WHAT IS COLOR?

Color is the subjective perception in our brain of an objective feature of light's specific wavelengths

- *Leonard Shlain*

COLOR THEORY

Color theory is a body of practical guidance to color mixing and the visual effects of specific color combinations

- *Wikipedia*

PRIMARY COLORS

- Colors that can't be obtained by mixing other colors
- Most other colors can accessed by mixing primary colors
- The three primary colors differ in additive and subtractive color systems

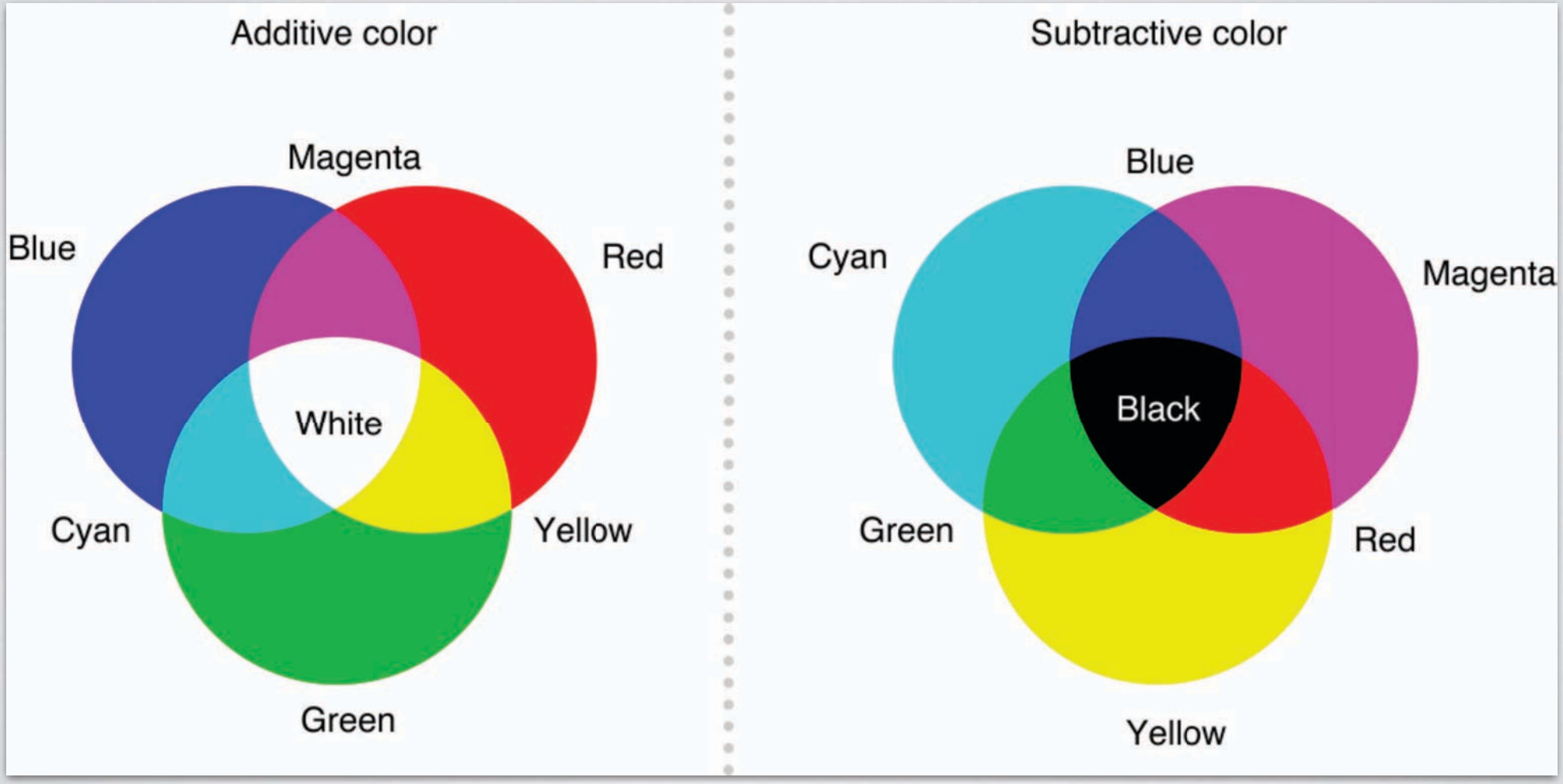
SECONDARY COLORS

- Colors obtained by mixing two primary colors in equal proportions
- Secondary colors are brighter in additive color systems and darker in subtractive color systems

ADDITIVE VS. SUBTRACTIVE COLOR MIXTURES

- Light is additive (Primary R, G, B; Secondary C, M, Y). When mixed they create lighter colors
- Pigments are subtractive (Primary C, M, Y; Secondary P, O, G). When mixed they create darker colors

ADDITIVE VS. SUBTRACTIVE COLOR MIXTURES



LIGHT MIXTURES

Can be created by…

- Superimposing lights of different colors
- Showing two different colors in rapid succession
- Placing small points of different colors close together

Why?

PIGMENT MIXTURES

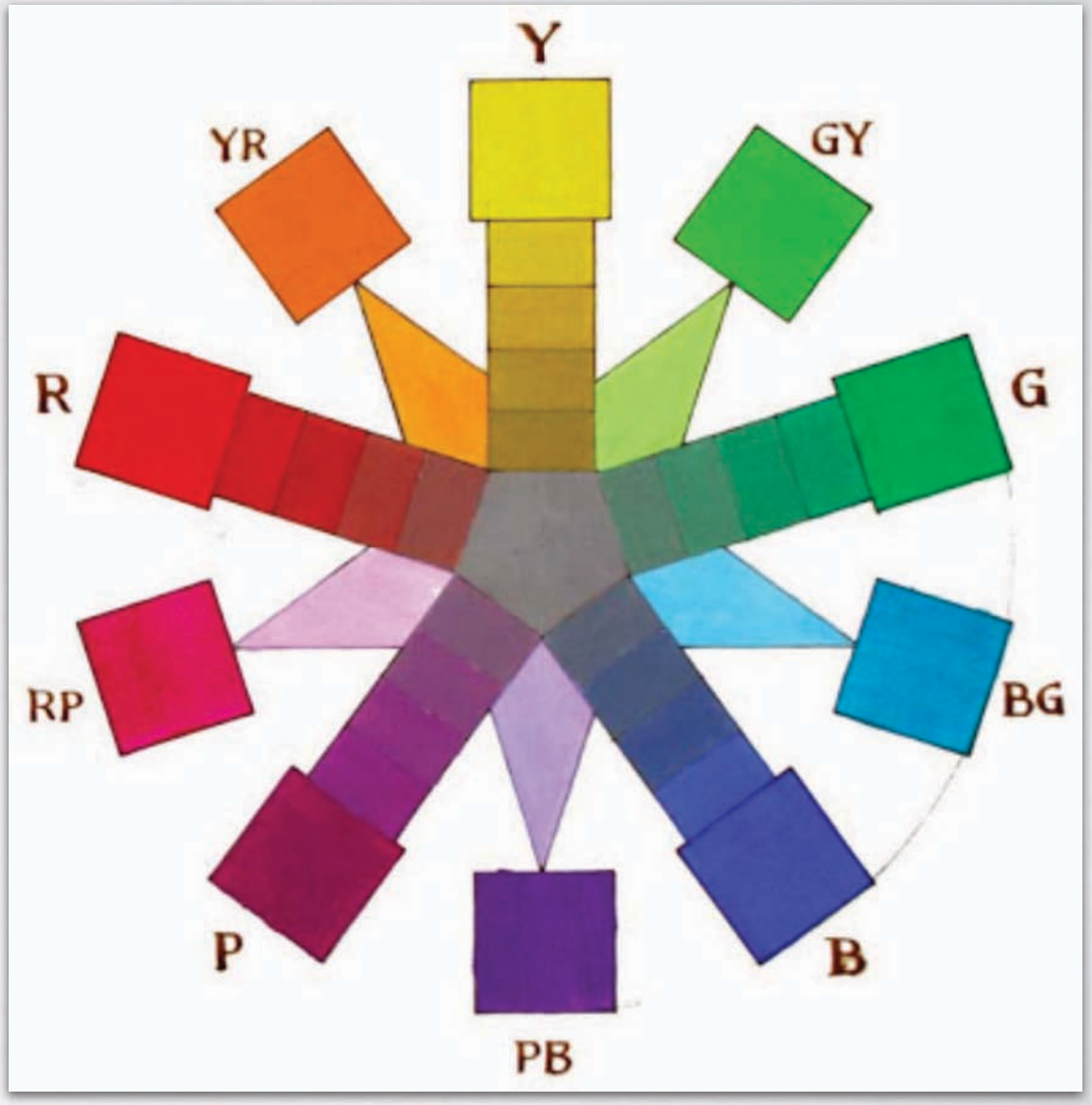
- It is not actually possible to access any color from mixing only three primaries
- In printing and photography, mixtures of cyan, magenta, and yellow are modified by the white of the paper and a black ink known as key (K).
- Thus, subtractive color systems like CMYK use at least four pigments to access all colors

THE 12-COLOR WHEEL

- 3 primary colors (Y, R, B)
- 3 secondary colors (G, O, V)
- 6 tertiary colors obtained by mixing a secondary with an adjacent primary

MUNSELL'S 10-COLOR WHEEL

- Albert Munsell proposed five pigment primaries (Y, G, B, P, R) which he called *principle hues*

