Understanding light and color from a digital artist's perspective

Hello

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- Working on Trezi, an immersive collaboration platform for the AEC industry
- 10 years working with real-time rendering engines

Outline

Understanding Light and color

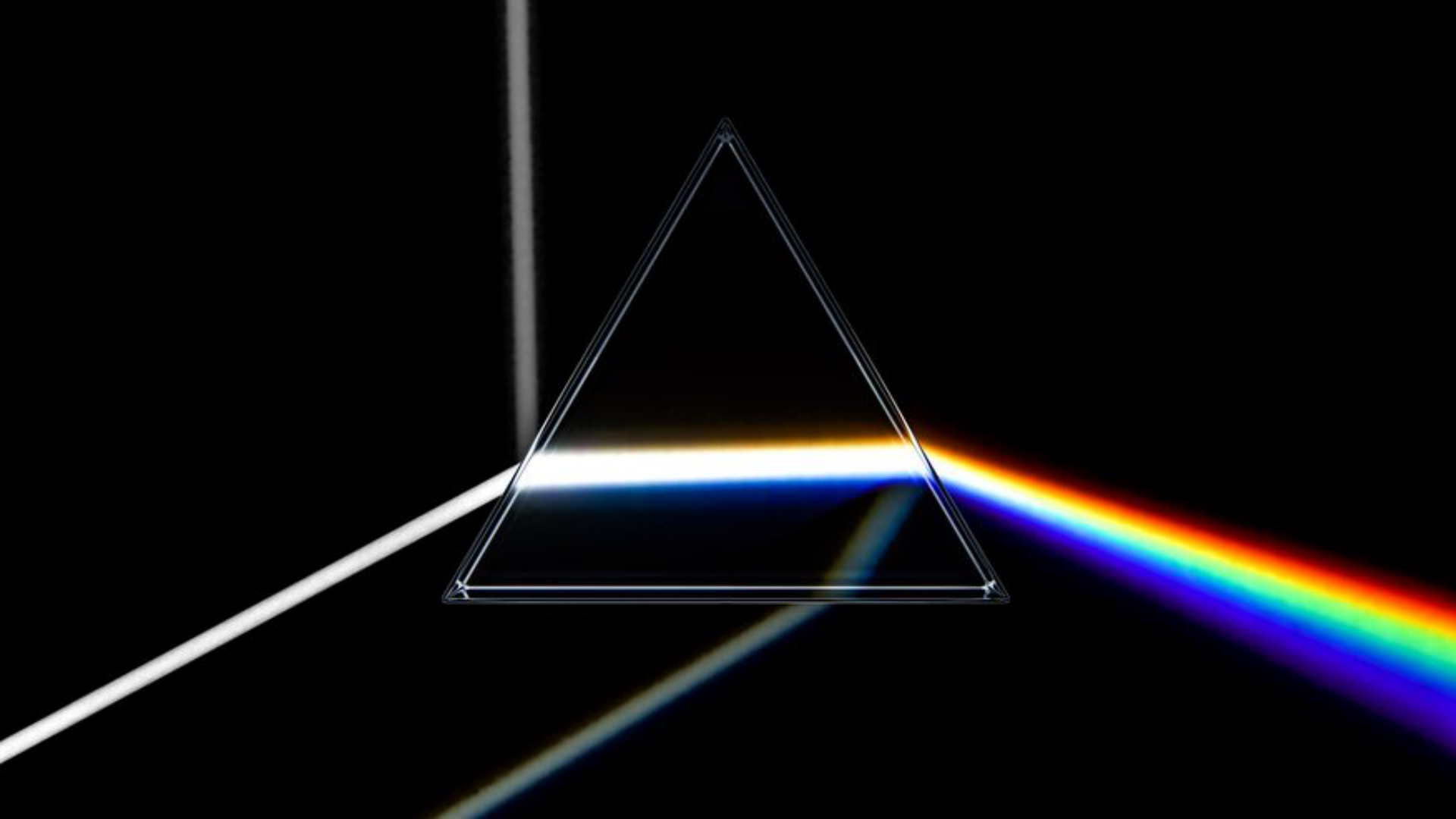
Digital tools and color

Color and the workflow

Understanding light and color

Visible light

- Small part of the electromagnetic spectrum
- 400 to 800 nanometers
- Light refracts when traveling across mediums
- Blue refracts more, red refracts less



Chromatic aberration

- Different wavelengths of light are focused at different distances within the eye
- Red and blue are the very end
- Our eyes adapt, but can’t focus both red and blue at the same time

