

THE COLOR BIBLE

For Rufus (*'ru:fəs*) my little 'red head'.

Laura Perryman

THE COLOR BIBLE

The Definitive Guide for Artists and Designers

PRESTEL

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6 Preface

Color is intrinsic to the human experience. It guides us with subconscious visual cues throughout our lives. Get it right in your design or art and you can enhance mood and atmosphere, and create a desired psychological or even physiological effect. Finding success in color requires a level of nuance in approach, context, form, and use, and that's where dedicated study of color comes into play.

The Color Bible is a contemporary handbook for navigating the fascinating world of color. Inside you will find 100 significant colors and explore their importance or role in the world around us, from milestone industrial processes to social media sensations. Every color profile starts from the color's origin then tracks its evolution, historical use, and where it lands today—the then and the now. Each entry finishes with a suggestion for the modern utility of the color. It is vital that we look to the present: As contemporary designers and arbiters of choice, style, and ethical practice, we each have a role to play in selecting color that has real value and meaning behind it, with the well-being of humans and of the planet at the forefront of our minds.

This edit includes only a fraction of the colors we see and experience, and the selection is based on my own research, associations, and informed preferences. The shades were chosen by observing the physical materials used in art and design as well as the resulting outcomes. Each chapter also reveals much about my own background and working methods as a design trend forecaster. I'm naturally drawn to sourcing visual cues, ordering and connecting ideas, and that is reflected in these pages. Color has many facets, and this isn't a list of colors from a paint chart but represent much more than physical pigment—they are digital, material, and even little pieces of cultural narrative.

This book is not just about singular colors; it's also about how to create successful palettes, and that is where context and color relationships come into play, as the context reveals other supportive tones and hues in which successful palettes can be observed and then formed. Color choice can be daunting, but with practice anyone can learn to create color combinations by eye in an instinctual way by exploring simple principles such as opposing cool and warm colors, and learning to recognize harmonious and dynamic color pairings.

The book aims to be an inspirational resource for your journey with color; to help you to make informed decisions in your work and art. Color is complex, a sum of many parts and approaches, and it's critical to understand the core ideas before searching for new ones. Color is useful beyond pure aesthetic appeal: it can aid, guide, and connect objects, services, people, and communities. Look to the work of inkmakers, pigment producers, artists, designers, architects, manufacturers, scientists, and even bioengineers to unlock this medium's true potential.

“Color choice can be daunting, but with practice anyone can learn to create color combinations by eye in an instinctual way.”

8 Color & Light

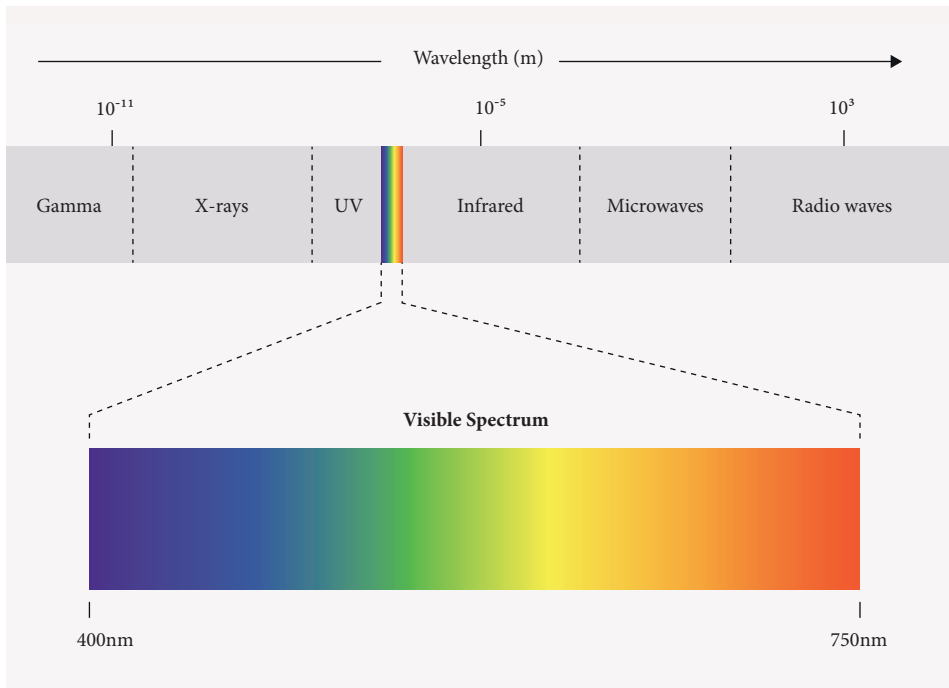
In the most basic sense, we see different colors because different objects absorb or reflect different wavelengths of light depending on their physicality or matter.

When the wavelengths they reflect reach our eyes, light receptors transmit messages to the brain via the optic nerve. The brain then interprets these messages as color. Humans are trichromats, meaning that our eyes have three cones that interpret color—one for red wavelengths, one for blue and one for green—with the potential to distinguish a million distinct colors.

