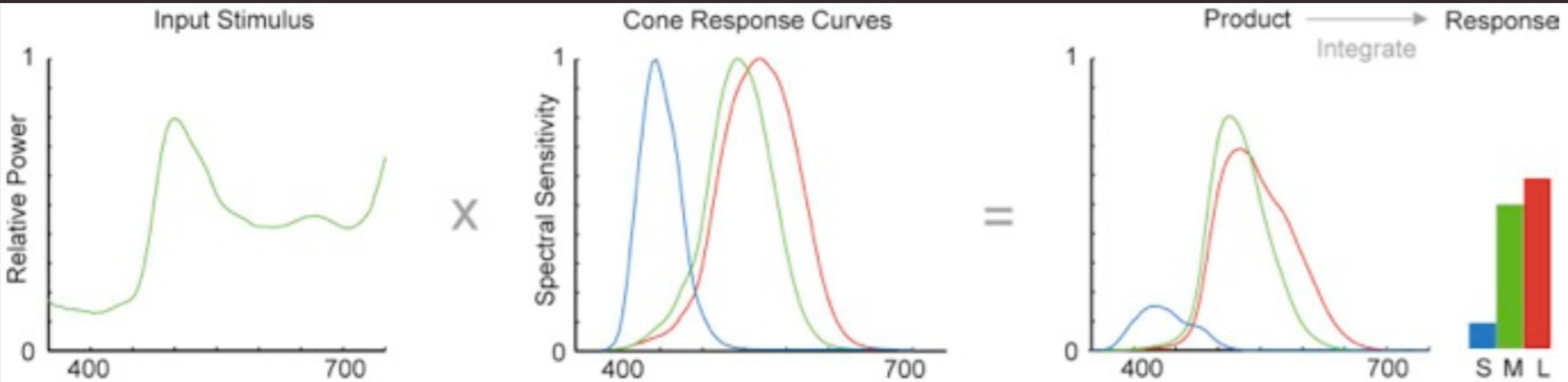
Middle

Short

## Cone Response Curves

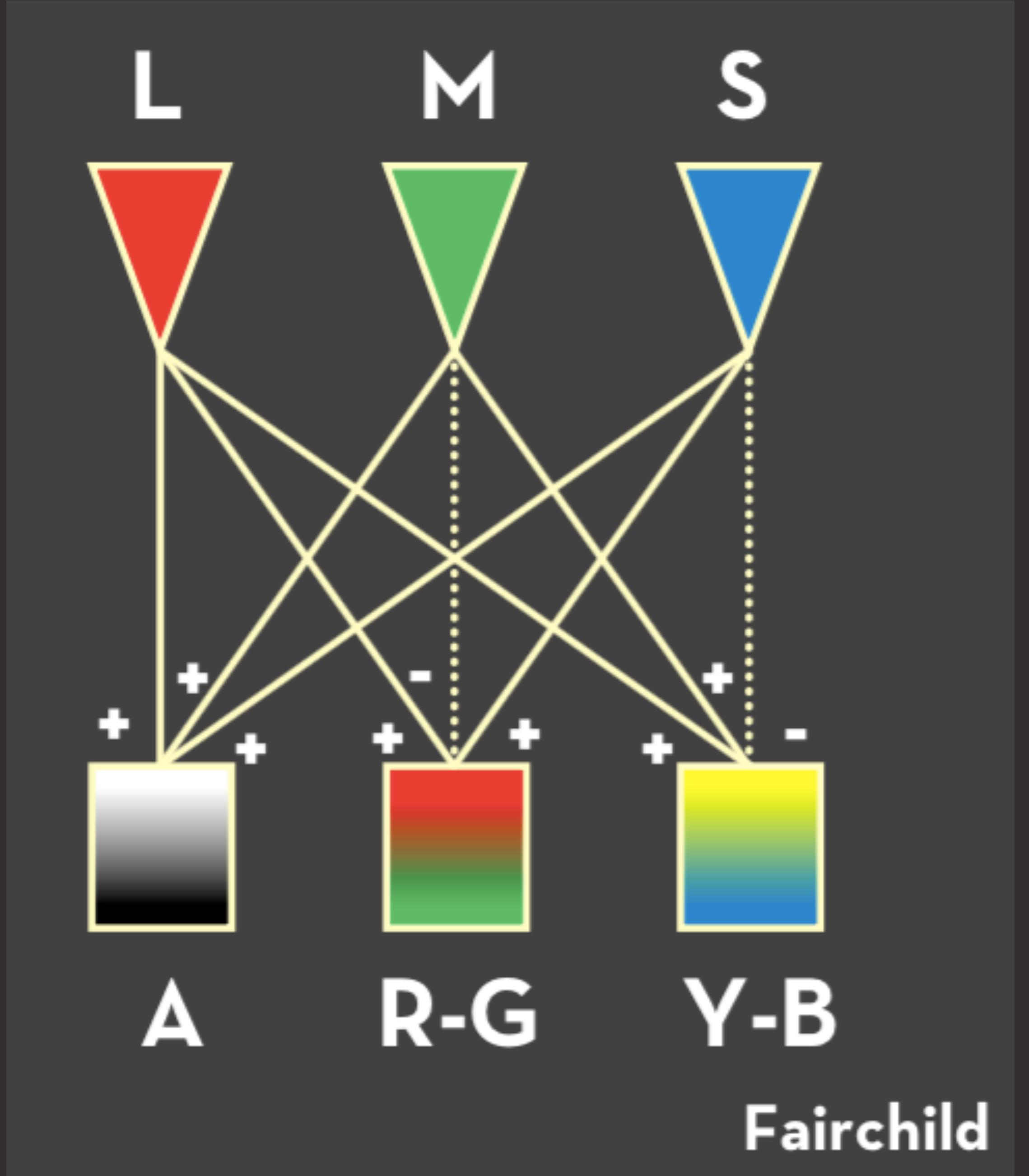


# Integration



# "Opponent Processing"

Long  
Middle  
Short



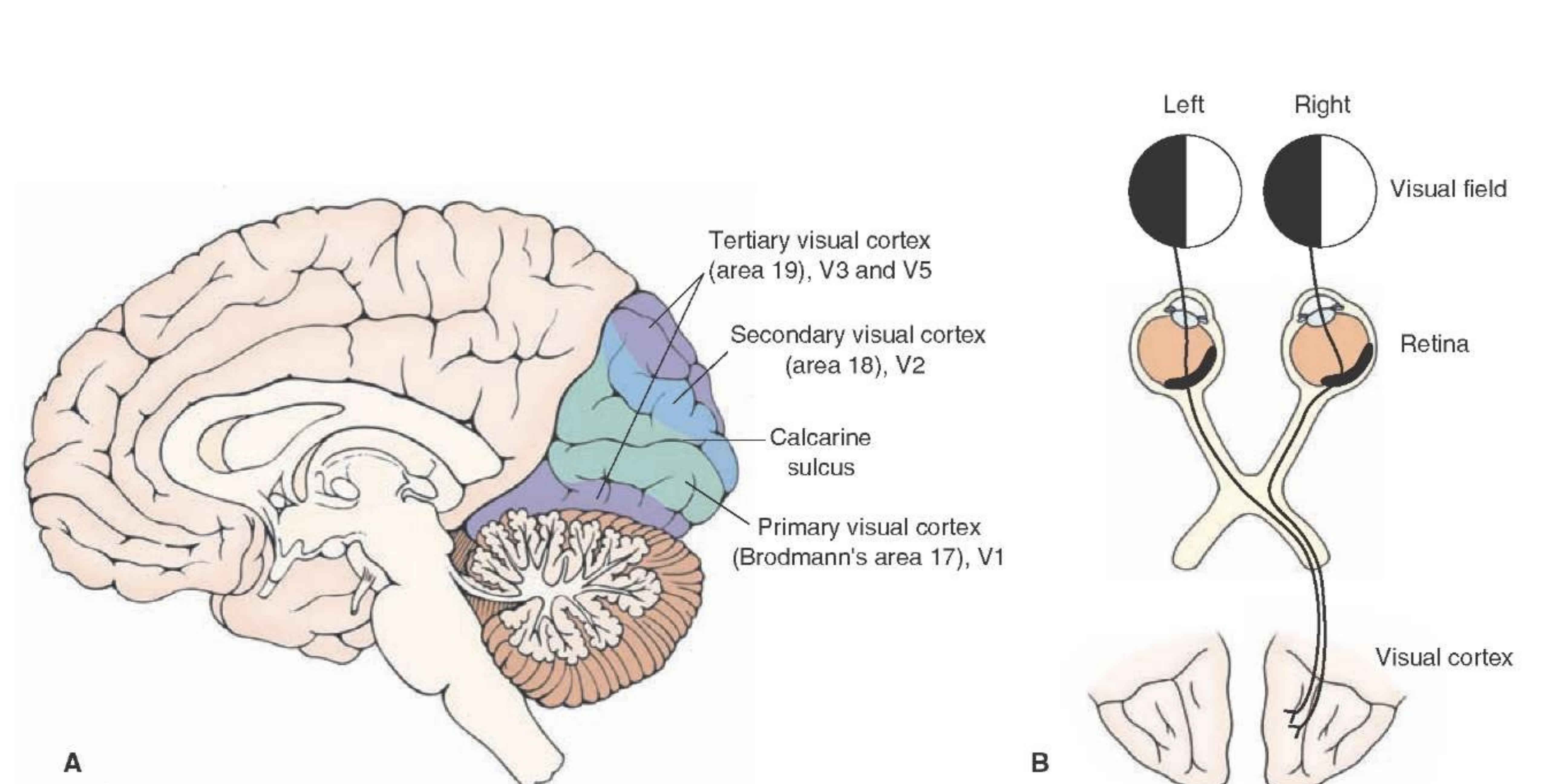
*Mind*

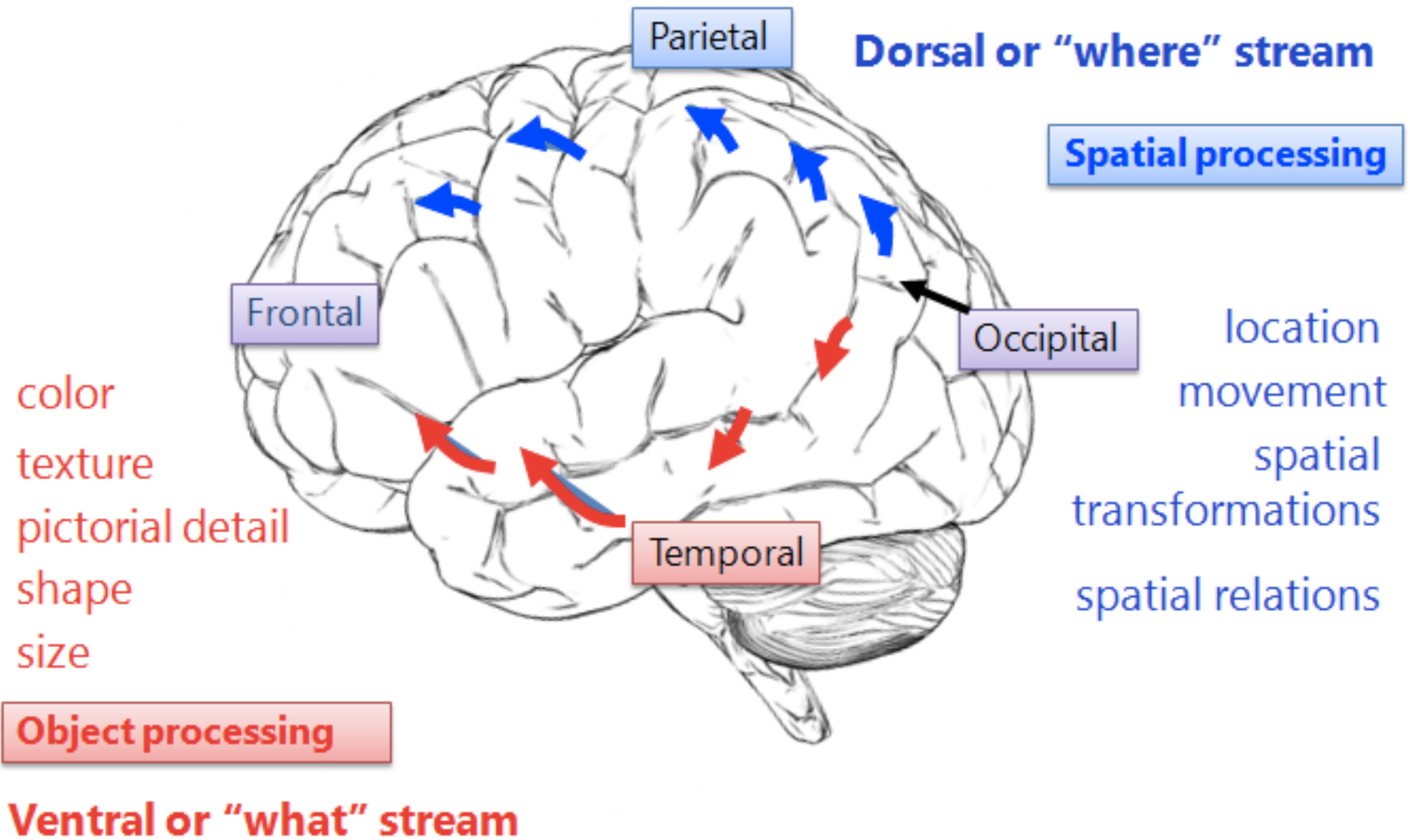
*What color...*







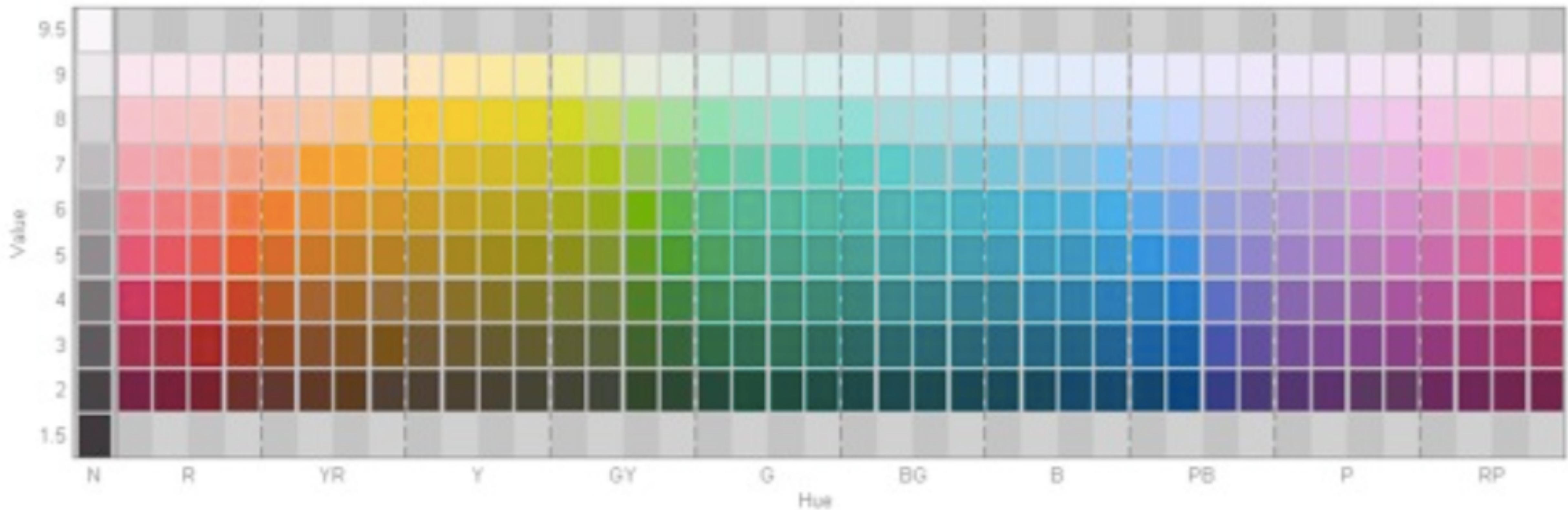




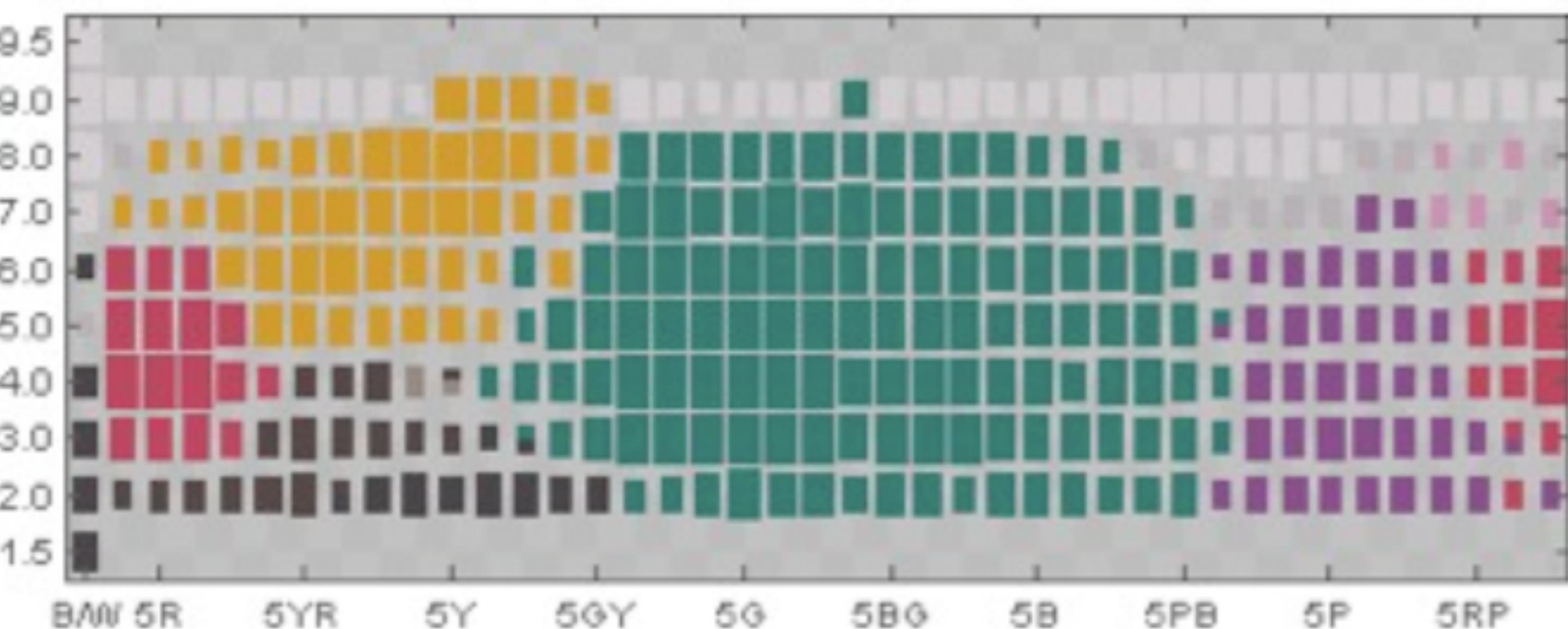
*Color is  
perceptual  
AND cognitive*

*World color  
survey*

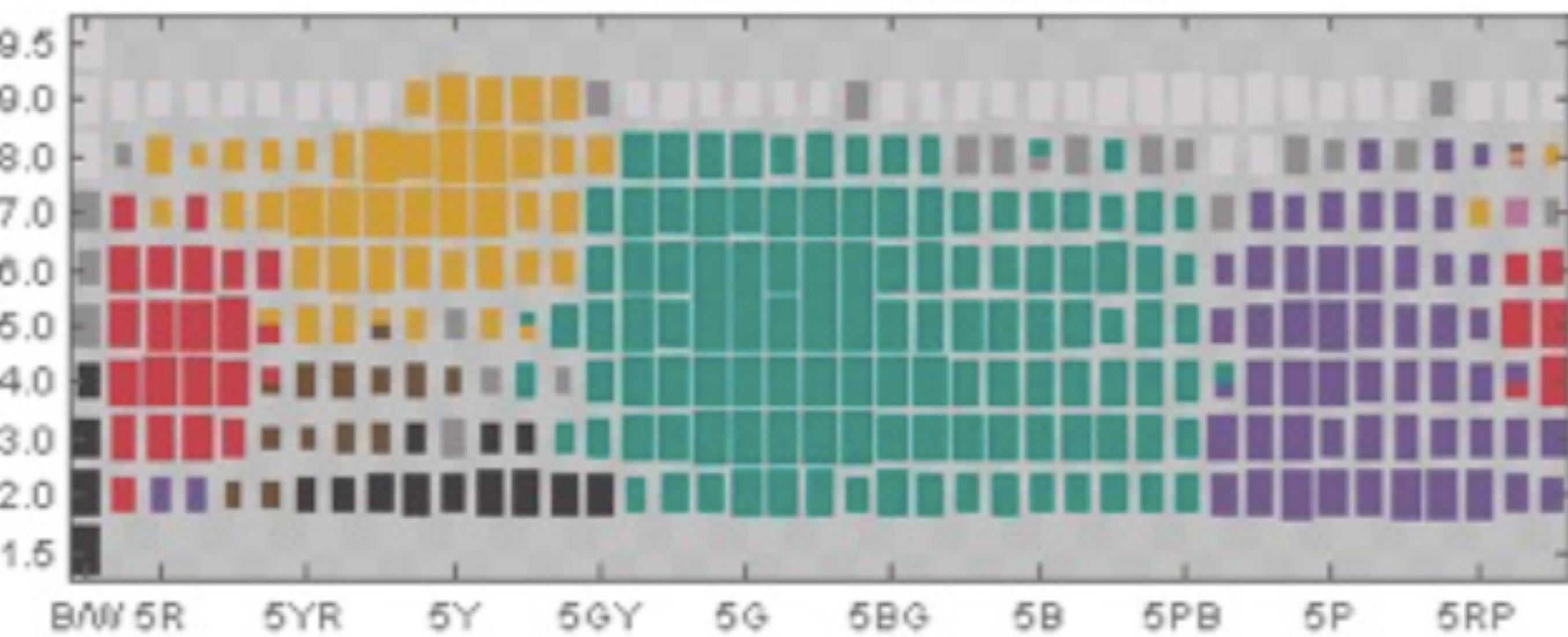
# *How do people around the world name these colors?*



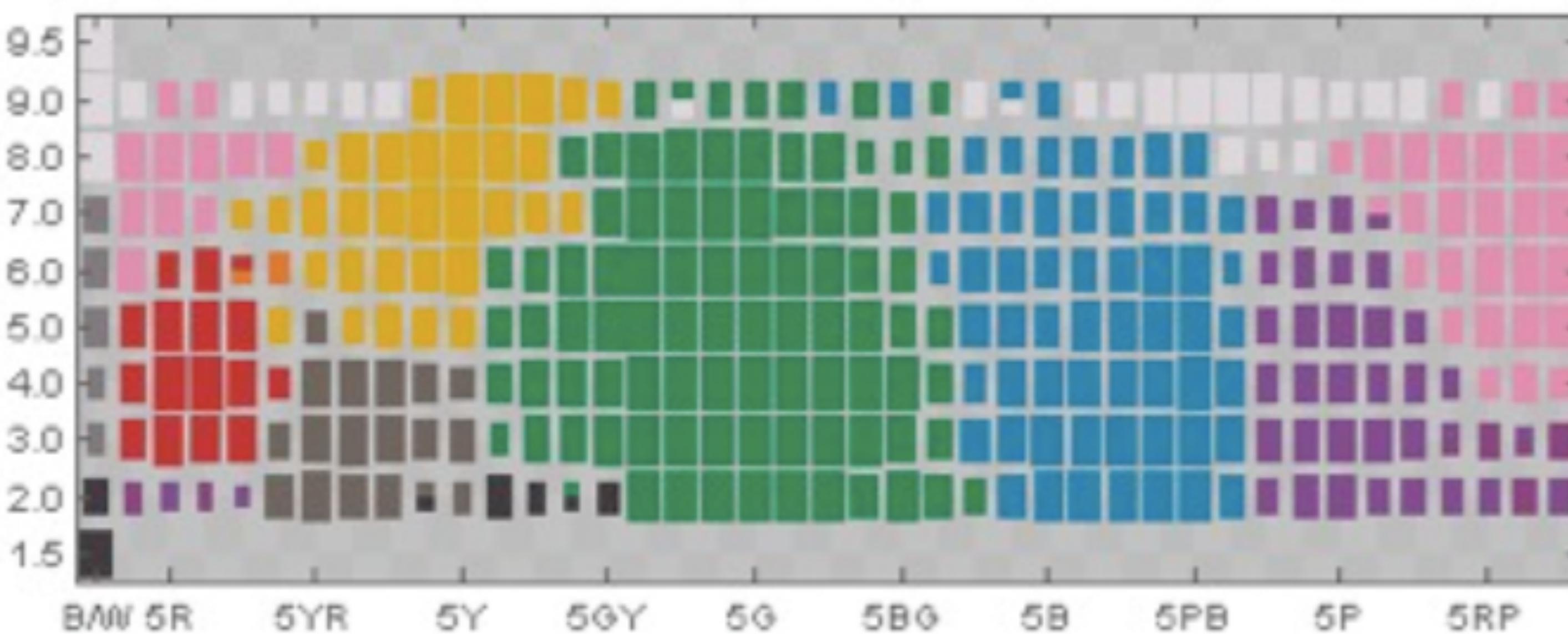
Language #72 (Modeco)  
Mutual info = 0.942 / Contribution = 0.476



