Experiencing Color

"Gertrude Esteros has summarized Departmental views on color and design,

> 'From the beginning we have realized that color teaching is never finished. It is repeated in each design class in new contexts. Every design teacher is a color teacher. It is hoped that some of the vocabulary will remain constant although the situations will vary.'"

Handbook for Design, 1-521 Color and Design, Marian Ortolf Bagley

HUE, VALUE, SATURATION

What is color?

In short, color is the visual byproduct of the spectrum of light as it is either transmitted through a transparent medium, or as it is absorbed and reflected off a surface. Color is the light wavelengths that the human eye receives and processes from a reflected source.

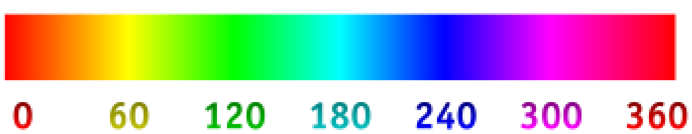
For the physics behind color, see the Primary Color Models page. This will REALLY help you understand how color works!

Color consists of three main integral parts:

1. hue
2. value
3. saturation (also called "chroma")

Let's start with "hue"

The degree to which a stimulus can be described as similar to or different from stimuli that are described as red, orange, yellow, green, blue, purple, etc.



Hue is more specifically described by the dominant **wavelength** that we perceive as color. We produce colors by pigments (CMY) or reflection of light (RGB):

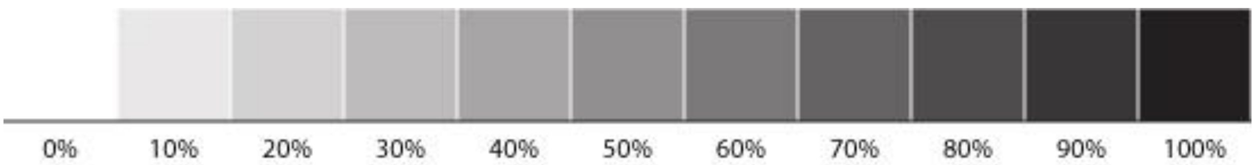
When discussing "pigment primaries" (CMY), a hue is pure when **no white, black, or gray is added**. (Full desaturation is equivalent to a muddy dark grey, as true black is not usually possible in the CMY combination.) [Our design will be mostly in the domain of pigment.]

When discussing spectral "light primaries" (RGB), a pure hue equivalent to full saturation is determined by the ratio of the dominant wavelength to other wavelengths in the color.

What is value?

Value refers to the lightness or darkness of a color. It indicates the quantity of light reflected. When referring to pigments, dark values with black added are called “shades” of the given hue name. Light values with white pigment added are called “tints” of the hue name.

A basic value scale is easiest to understand, however, in grayscale (without the addition of color):



Grayscale Value Chart
While value affects the way color appears, it is technically independent of color in concept. Images that have a full tonal range are considered to have “good contrast” because they have a representation of each value in the full value scale. That means the 11 steps above would be well-distributed in an image. This can even be true of images that have a limited palette, as in “posterized” images. In the case of a grayscale composition, the values would have pure white (0% pigment), pure black (100% pigment), and a representational distribution of the values in between (“gammas” or “midtones”).

In a “low contrast” image, the values are limited primarily to the gammas, or midtones. That means there is typically no representation in the image of pure black or pure white.