The color spectrum was first identified by Isaac Newton in 1666. By splitting a ray of white light through a prism, he cast a rainbow on his wall and divided the spectrum into seven observable zones: red, orange, yellow, green, blue, indigo, and violet. We are now able to identify the wavelengths that make up Newton's spectrum, which are measured in nanometers, and we know that the visible section only makes up a part of the broader electromagnetic spectrum of light. Our eyes find it harder to interpret colors at the edges of the color spectrum, namely red and violet, and are more able to read yellow, green, and blue tones in the middle. The fringes of infrared and ultraviolet are in fact invisible to the human eye. On one side, violet (380–450nm) has the shortest wavelength and therefore the highest frequency and energy, and on the other, red (620–750nm) has the longest wavelength and therefore the shortest frequency and lowest energy.

“Colors and light . . . stand in the most intimate relation to each other.”
—Johann Wolfgang von Goethe

These delineated color zones bleed into one another: greens range from grassy yellow tones to watery teals as they begin to encroach upon the blues. It's hard to say precisely where we can locate the perfect shade of shimmering emerald, but it sits somewhere just before green tips into the blues. Half the allure of color is the hunt for the perfect shade, to reproduce what we've witnessed in nature, or even to invent a new hue that might exist only in the mind's eye or not at all before its creation. The advancement of color has always balanced between happy accidents and focused pursuit, but throughout its history color has repeatedly shown its capacity to surprise us, to fascinate us, and often to help us in unexpected ways.



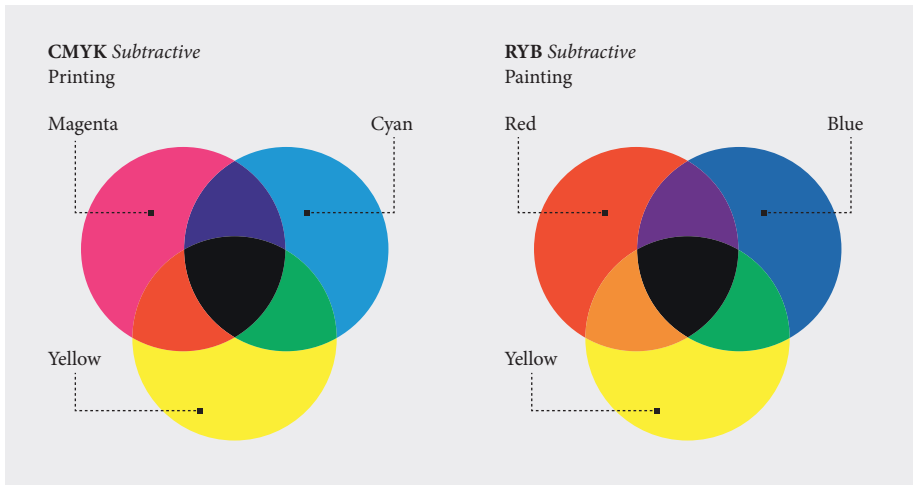
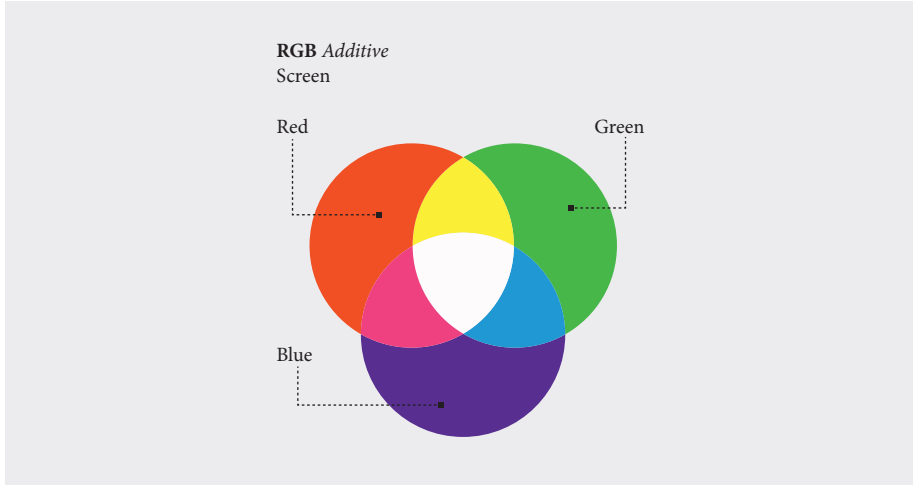
10 Addition & Subtraction: Material & Immaterial Color

The interplay of primary colors is fundamental to how we craft color for use in art, design, in print or on screen, but there are different models of primaries depending on the nature of our medium. First, it depends on whether we are working with immaterial color, or light, which entails an *additive* system, or material color, such as paint and ink, which is known as *subtractive*.

Artists and designers who work with light as a medium rely on additive color theory. Light has three primary colors from which the other spectral colors can be made: red, green, and blue (RGB). An overlap of pure red and green light makes yellow; green and blue make cyan; and red and blue create magenta. If all three overlap in one spot, they make white light—hence the term additive because adding color adds light. RGB is the color system used for digital displays such as computer and phone screens.

