

Reflection session

Step 1:

In clusters (~4-6 people), take turns discussing with your neighbors what you read and what you found interesting about it.

- 7 minutes

Reflection session

Step 2:

Share some of your favorites with the rest of the class. Discuss.

(Post to Slack thread w/ links so I can show)

- 7 minutes



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

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

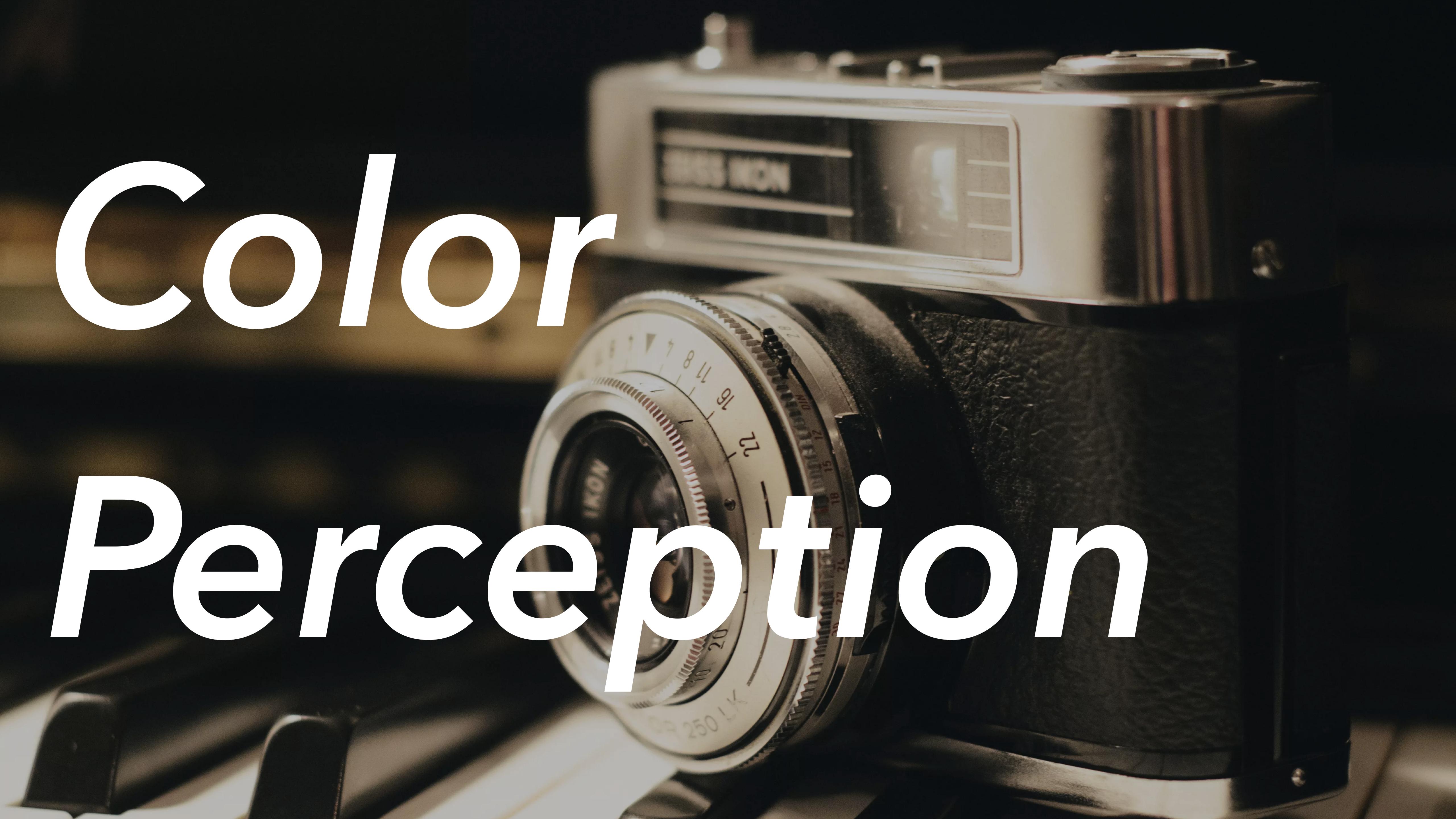
Color helps you

Engage





Color Perception



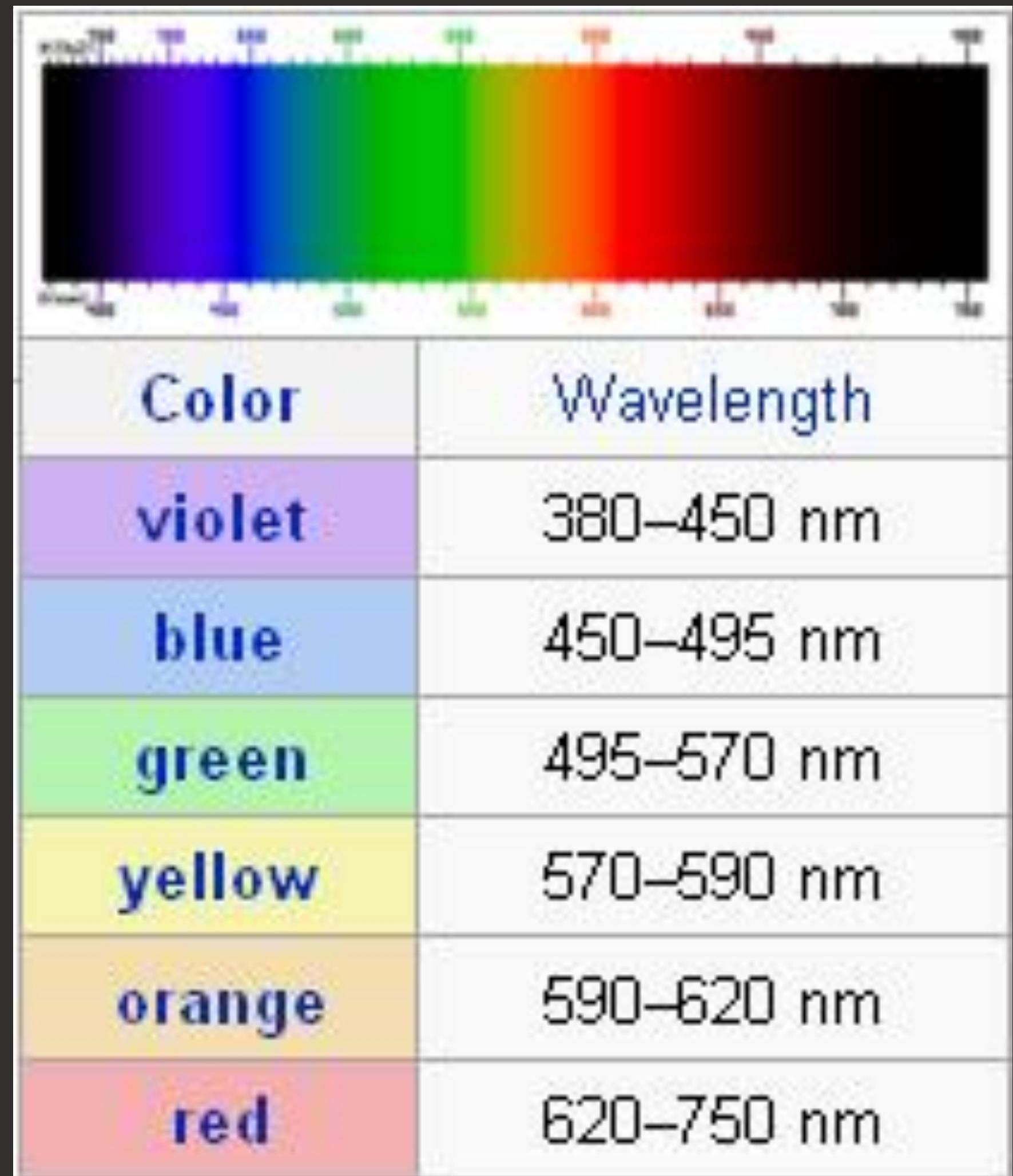
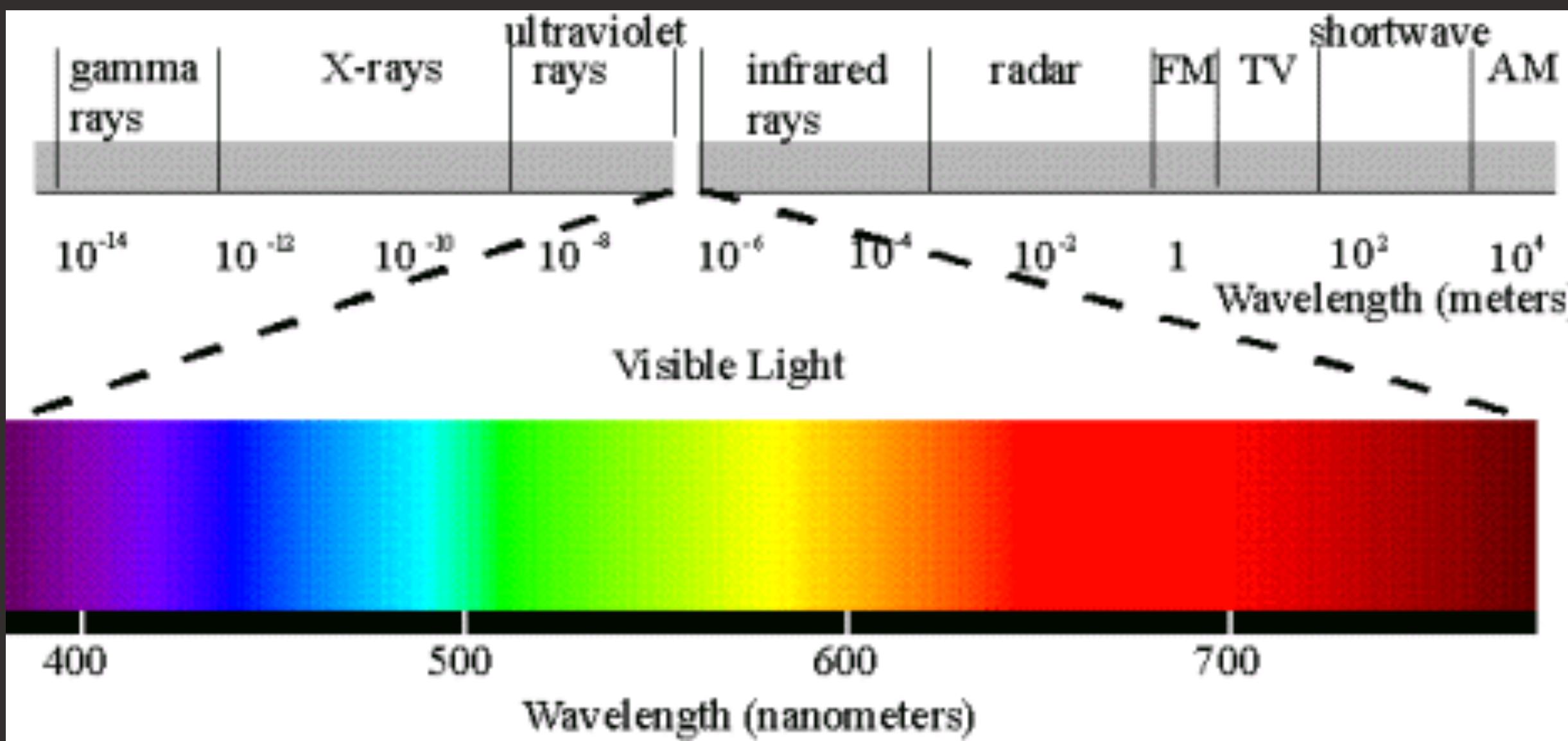
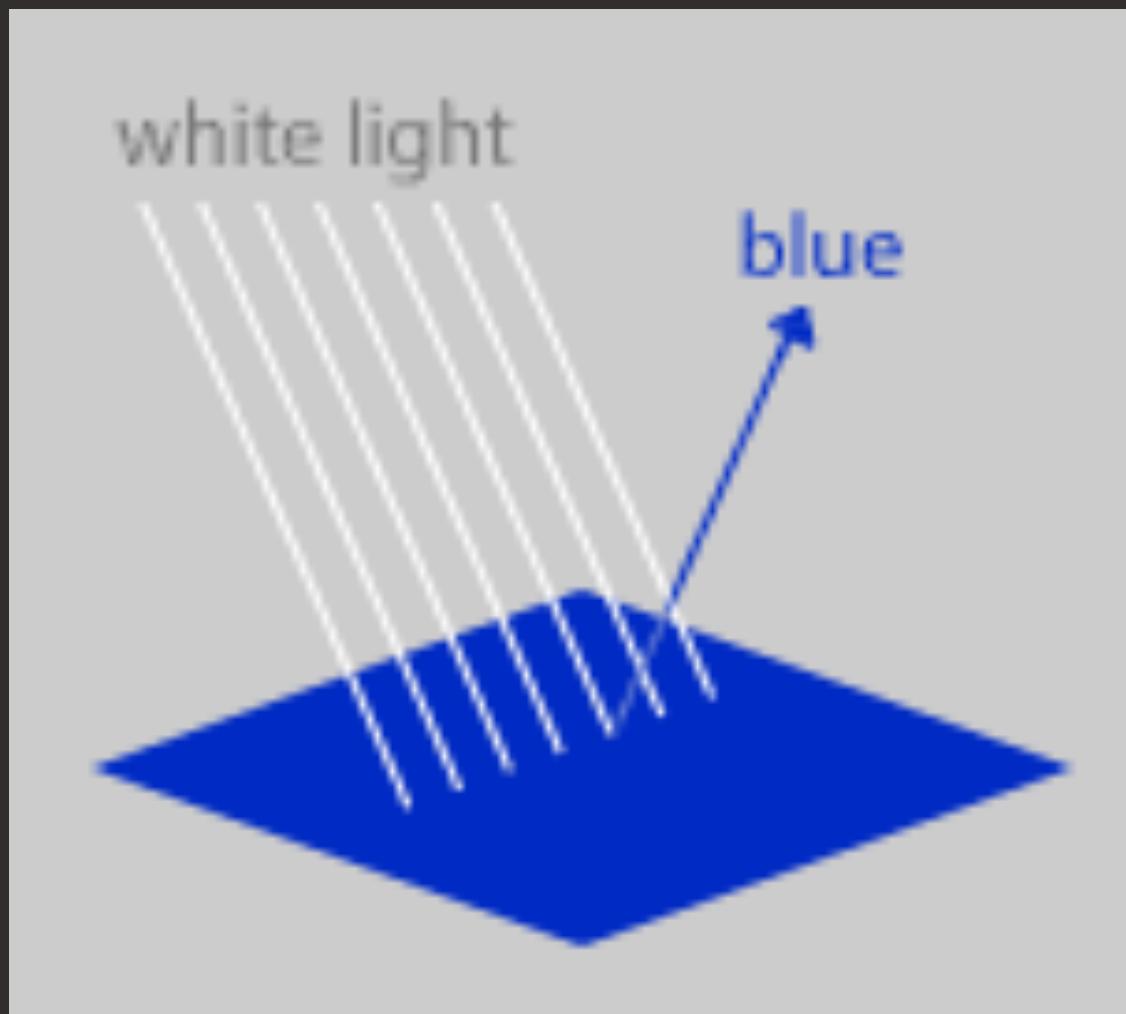
Light

Eyes

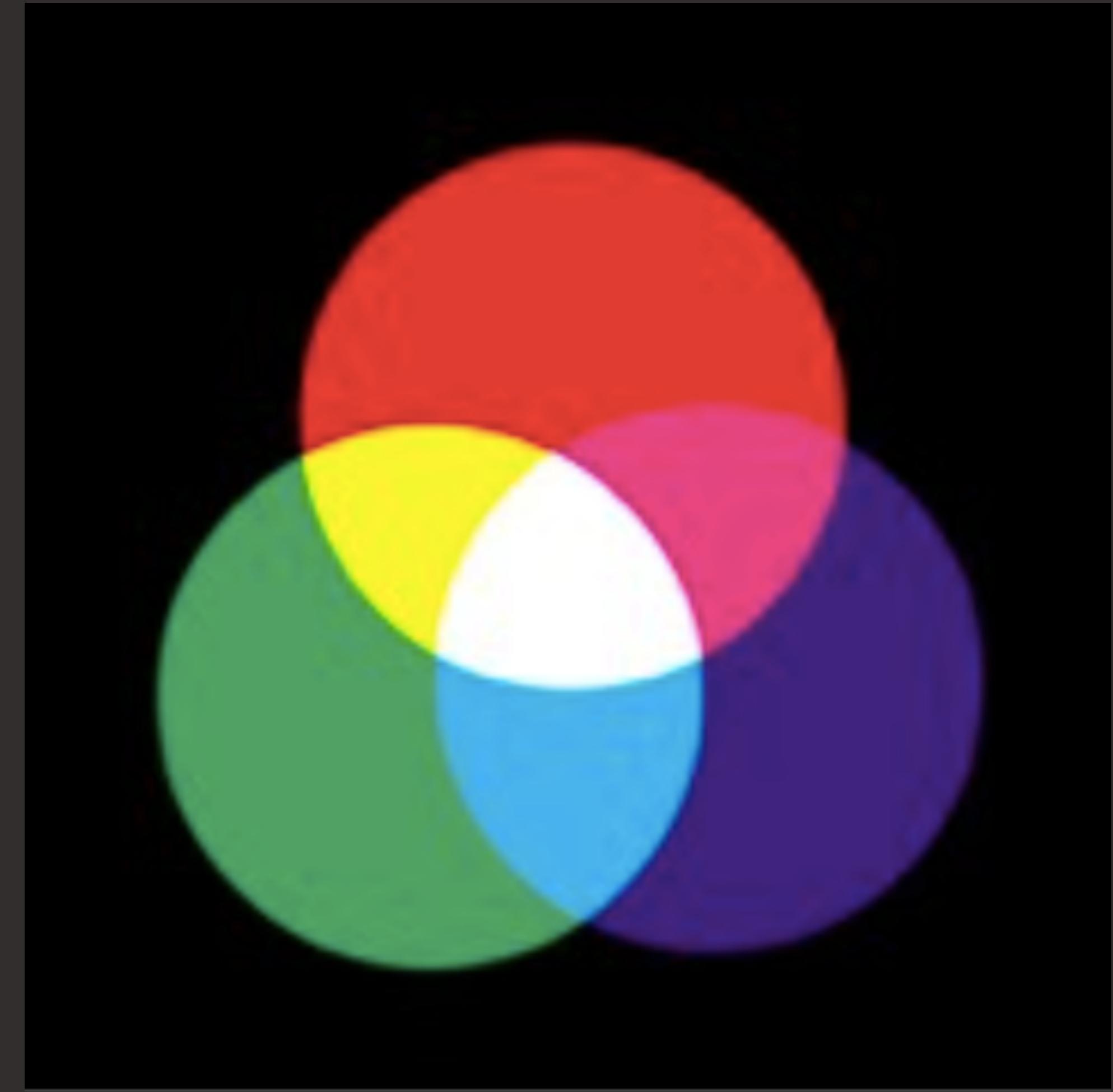
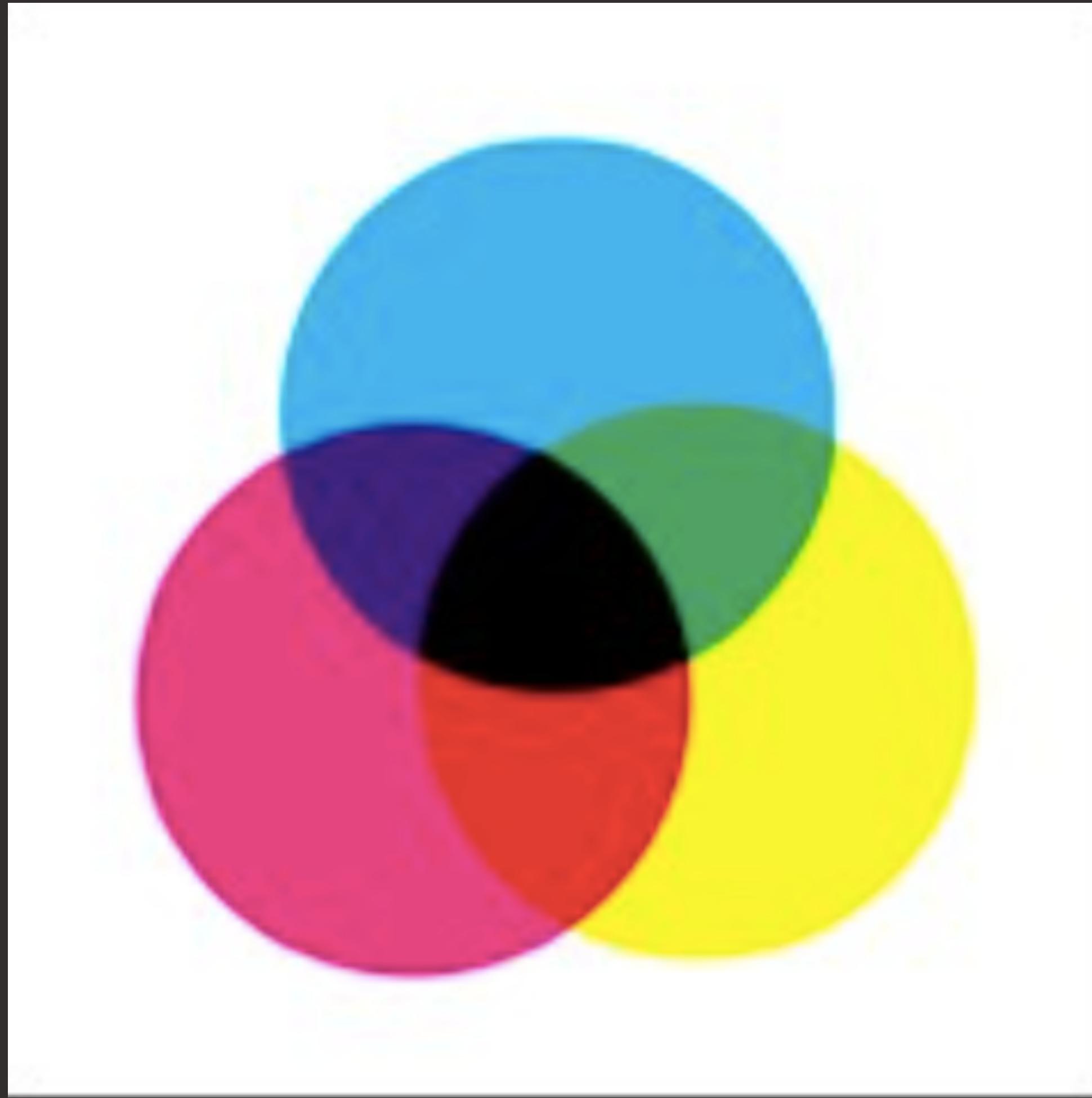
Mind

Light

Light



Light + color “types”