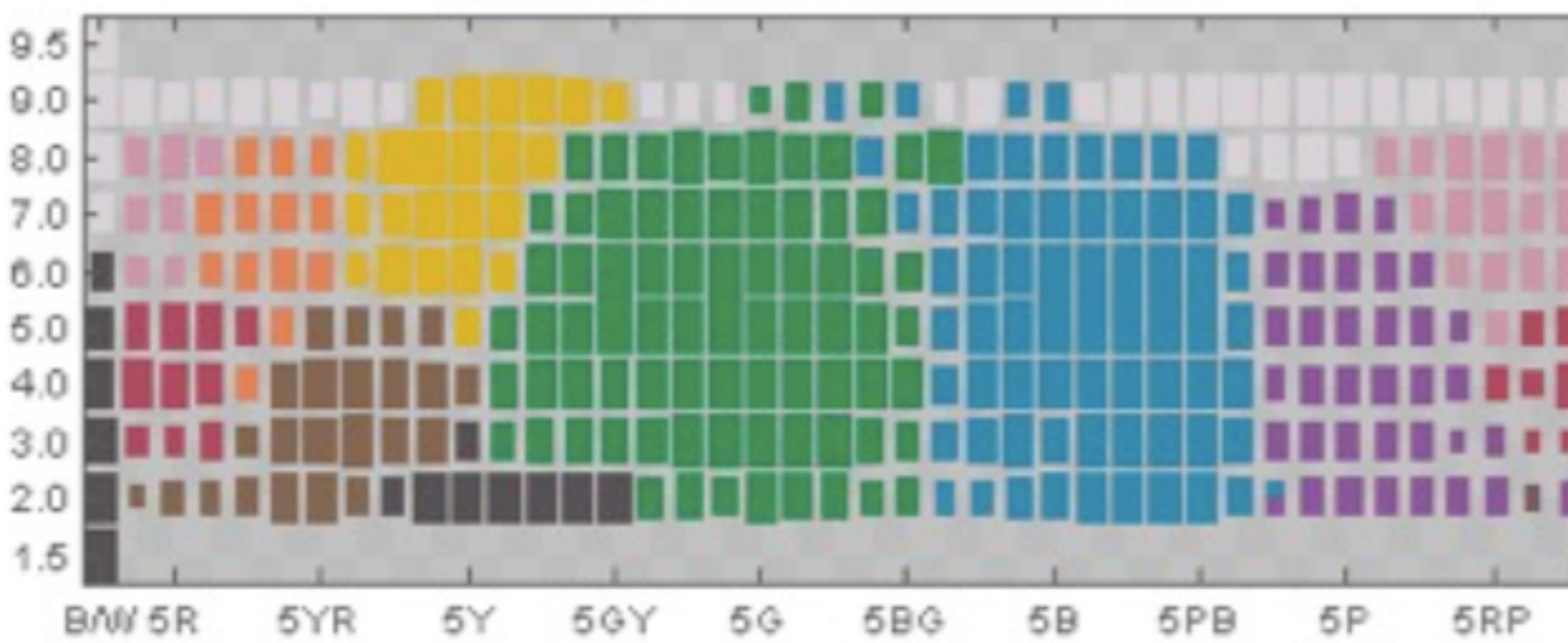
Language #98 (Tlapaneco)  
Mutual info = 0.942 / Contribution = 0.524



Language #19 (Camsa)  
Mutual info = 0.939 / Contribution = 0.487

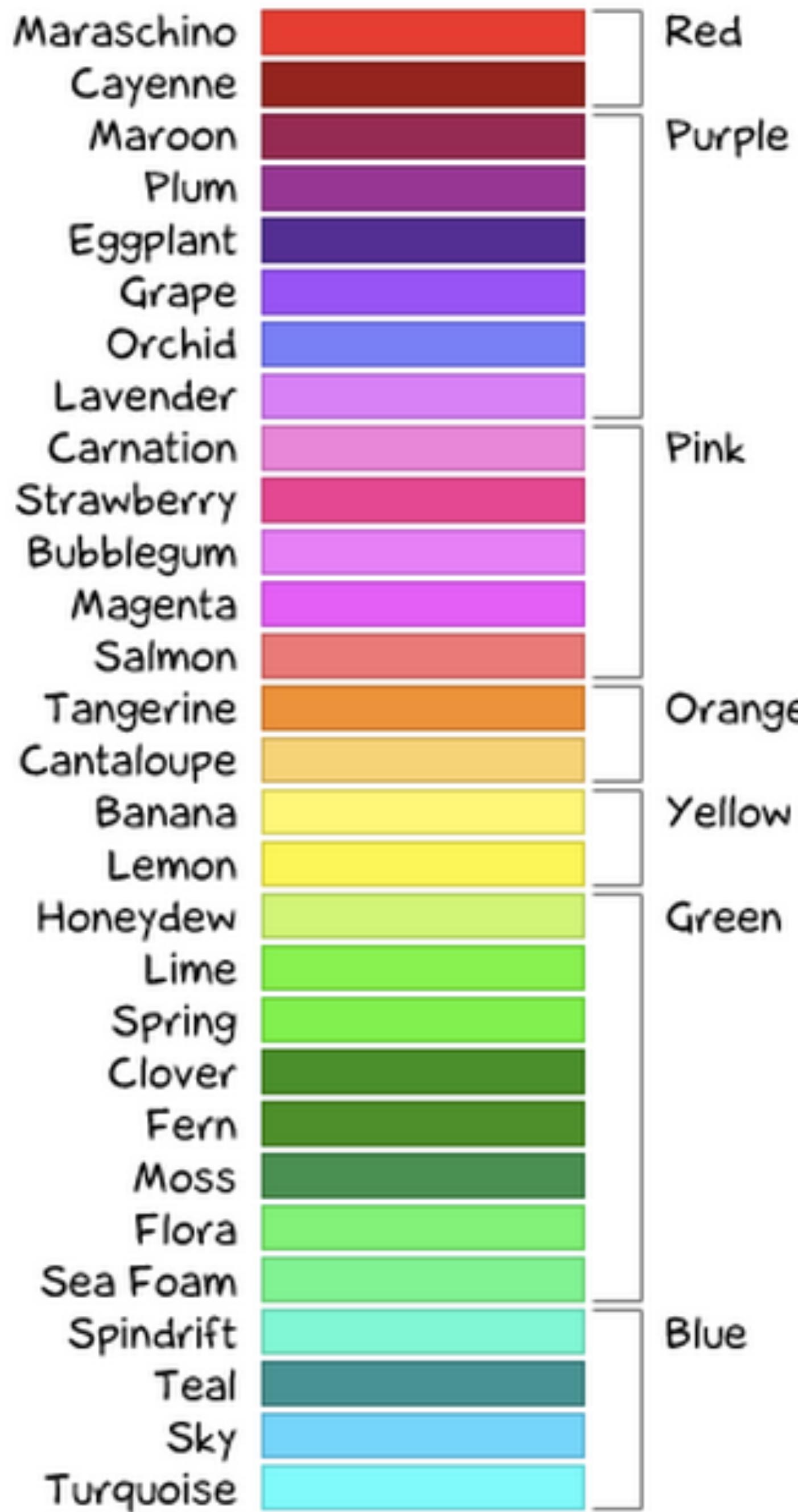


Language #24 (Chavacano)  
Mutual info = 0.939 / Contribution = 0.513

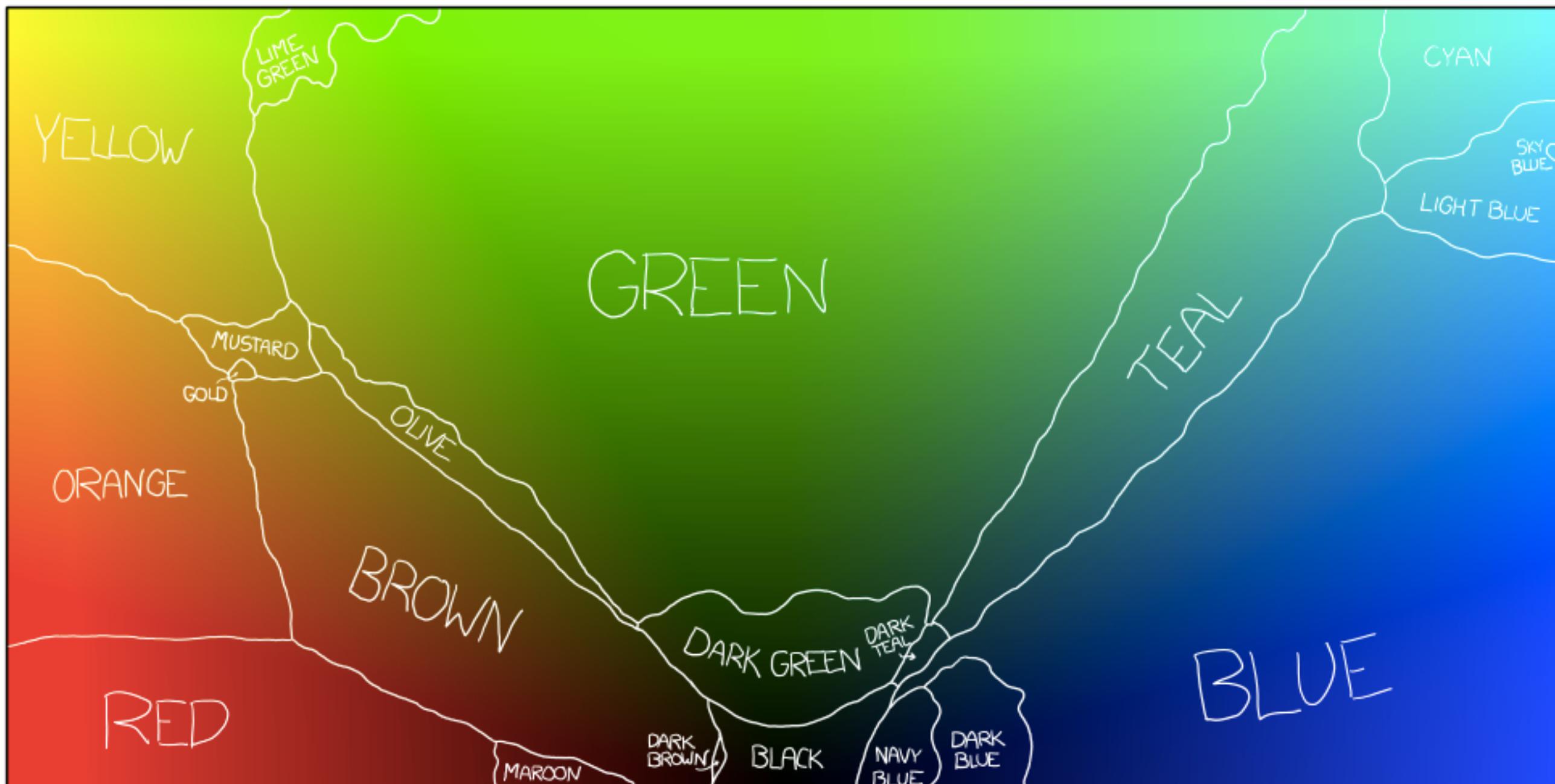


*Slightly less  
scientific...*

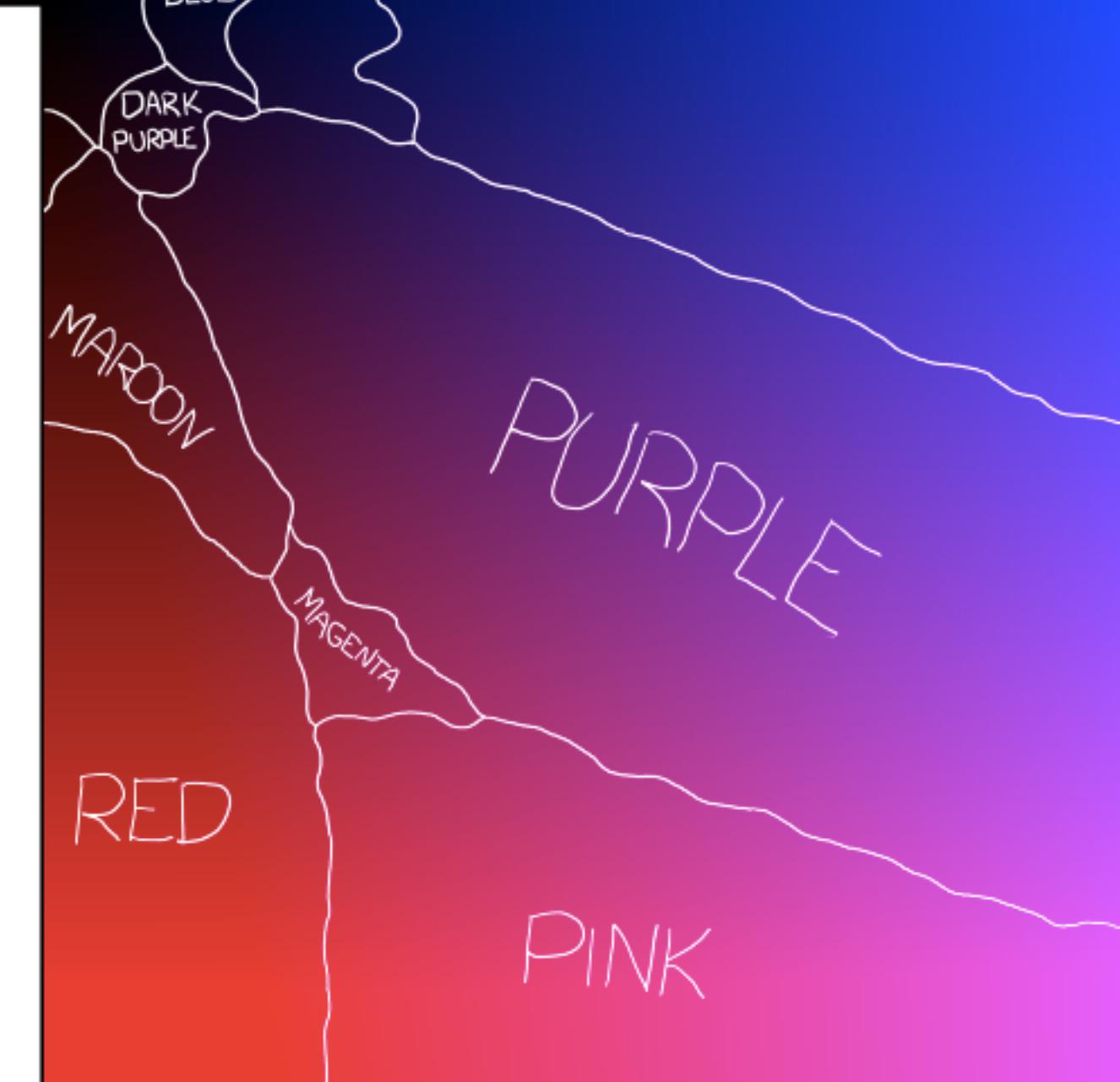
Color names if  
you're a girl...



Color names if  
you're a guy...



THIS CHART SHOWS THE DOMINANT COLOR NAMES OVER THE THREE FULLY-SATURATED FACES OF THE RGB CUBE (COLORS WHERE ONE OF THE RGB VALUES IS ZERO)



# Color Spaces



# *Tension*

# *Tension*

*good for  
machines*

---

# *Tension*

*good for  
machines*

---

*good for  
people*

# *rgb*



**Red**

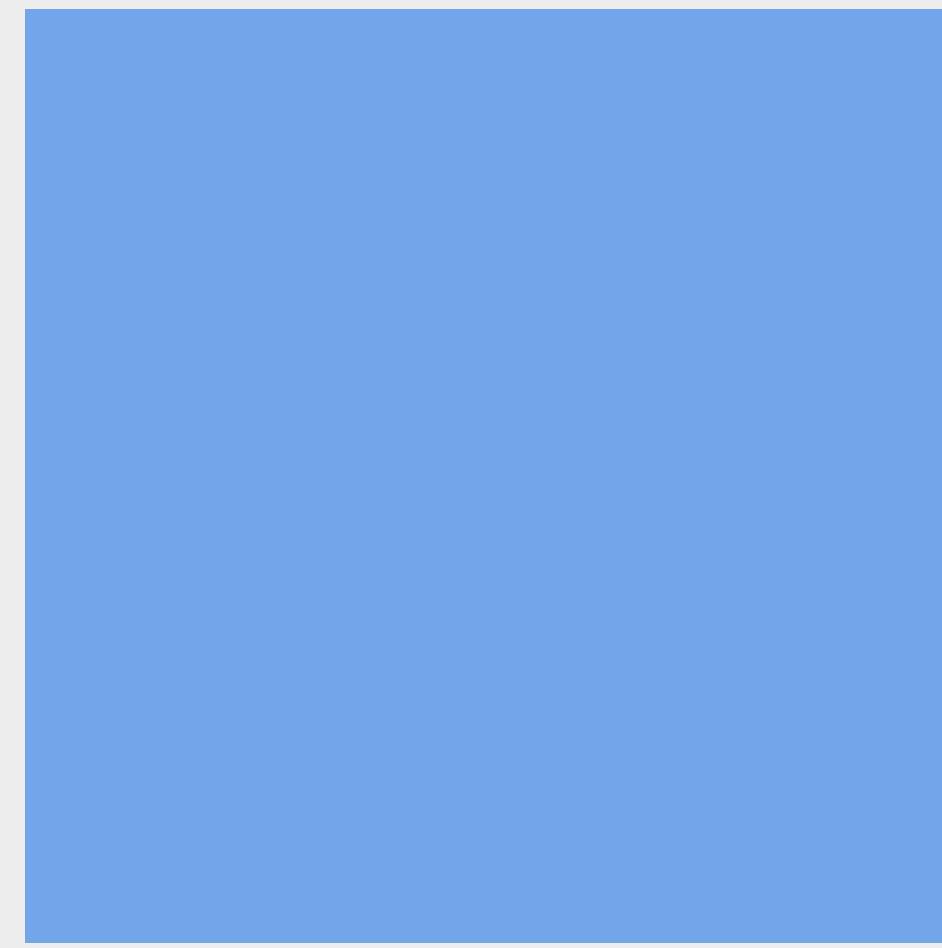


**Green**



**Blue**

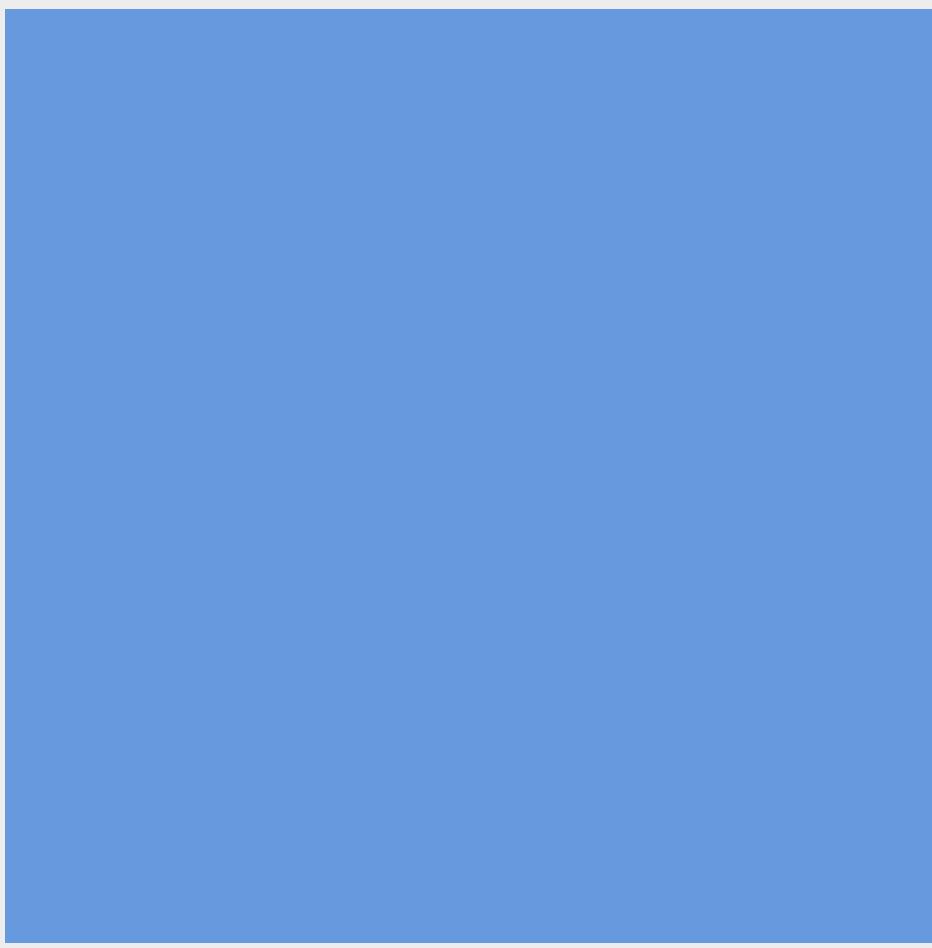
*rgb*



*rgb*



**-5%**



**+5%**



*good for  
machines*

---

*good for  
people*

---

*rgb*

# *hsv*



**Lightness**



**Hue**



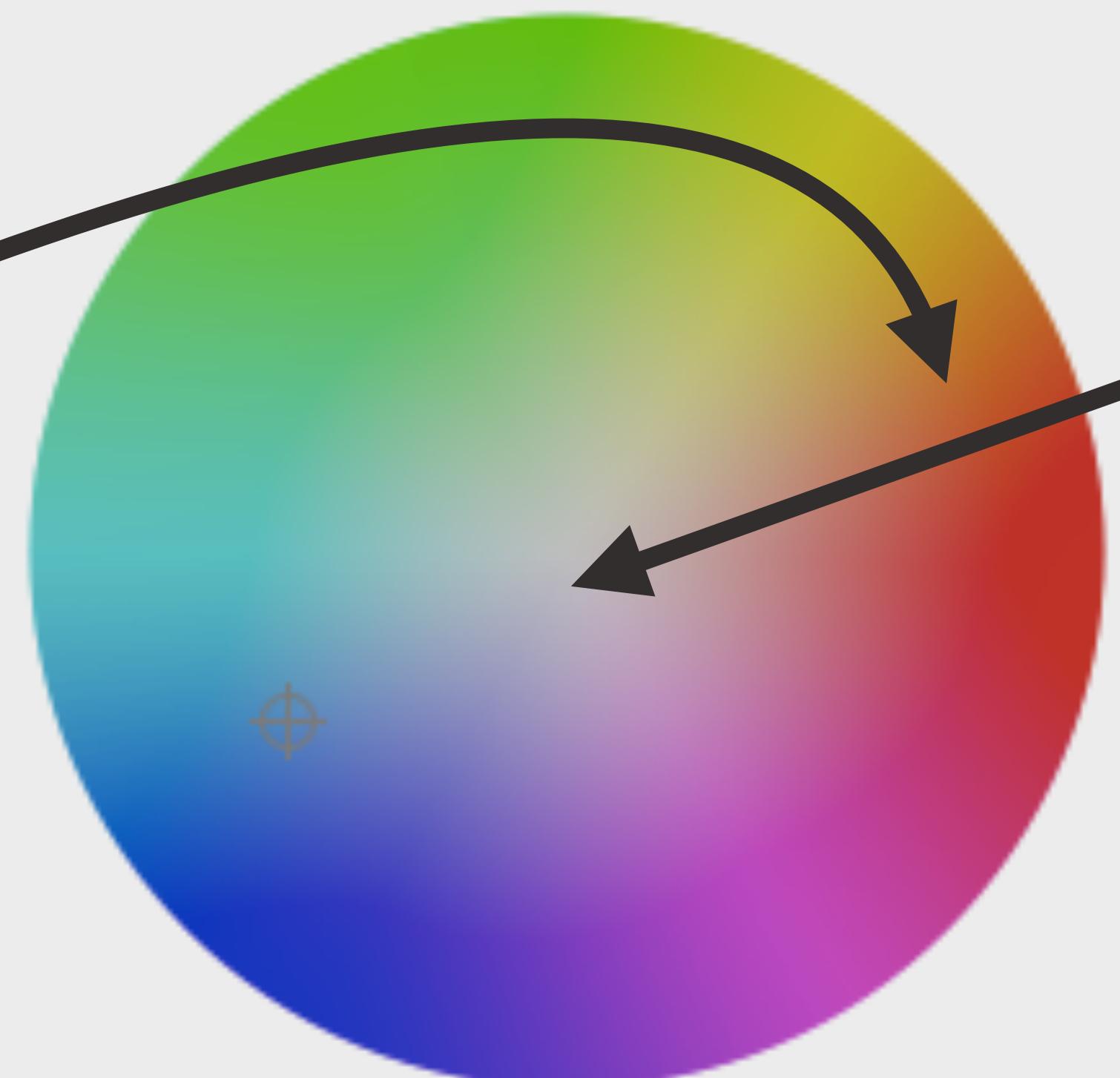
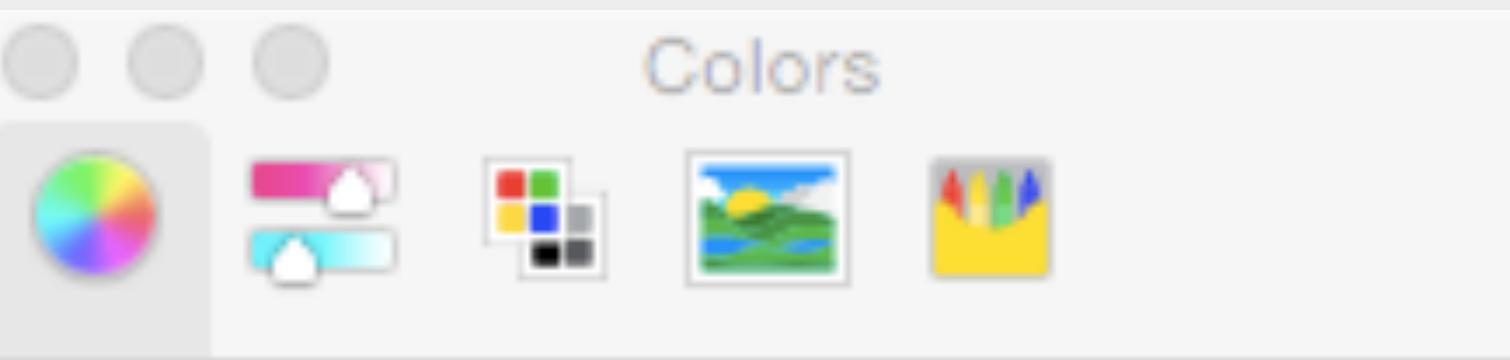
**Saturation (Chroma)**

