

# Basic Principles of Color Theory

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## Overview of Color Usage in Art History

### 1) Local color

Byzantine mosaics, decorative art of the medieval, stained glass of the Middle Ages, folk art, Chinese/Japanese painting.

### 2) Perceptual color (Atmospheric color)

Started in Roman Art, developed in Renaissance, Rembrandt (1606-1669), Turner (1775-1851) and others, intensively studied and fully understood by the Impressionist (Monet, 1840-1926).

### 3) Optical color (scientific, divided color into points/dots)

(Pointillism - Seurat's painting, printing technology)

### 4) Logical construction (substantial, return to continuous internal modulation)

(Cezanne's painting, 1839-1906 - to modulate a color meant varying it between cold and warm, light and dark, or dull and intense)

### 5) Arbitrary color

Expressive - play between warm and cool colors, over and above those of the objects (Matisse, Bonnard and others).

### 6) Symbolic color

Create a sense of visual tension and emotional imbalance (Van Gogh, Kandinsky and Surrealists).

## Why Study Color

- 1) Intuition in strong moments
- 2) Doctrines are for weaker moments. If one is unable to create masterpieces in color out of one's non-knowledge, then one ought to look for knowledge
- 3) All great master colorists possessed a science of color
- 4) Personal expression with color supported by adequate knowledge

## Bases of Color Theory We Study in This Course

- *The Elements of Color*, by Johannes Itten, 1961  
(Johannes Itten, Switzerland, b. 1888, in 1913 studied under German color theorist Adolph Holzel, 1919 joined the Bauhaus, colleague of Paul Klee & Kandinsky)

## Color Physics (Newton, 1676)

- 1) A triangular **prism** disperses white **sunlight** into a **spectrum of colors** (rainbow):

**Red, Orange, Yellow, Green, Blue, Dark blue and Violet**

Each hue (color) can be accurately defined by specifying its wavelength of frequency. The light waves are not in themselves colored. Color arises in the human eye and brain. Each spectral hue is the complement of the mixture of all the other spectral hues.

**2) Light generates the color:** Colors are the children of light, and light is their mother. An object does not have any color in itself. A red object looks red because the molecule constituting its surface absorbs all other colors of light, and reflects only red.

**3) Color Temperature:**

Standard Incandescent Halogen	Tungsten	Fluorescent	Daylight	
Temperature 2700 Kelvin	3000K	3200K	4200K	5000K

### Two Kinds of Color Process

**1) Subtractive Color (reflected pigment):** color resulting from absorption of light. Their mixtures are governed by the rule of subtraction. All color, when mixed in certain proportions, the subtractive result is black. (pigmentary, objects, printed matter & CMYK color)

Primary color of pigment		Primary	Secondary
Cyanine (Blue)	+	Magenta	= Violet
Magenta (Red)	+	Yellow	= Orange
Yellow	+	Cyanine	= Green