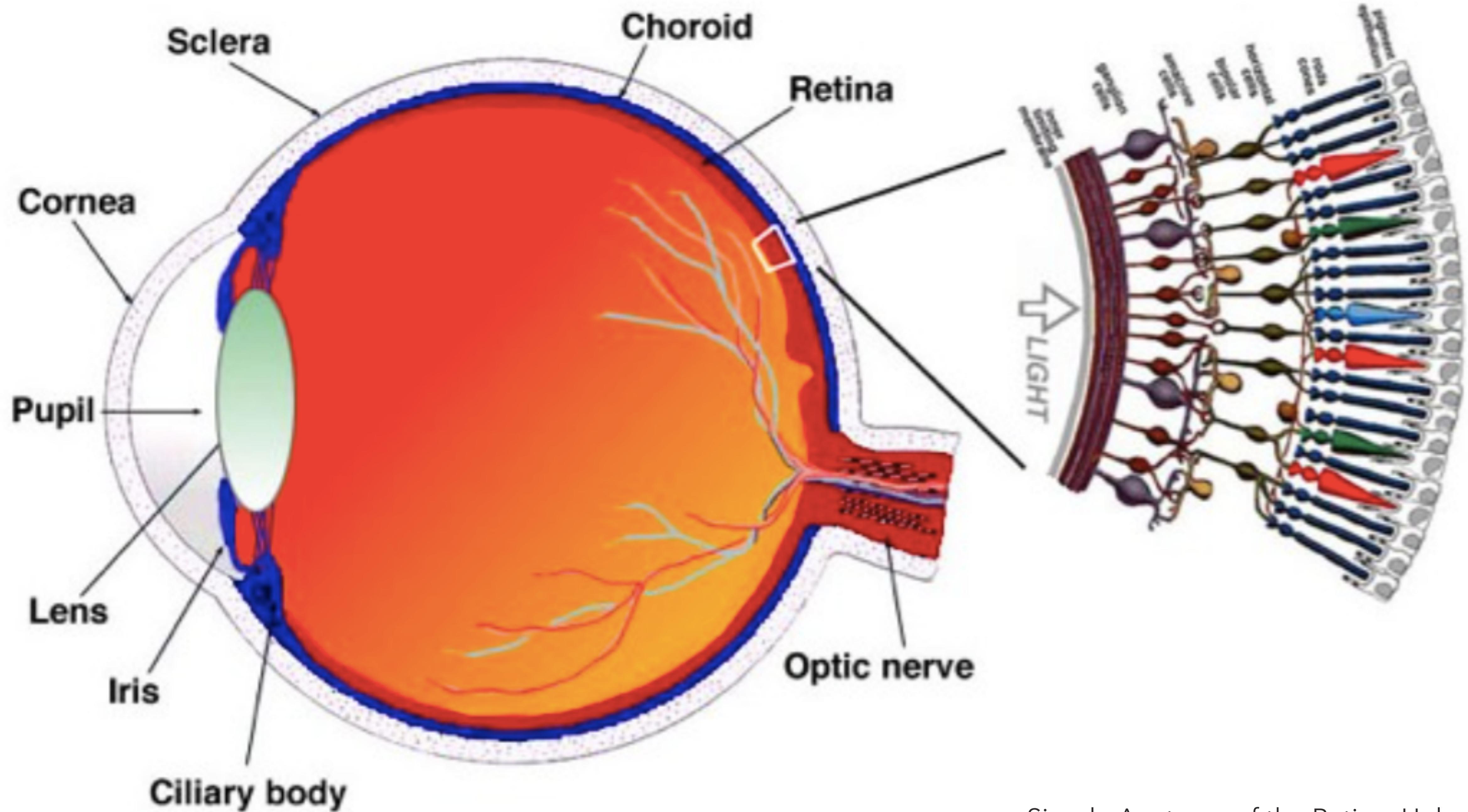
Subtractive



Additive



Eyes



Simple Anatomy of the Retina, Helga Kolb

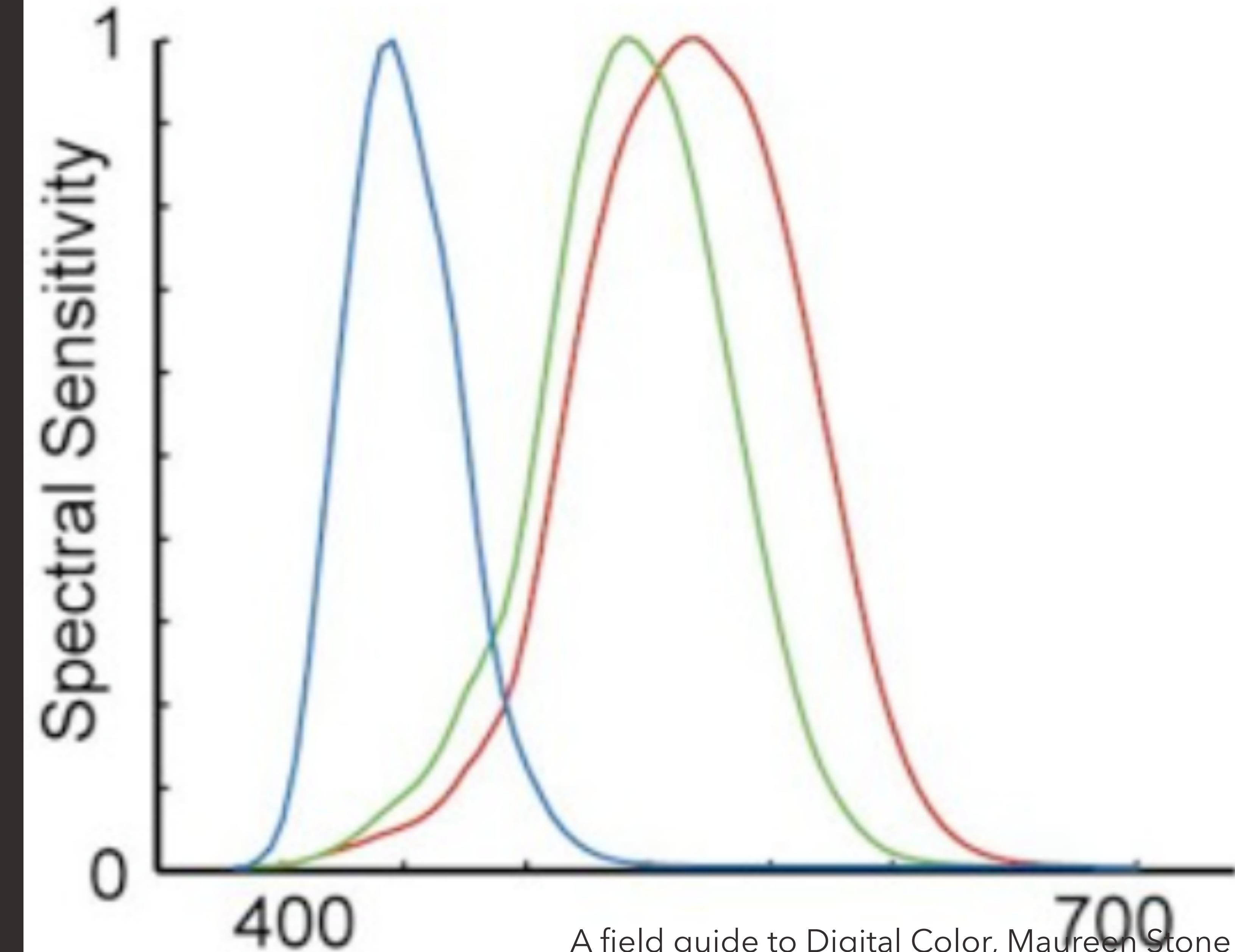
Cones

Long

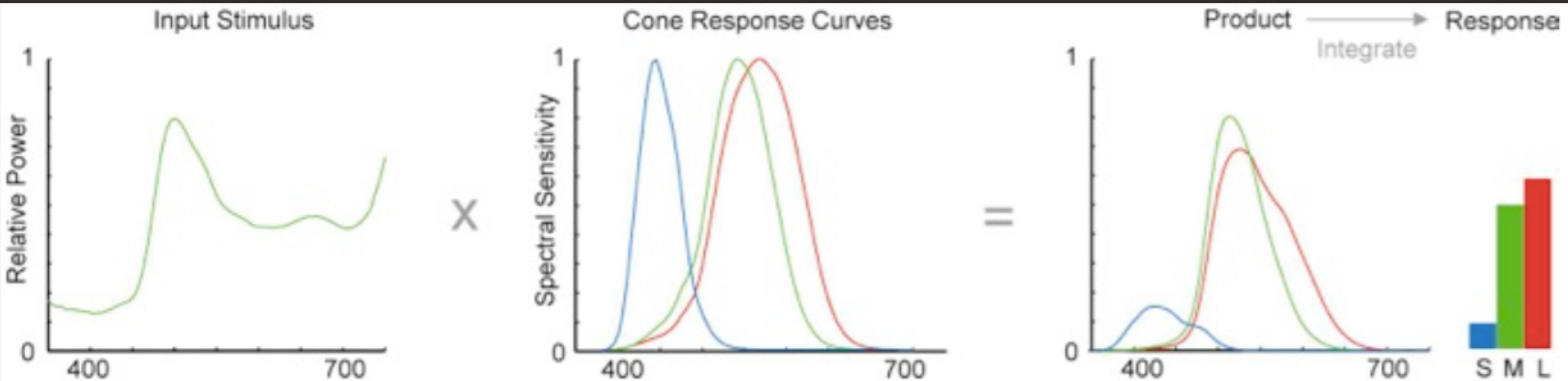
Middle

Short

Cone Response Curves

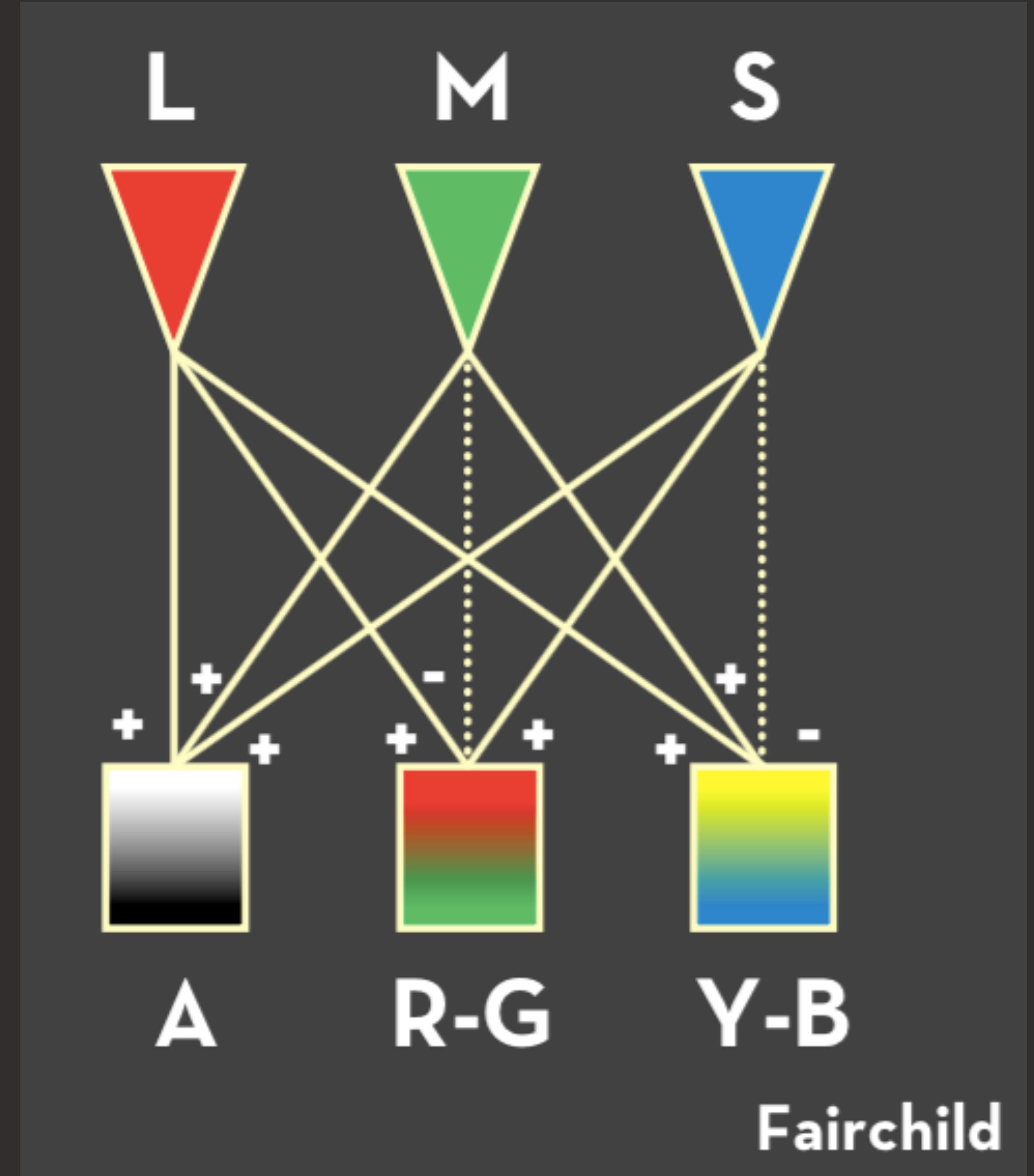


Integration



"Opponent Processing"

Long
Middle
Short

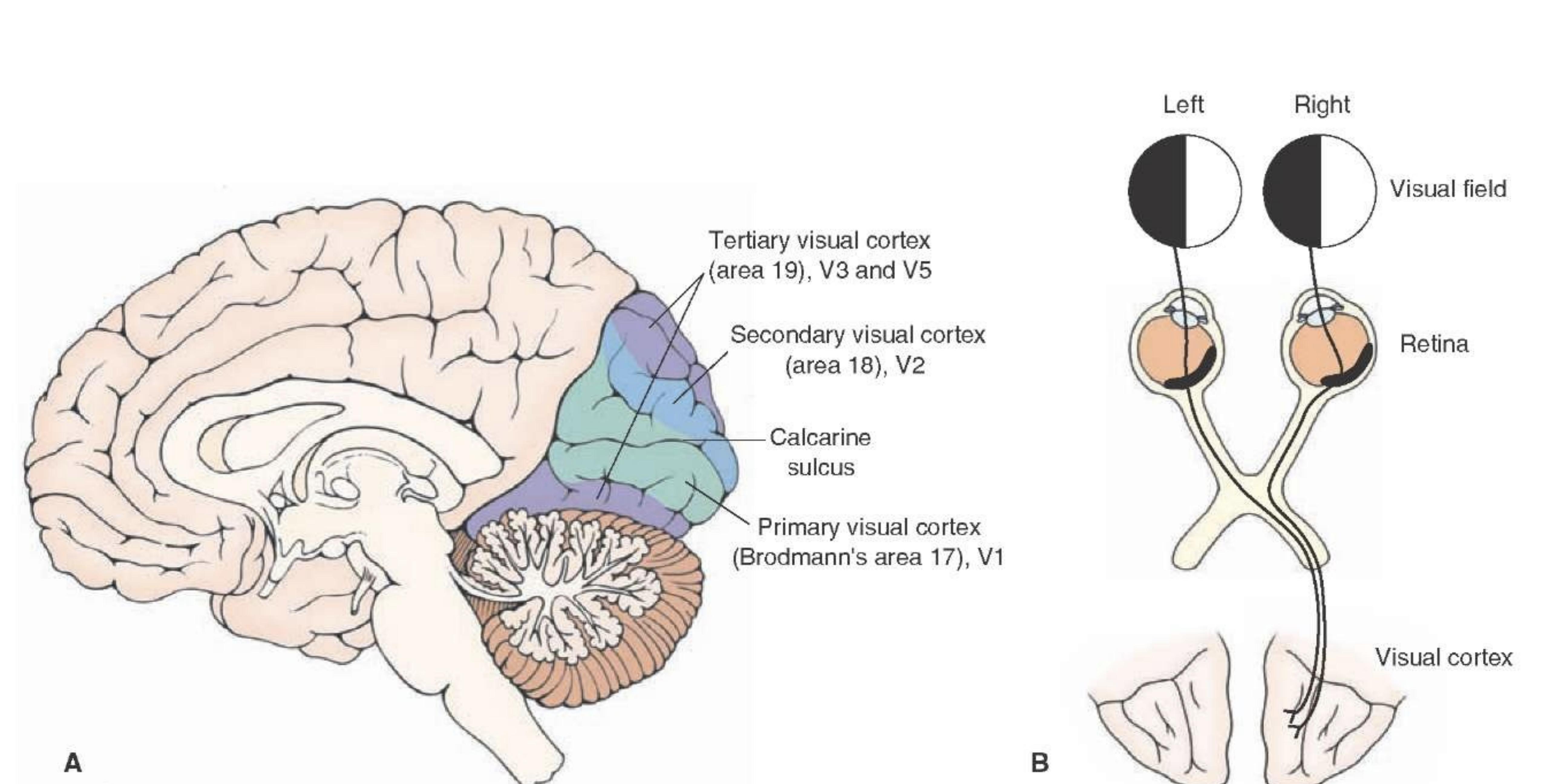


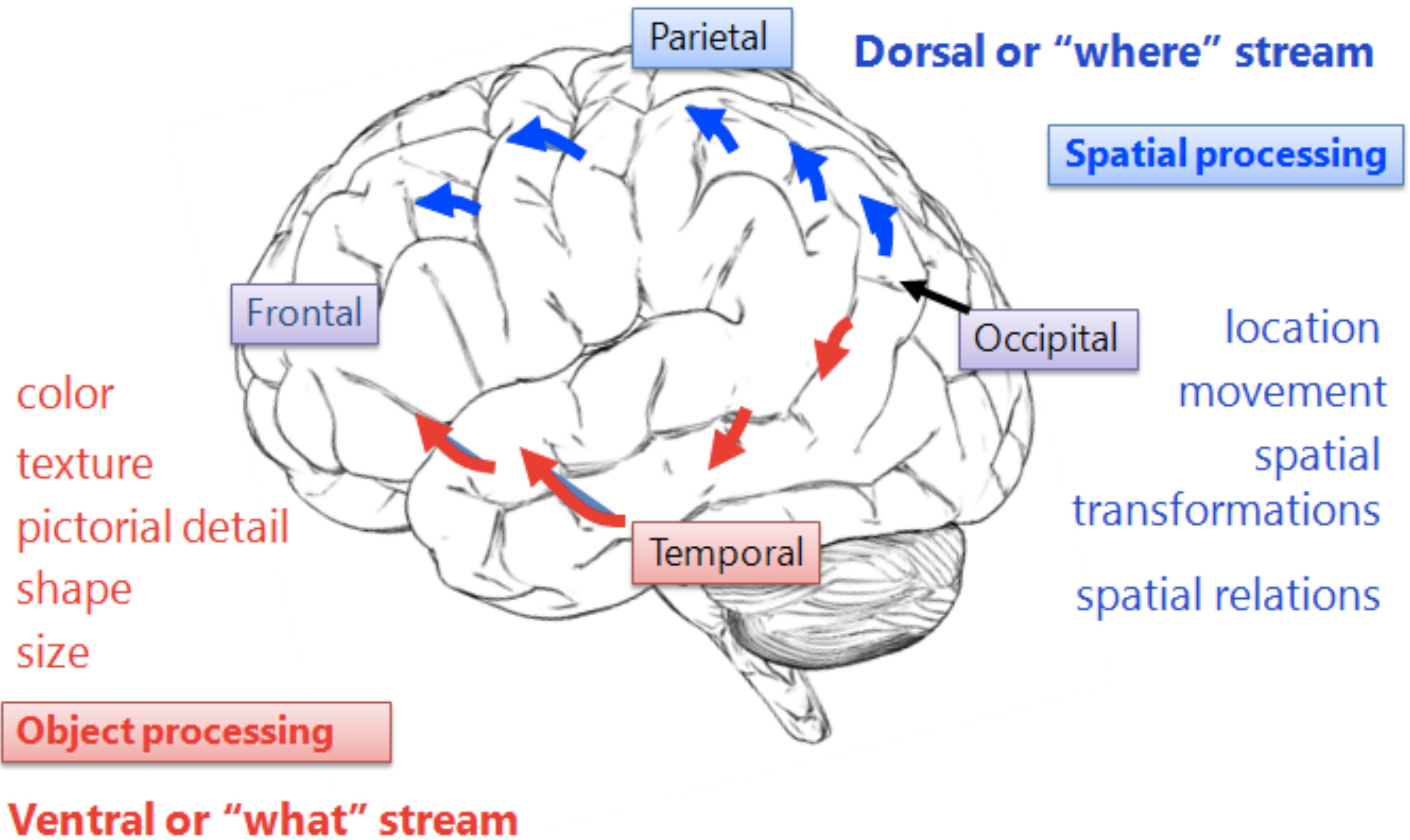
Mind

What color...





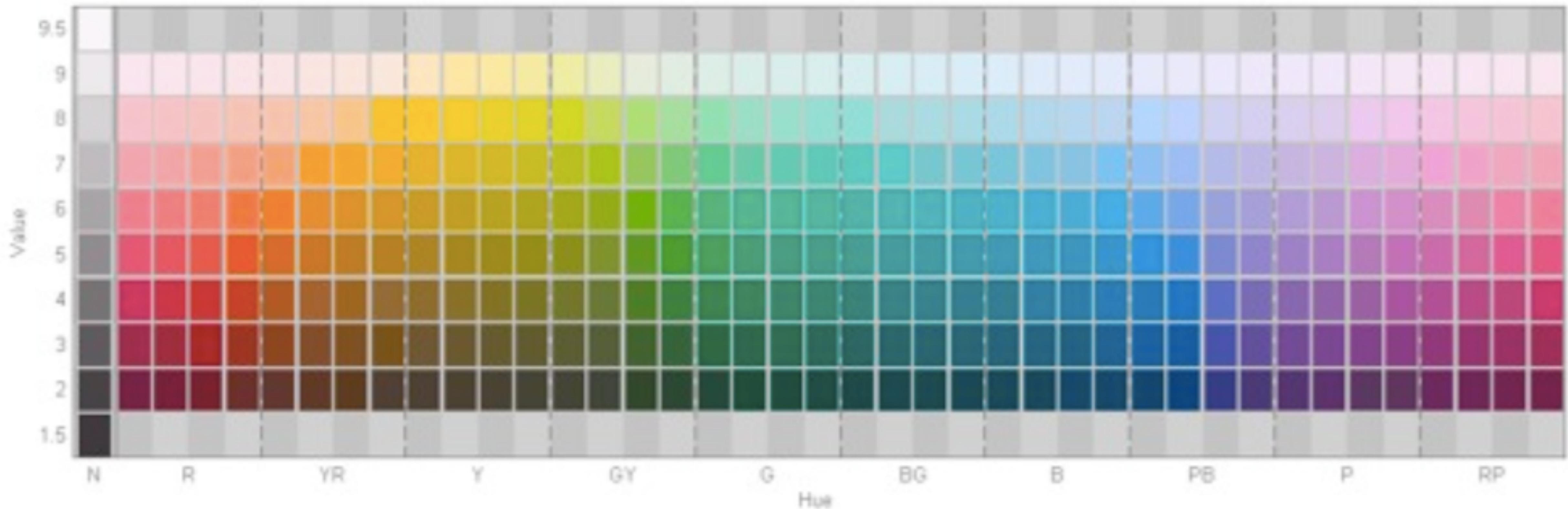




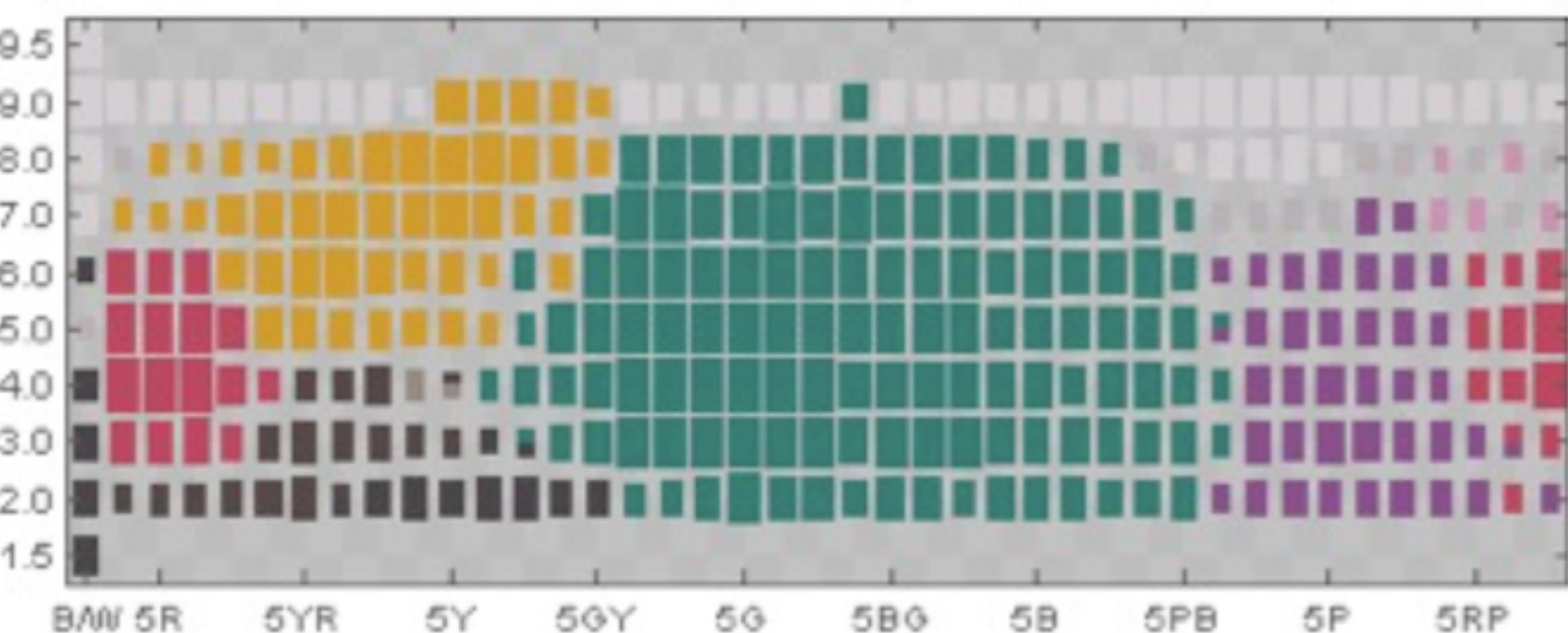
*Color is
perceptual
AND cognitive*

*World color
survey*

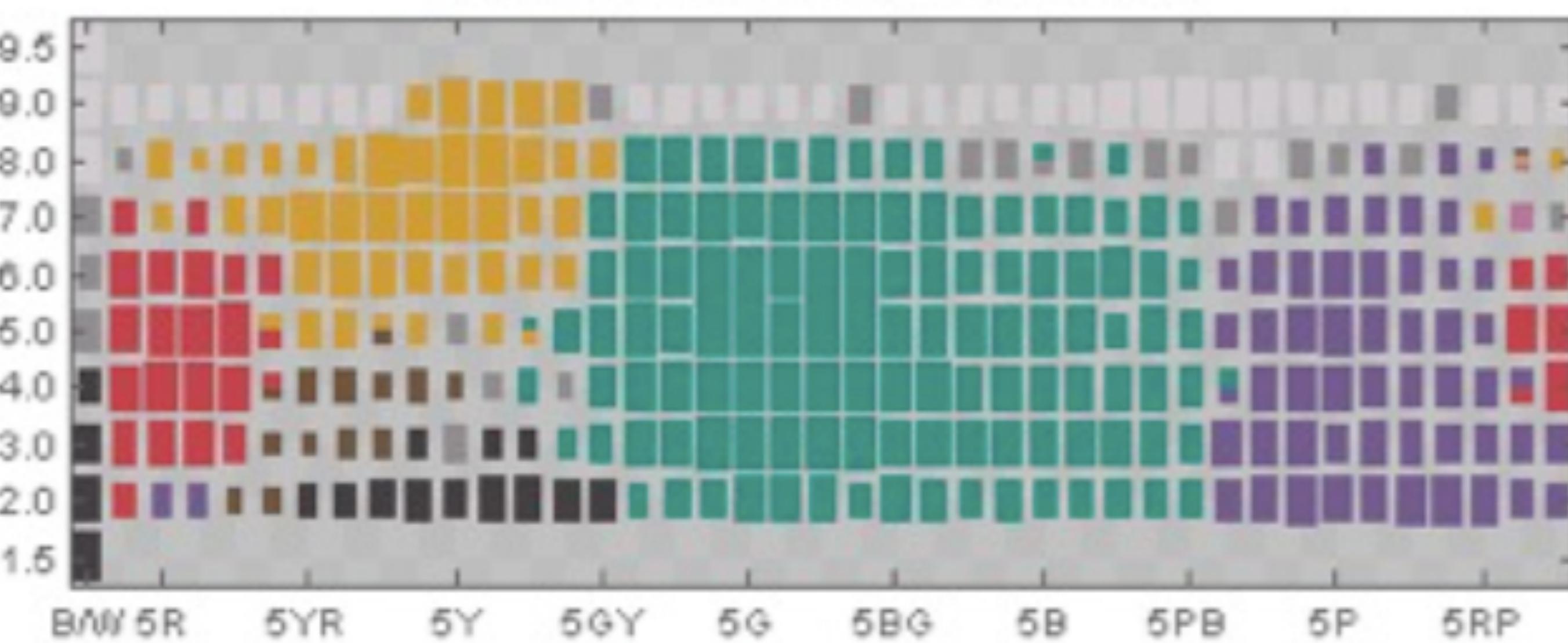
How do people around the world name these colors?



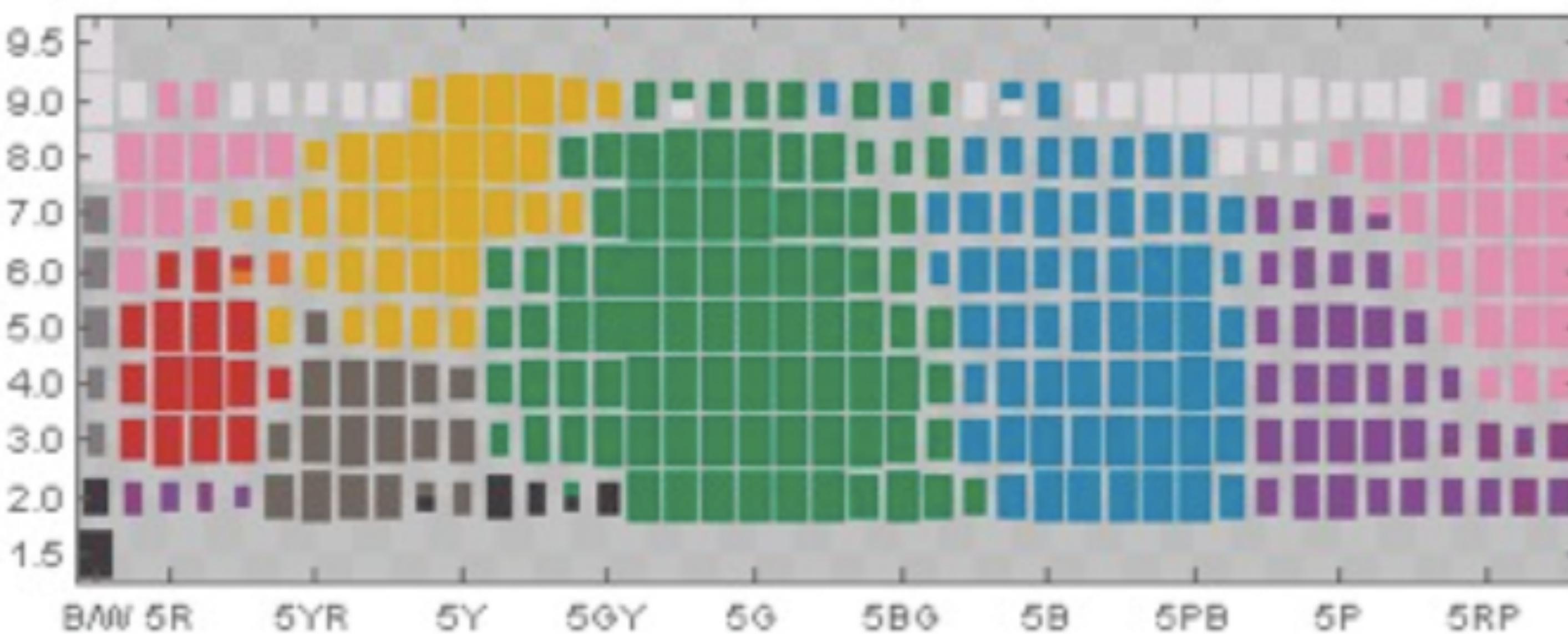
Language #72 (Modeco)
Mutual info = 0.942 / Contribution = 0.476



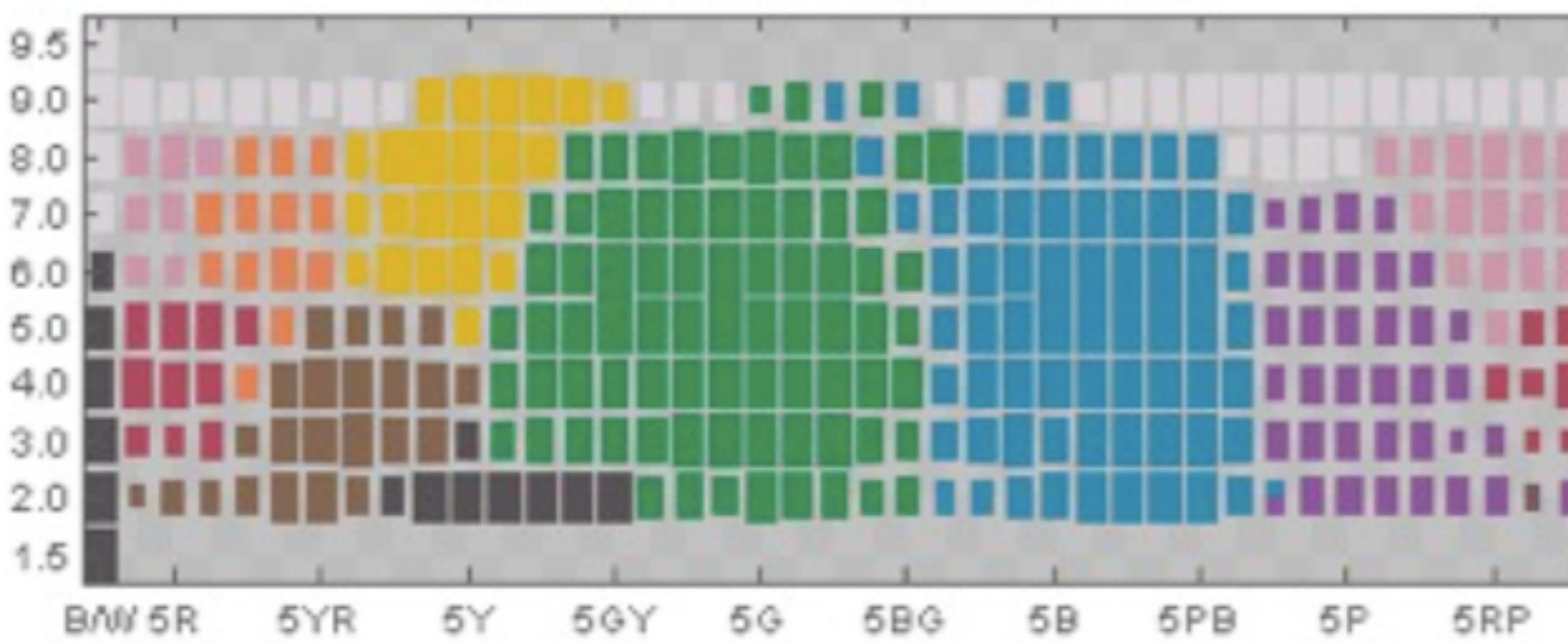
Language #98 (Tlapaneco)
Mutual info = 0.942 / Contribution = 0.524