It is important to note that although we have only discussed value here in terms of grayscale, adding a color to the scale does not change the value range! A useful way to think about how value translates between grayscale and color equivalently is when you take a color image and make a black-and-white copy of it on a copy machine. The color is eliminated, but the values are still identical to the original color image. Look at the examples below for a better understanding:

Figure 1: Posterized Monochromatic, Good Contrast

Figure 2: Posterized Grayscale, Low Contrast

Figure 3: Posterized Grayscale Version, Good Contrast

Figure 2: Posterized Image, Analgous Color

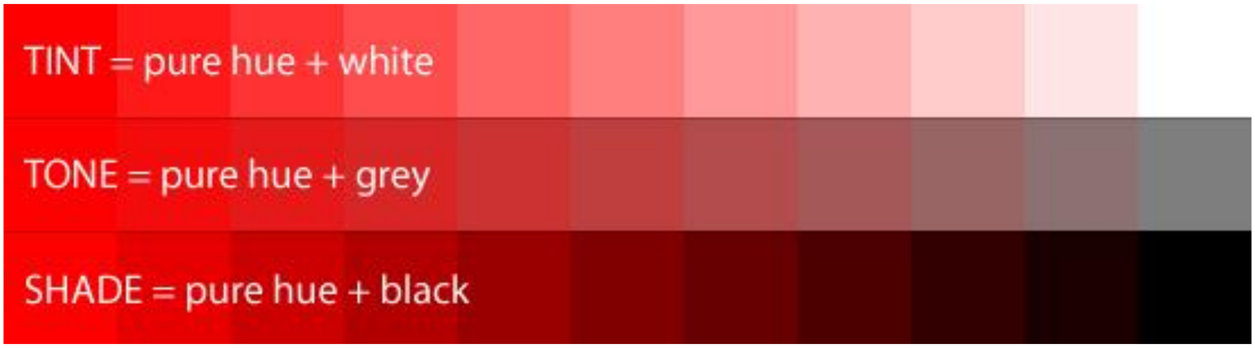
Figure 3: Posterized Monochromatic, Low Contrast

Figure 4: Posterized Analgous, Low Contrast

Lastly, let's look at "saturation," or "chroma"

Saturation defines the brilliance and intensity of a color. When a *pigment* hue is "toned," both white and black (grey) are added to the color to reduce the color's saturation. In terms of the "additive" *light* color model, though, saturation works on a scale based on how much or how little other hues are represented in the color.

(NOTE: In the simple scale diagrams below, the first model indicates amount of black, white, or grey ***pigment*** added to the hue. The second model illustrates the same scale but explains the phenomenon based on *light* [spectral] properties.)



Pigment Scale

Light Scale

The HSV Color Scale

The scales above illustrate the value and saturation changes of a hue in the same way visually, although they explain what's happening differently based on how pigment works vs. how light works. This is a fairly simple way of looking at it, but it still might not be completely clear. There is a more complex, 3-dimensional scale that allows us to look at how hue, saturation, and value intersect to create colors: the "HSV Scale."

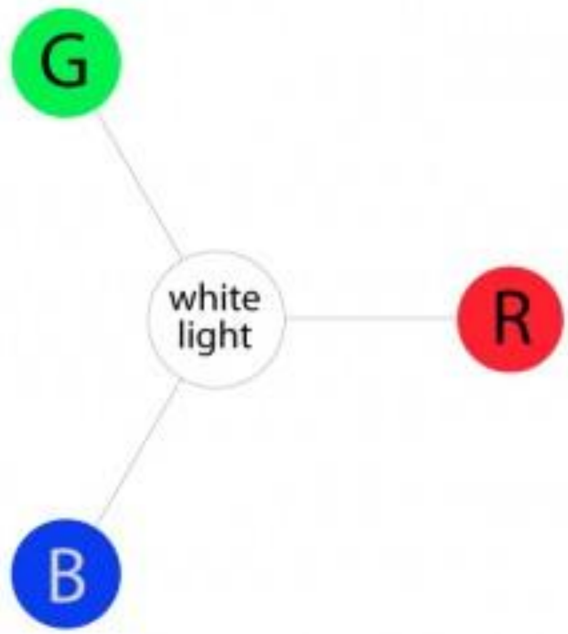
The HSV scale clearly stands for "Hue, Saturation, Value." It does a better job at visually explaining the concept of light, and it is a very useful one to comprehend, as it is what most sophisticated digital color pickers are based on (including all Adobe software). Not only do graphic designers need to understand this color construct, but fine artists do as well since digital art and rendering has become such an integral part of art processes.