The subtractive color method that applies to physical color takes yellow, cyan, and magenta as its primaries (CMY), while red, blue, and green are secondary shades. Color mixing in this system subtracts the amount of reflective light: Adding more different colors gives a darker result. Fully coalesced, CMY creates a murky mud color, hence the need for a pure black added to the trio to complete the CMYK four-color process that was developed specifically for the print industry. The unspoken letter in this system would be W for white—the base color of the paper that designers learn to work with instinctively.

Subtractive color also includes the red, yellow, and blue primary model (RYB), developed for painters as a tool to explain color relationships, and the system most commonly used in school art classes. In most fields today, this has been largely replaced by the RGB/CMY models that offer a gamut of colors more relevant to modern uses.



Color & Visual Perception

Bias or debate around precise shades is a natural human response. As artist Josef Albers reflected, “If one says ‘red’—the name of a color—and there are 50 people listening, it can be expected that there will be 50 reds in their minds.”* One reason is that reflective light depends on its environment: Sunlight in the late afternoon has a different color to light at midday or at dusk. The amount of light in a space makes a difference, as does influence from light reflecting off colored walls or other surfaces. The use of LEDs, fluorescent, incandescent, and other artificial lights do no favors for the accurate perception of physical color if the full gamut is only visible under white, “daylight” conditions.

Our perceptions of colors and tones are also affected by the shades around them, a phenomenon known as “simultaneous contrast.” Placing a saturated color beside more muted tones can make the bright color appear brighter, for example. Contrasting tones can produce unexpected effects on each other when closely placed. For instance what appears a vibrant red in isolation can take on an orange hue when placed next to blue, as our eyes try to balance the contrast.

“The sensation of color is a reverberation of light, originating on a surface of an object that then absorbs, reflects and resonates, and finally evolves into a tangible material phenomenon.”—Hella Jongerius

* Albers, Josef *The Interaction of Color*, 50th Anniversary Edition, New Haven and London: Yale University Press, 2013

We should aim to see these subtle variances, as many artists have done in the past, as opportunities. Hella Jongerius is a contemporary designer who studies the evolution of light throughout the day through materials. The textured forms of her vessels break the changing light into patterns of tone and color, revealing the interplay between light, color, and form.

Color systems tend to be printed on brilliant white paper stock, but the reality is that very little is genuinely white in the world. The consistency, texture, and tonality of the base material—onto which the color will be added or which comprises the color itself (a pigment, for example)—can drastically affect how the color is perceived. (See also *Color & Material*, page 30.)



Diamond vase, Day and Diamond vase, Night by Hella Jongerius, 2019. Limited Edition Galerie kreo

14 Color Theory

You might remember being taught the basics of color theory at school by mixing pots of primary red, yellow, and blue paints. Basic color principles can help us use color more effectively, and make sure you pick the right type of palette for your projects. The following timeline highlights ideas that have transformed our understanding of color.

A brief history of color theory

Aristotle (384–322 B.C.E.):

Aristotle developed what is generally thought of as the first linear color scale, from white at midday to black at midnight. He also proposed that all hues came from light/white and black/no light.

Isaac Newton (1642–1727):

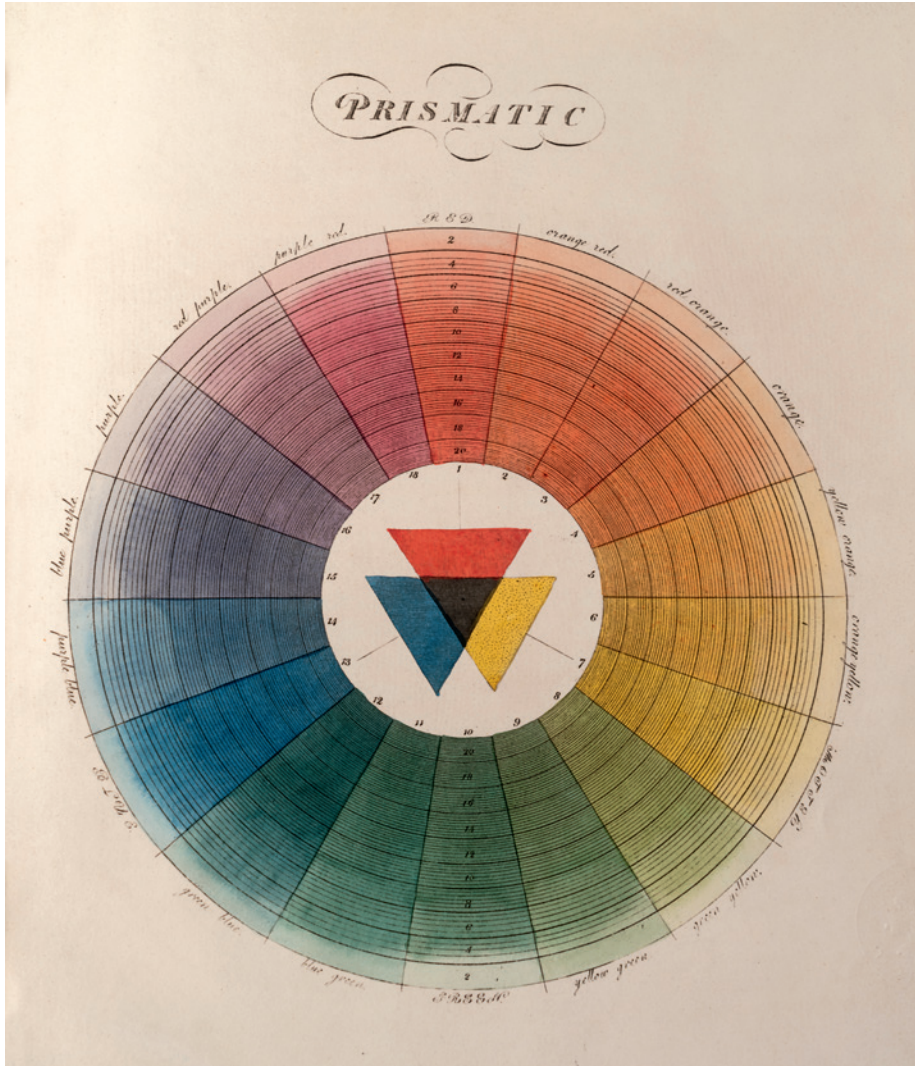
Newton's work established the relationship between color and wavelengths of light, identifying seven distinct colors in the visible light spectrum. A new interest in color theory took off from this point.

