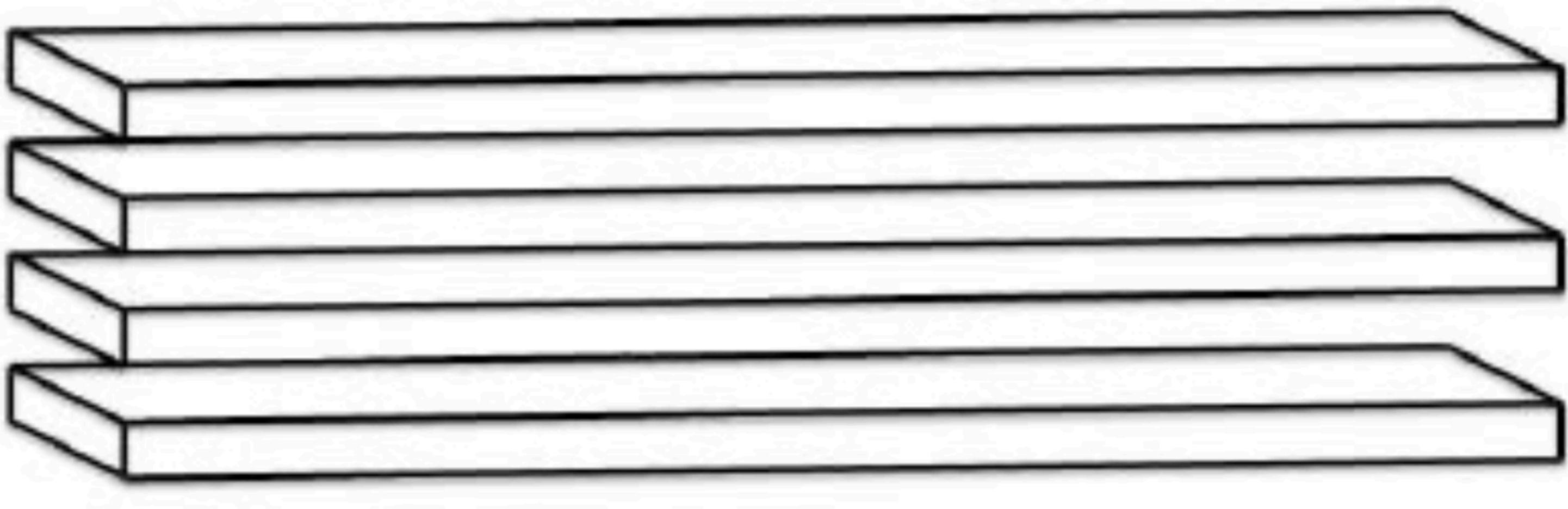


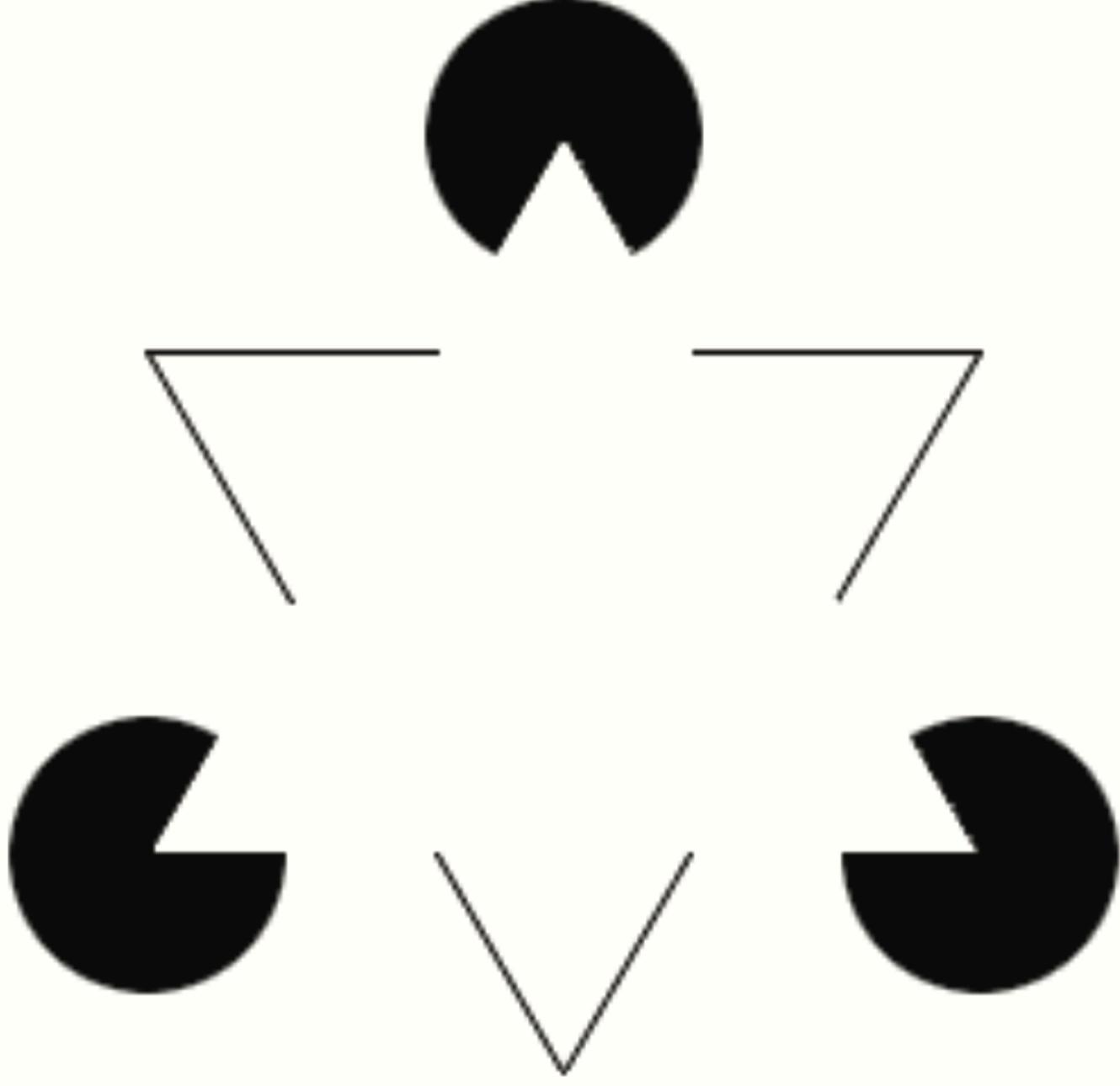
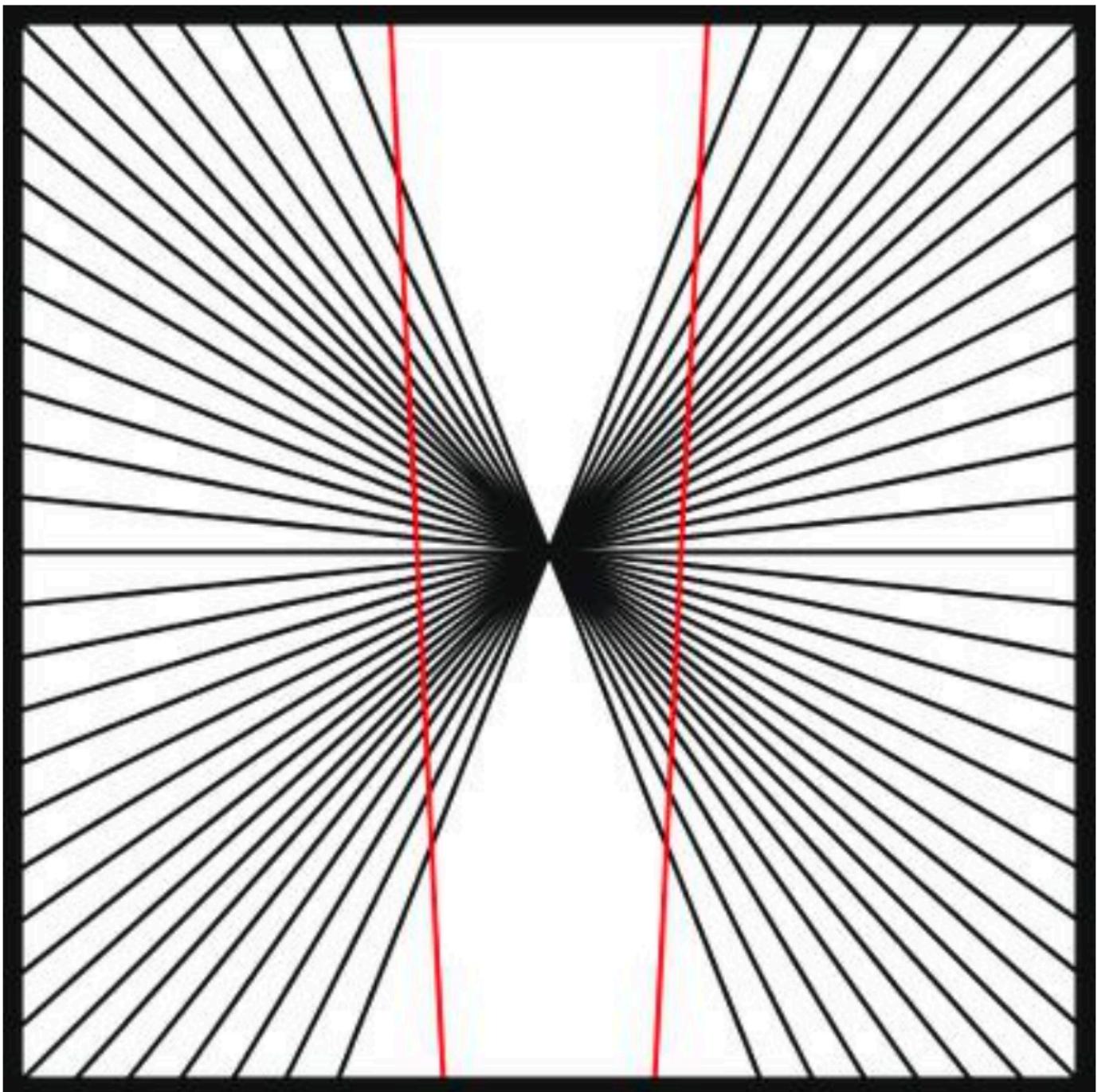
Lecture : Color in Visualization Design

(The basics)

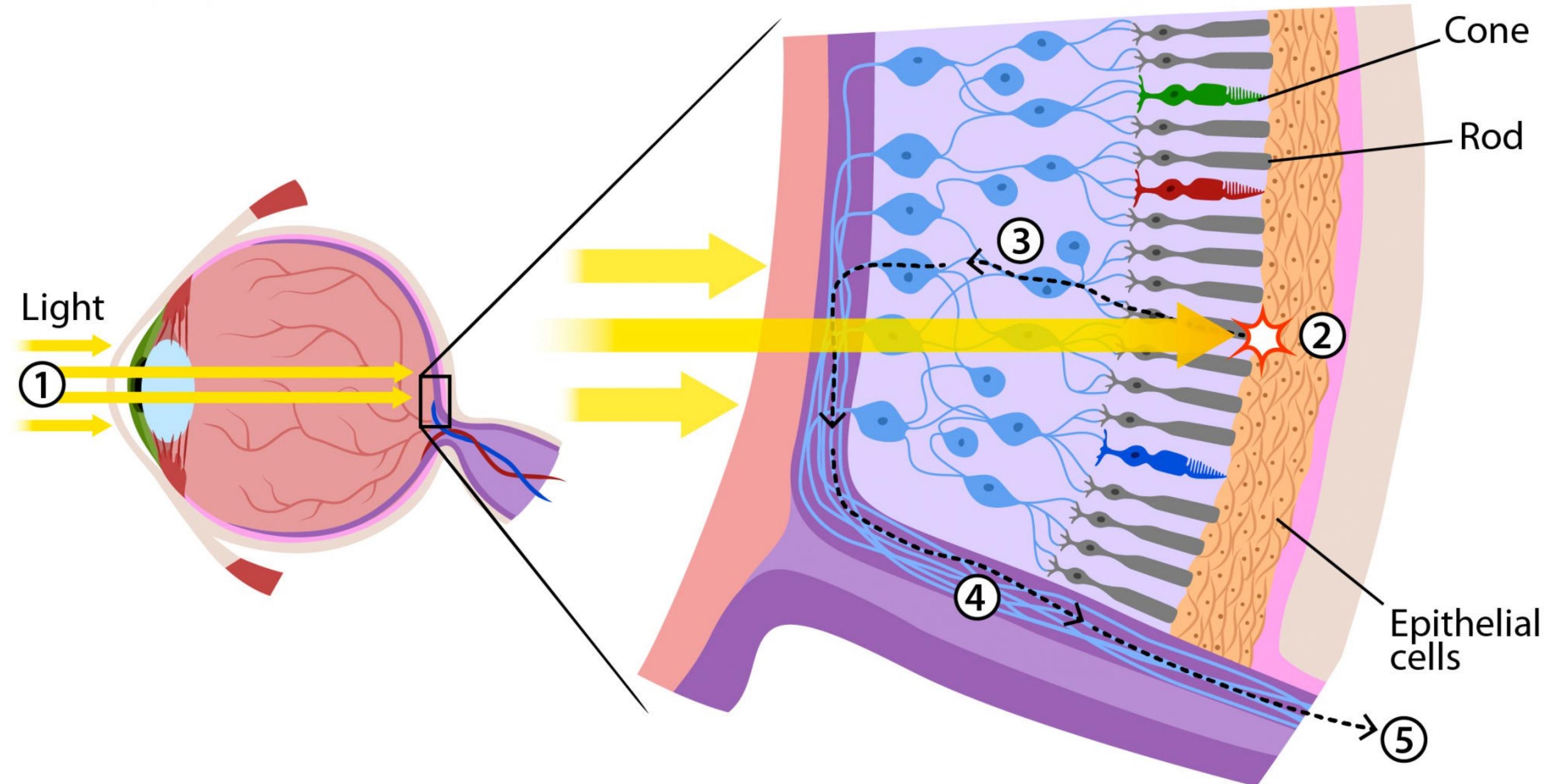
DATA ANALYSIS & VISUALIZATION
FALL 2021

Dr. Muhammad Faisal Cheema
FASTNU

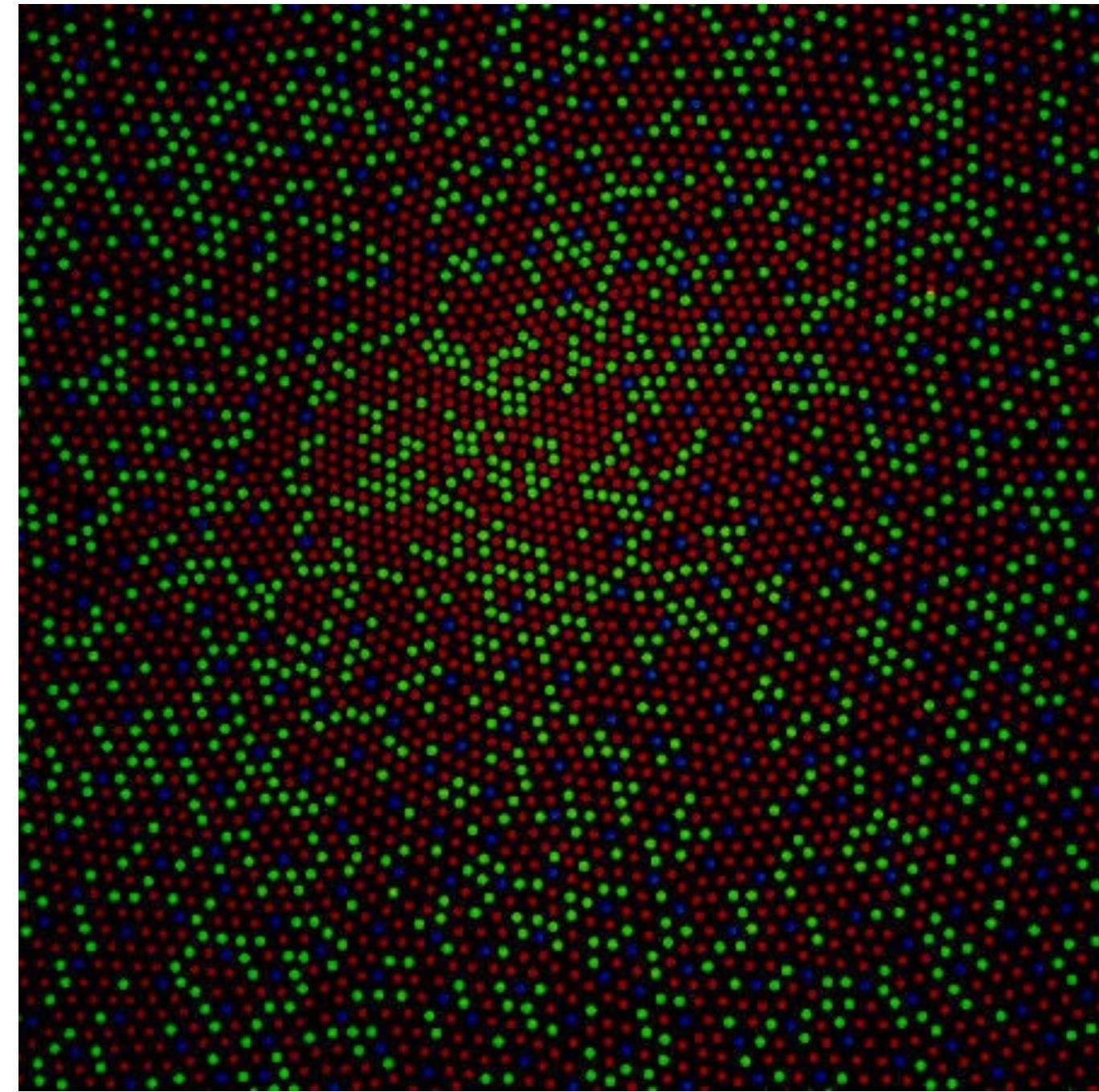
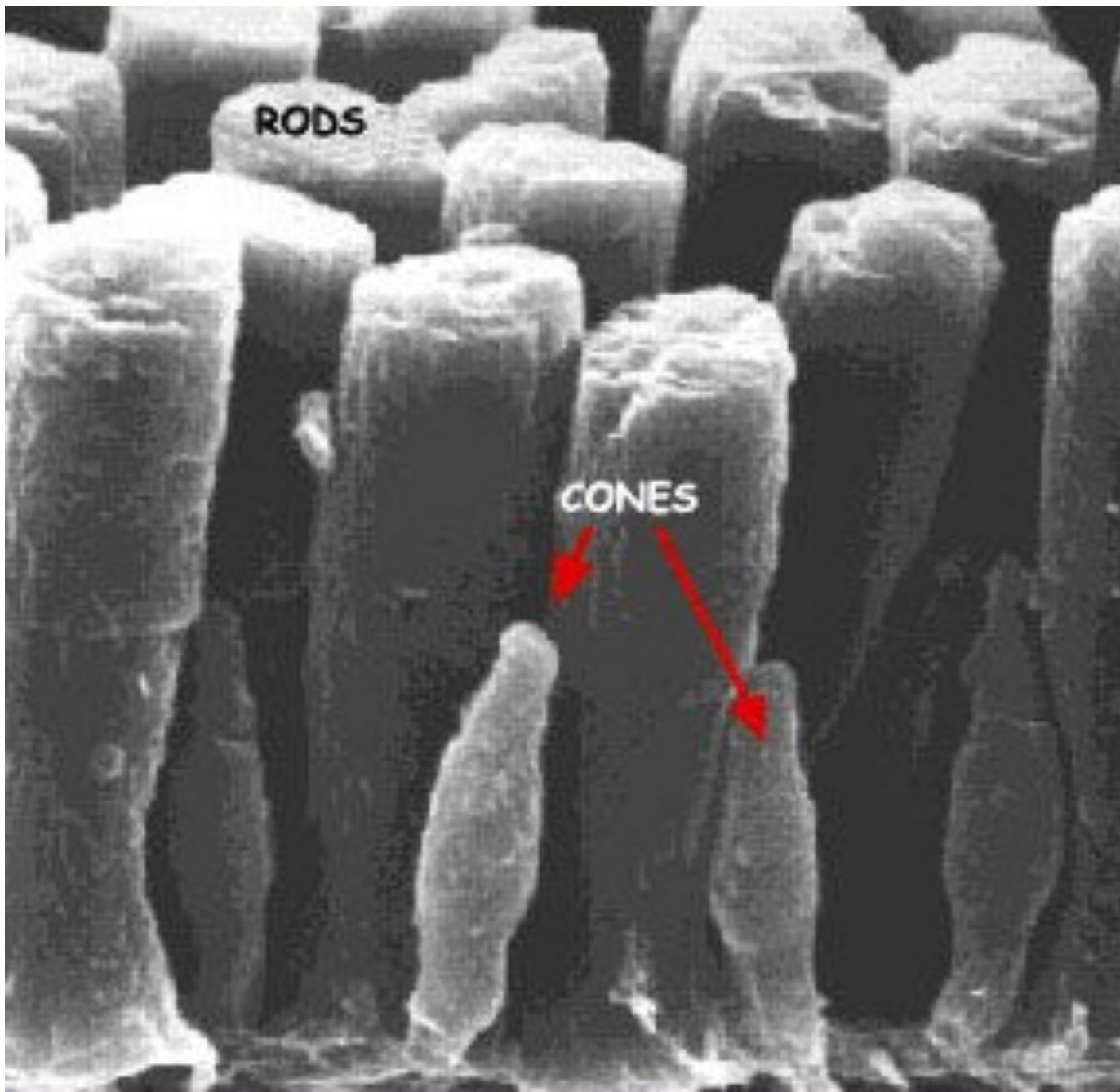




