Chapter Six

Colour for Emotion and Focus

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Introduction

Everything we see is dependent upon light and colour. No colour, no world (with the very rare exception of *achromatopsia*, which is the inability to *perceive* colour at all even though the eyes can distinguish them, or the true *monochrome*). But light and colour are fleeting things, capricious and temperamental, and many people have found good reason to distrust how reliable these indicators are of 'reality' as we perceive it. Sir Isaac Newton (1642-1727), to whom we owe in large part the founding of modern colour theory, once said that objects have "no appropriate colour, but ever appear of the colour of the light cast upon them"[1]. Regardless of its deceptive nature, there is no denying that we are affected emotionally and psychologically by colour. As image-makers, colour is one of the most powerful, and widely recognized tools we have to impact our audience.

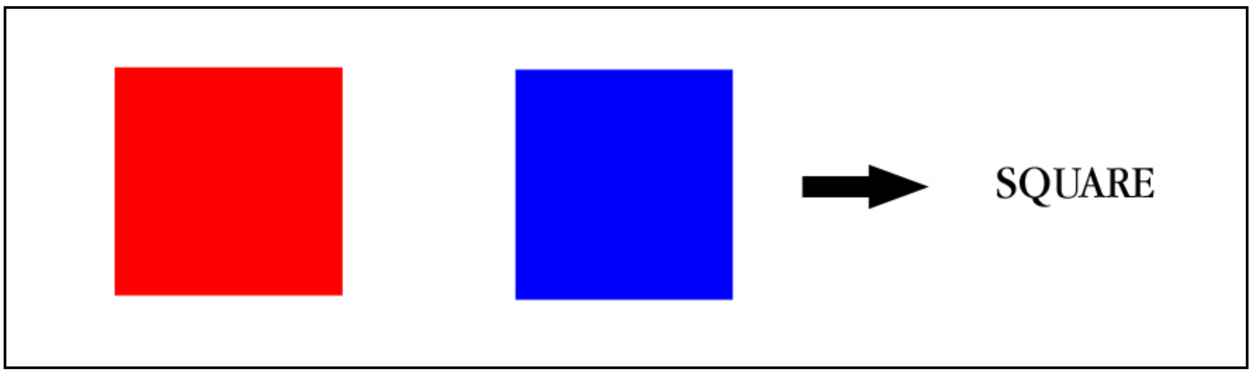
This chapter is devoted to developing a basic understanding of the properties, history, compositional application, and symbolic meaning of colour. Through a better grasp of what colour is, and how it can be manipulated, more effective images can be created for communication with a viewer. At the end of the chapter the reader should expect to be familiar with these topics:

1. What *colour* is, and how it is *perceived*;
    a. The definitions of, and difference between, *Additive* and *Subtractive Colour Theory;*
2. The meaning of the terms, *hue*, *saturation*, *value*, and *temperature as they apply to colour*;
    a. How systems of colour interpretation and categorization differ;
3. The definition of *Primary, Secondary,* and *Tertiary Colours*;
4. How colours *Compliment* and *Contrast* each other;
5. The definition and different types of *Colour Harmony*;
6. The creation of *Realistic Depth, Focus,* and *Emotion* through *Colour*;
7. *Symbolism* and *Meaning* in *Colour*;
8. The relationship between *Colour* and *Storytelling*.

[1] *Opticks, 1704*

Colour and Perception

Shapes are almost completely unaffected by changes in light and associated changes in colour. The ambiguity that environmental variability can cause in our perception of the colour of objects causes children (between the ages of 3 and 6) to be disturbed by colour when trying to compare shapes (i.e. triangles and squares) of varying colours. They will rely mainly on shape as a way of distinguishing between the different objects: a square object will be interpreted as 'square' regardless of its colour (*Ill.1*). The same ambiguity causes the vast majority of people to think, and speak, of colour and shape as separate phenomena. Privileging shape over colour as an organizing principle has been in place ever since colour became a serious object of study. Shape has ever been thought of as being solid, and foundational to the structure of images, while colour has more often than not been associated with the seductive or deceptive qualities of pictures. Because of this we gravitate towards shapes as a more stable reflection of the world, and as a result, we tend to think of the world around us as occupied by shapes and objects rather than by colours.