All Color Starts With Light

Regardless of the two Additive and Subtractive color models, all color is a result of how our eyes physically process light waves. So let's start with the light Additive model to see how it filters into the Subtractive model and to see how hues, values and saturation interact to produce unique colors.

Hues

The three primary hues in light are red, green, and blue. Thus, that is why televisions, computer monitors, and other full-range, electronic color visual displays use a triad of red, green, and blue phosphors to produce all electronically communicated color.



RGB Primary Color Triad

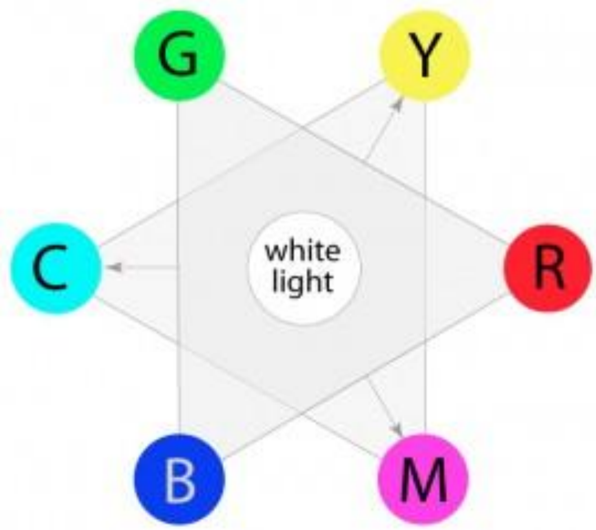
As we mentioned before, in light, all three of these wavelengths added together at full strength produces pure white light. The absence of all three of these colors produces complete darkness, or black.

Mixing Adjacent Primaries = Secondary Hues

Making Cyan, Magenta, and Yellow

Although additive and subtractive color models are considered their own unique entities for screen vs. print purposes, the hues CMY do not exist in a vacuum. They are produced as secondary colors when RGB light hues are mixed, as follows:

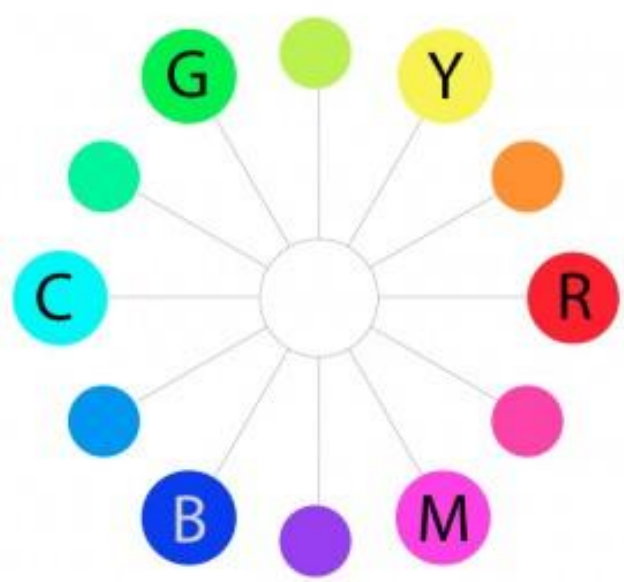
1. Blue + Red light –> Magenta
2. Red + Green light –> Yellow
3. Green + Blue light –> Cyan