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

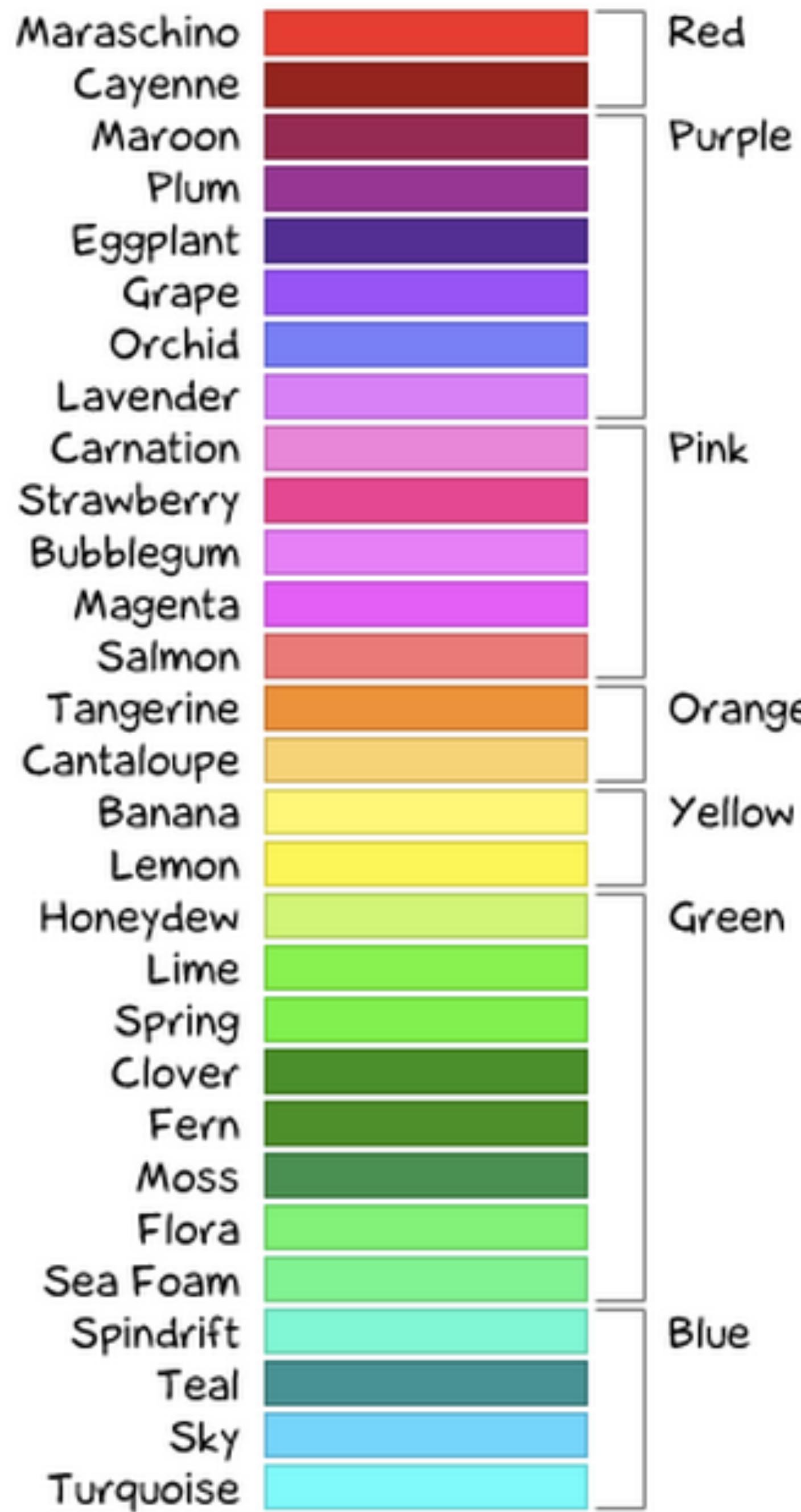


Language #24 (Chavacano)
Mutual info = 0.939 / Contribution = 0.513

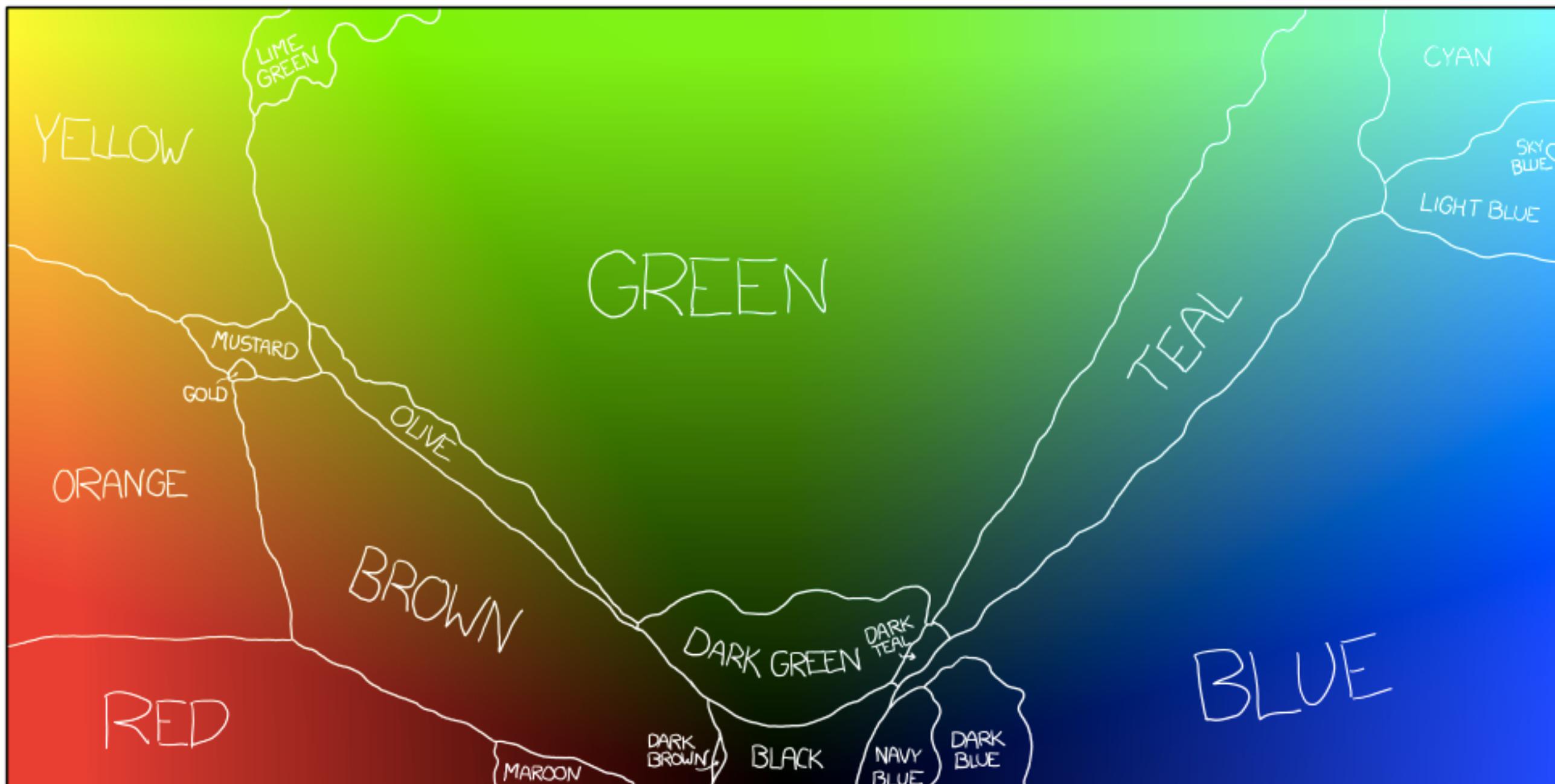


*Slightly less
scientific...*

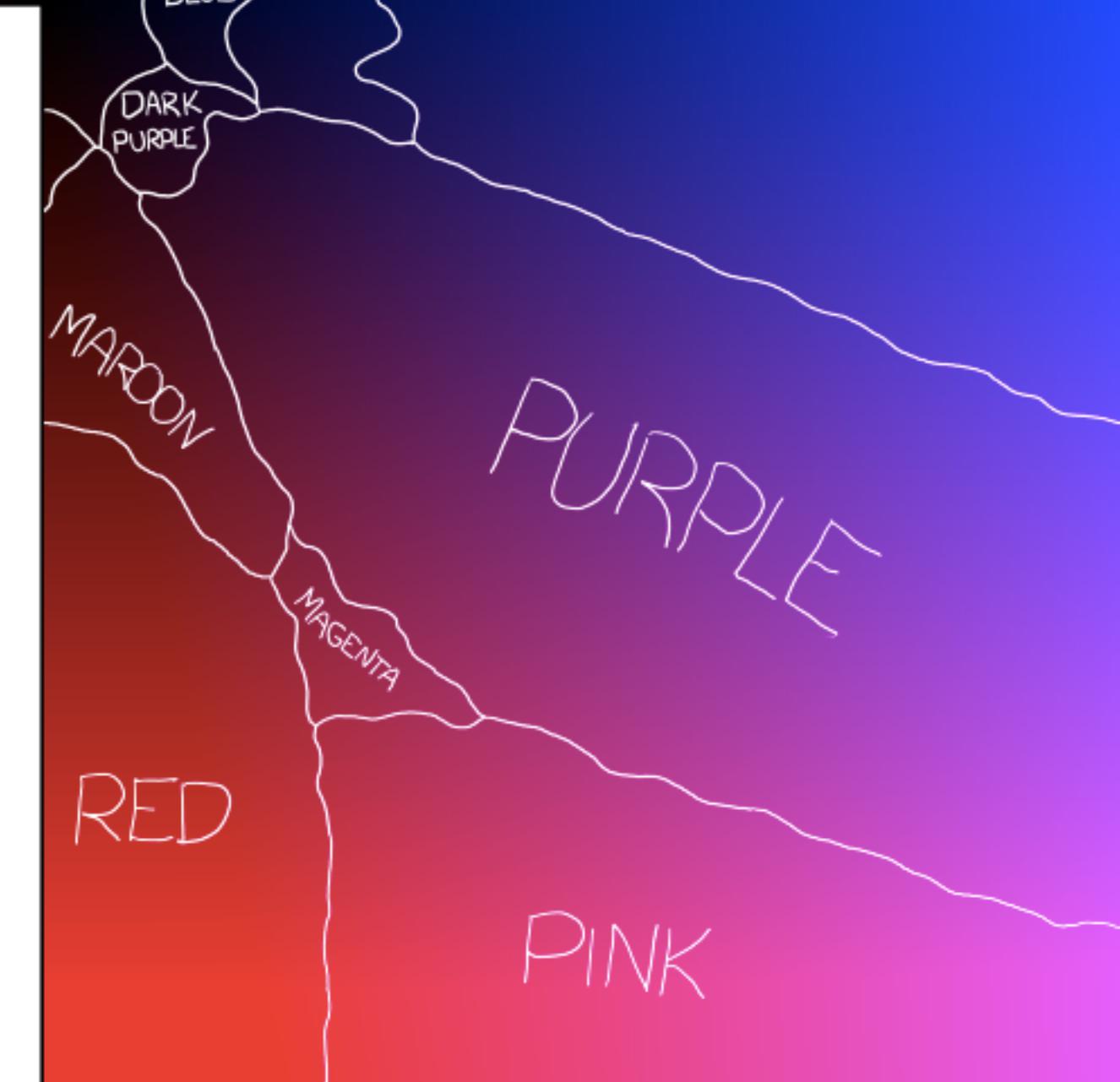
Color names if
you're a girl...



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

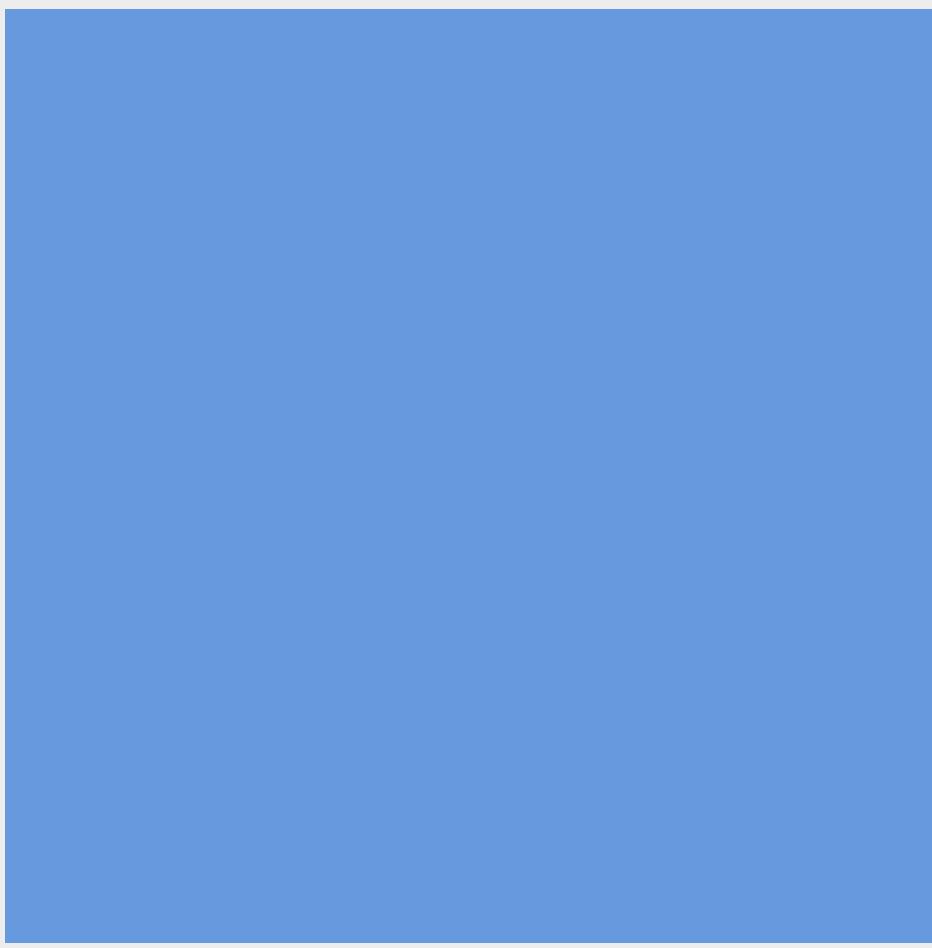
rgb



rgb



-5%



+5%



*good for
machines*

*good for
people*

rgb

hsv



Lightness



Hue



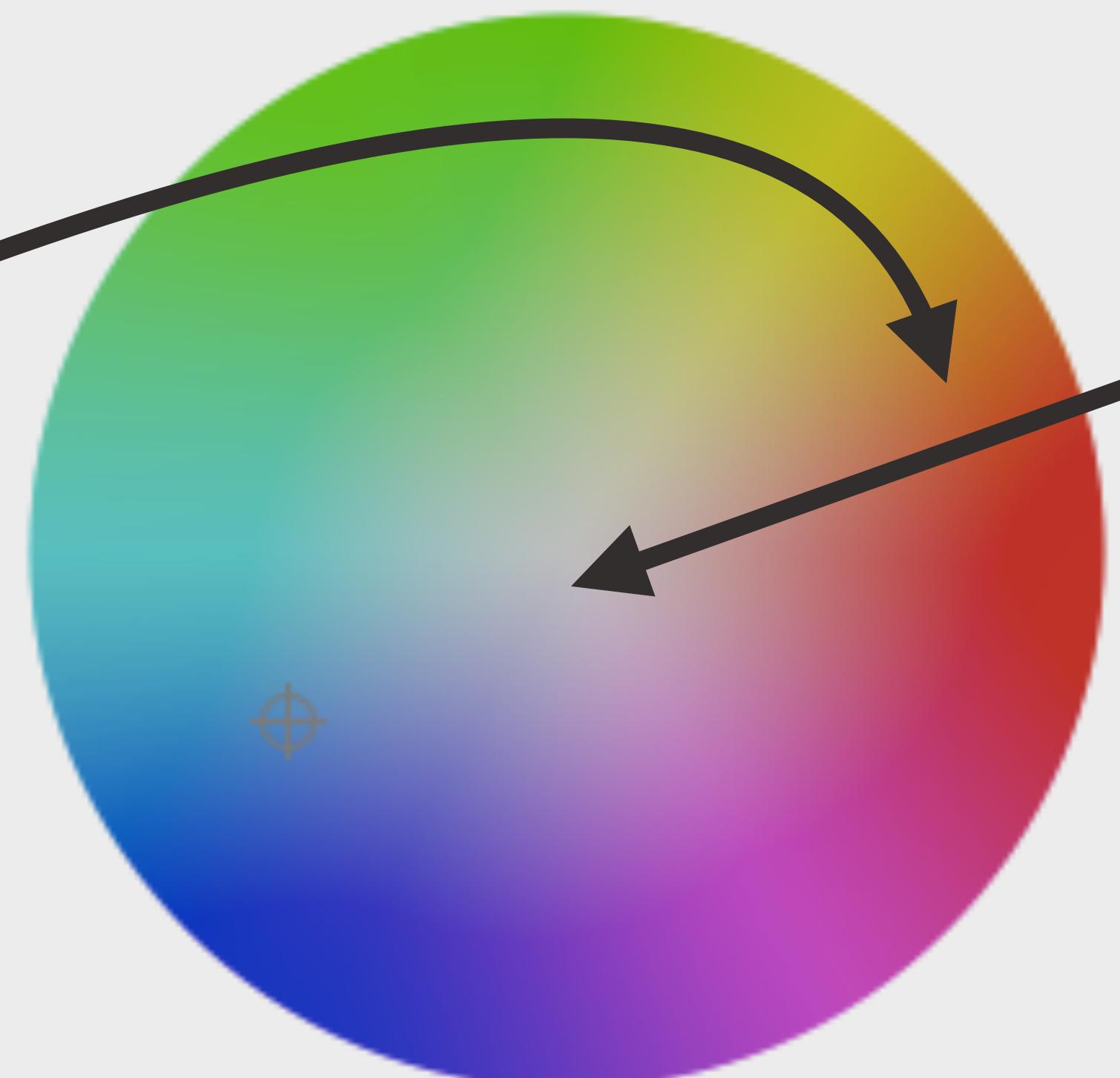
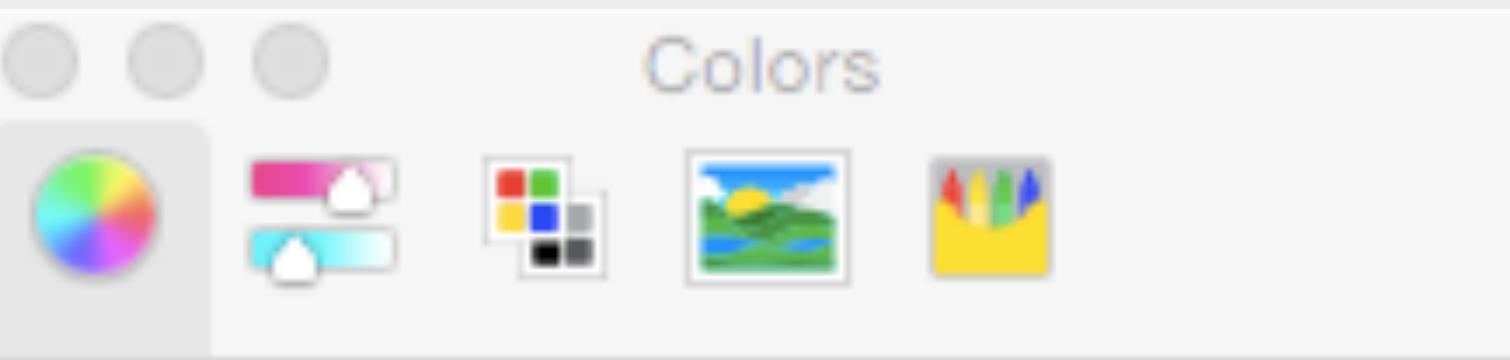
Saturation (Chroma)