*hsv*

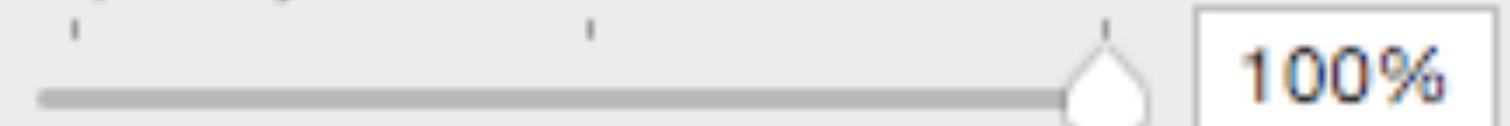
*hue*

*saturation*

*value*



Opacity



100%



# HSV

Colors

HSB Sliders ⚙️

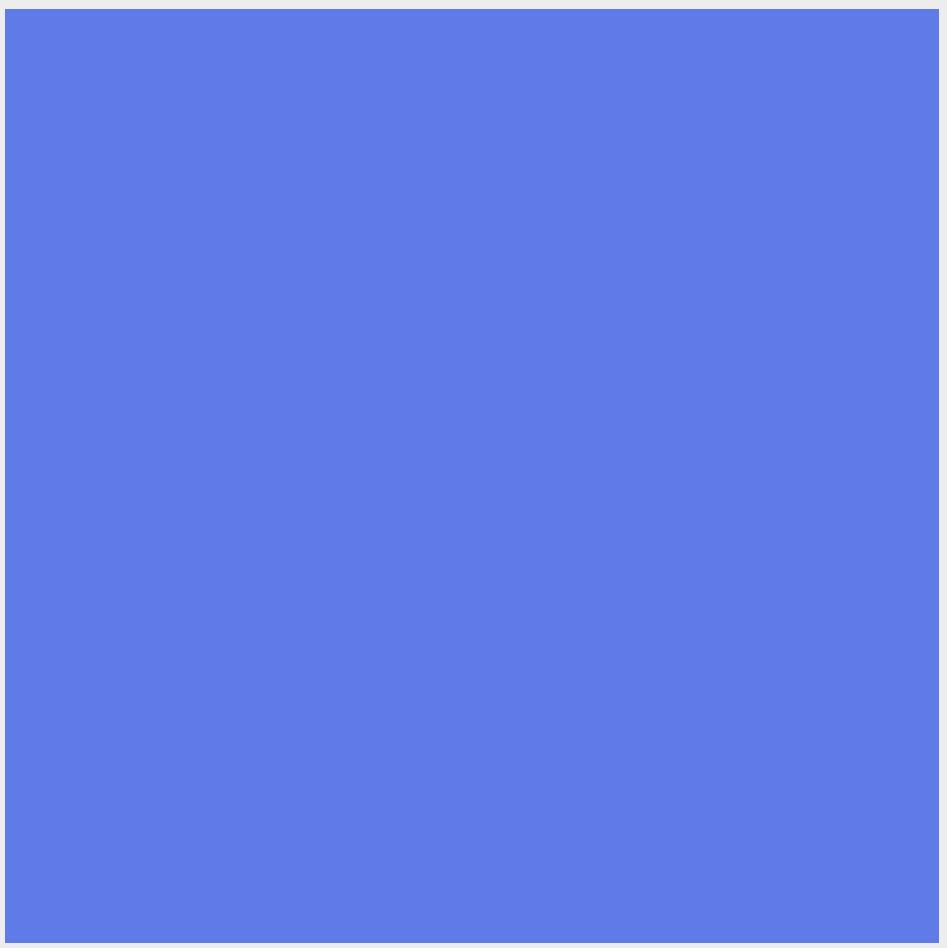
Hue 212°

Saturation 61%

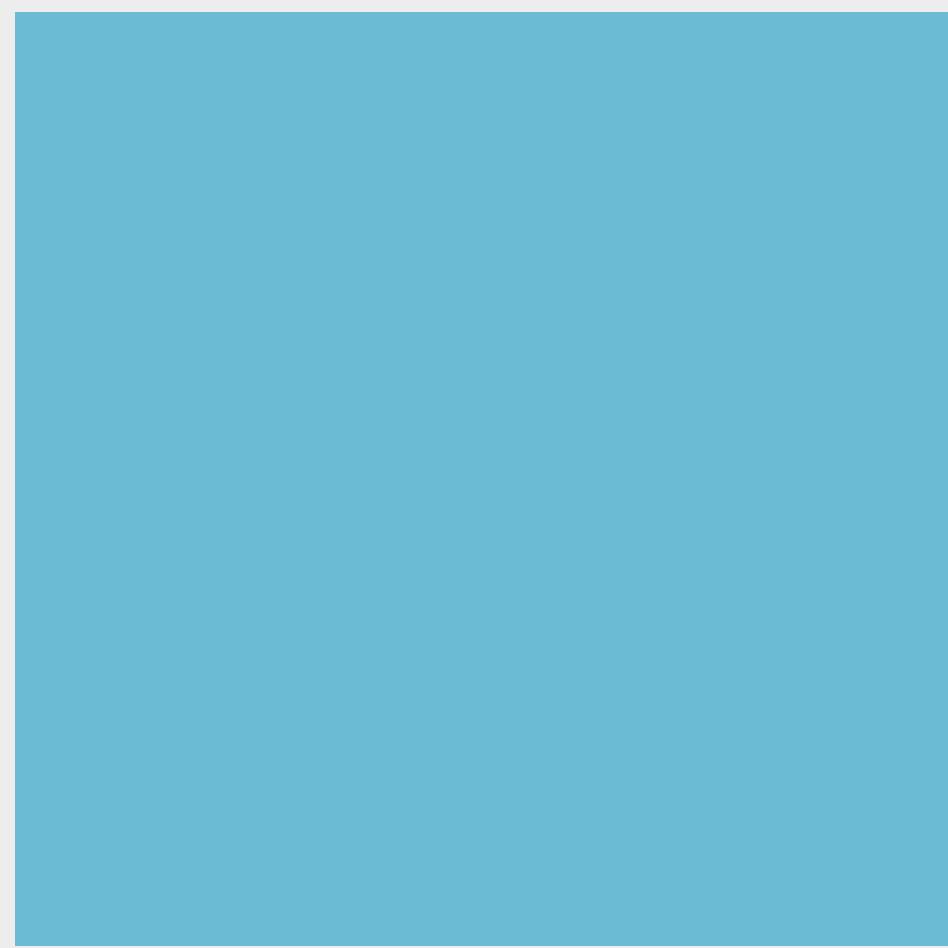
Brightness 75%

Opacity 100%

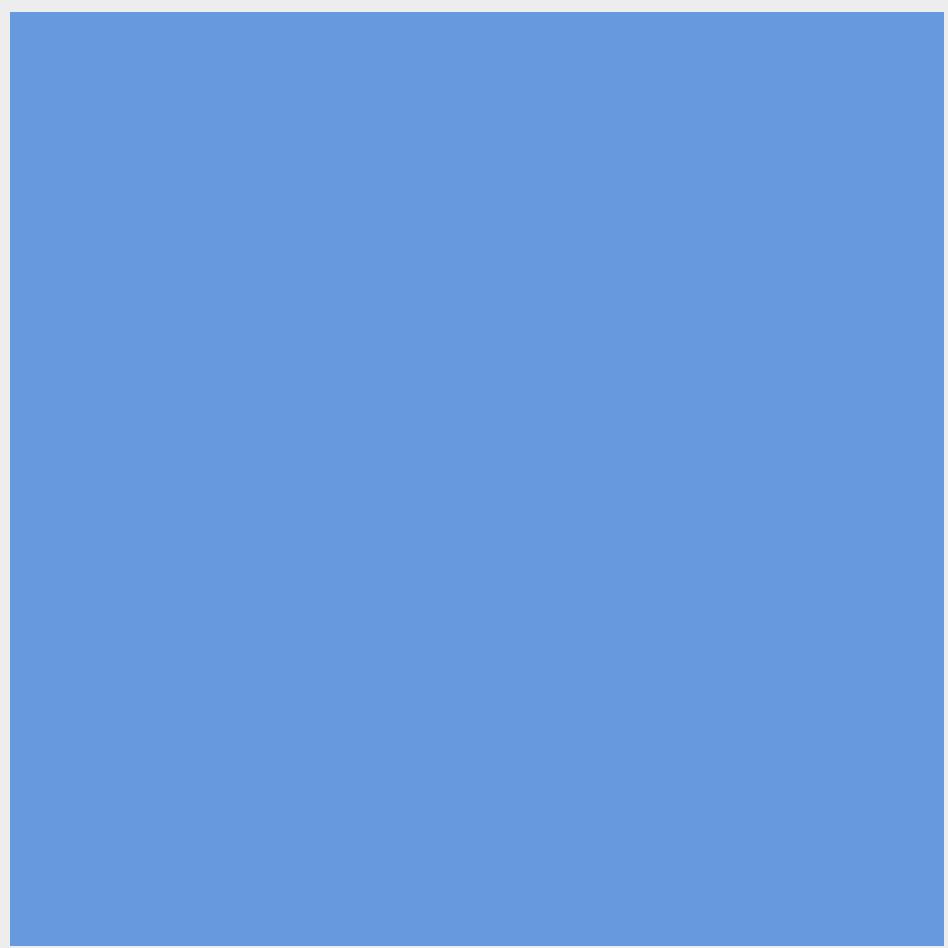
*hsv*



*hsν*



-5%



+5%



*good for  
machines*

---

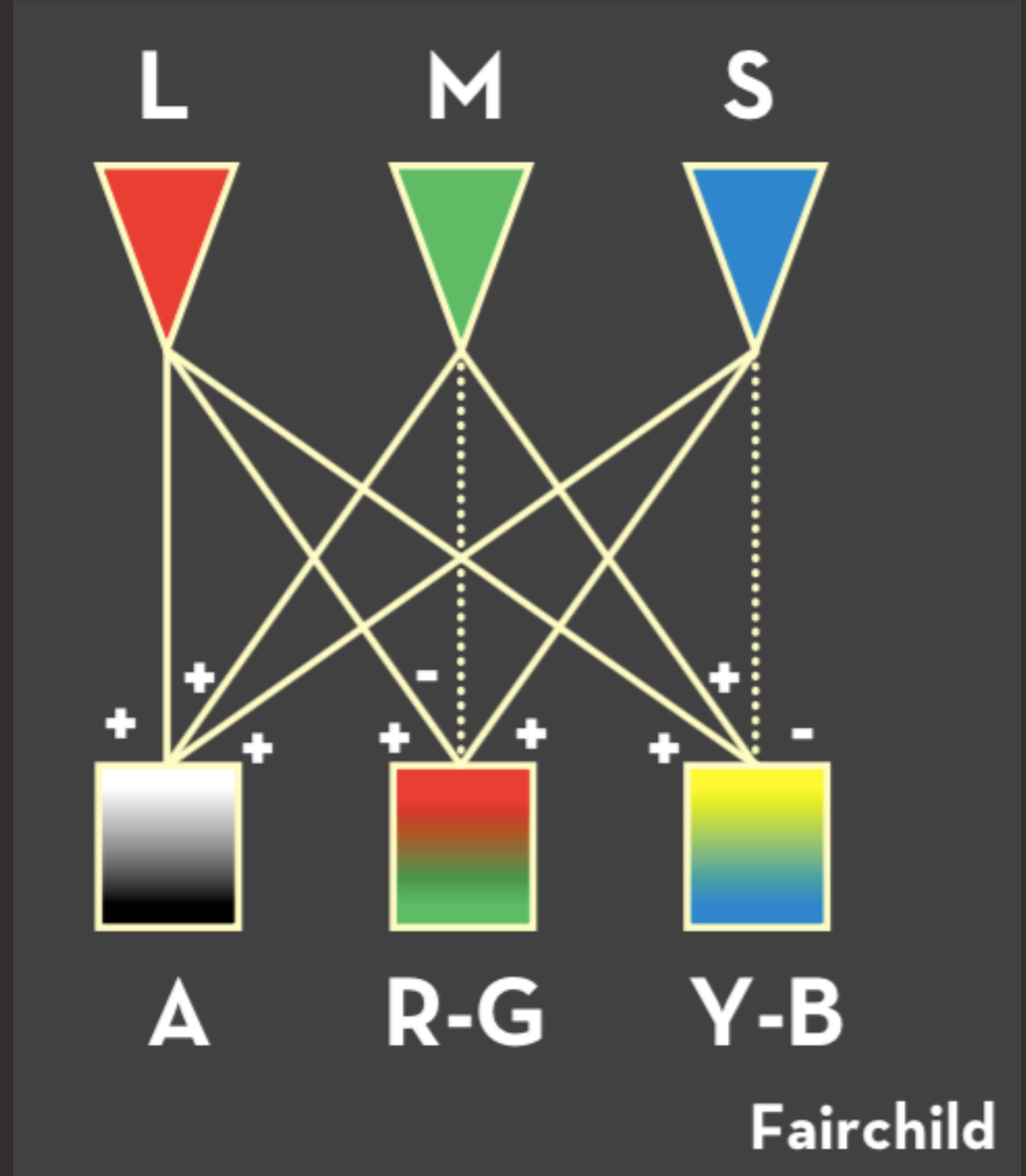
*good for  
people*

---

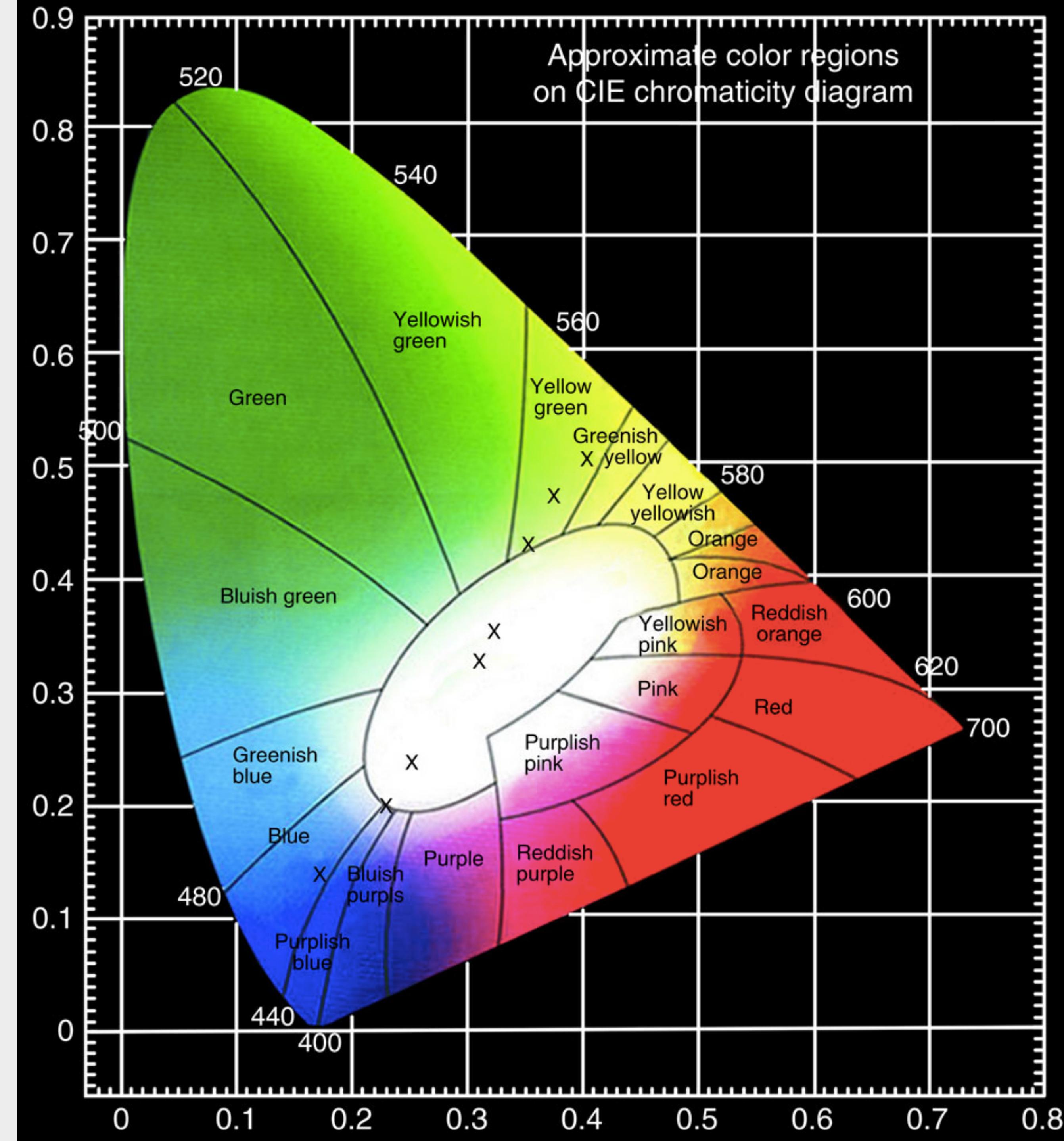
*rgb      hsv*

# Remember?

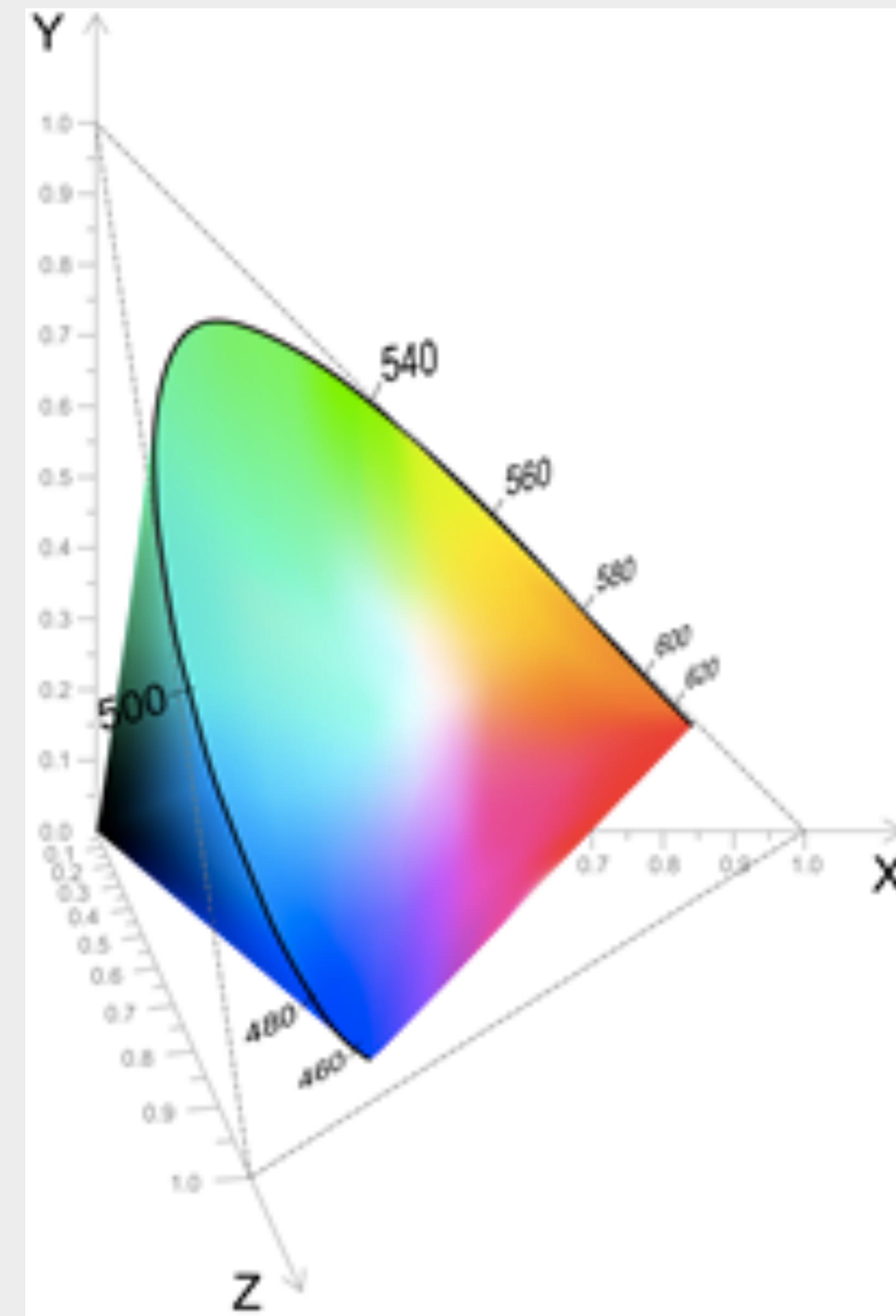
Long  
Middle  
Short



# CIE XYZ

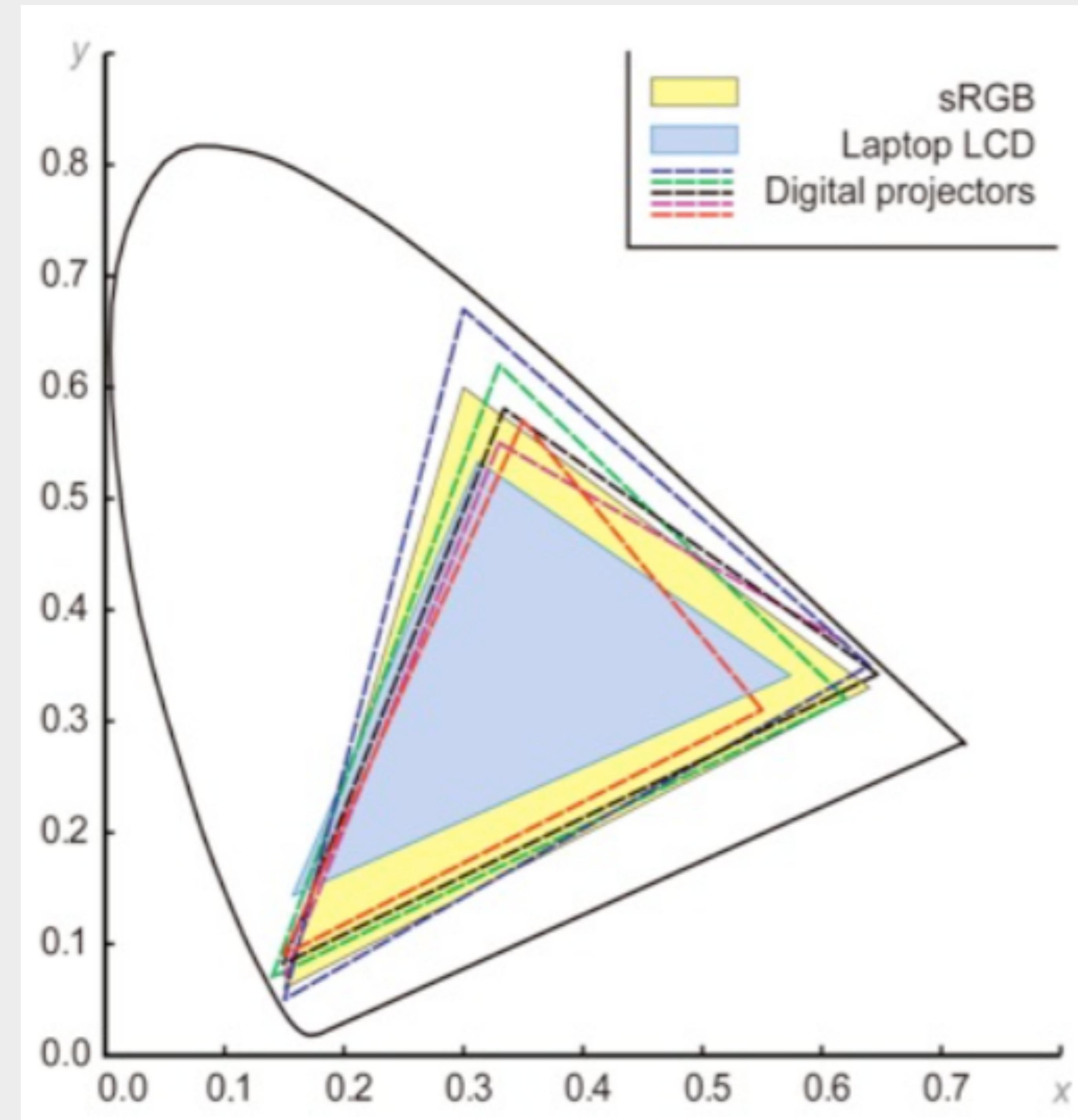


# CIE XYZ



# CIE XYZ

*displays are an embedding*

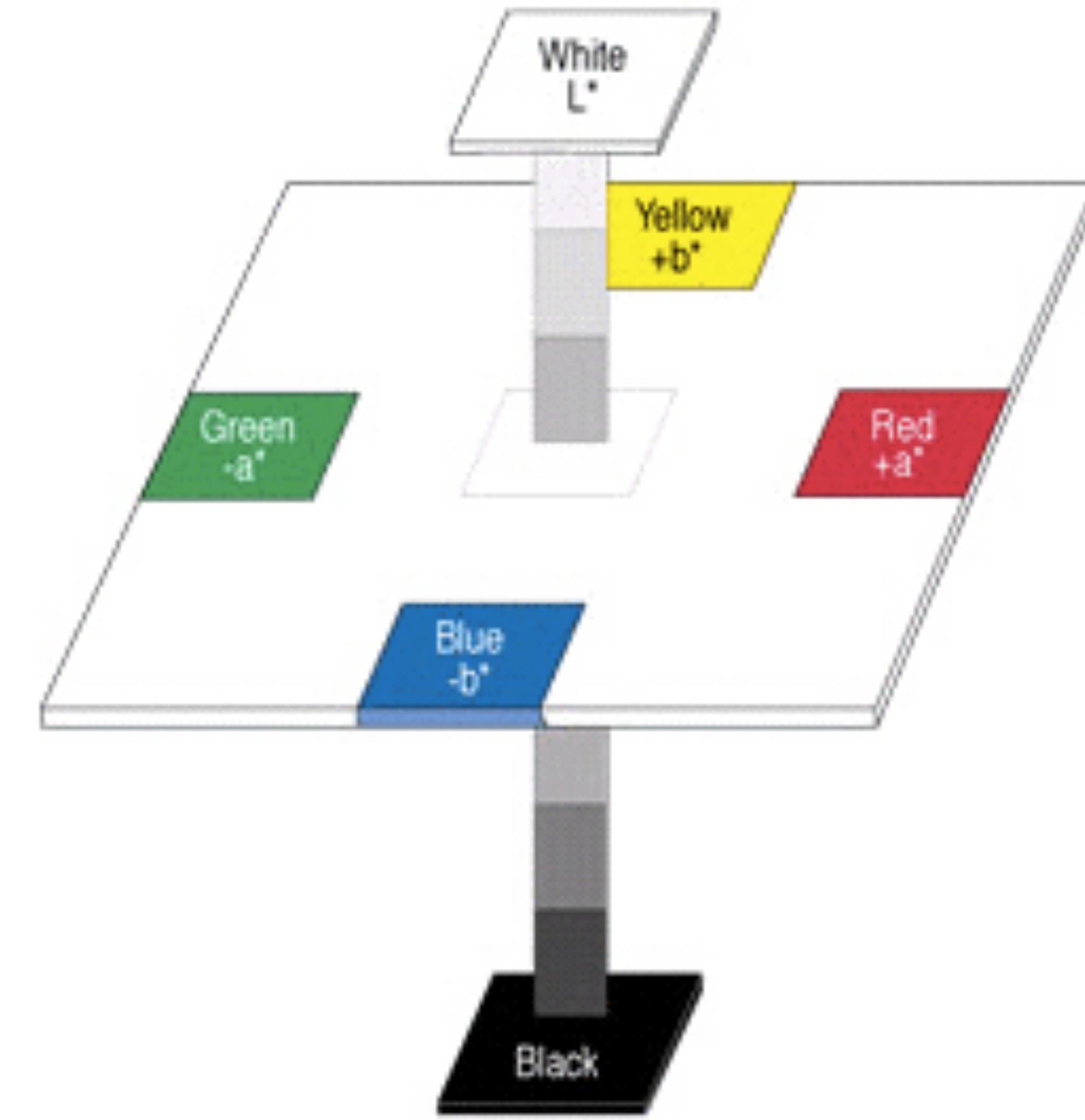


# CIE Lab

Luminance

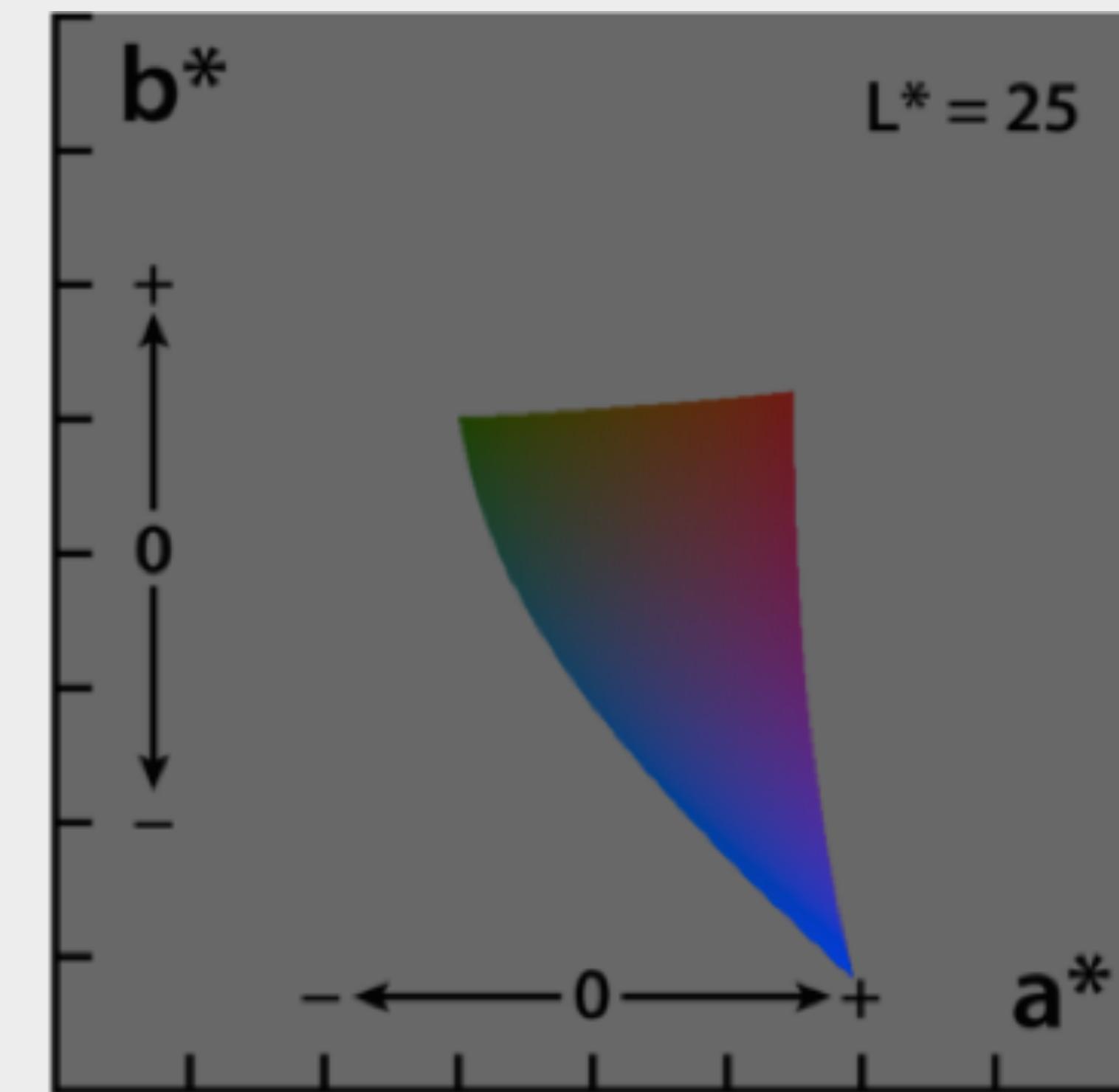
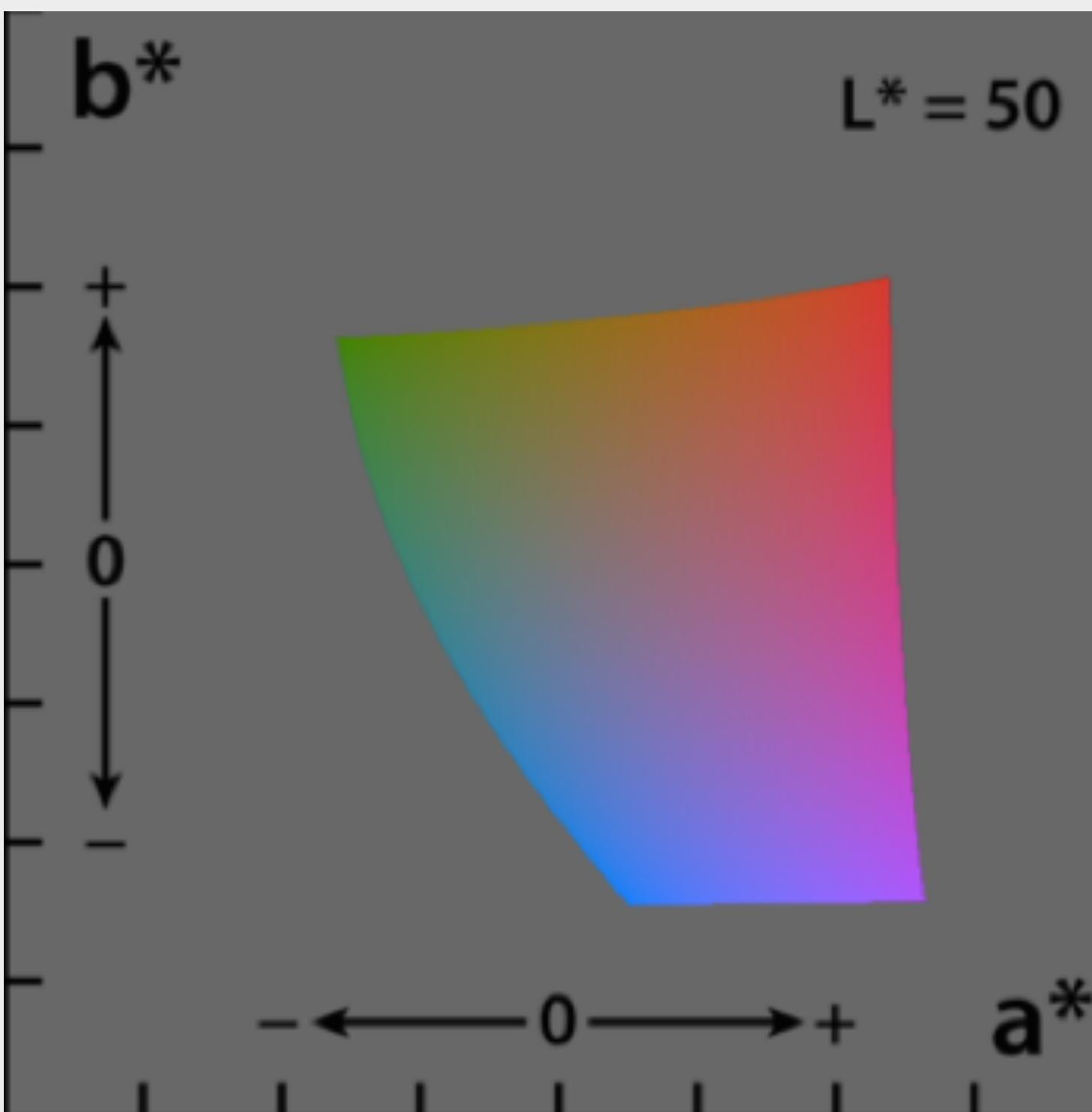
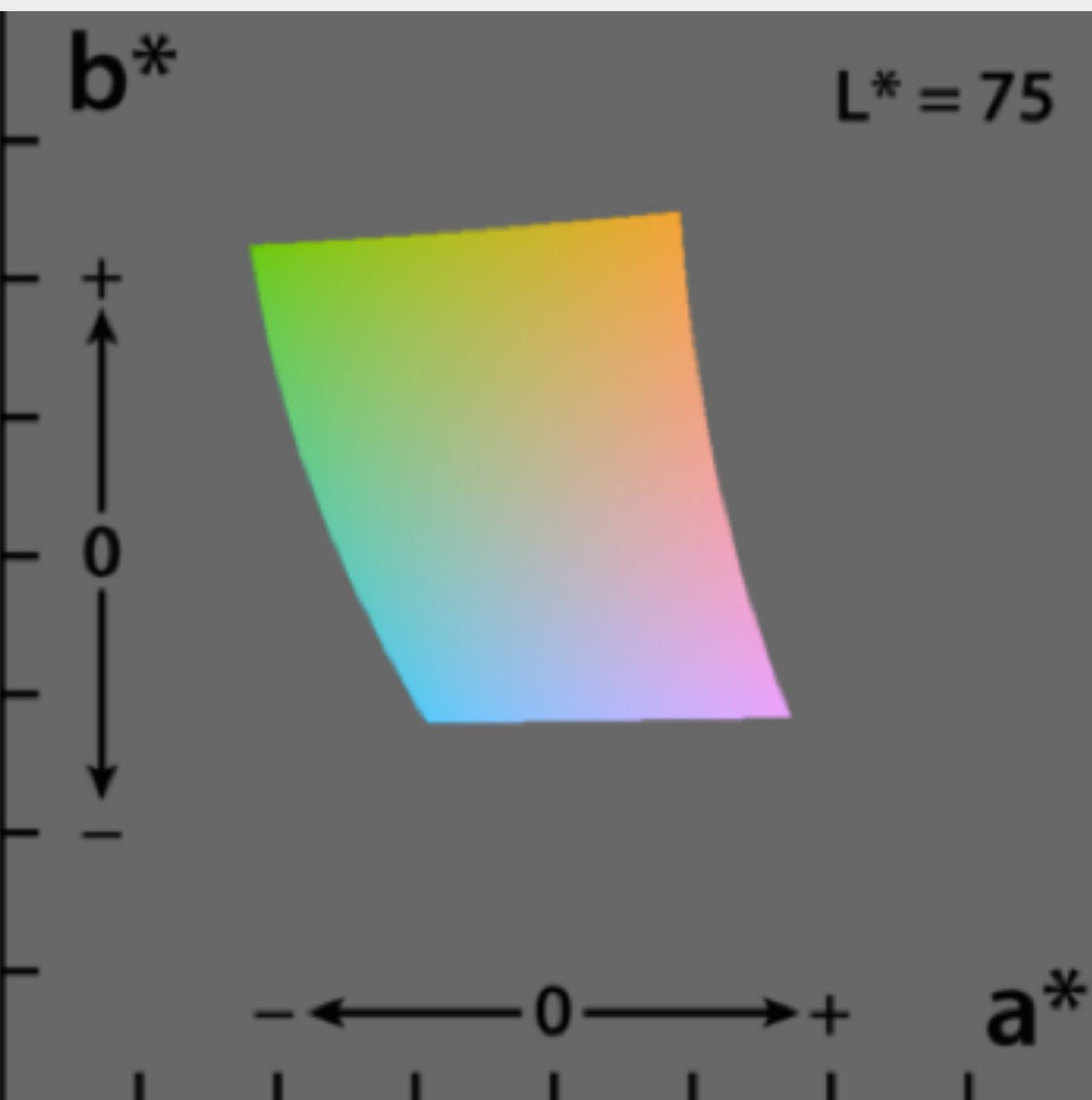
a (red green)

b (blue yellow)



Example	L*	a*	b*
Pale Gray (nearly white)	83.70	-0.50	0.05
Medium Gray	59.60	0.00	0.50
Brilliant Red	43.70	37.10	18.70
Brilliant Yellow	83.30	1.90	77.00
Green	56.80	-30.00	15.40
Deep Blue	29.30	8.0	-17.90

# CIE Lab



# *Lab*



**-5%**



**+5%**



*good for  
machines*

---

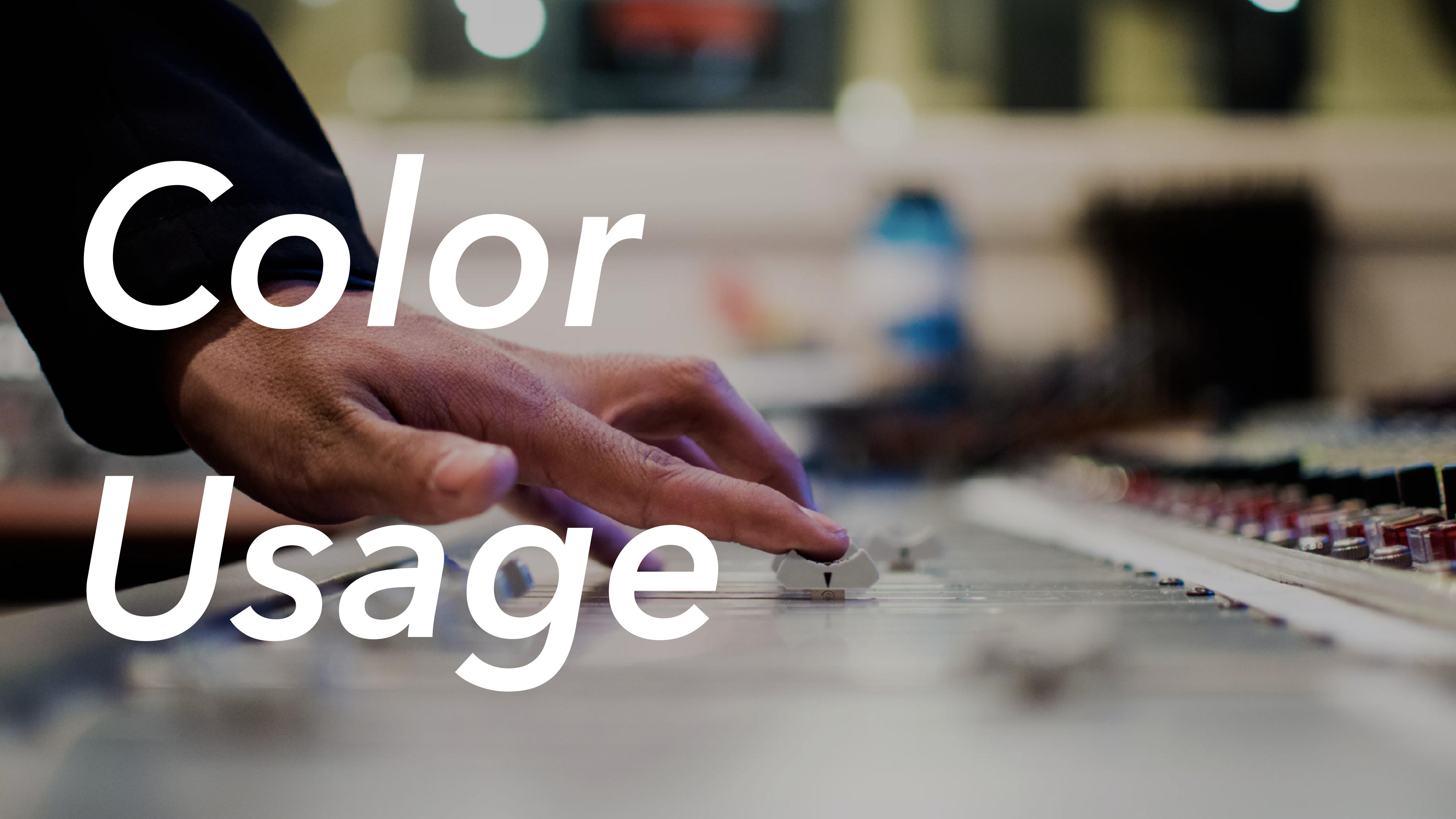
*good for  
people*

---

*rgb      hsv*

*Lab*

# Color Usage



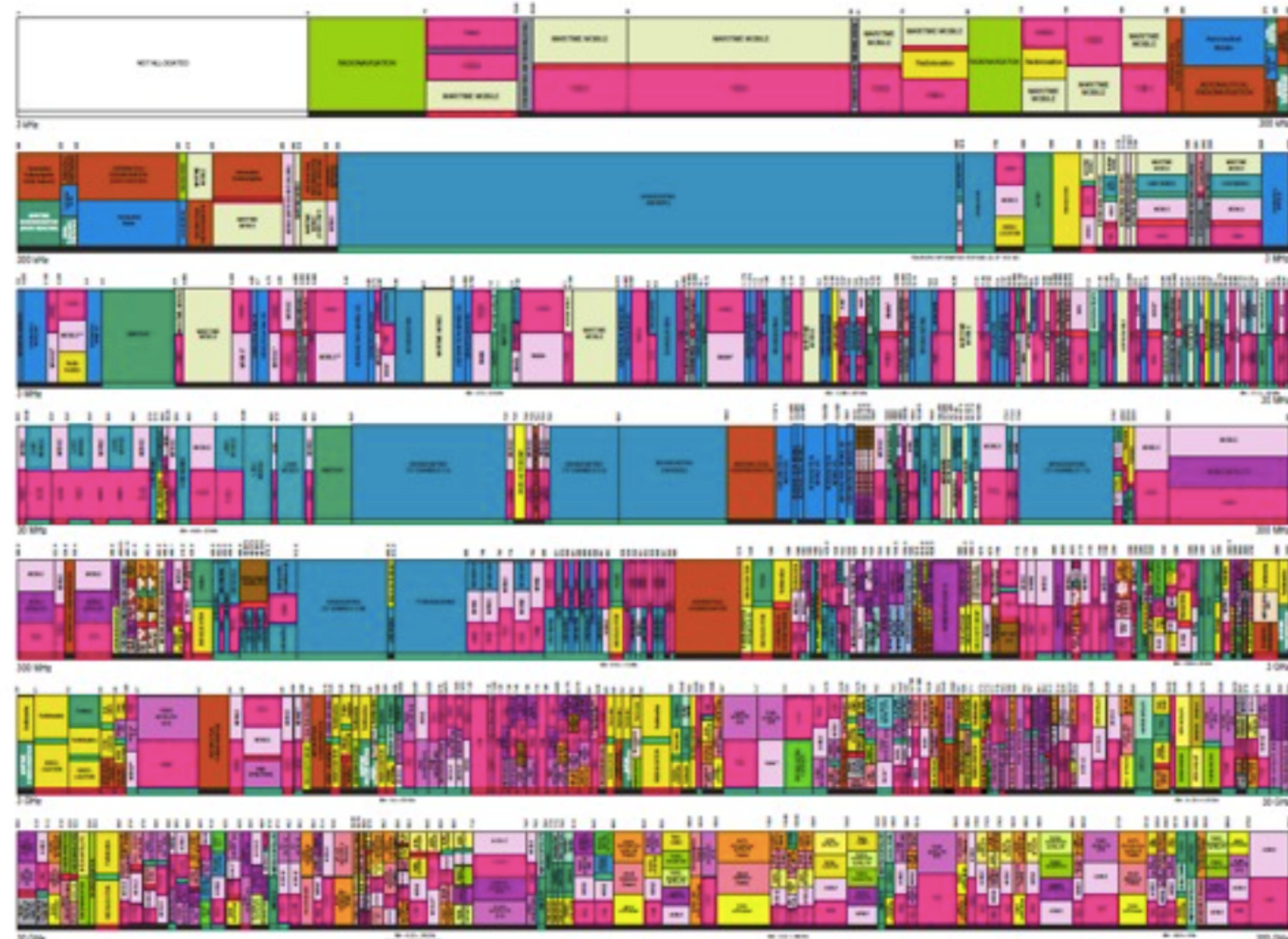
*Map Data*

*to Color*

*Nominal*

# UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

## THE RADIO SPECTRUM



# UNITED STATES FREQUENCY ALLOCATIONS

## THE RADIO SPECTRUM



ACTIVITY CODE