Most people see red closer than the blue but some see the exactly opposite effect

Receptors

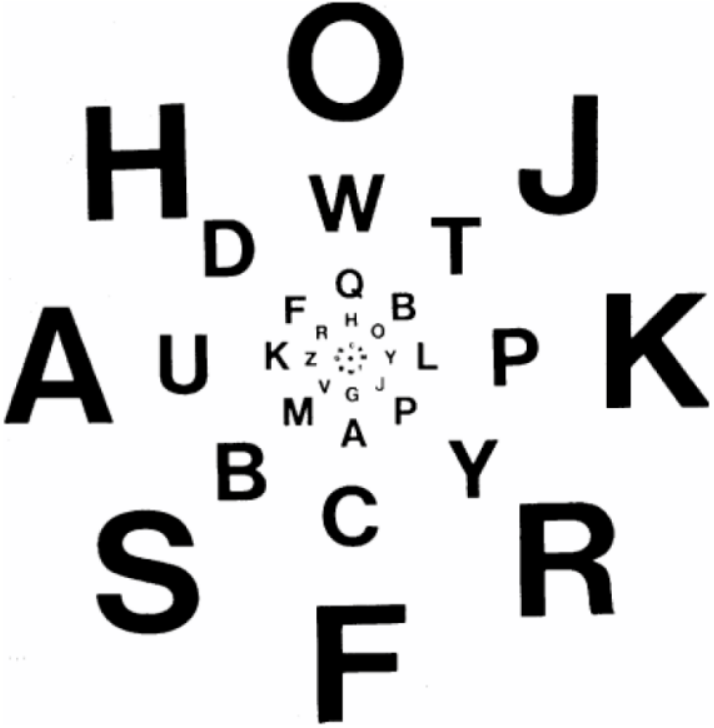
- Rods - sensitive at low light levels
- 100 million
- Overloaded in daylight

- Cones - sensitive at normal lighting levels
- 6 million
- The primary basis for visual research

Fovea

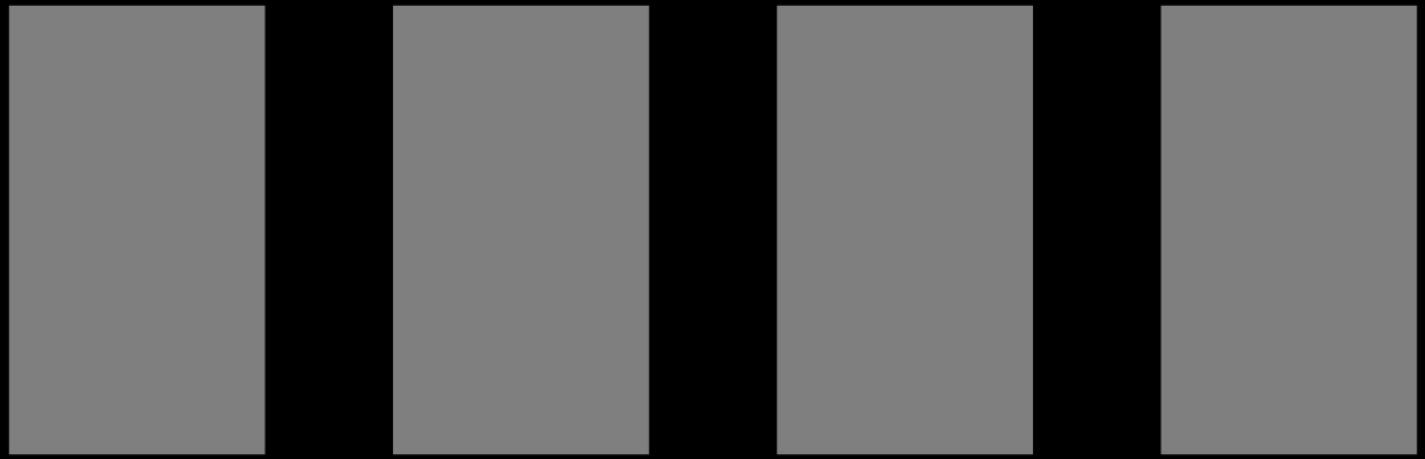
- Small area in the center of the retina
- Densely packed only with cones
- Vision is the sharpest here for a very small degree 2
- Sharpness falls off very quickly as we move away from fovea