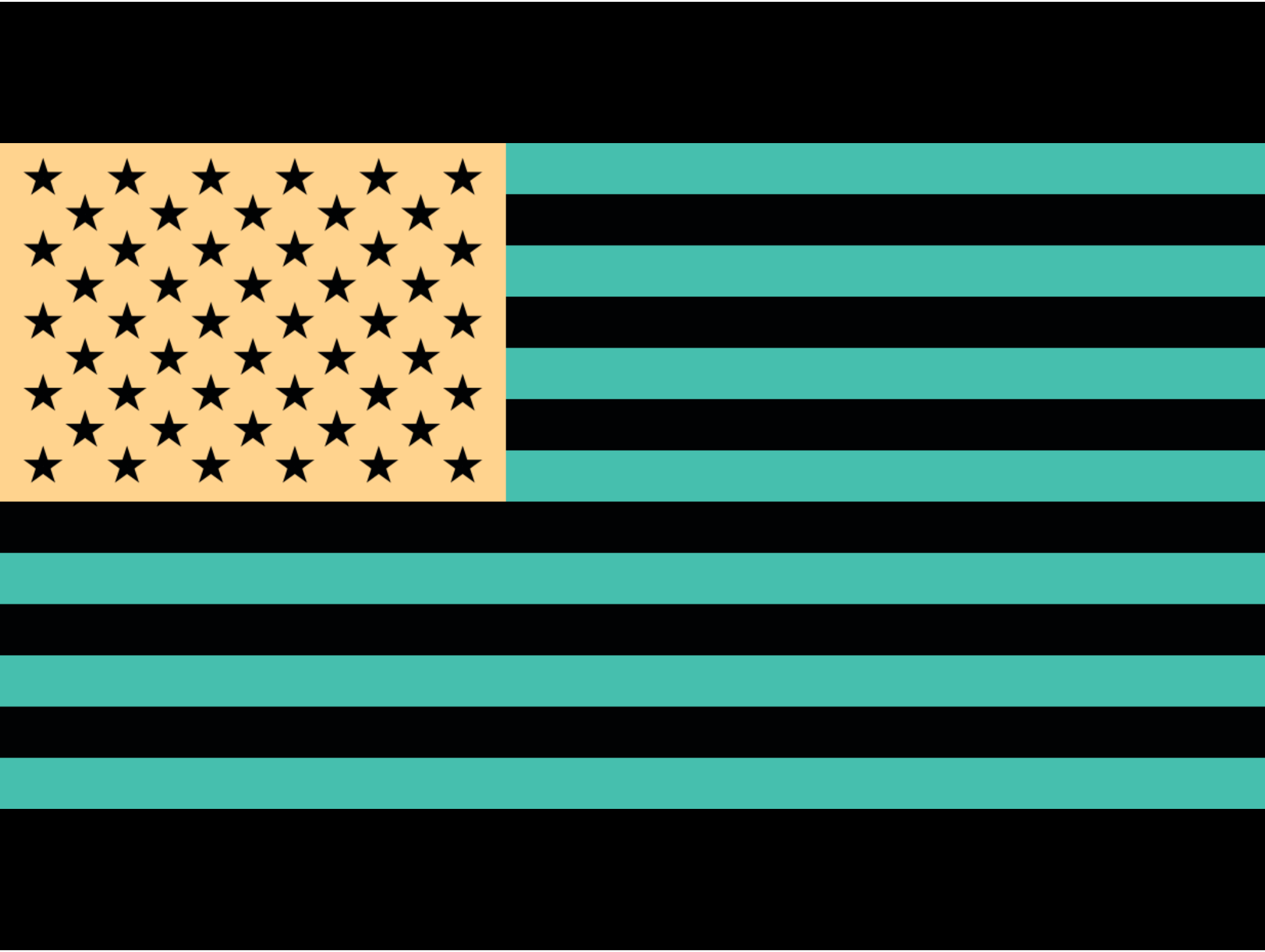


COMPLEMENTARIES

- Two colors that are opposite each other on a color wheel are called complementaries
- Mixing truly complementary pigment colors yields a neutral grey
- When placed side by side, complementary colors intensify each other

AFTERIMAGE / PALINOPSIA

- Photochemical activity in the retina continues after the stimulus
- Negative afterimages are caused when rods and cones are overstimulated and lose sensitivity (the dim spot floating in your view after you look at a bright light)
- The color of a negative afterimage is the *complement* of the image itself. Why?
- A positive afterimage (uncommon) is the same color as the starting image



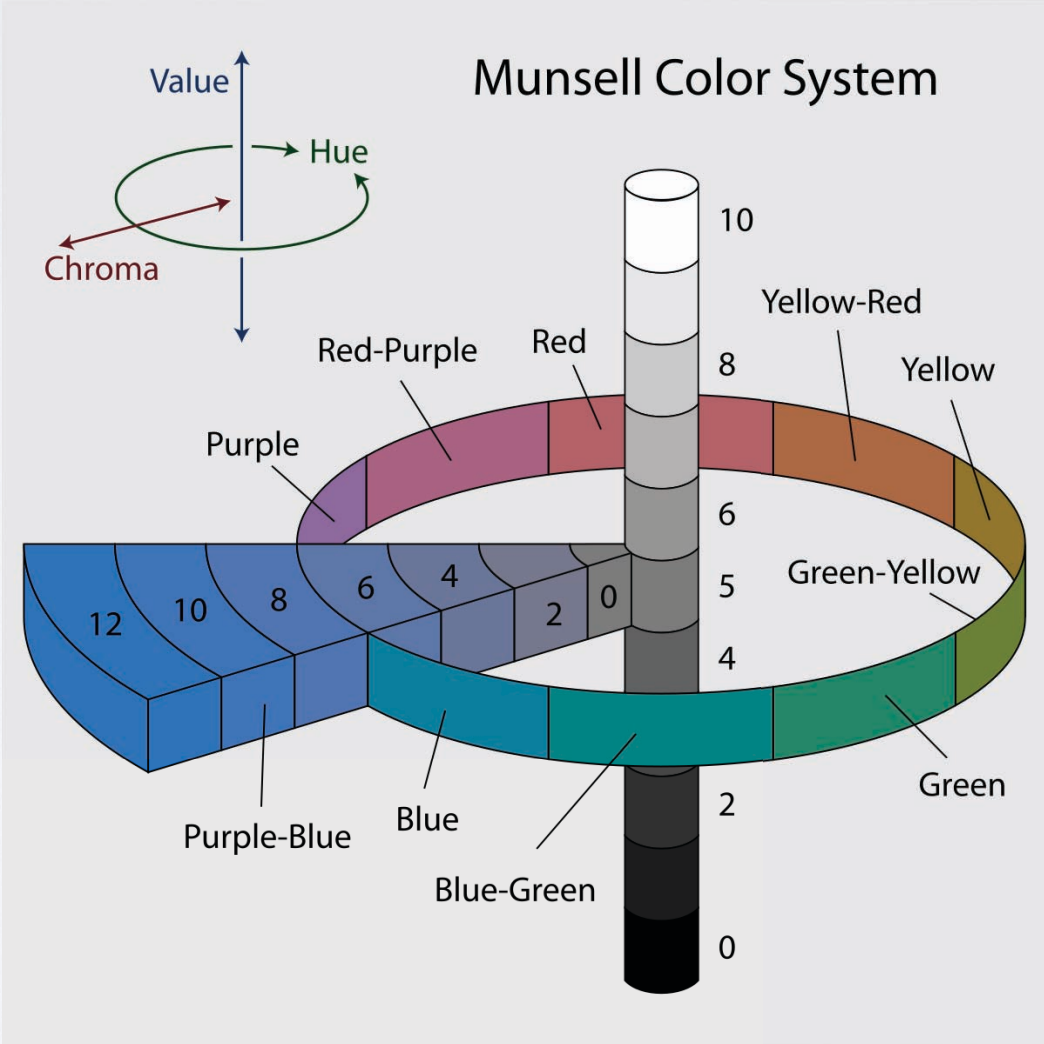
BLUE/GREEN IN HOSPITALS

Green is easier on the surgeon's eyes, since they are looking at red on the operating table!

- Looking at green refreshes sensitivity to red.
- Green walls camouflage the green afterimage after staring at red blood.

3 DIMENSIONS OF COLOR

- Munsell's 3D system has a vertical axis for value, a circumferential axis for hue, and a radial axis for *chroma* (saturation)
- The fully desaturated values at the center are known as *neutral* colors (greyscale = neutral)
- Colors along the radial lines are called *chromatic hues*
- Every color gets a number

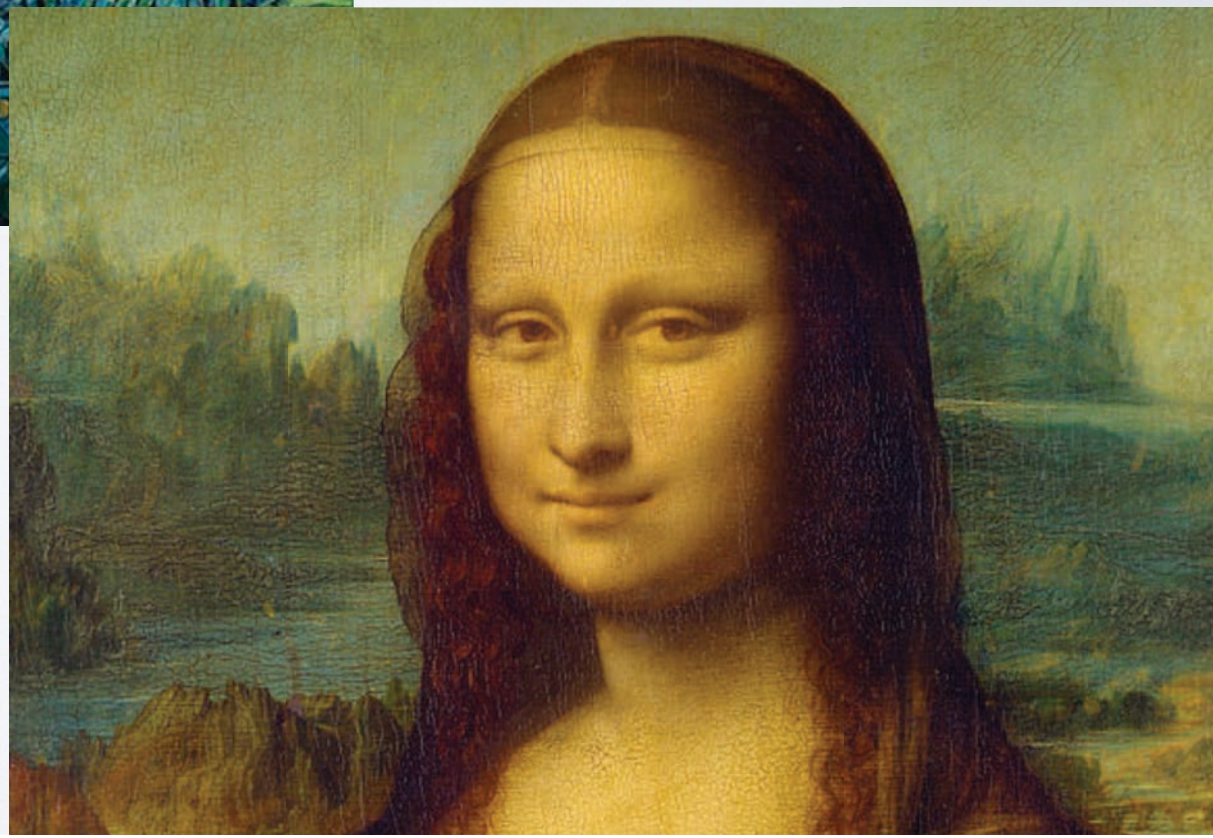


HUE

- **Hue** is the quality of a color we identify by name, such as red, blue, etc.
- Hue can be considered as the wavelength profile of a color

SATURATION

- **Saturation**: the degree to which colors are greyed by being mixed with their complementaries
- Also known as "intensity"
- The grayer a color, the less saturated; greyscale images are fully desaturated (also known as unsaturated, achromatic, neutral)



VALUE

- **Value** is the brightness or darkness of a color. Also known as *luminance*
- Brighter colors have more value, darker colors less
- Value differences in color are most easily seen in greyscale, where pure black is the lowest value and pure white is the highest value
- In pigment mixtures, values lowered by adding black or raised by thinning so more white shows through