Jacob Christoph le Blon (1667–1741):

Le Blon invented the system of three- and four-color printing, using an RYB-K color model similar to the modern CMYK system. Using the mezzotint method, he proved you can create a wide range of colors by layering these simple primaries in different densities.

Moses Harris (1730–1787):

An entomologist and engraver by trade, Harris's *The Natural System of Colors* presented a comprehensive color system, with two color wheels that broke colors down into 18 “prismatic” hues based on RYB primaries, and 18 compounds based on the “mediates.”



Prismatic Color Wheel by Moses Harris, 1766



Colour Experiment No. 10, by Olafur Eliasson, 2010

Michel Eugène Chevreul (1786–1889):

Chevreul's *Laws of Simultaneous Contrast* demonstrates his influential theory that it is not the material aspect of a color that is most important but how it is perceived by the viewer. He coined the idea of “contrast,” to describe the optical mixing that happens when colors are affected by those around them.

Albert Munsell (1858–1918):

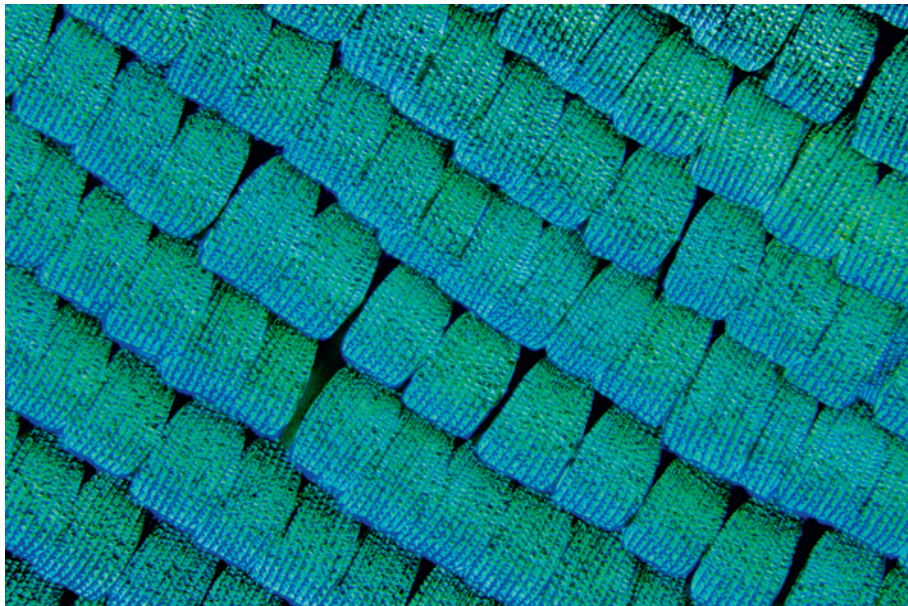
Munsell created the first functional and universal color-matching tool, allowing the accurate reproduction of colors. Explaining color through numerical systems of hue, value, and chroma, his work gave birth to a standardization of color still widely used by industry today, laying the foundation for ordered color libraries such as Pantone, NCS, and RAL (see Color Systems, page 42).

The Bauhaus (1919–1933):

The combined teachings of Johannes Itten, Wassily Kandinsky, Paul Klee, and Josef Albers contributed to what we know today as applied color theory. The movement developed the idea of color's synesthetic qualities—relating color to shape and form, as well as music—and built on Chevreul's work on simultaneous contrast to outline key contrast effects and properties. Albers went on to write his seminal *Interaction of Color* (1963) that helped train artists and designers to interpret color through examples of color harmony, juxtaposition and simultaneous contrast.