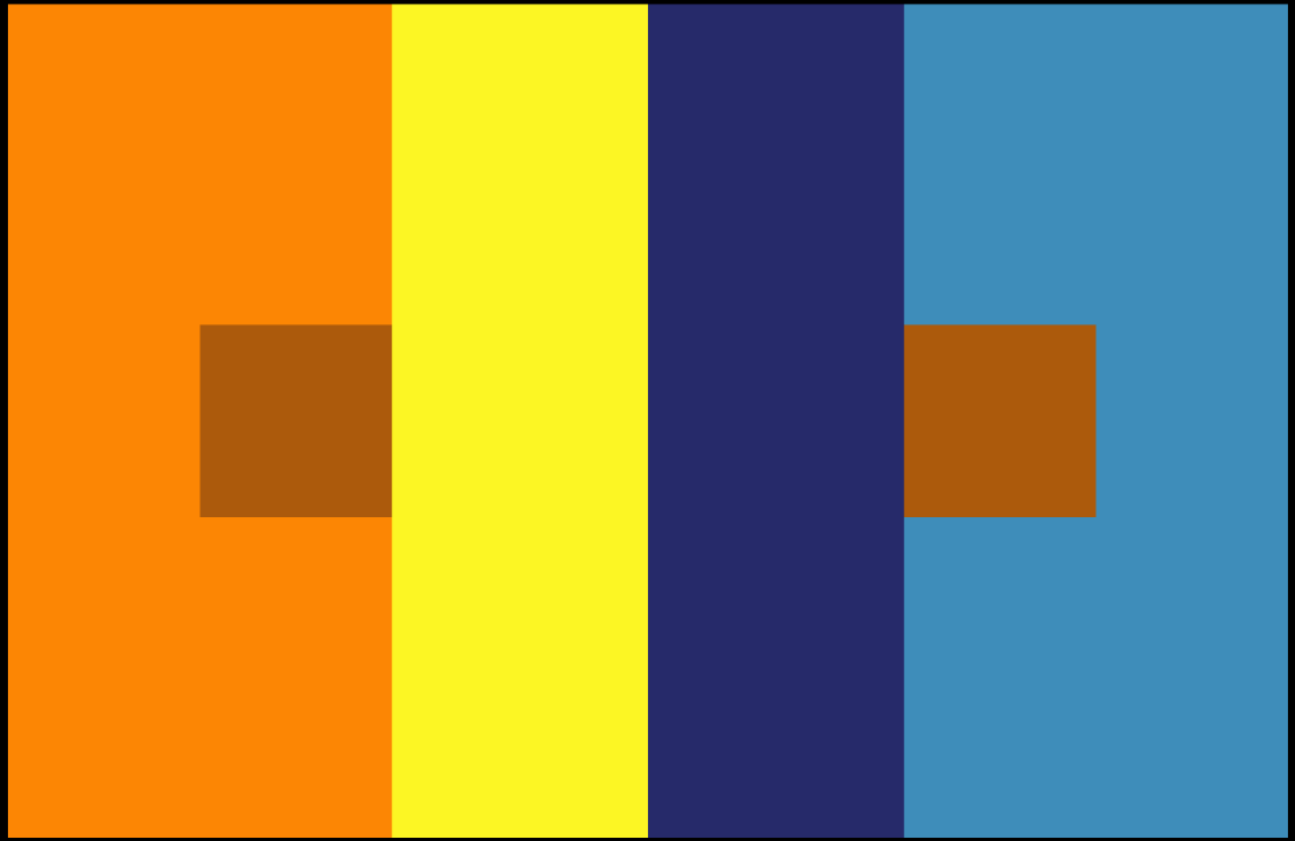
Stuart Anstis eye chart

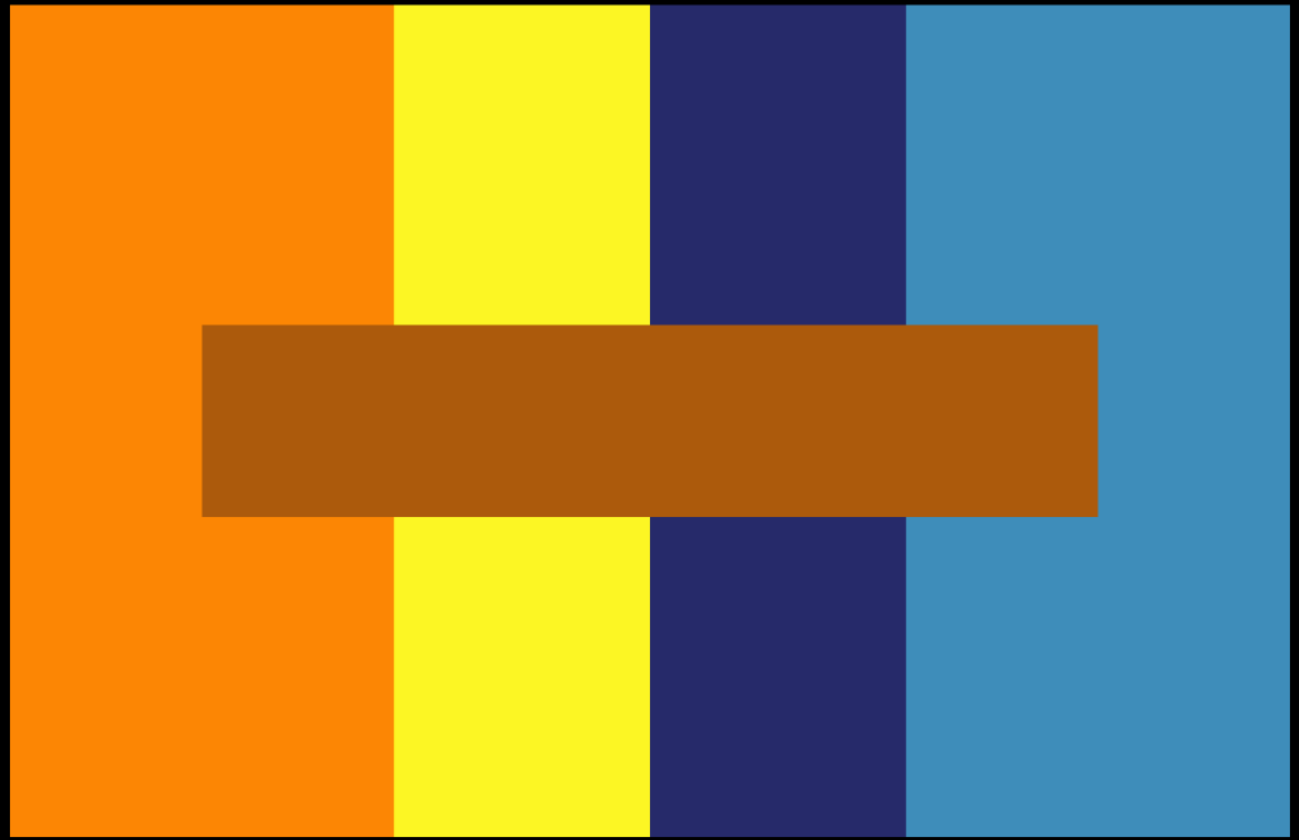


Vision is perceived as differences, not absolutes

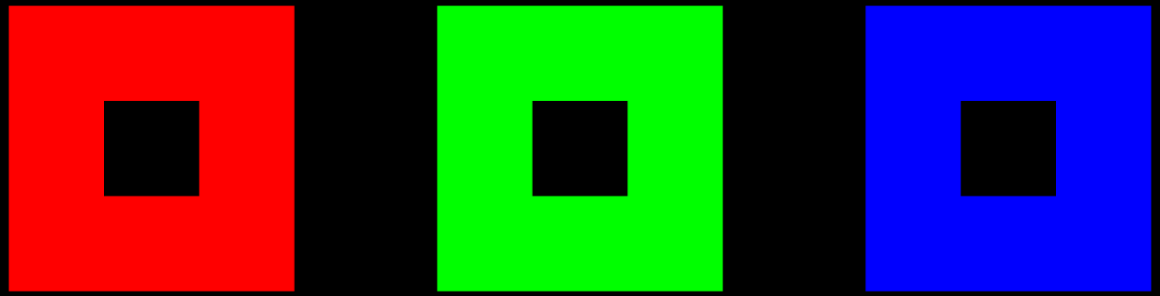
- Nerves transmit nothing about the amount of light falling on the retina
- They signal the relative amount of light
- How a patch of light differs from a neighbouring one
- How a particular patch of light has changed in the past instant
- Perception of light is nonlinear
- Implications on grey-scale coding of information