CMY Secondary Light Colors

Overview of Hues

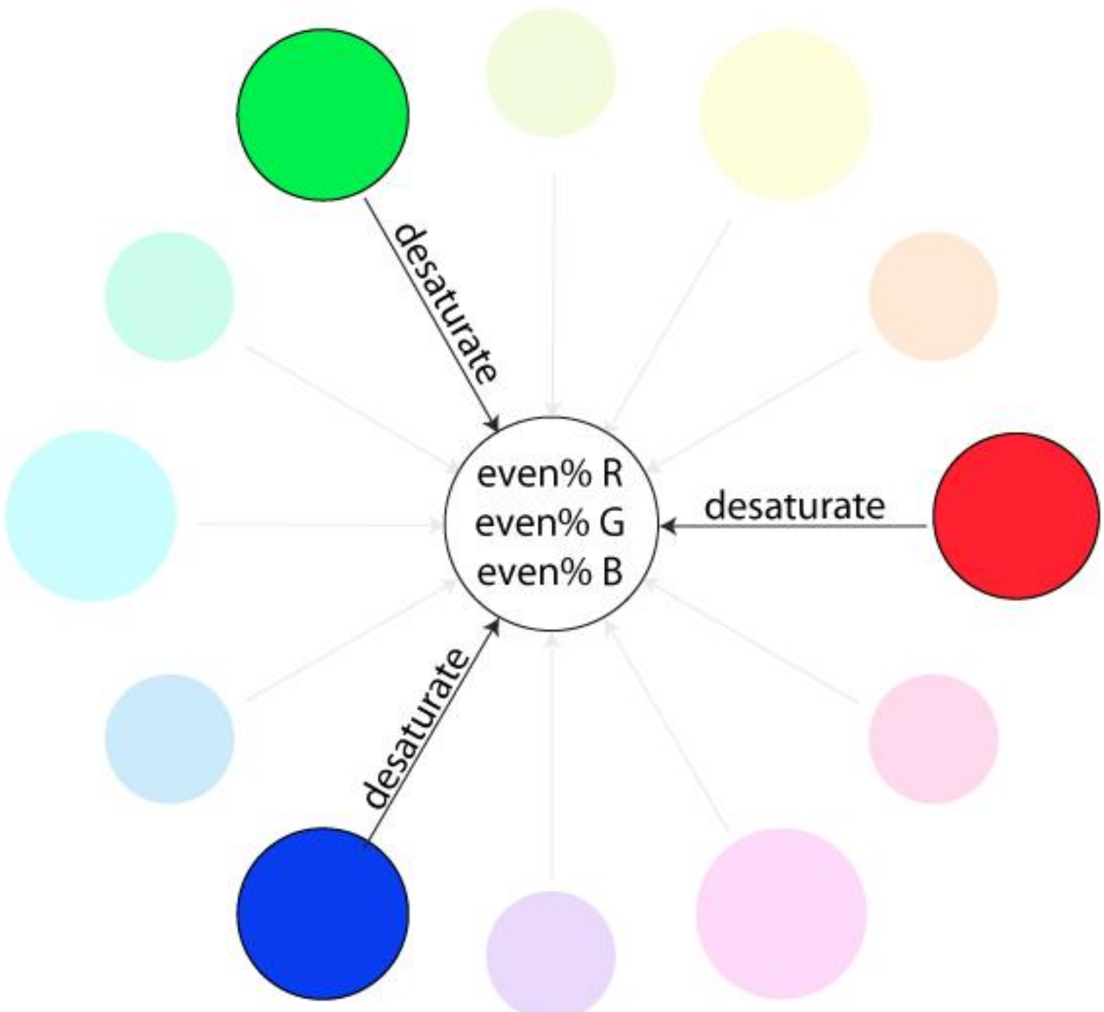
The colors on the outermost perimeter of the color circle are the"hues," which are colors in their purest form. This process can continue filling in colors around the wheel. The next level colors, the tertiary colors, are those colors between the secondary and primary colors.