Olafur Eliasson (*1967):

In an ongoing project that began in 2009, Eliasson worked with a chemist to create a model representing an exact pigment match for every nanometer of the visible spectrum. He went on to use this palette to create painted works on circular canvases, known collectively as the *Colour Experiment Paintings*. By transforming what we perceive in light (RGB) into physical pigment, the model represents a single, cohesive color theory.



Photonic crystals in the wing scales of some butterfly species enable them to shine.

Color into the 21st Century

Today, leaps in science and technology, and knowledge of the way color is embedded in materials, have profoundly changed how we see, feel, and relate to color. Carriers such as liquid-suspended pigments, glossy plastics, plied weft fibers and layered computerized dots have indeed led to dimension and nuance. The Structural Colour Studio, a research platform at Finland's Aalto University, has proven that nonpigmented photonic crystals (found in nature), which assume shades through their contact with light alone can be engineered to surfaces. The result is a shimmering polychromic spectrum rather than just one flat hue.

As we continue to develop our understanding of what color is—and what it can do—materiality may well be key to the future of color theory. Almost all the color chapters in this book include at least one color or pigment that pushes the boundaries of our traditional ideas about color, from the plant-derived pigments with extraordinary qualities to the engineered substances with untold possibilities.

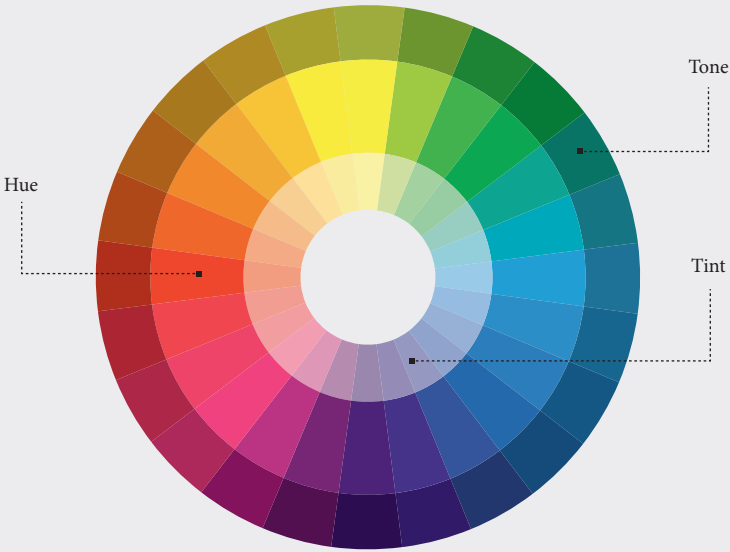
The Color Wheel

First visualized in the 17th century, today, the color wheel is one of the most useful tools for understanding color relationships. Unlike most color wheels, which are based on the subtractive RYB model, the wheel opposite is based on the RGB/CMY additive/subtractive models, whose primary colors form each other's secondaries, with tertiaries in between.

Although the wheel neatly divides color into 12 colors, the full spectrum contains a plethora of nuanced shades in between each distinct hue. Its basic circular form shows us that color is connected, while also allowing us to see at a glance how distinct primary, secondary, and tertiary colors relate to each other. It also indicates how the spectrum can also be graded into values of lightness and darkness, helping us to grasp a sense of the full dimension of color.

Over the following pages you will find some of the key color relationships, and how they relate to the color wheel. It will be useful to familiarize yourself with some of the key terms used to describe color and color relationships that will pop up throughout this book.

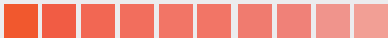
RGB/CMY Color Wheel



Key Terms



Hue: A color family, e.g. blue, yellow, green.



Chroma: The purity or saturation of a color, when it is not mixed with any white, gray, or black.



Value: The relative lightness or darkness of a color.



Tint: A mixture of a color with white, which decreases darkness.



Tone: A mixture of a color with gray or black that makes a muted nuance.

For more definitions, see the glossary on page 46.

Primary Colors

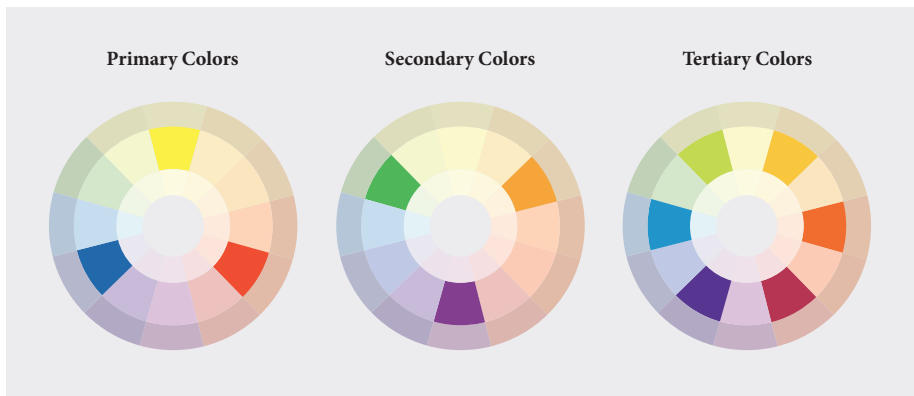
The main hues that can be mixed to achieve other all other colors. They cannot be made from any other colors and therefore considered to be “pure.” Primary colors vary according to different color models; the one illustrated below is the familiar model based on RYB primaries.