Colors differ in luminosity levels



RGB 255,0,0

5.3 : 1

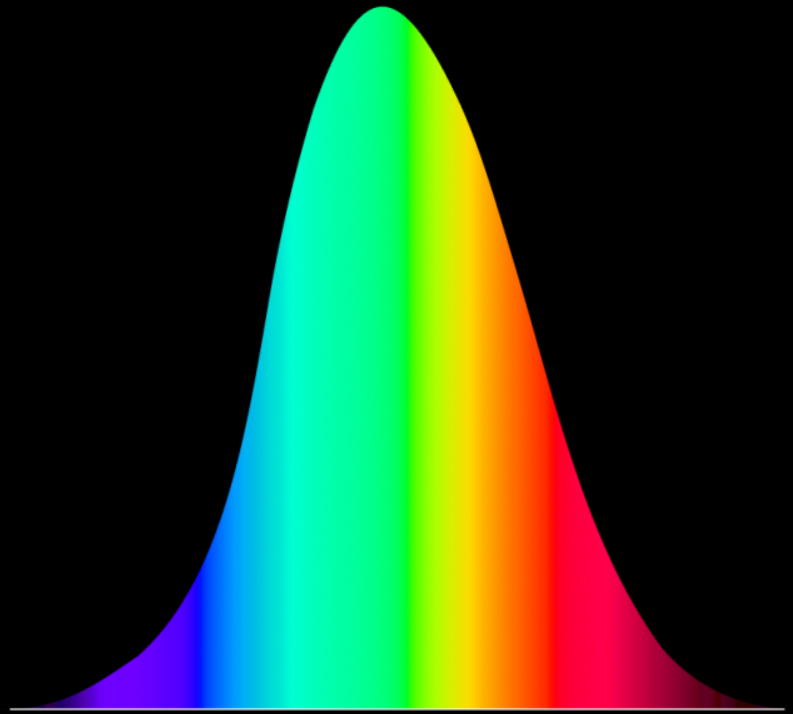
RGB 0,255,0

15.3 : 1

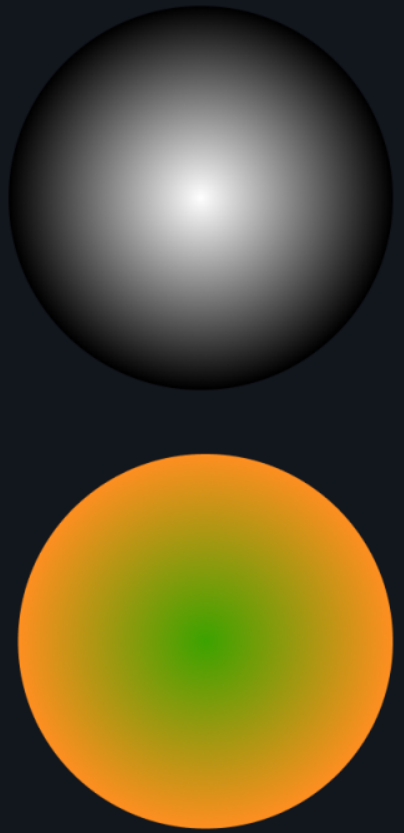
RGB 0,0,255

2.4 : 1

Color response curve



We see depth in luminance, not color

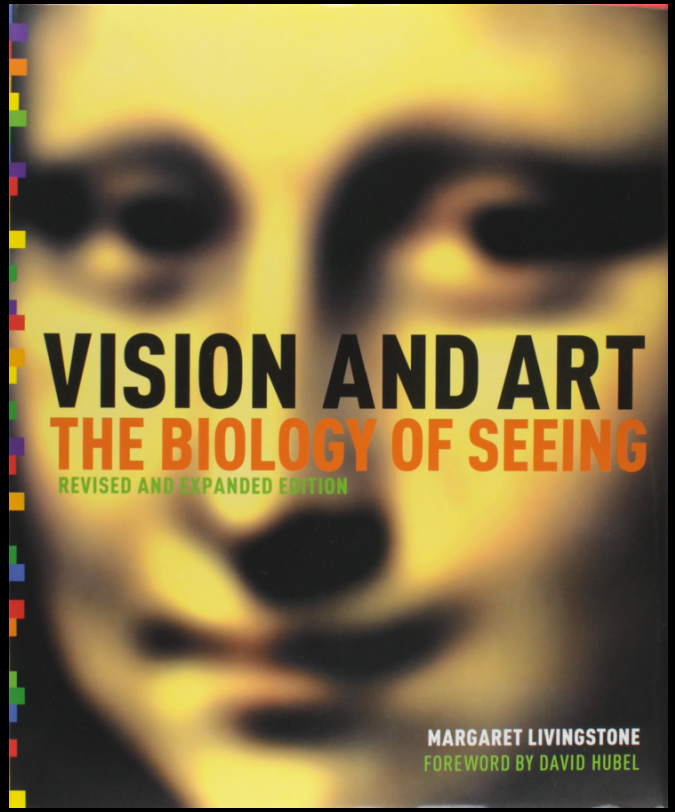


Further reading

Interaction of Color by Josef Albers

Further reading

Vision and Art: The Biology of Seeing
by Margaret S. Livingstone

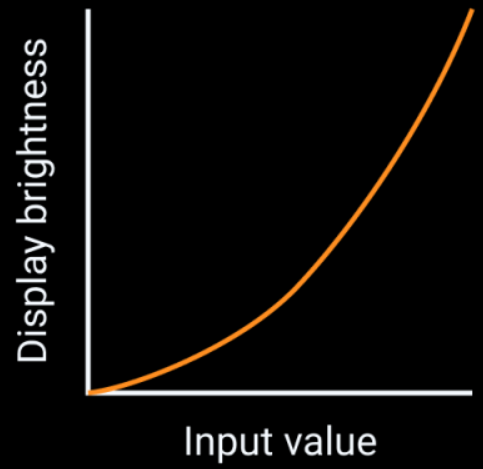