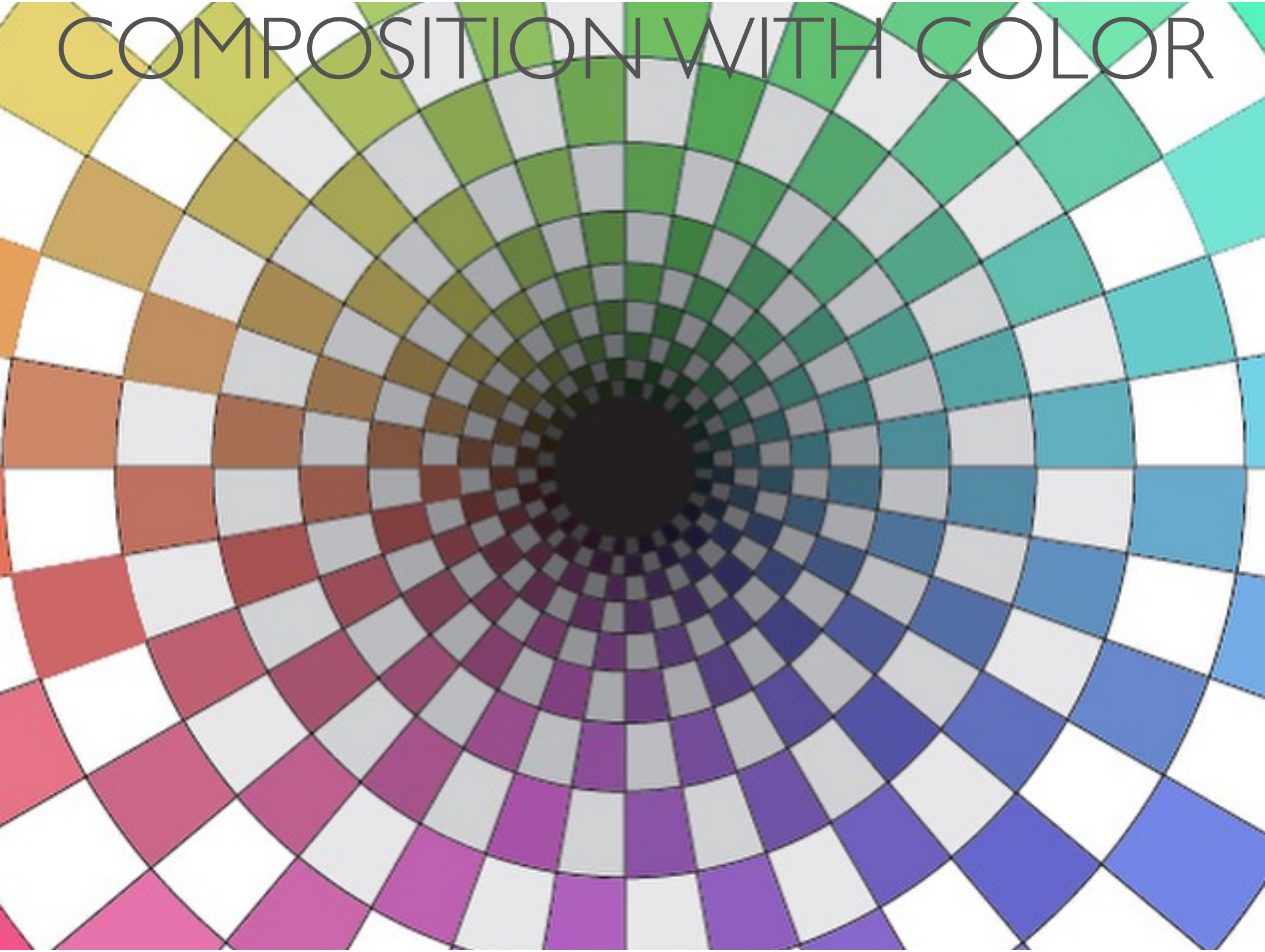
La Femme au Chapeau, Henri Matisse, 1905


"Colors are only symbols. Reality is to be found in luminance alone"
Pablo Picasso

RECAP

- Additive colors (light) get brighter when mixing
- Subtractive colors (dyes/pigments) get darker when mixing
- Additive and subtractive have different primaries
- Complementary colors lie opposite on the color wheel
- Mixing a color with its complement gives a neutral color (grey)
- Hue is the color
- Saturation is the purity or intensity of a color
- Value is the brightness

COMPOSITION WITH COLOR



COMPOSITION WITH COLOR

- Spatial Effects
- Balance and Proportion
- Emphasis
- Unity

SPATIAL EFFECTS

- Hues that are lighter at maximum saturation (e.g., yellow, orange) appear larger than hues that are darker at maximum saturation (e.g., blues, purples)
- Highly saturated colors appear larger than less saturated ones
- Warm colors appear to advance and cool colors recede
- Objects displaying more contrast appear closer (atmospheric perspective)
- Depth and flatness can be manipulated by variations in saturation and value (more variation creates more depth)

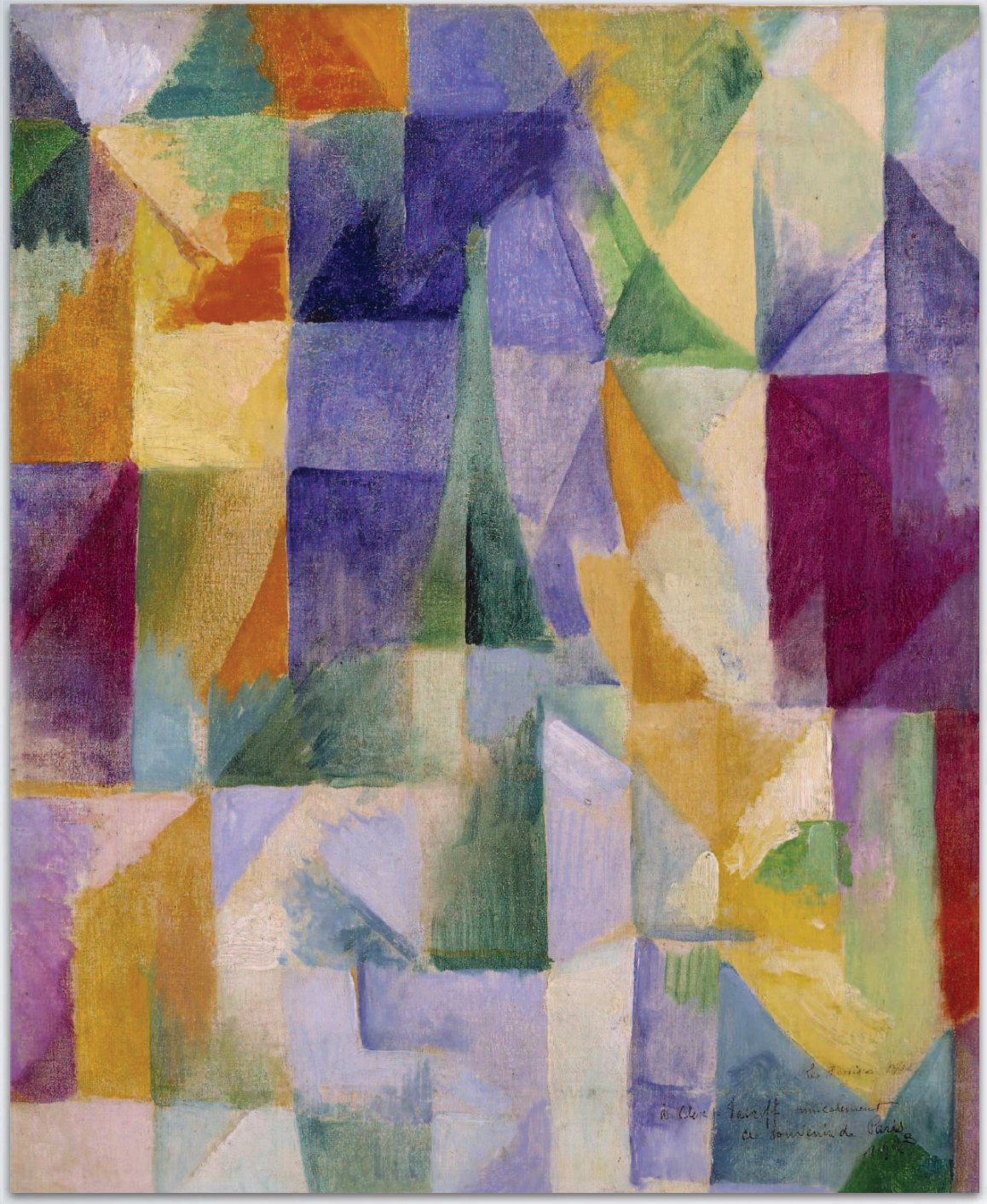
ATMOSPHERIC PERSPECTIVE

Stuff that is further away looks bluer

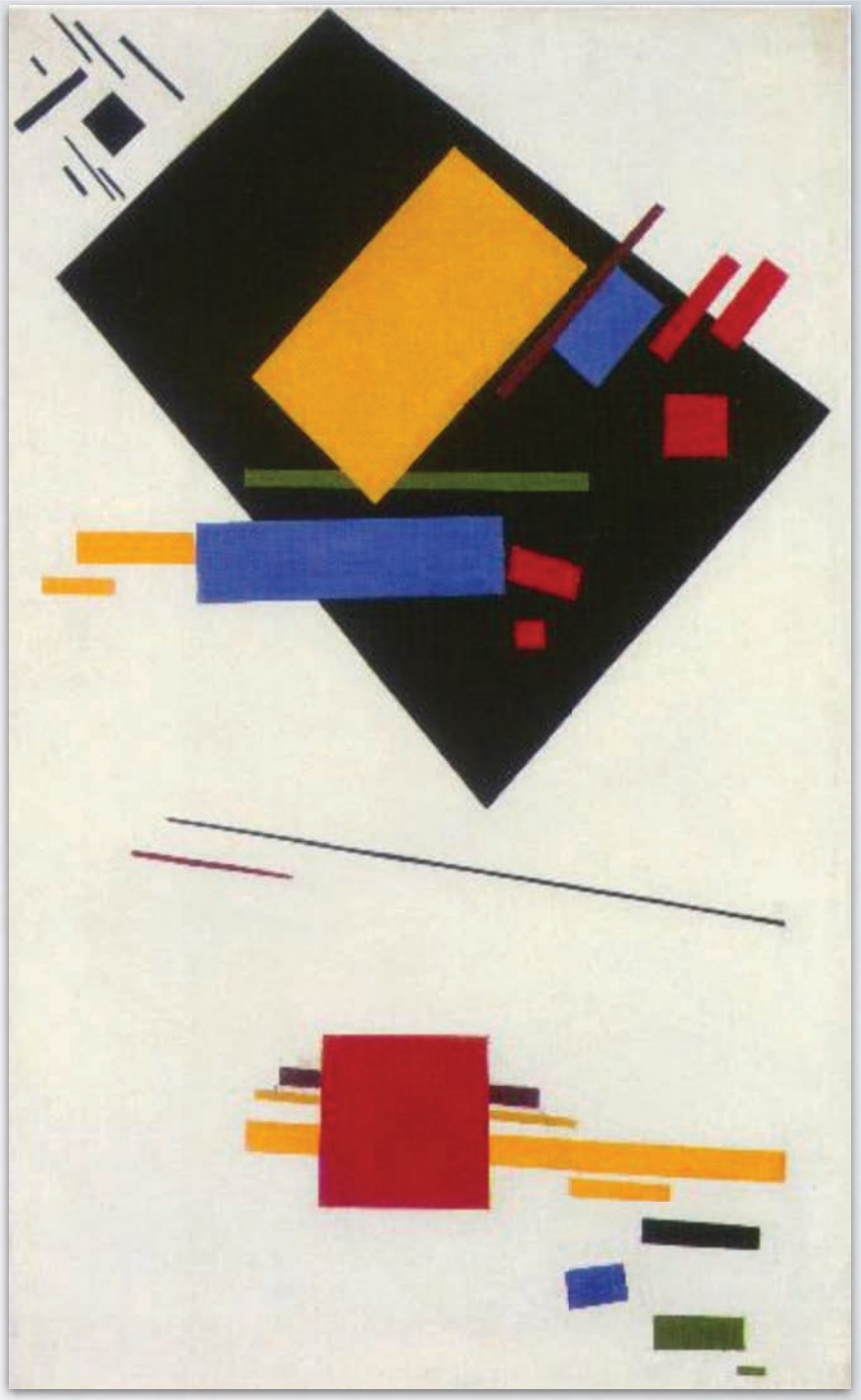
Tim Bavington, *Step (In) Out*

BALANCE AND PROPORTION

- Colors give a visual suggestion of "weightiness"
- Highly saturated or busily detailed areas draw more attention and therefore carry more weight
- Colors can be used to create a feeling of balance or imbalance in a work
- Some theorists feel that warm and cool hues, or light and dark values, should cover equal parts in a work to creating a satisfying symmetry, yet many successful works do not conform to any theory of color balance