**Mixture of 3 primaries of reflected pigment: Black (Brown)**

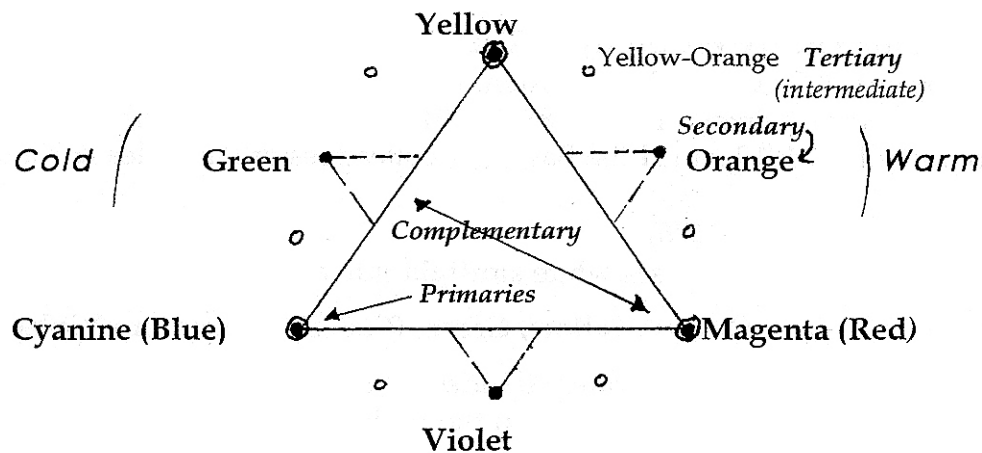
Complementary + Complementary = Gray

**2) Additive Color (projected light or reflected light):** All colored light, when mixed in certain proportions, the additive result is white. Color resulting from projection of light. (TV screen, computer screen, web color & RGB color)

Primary color of light		Primary	Secondary
Red	+	Green	= Yellow
Green	+	Blue	= Cyanine
Blue	+	Red	= Magenta

**Mixture of 3 primaries of projected light: White**

### Color Wheel of the Pigment Color (artificially augmented spectrum, added purple)



## Three Main Qualities of Color

- 1) **Hue** (color): The relative position located on the color wheel
- 2) **Value**: Intensity of tone, lightness or darkness of the color
- 3) **Saturation** (Chroma): Purity of the color

## Variation of Contrast:

### 1) Hue Contrast

- Undiluted colors in their most intense luminosity.
- Extreme instance of contrast of hue: red/yellow/blue (effect: tonic, vigorous, and decided).
- The intensity of contrast of hue diminishes as the hue moves away from primaries, secondary colors are weaker in character, tertiary colors are still less distinct.
- When the single colors are separated by black or white lines, their individual characters emerge more sharply.
- White weakens the luminosity of adjacent hues and darkens them; black causes them to seem lighter.
- Significance: The interplay of primeval luminous forces; aboriginal cosmic splendor and concrete actuality.
- Contrast of hue found in folk art, embroidery, costume, and pottery testifies to primitive delight in colorful and decorative effects. Matisse sometimes uses color in this way too.

### 2) Value Contrast (brilliance, brightness & darkness, intensity of tone)

- Strongest expressions of light and dark are white/black, and yellow/violet.
- Gray: mixture of black and white, or red/yellow/blue and white, or any pair of complementary colors.
- Tonal differences:      Low key              Intermediate              High Key
- Significance: sharpen one's sensitivity to shading; develop the feeling for proportion; be aware of the relationship between positive & negative forms.
- Monochromatic color is found in Chinese and Japanese ink painting. Seurat's drawings give the feeling that he is devoting thought to each pinpoint in order to evoke the most delicate of shadings.
- Equality of light or dark relates colors to each other.
- Exercise: Matching Brilliance's - the 12 equidistant steps of gray from white to black in the first row have been repeated for the 12 hues of the color circle in brilliance equal to the corresponding grays.
- Most saturated color in this scale: yellow 3, orange 5, red 6, blue 8, violet 9.

### 3) Cold & Warm Contrast

- Sensation of temperature related to the visual realm of color sensation.
- The two poles of cold-warm contrast: Red-orange is the warmest, and blue-green, or manganese oxide, is the coldest. The hues intermediate between them in the color circle may be either cold or warm according to their relationship with warmer or colder tones.

**Cold:** shadow      transparent      sedative      rare      airy      far      light      wet

**Warm:** sun          opaque          stimulant dense          earthy near heavy dry

#### 4) Complementary Contrast

- **Projected light:** Complementary + Complementary = white
- **Pigment color:** Complementary + Complementary = Gray-black
  - a) Two such pigment colors make a strange pair. They are opposite, but require each other. They incite each other to maximum vividness when adjacent; and they annihilate each other, to gray-black, when mixed - like fire and water.
  - b) All three primaries are always present:
    - yellow, violet = yellow, red + blue
    - blue, orange = blue, yellow + red
    - red, green = red, yellow + blue
  - c) The eye requires any given color to be balanced by the complementary, and will spontaneously generate the later if it is not present.
  - d) Stabilizing power: Statically fixed image. Each color stands unmodified.
  - e) Peculiarity: Saturated red and green have the same brilliance.
  - f) Graduated mixtures of a contrasting complementary as intermediates and compensating tones unite the two into one family.