hsv

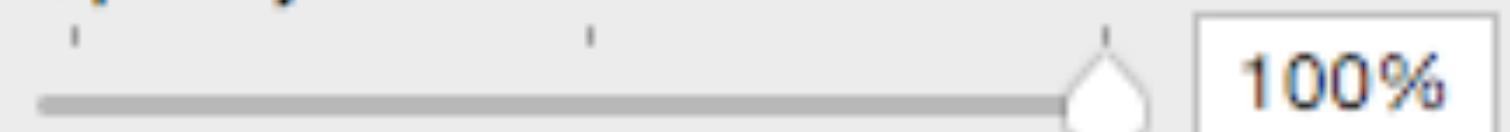
hue

saturation

value



Opacity



hsv

Colors

HSB Sliders ⚙️

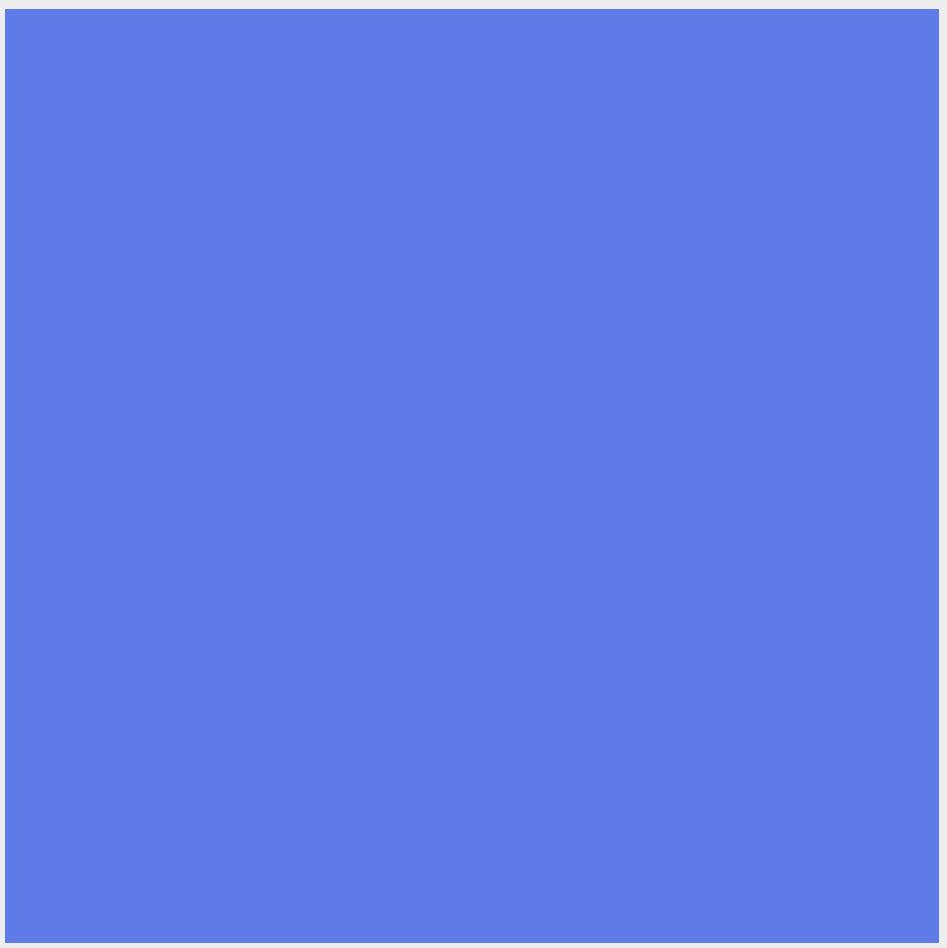
Hue 212°

Saturation 61%

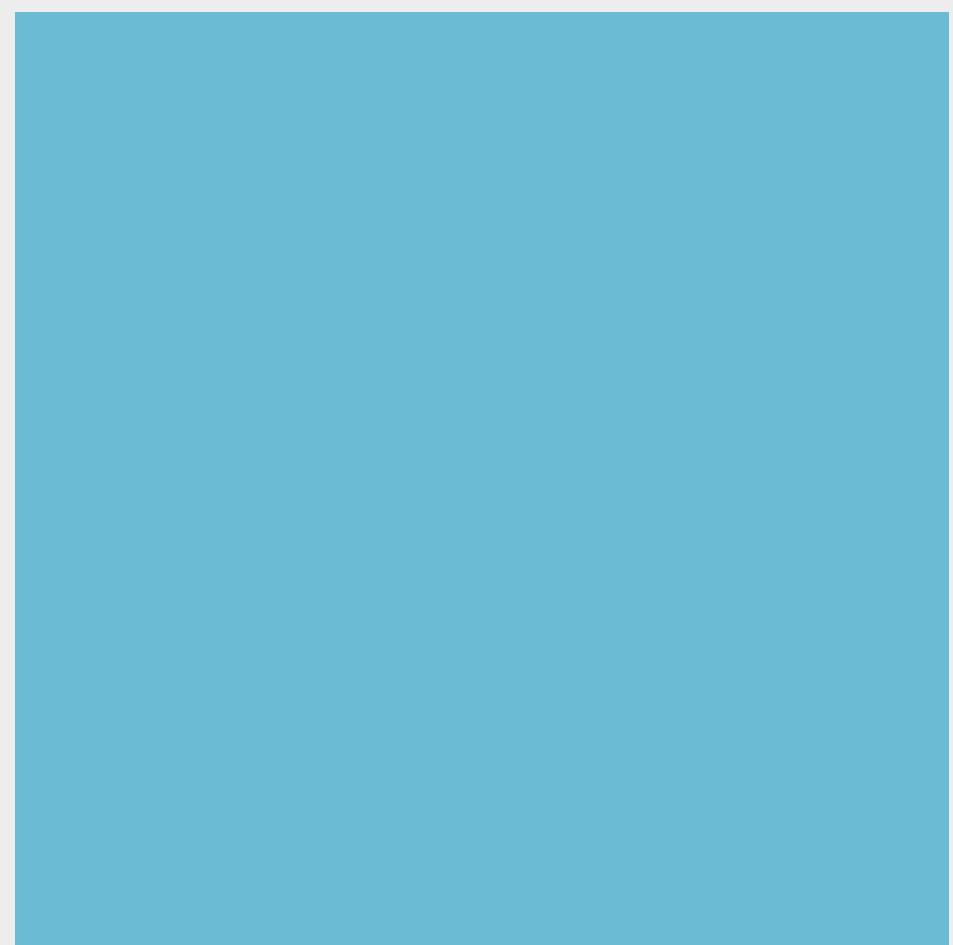
Brightness 75%

Opacity 100%

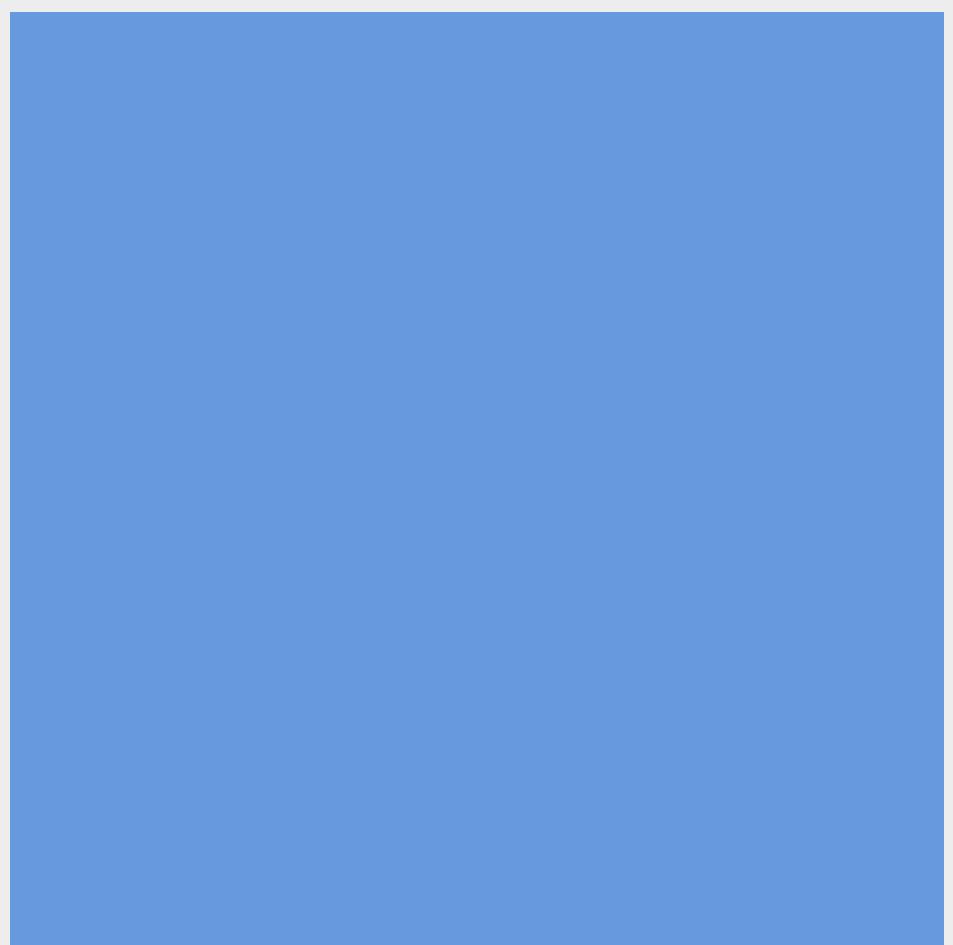
hsv



hsv



-5%



+5%



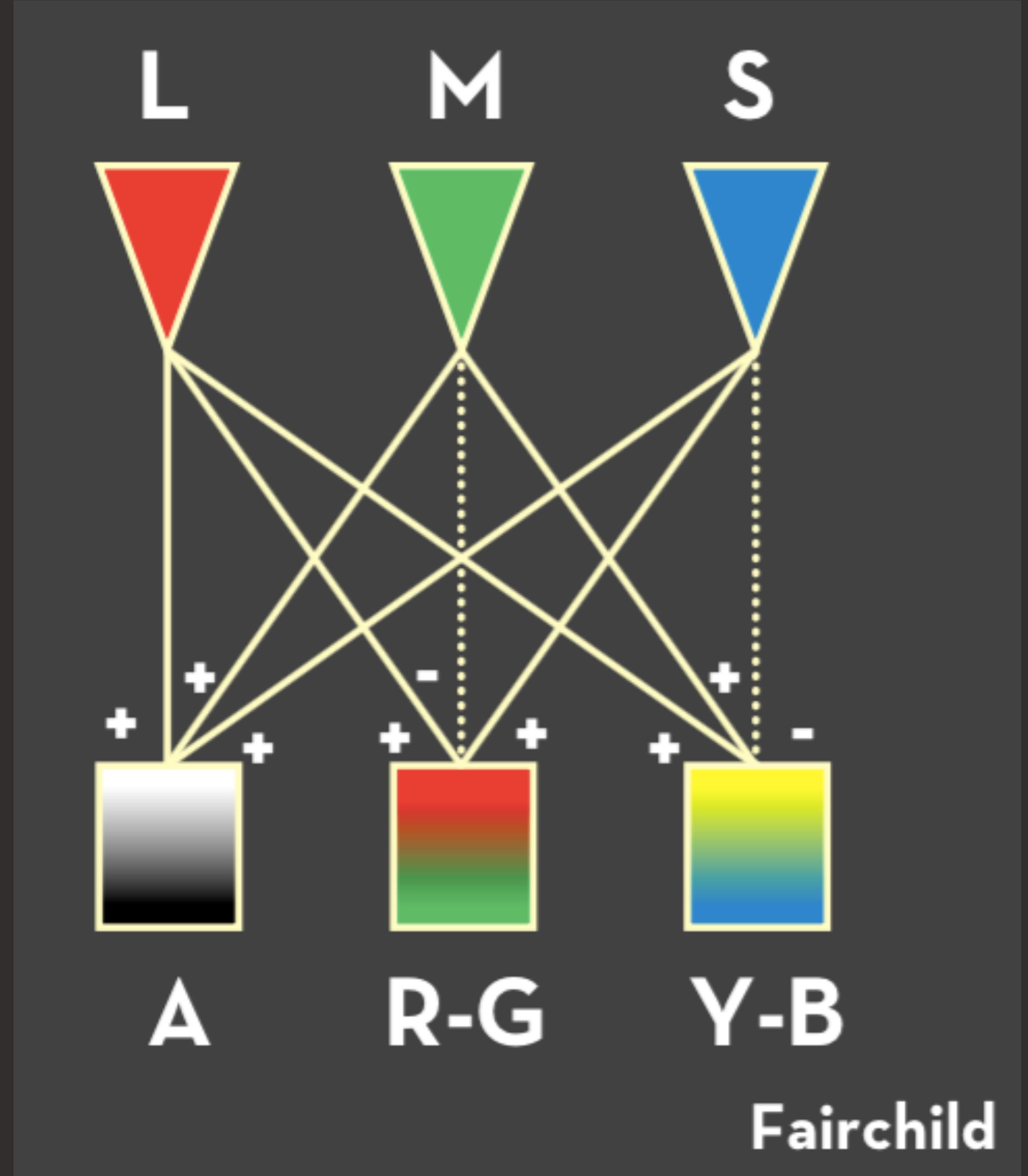
*good for
machines*

*good for
people*

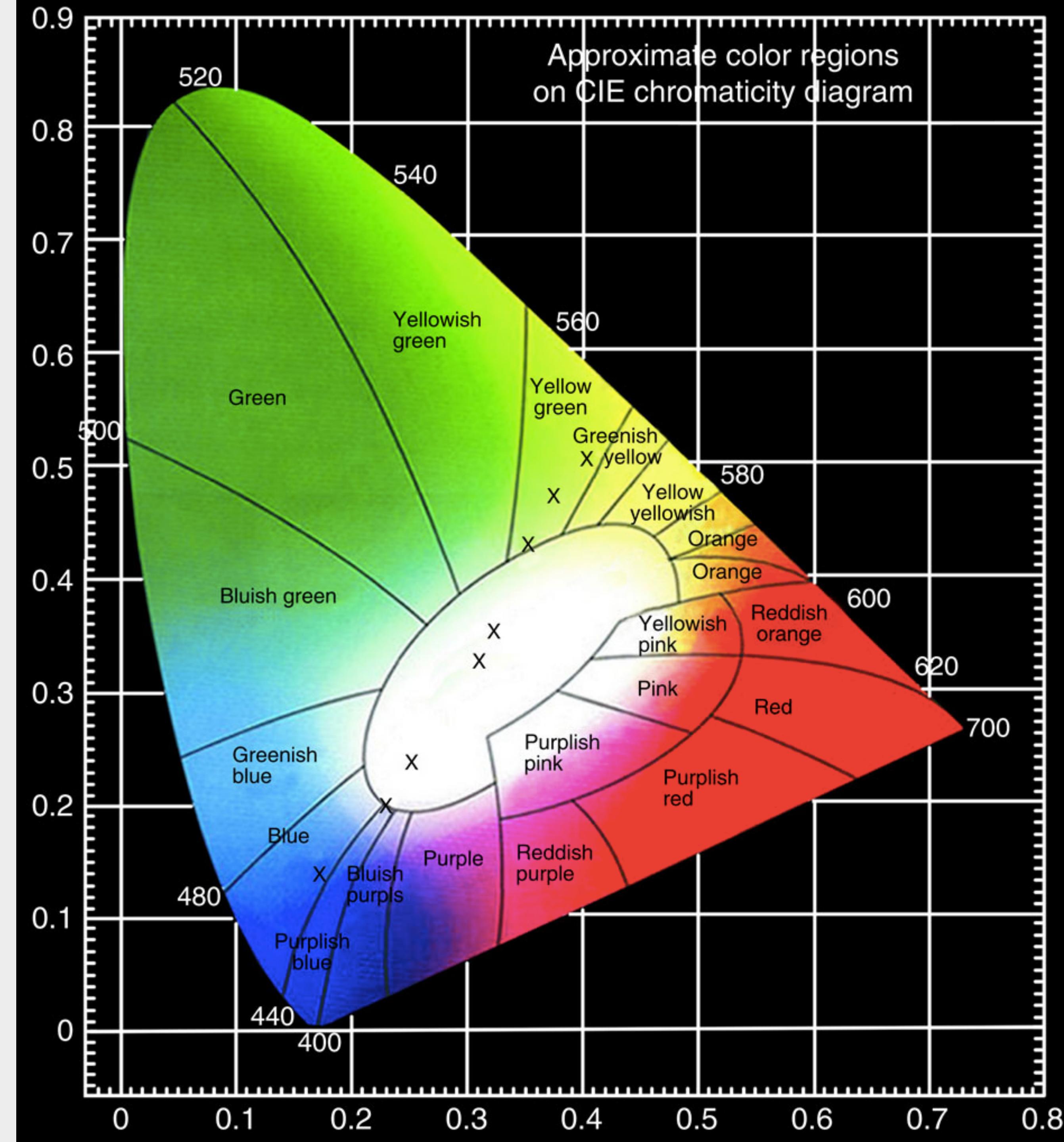
rgb hsv

Remember?

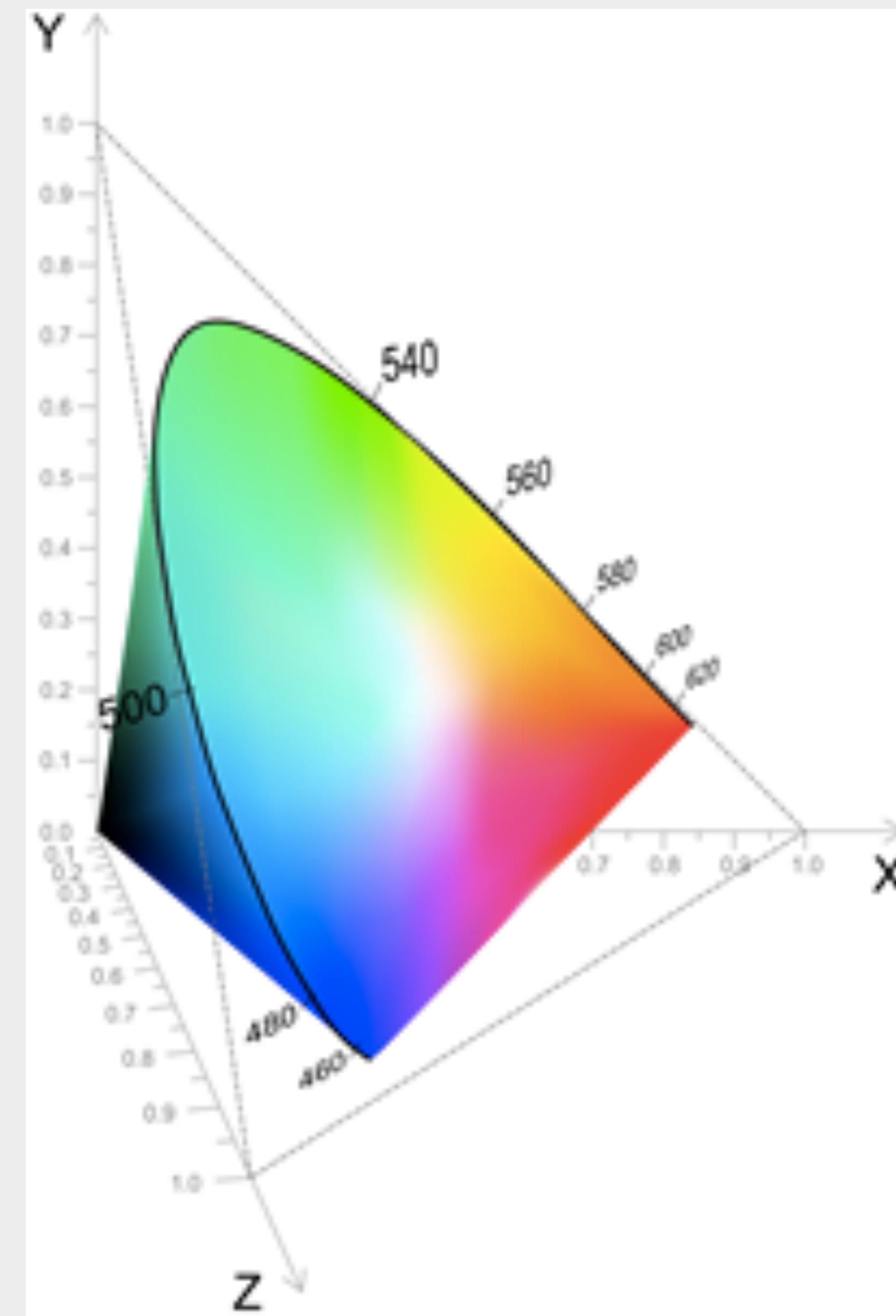
Long
Middle
Short



CIE XYZ

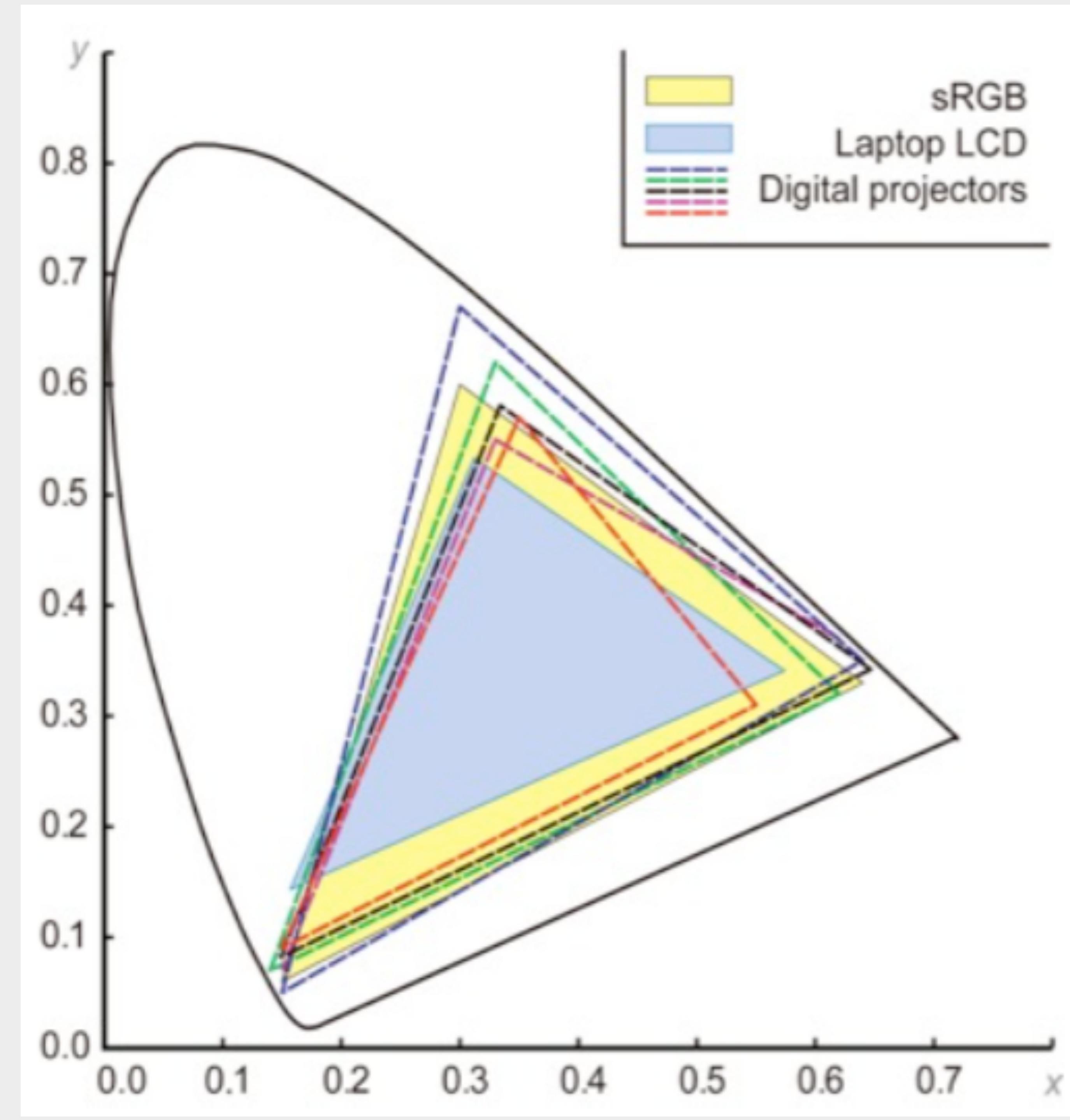


CIE XYZ



CIE XYZ

displays are an embedding

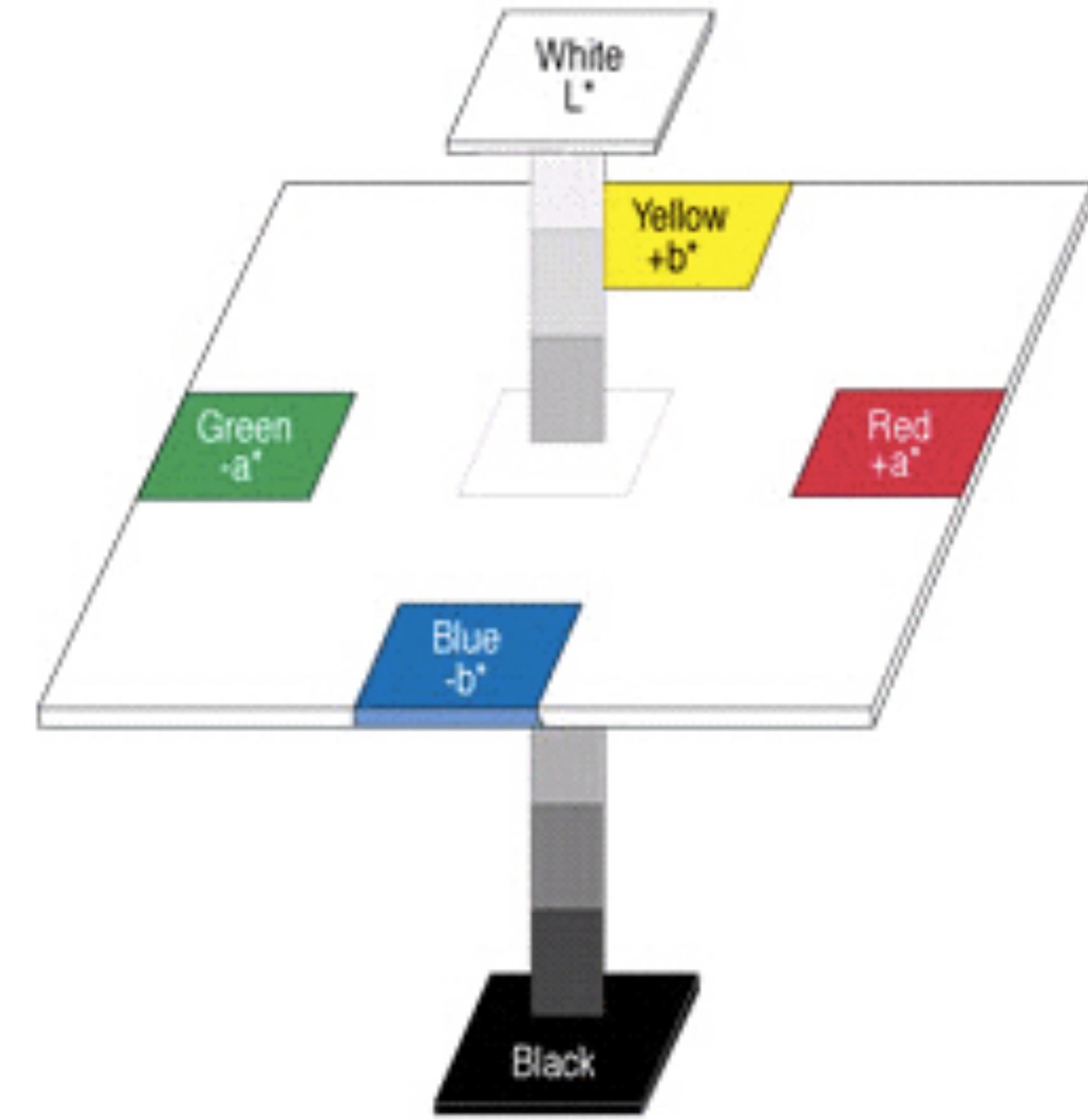


CIE Lab

Luminance

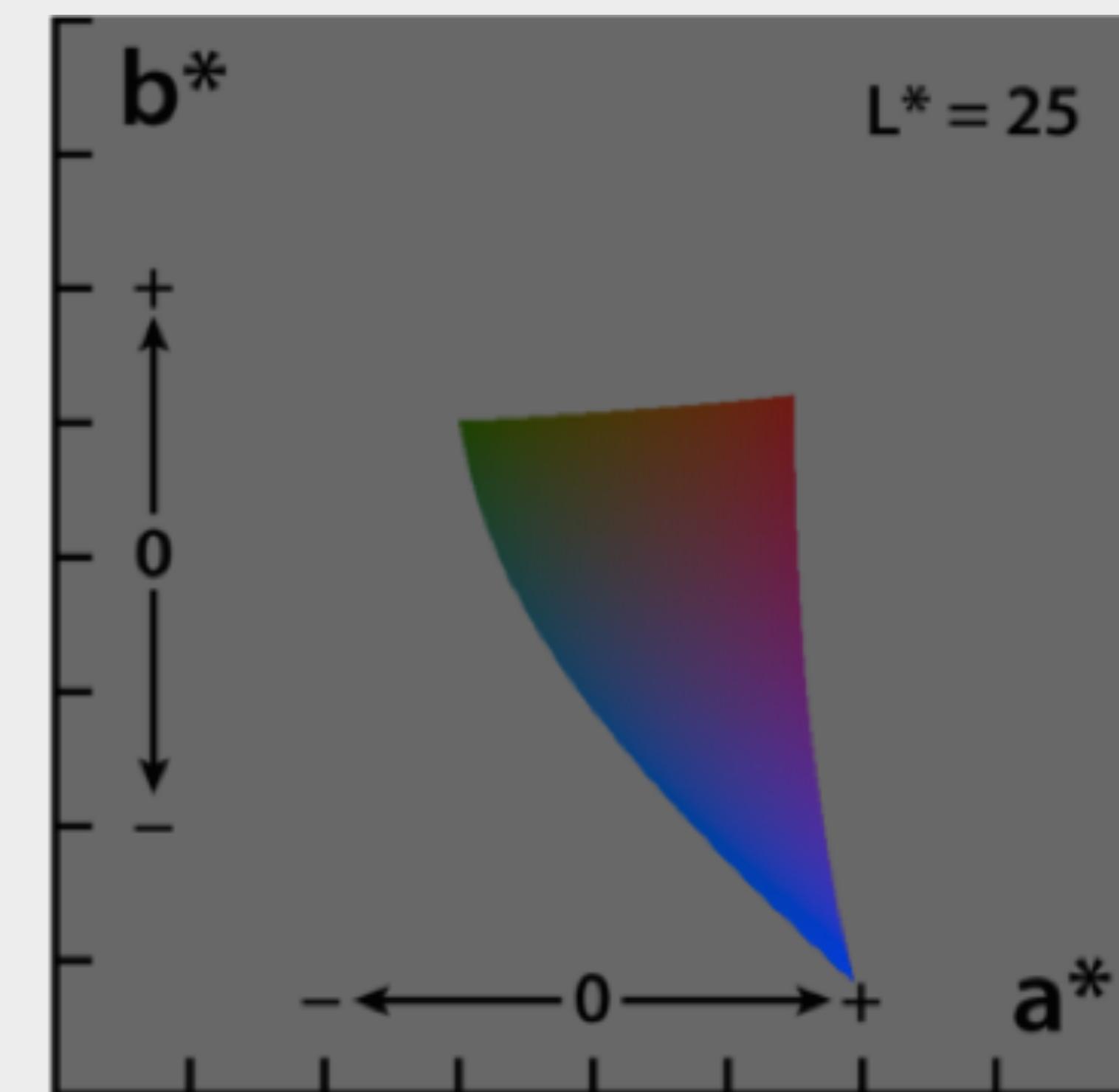
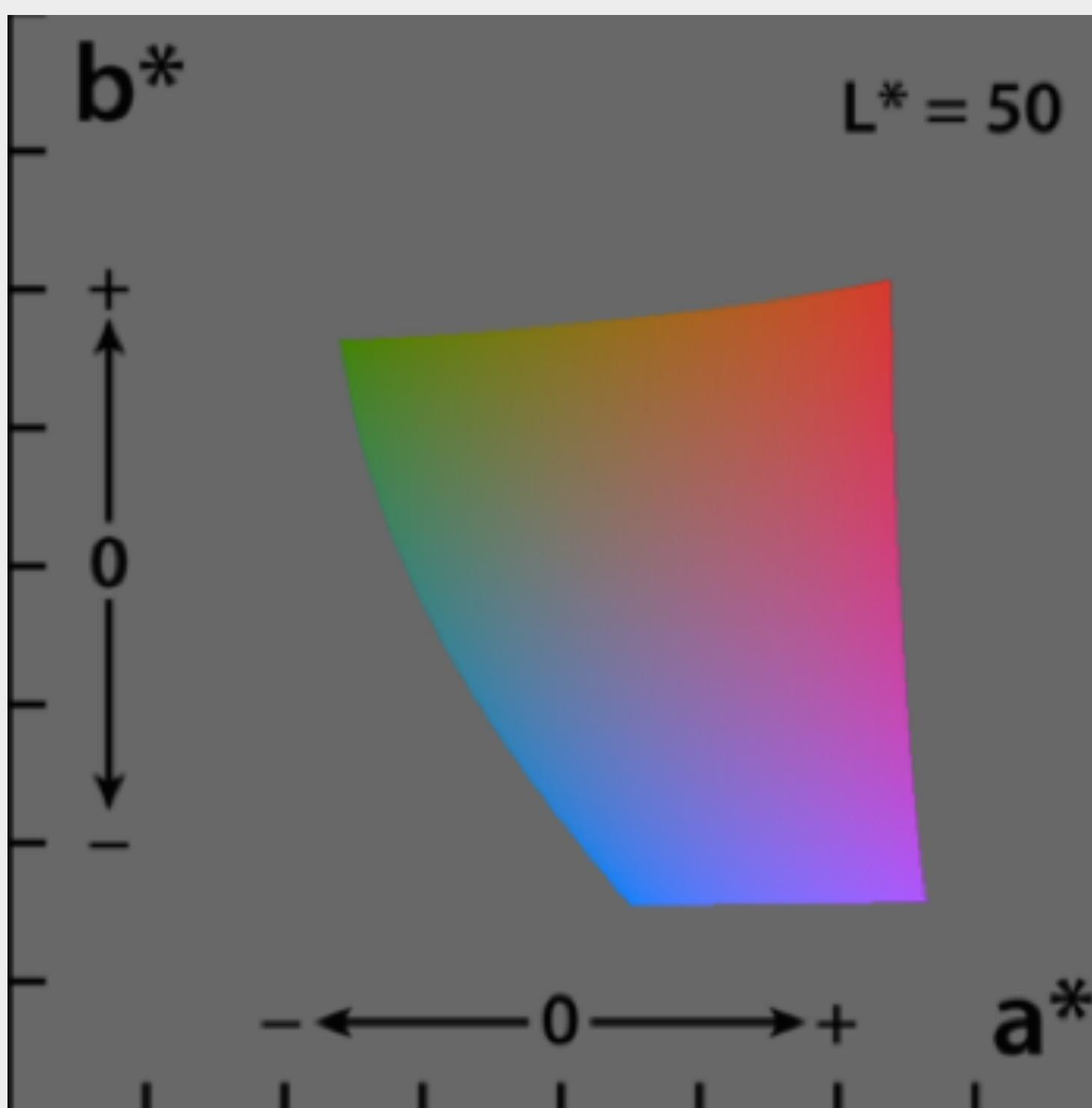
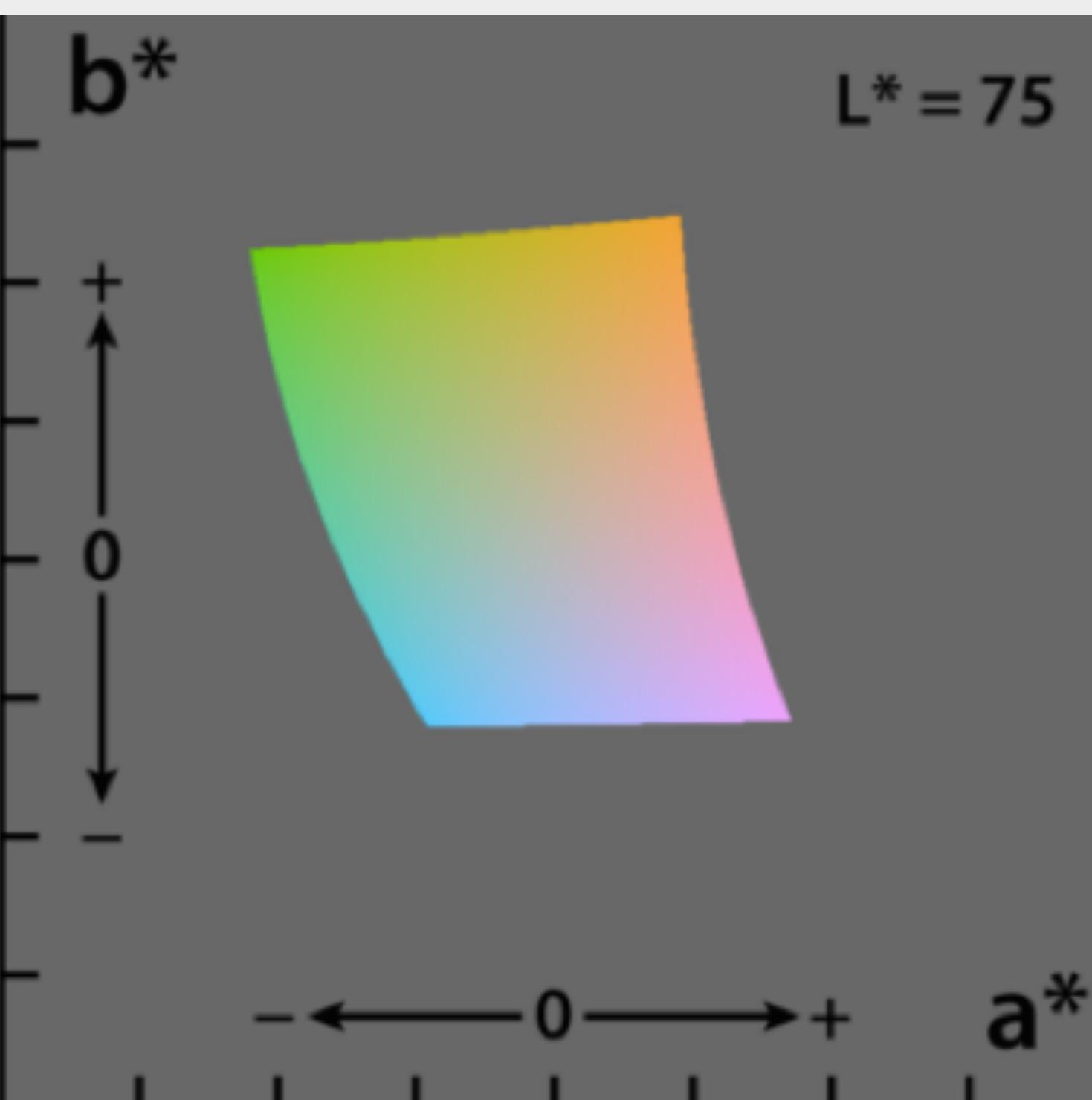
a (red green)