Windows Open Simultaneously, Robert Delaunay, 1912



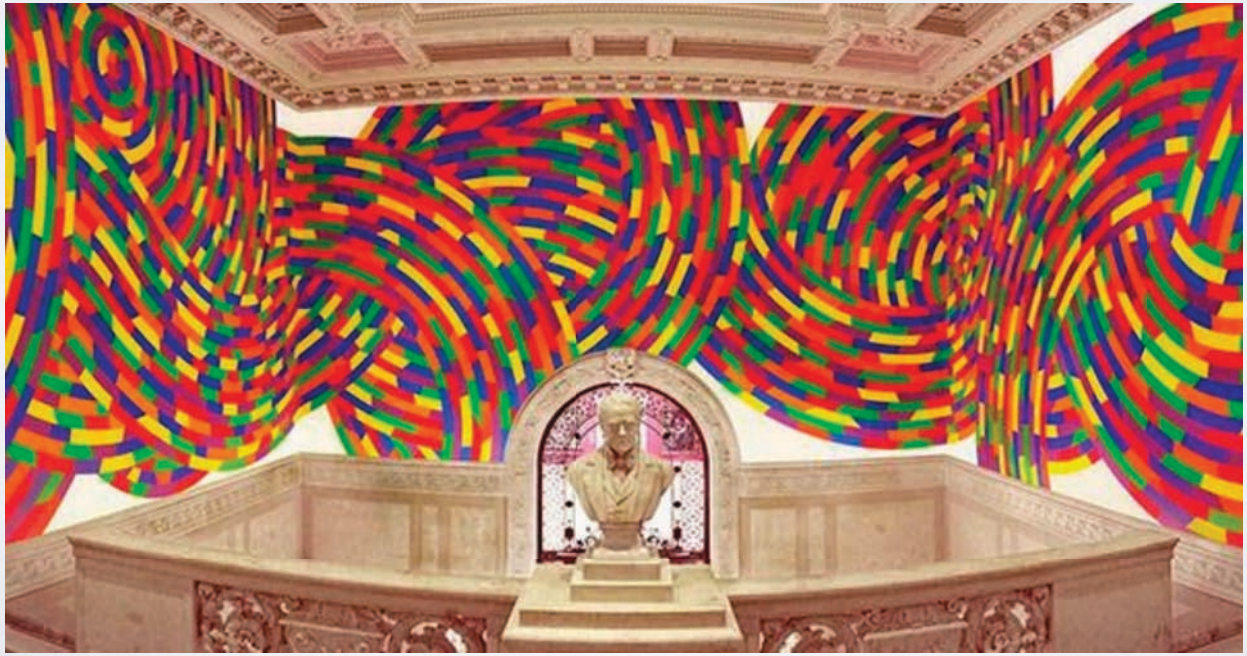
Suprematist Painting, Kazimer Malevich, 1915

EMPHASIS

- Color is often used to emphasize a certain area of a work
- One strategy of emphasis is visual understatement of everything surrounding the object
- Another strategy of emphasis is *contrast*, in saturation, value, or hue


Why we have the youngest customers in the business
Nothing does it like Heineken


Levi's



UNITY

When all of the elements of a work combine to make a balanced, complete, harmonious whole

- The use of color to unify a composition often involves repetition of a color theme.
- Unity is often easier to achieve with a limited palette
- In more open palettes, unity may be achieved by repetition of one or two dominant colors, or to mix a little bit of a color into everything

Christ of St. John of the Cross,
Salvador Dali, 1951

Spring, Joseph Raffael, 2003

QUICK SUMMARY

- Contrast in hue and value are interpreted with spatial meaning
- Objects with higher values and/or higher saturation appear larger
- Warm colors appear closer than cool colors
- A balance of colors leads to a feeling of **balance** in an image
- Colors that dominate an image can be used to **emphasize** or **unify**

COLOR SCHEMES / PALETTES

MONOCHROMATIC

- A single hue, with variations only in saturation and value.

OPEN PALETTE

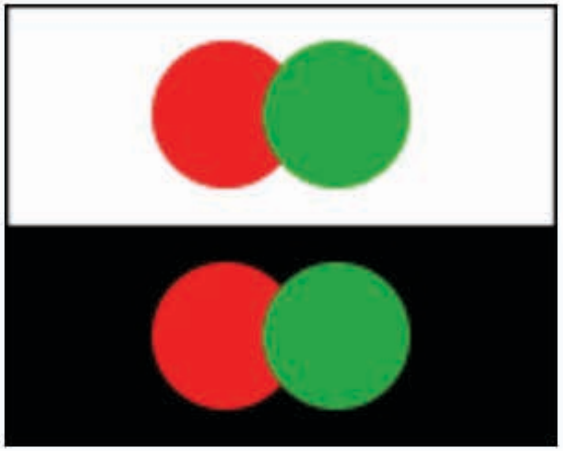
- The use of a wide range of colors

Complementary
Colors that are opposite each other on the color wheel are considered to be complementary colors (example: red and green).

The high contrast of complementary colors creates a vibrant look especially when used at full saturation. This color scheme must be managed well so it is not jarring.

Complementary colors are tricky to use in large doses, but work well when you want something to stand out.

Complementary colors are really bad for text.



Analogous

Analogous color schemes use colors that are next to each other on the color wheel. They usually match well and create serene and comfortable designs.

Analogous color schemes are often found in nature and are harmonious and pleasing to the eye.

Make sure you have enough contrast when choosing an analogous color scheme.

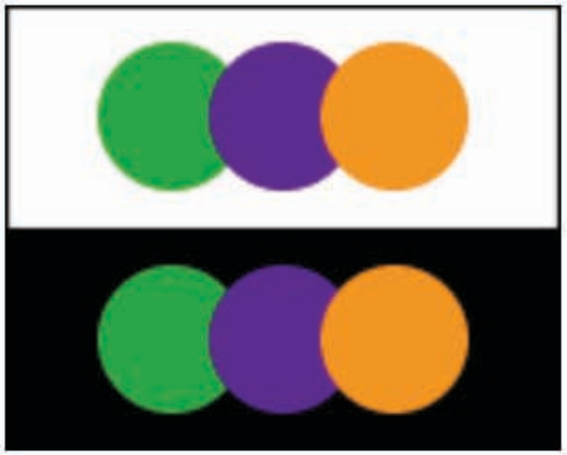
Choose one color to dominate, a second to support. The third color is used (along with black, white or gray) as an accent.

Triad

A triadic color scheme uses colors that are evenly spaced around the color wheel.

Triadic color harmonies tend to be quite vibrant, even if you use pale or unsaturated versions of your hues.

To use a triadic harmony successfully, the colors should be carefully balanced - let one color dominate and use the two others for accent.

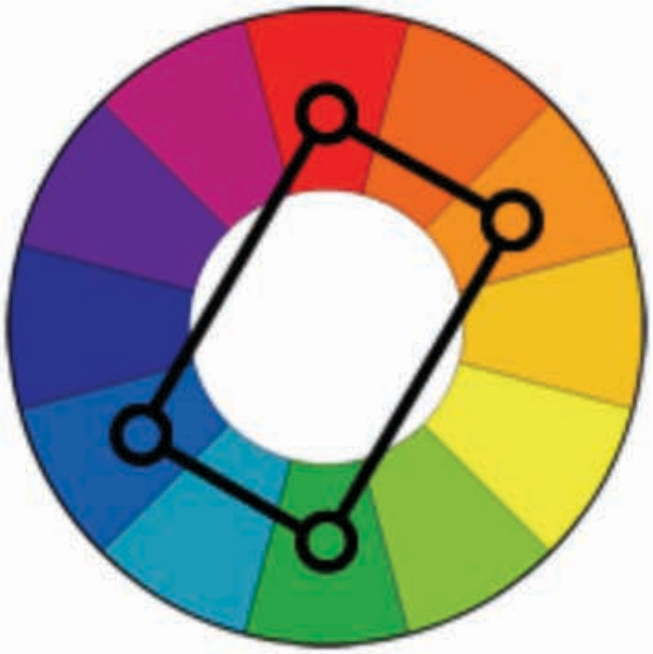


Split-Complementary

The split-complementary color scheme is a variation of the complementary color scheme. In addition to the base color, it uses the two colors adjacent to its complement.

This color scheme has the same strong visual contrast as the complementary color scheme, but has less tension.

The split-complimentary color scheme is often a good choice for beginners, because it is difficult to mess up.



Rectangle (tetradic)
The rectangle or tetradic color scheme uses four colors arranged into two complementary pairs.

This rich color scheme offers plenty of possibilities for variation.

The tetradic color scheme works best if you let one color be dominant.

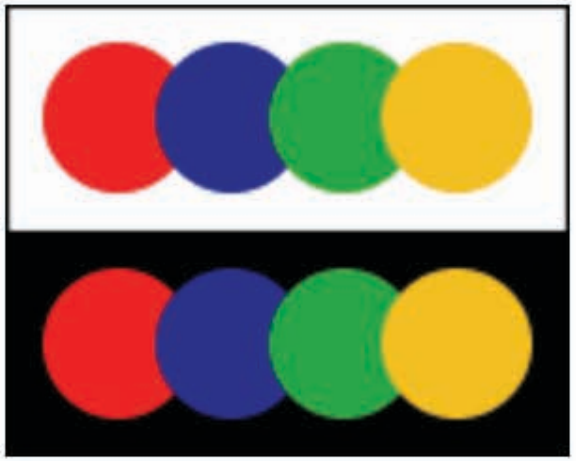
You should also pay attention to the balance between warm and cool colors in your design.

Square

The square color scheme is similar to the rectangle, but with all four colors spaced evenly around the color circle.

The square color scheme works best if you let one color be dominant.

You should also pay attention to the balance between warm and cool colors in your design.