CONES & RODS



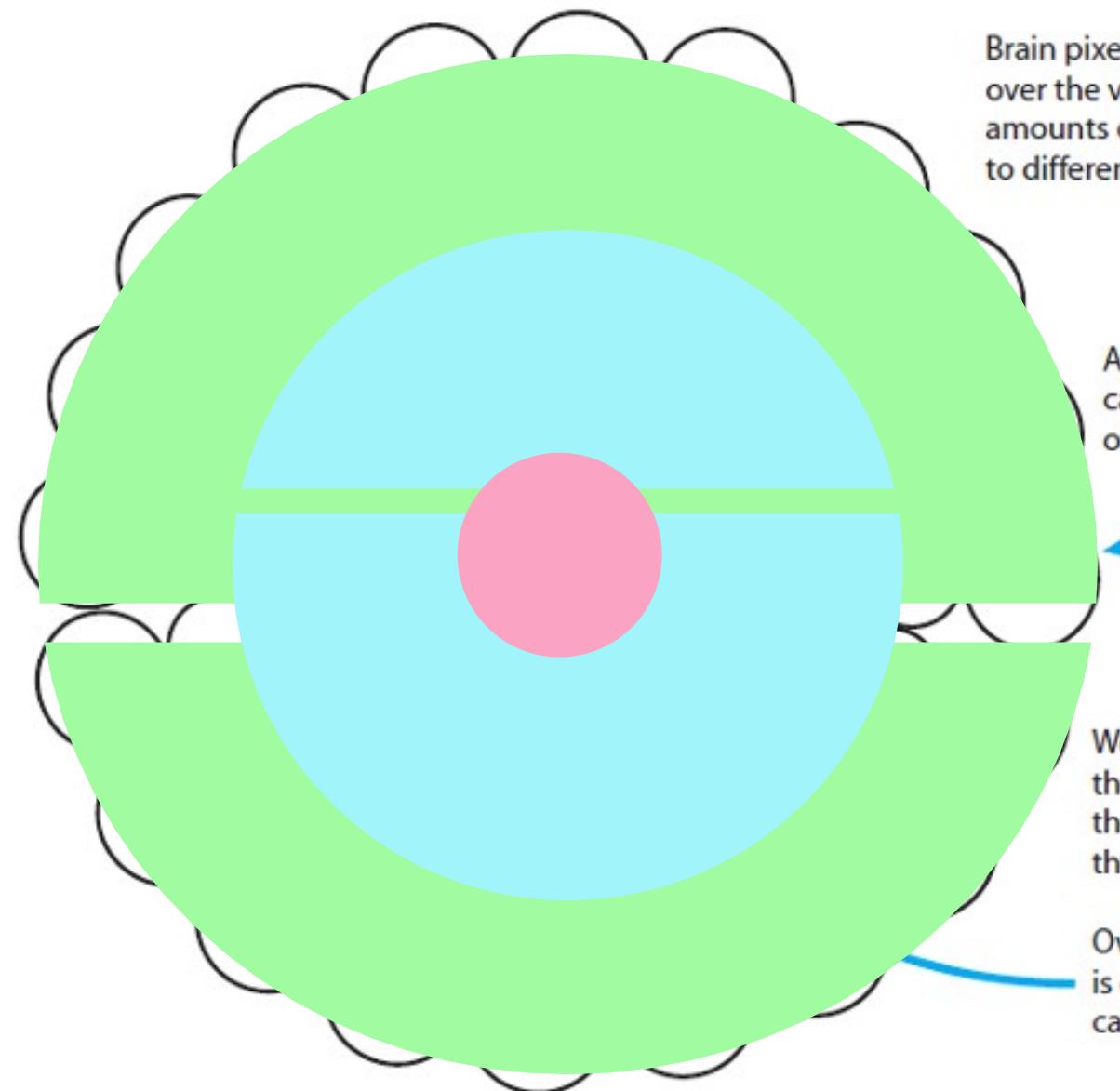
CONES & RODS



<http://i.stack.imgur.com/wbcE.jpg>

http://thebrain.mcgill.ca/flash/a/a_02/a_02_m/a_02_m_vis/a_02_m_vis.html

PERIPHERAL VISION

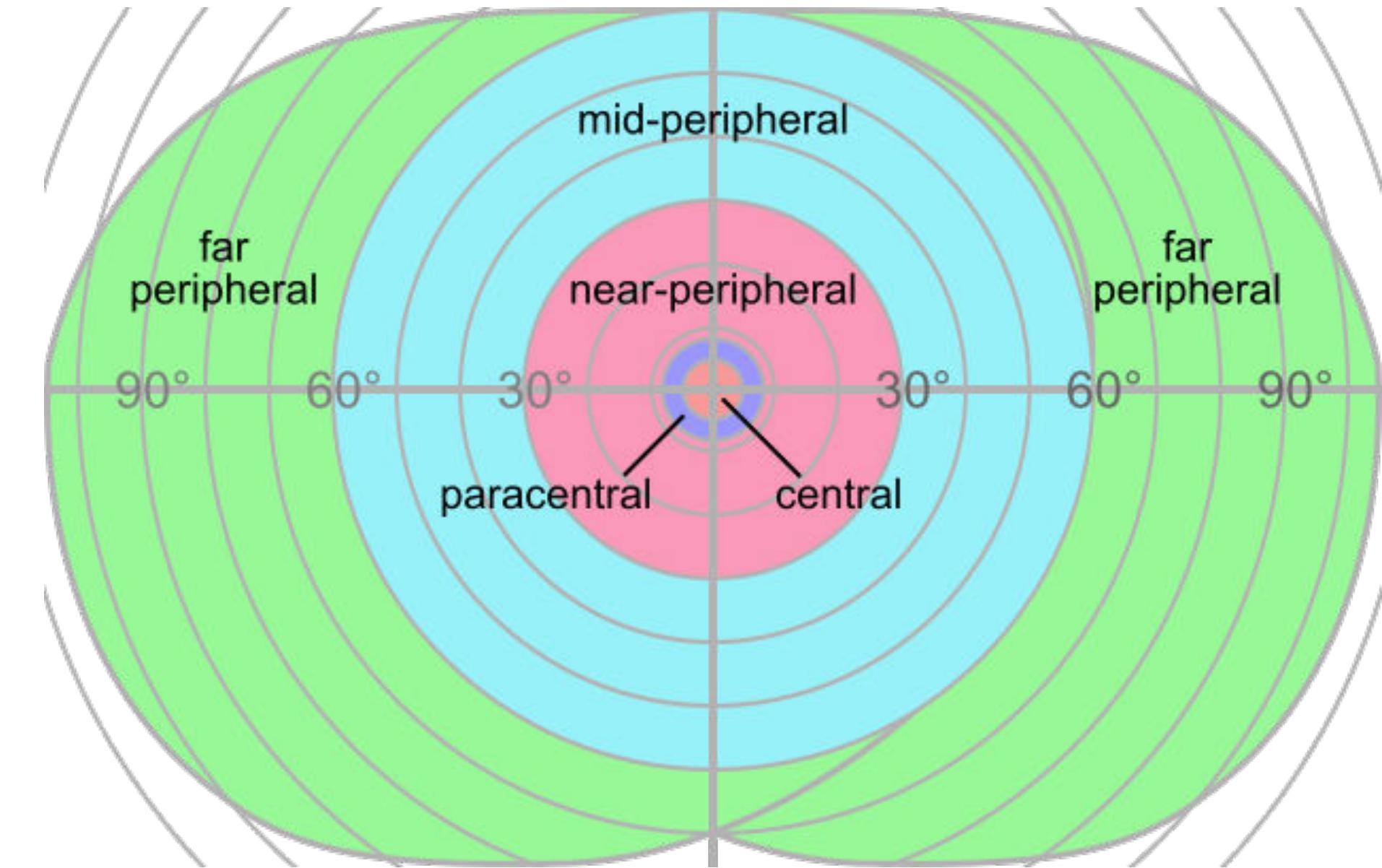


Brain pixels vary enormously in size over the visual field. This reflects differing amounts of neural processing power devoted to different regions of visual space.

At the edge of the visual field we can only barely see something the size of a fist at arm's length.

We can resolve about 100 points on the head of a pin held at arm's length in the very center of the visual field called the fovea.

Over half of our visual processing power is concentrated in a slightly larger area called the parafovea.

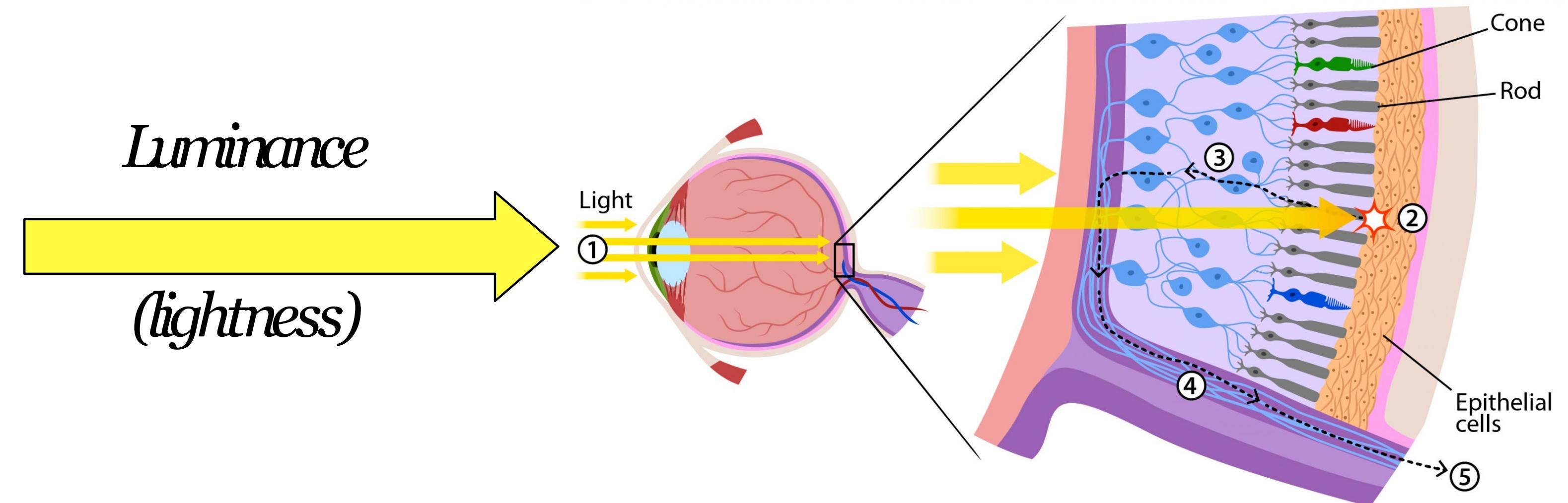


“Get it right in black and white”

-Maureen Stone

Luminance

Luminance = the amount of visible light that comes to the eye from a surface

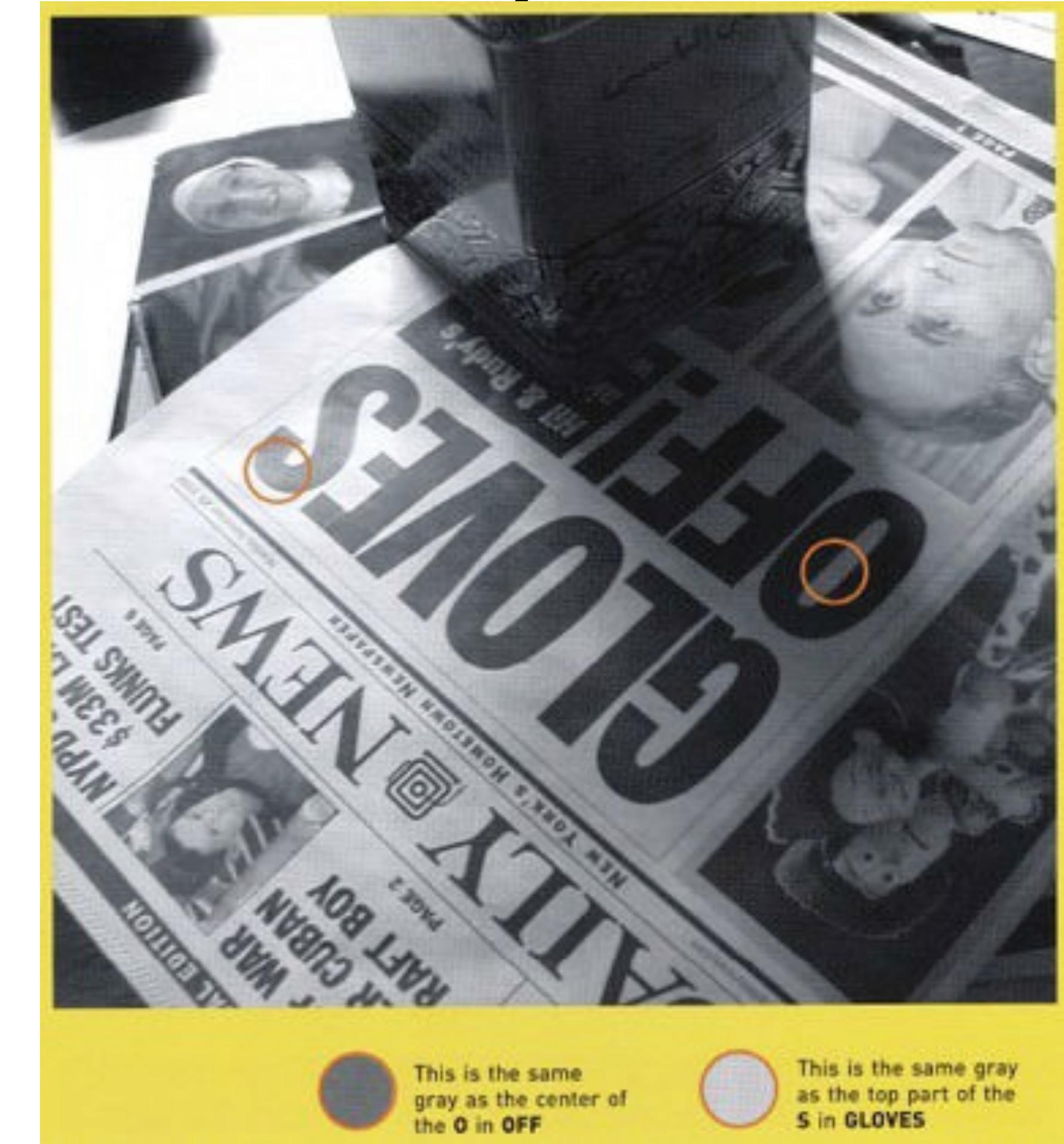


Lightness = the perceived intensity of reflected light (reflectance) from a surface

Brightness = the perceived intensity of emitted light

Lightness Constancy

The perception that the apparent brightness of light and dark surfaces remains more or less the same under different luminance conditions is called **lightness constancy**.