#### 5) Simultaneous Contrast

- Afterimage: Eye simultaneously requires the complementary color, but as a sensation in the eye of the beholder, and is not objectively present. It can't be photographed, just tinged for the eye.
- Any two colors that are not precisely complementary will tend to shift the other towards its own complement.
- Significance: Aesthetic utility. (amplify, cancel, suppress, or modify)

#### 6) Chroma Contrast (**Saturation**, purity, intensity of color)

- The prismatic hues are colors of maximum saturation.
- Colors may be diluted into lower saturation in four different ways:
  - \* Color + White = Tint Color (lighter, colder)
  - \* Color + Black = Shade Color (heavy, color's splendor is gone, deprives colors of their quality of light, deadens them)
  - \* Color + Gray = Tonal Color (Soft, dull and neutral)
  - \* Admixture of the corresponding complementary colors.

#### 7) Contrast of Extension (**Area, size, proportion**)

- Goethe's light values:
  - Yellow 9, Orange 8, Red 6, Violet 3, Blue 4, Green 6
- The harmonious areas for colors (reciprocals of light values):
  - Yellow 3, Orange 4, Red 6, Violet 9, Blue 8, Green 6
- Converting these values to harmonious areas:
  - Yellow: Violet = 1:3    Orange: Blue = 1:2          Red: Green = 1:1

- If other than harmonious proportions are used in a color composition, thus allowing one color to dominate, the effect obtained is expressive.

### **The Color Sphere (Philipp Otto Runge) & The Color Star**

- 1) Symmetrical shape with six parallels and 12 meridians. Illustrates all fundamental relationships among colors, and between chromatic colors and black and white. All conceivable colors have a place.
- 2) **Pantone** color system for printing.
- 3) Colors we can construct by means of the **color sphere**:
  - a) The pure prismatic hues, located on the equator of the spherical surface;
  - b) All mixture of the prismatic hues with white and black are on the surface;
  - c) The mixture of complementary pair are in a horizontal section.
  - d) The mixture of any complementary pair, tinted and shaded towards white and black, as represented in the corresponding vertical section.

### **Color Harmony**

#### **1) Itten's theory:**

- **Dyads:** Two diametrically opposed complementary form a harmonious dyad. Two tones should be symmetrical to the center.
- **Triads:** Three hues form an equilateral triangle form a harmonious triad.
- **Tetrads:** Two pairs of complementary in the color circle whose connecting diameters are perpendicular to each other, we obtain a square or rectangle. Such colors form a harmonious tetrad.

#### **2) Ostwald's color harmony:**

- Monochromatic harmony:  
Equal whites, equal blacks and the shadow series.
- Two-hue & multicolor harmonies:  
Complementary pairs in equal white and black  
Transverse Complementary pairs  
Non Complementary pairs  
Three-hue harmony

#### **3) Munsell's color harmony:**

- Vertical harmony
- Interior harmony
- Circular harmony
- Oblique harmony
- Oblique side harmony
- Spinal harmony

#### **4) Summary of color theorists' approaches:**

- **Equal whites and equal blacks color schemes.**
- **Analogous color schemes:** The variation of hue goes no further than four successive steps of the 12-hue color circle, on the basis of color temperature - warm or cool tones.
- **Complementary color schemes:** Color organization bases on a set of complementary color. One color is given the principal role, others are used in small quantities merely as accents. Emphasizing one color enhances expressive character, evokes a sense of contrast and tension.

- **Polychromatic colors united by neutral:** Unity created by repetition of certain colors, or employed neutral colors such as black, white, gray, brown, gold and silver.

### Spatial Effect of Color

- 1) On black background, yellow appears to advance, while violet, just as any dark tone, lurks in the depth.
- 2) On white background, violet seems to advance, while yellow, just as any light tone, is held back.
- 3) Among cold and warm tones of equal brilliance, the warm will advance and the cold retreat. Distant objects seem colder because of the intervening depth of air (Aerial perspective).
- 4) A pure color advances relative to a duller one of equal brilliance.