- COMMERCIAL
- NONCOMMERCIAL

NONCOMMERCIAL

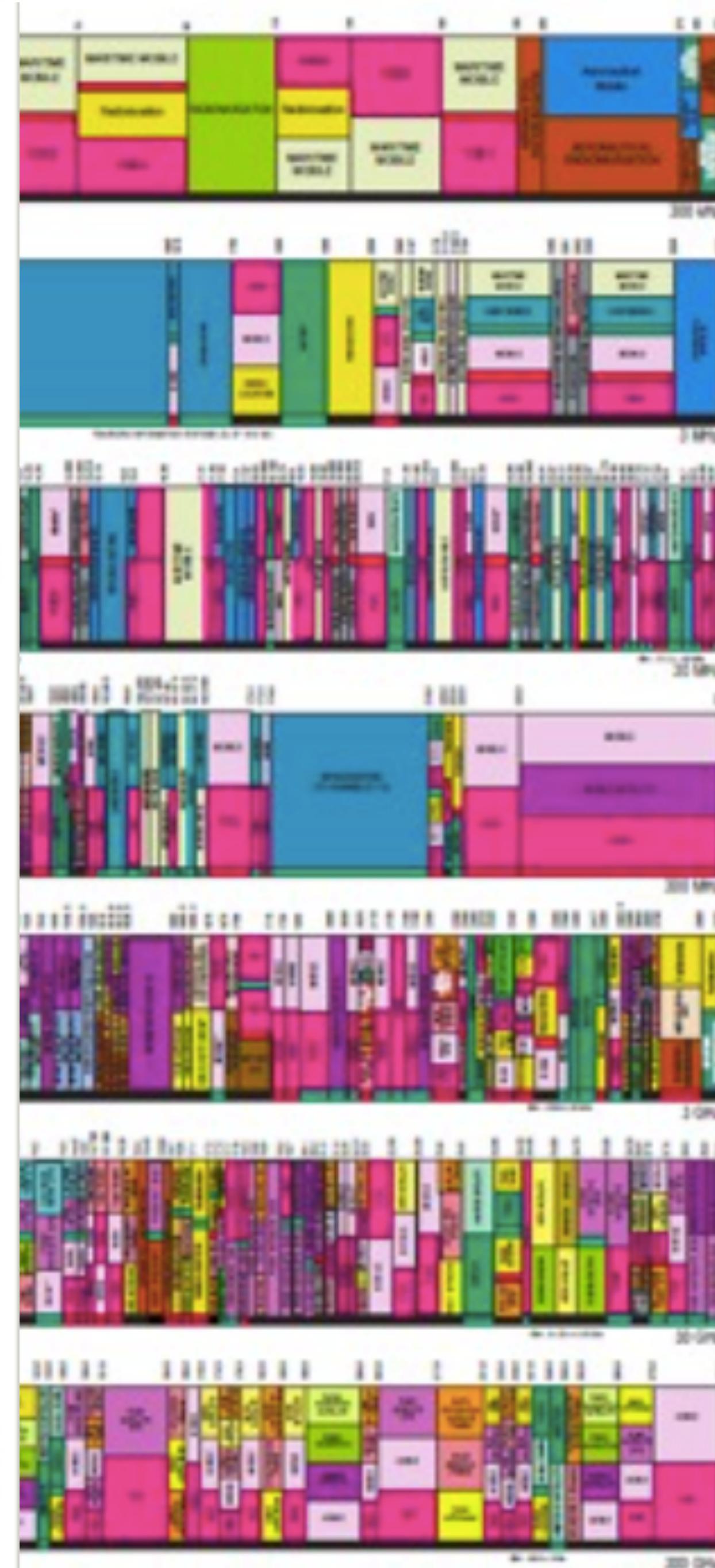
ALLOCATION USAGE DESIGNATION

PRIMARY SECONDARY CO-PRIMARY CO-SECONDARY

### RADIO SERVICES COLOR LEGEND

AERONAUTICAL MOBILE	INTER-SATELLITE	RADIO ASTRONOMY
AERONAUTICAL MOBILE SATELLITE	LAND MOBILE	RADIODETERMINATION SATELLITE
AERONAUTICAL RADIONAVIGATION	LAND MOBILE SATELLITE	RADIOLOCATION
AMATEUR	MARITIME MOBILE	RADIOLOCATION SATELLITE
AMATEUR SATELLITE	MARITIME MOBILE SATELLITE	RADIONAVIGATION
BROADCASTING	MARITIME RADIONAVIGATION	RADIONAVIGATION SATELLITE
BROADCASTING SATELLITE	METEOROLOGICAL AIDS	SPACE OPERATION
EARTH EXPLORATION SATELLITE	METEOROLOGICAL SATELLITE	SPACE RESEARCH
FIXED	MOBILE	STANDARD FREQUENCY AND TIME SIGNAL
FIXED SATELLITE	MOBILE SATELLITE	STANDARD FREQUENCY AND TIME SIGNAL SATELLITE

### ACTIVITY CODE



UNITED

STATES

FREQUENCY

ALLOCATION

THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

AERONAUTICAL MOBILE	INTER-SATELLITE	RADIO ASTRONOMY
AERONAUTICAL MOBILE SATELLITE	LAND MOBILE	RADIODETERMINATION SATELLITE
AERONAUTICAL RADIONAVIGATION	LAND MOBILE SATELLITE	RADIOLOCATION
AMATEUR	MARITIME MOBILE	RADIOLOCATION SATELLITE
AMATEUR SATELLITE	MARITIME MOBILE SATELLITE	RADIONAVIGATION
BROADCASTING	MARITIME RADIONAVIGATION	RADIONAVIGATION SATELLITE
BROADCASTING SATELLITE	METEOROLOGICAL AIDS	SPACE OCCUPATION
FIXED	METEOROLOGICAL SATELLITE	SPACE SEARCH
MOBILE	STANDARD FREQUENCY AND TIME SIGNAL	STANDARD FREQUENCY AND TIME SIGNAL SATELLITE
FIXED SATELLITE	MOBILE SATELLITE	