This is the same
gray as the center of
the O in OFF

This is the same gray
as the top part of the
S in GLOVES

“Simultaneous Contrast”



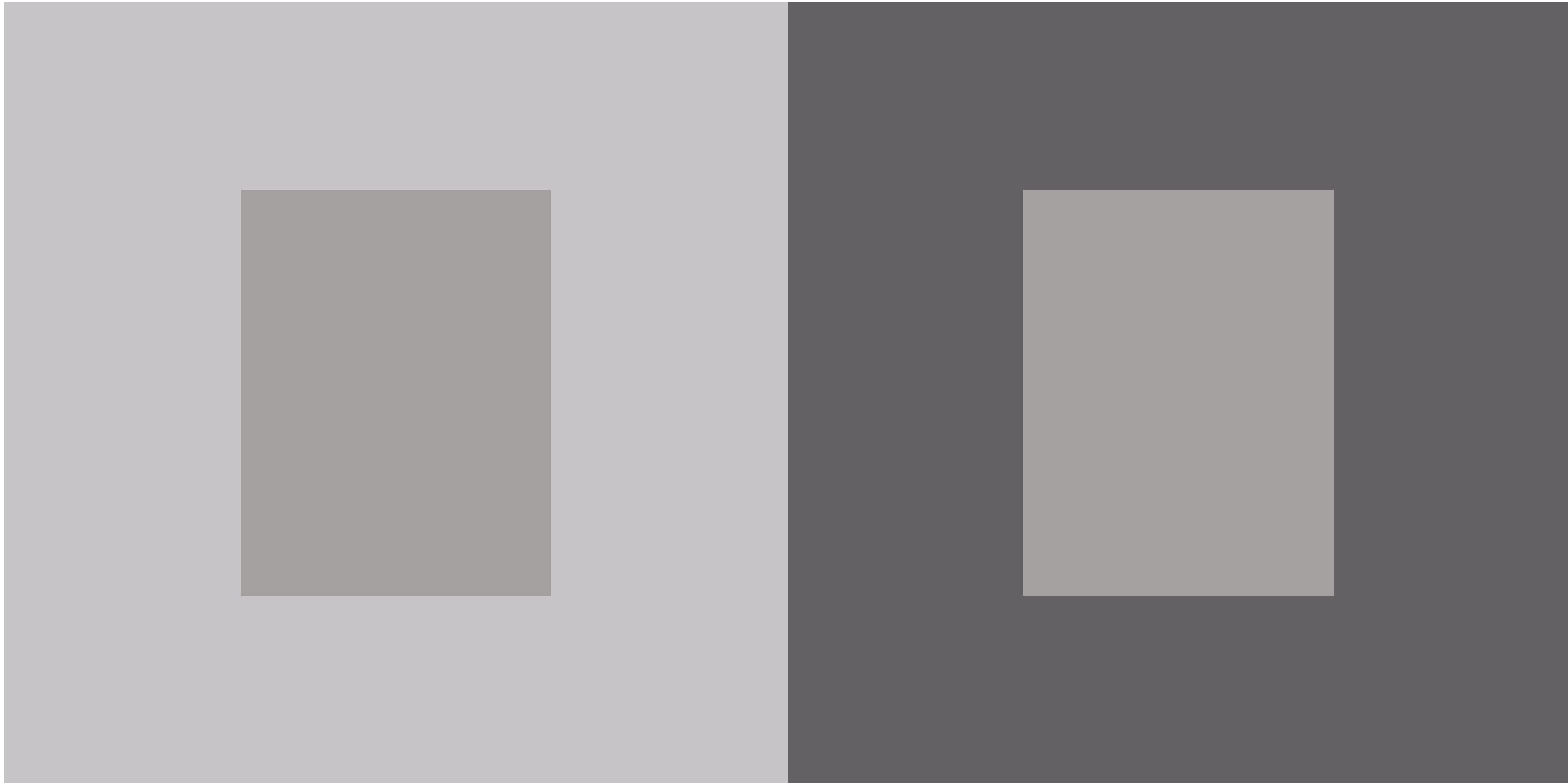
“Simultaneous Contrast”



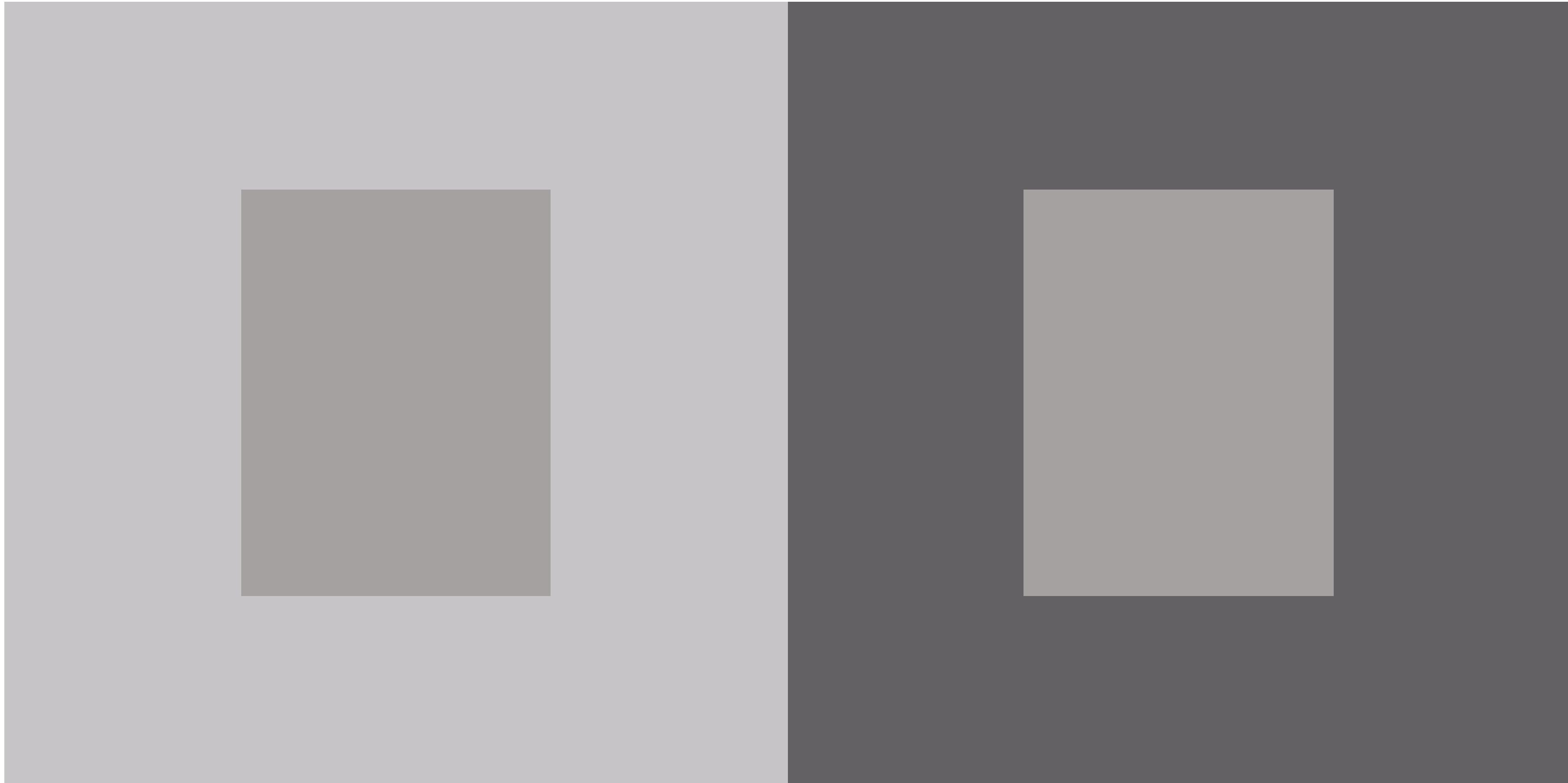
“Simultaneous Contrast”



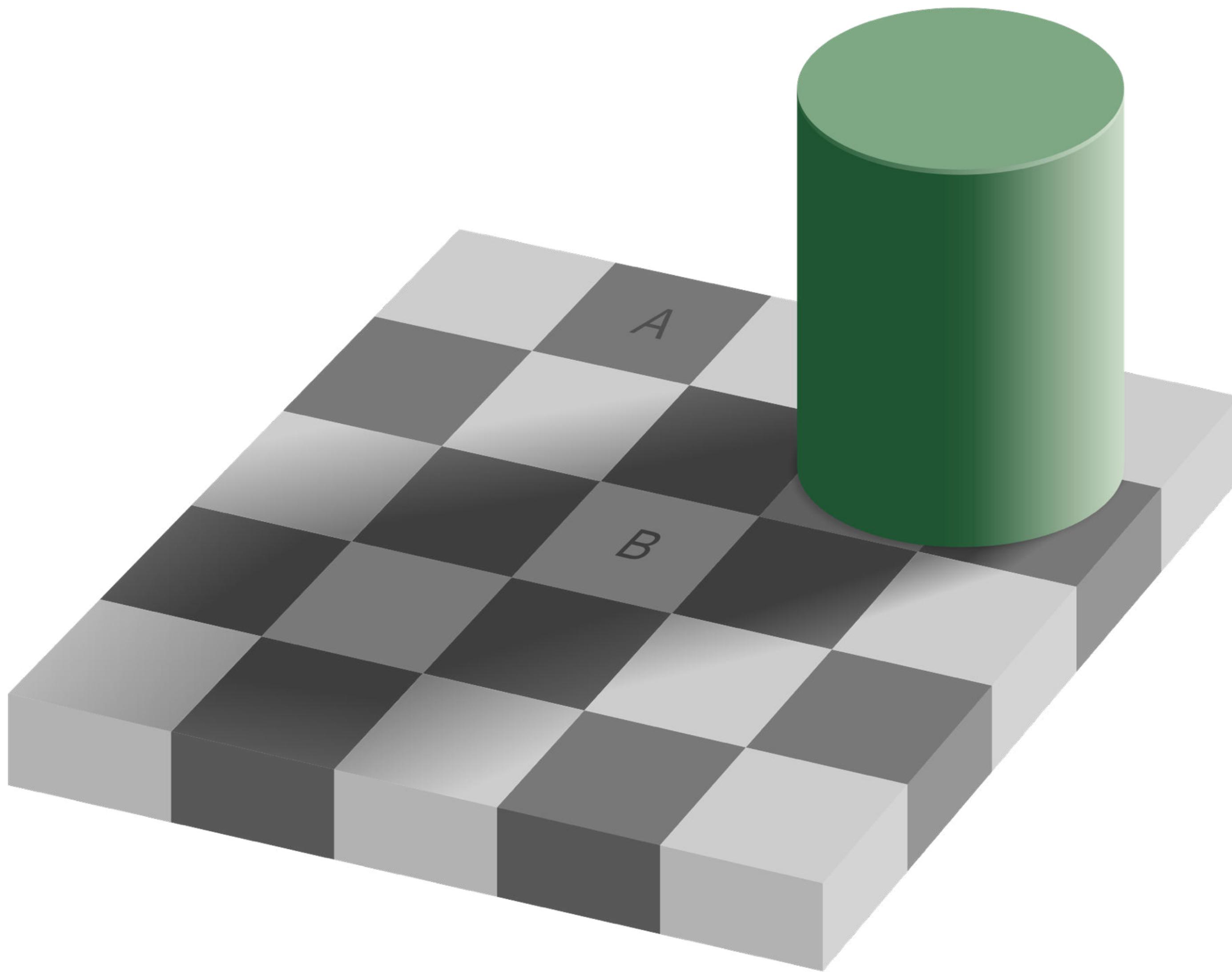
Why this happens? LATERAL INHIBITION











A

B

Luminance Channel Summary

- No edges without lightness difference
- No shading without lightness variation
- Has higher spatial sensitivity than color channels
- Contrast defines legibility, attention, layering
- Controlling luminance is primary rule of design

COLOR

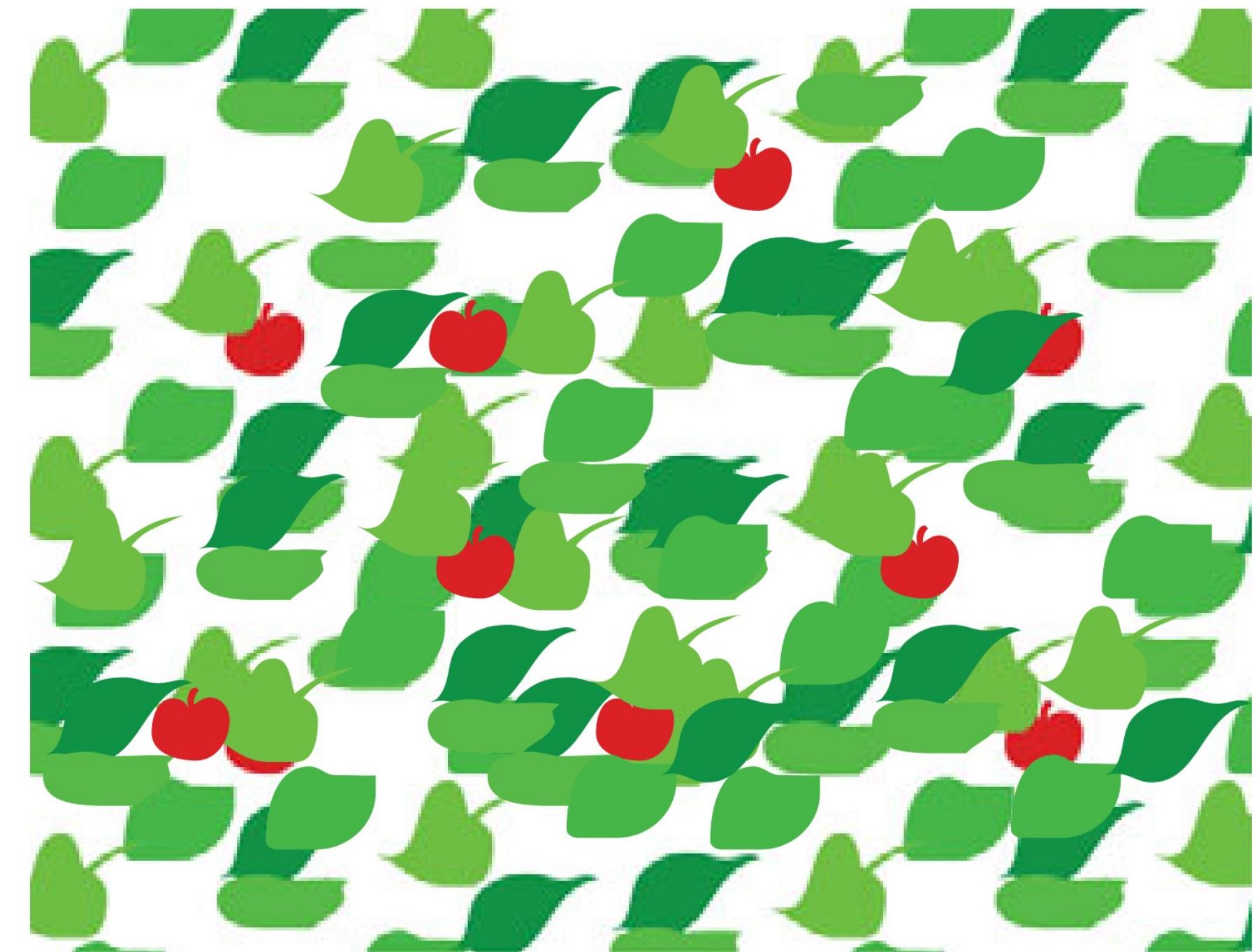
Why color...?

- Color for labeling and annotation
- Color for measuring (encoding sequential data)
- Color for encoding categories
- Color to encoding meaning (conventions, representation)
- Color as beauty (aesthetics)

Why color...?

Functions of color:

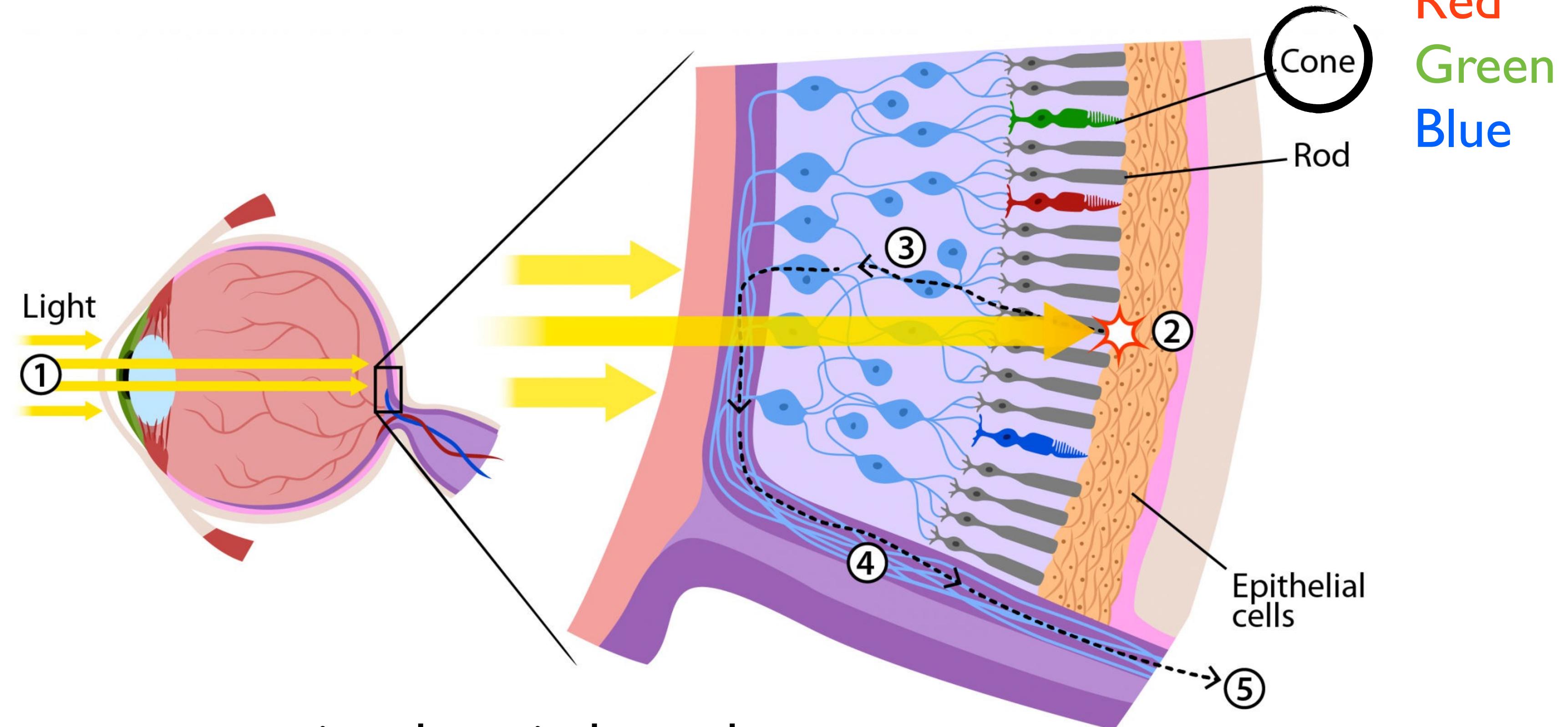
Identify, Group, Layer, Highlight



“... avoiding catastrophe becomes
the first principle in bringing color
to information: above all, do no harm”

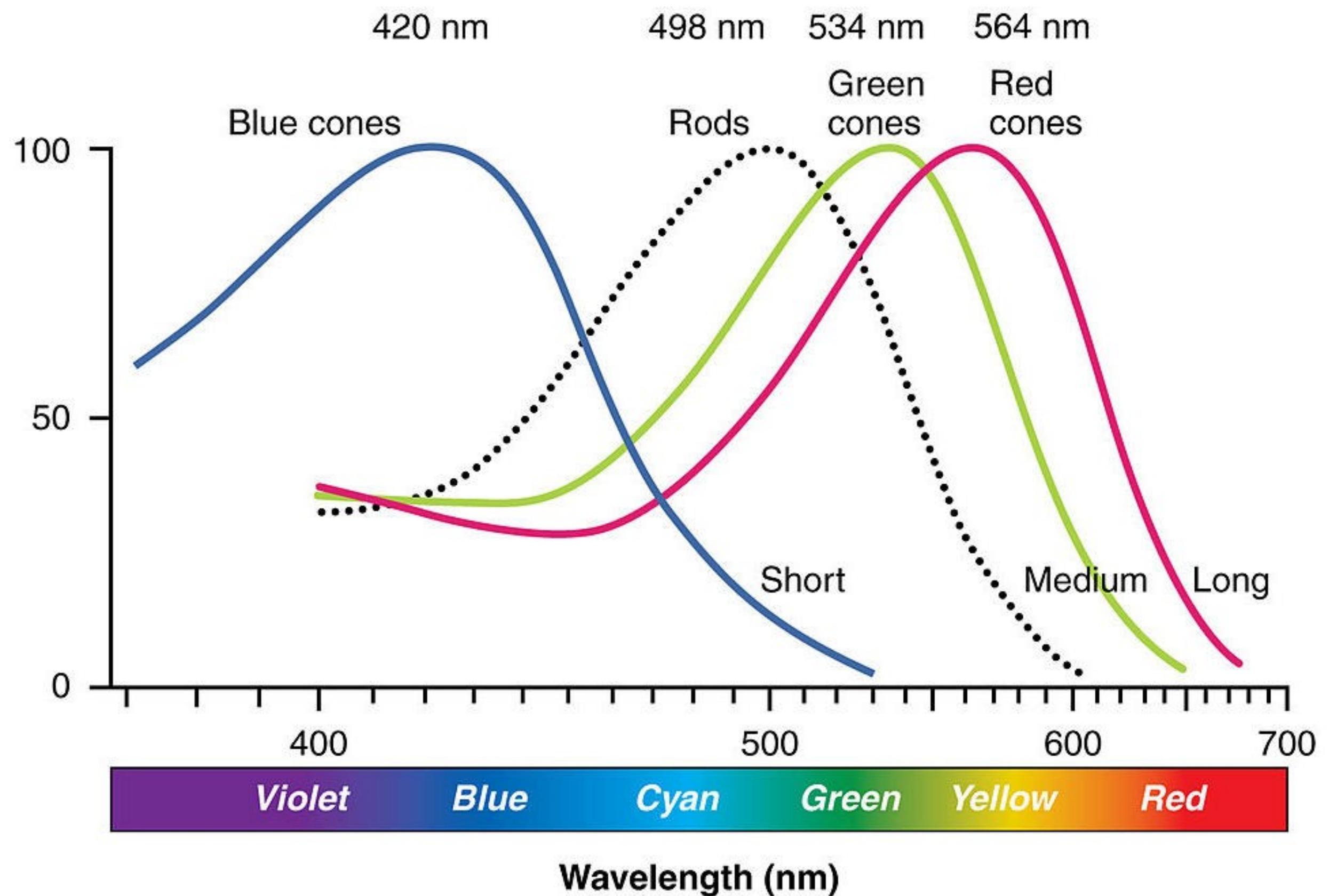
-Edward Tufte

CONES & RODS



trichromacy = possessing three independent channels for conveying color information

CONES & RODS



This is why we luminance
(brightness) is more
effective encoding channel!