### Color & Form

**Red-square:** A marked tension, symbolizes matter, gravity and sharp limitation. The square corresponds to red - the color of matter. The weight and opacity of red agree with the static and grave shape of the square.

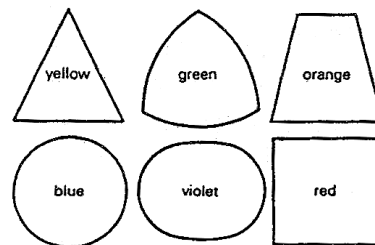
**Yellow-triangle:** Its acute angles produce an effect of pugnacity and aggression. It is a symbol of thought, matching the weightless character of the lucid yellow.

**Blue-circle:** The circle generates a feeling of relaxation and smooth motion. It is the symbol of the spirit, moving undivided within itself. Corresponds to transparent blue.

**Orange-trapezoid**

**Green-spherical-triangle**

**Violet-ellipse**



### Theory of Color Impression

#### 1) Color effects in nature:

“Nature study should not be an imitative reproduction of fortuitous impressions of nature, but rather an analytical, exploratory development and interpretation of the characteristic of nature.”

#### 2) Majestic cycle of nature:

- **Spring:** youthful, light, radiant, growth, luminous, yellow, pink & light blue.
- **Summer:** maximum luxuriance of form & color, maturation, outward, fullness of power, saturated, dense, deep green.
- **Autumn:** golden autumn, harvest, maturity, brown & orange.
- **Winter:** passivity in nature, inward, cold, withdrawal, gray & white.

#### 3) Three different intensities of light:

- **Medium light:** reveals the local color effectively, most details and textures.
- **Full light:** whitens the intrinsic color.
- **Shadow:** obscures and darkens the color.

## Color Expression

The following colors evoke certain meanings in this culture. These subconscious perceptions, intuitive thought and positive knowledge should always function together. They bear some general truth, but may vary in different societies. They are related to the psychological realm, mental and emotional experience of the viewer.

- 1) **Red** signifies primitive & fiery strength, inner warmth, active, vivacity, passionate, dynamic force, mars, revolution. It can be widely varied between cold and warm.
- 2) **Orange** express radiant activity, communication, active energy, fire burning, solar luminosity, self-respect and generosity. It could be lightened to beige for a quiet and intimate interior space.
- 3) **Yellow** is most luminous & bright color with the sense of radiant, weightless & pure vibration. It symbolizes understanding, knowledge and intelligence. It is most aggressive and luminous on black. Golden yellow represents the highest sublimation of matter, but greenish yellow is a sickly color to a lot of people.
- 4) **Green** symbolizes growth, hope, tranquility, sympathy & compassion. It is the fusion & interpenetration of knowledge and faith. Yellow-greens are joyful, young and sunny; while blue-green are cold, pensive and vigorous.
- 5) **Blue** express relaxation, passive, submissive faith, stability, grief & associated with nervous system. It symbolizes inner spiritual life, immortality and transcendental. Darker shades - infinity; lighter tints - dreamlike quality.
- 6) **Violet** is a mysterious, meditative, emotional, piety color and the color of dignity. Its tints symbolize the brighter aspects of life, whereas shades represent the dark, negative forces and terrors.
- 7) **Gray** is a neutral and the color of inertia. It symbolizes indecision, monotony and depression in dark tones

## Websites about color

Course syllabus: <http://www.lampoleong.com>

Interactive program about CMYK colors:

[http://www.explorescience.com/activities/Activity\\_page.cfm?ActivityID=37](http://www.explorescience.com/activities/Activity_page.cfm?ActivityID=37)

Interactive program about RGB colors:

[http://www.explorescience.com/activities/Activity\\_page.cfm?ActivityID=36](http://www.explorescience.com/activities/Activity_page.cfm?ActivityID=36)

Assorted Color Charts: <http://home.flash.net/~drj2142/>

Note: Some information and diagrams in this document are quoted from *The Elements of Color* by Johannes Itten (Translated by Ernst Van Hagen), New York: Van Nostrand Reinhold Company, 1970. ISBN 0-442-24038-4