ACTIVITY CODE

SATELLITE	SATELLITE/SATELLITE
NON-SATELLITE	

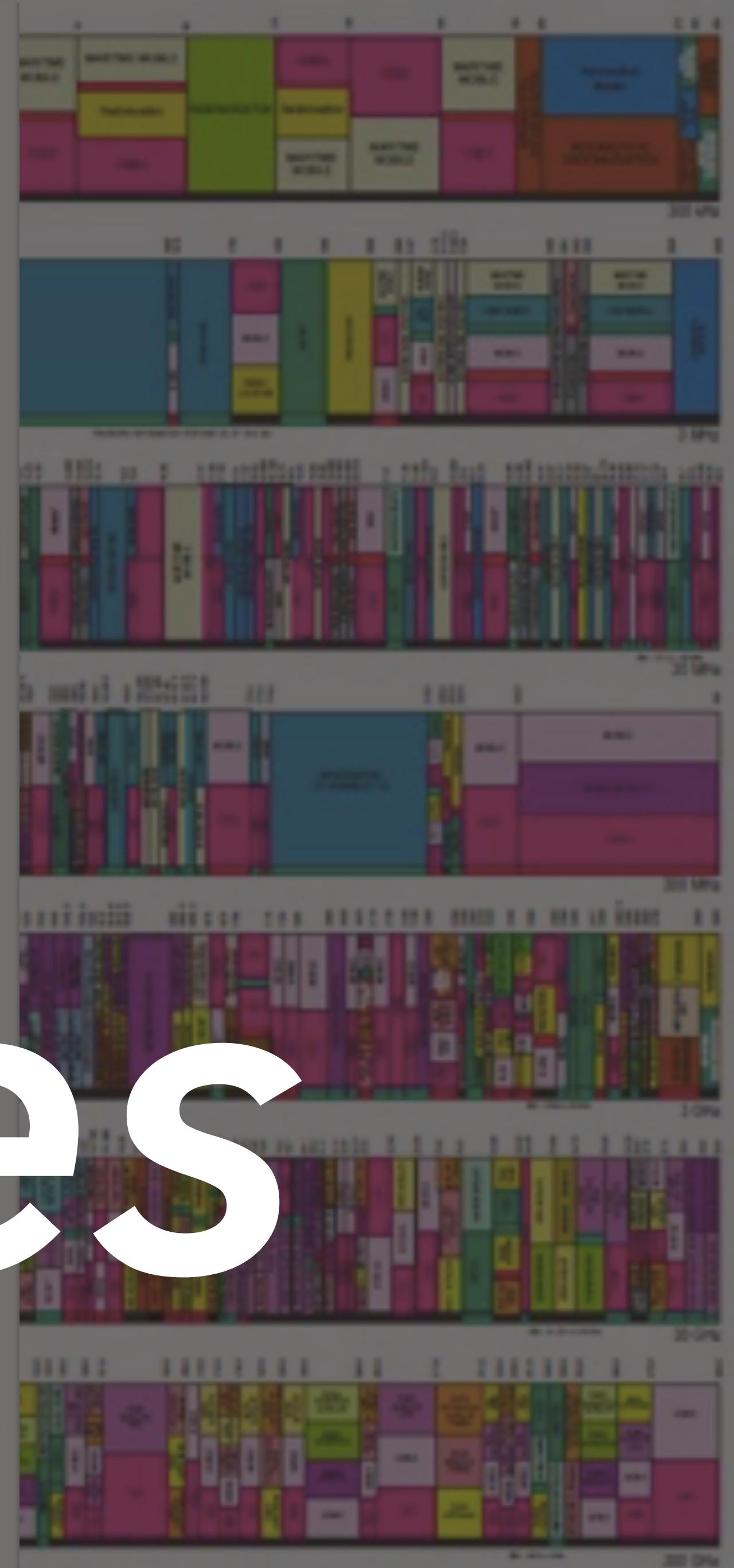
ALLOCATION USAGE DESIGNATION

PRIMARY	SECONDARY	RESERVE
PRIMARY	SECONDARY	RESERVE

RADIO SERVICES COLOR LEGEND

AERONAUTICAL MOBILE	INTER-SATELLITE	RADIO ASTRONOMY
AERONAUTICAL MOBILE SATELLITE	LAND MOBILE	RADIODETERMINATION SATELLITE
AERONAUTICAL RADIONAVIGATION	LAND MOBILE SATELLITE	RADIOLOCATION
AMATEUR	MARITIME MOBILE	RADIOLOCATION SATELLITE
AMATEUR SATELLITE	MARITIME MOBILE SATELLITE	RADIONAVIGATION
BROADCASTING	MARITIME RADIONAVIGATION	RADIONAVIGATION SATELLITE
BROADCASTING SATELLITE	METEOROLOGICAL AIDS	SPACE OCCUPATION
FIXED	METEOROLOGICAL SATELLITE	SPACE SEARCH
MOBILE	STANDARD FREQUENCY AND TIME SIGNAL	STANDARD FREQUENCY AND TIME SIGNAL SATELLITE
FIXED SATELLITE	MOBILE SATELLITE	

ACTIVITY CODE



UNITED

STATES

FREQUENCY

ALLOCATIONS

THE RADIO SPECTRUM

## RADIO SERVICES COLOR LEGEND

AERONAUTICAL  
MOBILE

INTER-SATELLITE

RADIO ASTRONOMY

AERONAUTICAL  
MOBILE SATELLITE

LAND MOBILE

RADIODETERMINATION  
SATELLITE

AERONAUTICAL  
RADIONAVIGATION

LAND MOBILE  
SATELLITE

RADIOLOCATION

AMATEUR

MARITIME MOBILE

RADIONAVIGATION SATELLITE

AMATEUR SATELLITE

MARITIME MOBILE  
SATELLITE

RADIONAVIGATION

BROADCASTING

MARITIME  
RADIONAVIGATION

RADIONAVIGATION  
SATELLITE

BROADCASTING  
SATELLITE

METEOROLOGICAL  
AIDS

SPACE OPERATION

EXPLOSION  
SATELLITE

METEOROLOGICAL  
SATELLITE

SPACE RESEARCH

FIXED

MOBILE

STANDARD FREQUENCY  
AND TIME SIGNAL

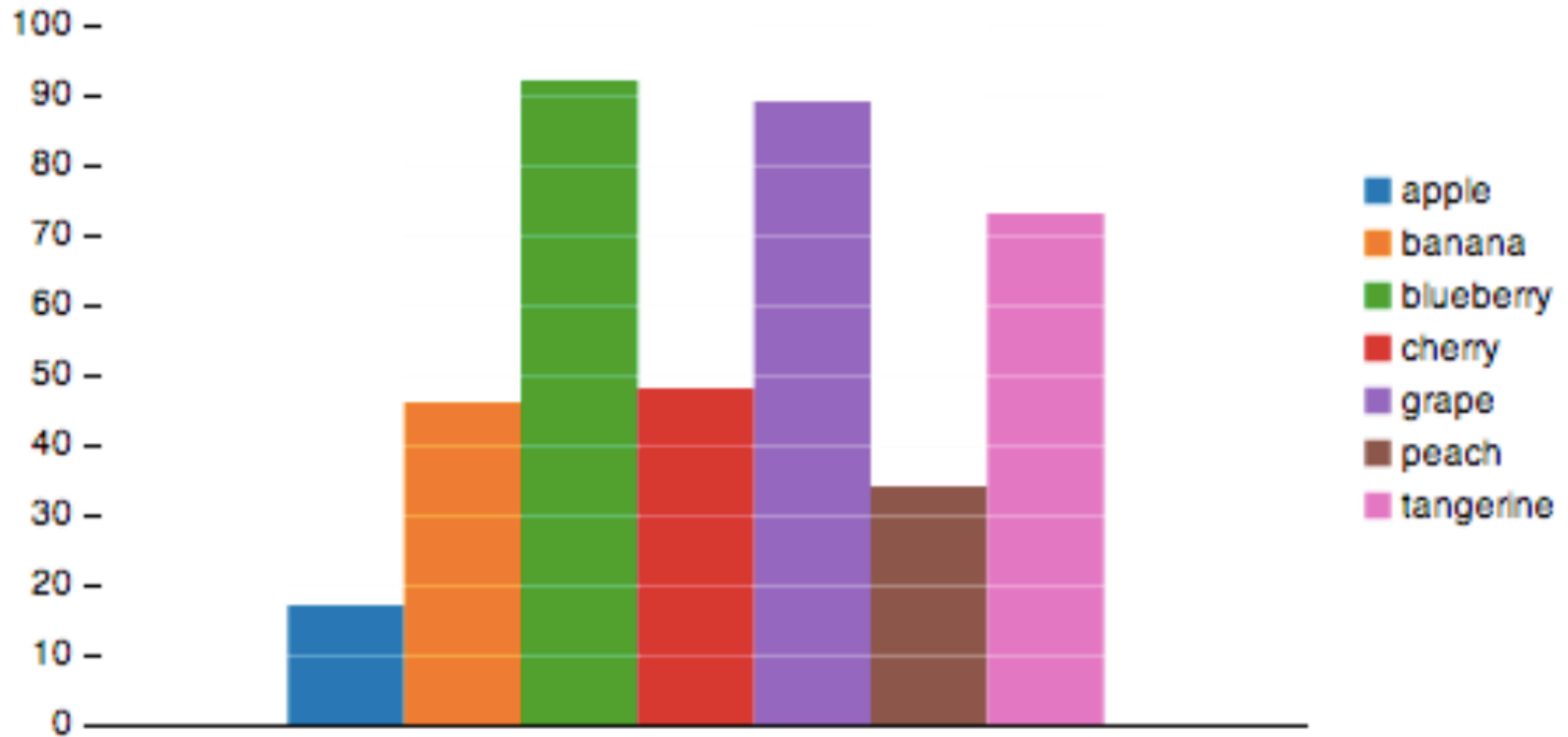
FIXED SATELLITE

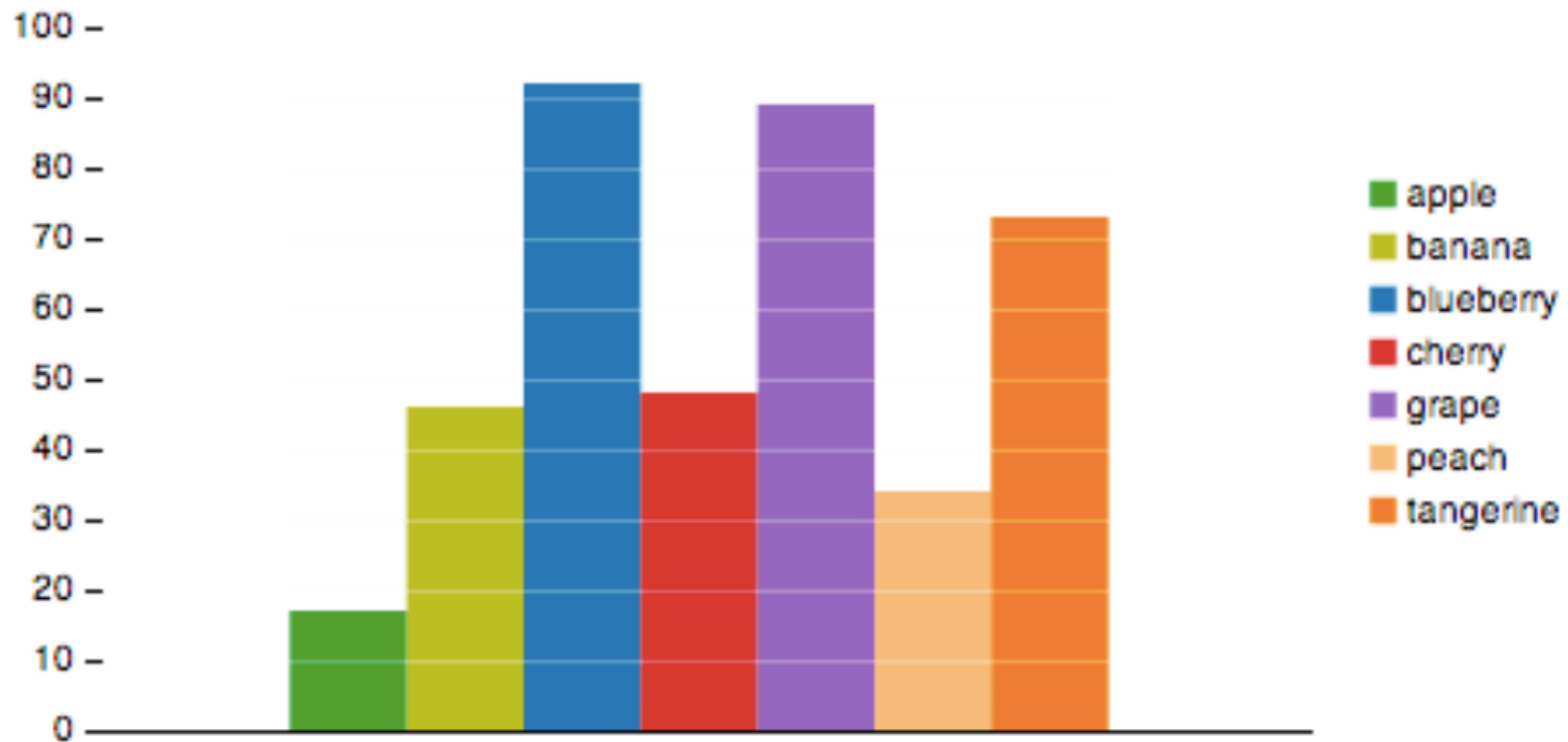
MOBILE SATELLITE

STANDARD FREQUENCY  
AND TIME SIGNAL SATELLITE

ACTIVITY CODE

Use distinct colors





**Fruits**

Apple  
Banana  
Blueberry  
Cherry  
Grape  
Peach  
Tangerine

**A    E****Vegetables**

Carrot  
Celery  
Corn  
Eggplant  
Mushroom  
Olive  
Tomato

**A    E****Drinks**

A&W Root Beer  
Coca-Cola  
Dr. Pepper  
Pepsi  
Sprite  
Sunkist  
Welch's Grape

**A    E****Brands**

Apple  
AT&T  
Home Depot  
Kodak  
Starbucks  
Target  
Yahoo!

**A    E**

# Semantic Naming

## Fruits

- Apple
- Banana
- Blueberry
- Cherry
- Grape
- Pear
- Tangerine



## Vegetables

- Carrot
- Celery
- Corn
- Eggplant
- Mushroom
- Olive
- Tomato



## Drinks

- A&W Root Beer
- Coca-Cola
- McDonald's Coffee
- Mountain Dew
- Sprite
- Sunkist
- Welch's Grape



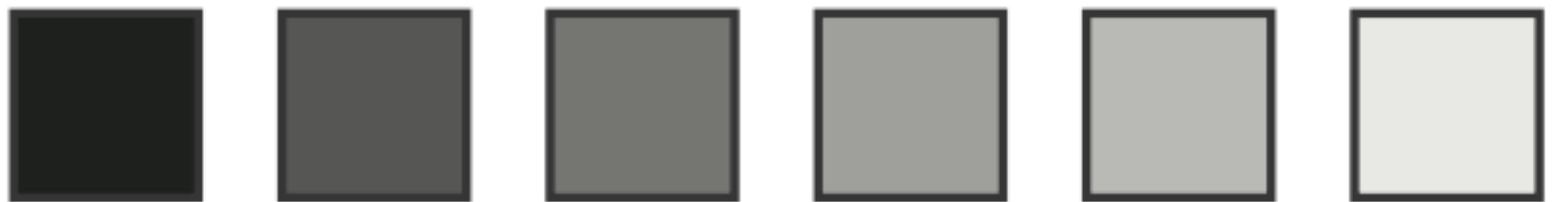
## Brands

- Apple
- AT&T
- Home Depot
- Kodak
- Samsung
- Target
- Yahoo!