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



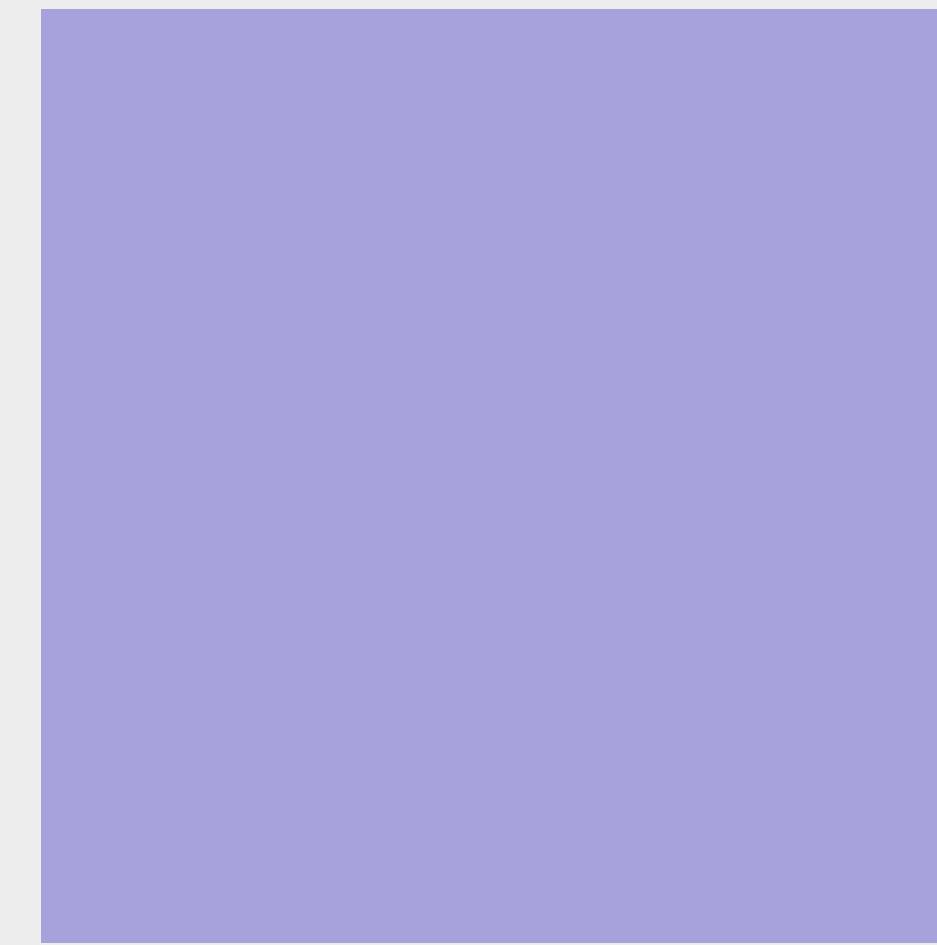
Lab



-5%



+5%



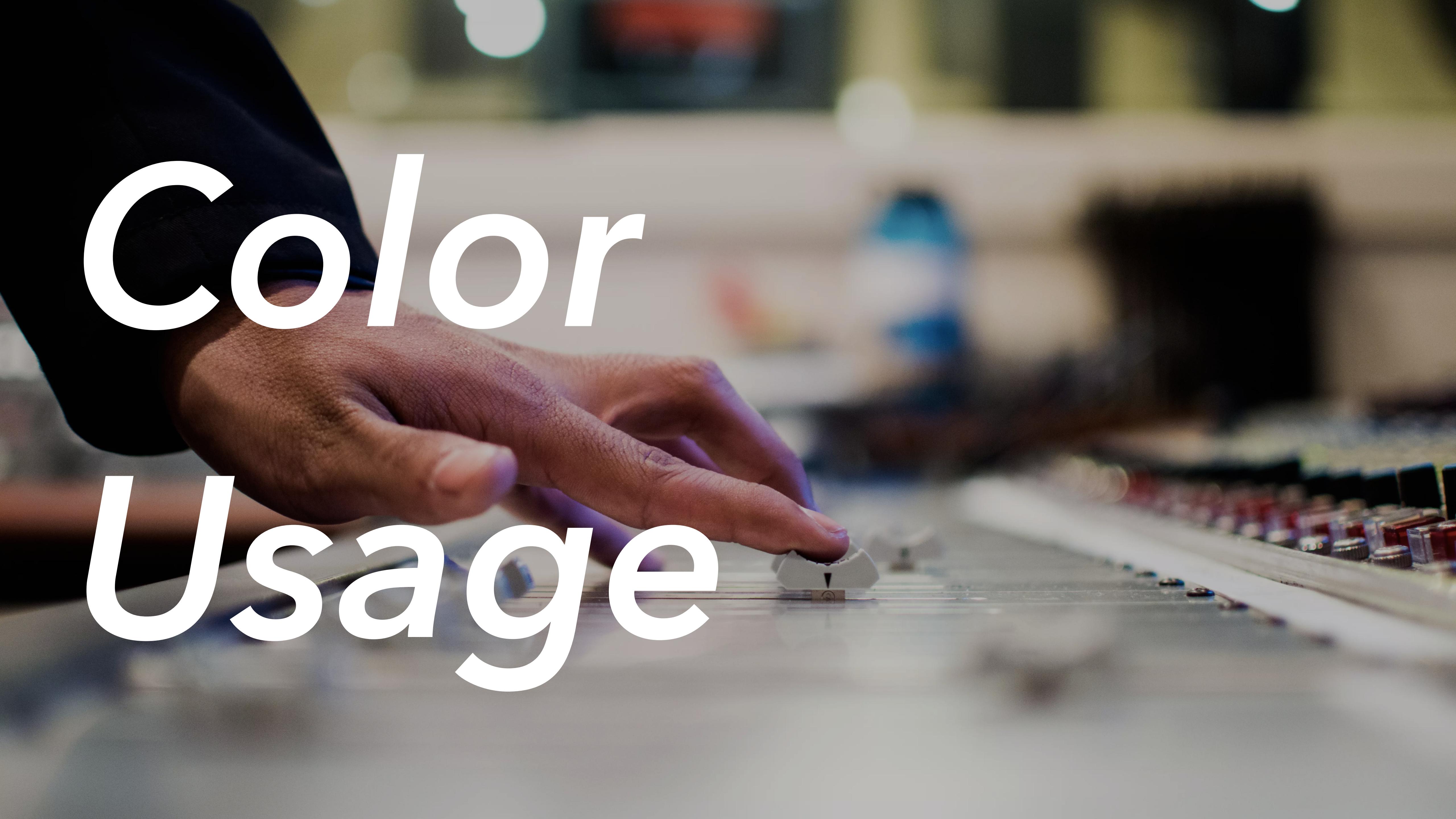
*good for
machines*

*good for
people*

rgb hsv

Lab

Color Usage



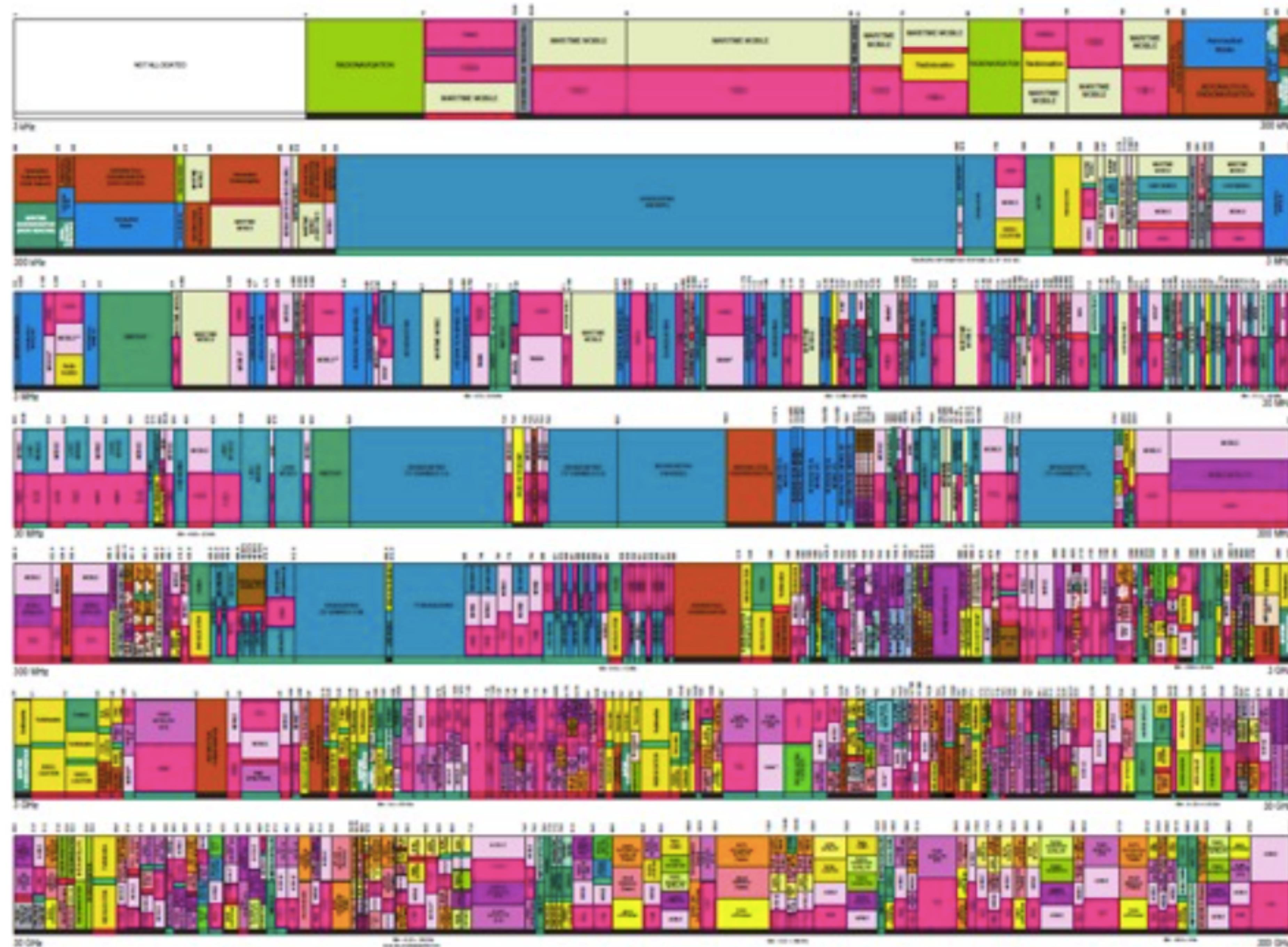
Map Data

to Color

Nominal

UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

THE RADIO SPECTRUM



UNITED STATES FREQUENCY ALLOCATIONS

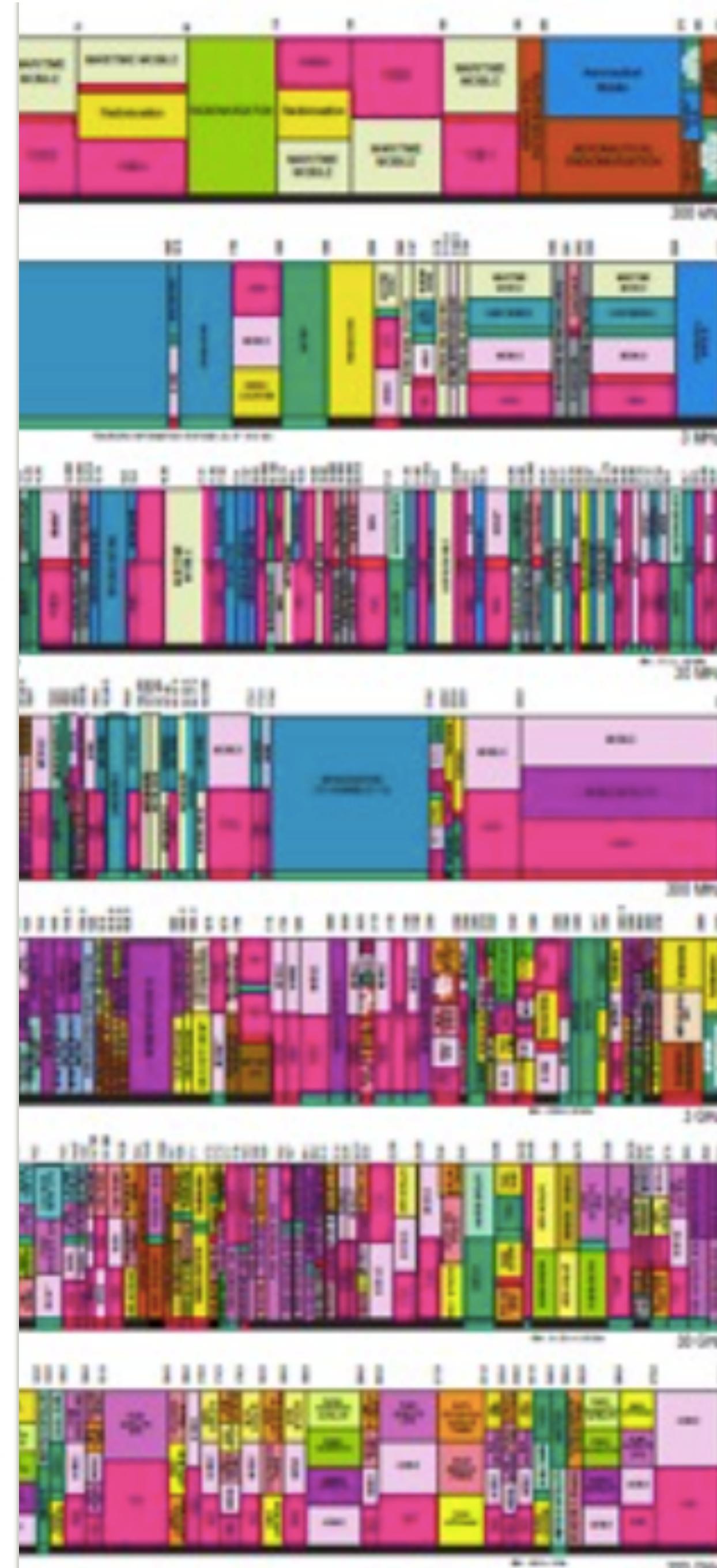
THE RADIO SPECTRUM



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

ALLOCATIONS

THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

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

ACTIVITY CODE

COMMERCIAL	NONCOMMERCIAL
INDUSTRIAL	NONINDUSTRIAL
SCIENTIFIC	NONSCIENTIFIC
TECHNICAL	NONTECHNICAL

ALLOCATION USAGE DESIGNATION

PRIMARY SECONDARY TERTIARY

PRIMARY SECONDARY TERTIARY

RADIO SERVICES COLOR LEGEND



Use few categories

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	RADIONAVIGATION SATELLITE
BROADCASTING	MARITIME MOBILE SATELLITE	RADIONAVIGATION
BROADCASTING SATELLITE	MARITIME RADIONAVIGATION	RADIONAVIGATION SATELLITE
BROAD EXPLOSION SATELLITE	METEOROLOGICAL AIDS	SPACE OPERATION
FIXED	METEOROLOGICAL SATELLITE	SPACE RESEARCH
FIXED SATELLITE	MOBILE	STANDARD FREQUENCY AND TIME SIGNAL
MOBILE SATELLITE		STANDARD FREQUENCY AND TIME SIGNAL SATELLITE

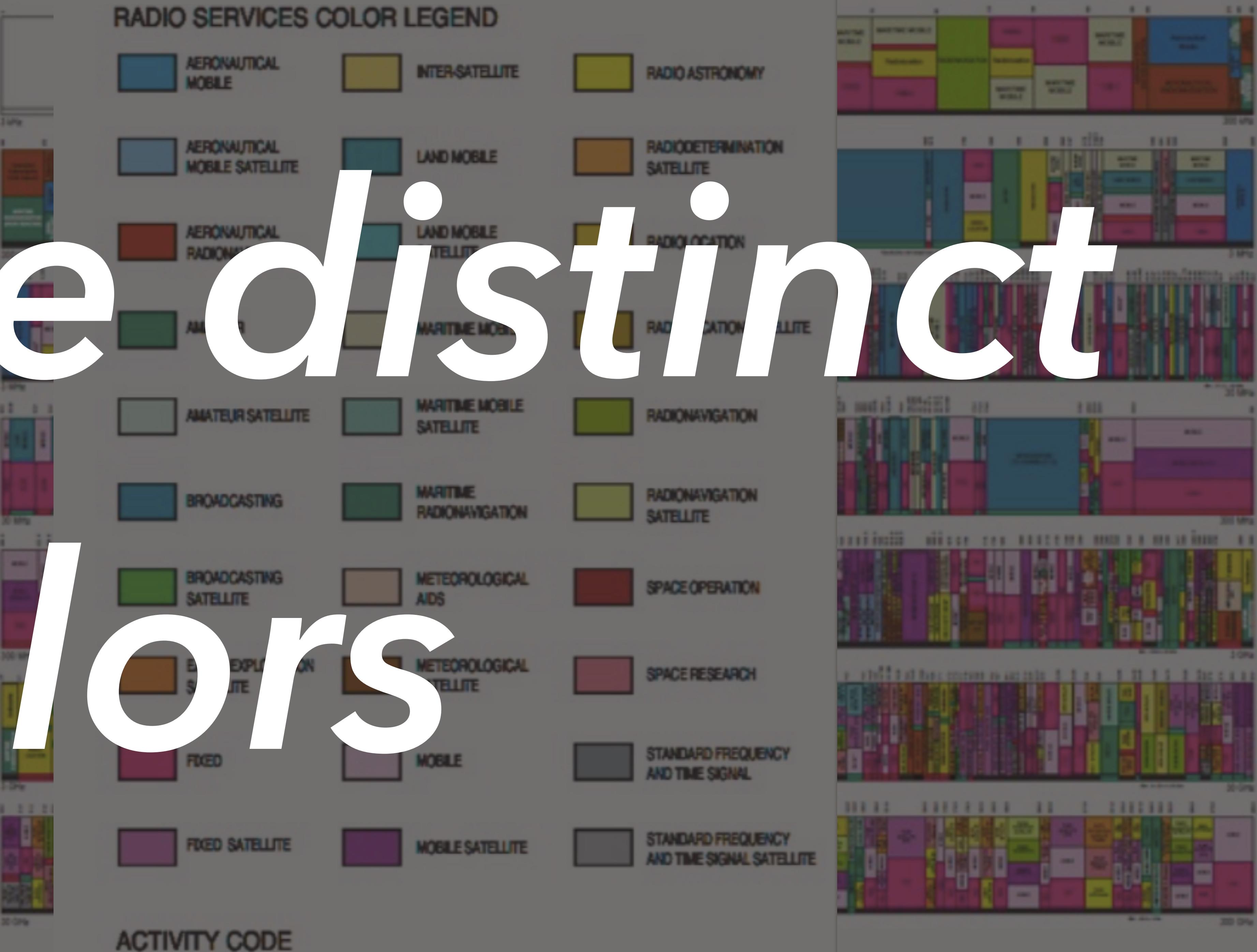
ACTIVITY CODE

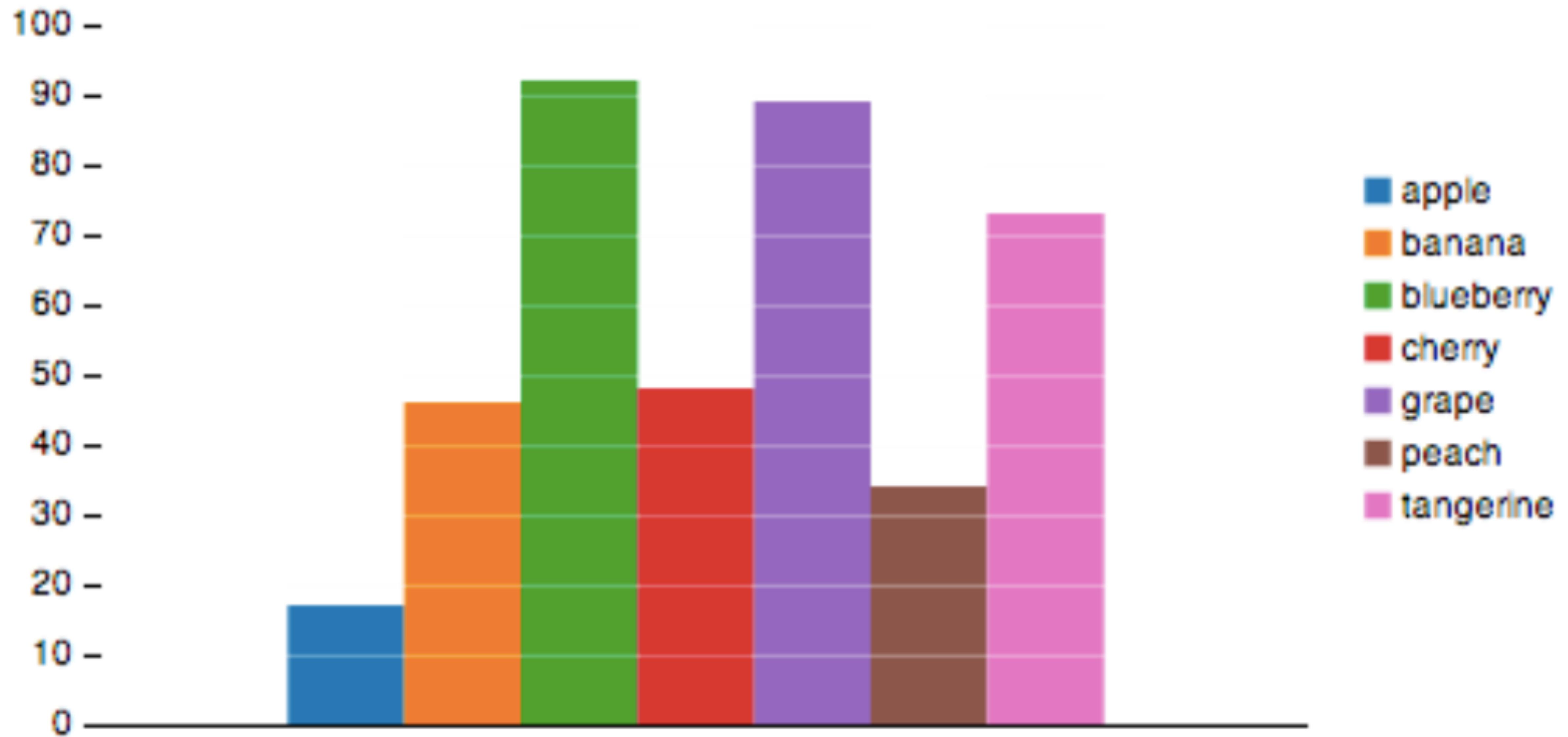
SIMPLY COLOR	SIMPLY COLOR/WHITE
UNIVERSITY COLOR	

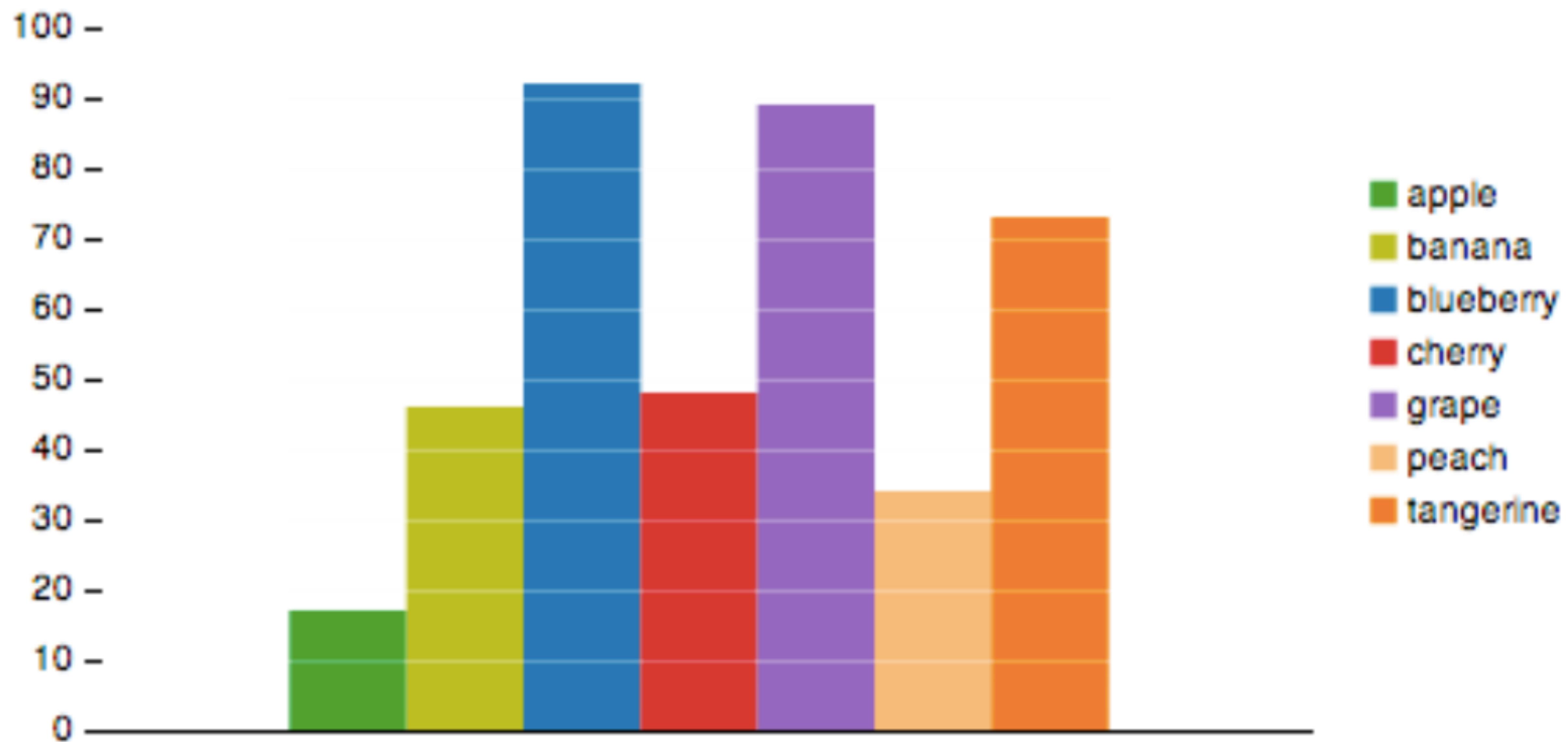
ALLOCATION USAGE DESIGNATION

PRIMARY	SECONDARY	OPTIONAL
PRIMARY	SECONDARY	OPTIONAL

ACTIVITY CODE







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
Daiquiri
Fanta
Sprite
Sunkist
Welch's Grape



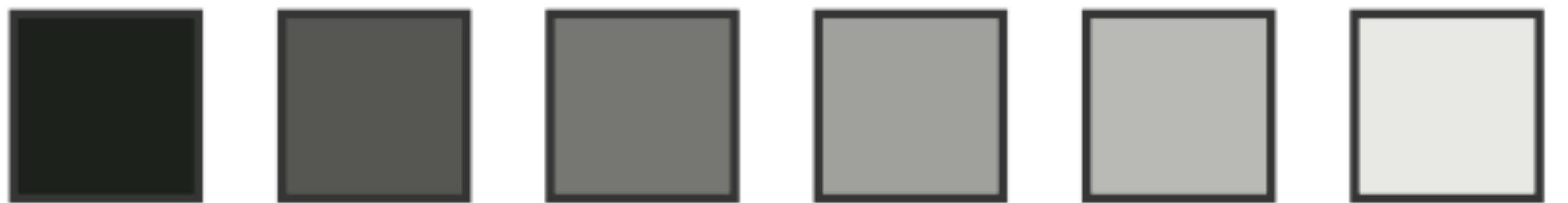
Brands

Apple
AT&T
Home Depot
Kodak
Starbucks
Target
Yahoo!