Rods: 120 million

Cones: 5-6 million

This is why we are so
sensitive to red!

Cones:

64% red-sensitive

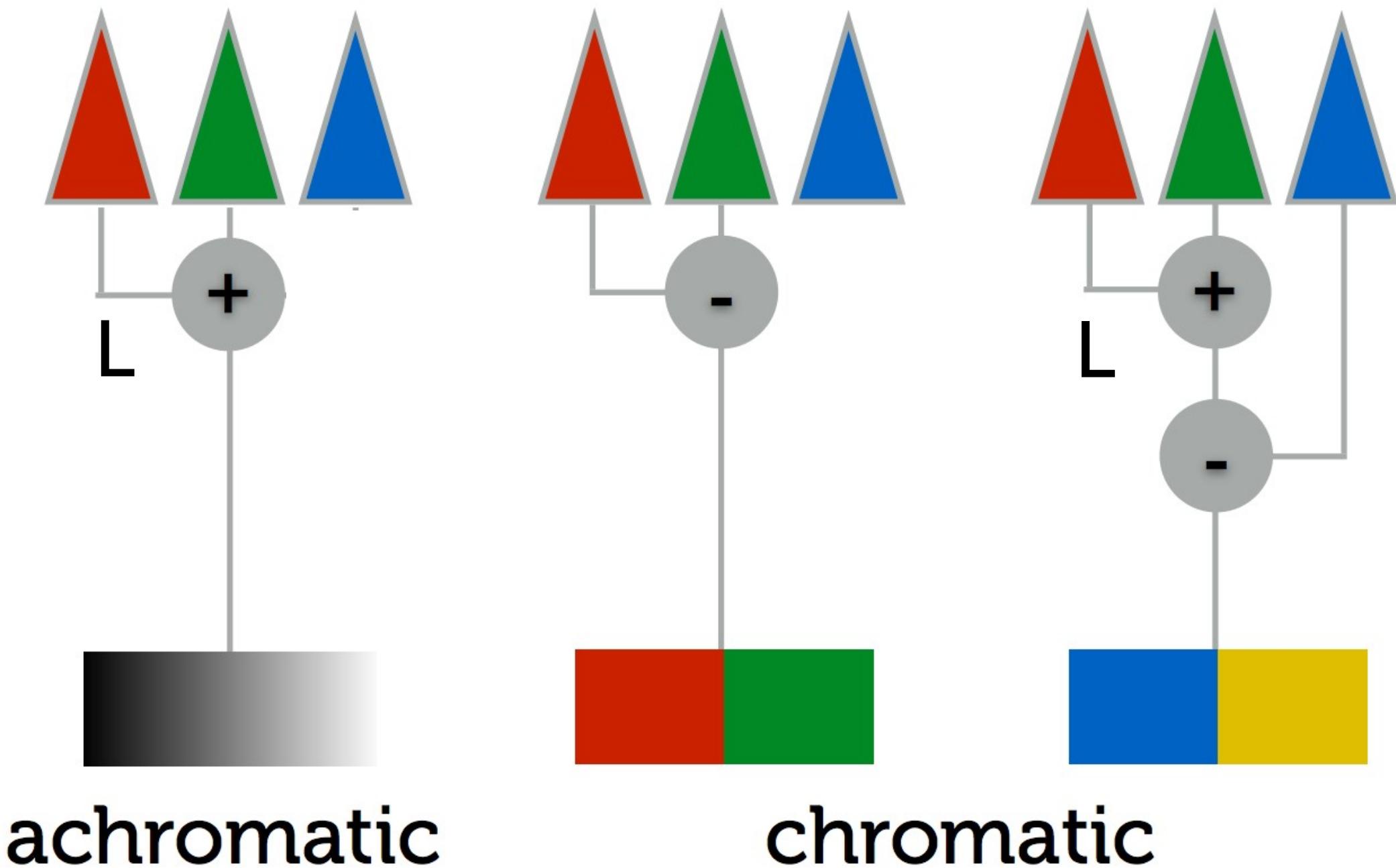
32% green-sensitive

2% blue-sensitive.

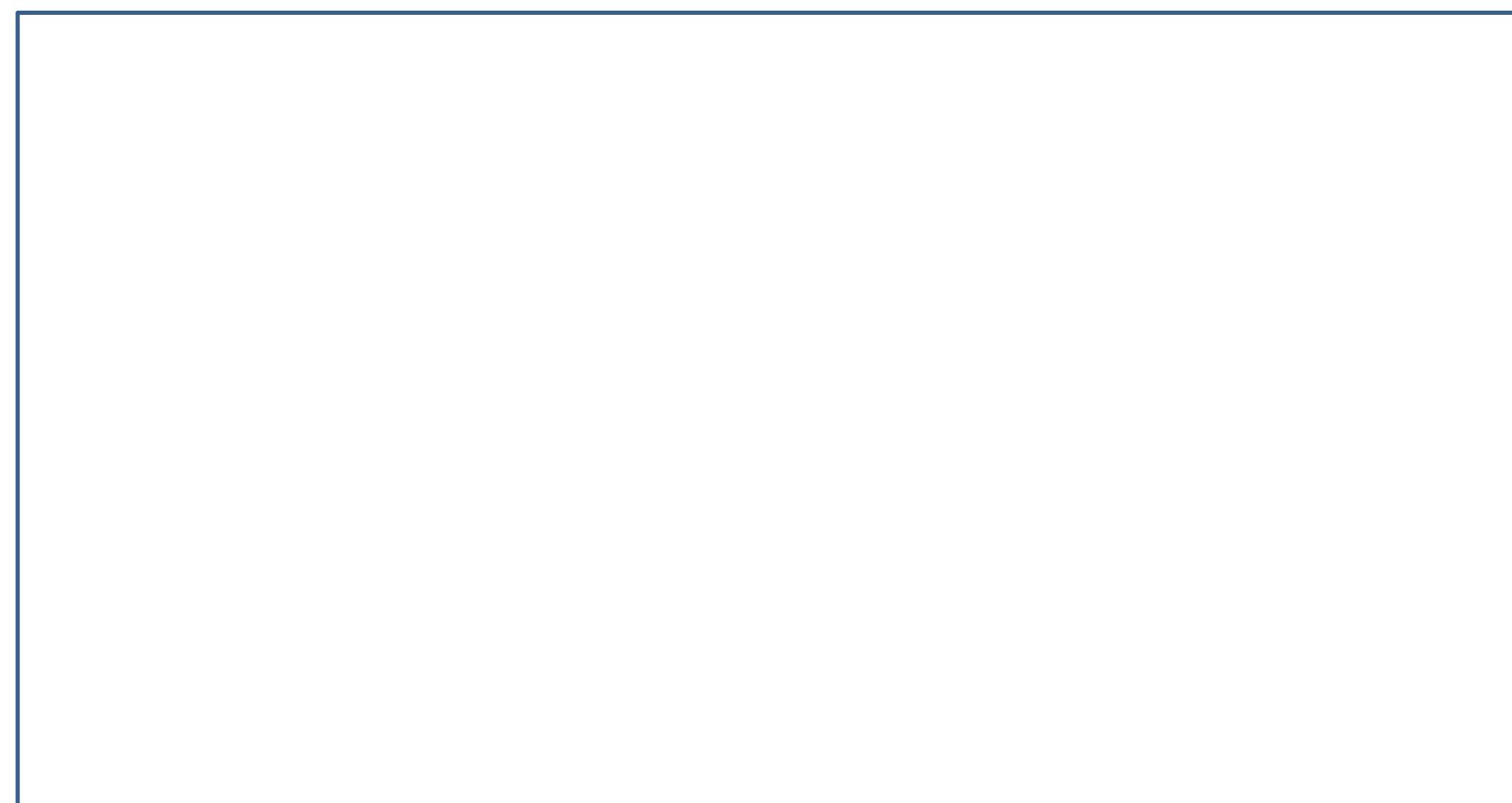
CONES & RODS - COLOR PERCEPTION

opponent-process model: visual system detects differences between the response of cones

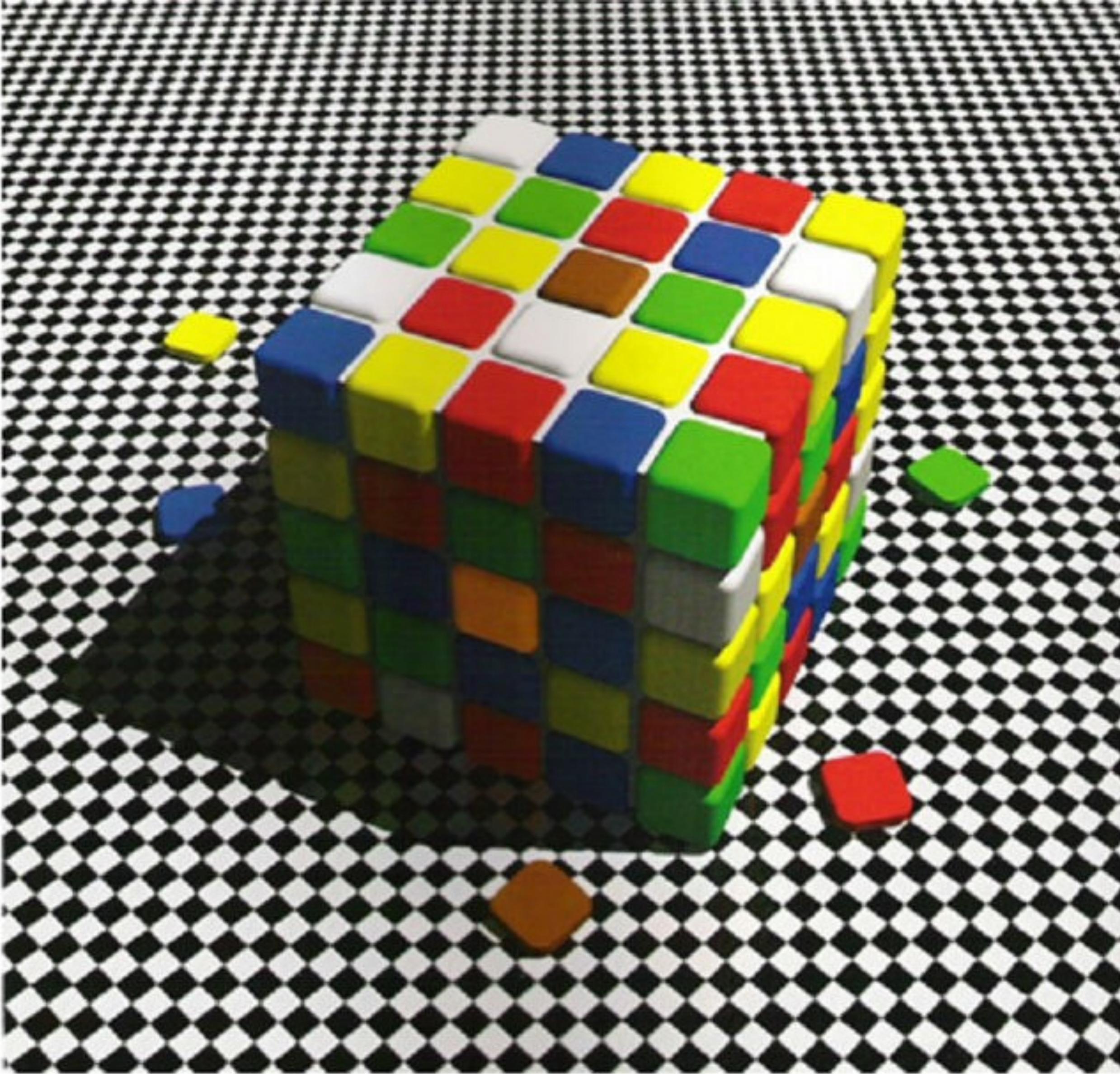
- 3 opponent channels:**
- black vs. white (Luminance)
 - ▶ combination of R & G
 - red vs. green
 - ▶ difference between R & G
 - blue vs. yellow
 - ▶ difference between L & B



NOTE: opposite colors are never perceived together (no reddish green or bluish yellow)

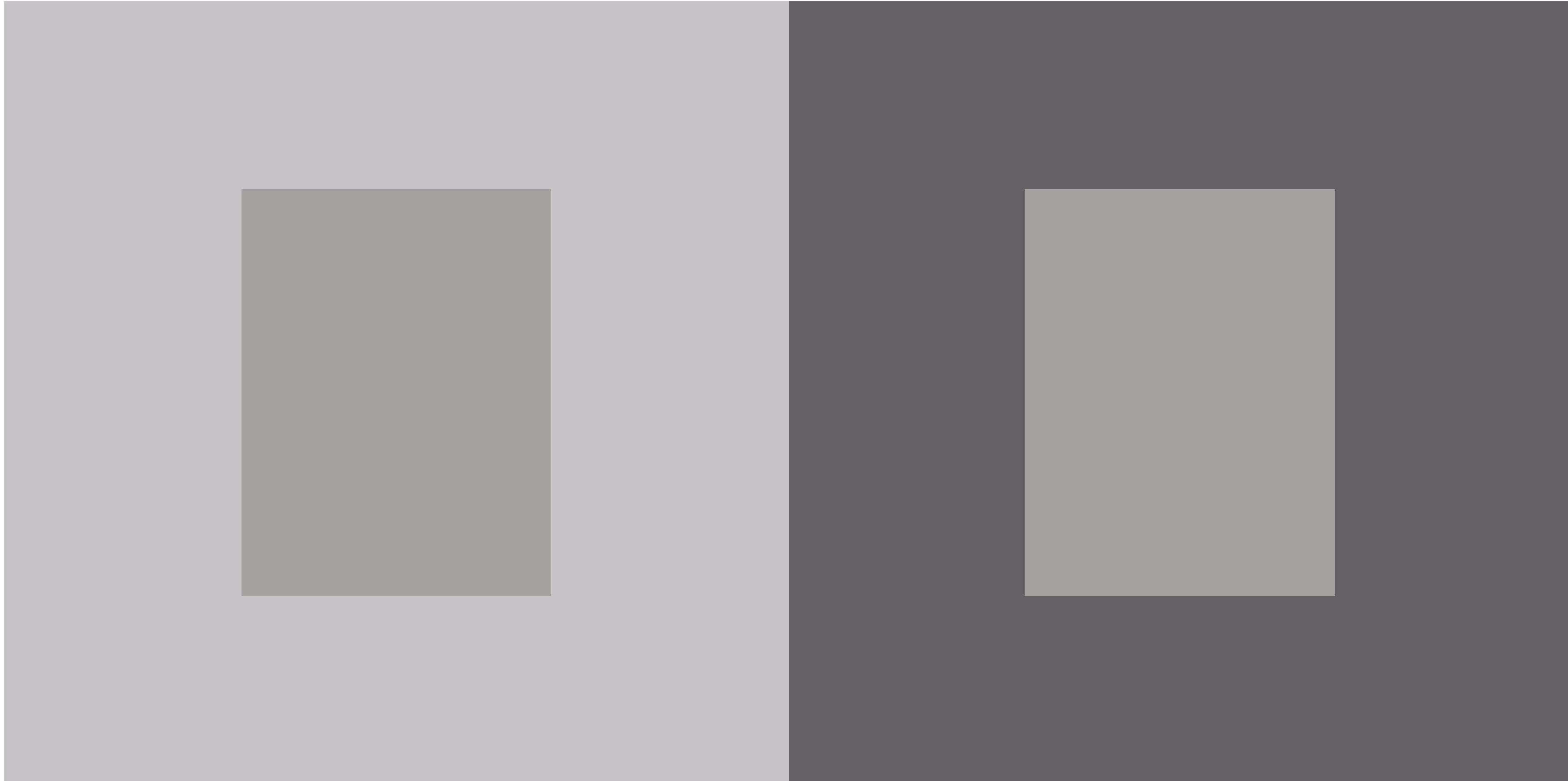


Color Constancy

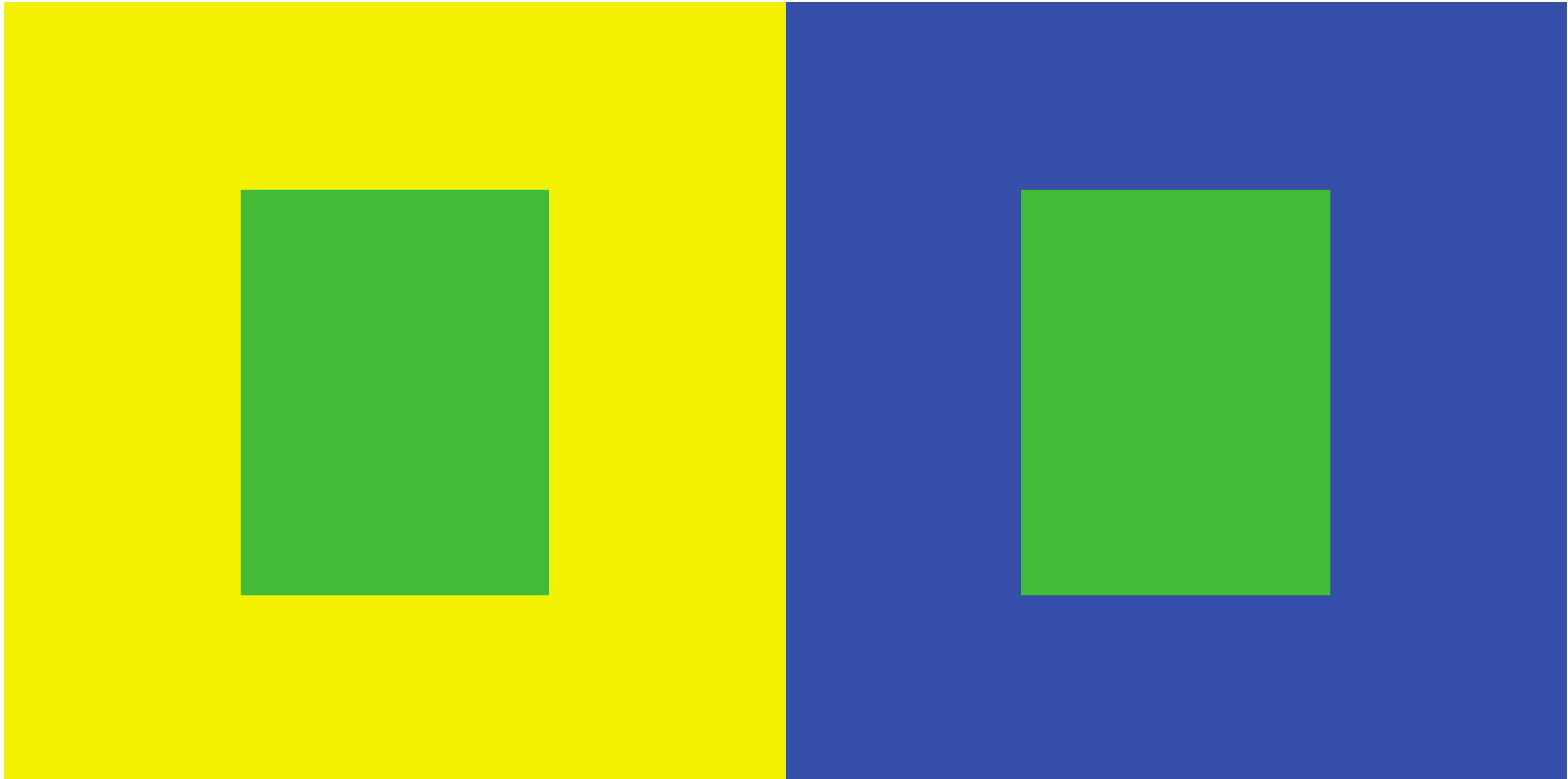




“Simultaneous Contrast”