LET'S PRACTICE

Identify the color scheme

Monochromatic

Complementary

Analogous

Triadic

Split Complementary

Open

LET'S PRACTICE

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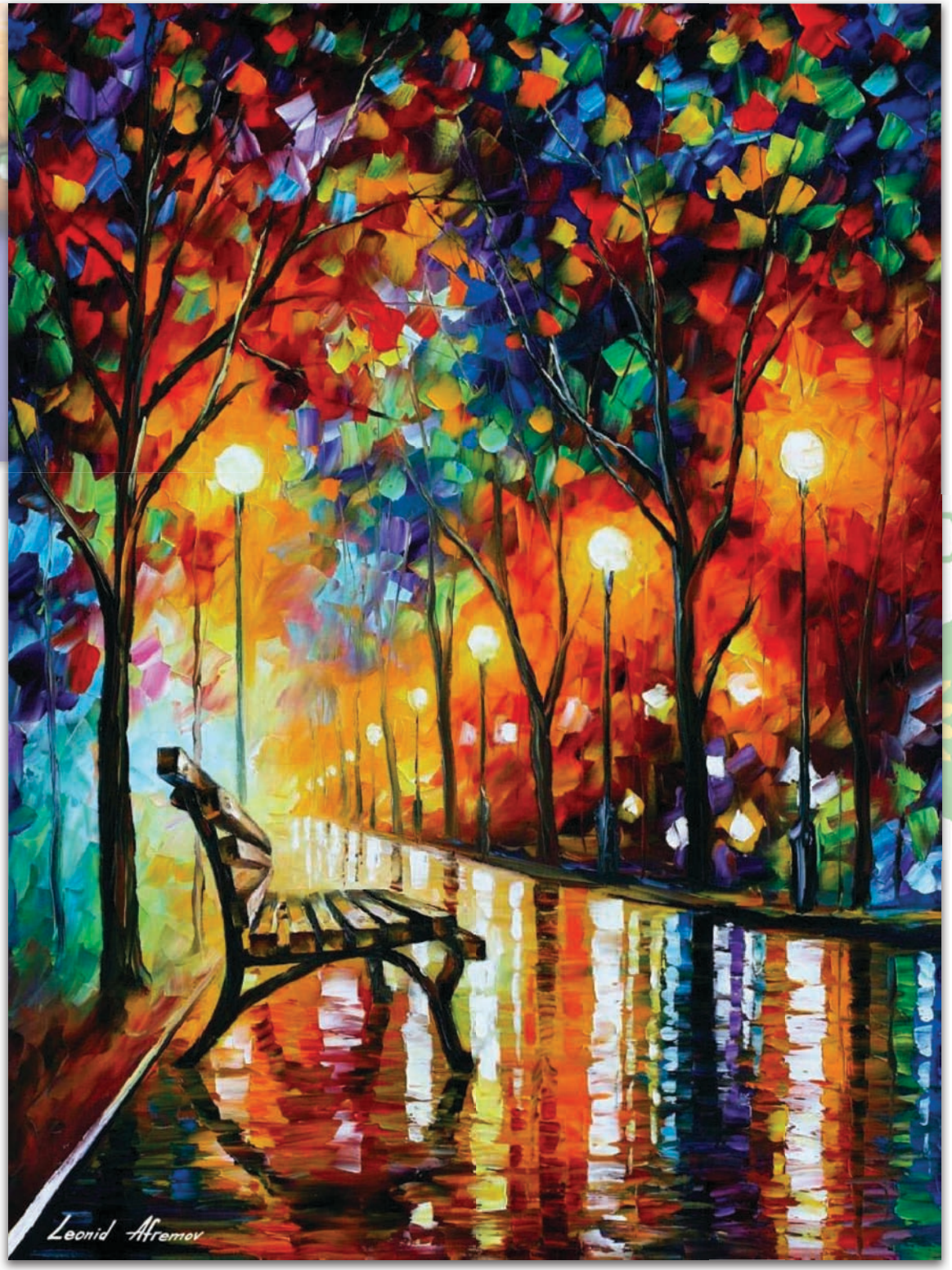

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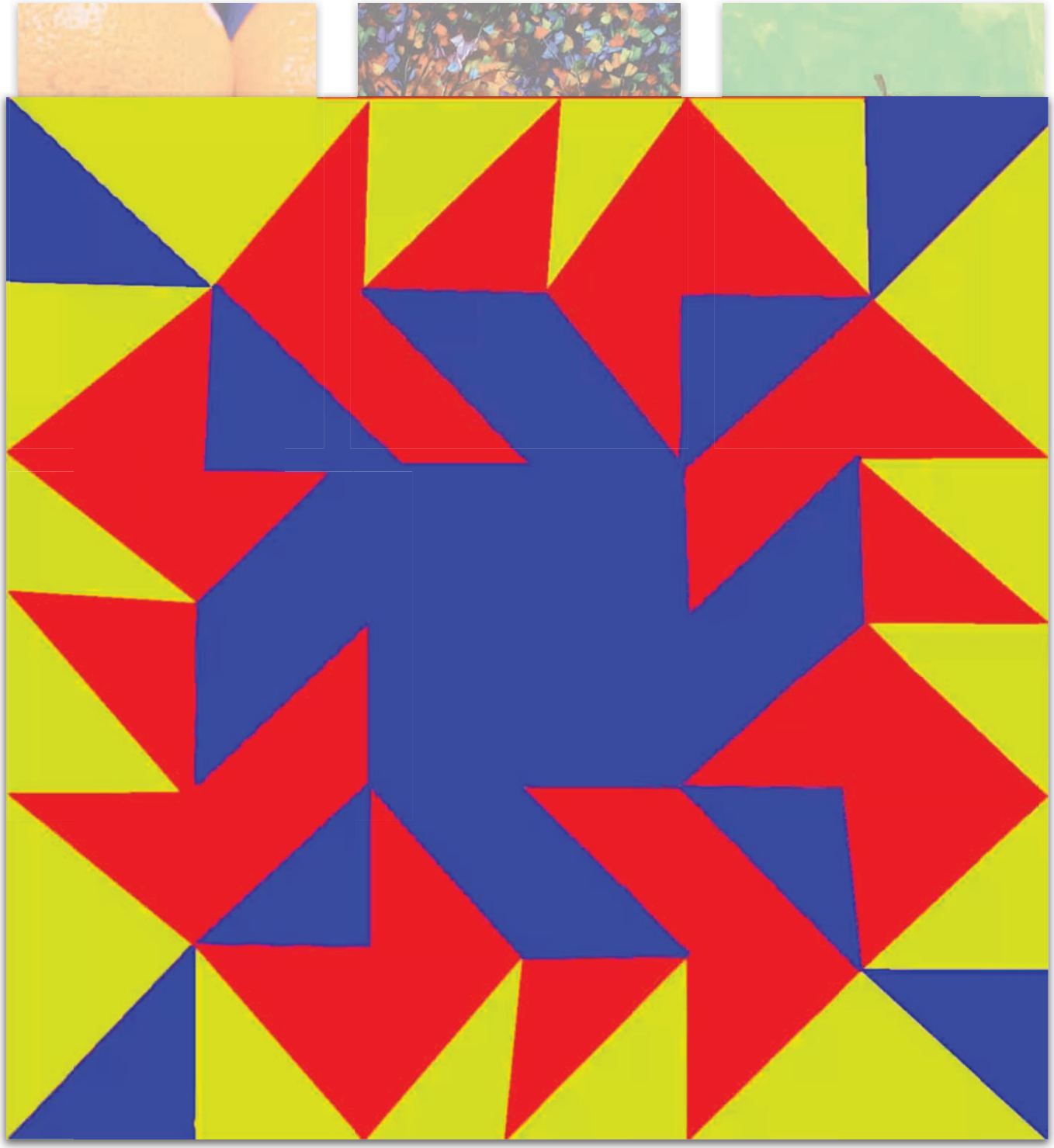

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Triadic

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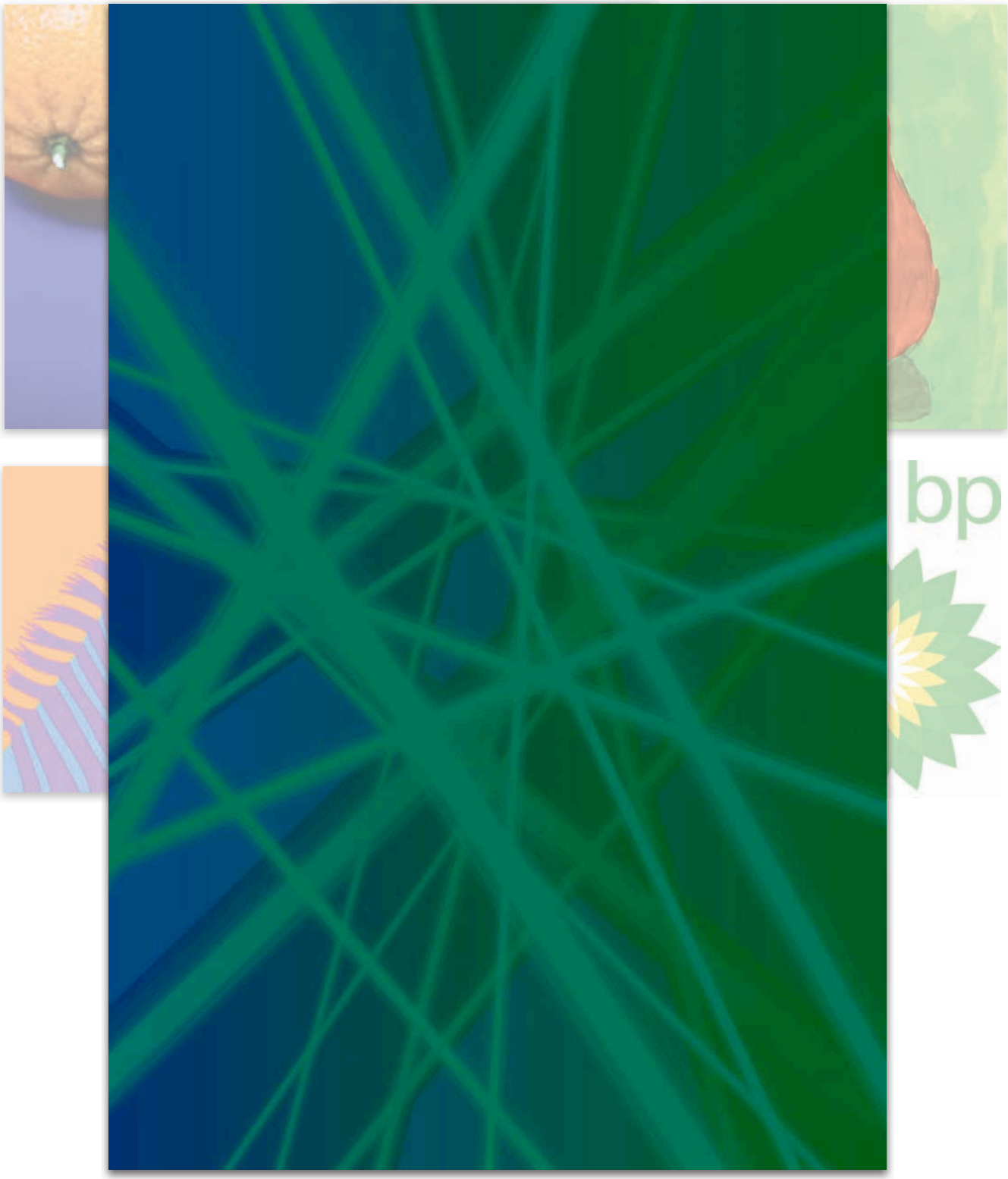
Open