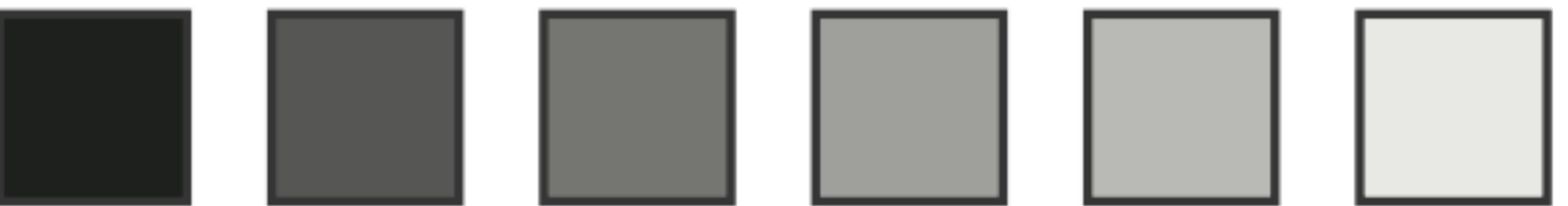


Ordinal

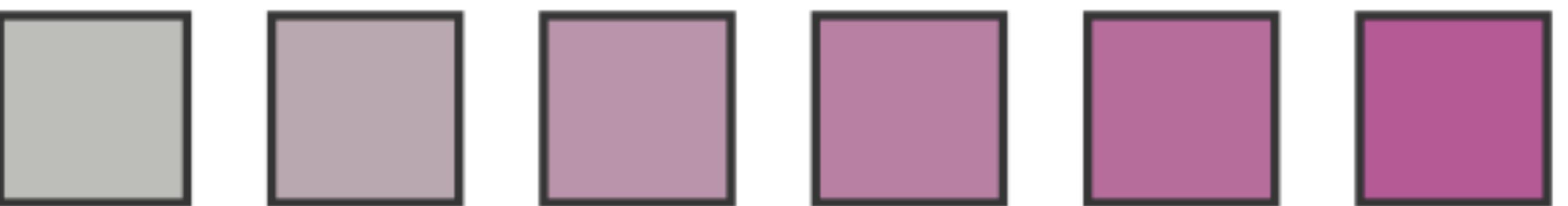
Luminance



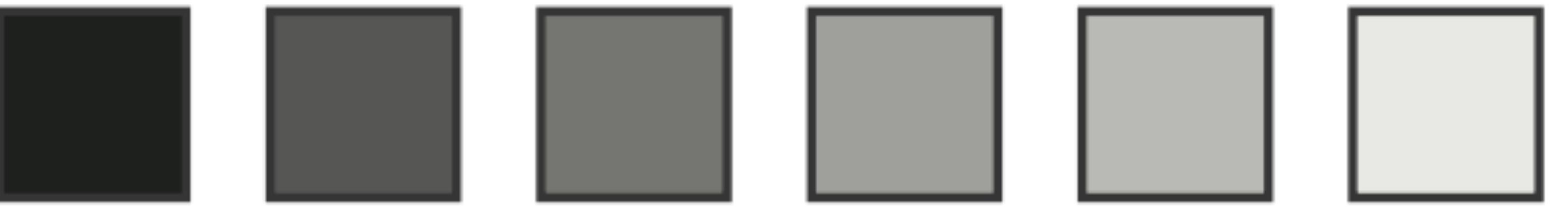
Luminance



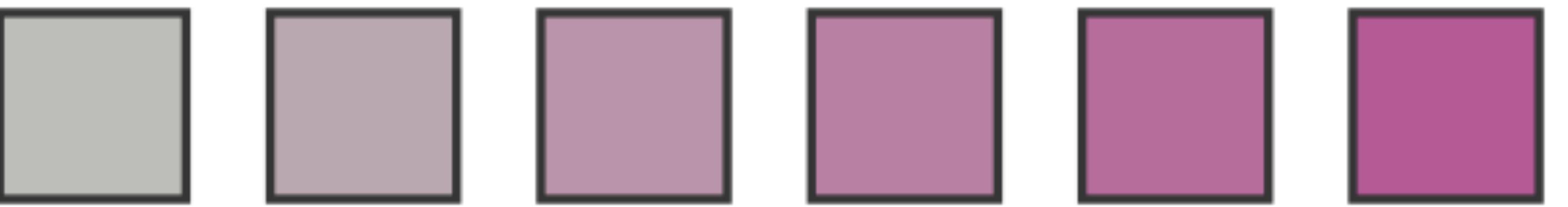
Saturation



Luminance



Saturation

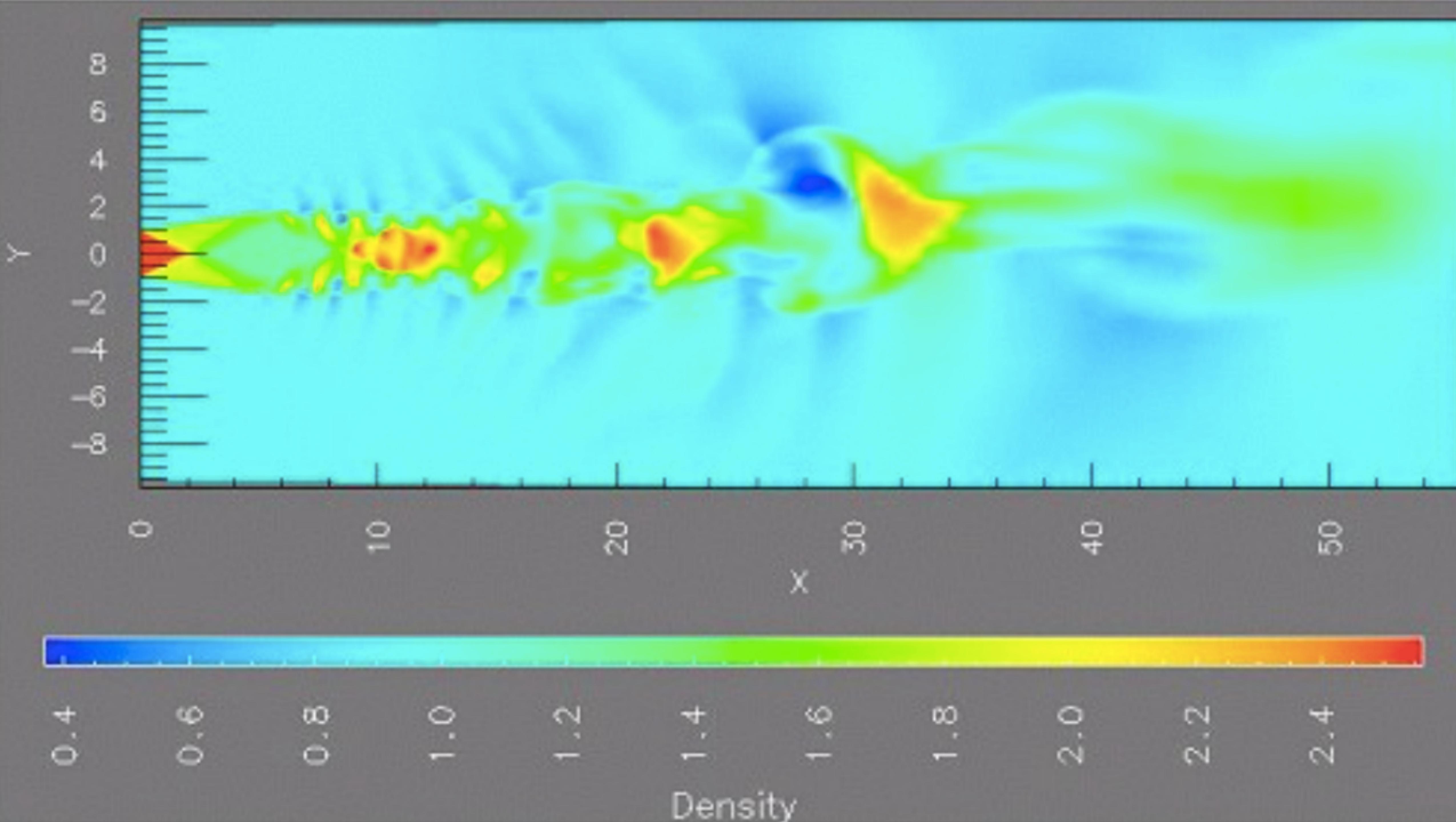


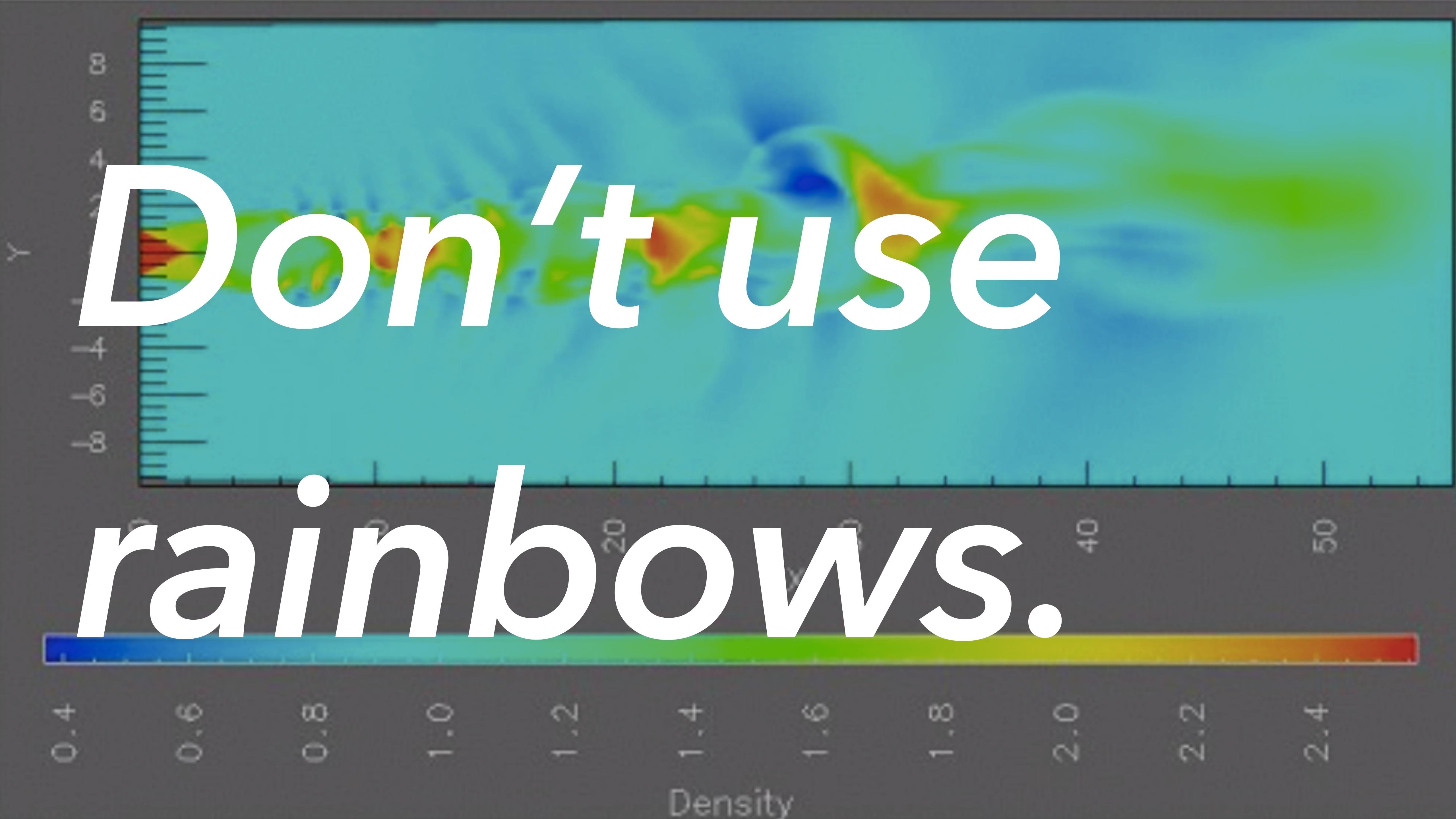
Hue



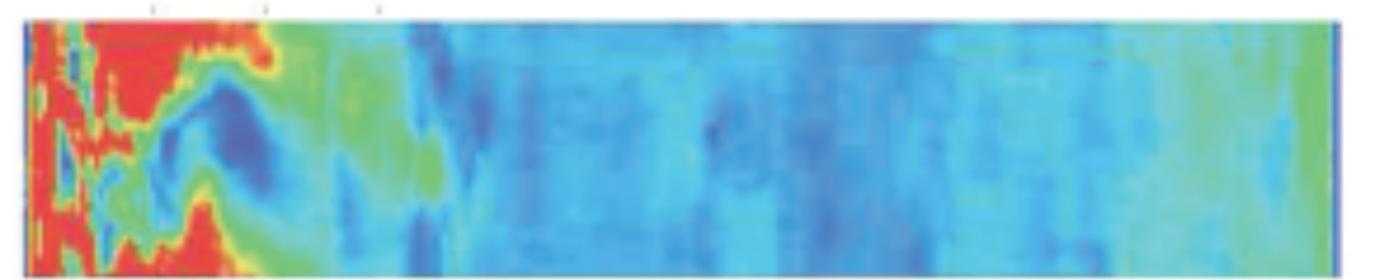
hue is not naturally ordered

Continuous



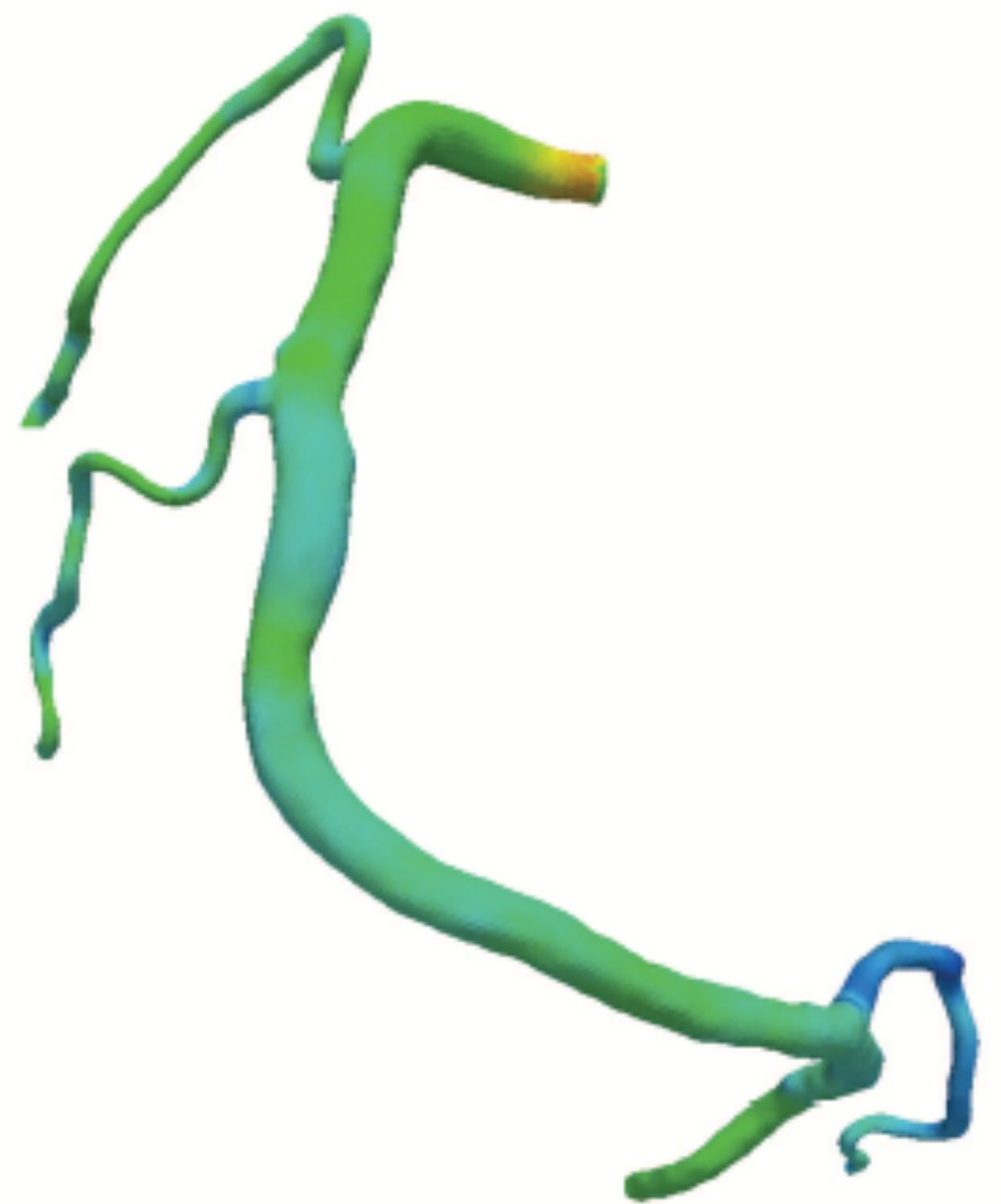


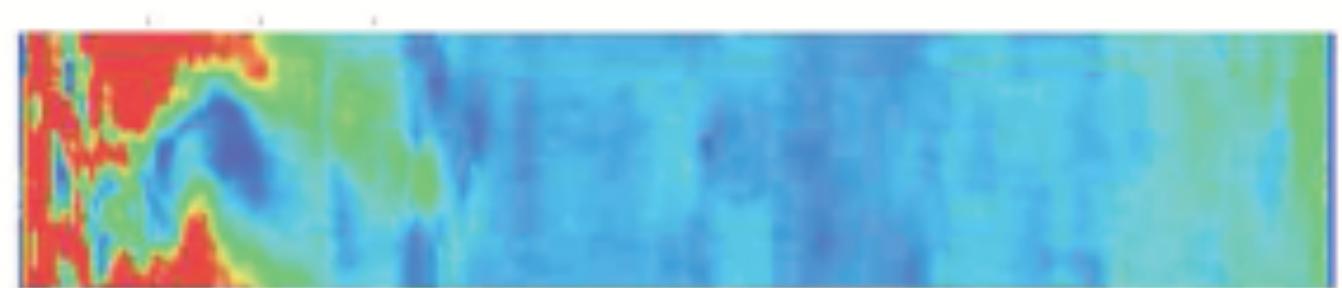
Don't use
rainbows.



Shear
Stress (Pa)

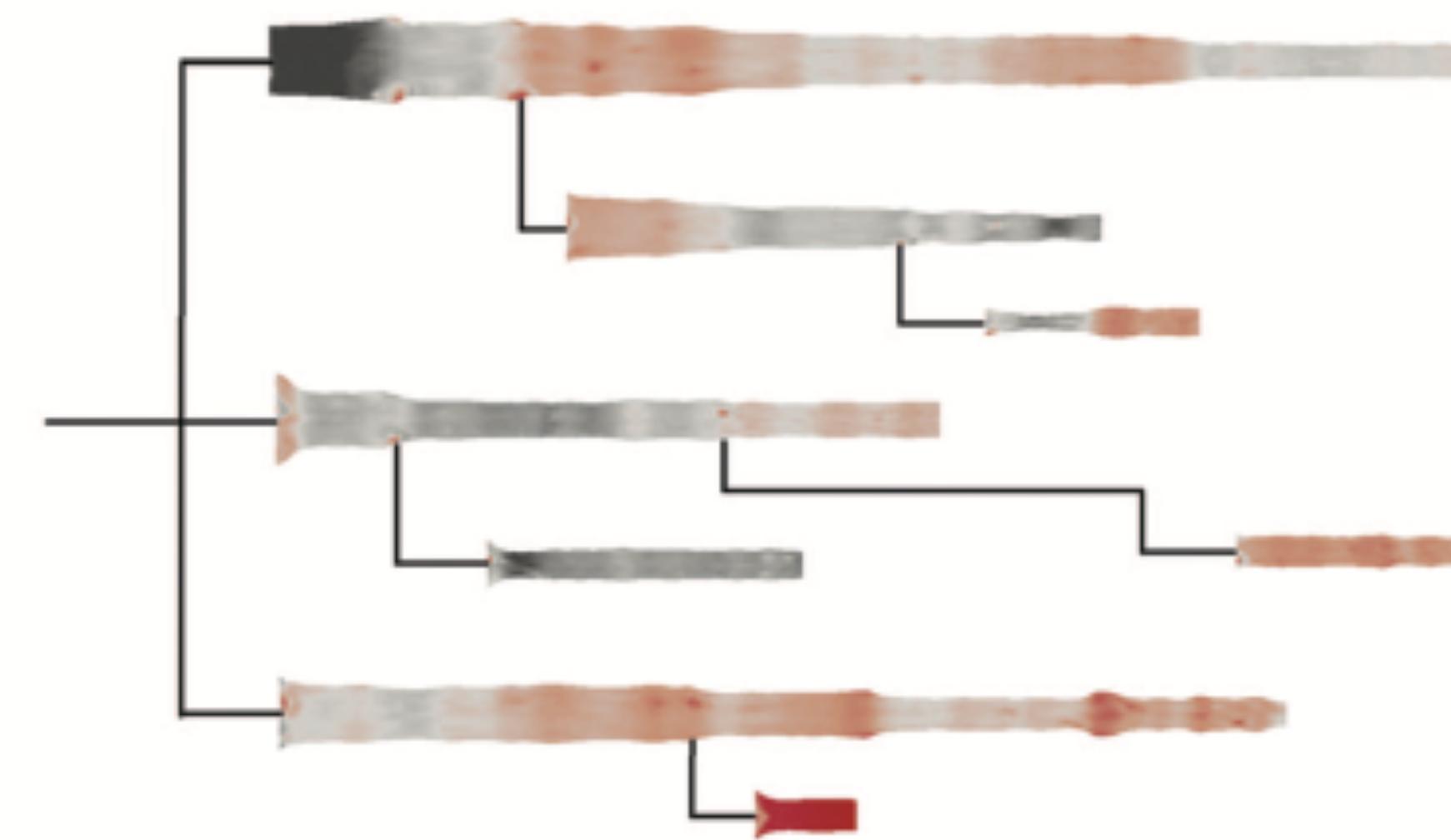
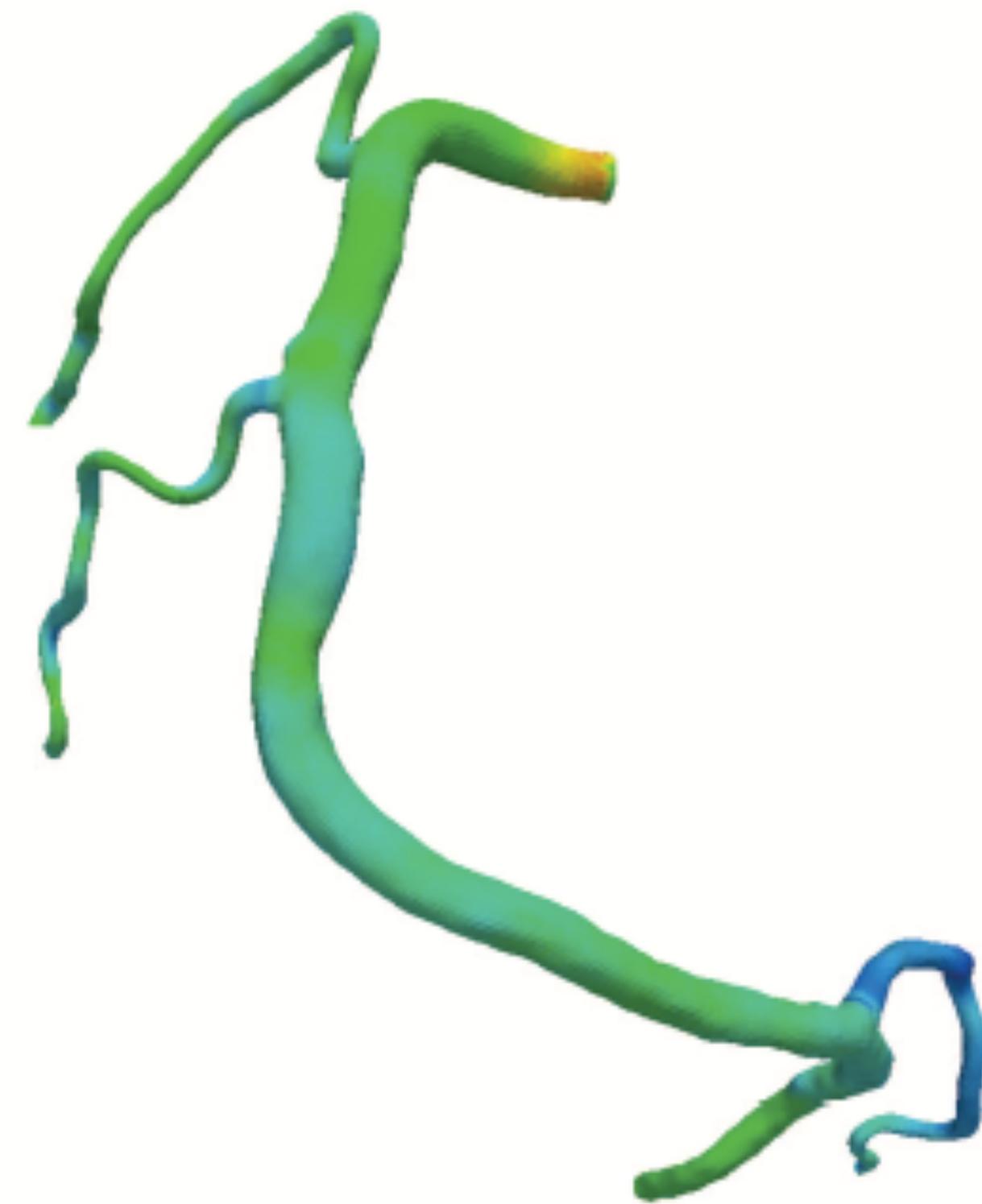
3
2
1
0





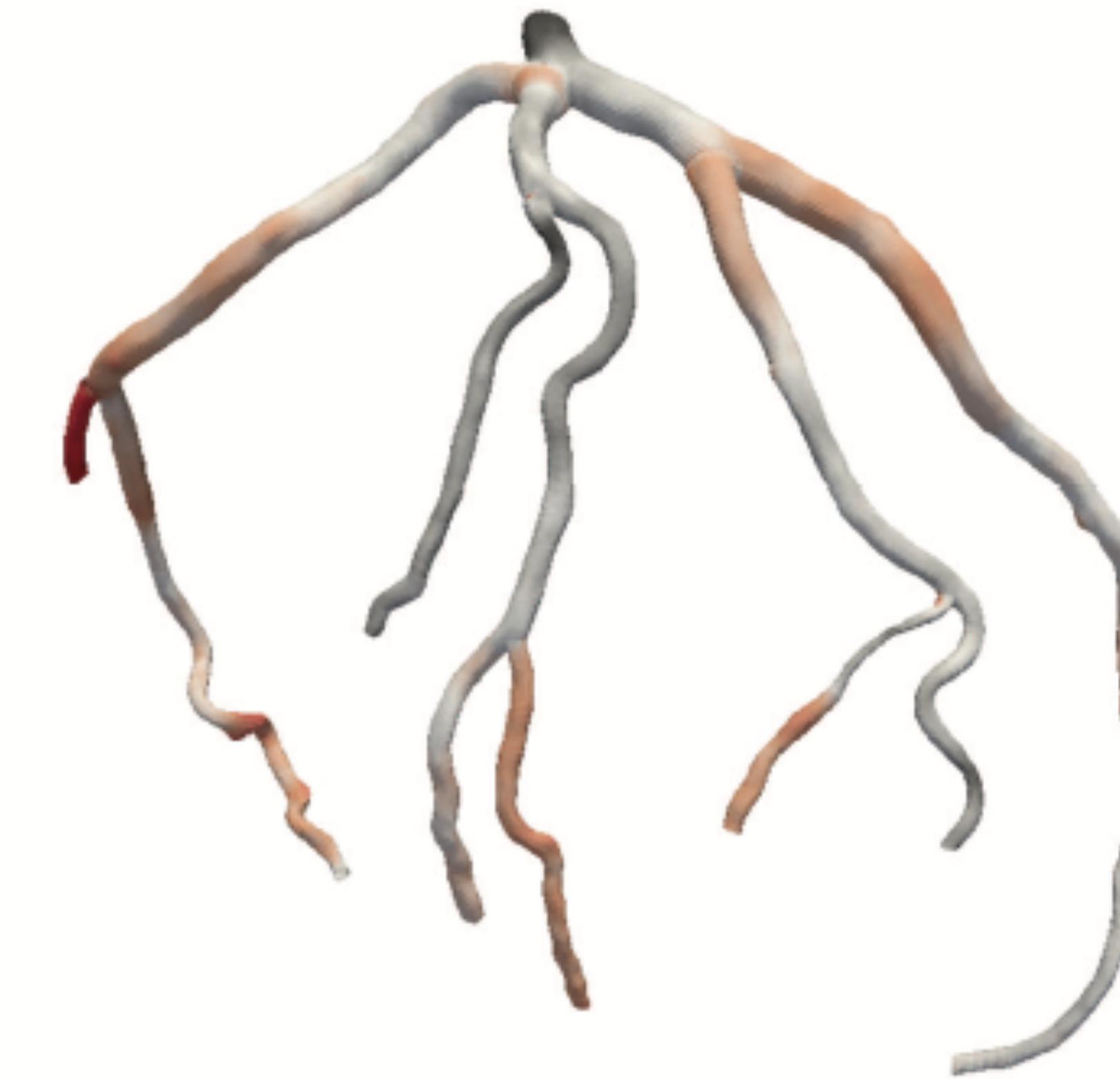
Shear
Stress (Pa)