“Simultaneous Contrast”



“Simultaneous Contrast”



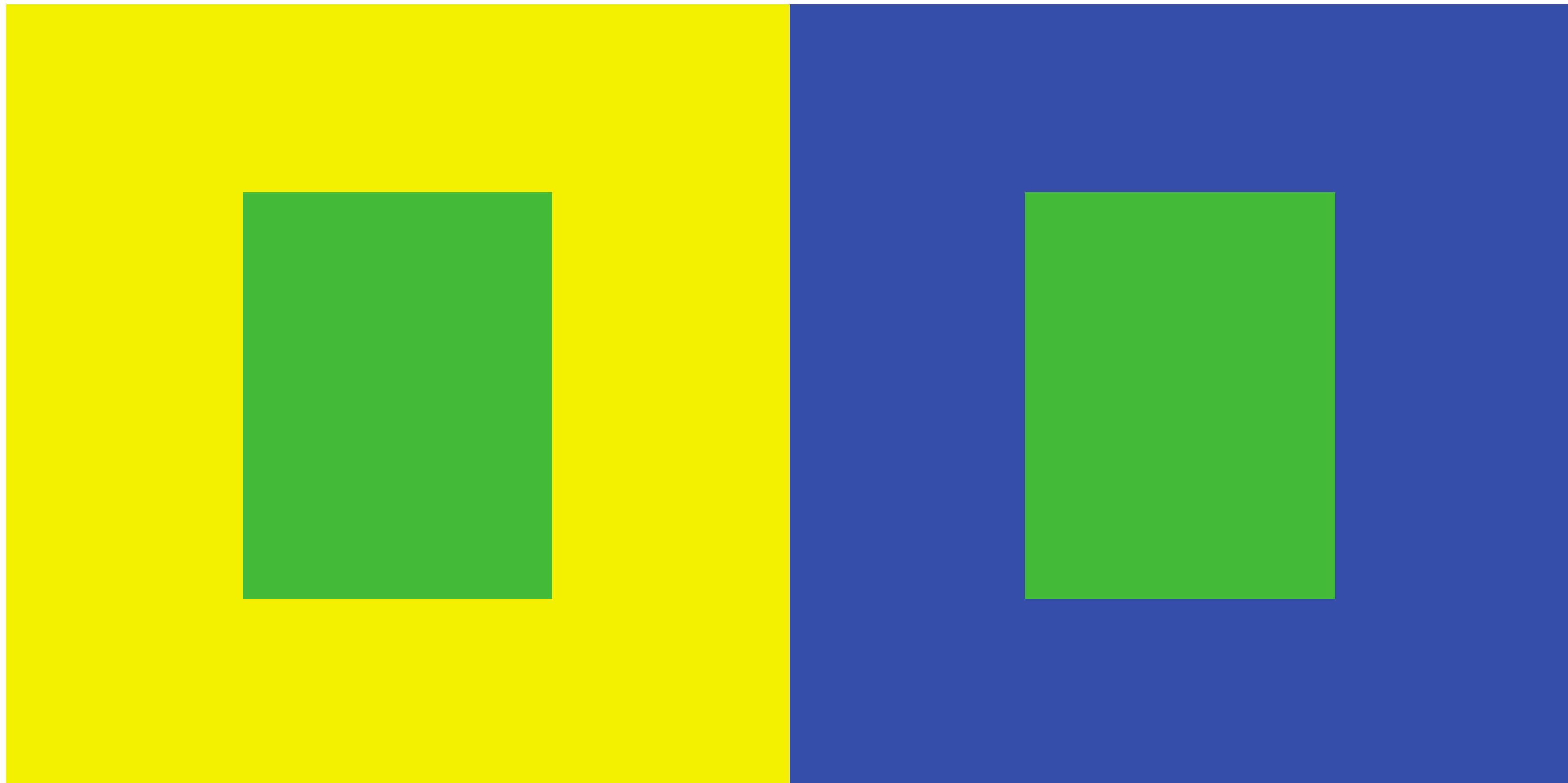
“Simultaneous Contrast”



Be careful with bars and scatter plot points - the colors may appear differently with different background colors and neighboring colors!

Be aware that colors in legends may appear different than on the plot!

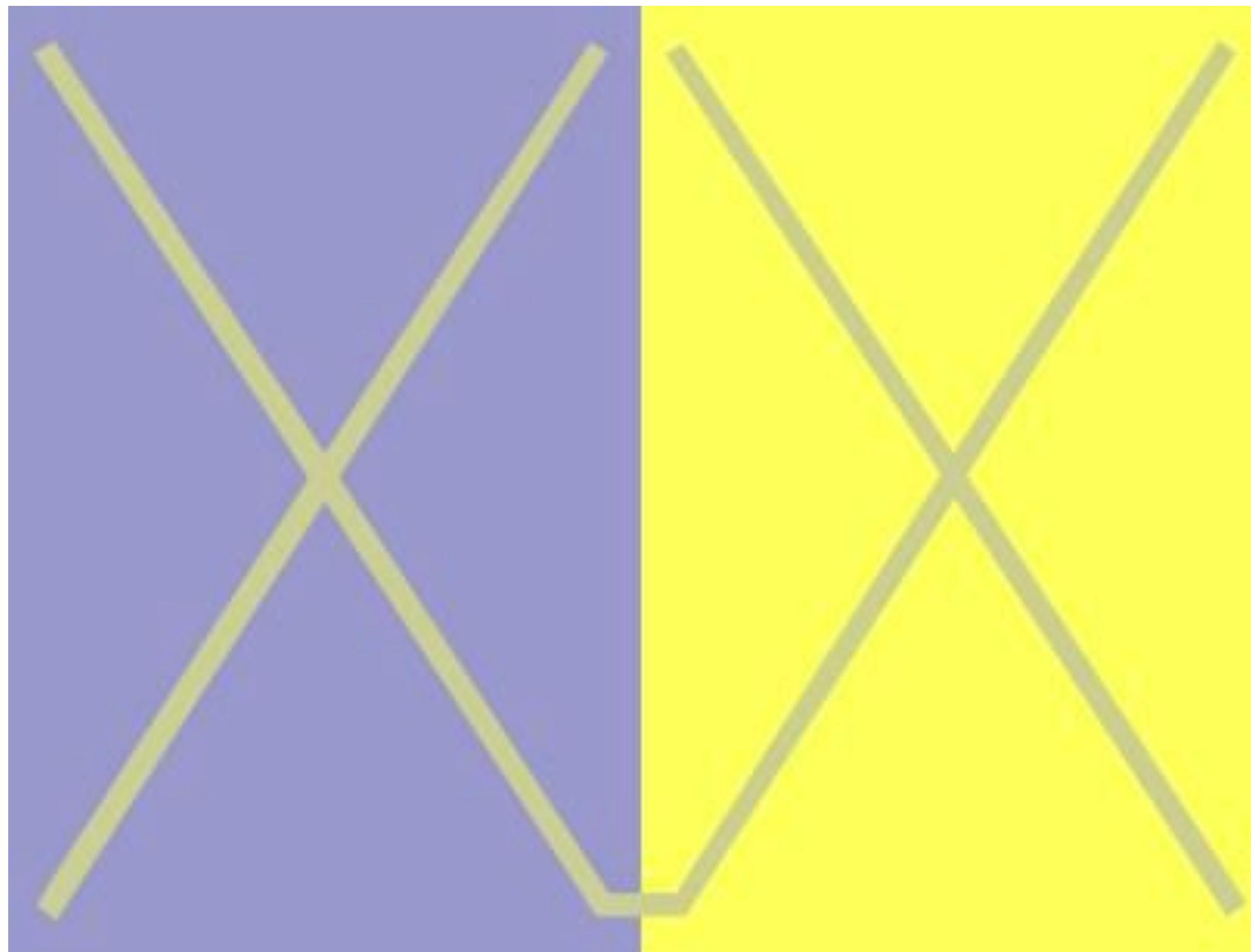
“Simultaneous Contrast”



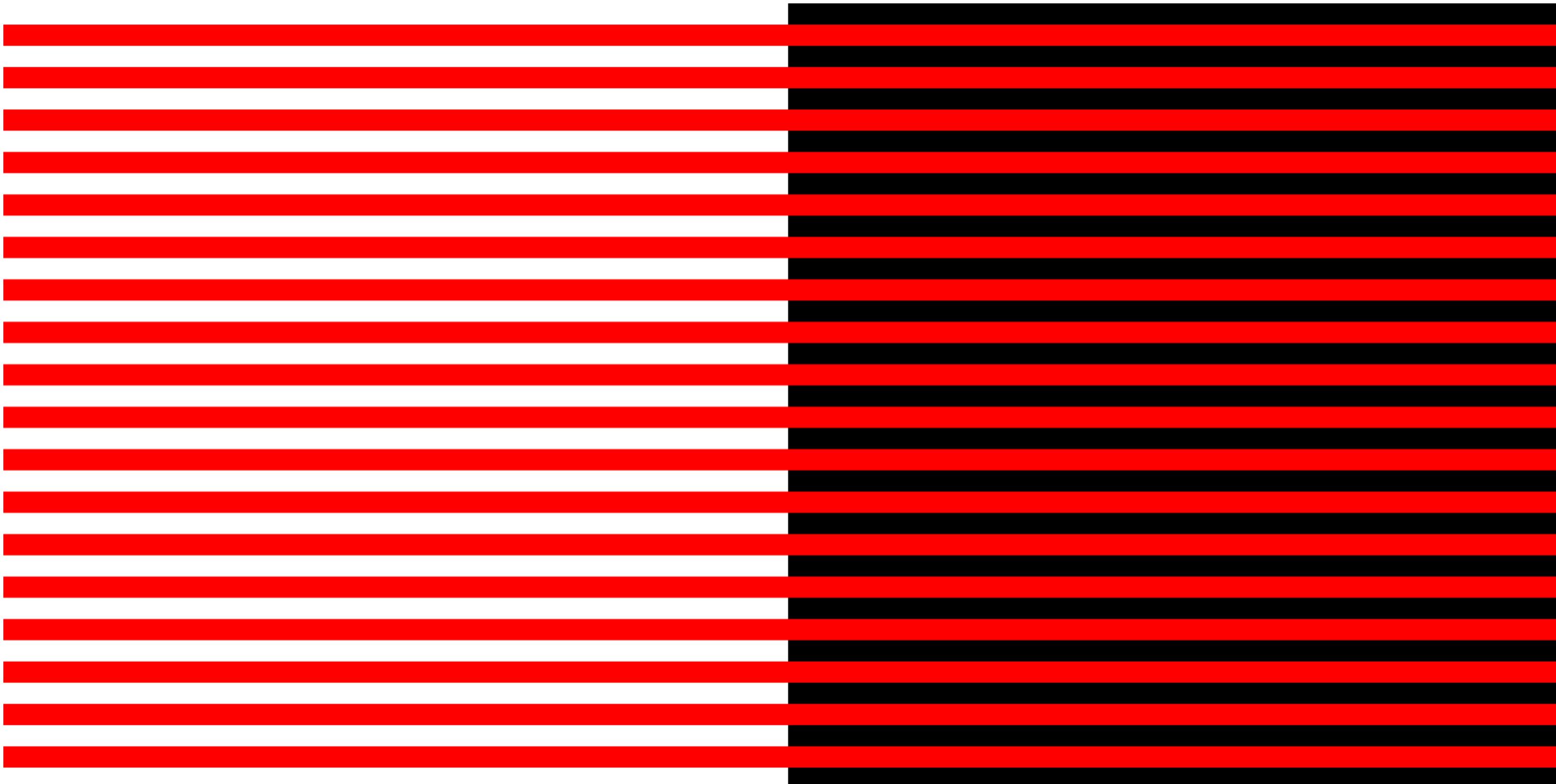
“Simultaneous Contrast”



“Simultaneous Contrast”



Small Area Effects



“Bezold Spreading Effect”

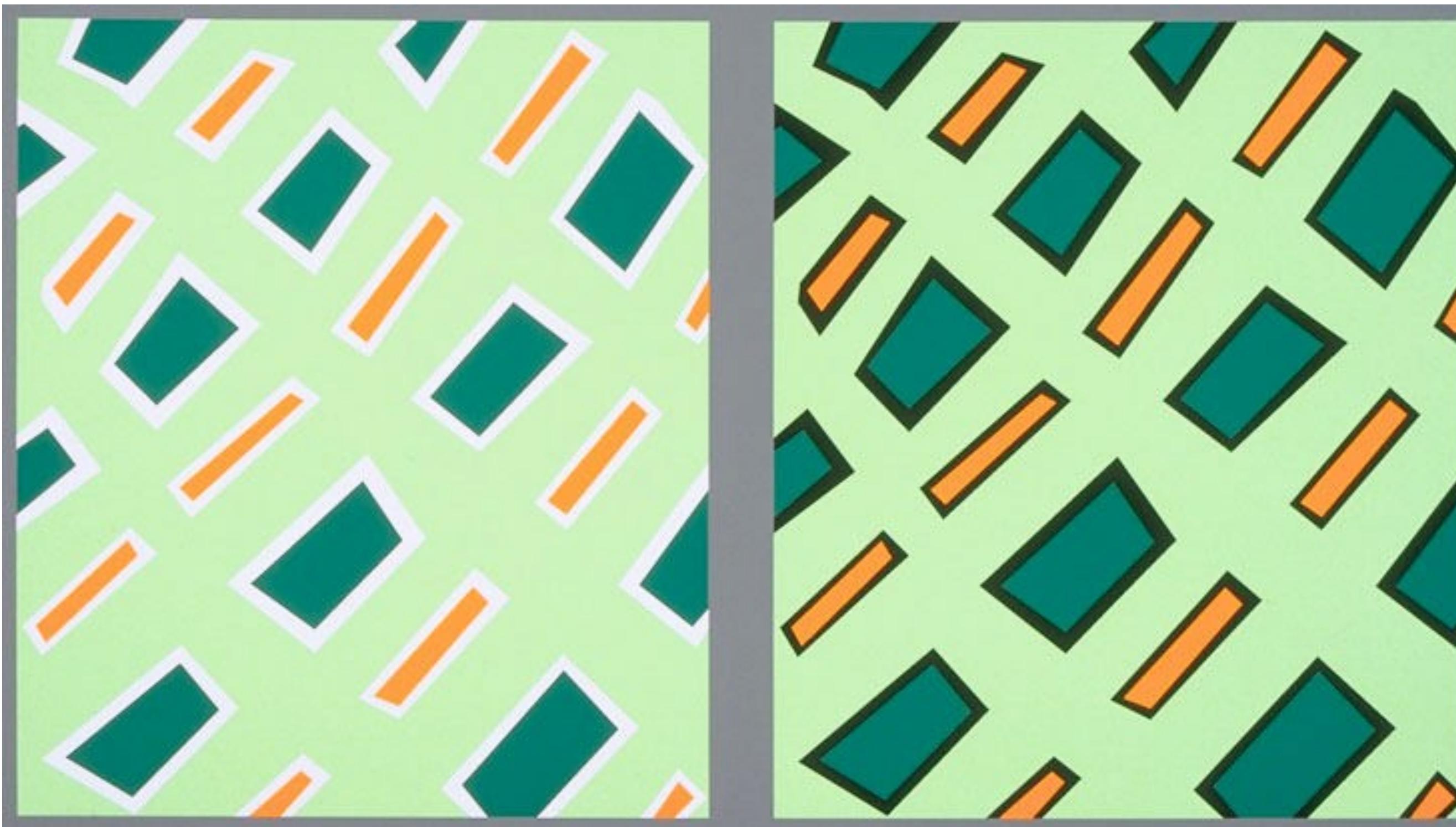
Small Area Effects



“Bezold Spreading Effect”

Be careful with colors in scatter plots!

Be aware that colors in legends may appear different than on the plot!



“Bezold Spreading Effect”

Which area is larger
(green or red)?

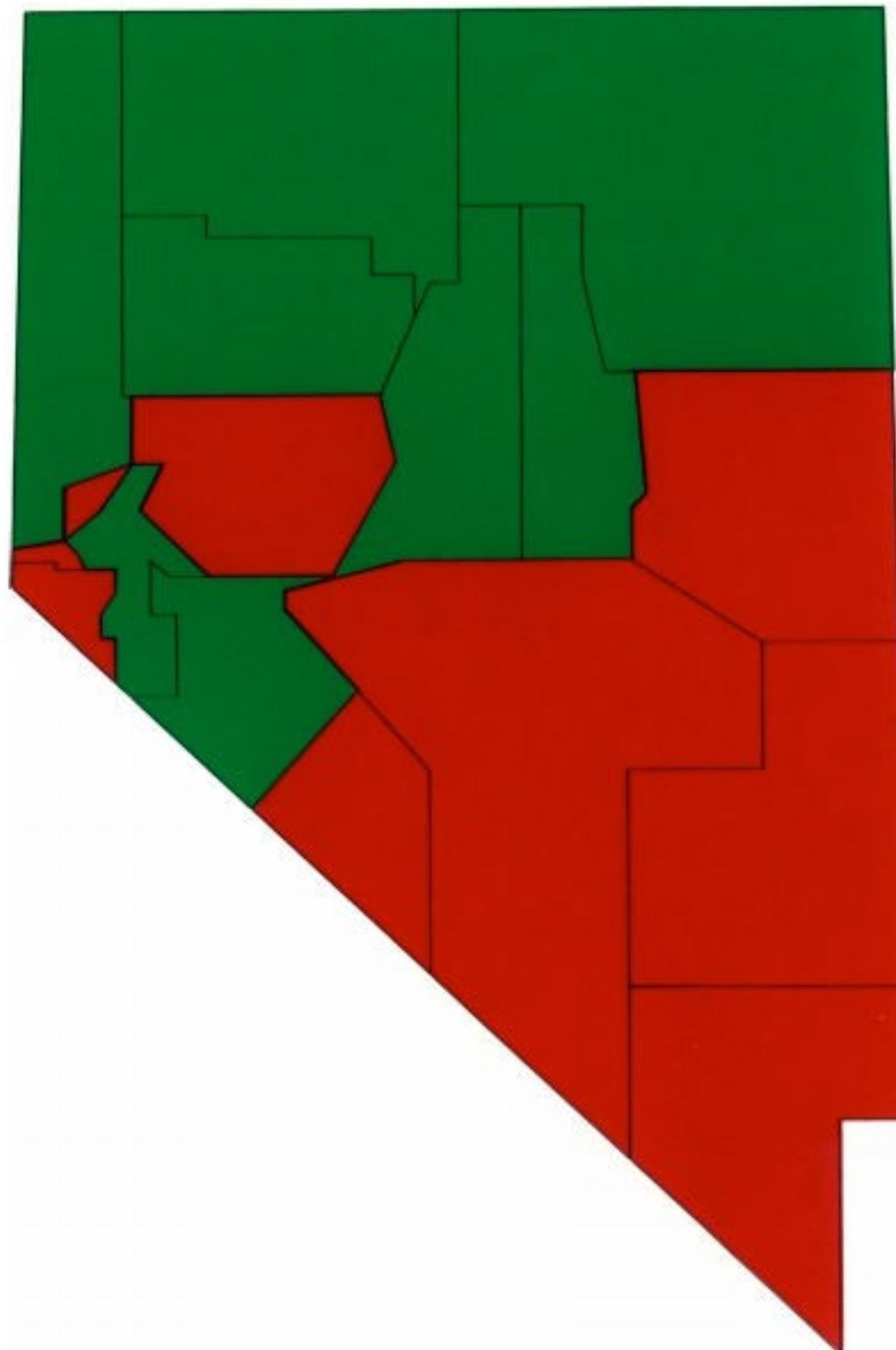


Figure 1. Stimulus From the High-Saturation Group

Which area is larger
(green or red)?