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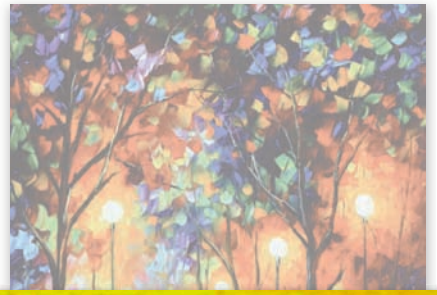

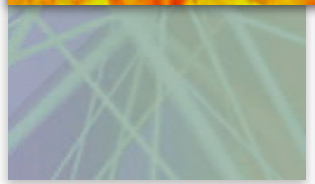

LET'S PRACTICE

Identify the color scheme

Monochromatic

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Triadic

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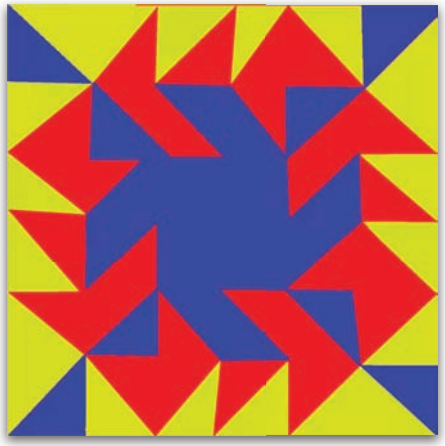
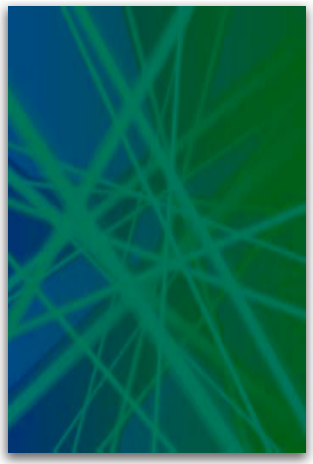




DYES AND PIGMENTS

- Pigment: a material that changes the color of reflected or transmitted light as a result of wavelength-selective absorption
- Dye: a colored substance that has an affinity for the material to which it is being applied
- In general, dyes are *soluble* (they dissolve in a liquid) and pigments are *insoluble* (they do not dissolve in a liquid)

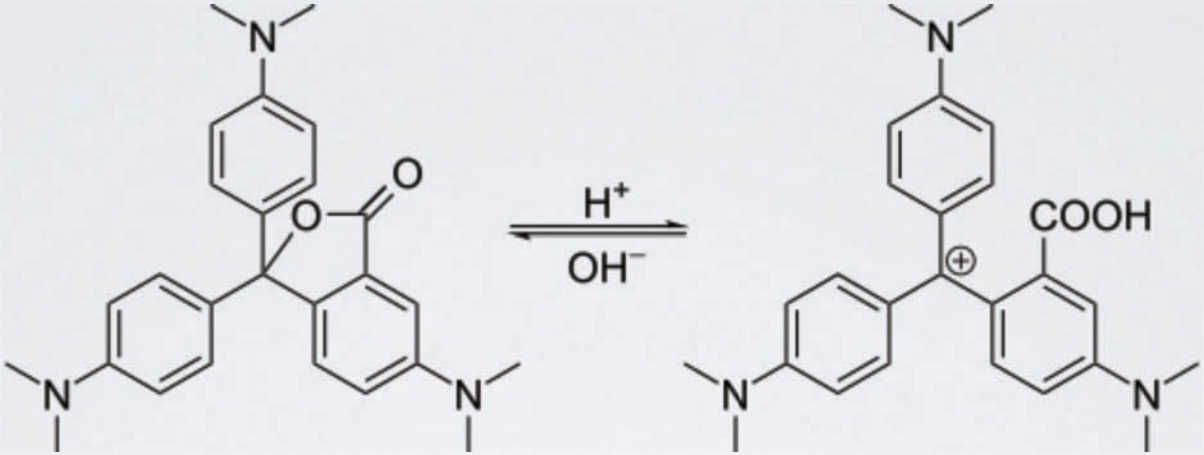
DYE/PIGMENT IDEAL TRAITS

- Remain stable (unchanged) upon exposure to sunlight, moisture, heat, chemicals, and time
- Non-toxic
- Cheap and easy to make or obtain

How Color-Changing Inks Work

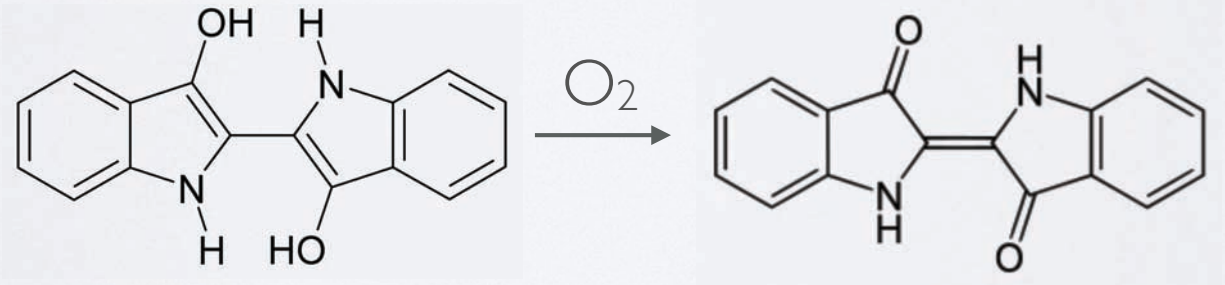
Leuco dyes: Dyes that change colors by switching between two chemical forms

High pH
Colorless



Low pH
Violet

Crystal violet lactone



Leucoindigo
White

Indigo
Blue

"CHROMISMS"

The suffix -*chromic* indicates a material that changes color reversibly with the presence of a factor

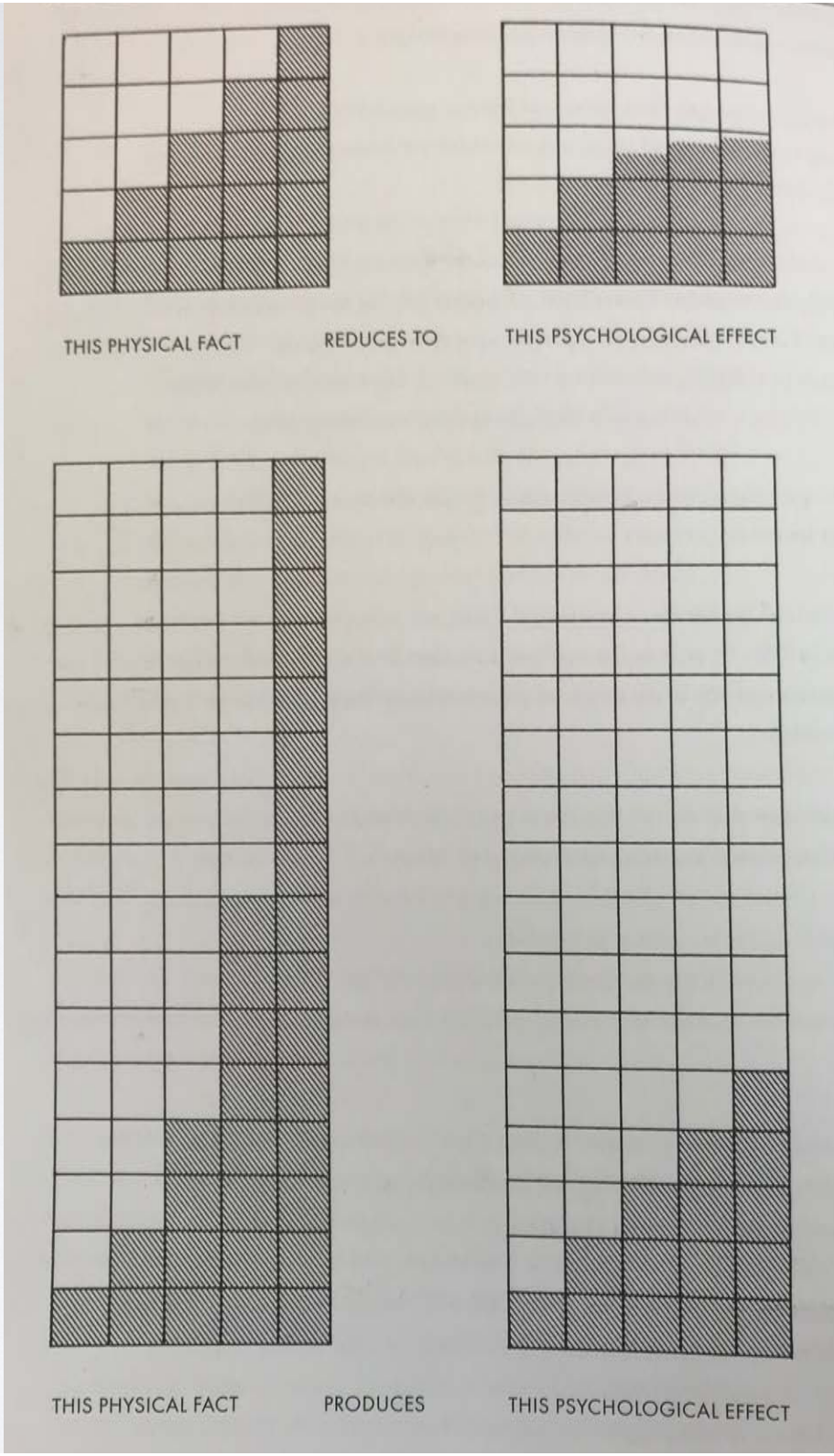
- **Halochromism**: Color changes triggered by pH changes
- **Thermochromism**: Color changes triggered by temperature changes
- **Photochromism**: Color changes triggered by lighting changes
- **Electrochromism**: Color changes triggered by electric fields
- **Magnetochromism**: Color changes triggered by magnetic fields
- **Solvatochromism**: Color changes triggered by changes in solvent
- **Piezochromism**: Color changes triggered by changes in pressure