Primary, Secondary, and Tertiary Hues

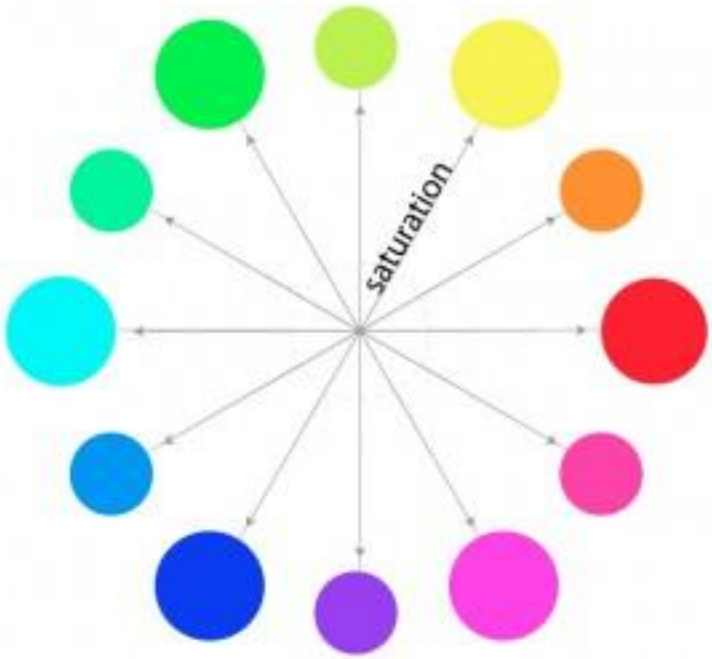
Saturation

Saturation is also referred to as “intensity” and “chroma.” It refers to the dominance of hue in the color. On the outer edge of the hue wheel are the ‘pure’ hues. As you move into the center of the wheel, the hue we are using to describe the color dominates less and less. When you reach the center of the wheel, no hue dominates. These colors directly on the central axis are considered **desaturated**.

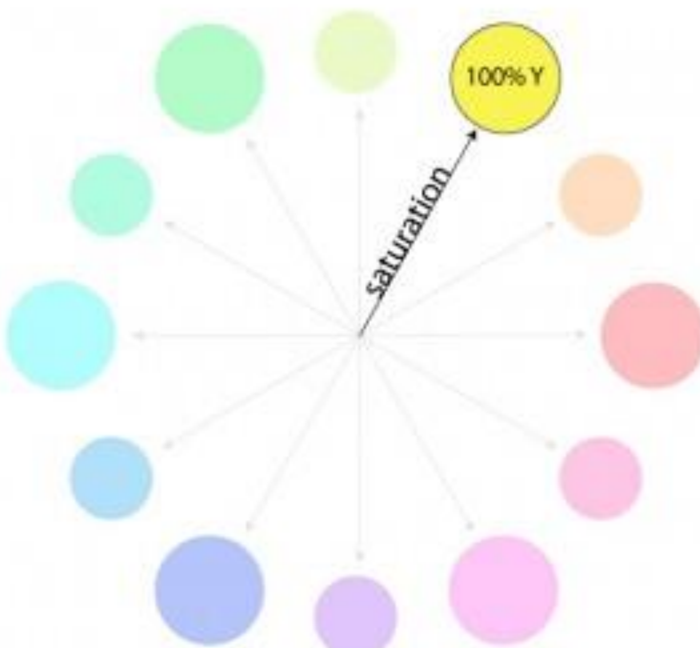


Desaturation: hue becomes less dominant, moves to circle’s center

Naturally, the opposite of the image above is to saturate color. The first example below describes the general direction color must move on the color circle to become more saturated (towards the outside). The second example depicts how a single color looks completely saturated, having no other hues present in the color.