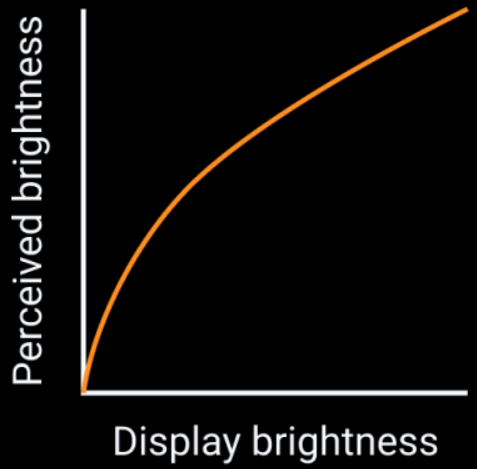
Digital tools and color

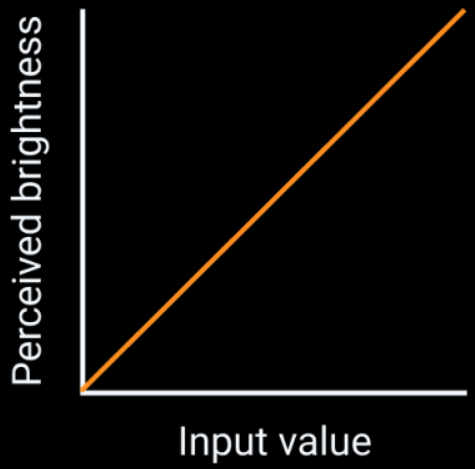
Gamma

- The function that defines how luminance is mapped to input signal
- Our perception of light isn’t linear
- We still want grey scale with perceptually equal steps

Gamma


Display brightness
Input value


Perceived brightness
Display brightness


Perceived brightness
Input value

The pixel

- The unit that defines color
- Carries a single color value
- Images are made from an array of pixels