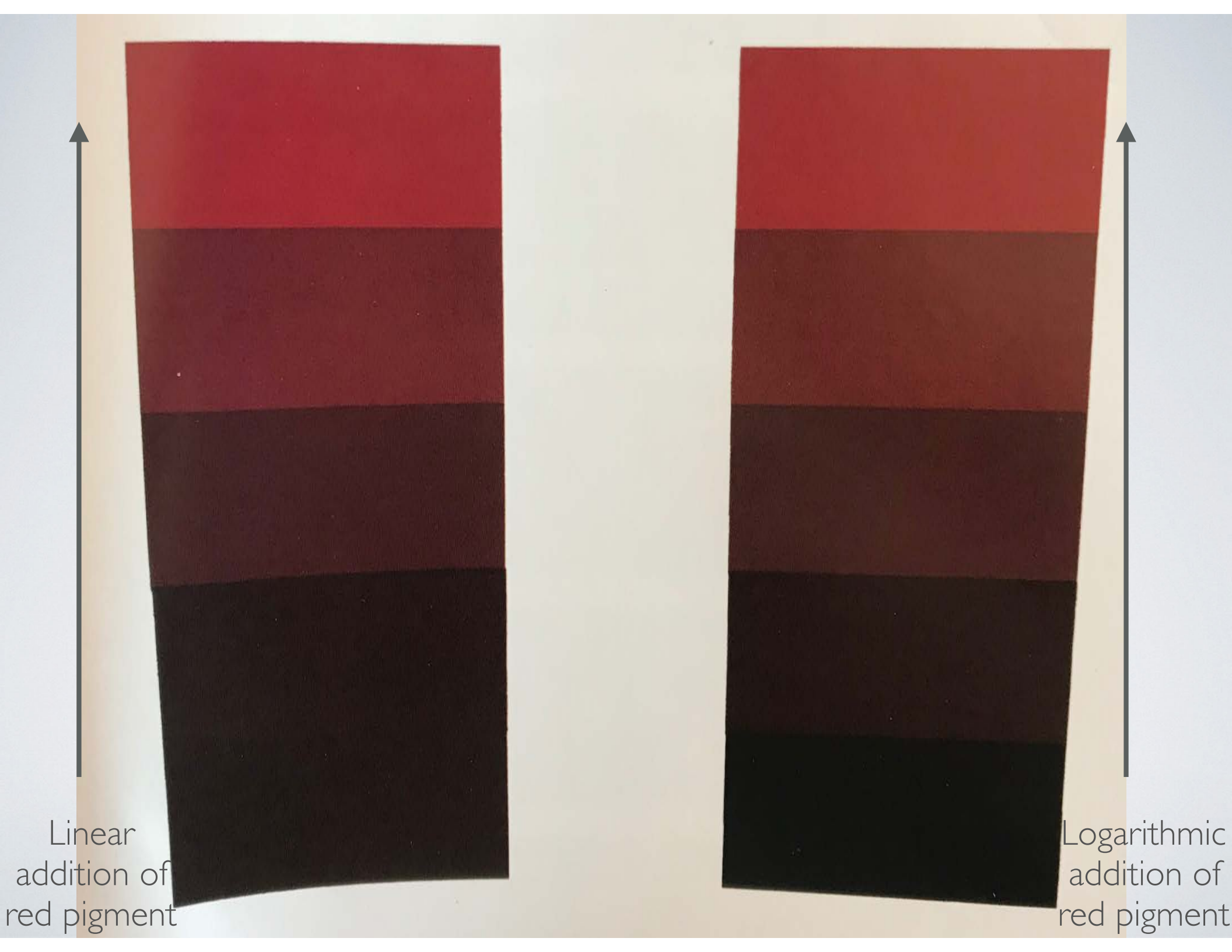
Color perception is non-linear (logarithmic)

One step of gradation in color perception requires a doubling of the amount of color

Discovered by Chevreul

This phenomenon is known as the **Weber-Fechner law** and applies to ALL senses

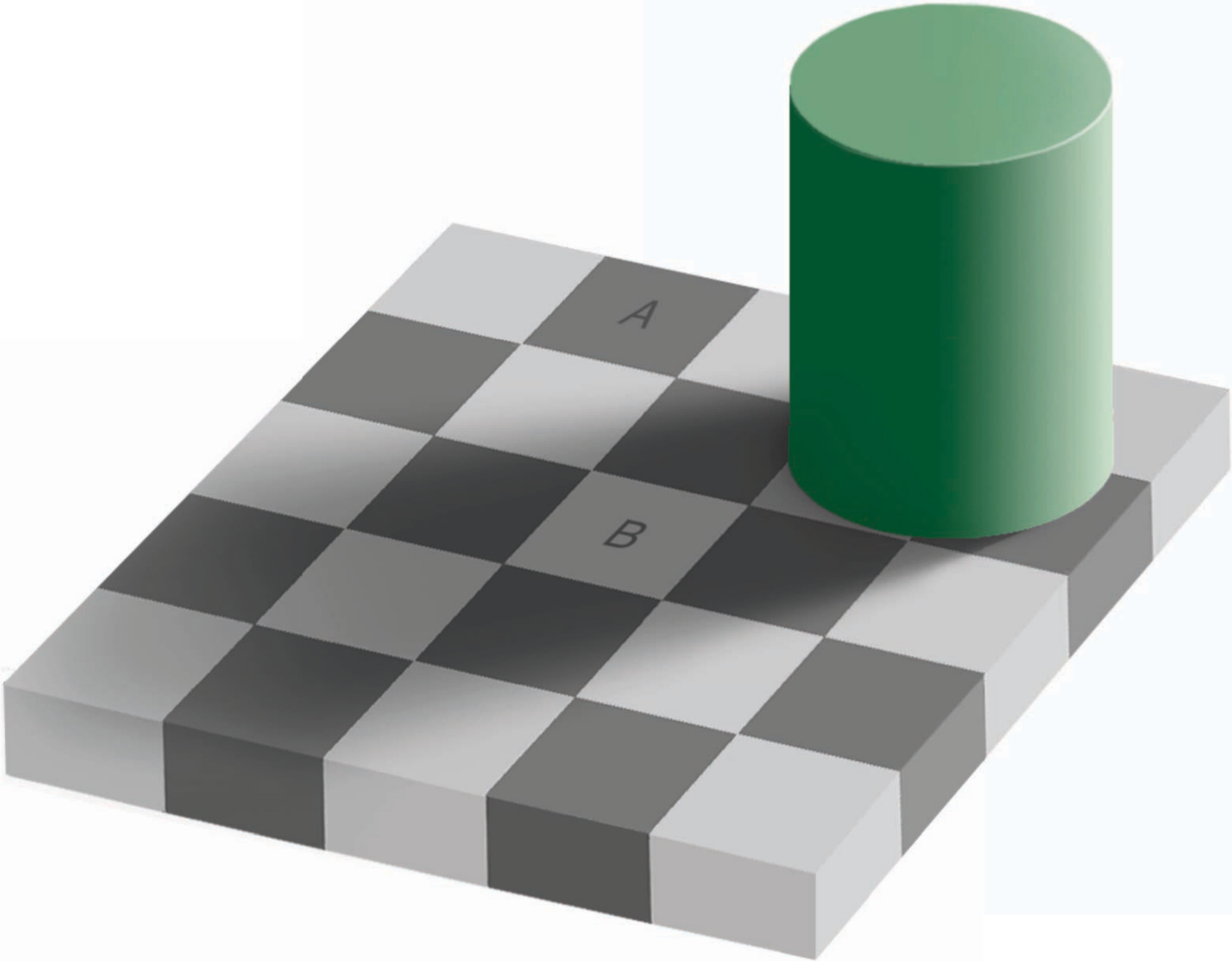



Linear
addition of
red pigment
Logarithmic
addition of
red pigment

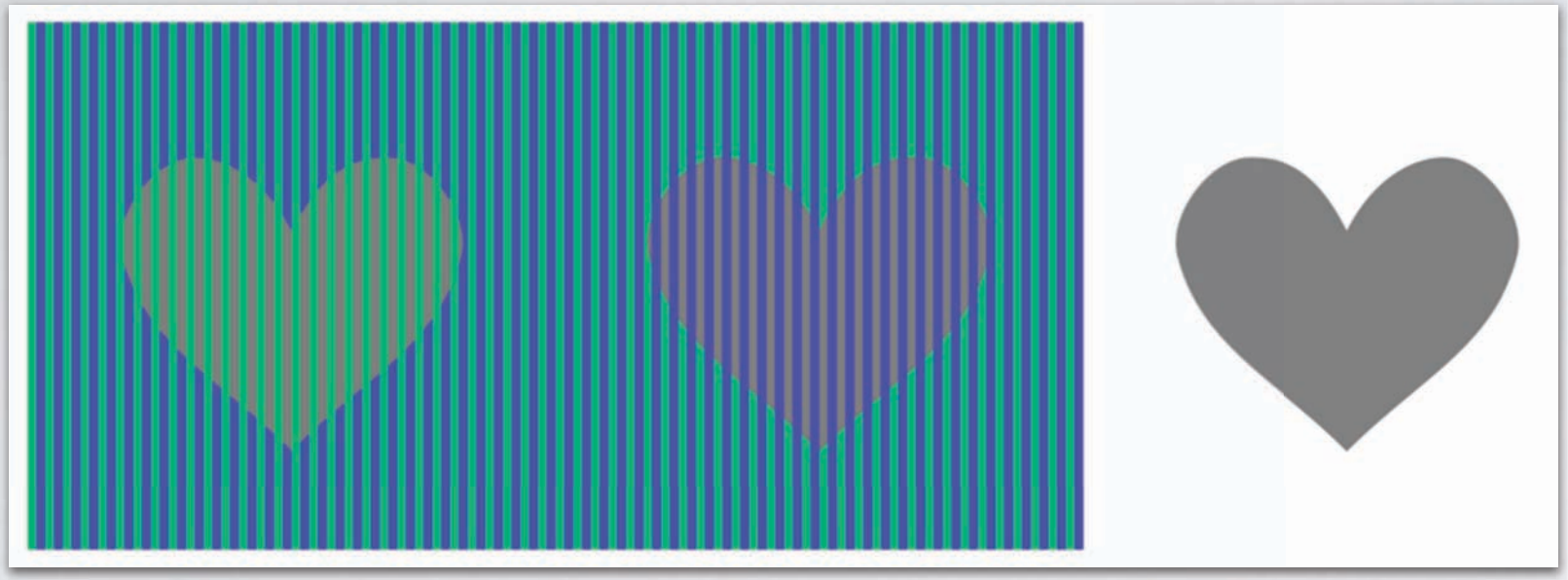
COLOR CONSTANCY

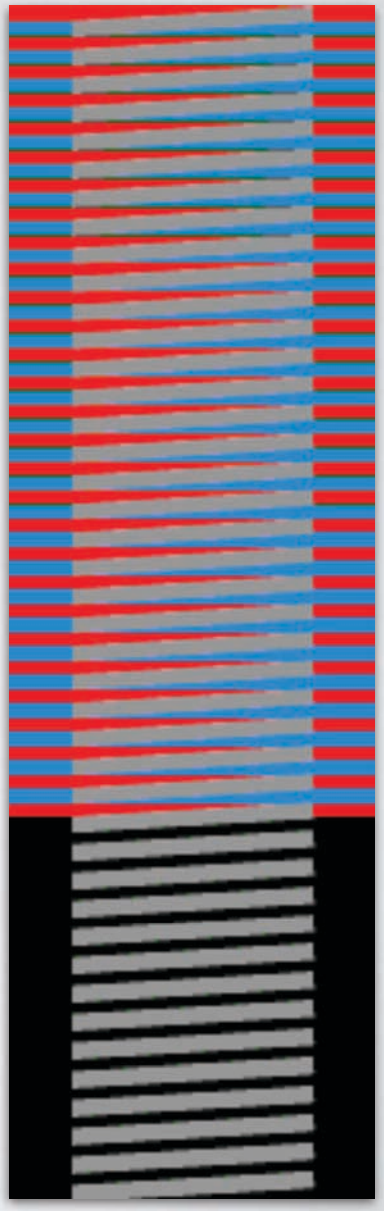
(Chromatic adaptation)