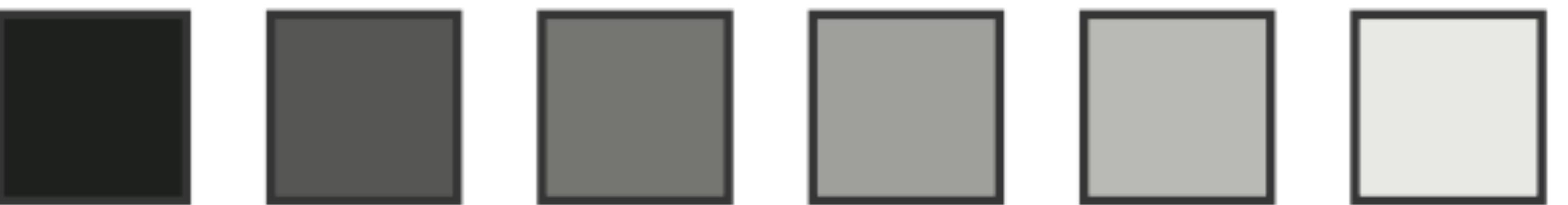


*Ordinal*

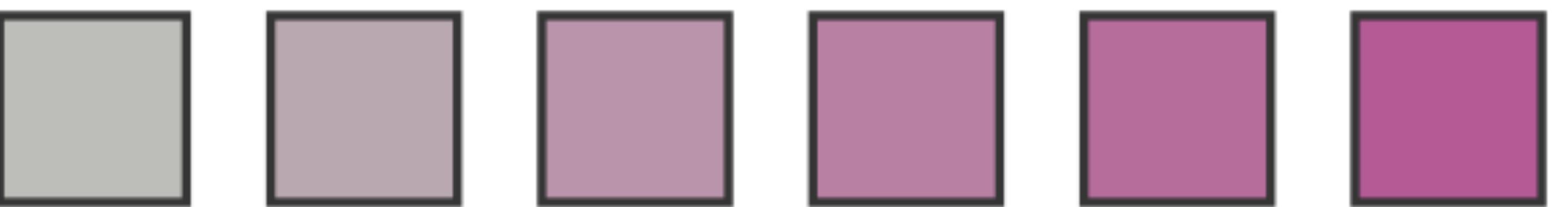
Luminance



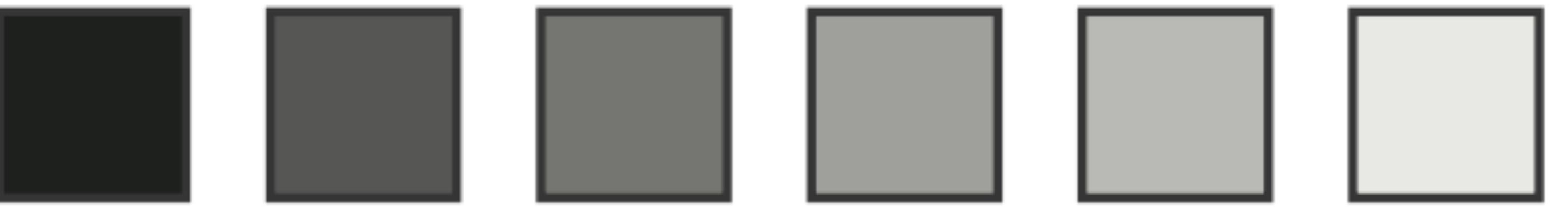
Luminance



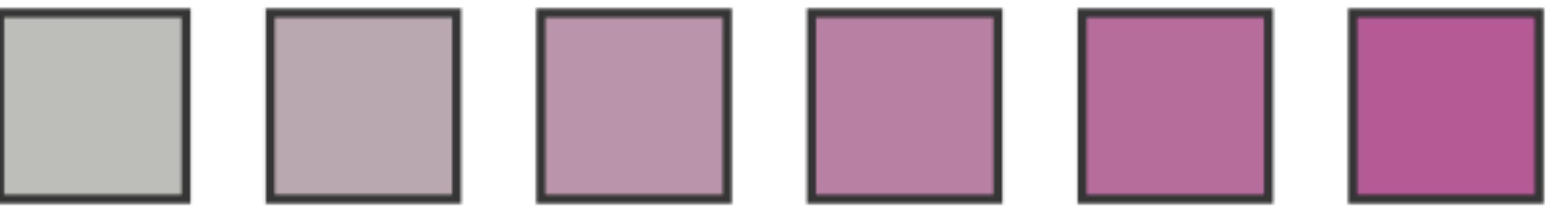
Saturation



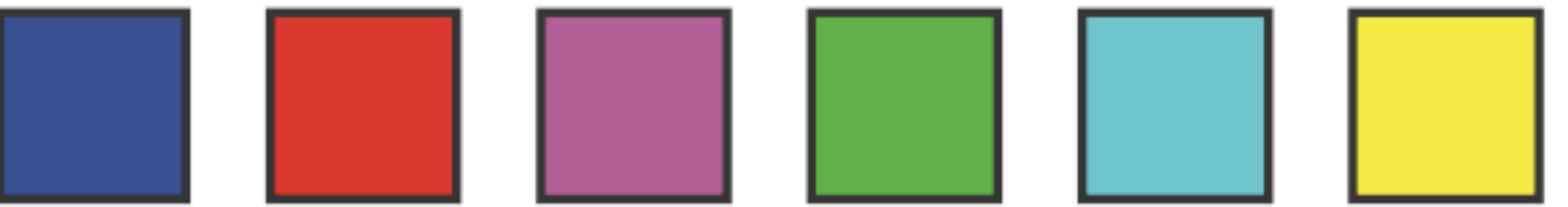
Luminance



Saturation



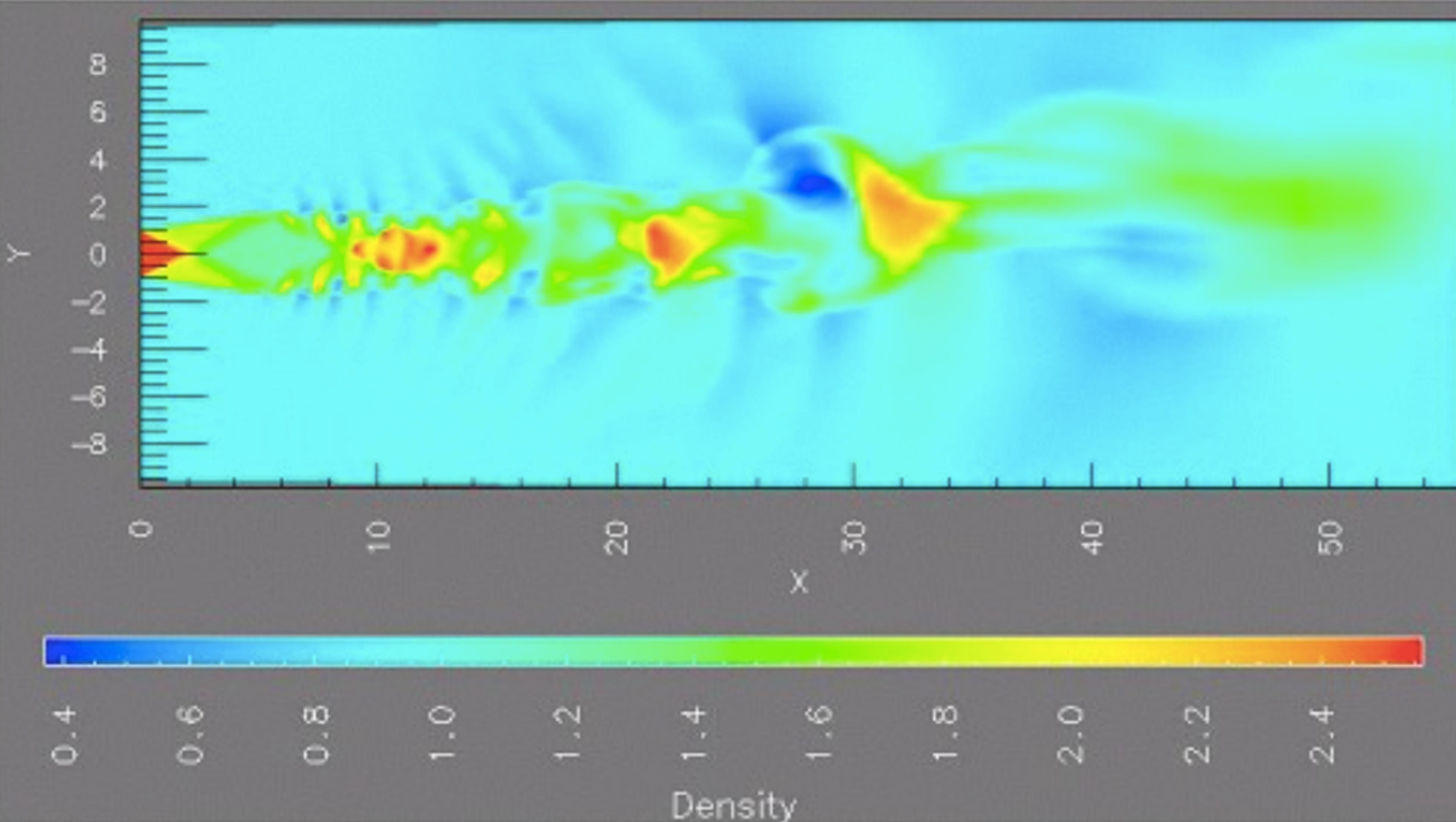
Hue

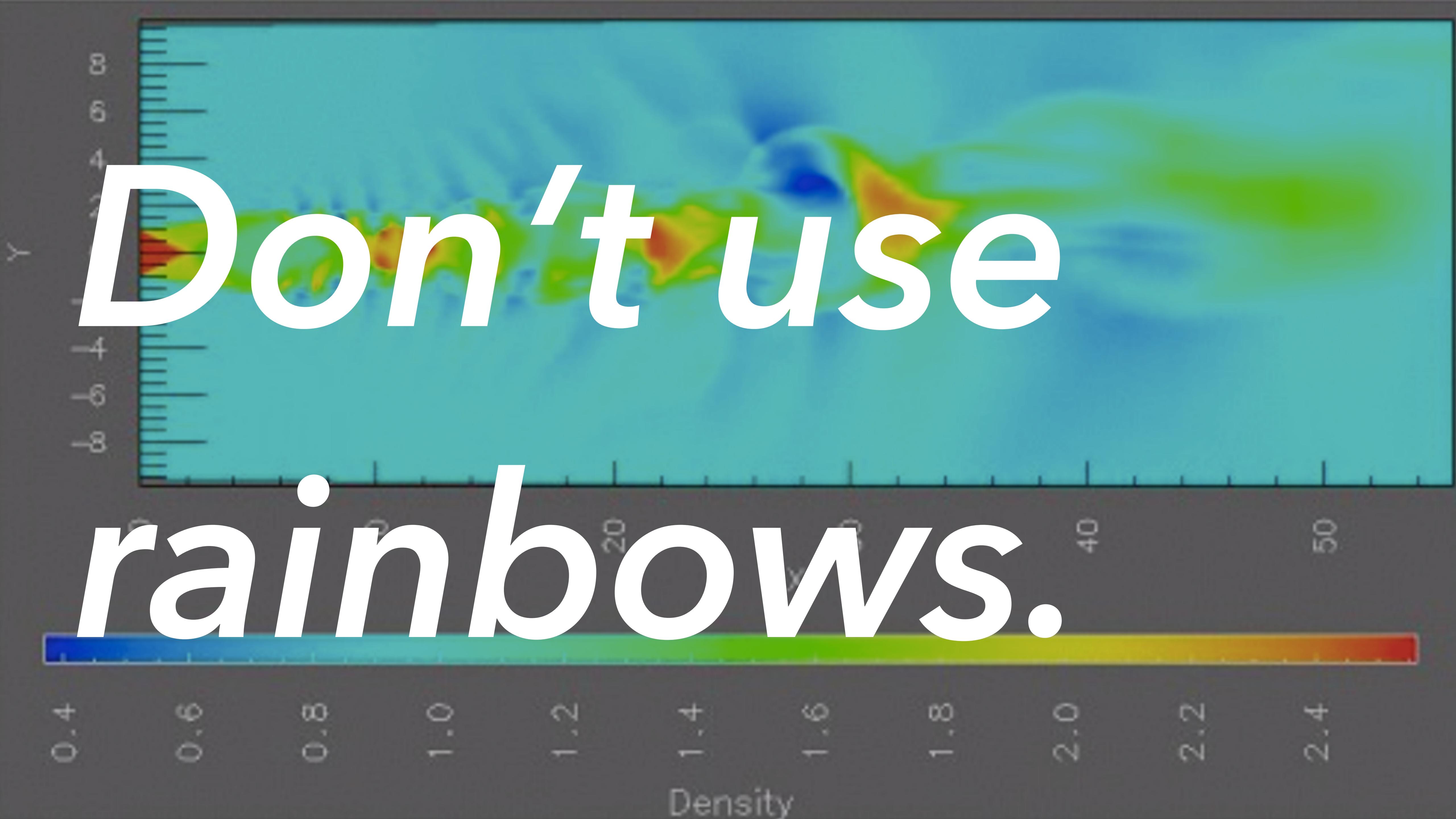


*hue is not naturally ordered*

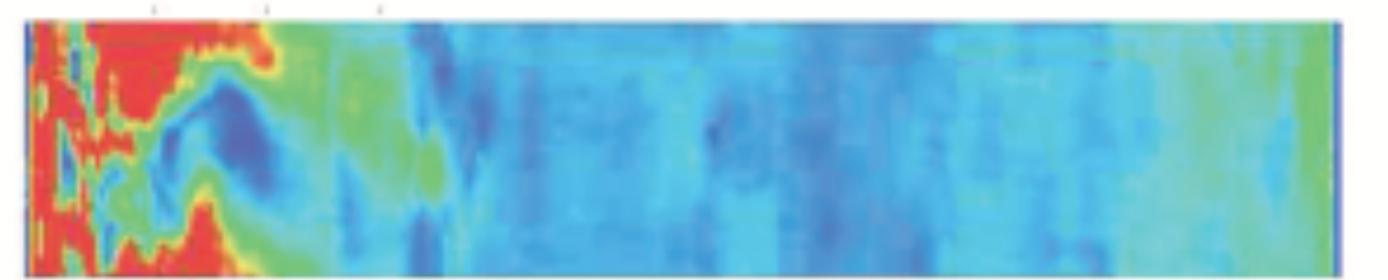


*Continuous*



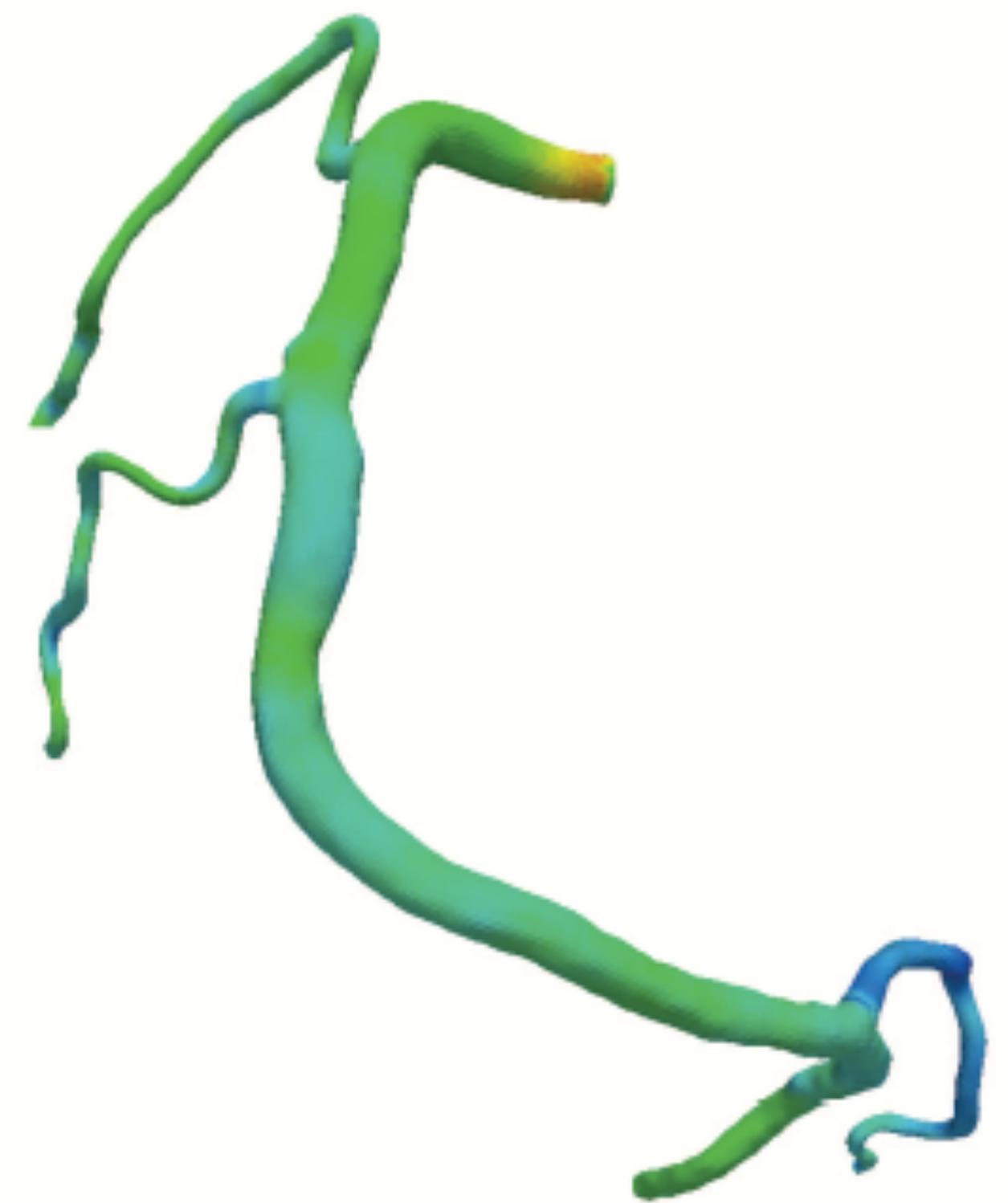


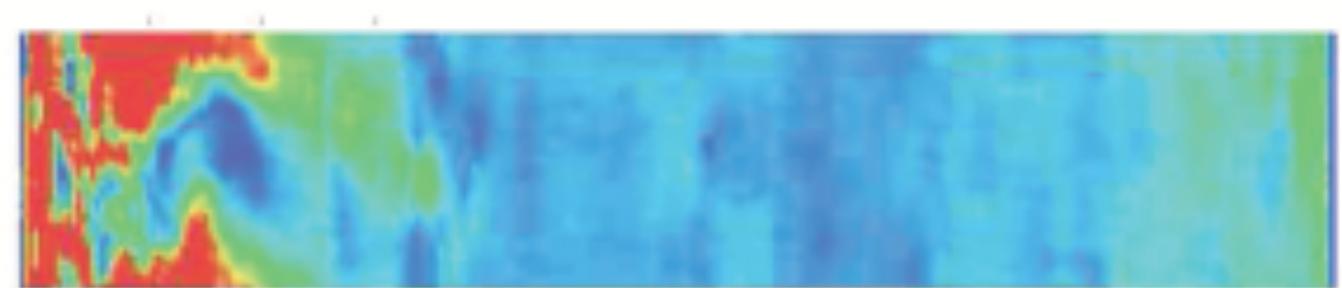
Don't use  
rainbows.



Shear  
Stress (Pa)

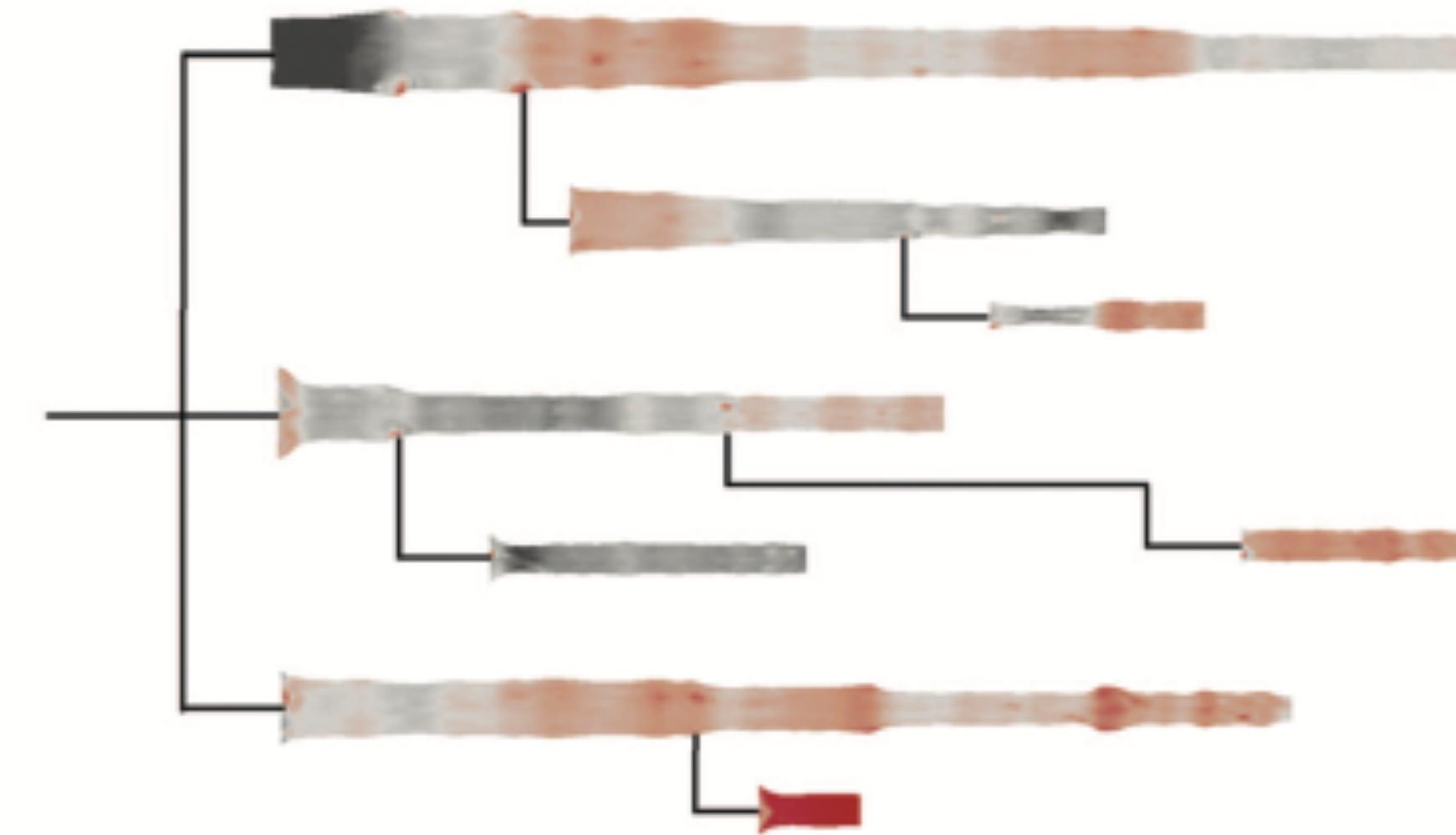
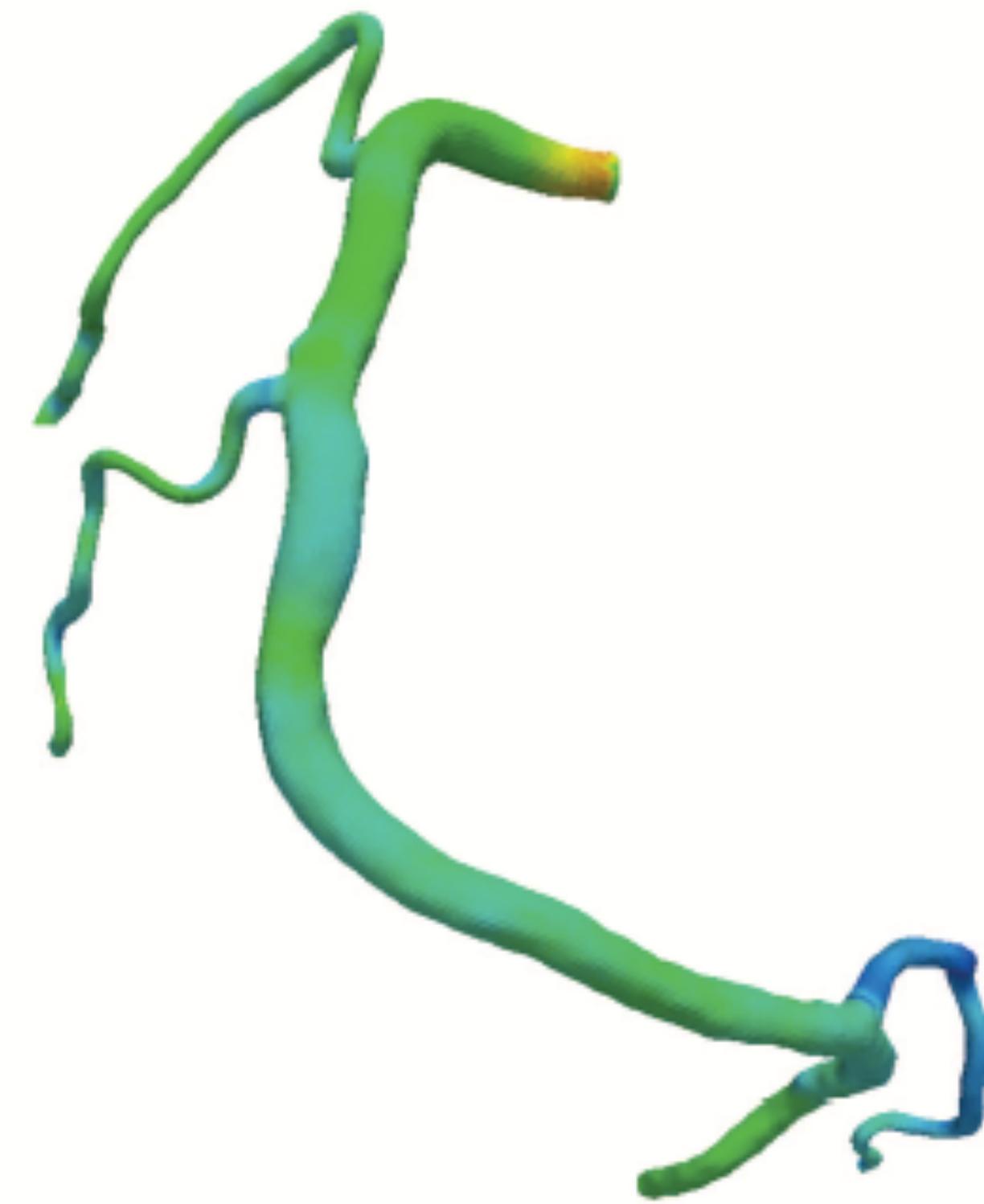
3  
2  
1  
0





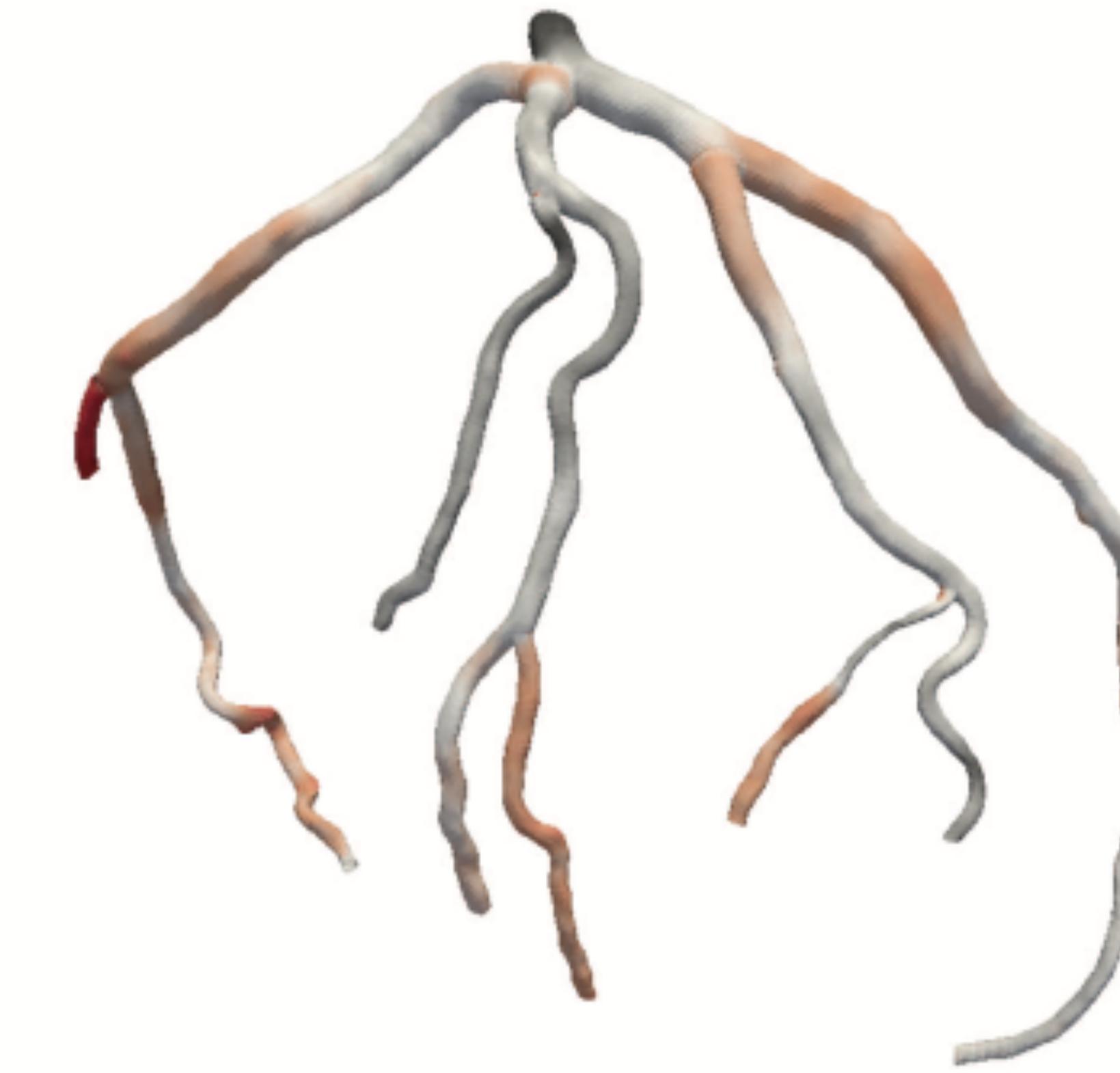
Shear  
Stress (Pa)

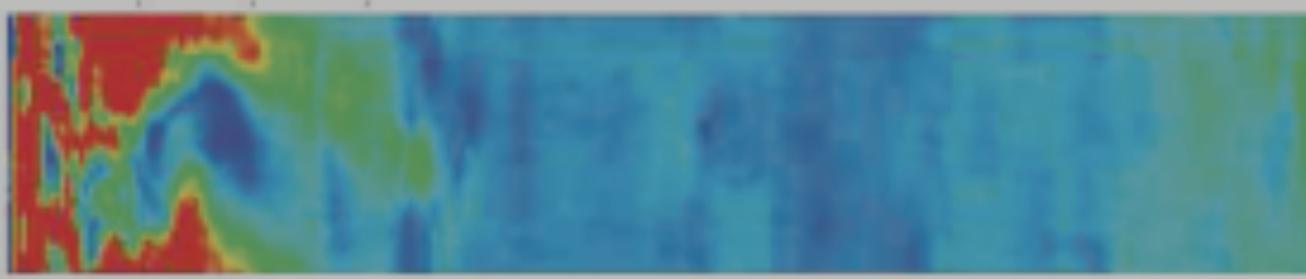
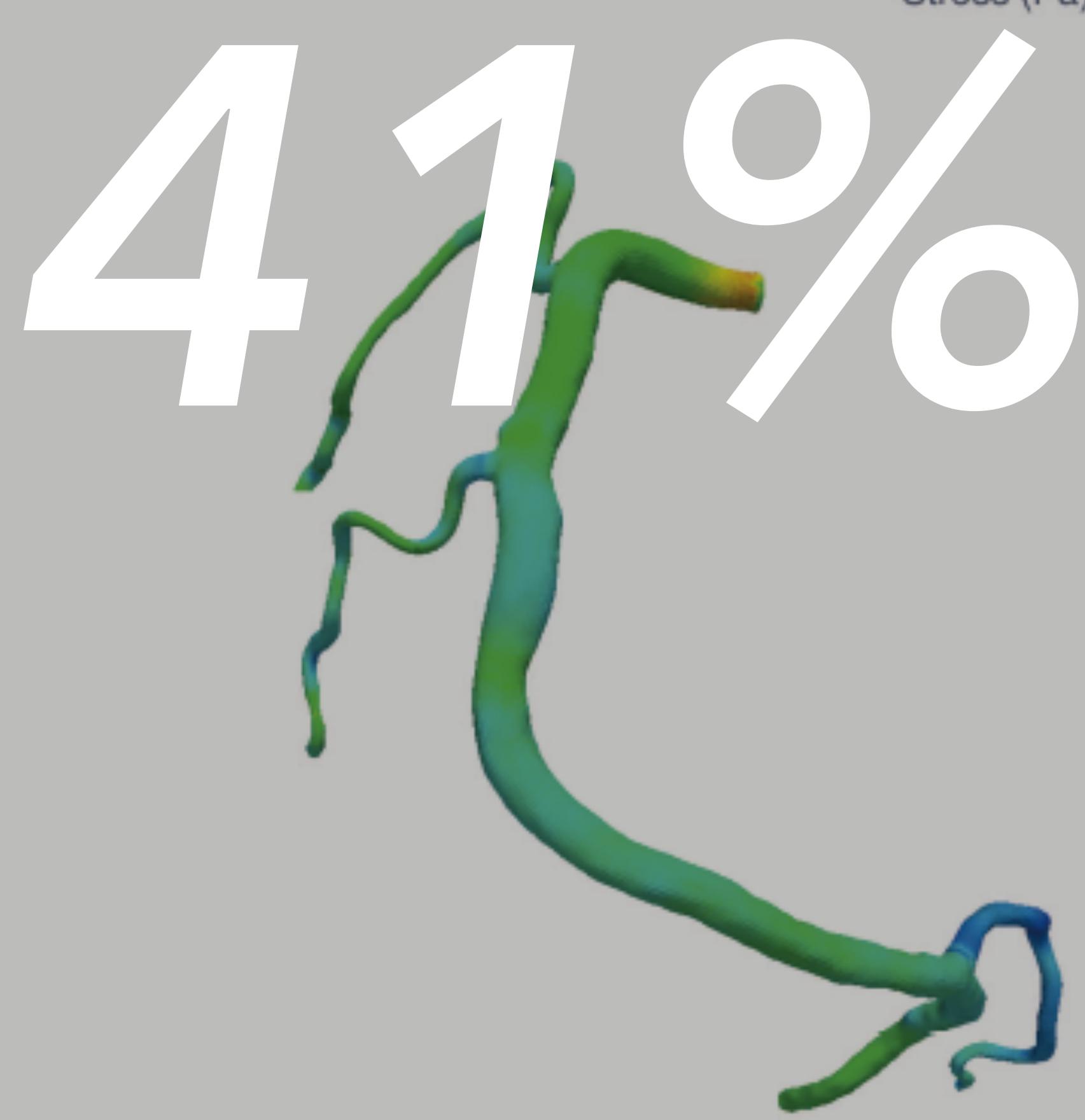
3  
2  
1  
0



Shear  
Stress (Pa)

3  
2  
1  
0





Shear  
Stress (Pa)

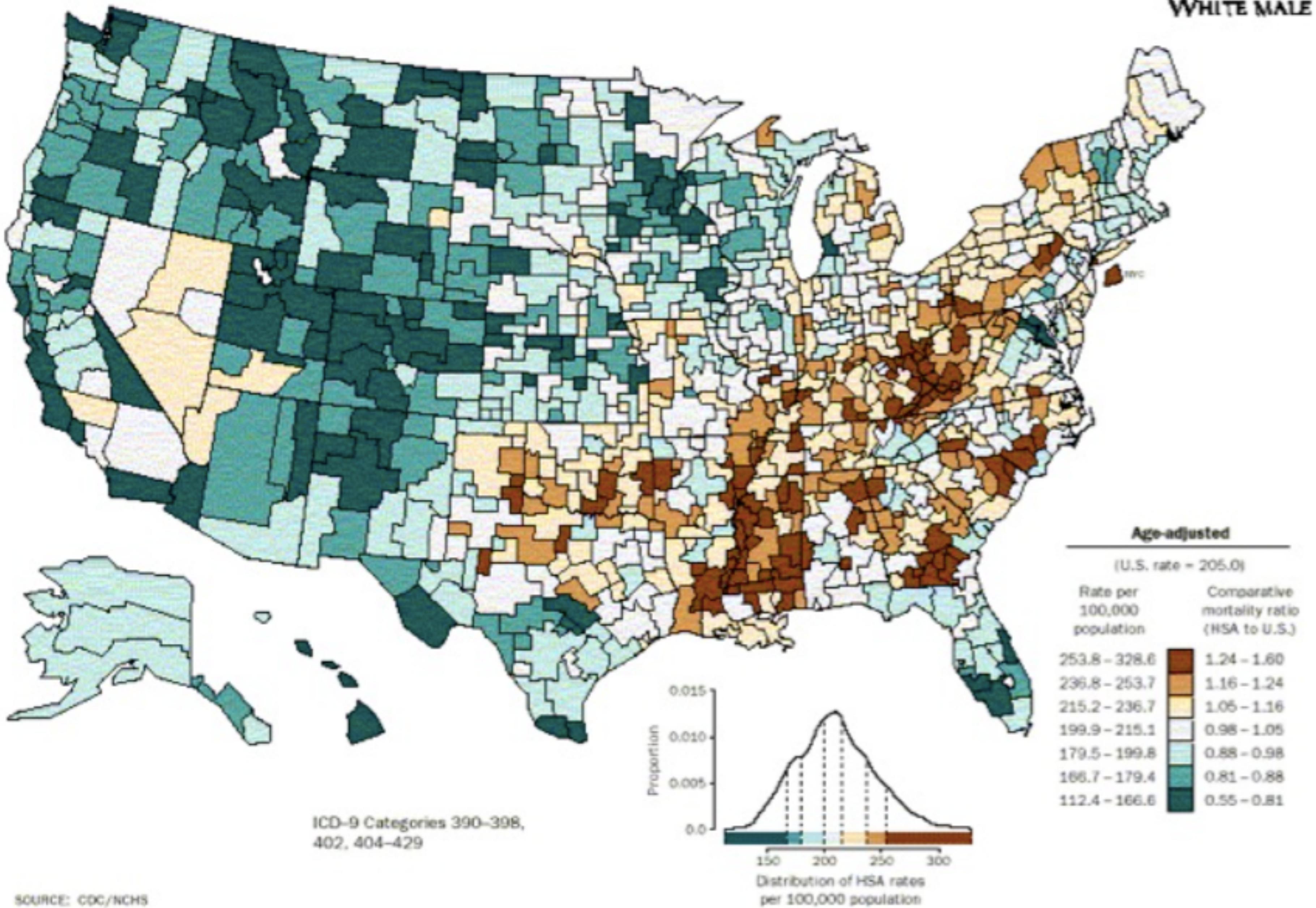
3  
2  
1  
0



Shear  
Stress (Pa)