Bit depth and possible values

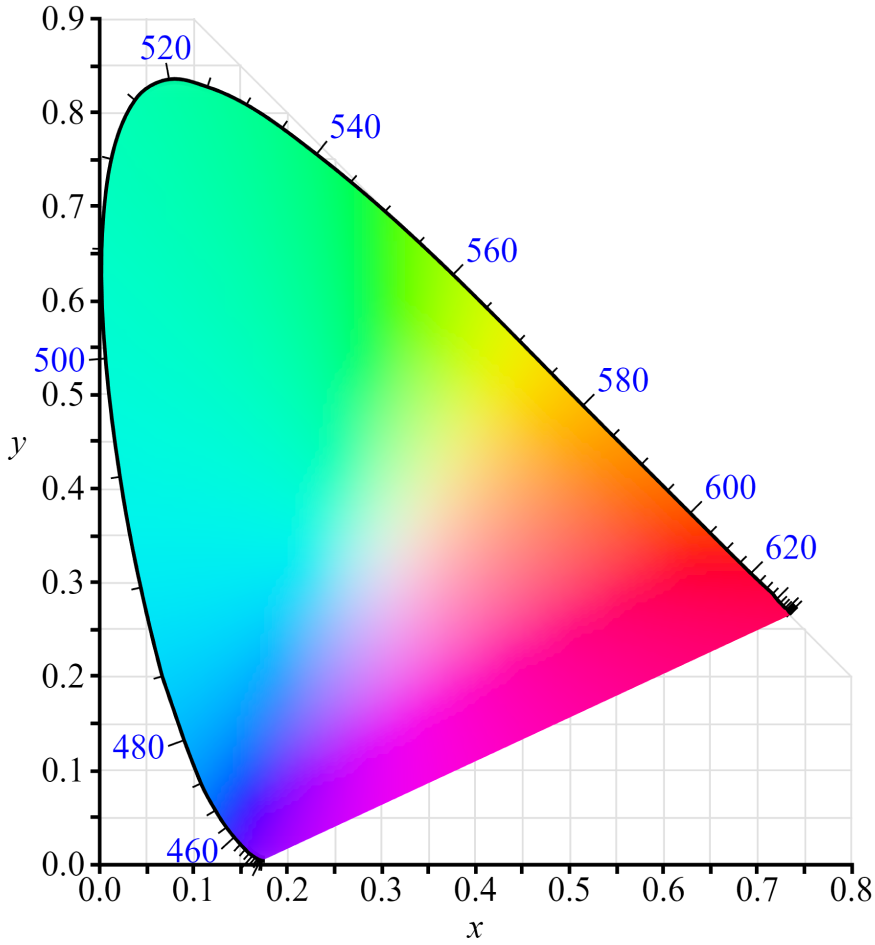
- Bit depth defines possible data values per channel
- 1 bit means 2, 2 means 4, 3 means 8 and so on
- The most common format is a 24 bits (8 bit per channel)
- Gives a total of 16777216 total colors

Color space and color model

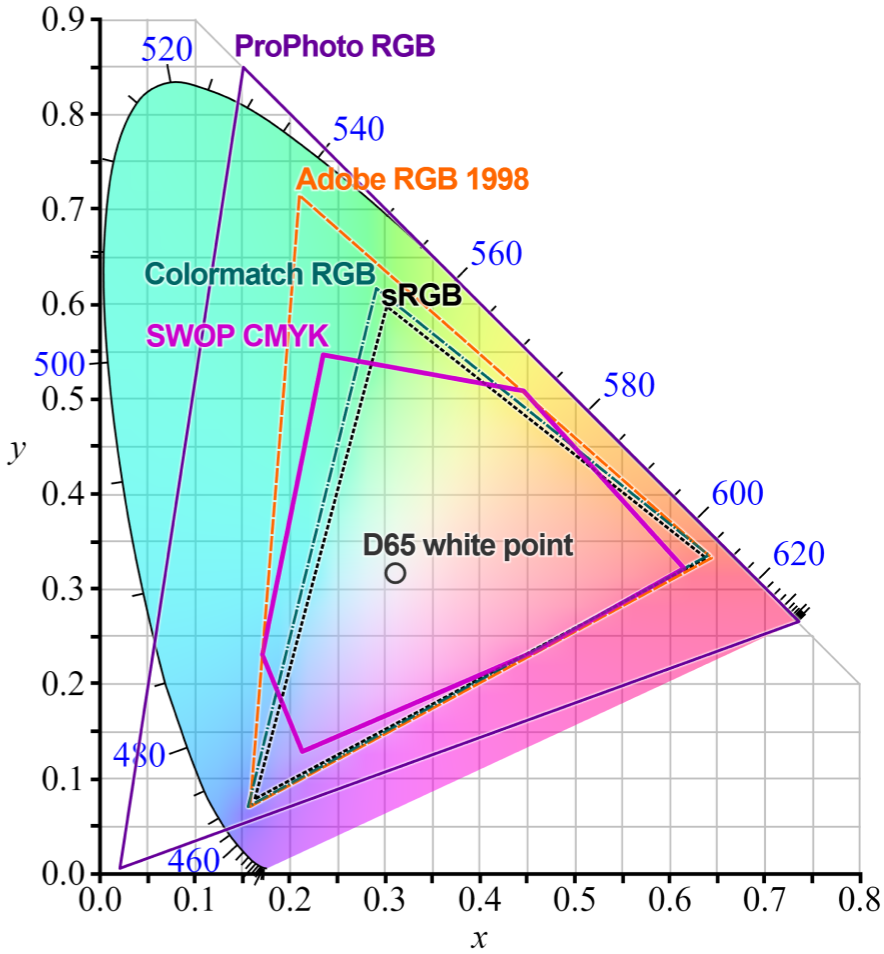
- A color space is a specific organization of colors
- The word is often used informally to identify a color model