A visual phenomenon where we see the color of an object in one light and continue to associate that color with the object even as the light changes

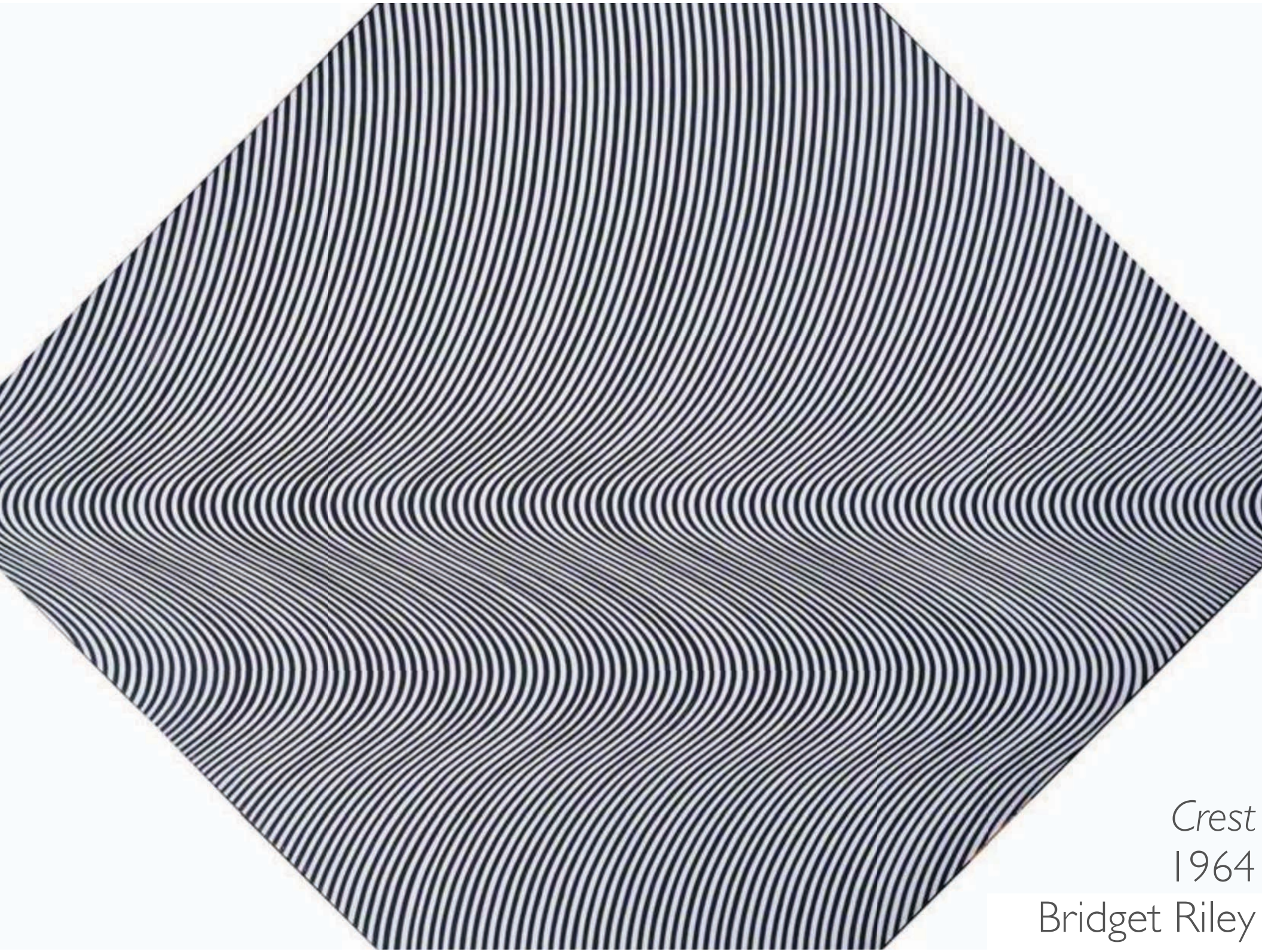

A
B

PHANTOM COLORS





Colors that spread beyond their physical boundaries causing illusory color sensations on adjacent neutral surfaces



Crest
1964
Bridget Riley

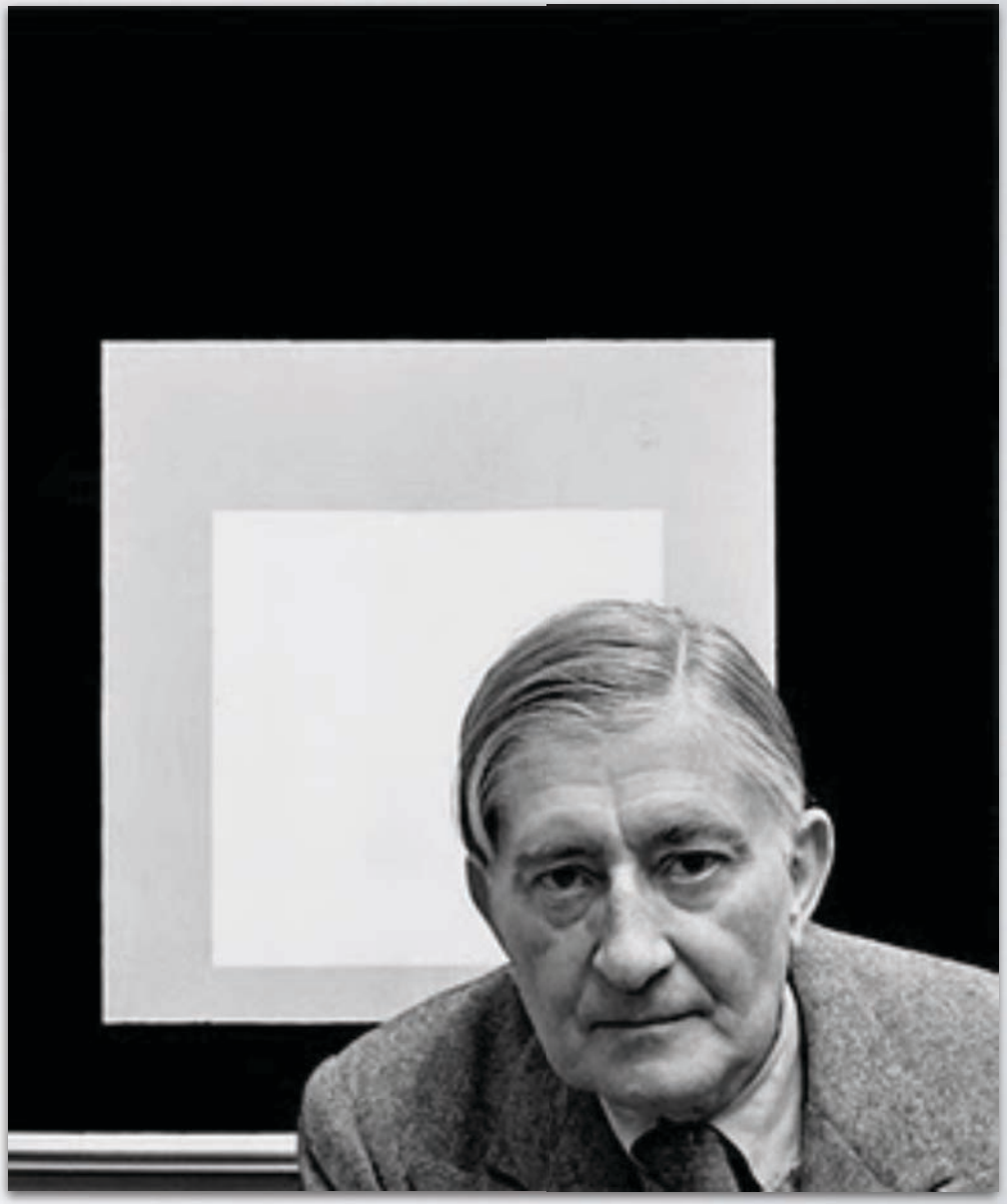
METAMERISM

- Two different colors can be made to look the same, or two of the same colors can be made to look different, depending on various factors affecting color perception

JOSEPH ALBERS

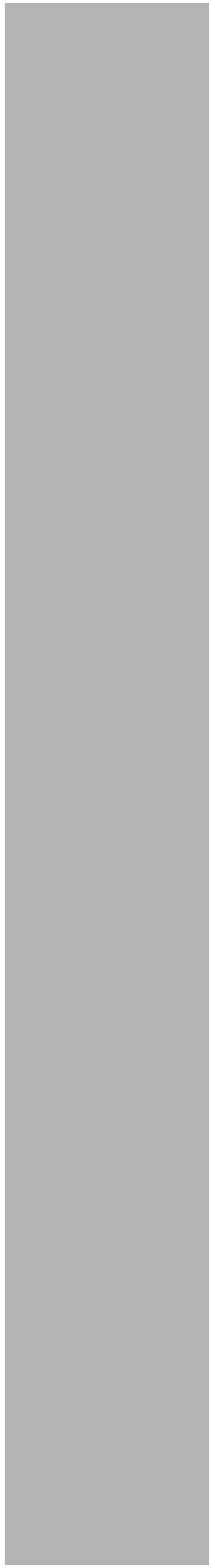
1888-1976

- German-born American
- Designer, photographer, typographer, printmaker, poet
- Most famous series, *Homage to the Square*, explored chromatic interactions in nested squares through hundreds of paintings and prints
- Author of *Interactions of Color*



PROBLEM 1

Make a single-value color look like it has a gradient of values



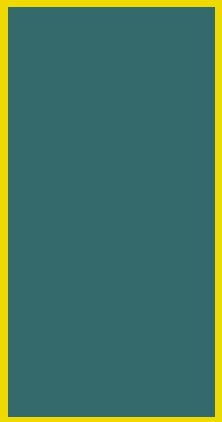
PROBLEM 2

Change a color's intensity by placing it on two different grounds

- One ground should be adjacent, one ground should be complementary

PROBLEM 3

Make three colors look like four

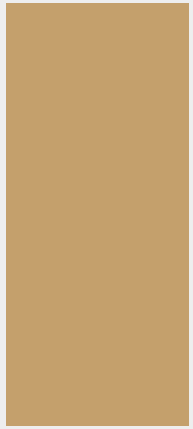


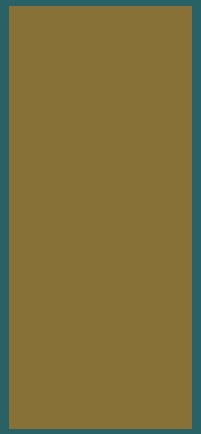
- Place two differently colored grounds side-by-side and select a third color that looks like two different colors when placed on top of them.

- Works best when both hue and value of the grounds are different

PROBLEM 4

Make four colors look like three





Works best when at least one of the grounds is complementary