Areas are equal(!).

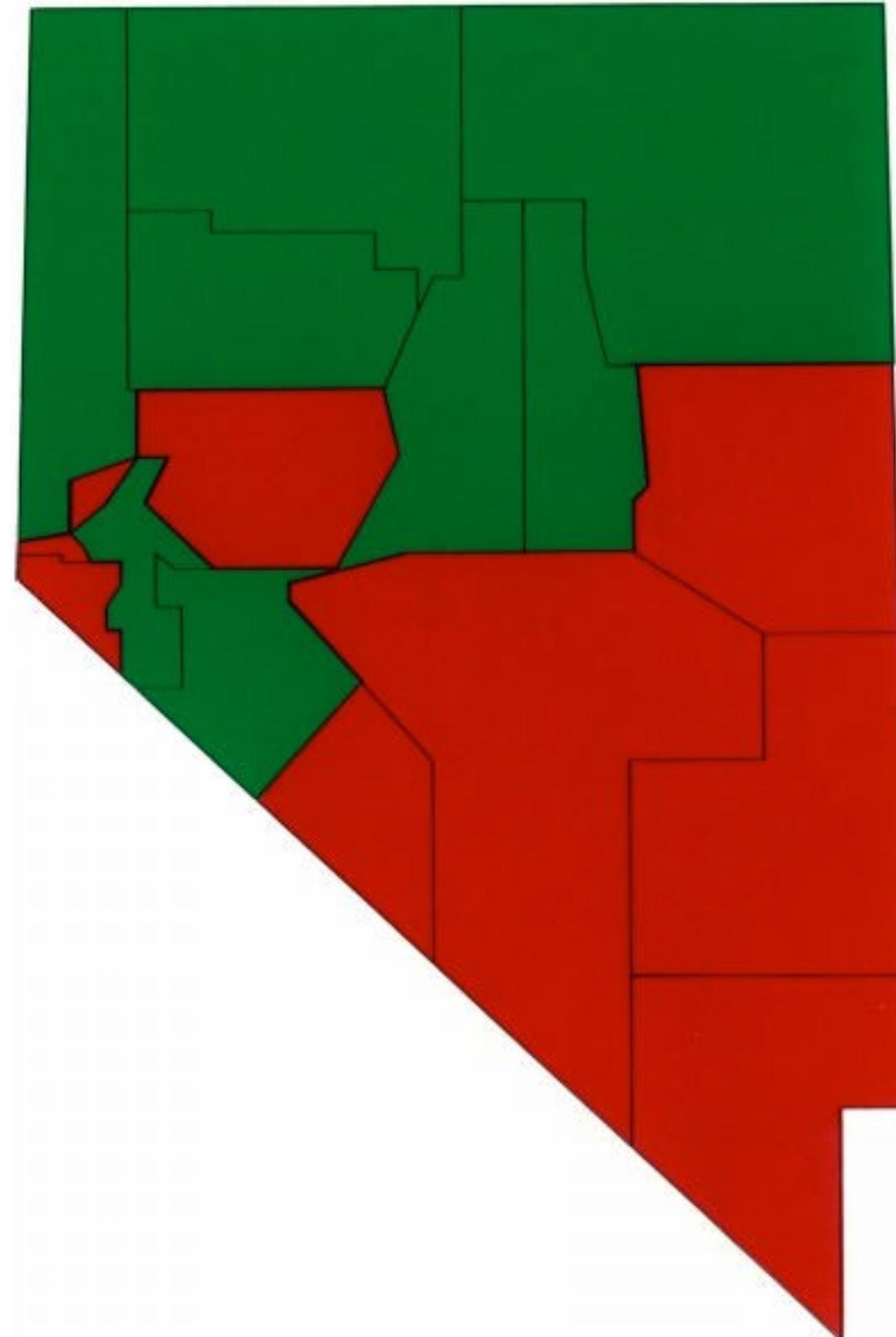


Figure 1. Stimulus From the High-Saturation Group

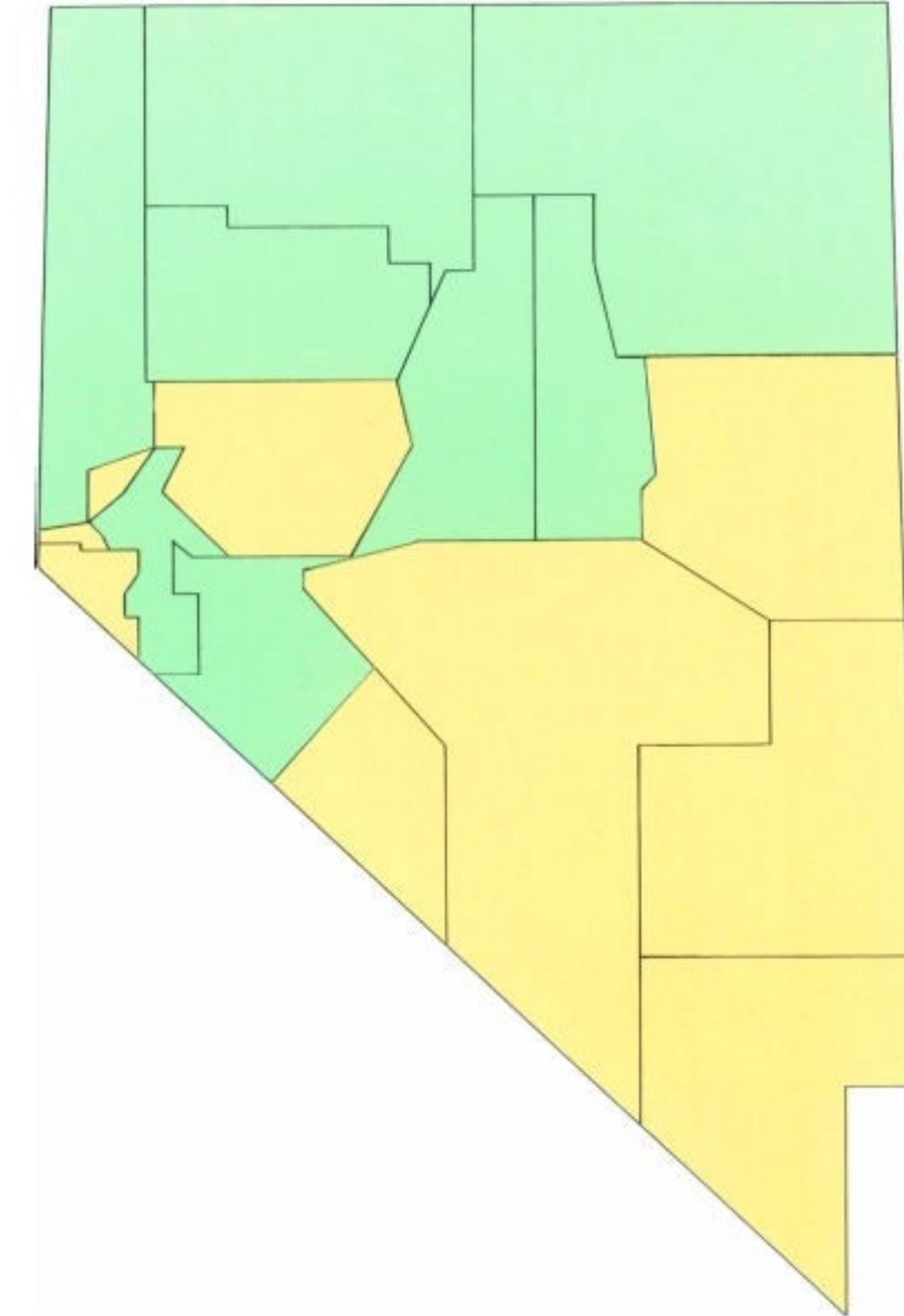
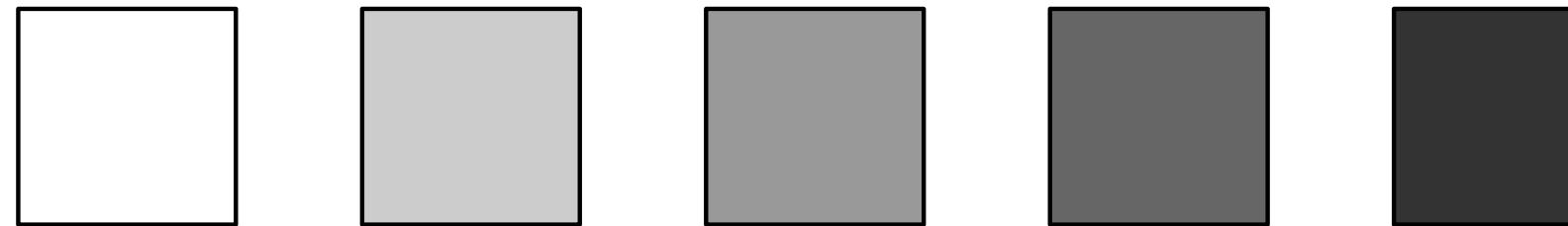


Figure 2. Stimulus From the Low-Saturation Group

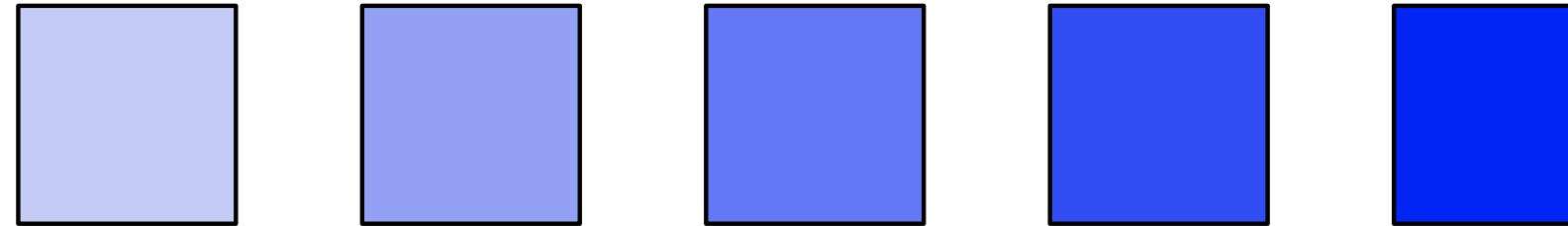
Cleveland & McGill, "A Color-Caused Optical Illusion on a Statistical Graph", 1983⁴⁴

Color Vocabulary Summary

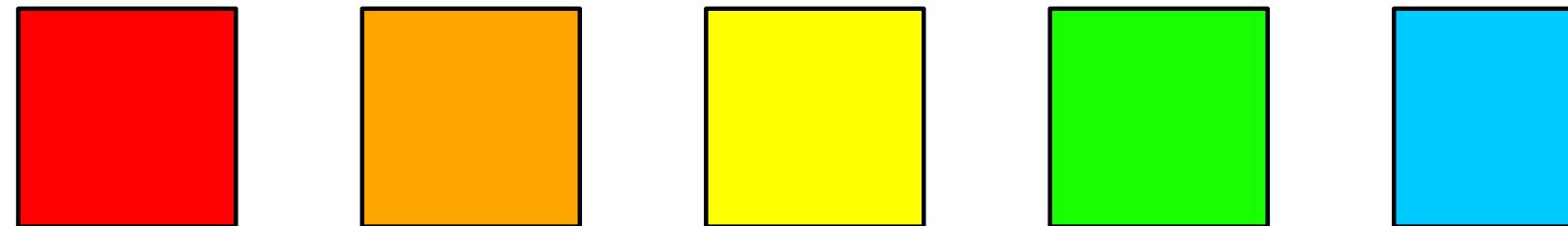
Luminance



Saturation



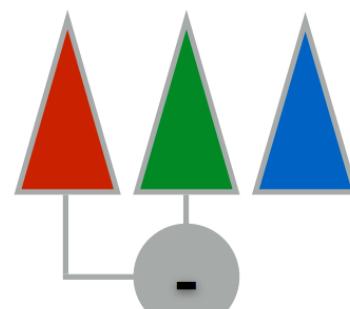
Hue



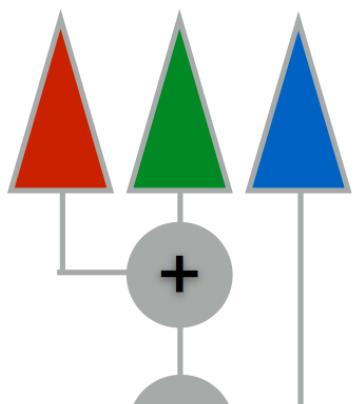
Color Deficiencies (Color Blindness)



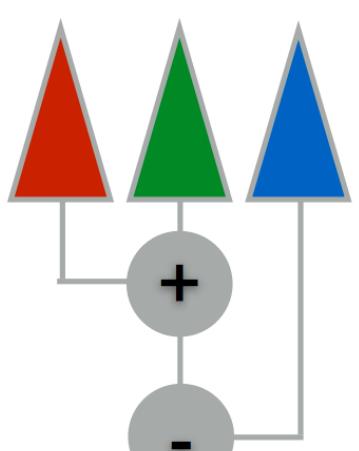
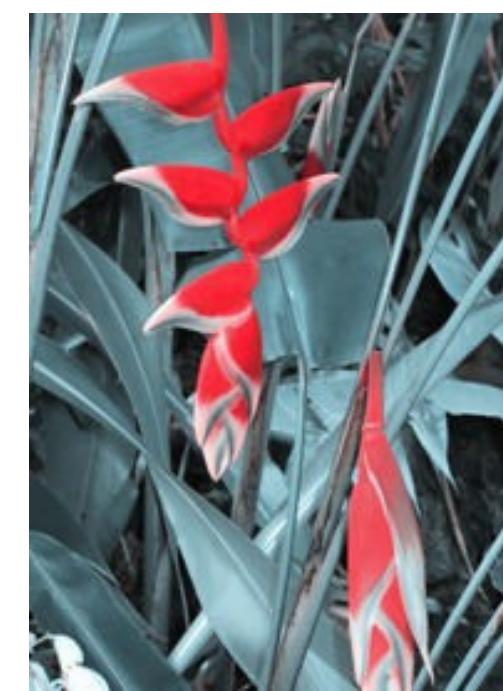
Person with faulty cones (or faulty pathways):