Secondary Colors

Colors that can be made from mixing two primary colors. For example, in RYB, red and yellow create orange. Secondary hues are often easier to look at and use as pure chromas than primaries.

Tertiary Colors

Intermediate colors on the color wheel, made from mixing one primary and one secondary; for example, blue and green make blue-green (teal). Tertiary colors can also be created by mixing two secondaries—for example, green-orange (citron)—and in theory the more you mix, the more nuanced the color becomes: Mix citron with russet (an orange-purple) and you’ll get shades of buff or taupe.



Monochromatic

A color scheme based on one hue that may be varied with tones or tints. The visual effect is simple and sophisticated, streamlining forms and minimizing distractions. Example approaches appear in *Carmine* (page 64), *Indigo* (page 168), *Violet* (page 210), and *Charcoal* (page 278).

Analogous

Colors that are neighbors on the color wheel, such as green-yellow, yellow, and yellow-orange. Analogous designs are harmonious by nature and can be used to evoke specific moods such as tranquility or warmth. See *Madder* (page 70), *Yellow-Red* (page 86), and *Bottle Green* (page 148).

Complementary

Opposites attract, and it's no different with colors directly opposite each other on the color wheel, such as blue and orange. Used together, these pairings create visual energy and interest. You can play with proportions to create different effects, and you can create calmer combinations by making one color lighter and the opposite darker. See *Tangerine* (page 92), *High-Vis Orange* (page 102), *Glauconic* (page 142), and *Teal* (page 188).

Split Complementary/Compound

A three-color palette based on complementary principles, but it uses the two colors on either side of a color's opposite number rather than the opposite itself. Split-complementary designs still pack the contrast but feel a bit more balanced than straightforward complementary pairs. See *Emerald Green* (page 146), *Pale Pink* (page 232), and *Burnt Sienna* (page 298).

Dyad

Two colors that are two spaces apart on the color wheel, such as blue-violet and blue-green. The closeness of the colors lends a dyadic pair natural harmony, while the degree of separation creates visual interest. This approach can include lighter tints as well as darker tonal combinations. See *Faded Sunflower* (page 120) and *Prussian Blue* (page 178).

Triad

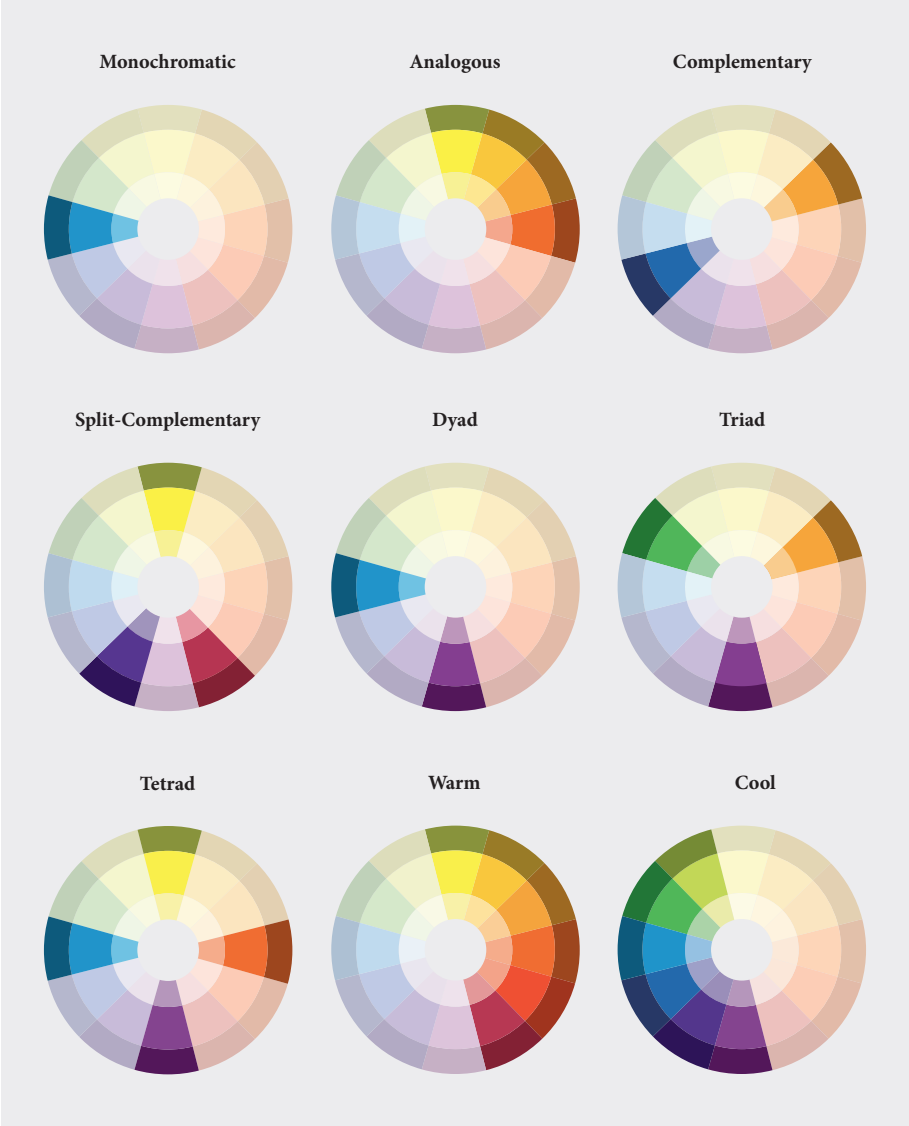
Three colors evenly spaced on the color wheel, e.g., violet, orange, and green. A vibrant combination that often works best with one dominant color and two accent colors within a palette. See *Blood Red* (page 72), *Coral* (page 100), and *Heliotrope* (page 214).