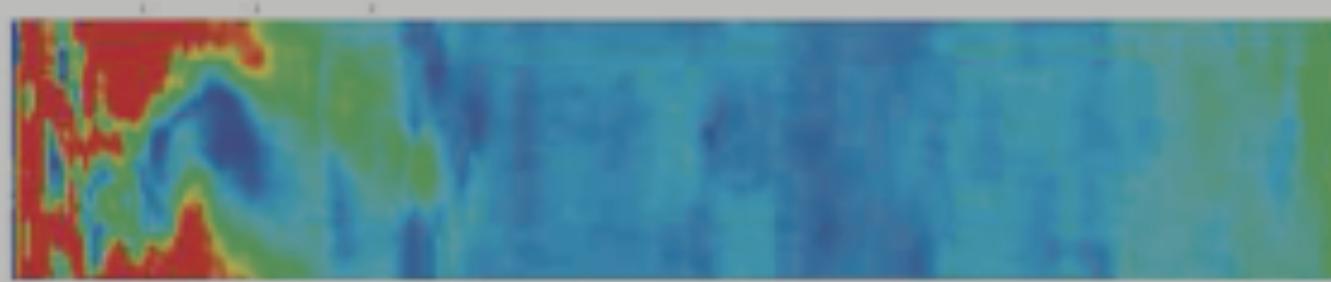
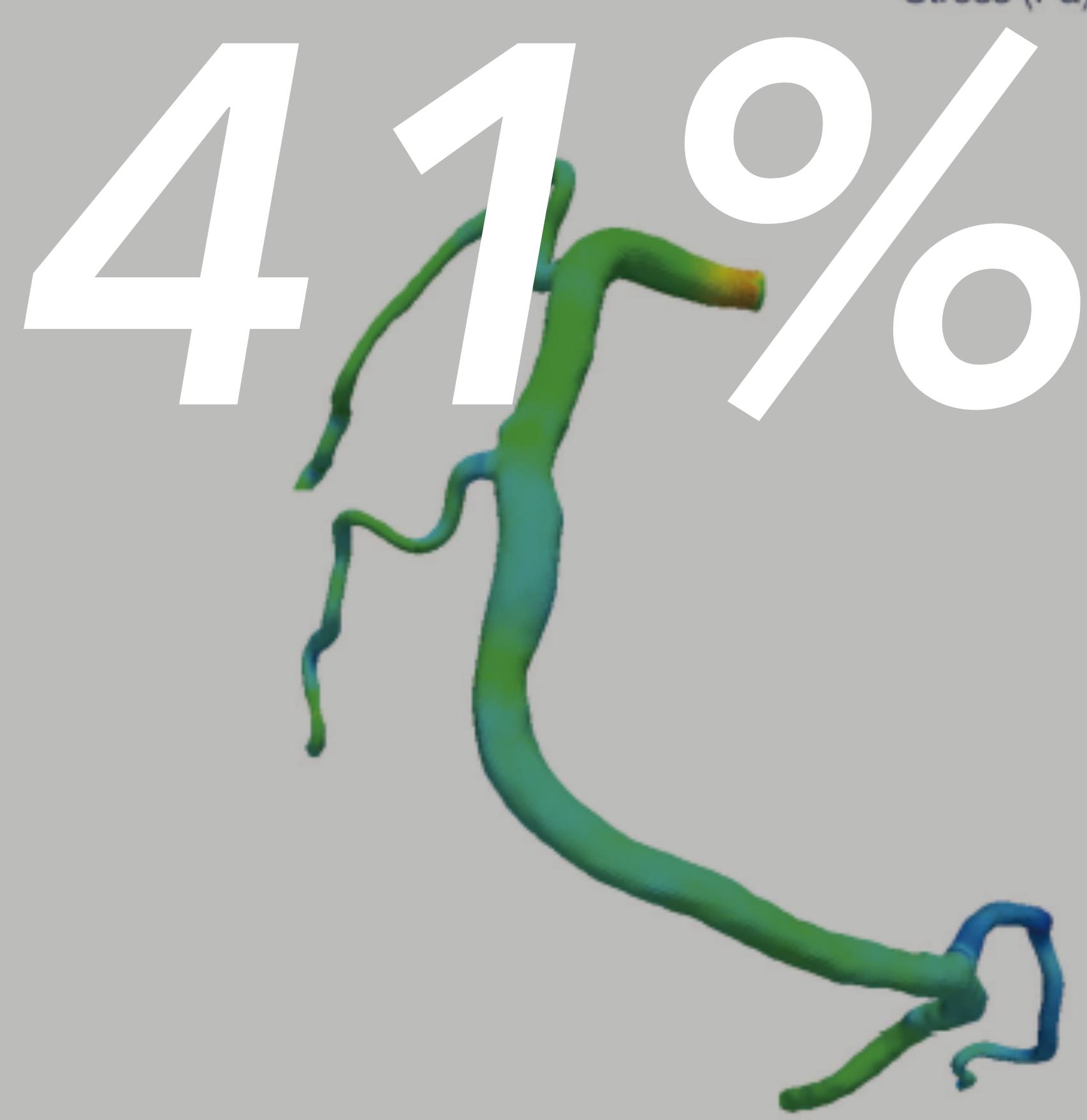
3
2
1
0



Shear
Stress (Pa)

3
2
1
0





Shear
Stress (Pa)

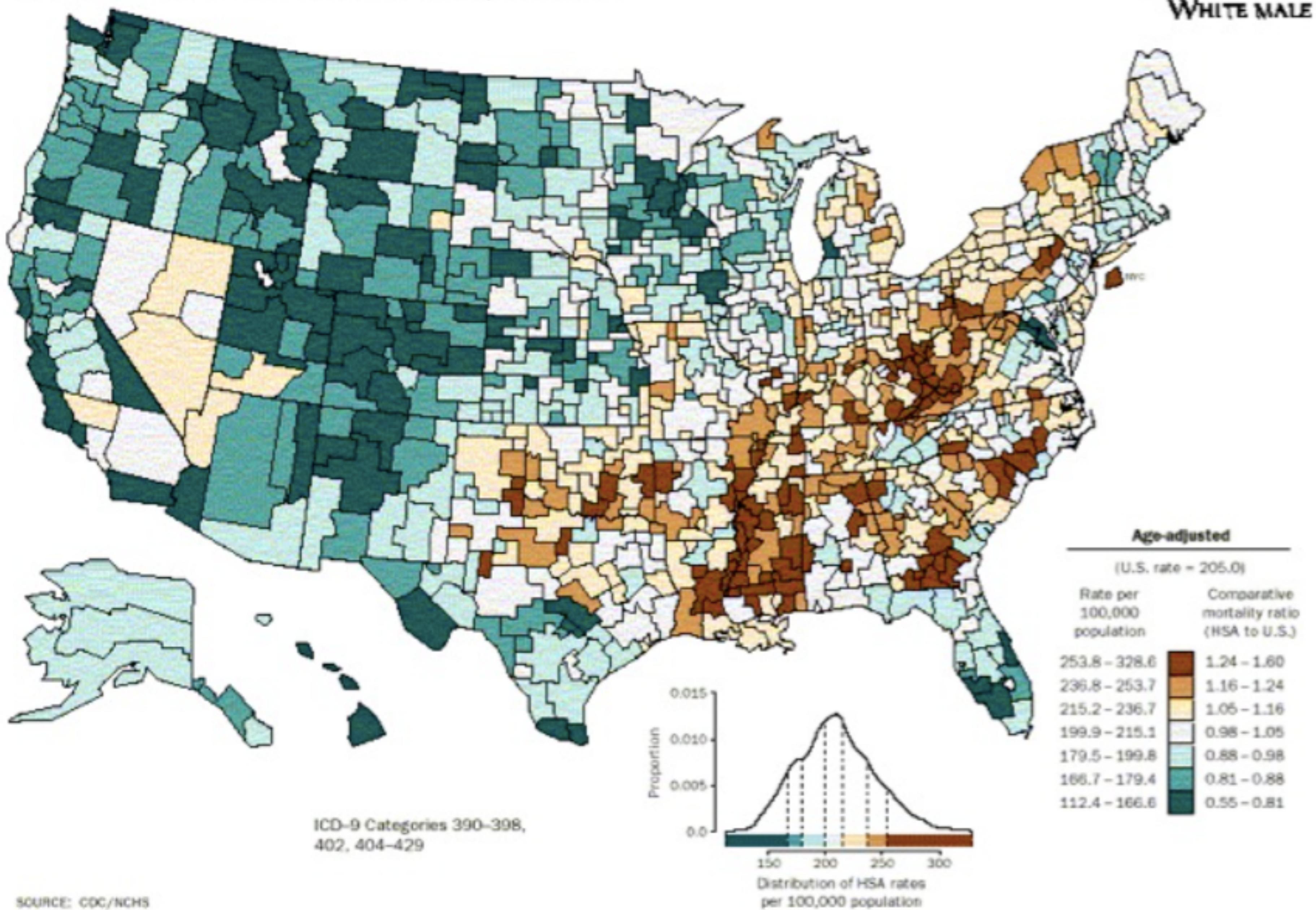
3
2
1
0



Shear
Stress (Pa)

3
2
1
0

AGE-ADJUSTED DEATH RATES BY HSA, 1988-92

HEART DISEASE
WHITE MALE

Age-adjusted

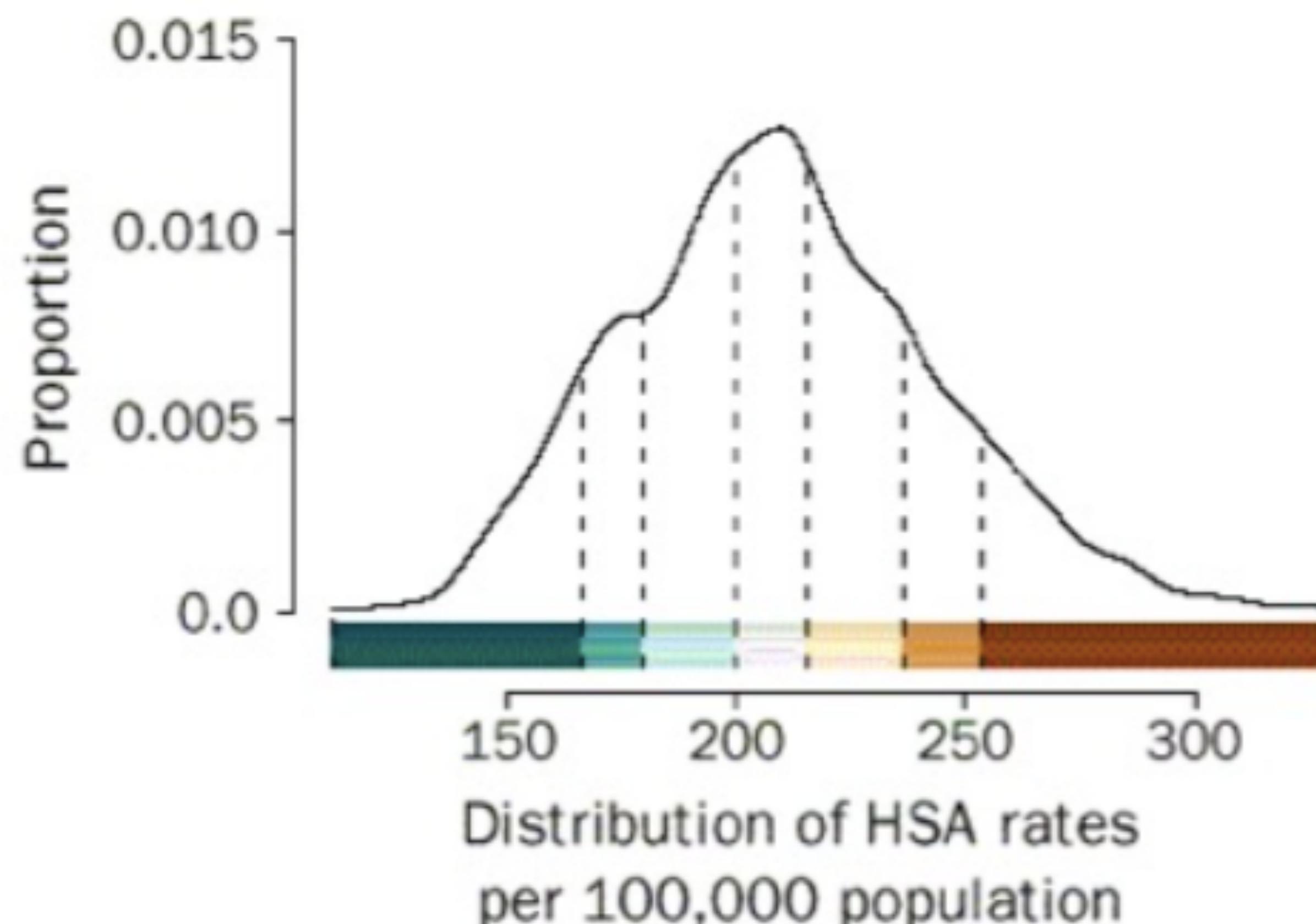
(U.S. rate = 205.0)

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)

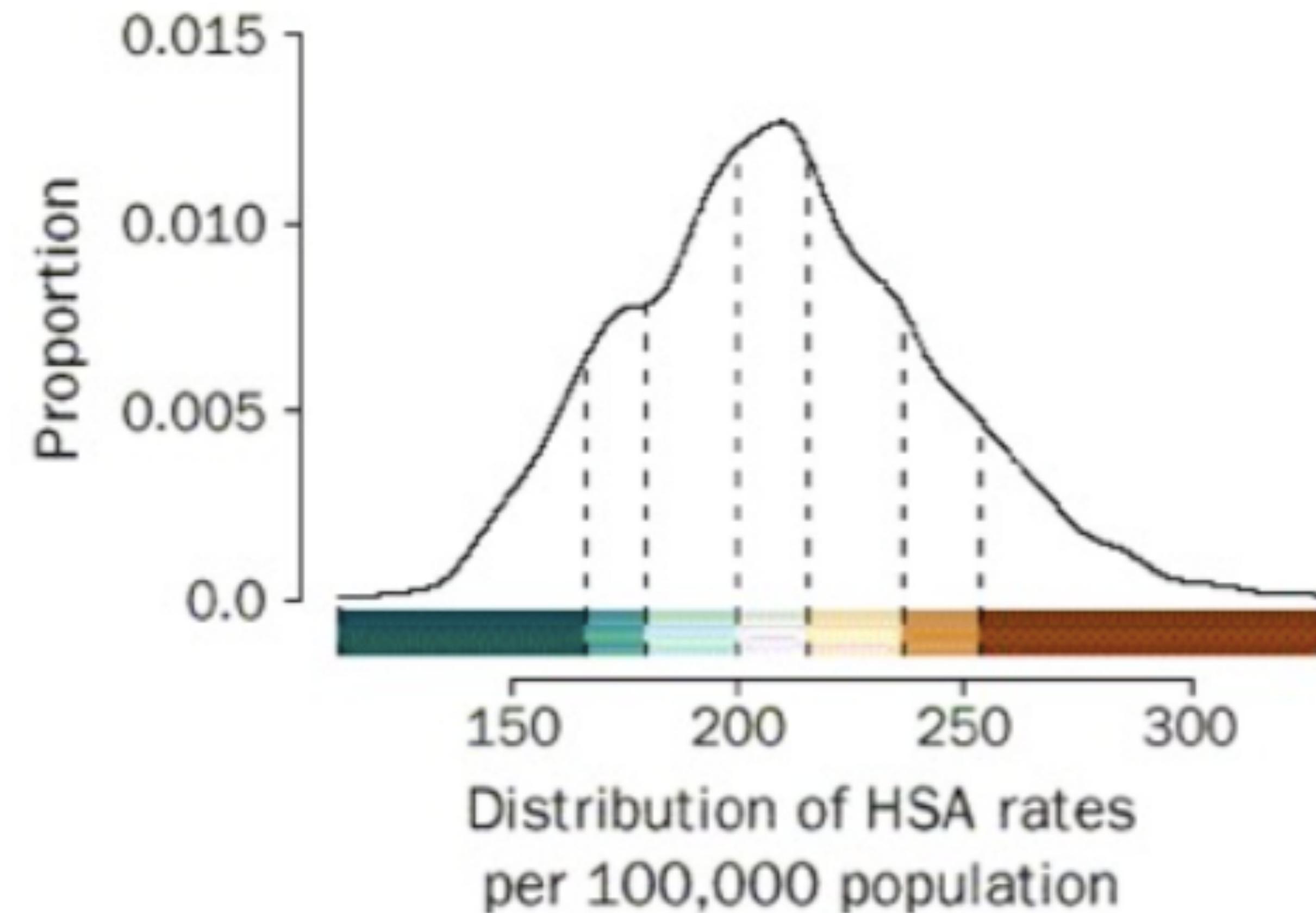
Rate per 100,000 population	Comparative mortality ratio (HSA to U.S.)
253.8 - 328.6	1.24 - 1.60
236.8 - 253.7	1.16 - 1.24
215.2 - 236.7	1.05 - 1.16
199.9 - 215.1	0.98 - 1.05
179.5 - 199.8	0.88 - 0.98
166.7 - 179.4	0.81 - 0.88
112.4 - 166.6	0.55 - 0.81



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:

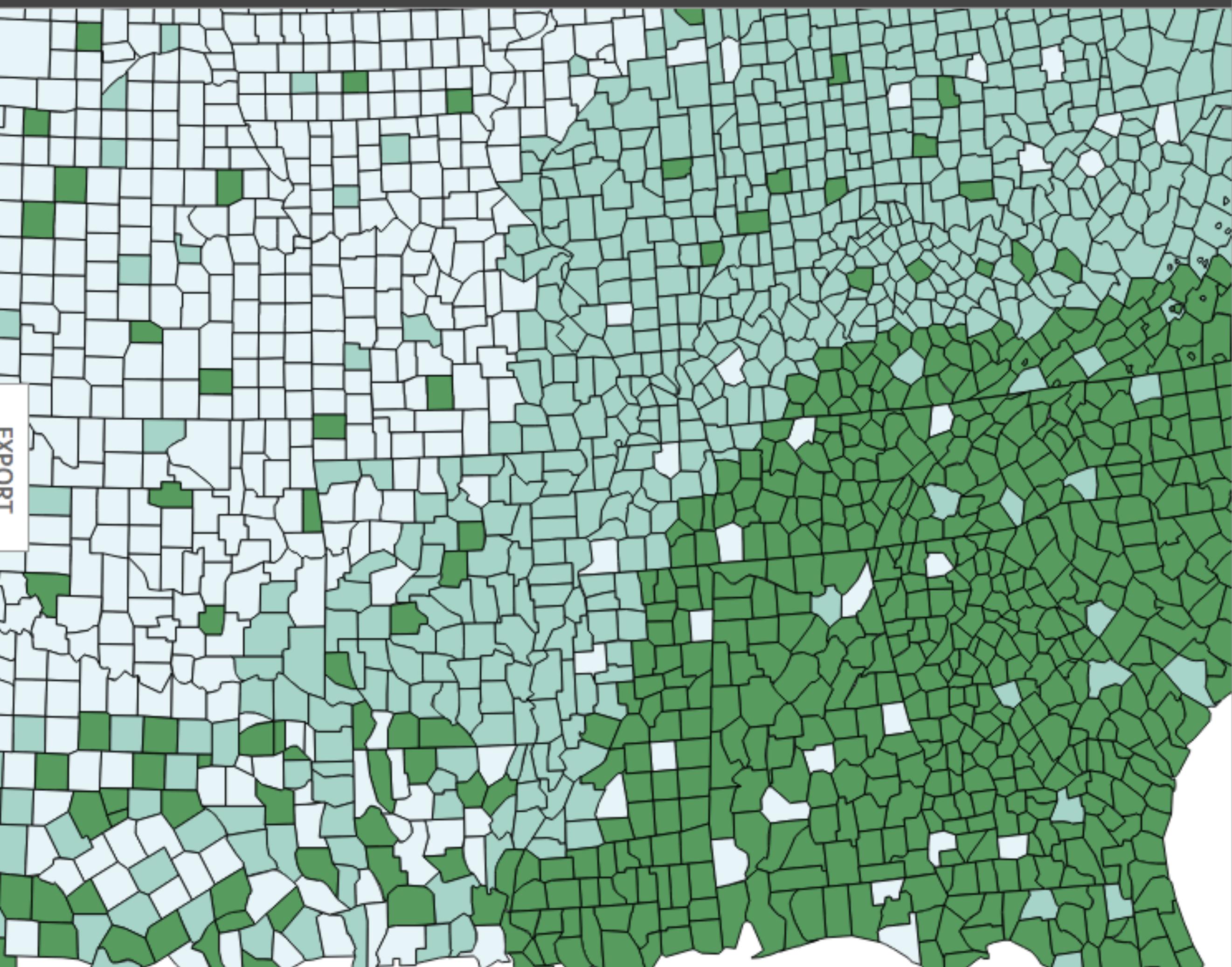
- solid color
- terrain

color transparency

[how to use](#) | [updates](#) | [downloads](#) | [credits](#)

COLORBREWER 2.0

color advice for cartography



i

3-class BuGn



HEX

#e5f5f9

#99d8c9

#2ca25f

EXPORT

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

 axismaps

<http://colorbrewer2.org/>

Generate



Number of colors

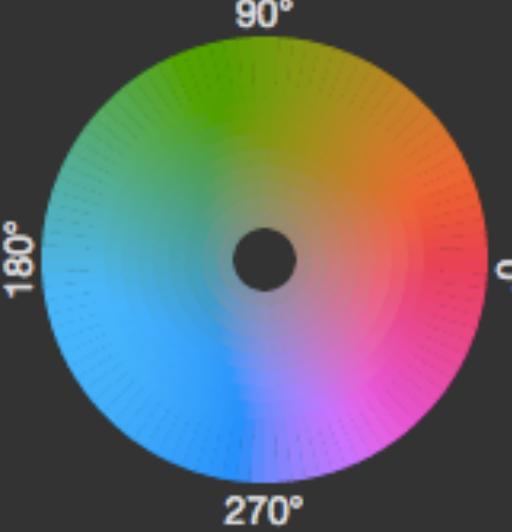
Score importance

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
CSV
JSON
PDF
Clear all



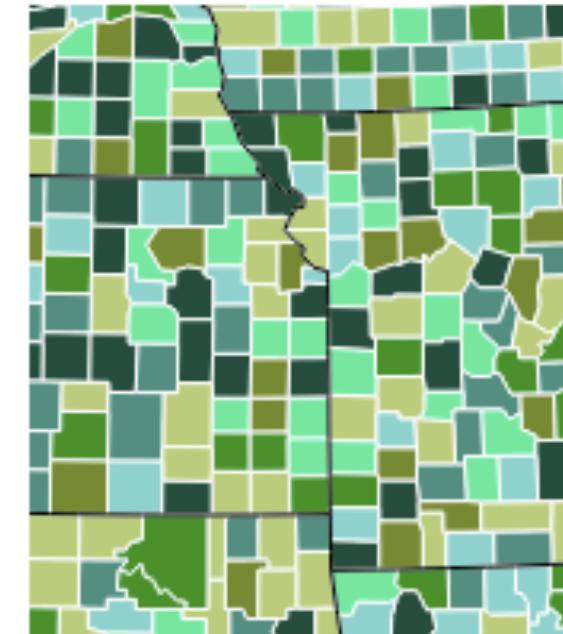
["rgb(57,146,131)", "rgb(119,214,207)", "rgb(14,80,62)", "rgb(28,241,163)"]