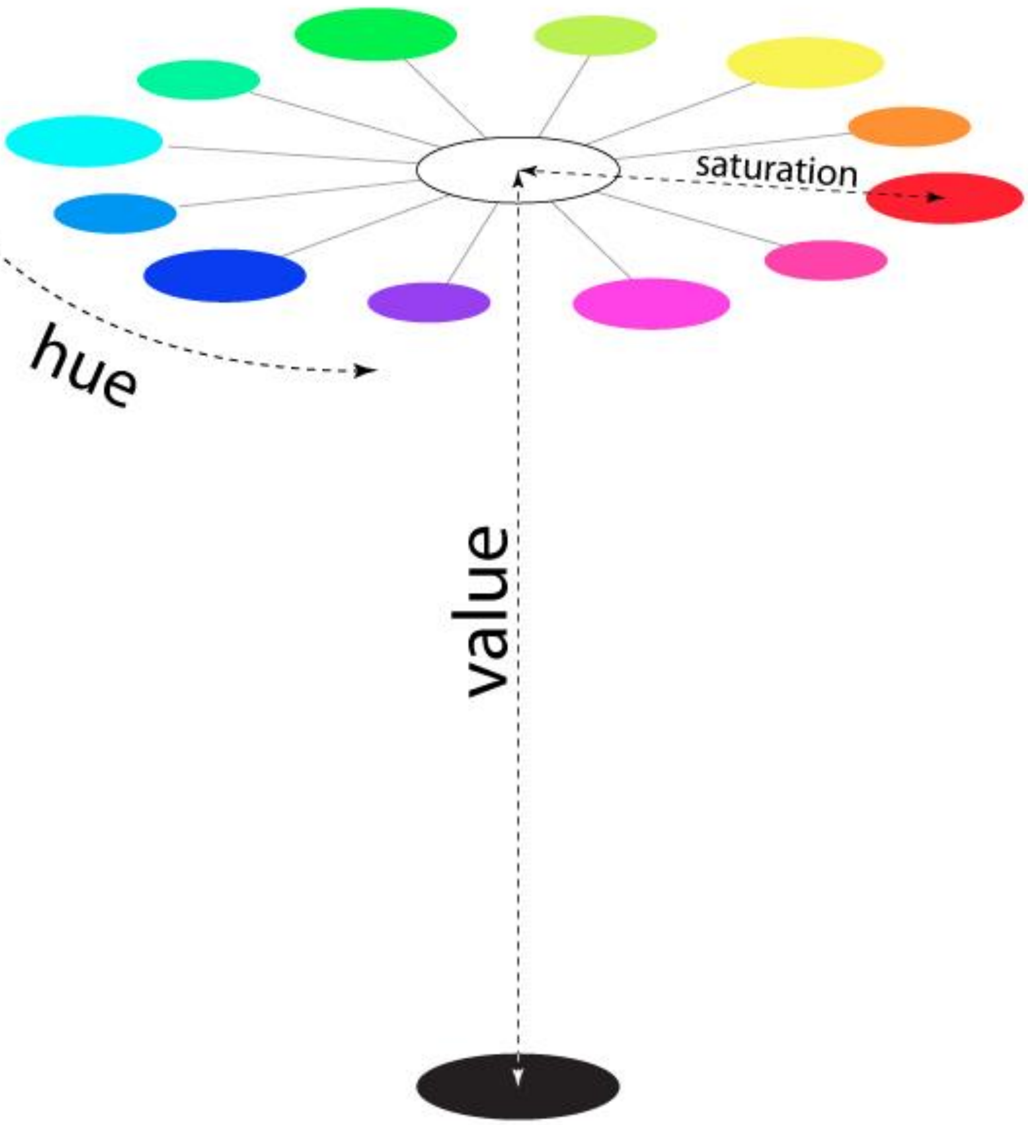
General Saturation Direction



“Pure” Hue With Complete Saturation: no other hues present

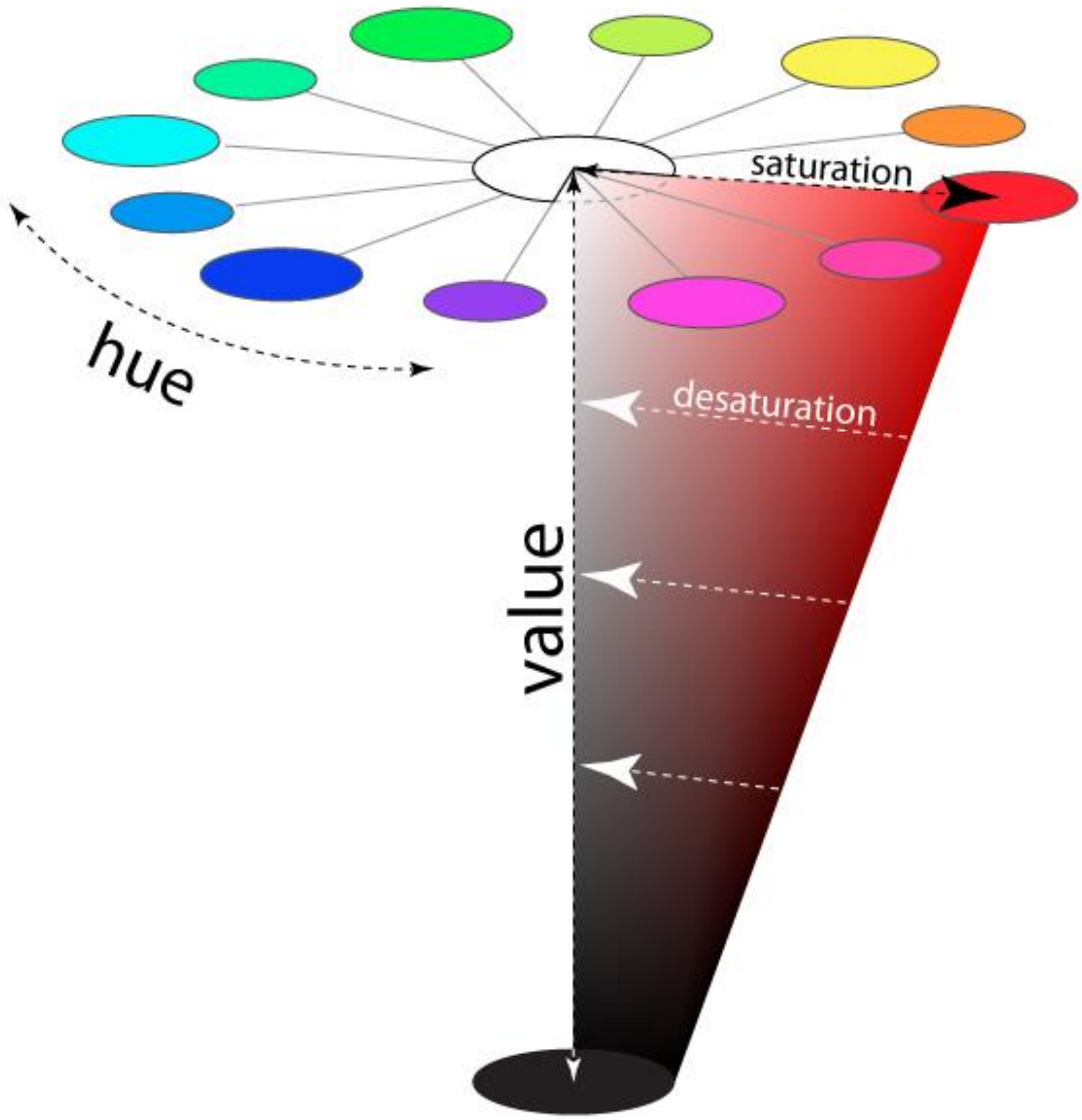
Value

Now let's add "value" to the HSV scale. Value is the dimension of lightness/darkness. In terms of a spectral definition of color, value describes the overall intensity or strength of the light. If hue can be thought of as a dimension going around a color wheel, then value is a linear axis running through the middle of the wheel, as seen below:



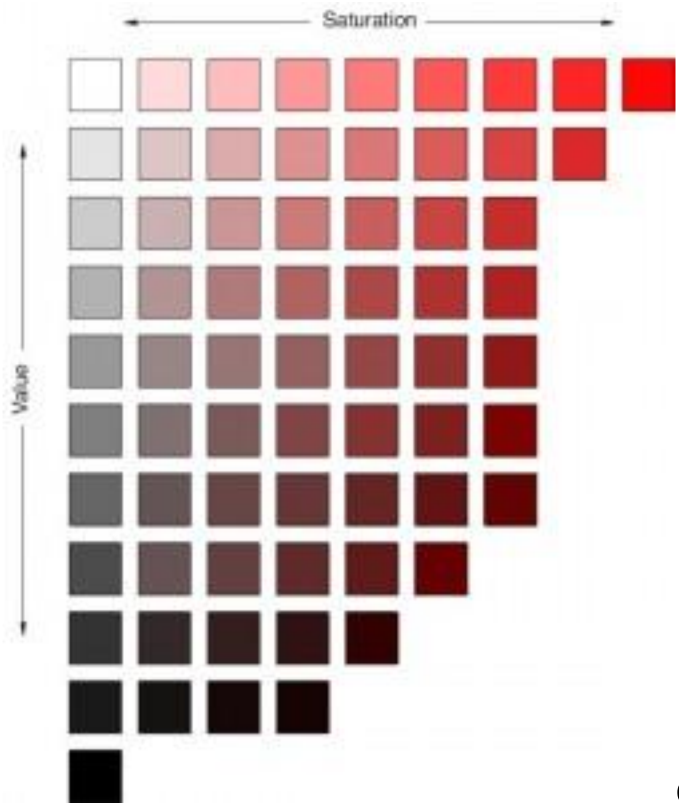
HSV Model with Hue, Saturation, and Value Explained

To better visualize even more, look at the example below showing a full color range for a single hue:



HSV Model With Full Range of Single Hue

Now, if you imagine that each hue was also represented as a slice like the one above, we would have a solid, upside-down cone of colors. The example above can be considered a slice of the cone. Notice how the right-most edge of this cone slice shows the greatest amount of the dominant red hue (least amount of other competing hues), and how as you go down vertically, it gets darker in “value.” Also notice that as we travel from right to left in the cone, the hue becomes less dominant and eventually becomes completely desaturated along the vertical center of the cone. This vertical center axis of complete desaturation is referred to as **grayscale**. See how this slice below translates into some isolated color swatches:



Cone Slice Swatches

Definition - What does *Color Saturation* mean?

Color saturation refers to the intensity of color in an image. As the saturation increases, the colors appear to be more pure. As the saturation decreases, the colors appear to be more washed-out or pale.

A highly saturated image has vivid, rich and bright colors, while an image with a low saturation will veer towards a scale of grey. When the saturation is zero, what you will see is a shade of gray.

[Saturation is sometimes called “chroma” although the two terms have a slightly different meaning. While chroma defines the brilliance of a color in absolute terms according to the Munsell Color System, saturation is relative to pure gray. However, in nearly all instances, this difference is quite negligible in practice.]

Color saturation determines how certain hue will look in certain lighting conditions. For example, a wall painted with a solid color will look different during the day than it does at night. Because of the light, the saturation of the wall will change over the course of day, although it is still the same color. When the saturation is zero, what you will see is a shade of gray.

However, saturation does not define how light or dark a color is. Although many saturated colors tend to be lighter than less saturated ones, adding white to the latter will increase their brightness until both values will match.

In fact, brightness of the color is controlled by the amount of the white in the hue.

Naturally, colors tend to get less saturated as the object is farther from the observer and recedes into the distance because of a phenomenon known as “atmospheric perspective.”

In natural light, tints get diluted by the atmosphere itself, so in many paintings progressive desaturation is used to creates the illusion of depth. The colors of distant object become gradually less saturated while those in the foreground are brighter and more vivid.

When using physical paints, the saturation of a color can only be decreased by mixing it with another color, and the process is irreversible.

More information: http://creativecurio.com/2008/05/the-color-wheel-and-color-theory/