Tetrad

Four colors spaced evenly on the wheel—or two sets of complementary opposites. A trick often used in fashion, tetradic grouping gives bold designs that offer both contrast and harmony, with the success of a combination highly dependent on the proportions used. See *Lemon Yellow* (page 112) and *Wheat* (page 122).

Cool & Warm Colors

Colors associated with heat and fire (yellows, oranges, and reds) are considered to be warm in temperature; colors we associate with cool things such as ice and water (mainly blues) are cool in temperature. Greens and purples have qualities of both. Temperature is relevant to all hue families—a yellow may be cooler than another if it has more green present, for instance. See *Electric Lime* (page 160).



Color Proportions

Knowledge of color behaviors and attributes in different combinations and contexts is essential to achieving good color proportions. The total number of colors chosen for a palette affects the outcome, as does the quantities in which they are used, and many other factors besides. Josef Albers' *Homage to the Square* series is a 26-year experiment in which everything in the composition of the paintings stays the same except the palette, allowing the artist to explore the effects of color interactions. The possible combinations are infinite so the below just offers a starting point; in addition to the contrasts outlined here, the color relationships described over the previous pages will always factor in.

Contrast of Quantity:

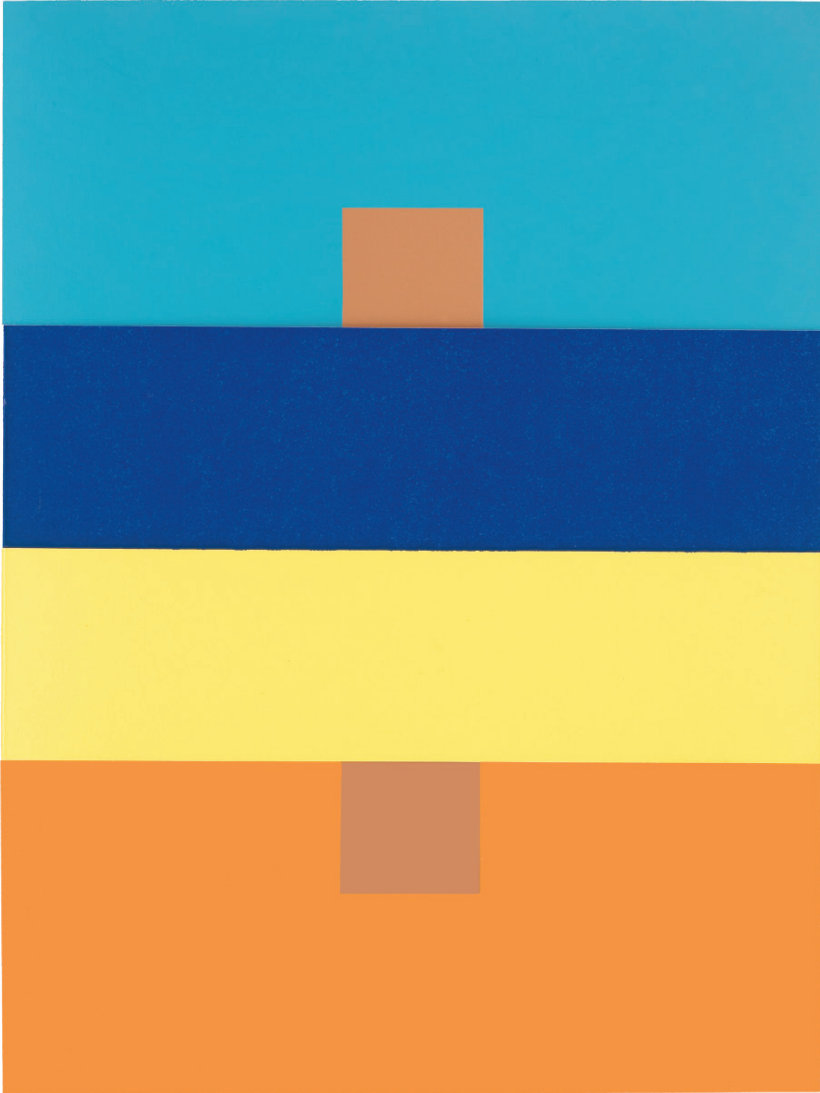
Using two or three colors in different quantities forms a simple dynamic between the dominant and supporting colors.