CIE 1931 color space

- Created by International Commission on Illumination (CIE) in 1931
- Every other color space can be contained within this



Color space comparison



RGB color model

- RGB stores individual values for red, green and blue
- Additive color mixing, start from black
- RGB is not a color space, it is a color model
- There are many different color spaces derived from this color model
- sRGB, Adobe RGB, ProPhoto RGB, DCI-P3, Rec 709, Rec 2020
- Perceptually non-uniform color space

CMYK color model

- Used primarily for print
- Subtractive color from white to create color
- Perceptually non-uniform color space

HSV and HSL

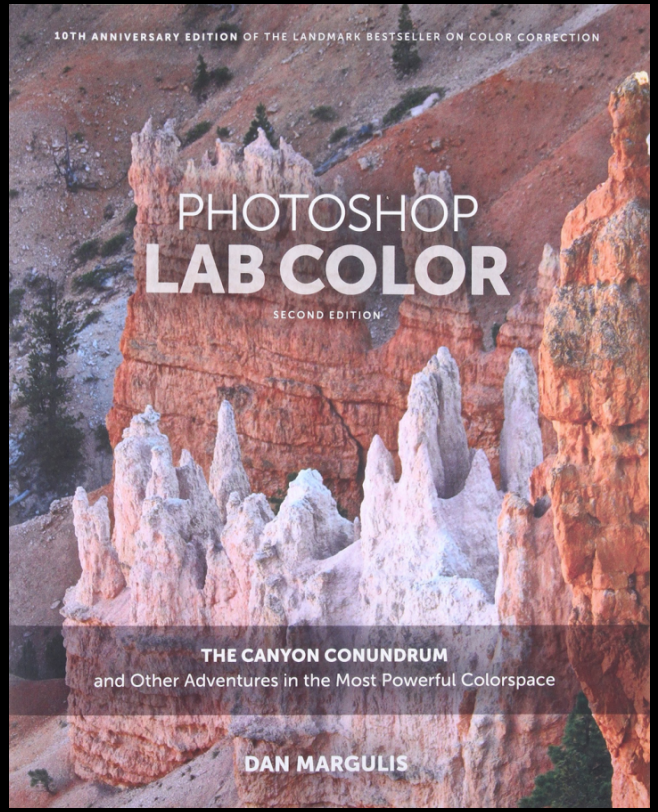
- More intuitive to use
- HSV: a colour of maximum value will be the most intense colour given the hue and saturation
- HSL: a colour of maximum lightness will always be white, regardless of hue and saturation

Lab color model

- Colour space designed for the human eye
- Perceptually uniform
- L is the lightness of the colour
- a is the position between green and red/magenta
- b is the position between blue and yellow
- Lab can describe all colours that the human eye can perceive

Further reading

Photoshop LAB Color: The Canyon Conundrum and Other Adventures in the Most Powerful Colorspace by Dan Margulis



Color gamut

- The entire range of colors available on a particular device
- Usually denoted by % coverage of a color space
- Colors get clamped when device get a signal it can’t render

HDR

- 10 bit color
- 90% of DCI-P3 color space coverage
- 1000 nits of brightness

Tone mapping

- Conversion of data from a higher to limited color space
- Like HDR to SDR or sRGB to CMYK

Texture compression

- JPG
- GIF
- DXT
- ASTC
- ETC
- PSD
- PNG
- BMP
- TGA
- TIFF

Color and your workflow

Color vision deficiency

- Also sometimes known as color blindness
- About 8% males and 0.5% females have some level of color blindness
- Do a quick test to understand where you are

Calibration

- White point to 6500K, Gamma at 2.2
- Monitor brightness at around 200 nits
- Keep environment lighting and tint into account

Environment

- Well-lit environment
- No tint in lighting
- Sit right in front of the monitor

Art tools and game engines

- If you are using Unity or Unreal use PSD
- No compression issues, simple workflow

Design for the target medium

- Displays can’t show pure black or white
- Printers can’t print clean gradients
- Keep in mind what the target medium is capable of

You should always use compressed textures

- Most of the time the size to quality ratio is very significant
- Only exceptions should be UI textures
- Unity and UE4 automatically apply required compression based on use case and platform

Questions?

Thank you!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