3  
2  
1  
0

## AGE-ADJUSTED DEATH RATES BY HSA, 1988-92

HEART DISEASE  
WHITE MALE

**Age-adjusted**

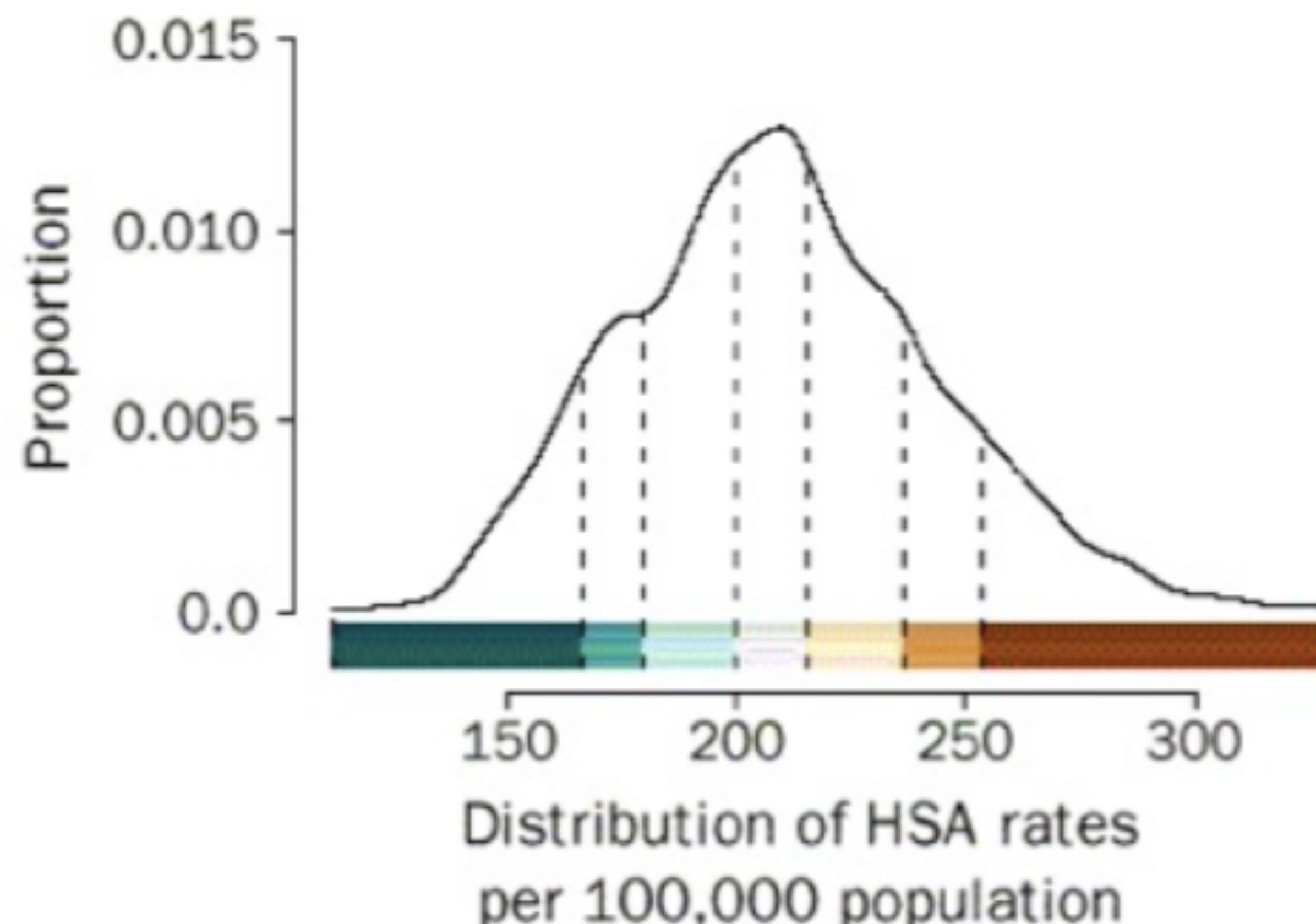
(U.S. rate = 205.0)

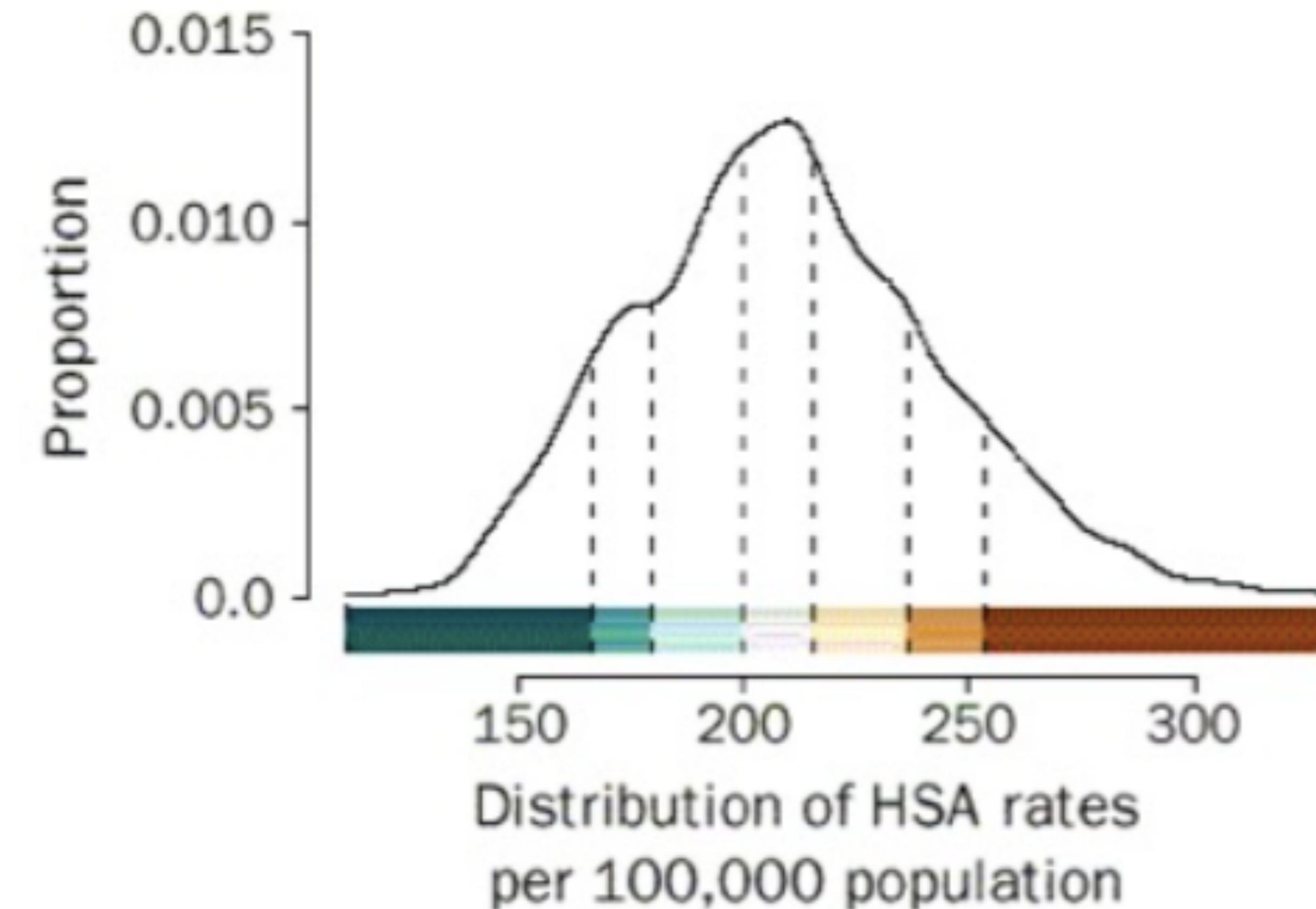
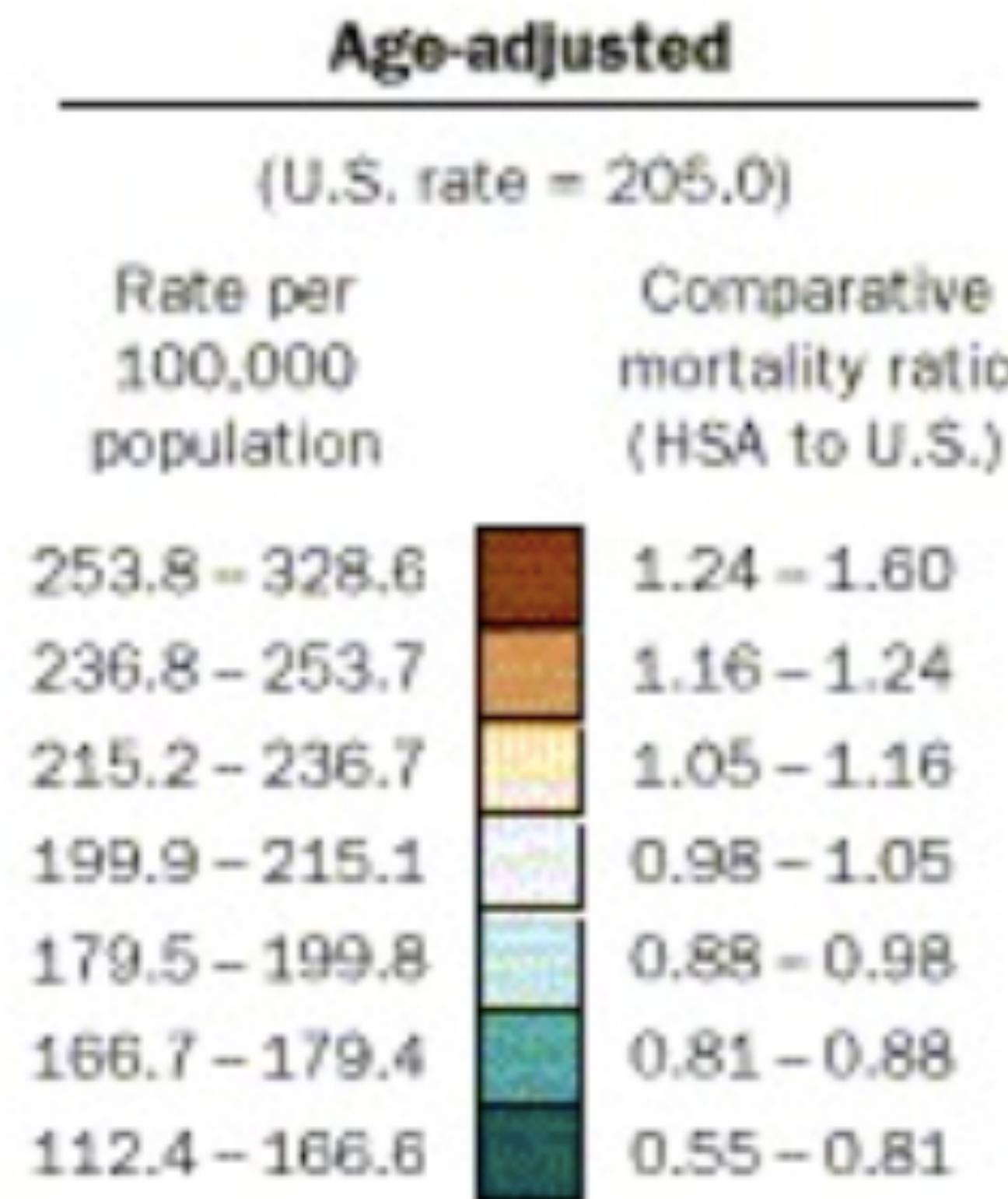
Rate per 100,000 population	Comparative mortality ratio (HSA to U.S.)
253.8 - 328.6	1.24 - 1.60
236.8 - 253.7	1.16 - 1.24
215.2 - 236.7	1.05 - 1.16
199.9 - 215.1	0.98 - 1.05
179.5 - 199.8	0.88 - 0.98
166.7 - 179.4	0.81 - 0.88
112.4 - 166.6	0.55 - 0.81

**Age-adjusted**

(U.S. rate = 205.0)

Rate per 100,000 population	Comparative mortality ratio (HSA to U.S.)
253.8 - 328.6	1.24 - 1.60
236.8 - 253.7	1.16 - 1.24
215.2 - 236.7	1.05 - 1.16
199.9 - 215.1	0.98 - 1.05
179.5 - 199.8	0.88 - 0.98
166.7 - 179.4	0.81 - 0.88
112.4 - 166.6	0.55 - 0.81





awesome ^

# Color Tools



Number of data classes: 3

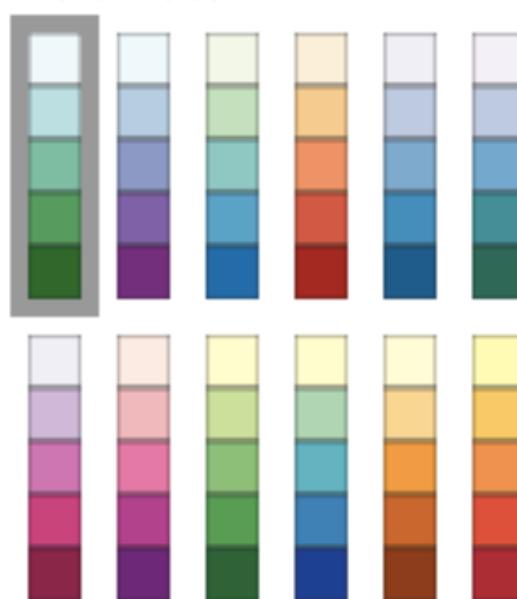
how to use | updates | downloads | credits

Nature of your data:

sequential  diverging  qualitative

Pick a color scheme:

Multi-hue:



Single hue:



Only show:

- colorblind safe
- print friendly
- photocopy safe

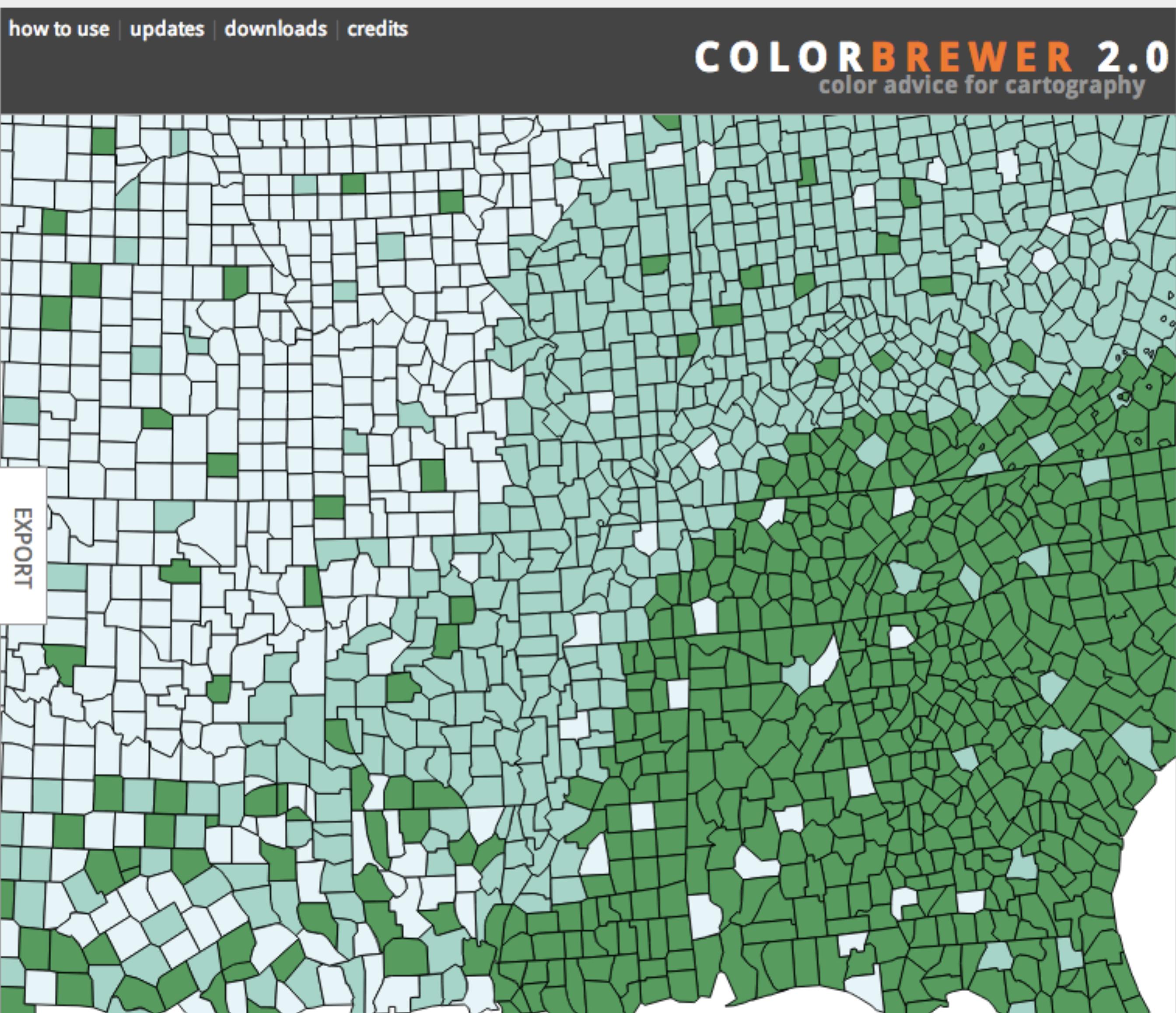
Context:

- roads
- cities
- borders

Background:

- solid color
- terrain

color transparency



© Cynthia Brewer, Mark Harrower and The Pennsylvania State University  
Support

axismaps

<http://colorbrewer2.org/>

Generate
  

  
**Number of colors**  

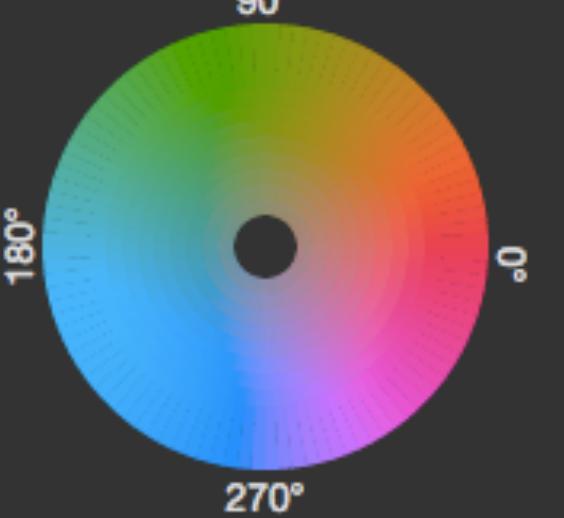
  
**Score importance**  

Perceptual Distance

Name Difference

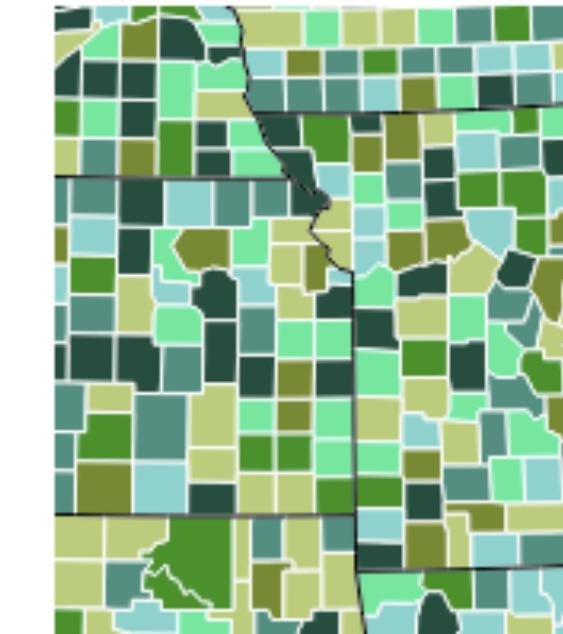
Pair Preference

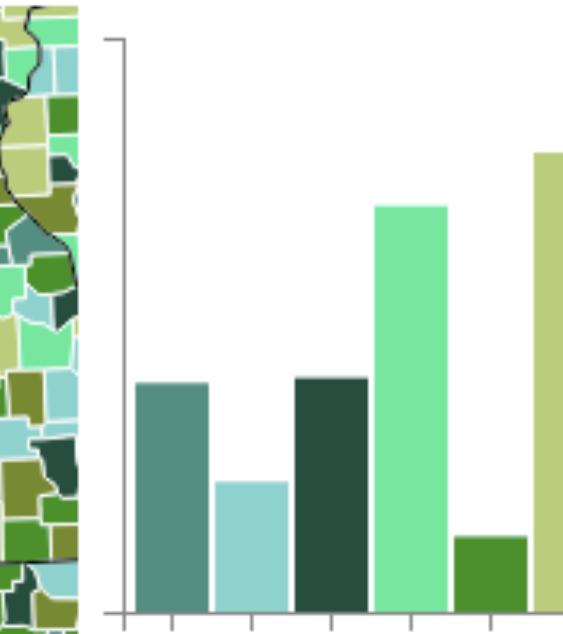
Name Uniqueness

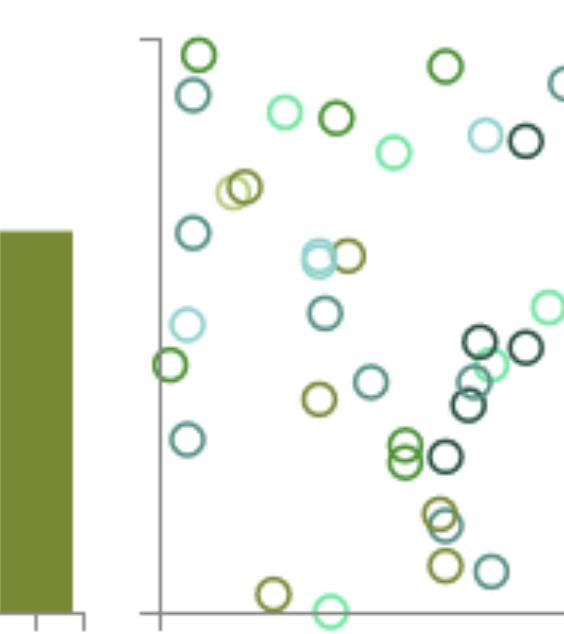
  
**Select hue filters**  


Drag wheel, or add angle:  
 to  +

Results: Color space Hex RGB Lab LCH Array format " ' No quote Charts  Clear all







## Instructions

To generate a palette with  $n$  colors, just enter the number of colors you want and click Generate. Bigger palettes will take longer than smaller palettes to make. Results will automatically appear when ready.

For greater detail, please consult our [paper](#) or the [source code](#).

### Score Importance

#### Perceptual Distance

Increasing *Perceptual Distance* favors palette colors that are more easily discriminable to the human eye. To accurately model human color acuity, this is performed using [CIEDE2000](#) in [CIE Lab](#) color space.

#### Name Difference

Increasing *Name Difference* favors palette colors that share few common names. This is similar to perceptual distance, but can lead to different results in certain areas of color space. This happens when there are many different names for perceptually close colors (e.g., red and pink are perceptually close but named differently). Colorgorical calculates this using Heer and Stone's [Name Difference](#)

## About

Colorgorical was built by Connor Gramazio with advisement from David Laidlaw and Karen Schloss.

## Documentation

If you'd like to read more about how Colorgorical works, please read our paper [here](#). If you're curious about the implementation, please see the Colorgorical GitHub repository located [here](#).

If you use Colorgorical, please use the following citation:

```
@article{gramazio-2017-ccd,
  author={Gramazio, Connor C. and Laidlaw, David H. and Schloss},
  journal={IEEE Transactions on Visualization and Computer Graph},
  title={Colorgorical: creating discriminable and preferable co},
  year={2017}
}
```

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

View

All Themes

Most Popular

Week Month All

Most Used

Random

Search



QB Studio

550 413 0



Modern Executive

343 188 0



Copy of A Creati...

197 128 0



Warm

107 97 0



MY GL

65 75 0



Pastel Range

85 83 0



Copy of CC02

273 242 0



Summer Beach

140 136 1



Annie Colour Sc...

135 115 0



Man Pink

104 92 0



Copy of Capri

58 74 0



Efendi

90 70 0



Deep Under the...

218 188 0



friends

146 130 0



HAI IN THE SEA

158 105 1



Copy of Close to...