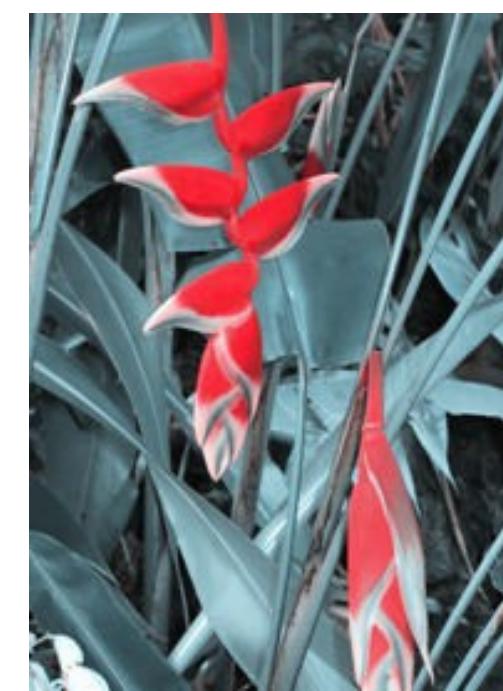
Protanope = faulty red cones



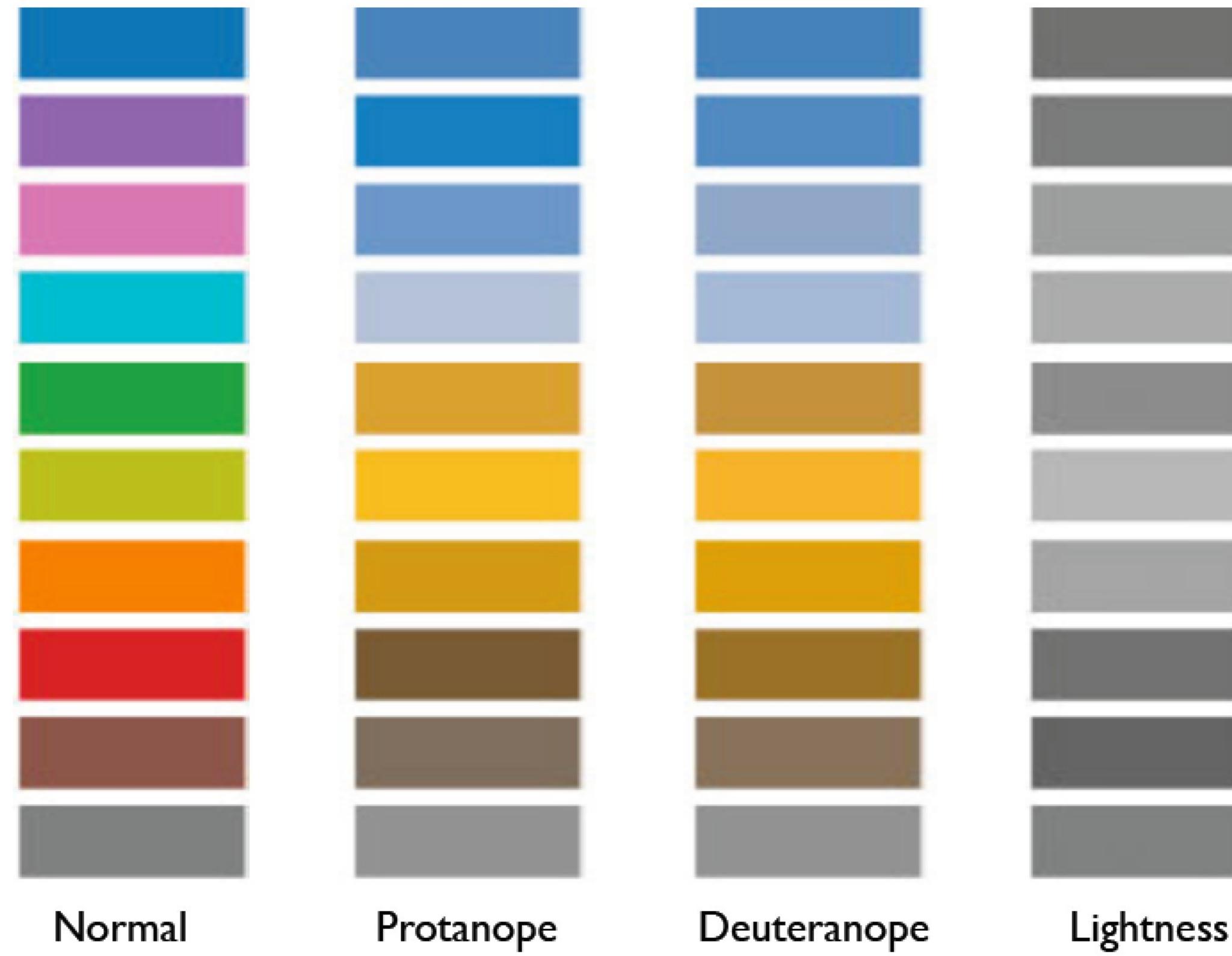
Deutanope = faulty green cones

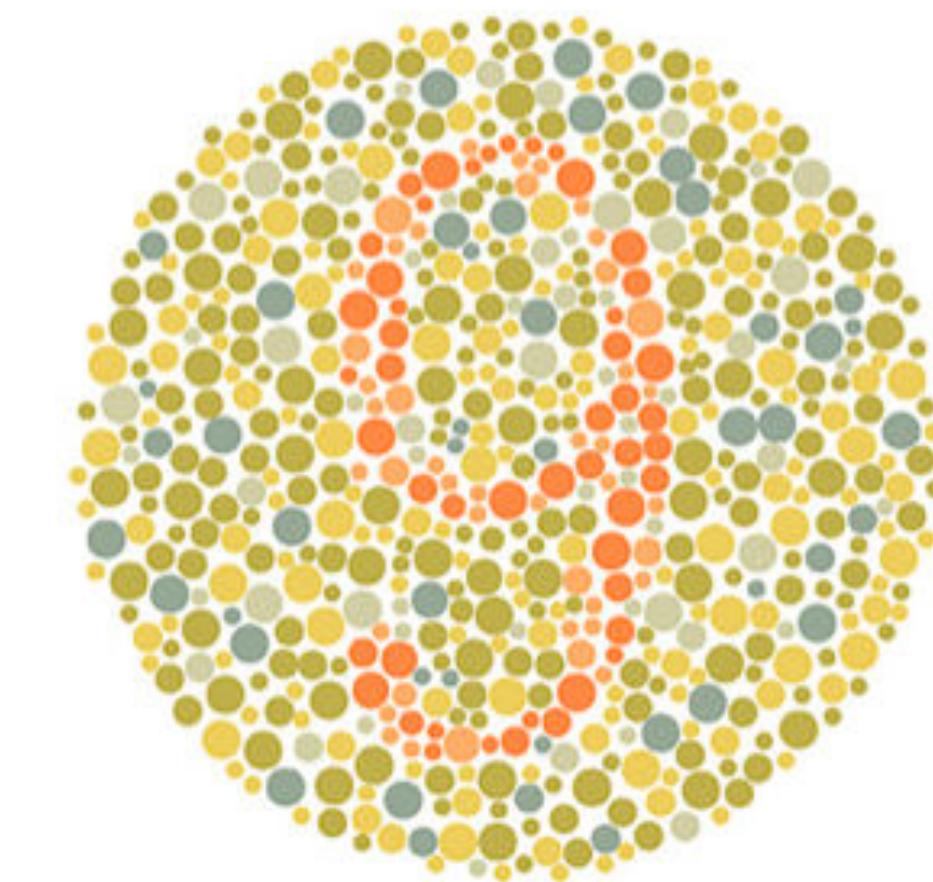
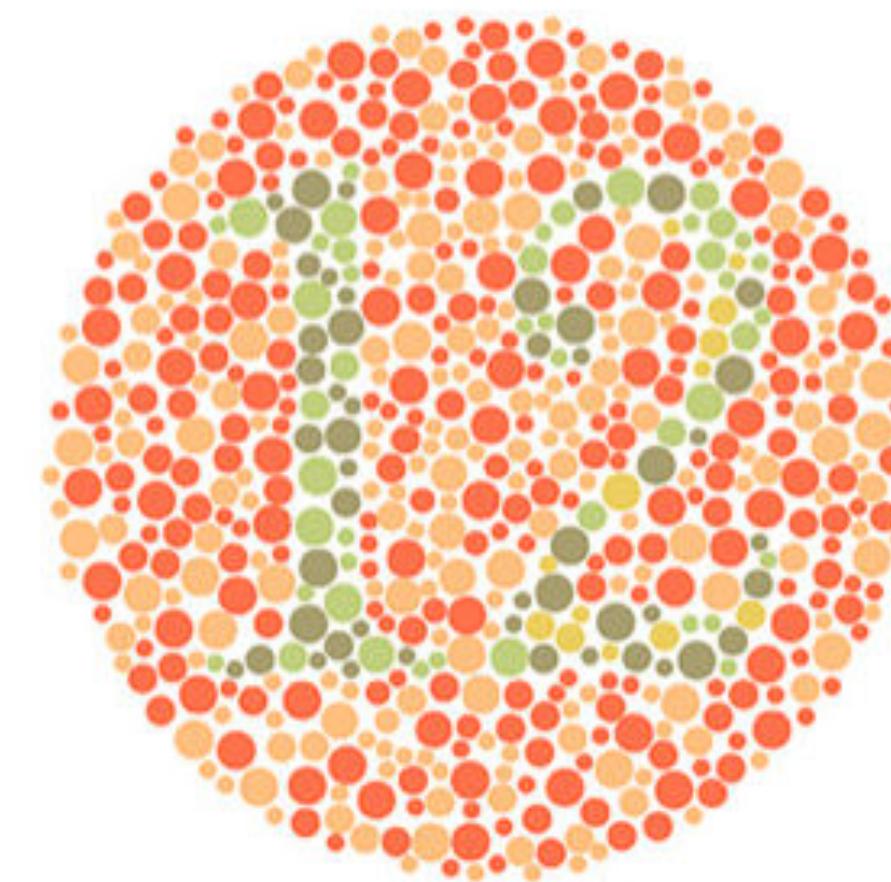
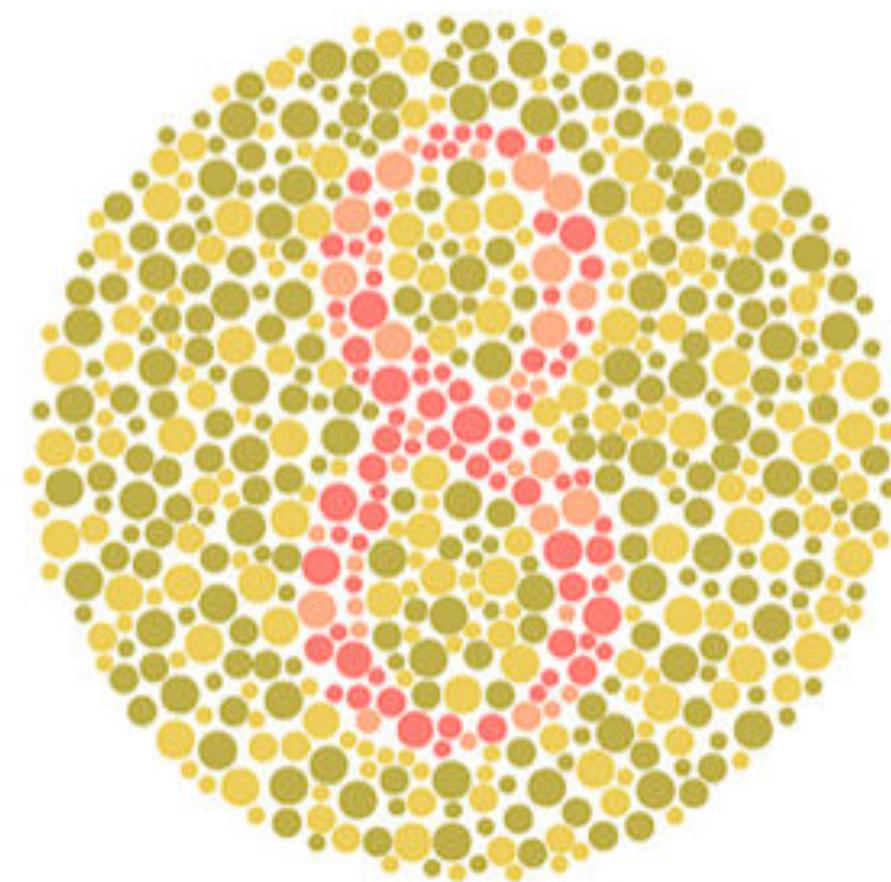
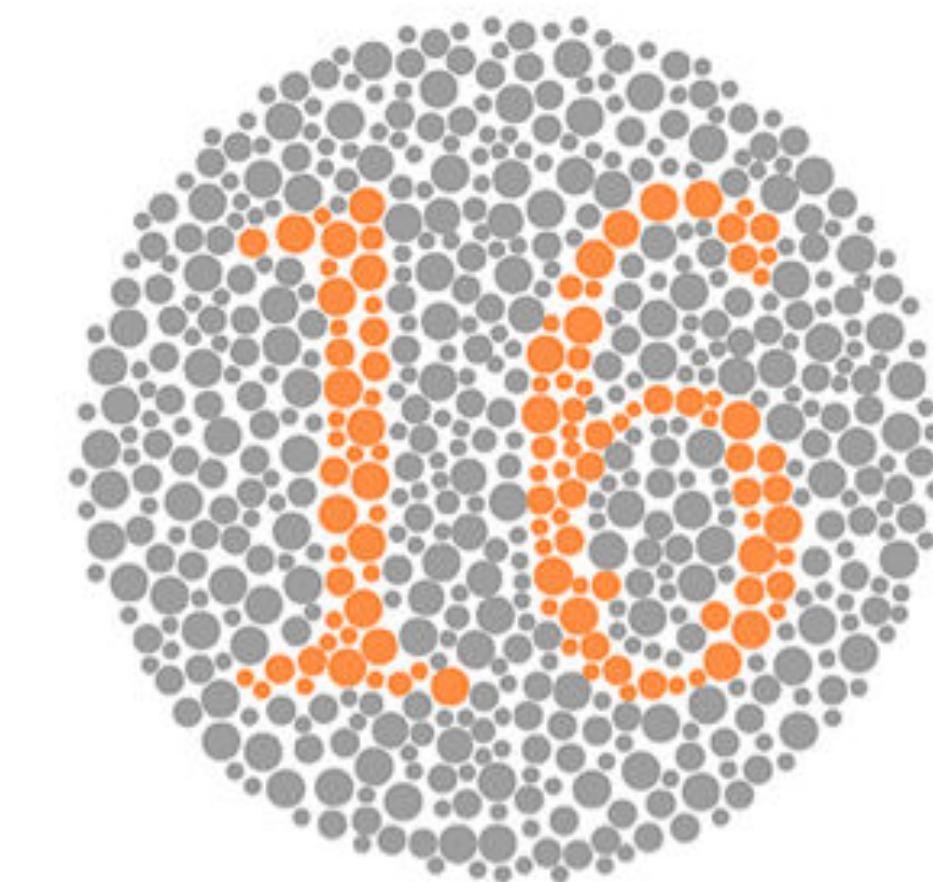
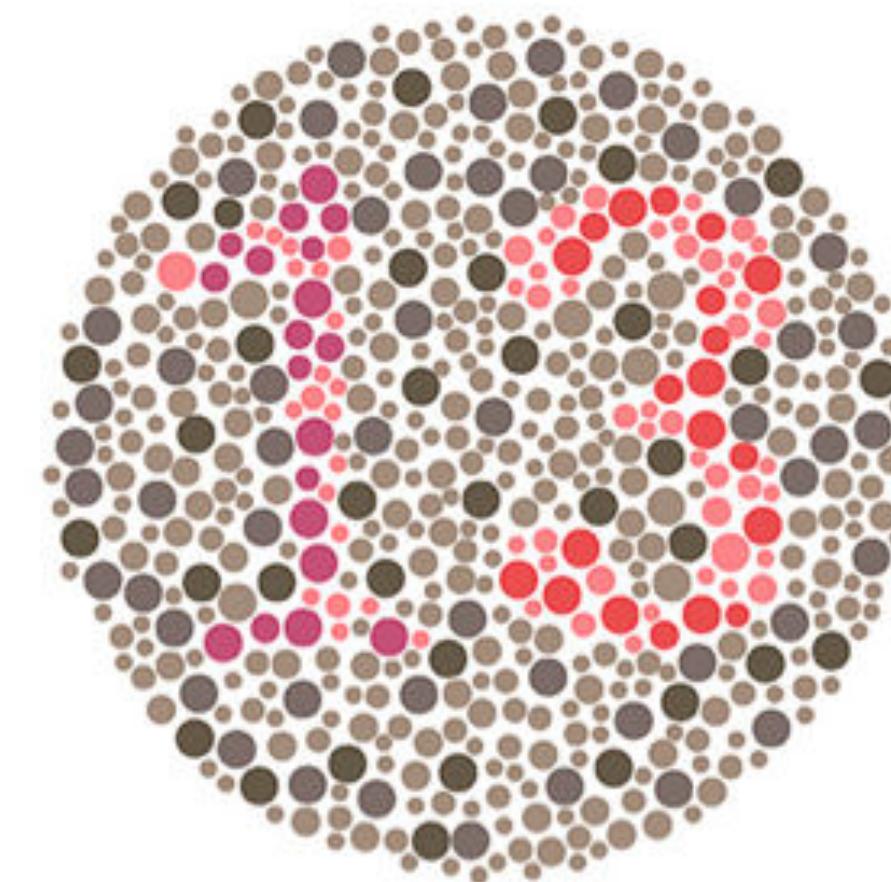
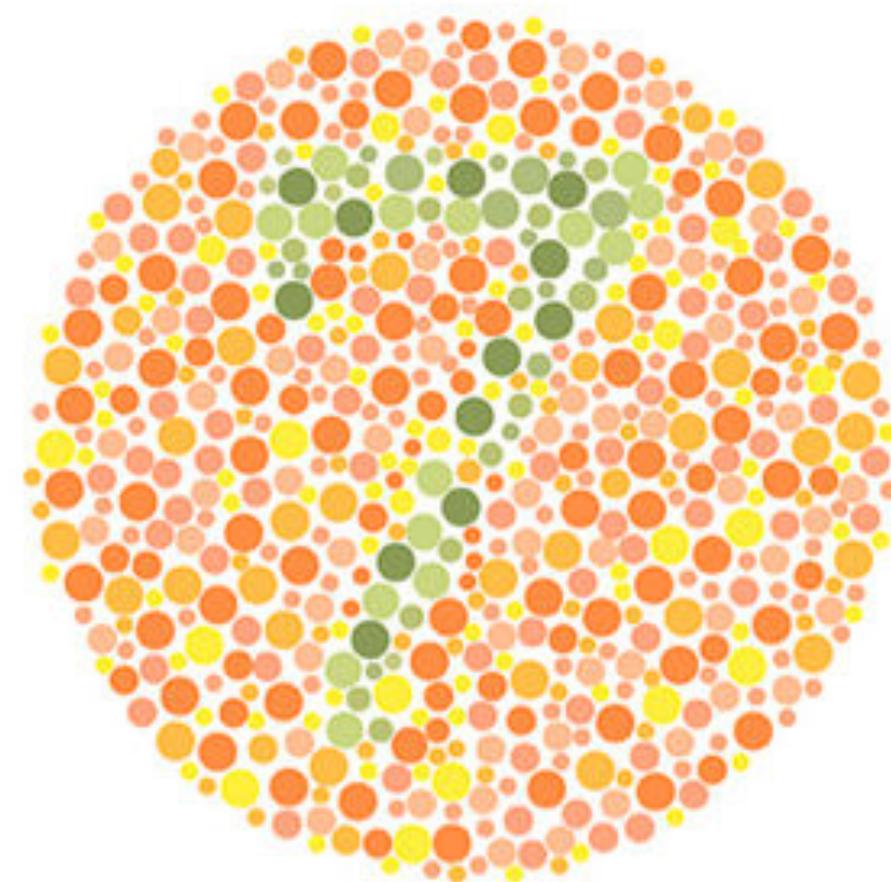


Tritanope = faulty blue cones



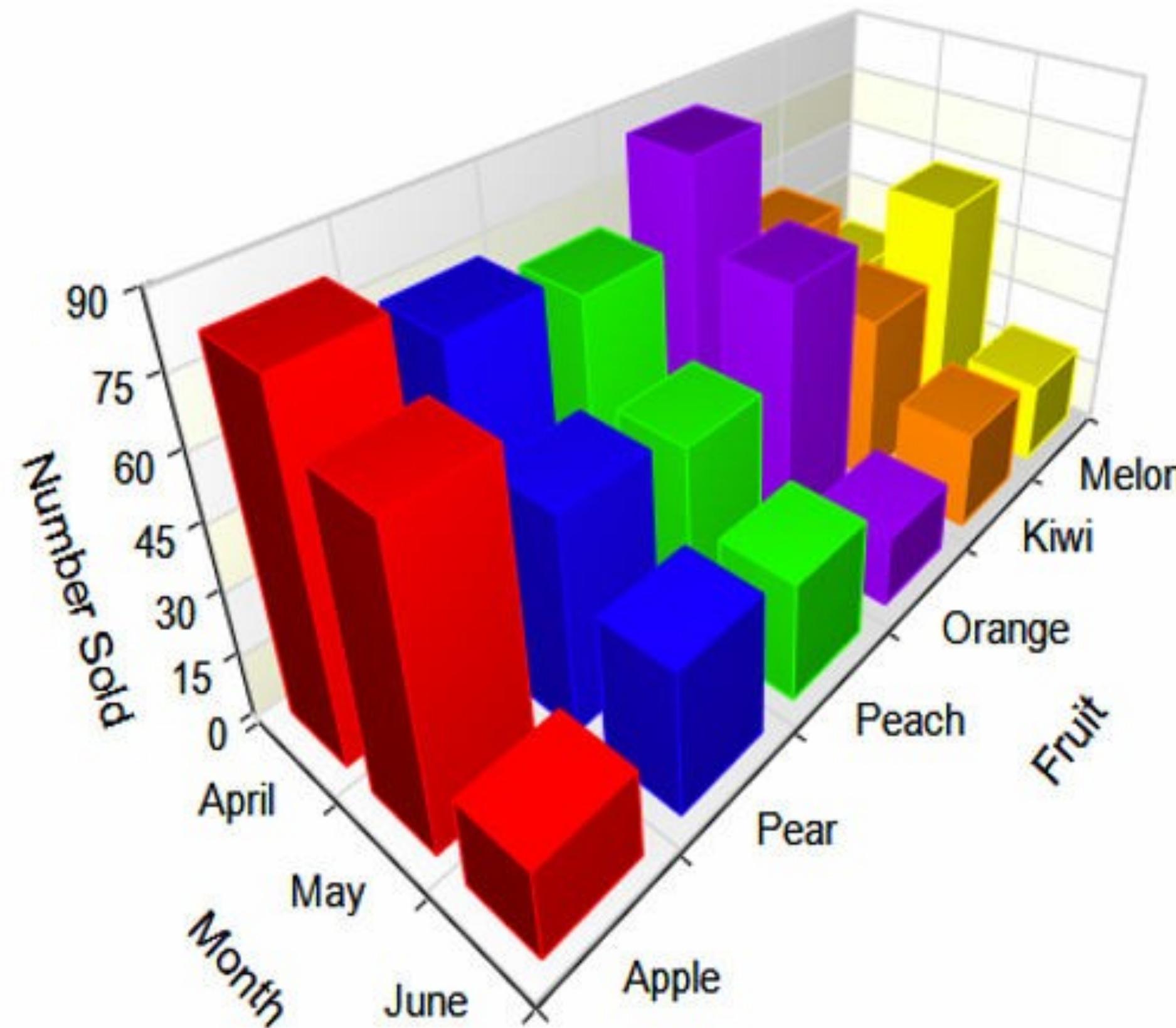
Color Deficiencies (Color Blindness)