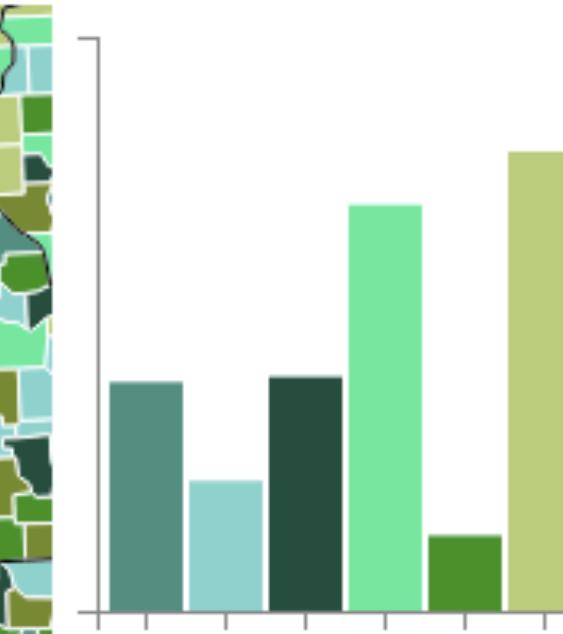
rgb(57,146,131)
+ start

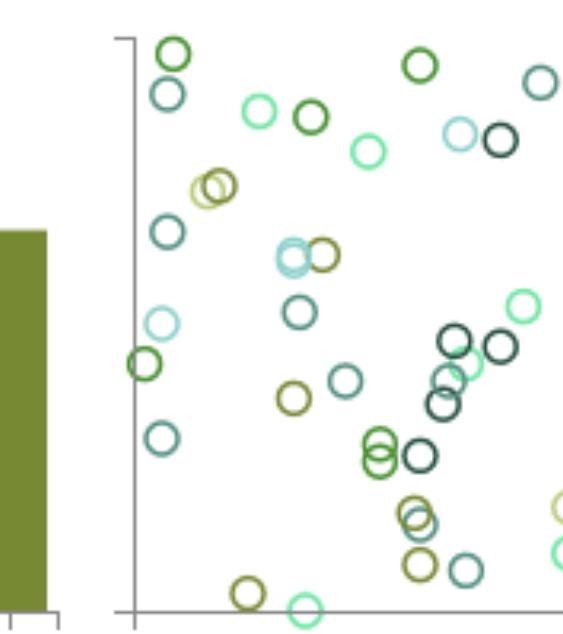
rgb(119,214,207)
+ start

rgb(14,80,62)
+ start

rgb(28,241,163)
+ start







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 Graphics},
  title={Colorgorical: creating discriminable and preferable color palettes},
  year={2017}
}
```

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

View

All Themes

Most Popular

Week Month All

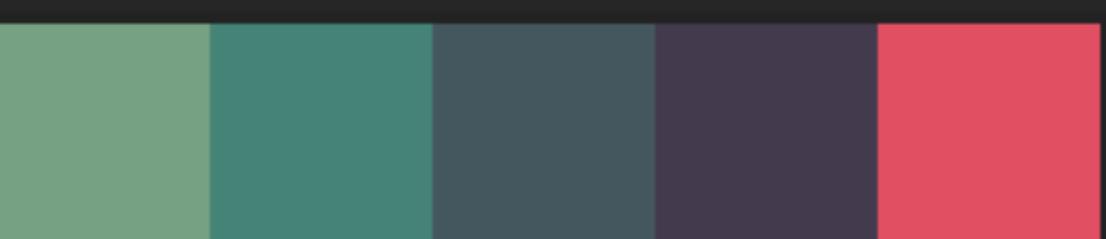
Most Used

Random



QB Studio

550 413 0



Copy of CC02

273 242 0



Deep Under the...

218 188 0



Modern Executive

343 188 0



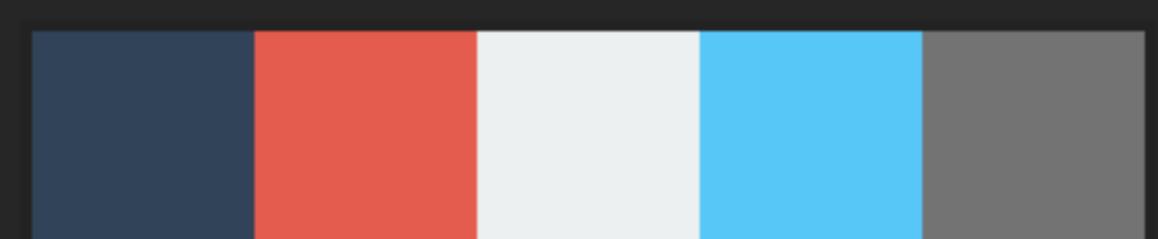
Summer Beach

140 136 1



friends

146 130 0



Copy of A Creati...

197 128 0



Annie Colour Sc...

135 115 0



HAI IN THE SEA

158 105 1



Warm

107 97 0



Man Pink

104 92 0



Copy of Close to ...

123 88 1



MY GL

65 75 0



Copy of Capri

58 74 0



Efendi

90 70 0

kuler.adobe.com/explore/

51%



40%



29%



21%



16-19

20-23

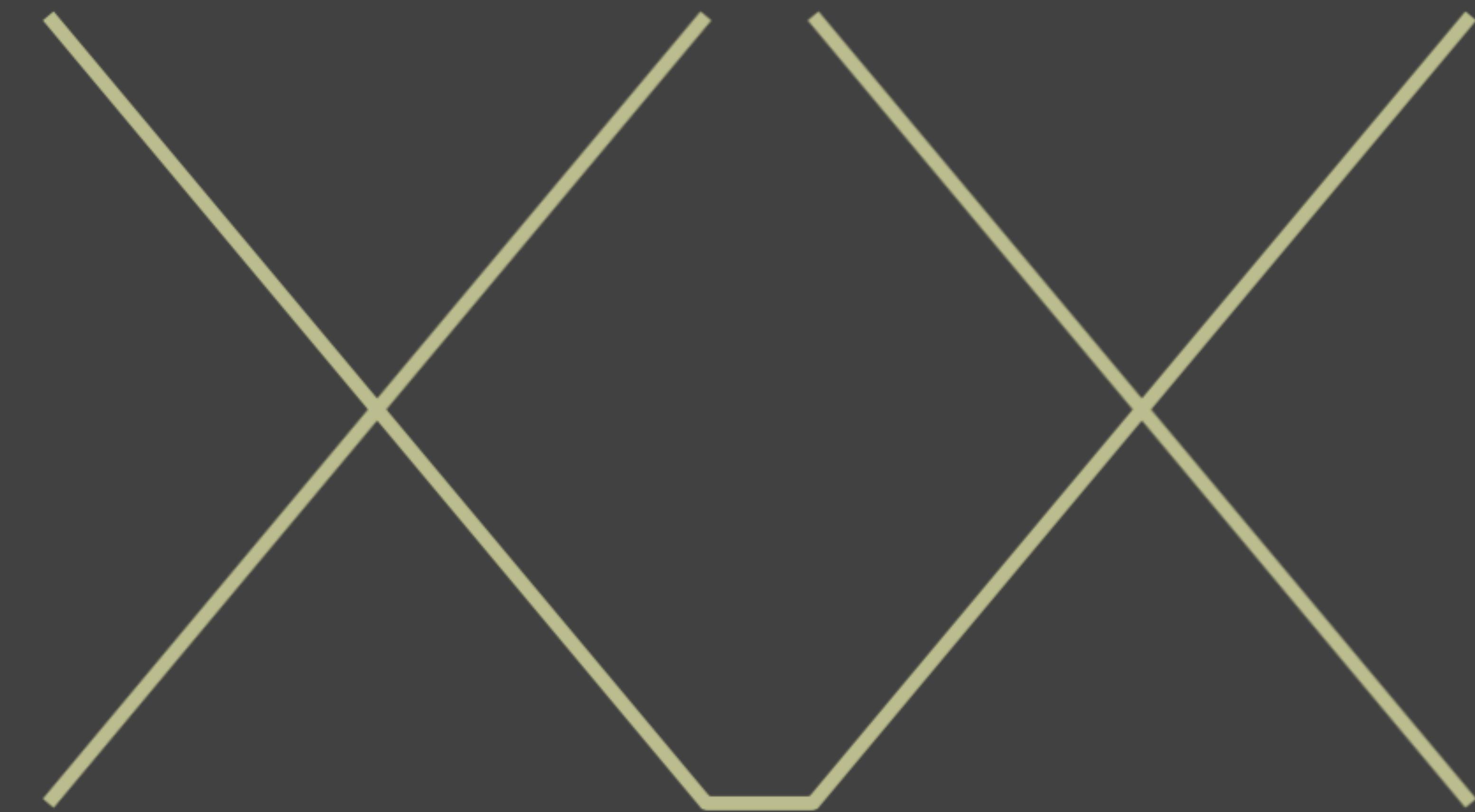
24-29

**early
30s**



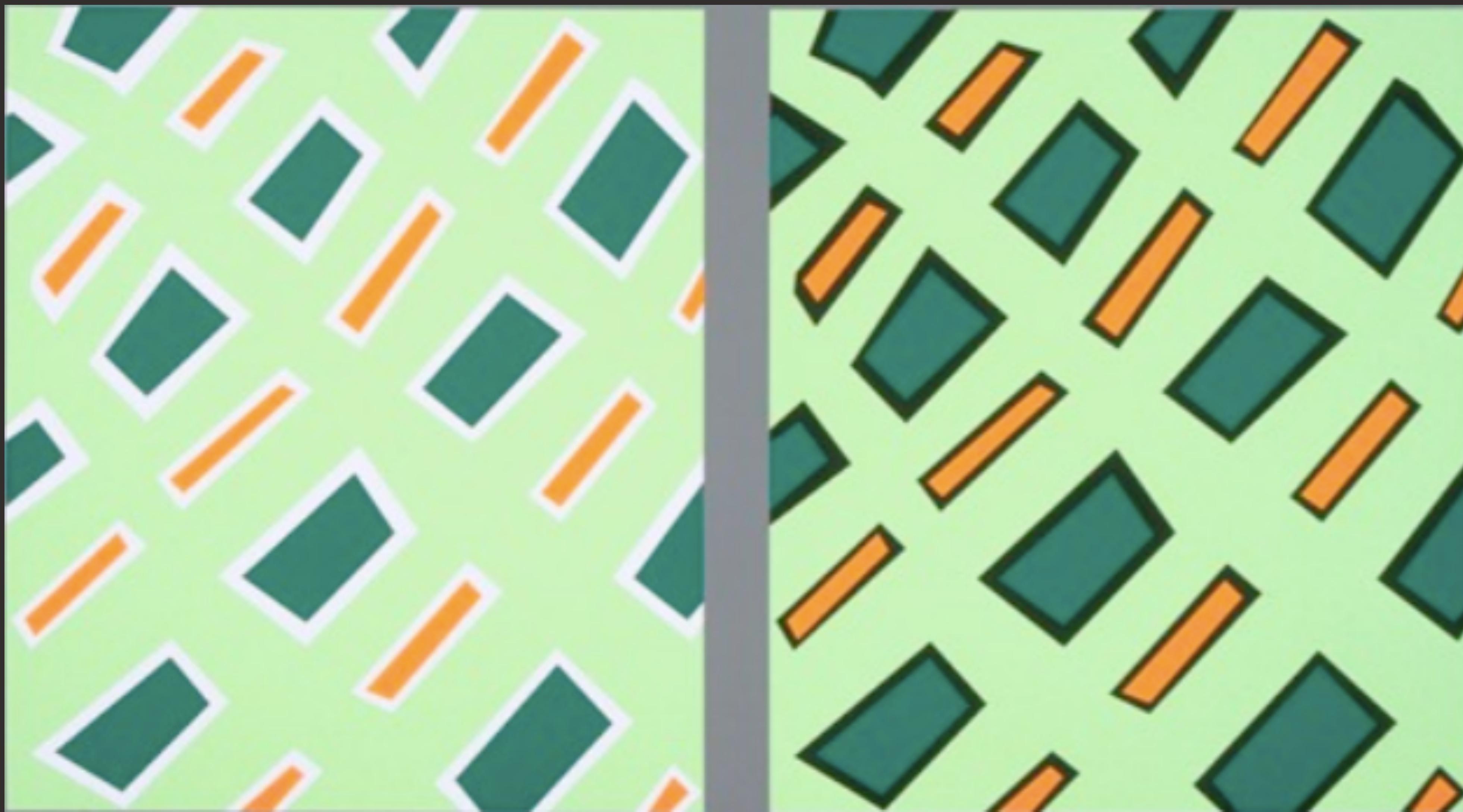
Color
Caveats





Contrast

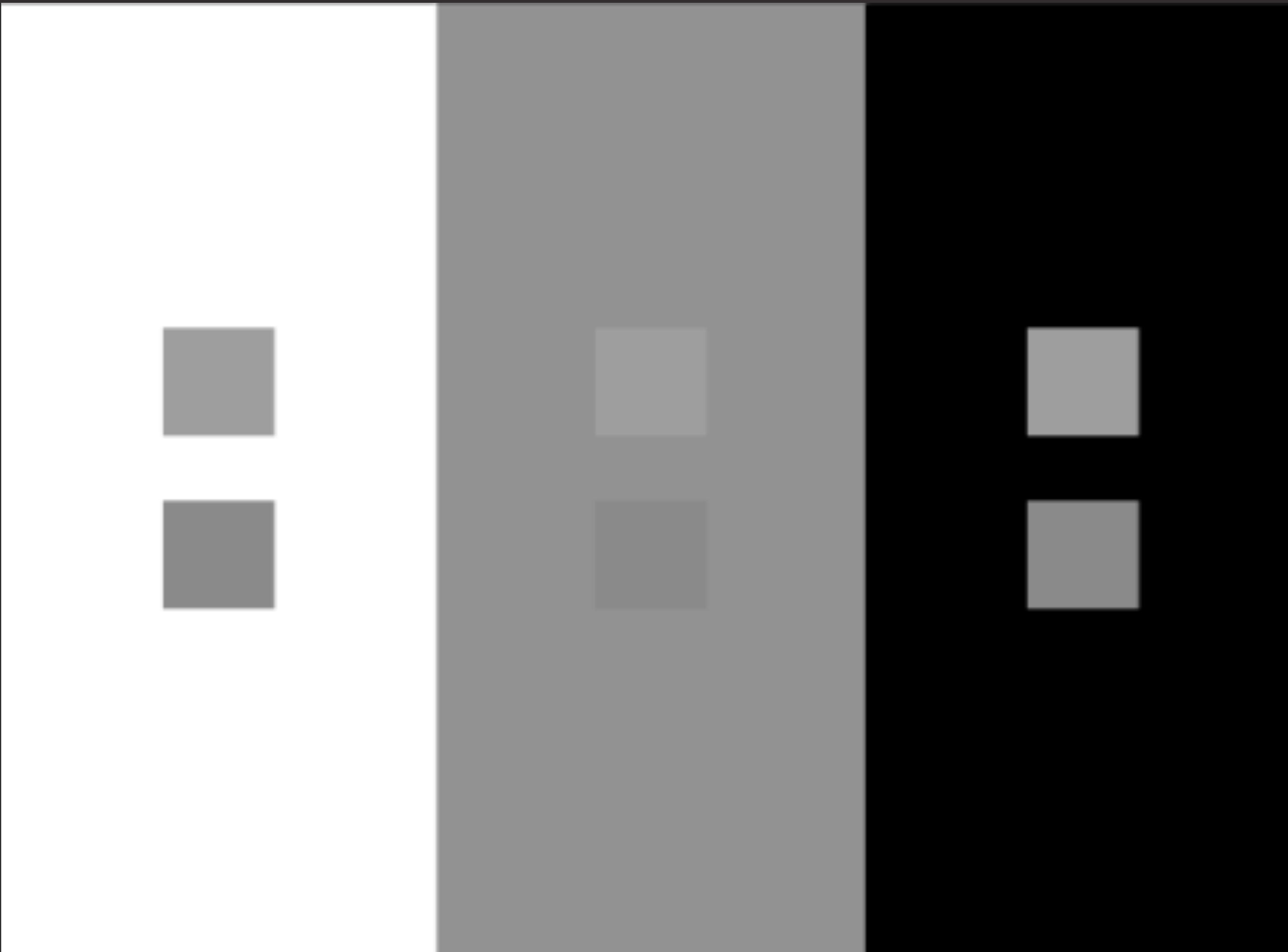
Effects



A field guide to Digital Color, Maureen Stone

Bezold

Effect



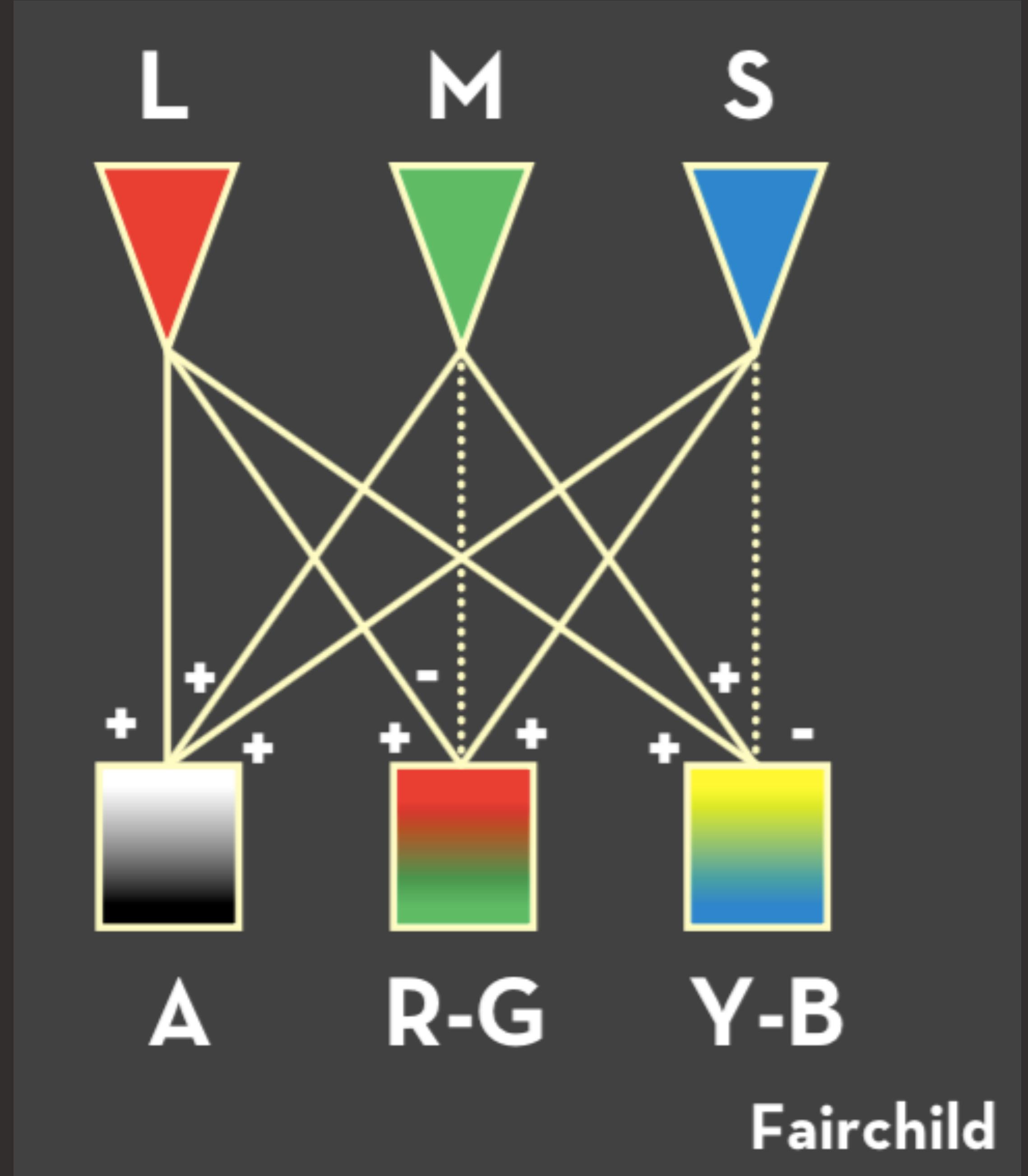
“Crispening”

Legibility and readability are very important

Color
Blindness

Remember?

Long
Middle
Short

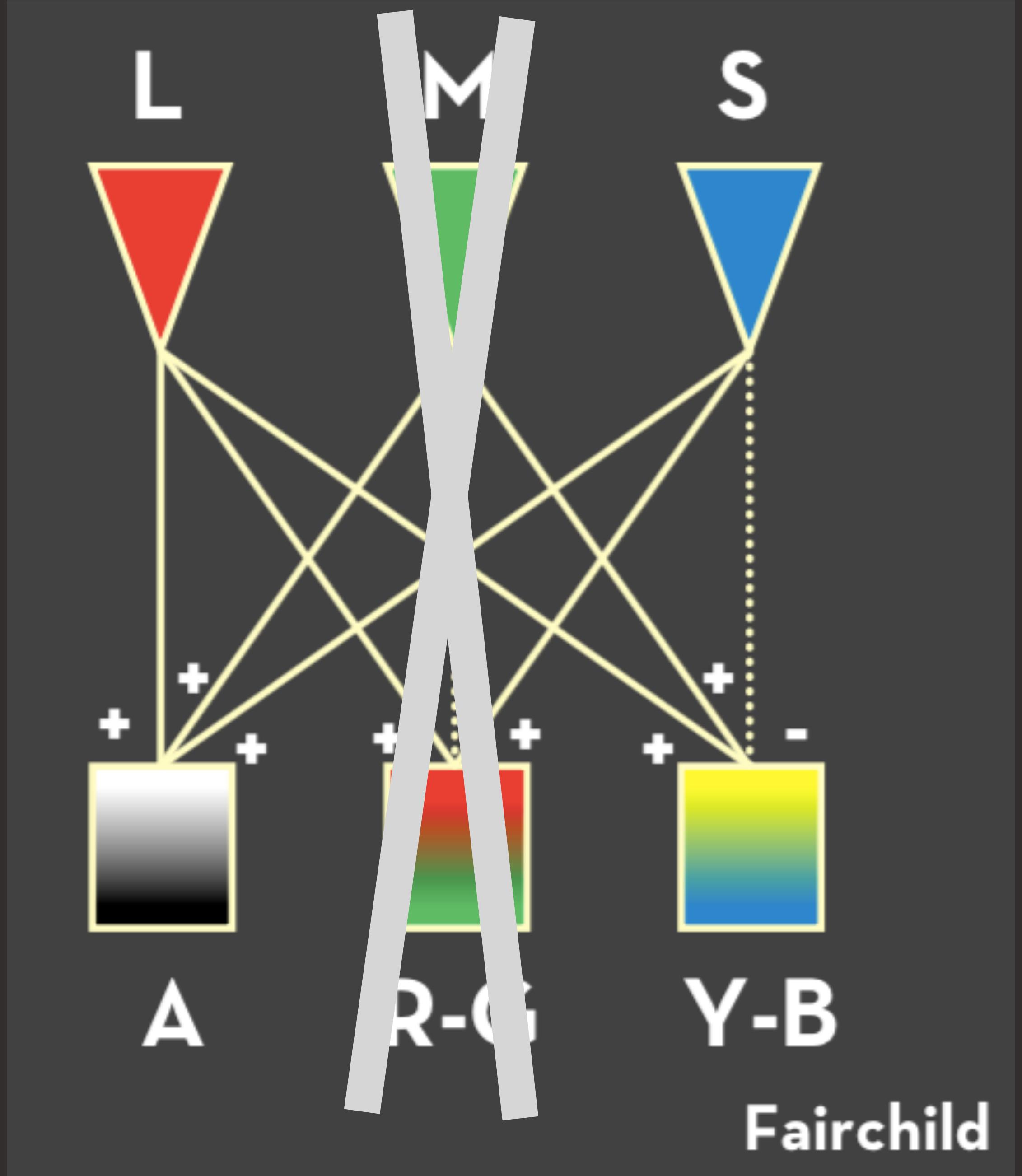


What if you're missing medium cones?

Long

Middle

Short



Colorblindness Types

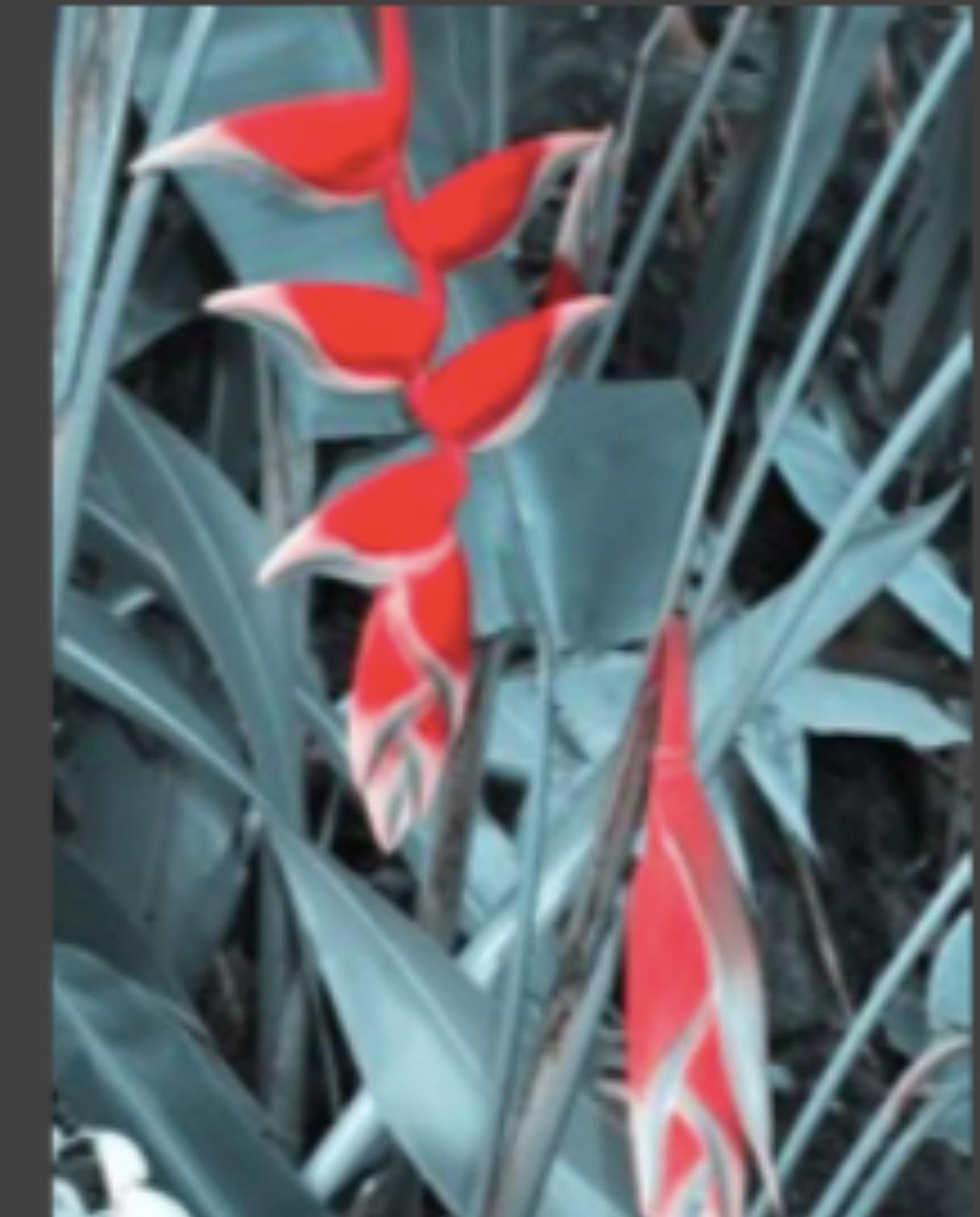
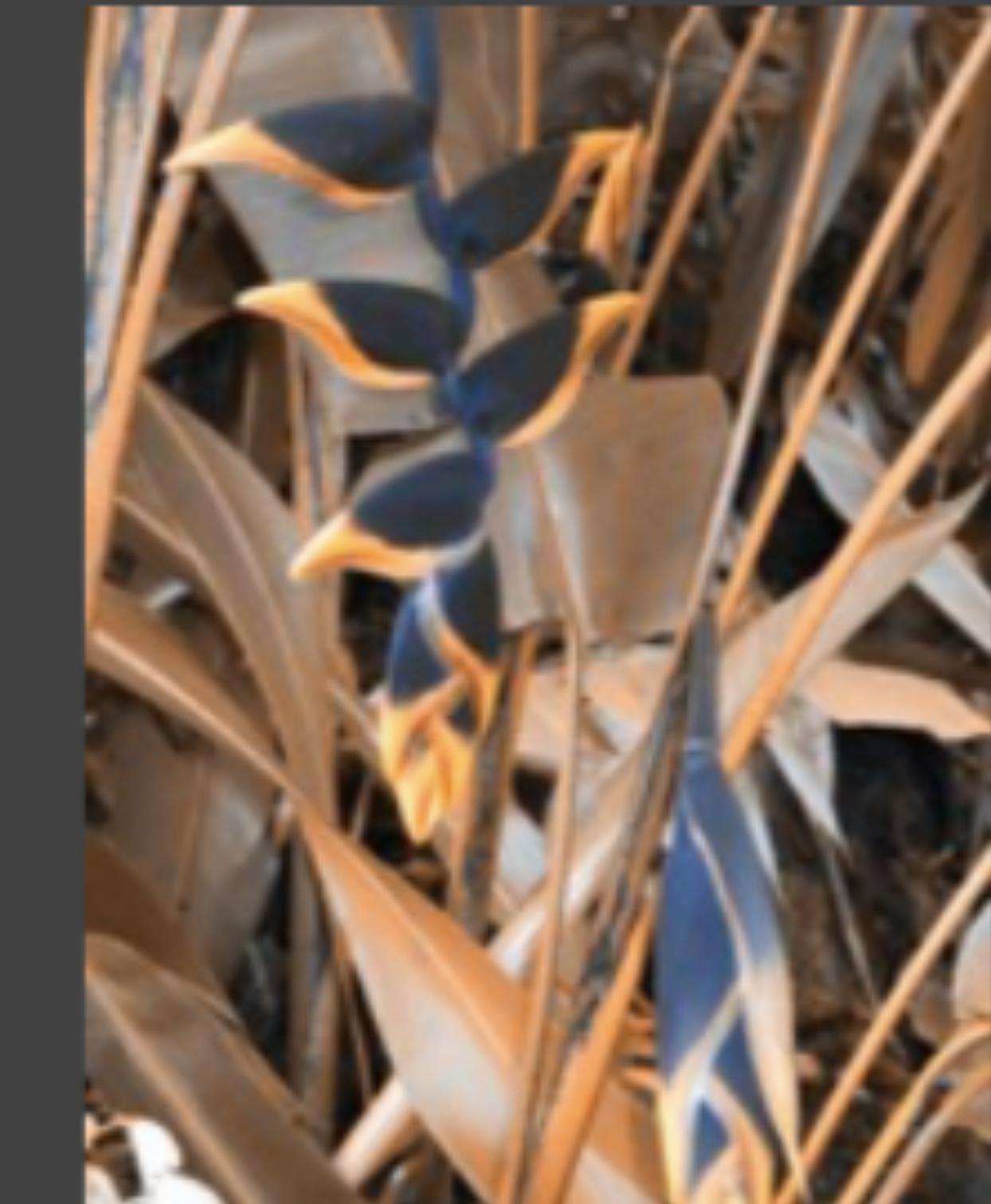
normal



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.

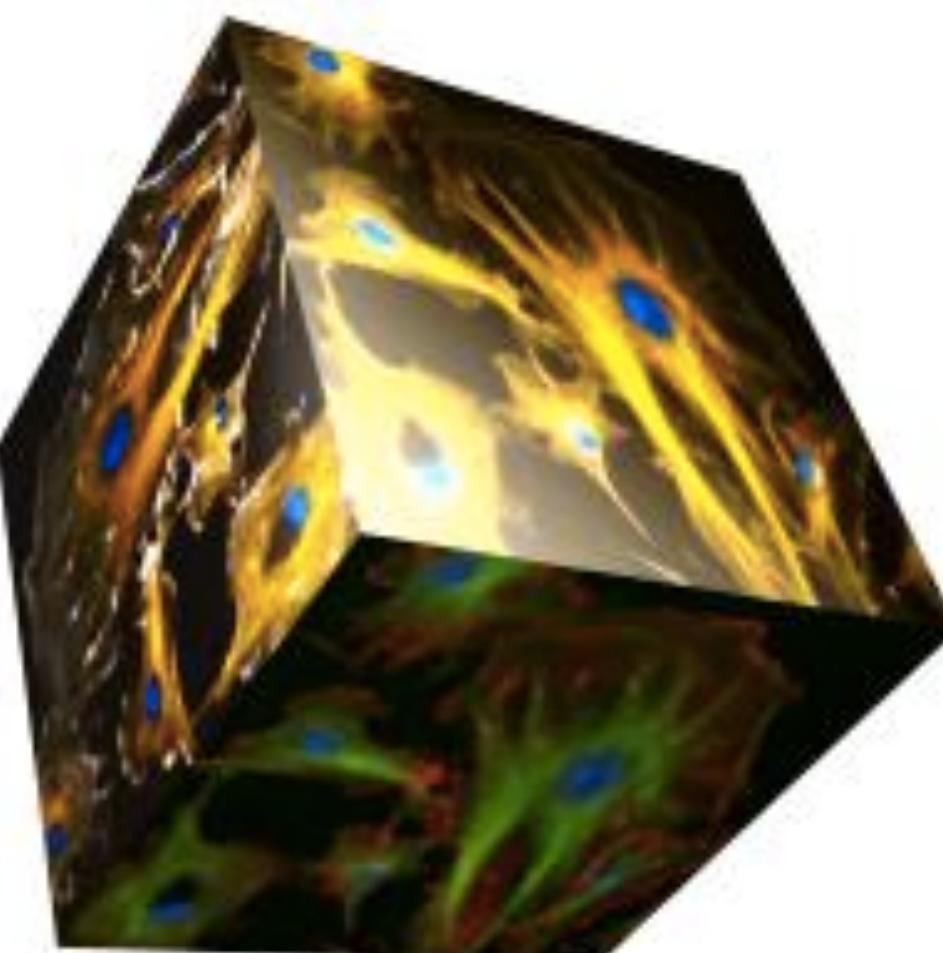


[Home](#)[Vischeck](#)[Daltonize](#)[Examples](#)[Downloads](#)[Info & Links](#)[FAQ](#)[About Us](#)**User quotes:**

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](#).

A painting of a still life arrangement featuring a red jar, a white vase, and various fruits like grapes and berries.

"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