Contrast of Saturation:

Combinations of pure, chromatic colors with more muted or low-chroma tints or tones from the same hue range can draw the eye to critical details and create supportive backgrounds.

Contrast of Value:

Tonal contrasts can influence mood and atmosphere. Strong tonal contrasts across a large space can be dramatic and energizing or provide structure. Try framing a light area between two areas of darkness to create a strong visual focus—a technique known as *chiaroscuro* in painting. Schemes with little tonal contrast can offer a soothing environment.



Josef Albers, *Interaction of Color*, Plate IV-1b, 1973

Contrasts of Quantity (*Bottle Green*, page 148)



Contrasts of Saturation (*Indigo*, page 168)



Contrasts of Value (*Van Dyke Brown*, page 292)



Contrasts of Chroma (*Factory Yellow*, page 114)



Contrasts of Neutral & Chroma (*Vital Green*, page 154)



Contrasts of Temperature (*Scarlet*, page 60)



Contrasts of Chroma:

Combinations of hues with chromas that are the same level of intensity can create a vibrant, cohesive harmony. If you want a colorful impact, try out three or four matching high-chroma colors together, but be mindful that they must really match: If they are only similar, they will cause visual tension not ease.

Contrasts of Neutral & Chroma:

A slice of a saturated hue among a predominantly neutral scheme can enliven the more subtle shades and will immediately draw the eye to a key function or detail. Conversely, achromatic black and white can be used to temper or frame strong chroma hues.

Contrasts of Temperature:

A simple yet key combination of the fundamental complementary shades, warm and cool. Place warm oranges on a background of blues and your eye will be immediately drawn through the composition to the warmth. Also useful with low-chroma combinations to encourage engagement without tiring out our eyes.

“Color, as the most relative medium in art, has innumerable faces or appearances. To study them in their respective interactions, in their interdependence, will enrich our ‘seeing,’ our world—and ourselves.”
—Josef Albers

Color & Material

From the precious stones used to make pigments that captured many artists' imaginations to the rise of material literacy in art and design in the later part of the 20th century and into the 21st—understanding material is the key to understanding the genesis and history of color.

The first pigments were made by hand. Until the 20th century, washing, thinning, smelting, crushing, grinding, and mixing with chalk, oils, animal fats, or egg to give different effects was still common practice. Plants provided deep yellows; reds such as scarlet came from insects; prized purples came from sea snails. Shades were often available only to the regions where the base materials could be found or the techniques for their production known. When it comes to creating new colors, science, technology, art, and design have played equal and symbiotic roles. The modern dye industry was devised and cultivated by the demand for color: Van Dyke's quest for all-encompassing shadows saw him devise a pigment from soil, while Yves Klein applied chemistry to create a new vibrant and arresting blue.

Raw Material

In some cases, a material's inherent color has been celebrated and exploited to create tone and shade. Many modern artists such as Max Lamb and Donald Judd have worked with raw materials as a primal aesthetic expression, either leaving them unprocessed or enhancing the surfaces with heat, chemicals, and the traces of making creating serendipitous outcomes. See *Copper* (page 98), *Smalt* (page 180), *Silver* (page 266), and *Aluminum* (page 268).



Blocks of indigo pigment

Light as a Medium

Shimmering light always catches the human eye. Artists such as Jan van Eyck mastered the replication of light in paint form by using gems and jewels in his pigment concoctions. Contemporary artists have even used colored light instead of pigment. For example, James Turrell's incandescent art mimics the changing conditions of night and day. New disciplines such as 3D visualization and digital arts are changing our perception of color all over again. *See Reactive Red (page 80), Vital Green (page 154), Neon Pink (page 226), and Lunar White (page 254).*

Scientific Color

Modern science links color to material and performance to take color beyond aesthetics. The photosynthetic qualities of natural pigments such as chlorophyll can be harnessed to generate energy, while the blackest nanotubes repel detection. Meanwhile, new color technology can limit production waste, with color biofabricated directly into material surfaces. *See Chlorophyll (page 162), YInMn Blue (page 198), Living Lilac (page 238), and Vantablack (page 286).*

Waste Color

Color derived from postconsumer, industrial, or agricultural waste is being harnessed by designers in order to curb landfill, resulting in recycled nuances that are unusual and diverse. Common examples include vegetable dyes derived from agricultural waste and metal-tinted glazes from postindustrial waste. *See Red Ocher (page 54), Beet (page 236), and Slag (page 276).*