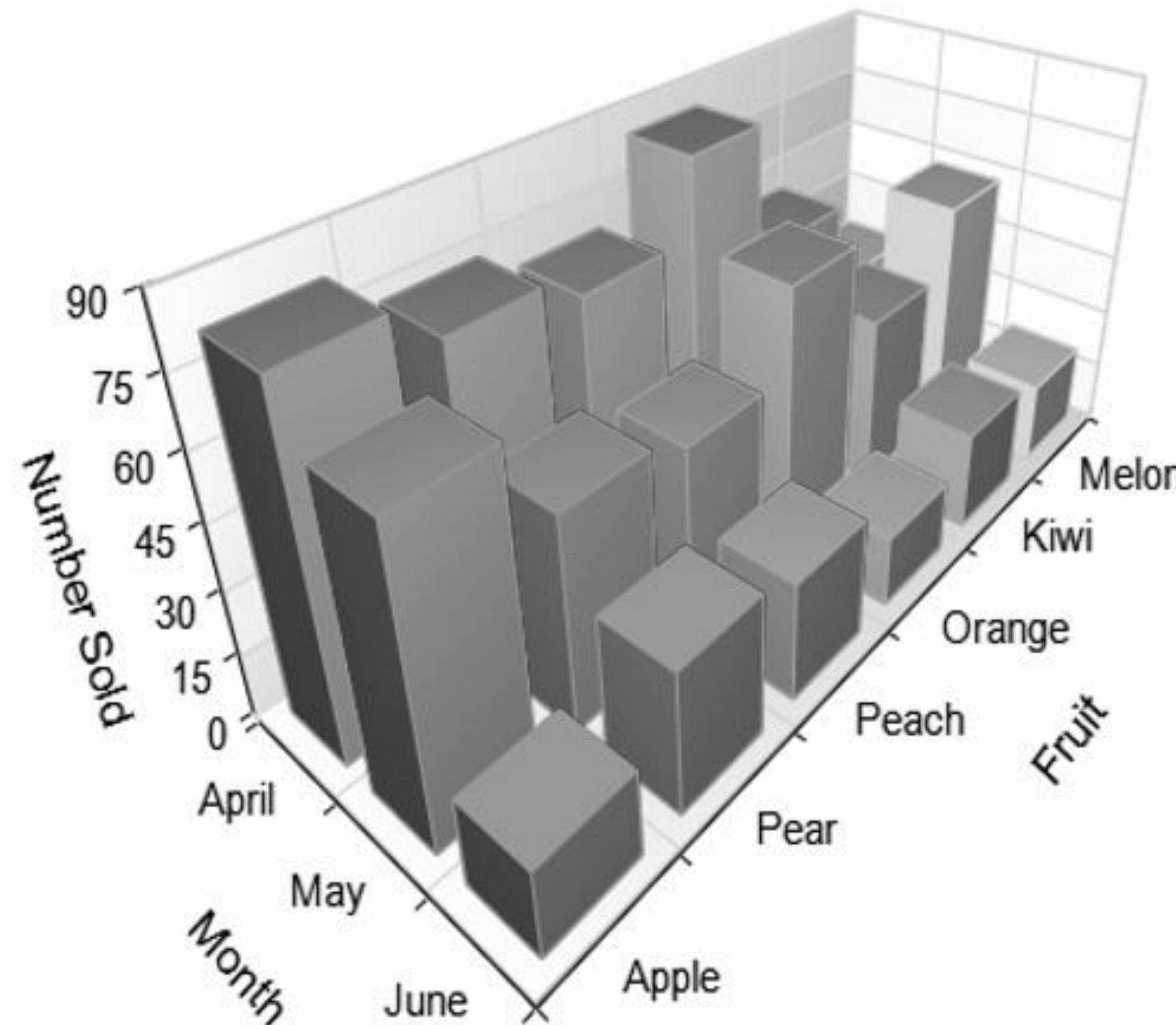


Those with deutanope color blindness (red/green) will have difficulty seeing the numbers.

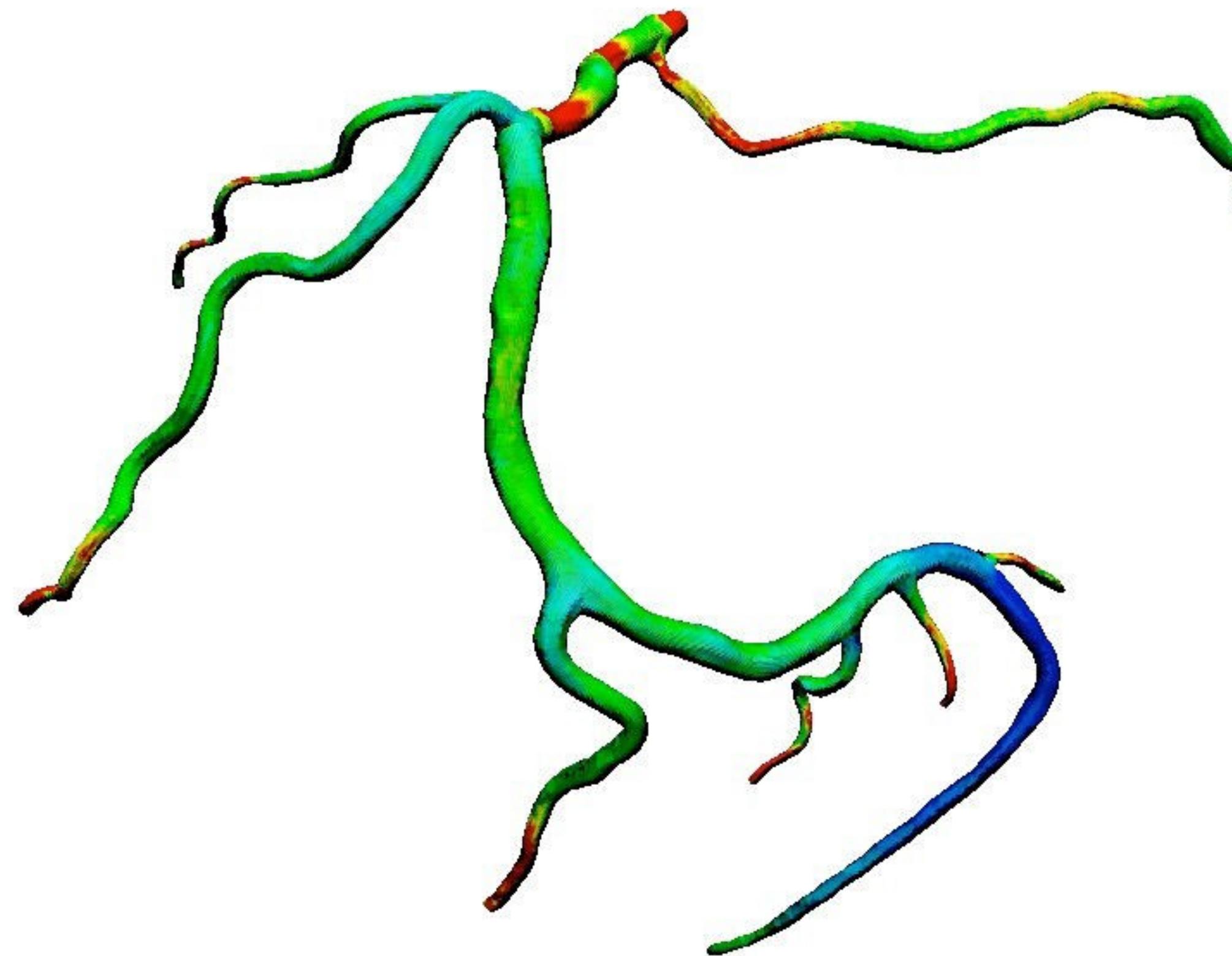
“Get it right in black and white.”



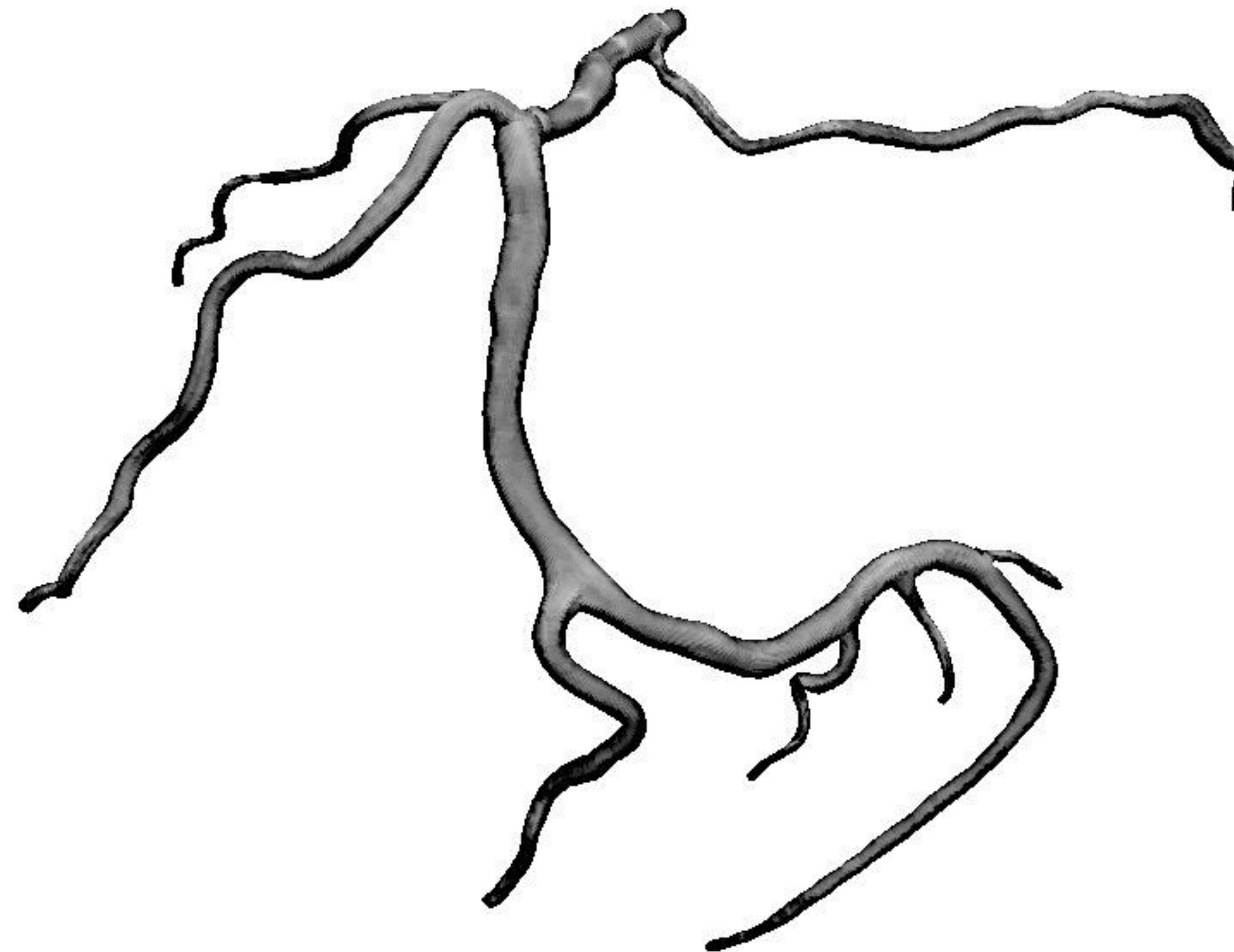
“Get it right in black and white.”



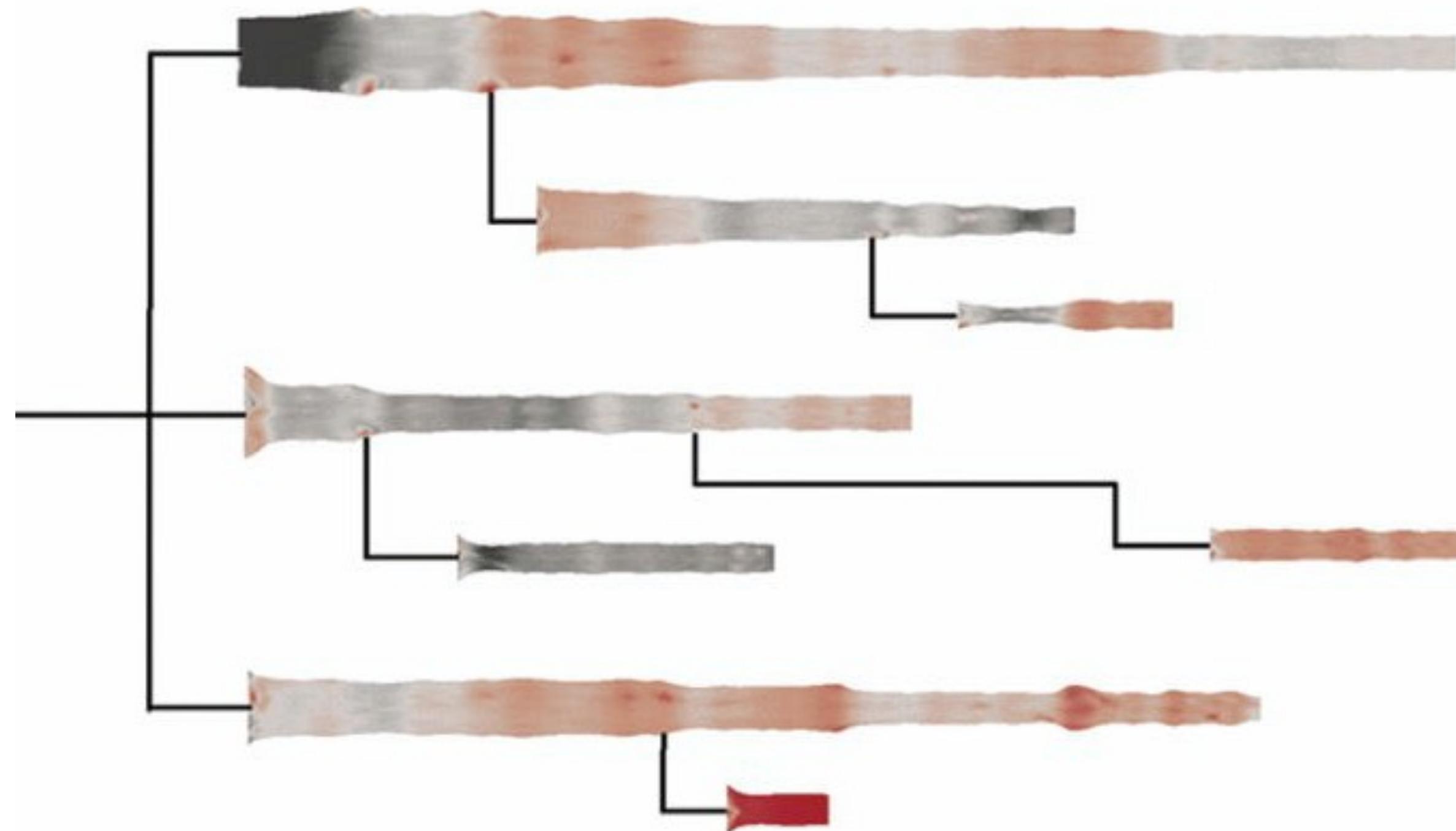
“Get it right in black and white.”



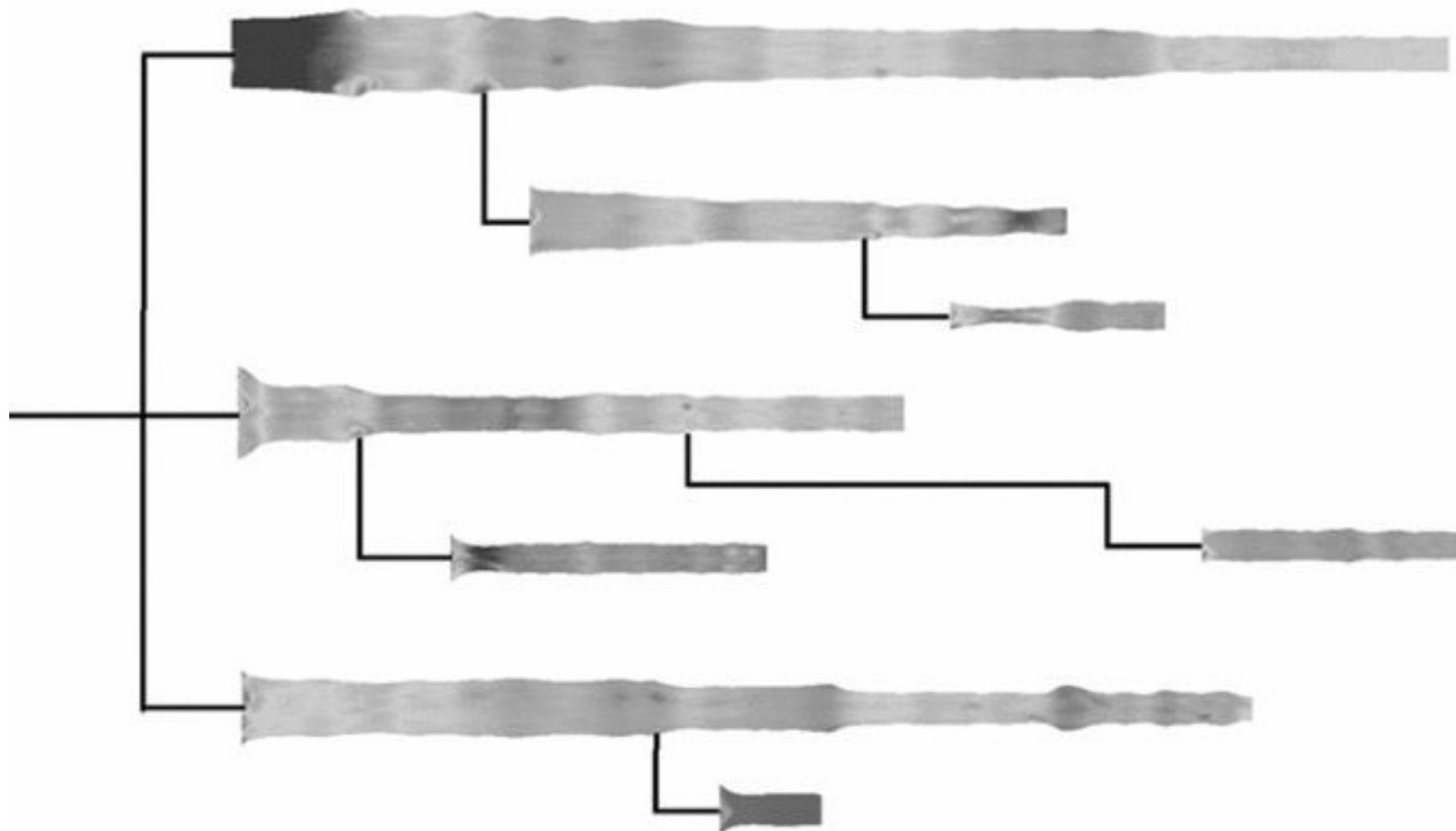
“Get it right in black and white.”



“Get it right in black and white.”



“Get it right in black and white.”



Color Deficiencies (Color Blindness)

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-Zoe N.

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Select the type of color vision to simulate:

 Deutanope (a form of red/green color deficit)
 Protanope (another form of red/green color deficit)
 Tritanope (a blue/yellow deficit- very rare)

Image file: No file chosen

Notes:

- Vischeck accepts most common image formats. However, we recommend that you use PNG or JPEG format for uploading large images as these tend to transfer faster.
- For PowerPoint slides, you can save all your slides as PNG images with "Save As..." and run Vischeck on each slide.
- If you have many images to process, consider [downloading](#) Vischeck to run on your own computer.)
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<http://www.vischeck.com/vischeck/vischeckImage.php>

**More Than 2,500 Sites That Handle Toxic Chemicals
Are Located in Flood-Prone Areas Across the Country.**

● Site in area at high risk of flooding ○ Site in area at moderate risk of flooding