123 88 1

kuler.adobe.com/explore/

**51%**



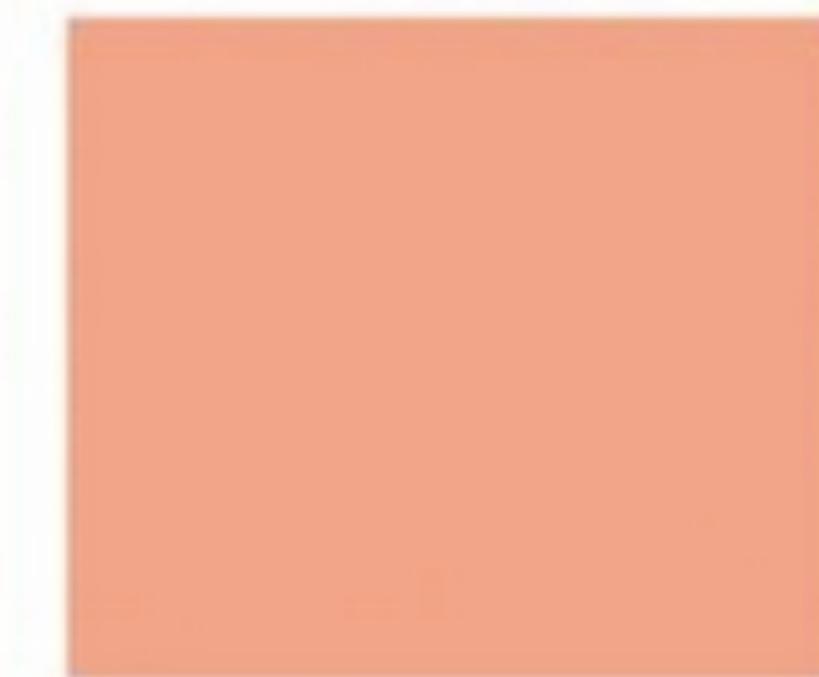
**40%**



**29%**



**21%**



**16-19**

**20-23**

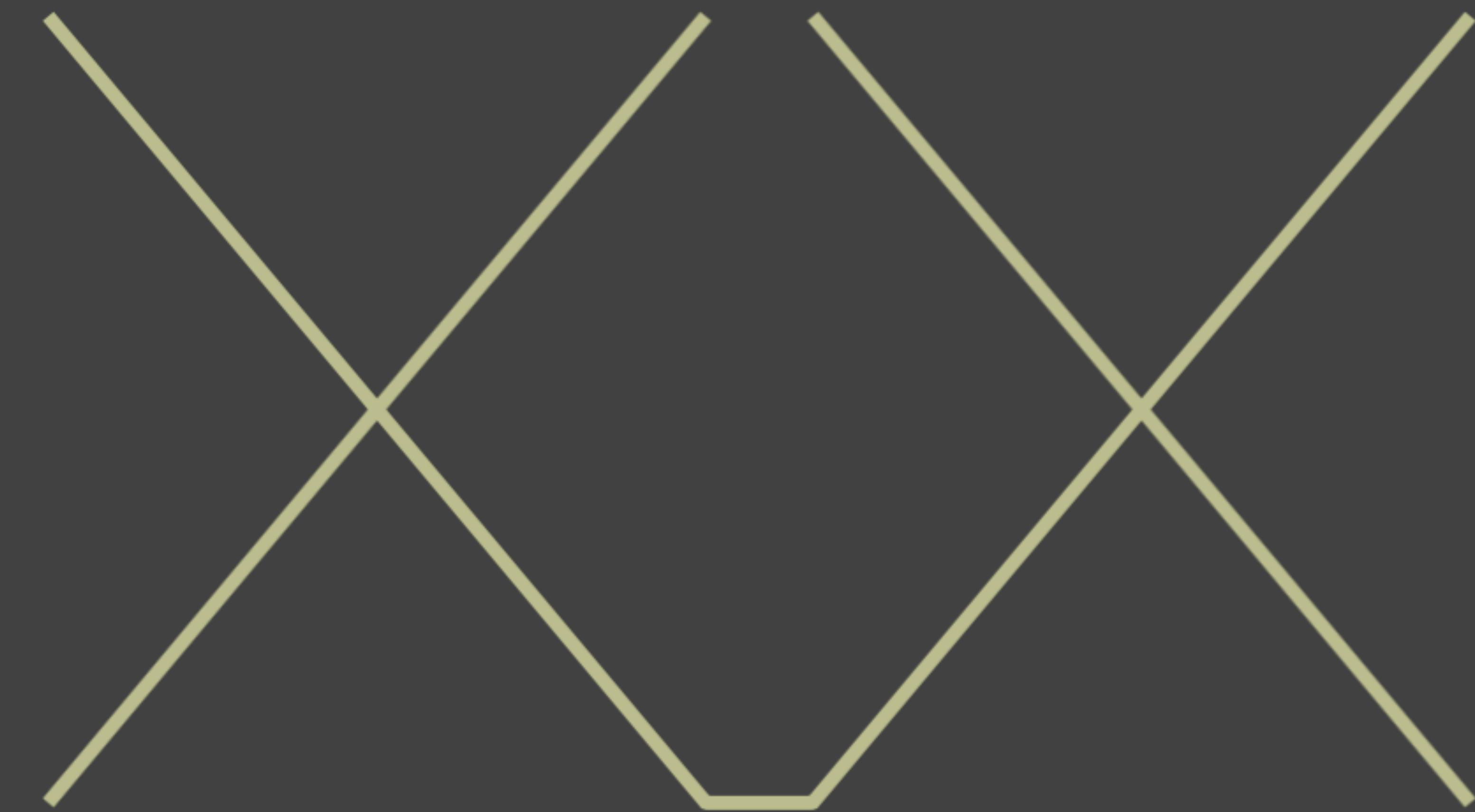
**24-29**

**early  
30s**



Color  
Caveats





# Contrast

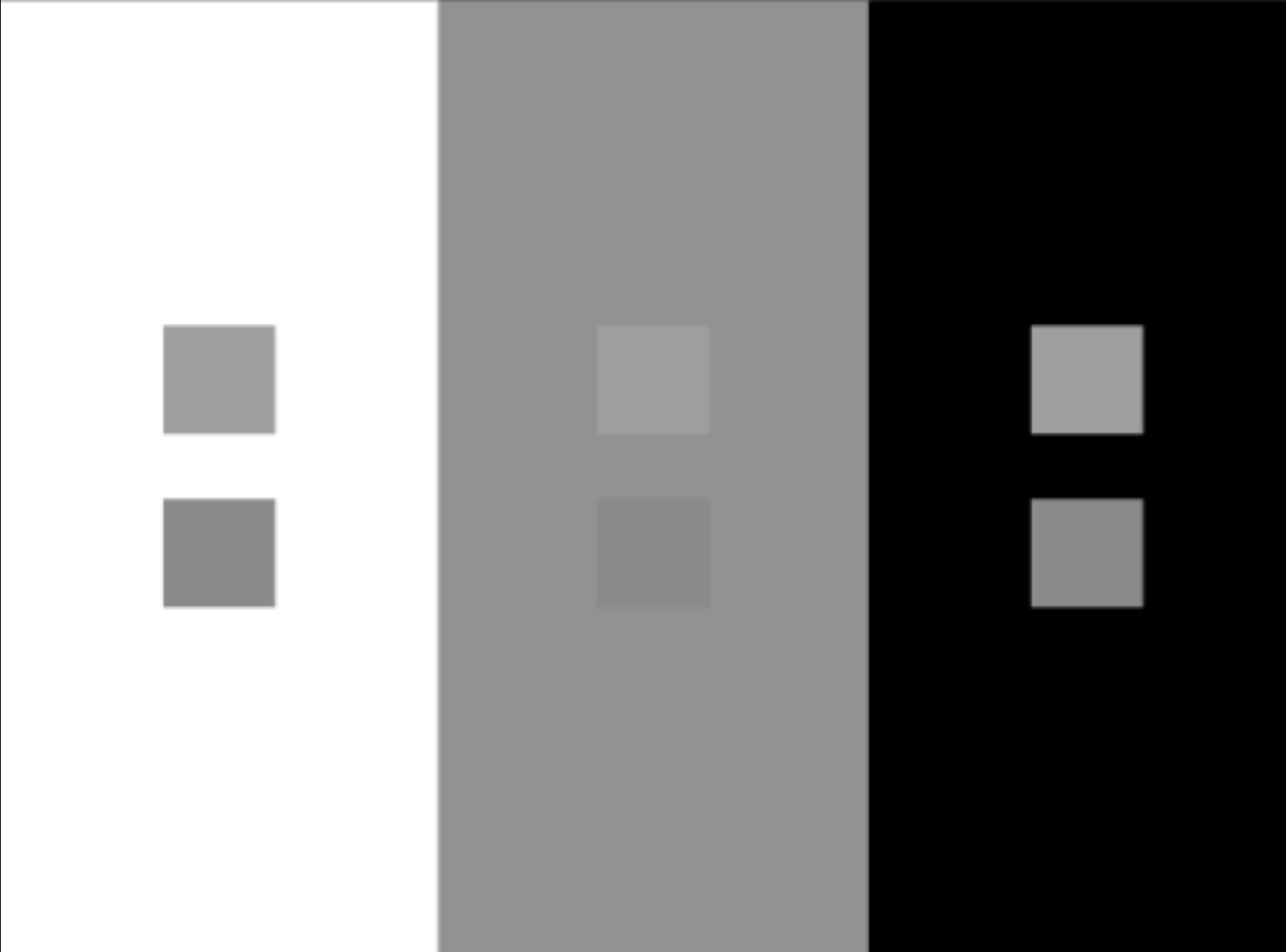
# Effects



A field guide to Digital Color, Maureen Stone

*Bezold*

*Effect*



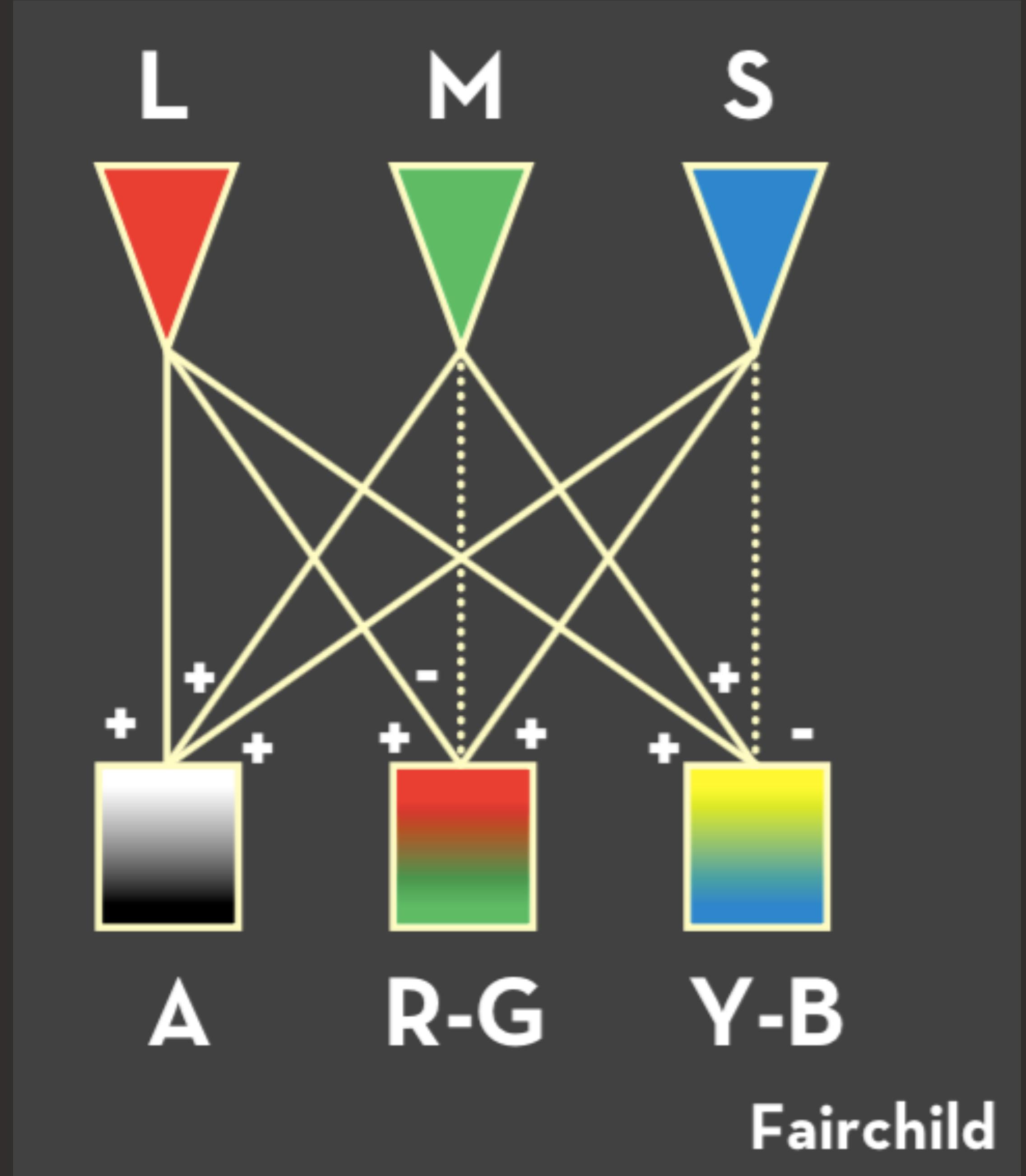
“Crispening”

Legibility and readability are very important

*Color*  
*Blindness*

# Remember?

Long  
Middle  
Short

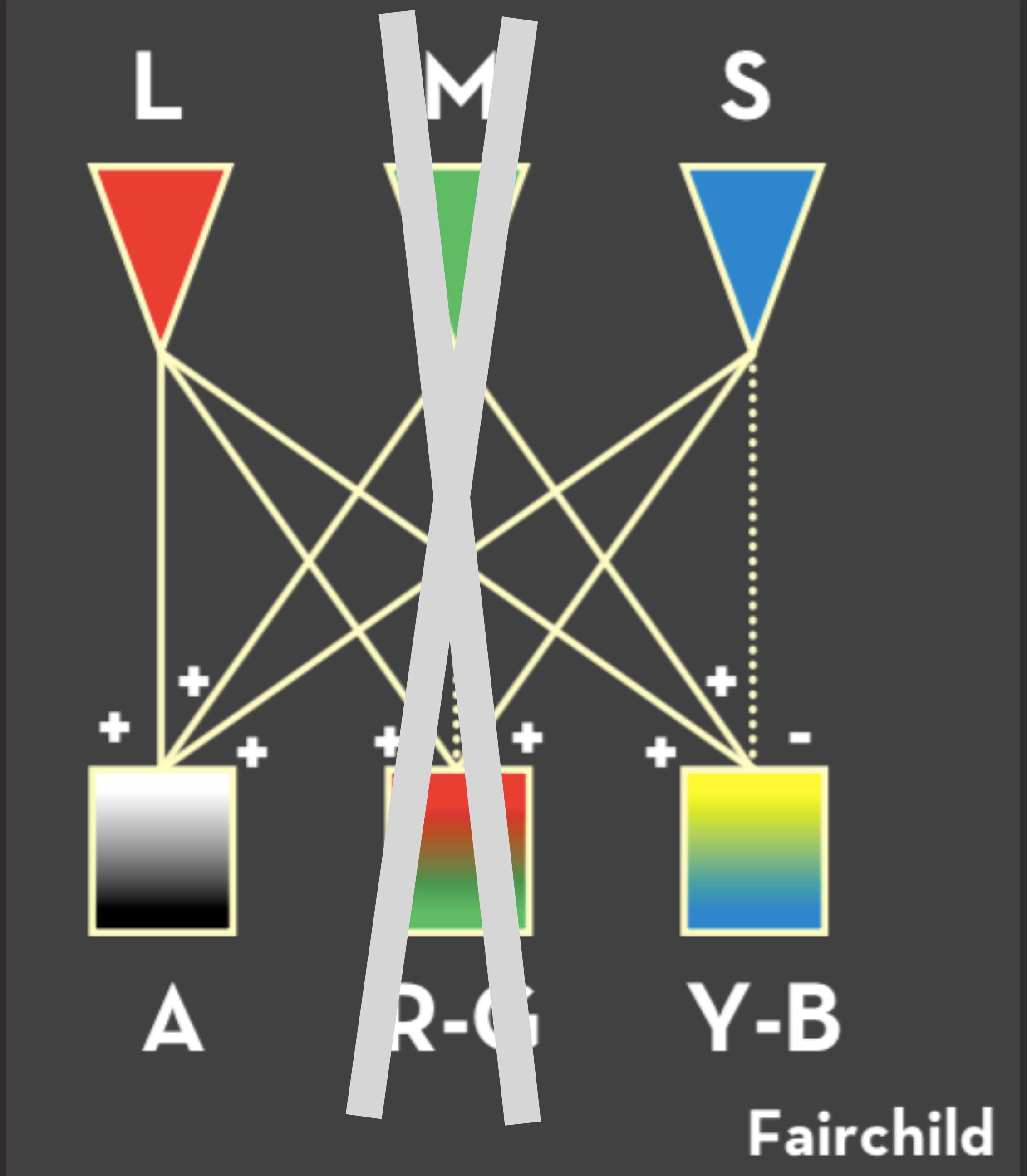


# What if you're missing medium cones?

Long

Middle

Short



# Colorblindness Types

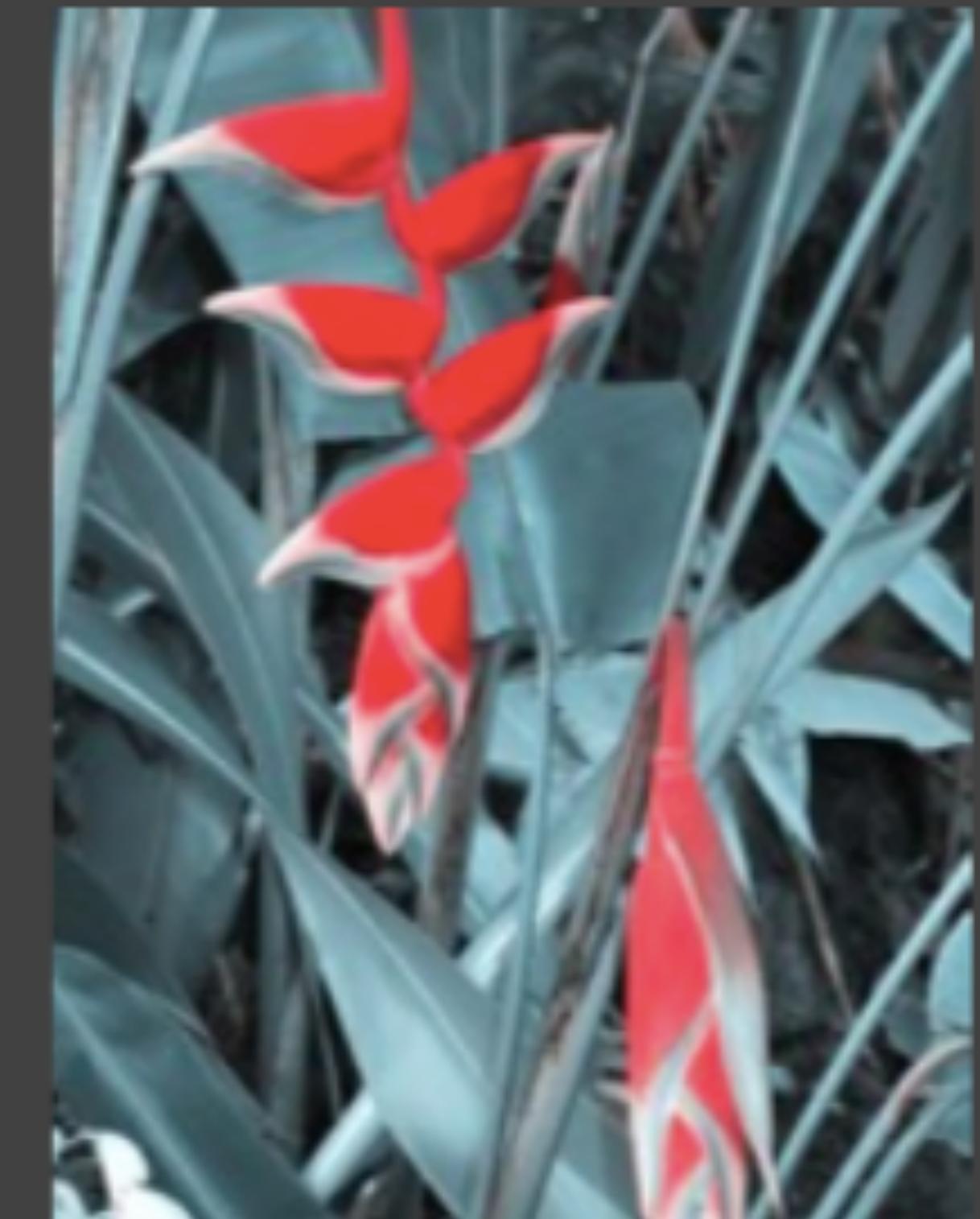
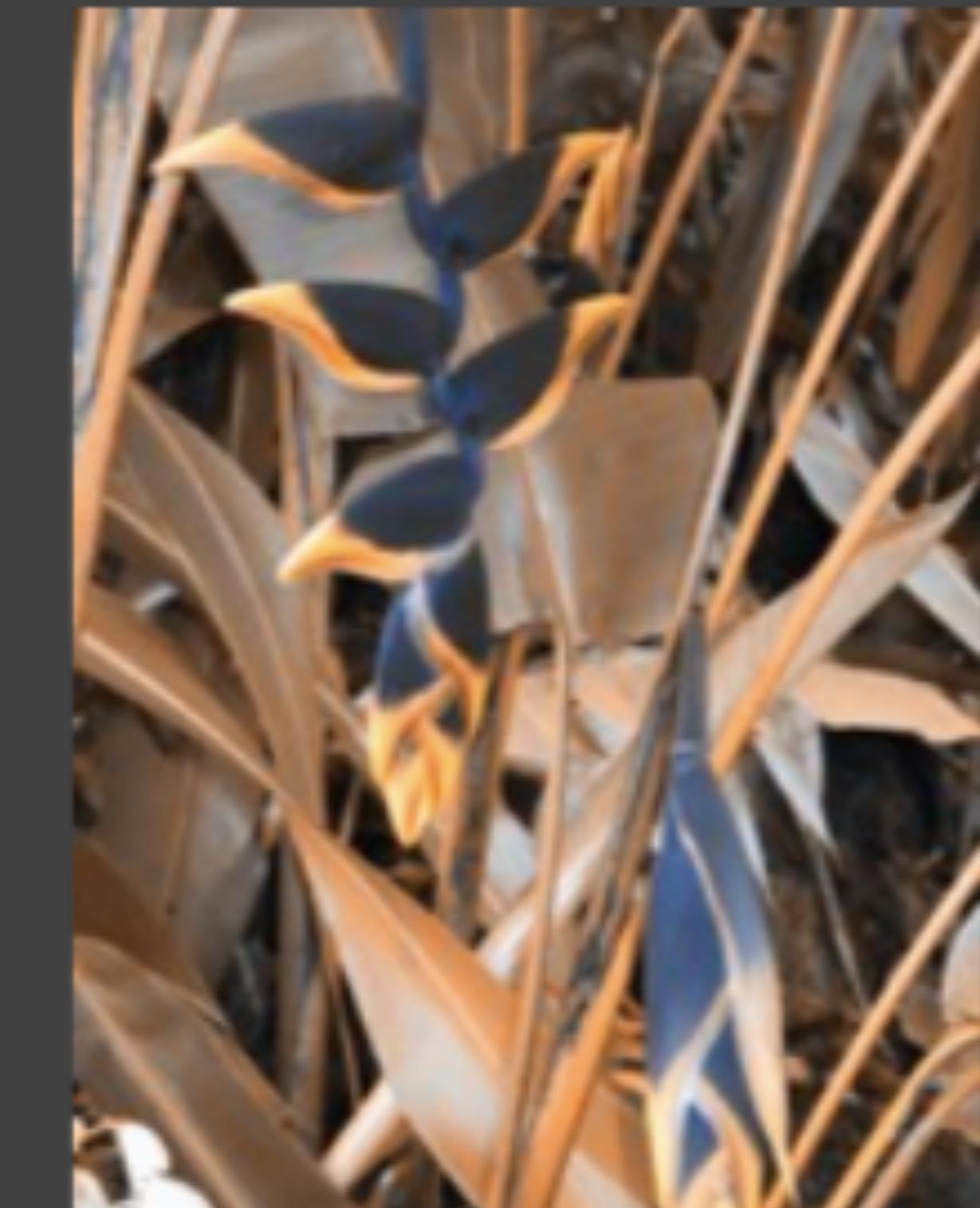
normal



red-green



yellow-blue



Deuteranope

Protanope

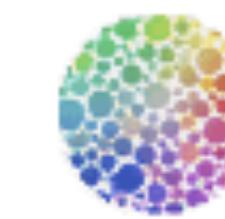
Tritanope

*Supporting*

**CB**

# Color Oracle

Design for the Color Impaired



Color Oracle is a free color blindness simulator for Window, Mac and Linux. It takes the guesswork out of designing for color blindness by showing you in real time what people with common color vision impairments will see.

Color Oracle applies a full screen color filter to art you are designing – independently of the software in use. Eight percent of all males are affected by color vision impairment – make sure that your graphical work is readable by the widest possible audience.

Read this article for more information: [Color Design for the Color Vision Impaired](#)

## Free Download

Version 1.2.1 for [Windows](#)  
Requires [Java 6 or 7](#).

Version 1.1.4 for [Mac OS X](#)  
10.4 or higher now supports  
Retina displays and OS X  
10.8 or higher.

**Important for Mac users:**  
If upon launching Color Oracle you get the error message "Color Oracle can't be opened because it is from an unidentified developer", right-click the Color Oracle icon and choose Open. Then click the "Open" button at the next dialog to launch Color Oracle. See [here](#) to permanently turn this feature off.



---

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[Daltonize](#)

[Examples](#)

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[Info & Links](#)

[FAQ](#)

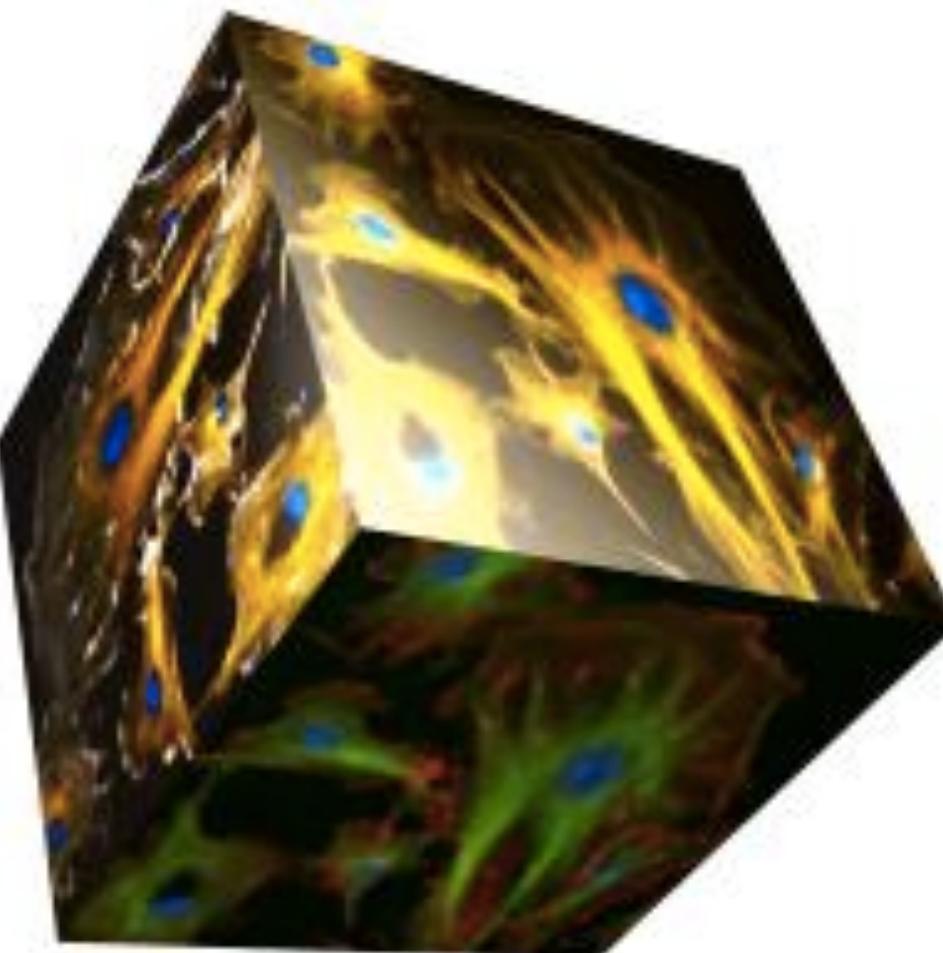
[About Us](#)

**User quotes:**

I was browsing the net looking for a program that would define colours on my computer screen when I came across your site. I am myself totally colour blind and, although I try to be patient, I find it hard work trying to explain to people what it is like. I am going to bookmark your site and send it to

**Vischeck simulates colorblind vision.**

**Daltonize corrects images for colorblind viewers.**



How do babies see the world? Visit [TinyEyes](#).



*"Good painting, good coloring, is comparable to good cooking.*

*Even a good cooking recipe demands tasting and repeated tasting while it is being followed.*

*And the best tasting still depends on a cook with taste."*

*- Josef Albers*