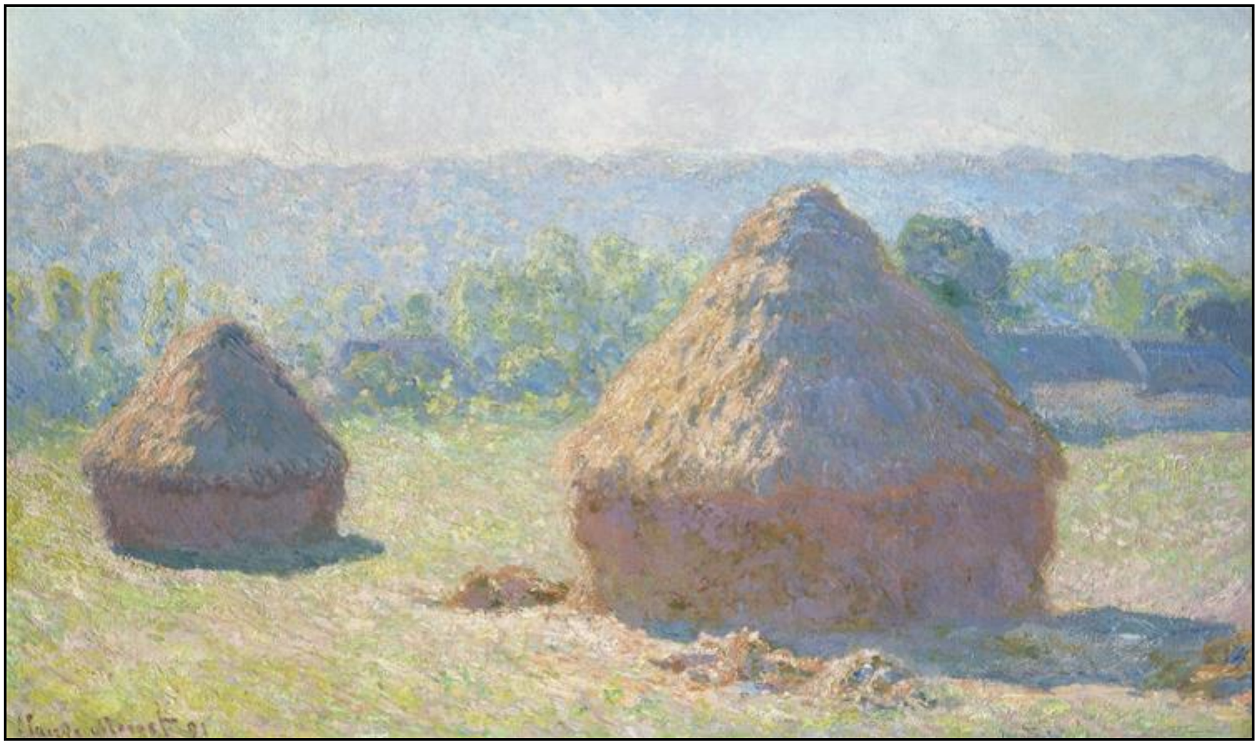


Ill.1: We tend to privilege shape over colour when interpreting the world because shapes are less changeable than colour. The object is interpreted as 'square' rather than 'red' or 'blue' object.

Like so many other topics discussed thus far however, colour and shape have a symbiotic, inseparable relationship. While it is true that there is no *essential* colour to any object, how we tend to think of, and react to, objects in the world has much to do with what we have come to be familiar with as the colour of those objects. The Anglo-Irish philosopher Bishop (George) Berkeley (1685-1753), went so far as to state that we do not see shapes and space but only coloured patches, and that we learn to associate those colours to shapes that we experience (prescient of how the Impressionists would come to interpret reality in their paintings at the end of the 19th century - *Ill.2*). This association eventually becomes so strong that we are fooled into believing we see certain shapes. So much so that it could very well be true "*that one born blind could not, upon being cured, immediately recognize shapes, since it takes time to associate the coloured patches we see with the shapes we feel*."[2] When post-renaissance Italian theorists started to codify how they thought pictures ought to be composed (*see Introduction*), they saw that both colour (*colore*) and structure (*disegno*) as being essential to the construction of a picture (*pictura*); but they considered colour to be the seduction that enticed spectators into viewing, so that they might appreciate the more substantial structural aspect of the underlying drawing (this has even been taken so far as to have the 19th century French theorist Charles Blanc

[2] *Visual Intelligence, 19*

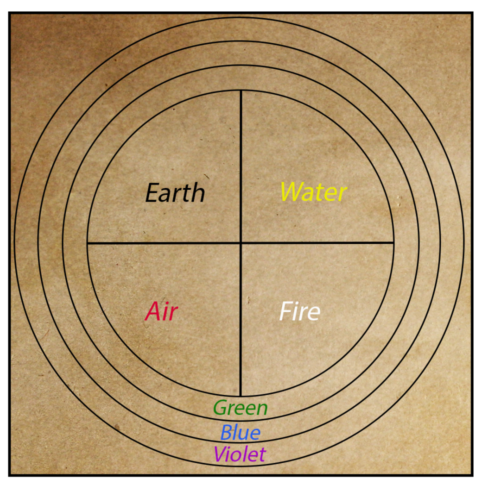
politicize this aesthetic prejudice by stating that "*drawing is the masculine sex of art and colour is the feminine sex*").



Ill.2: Haystacks, End of Summer, Claude Monet, 1891, Musée d'Orsay, Paris. The Impressionists realized (along with science) that the world is seen by us as coloured patches, making it less stable than shape as a descriptor of reality.

Colour and its affects upon our psyche have been of interest to people since at least the 4th/5th centuries BCE. The Greek philosopher Democritus wrote on the subject (unfortunately these writings are lost), as did Ptolemy in the 2nd century CE in his *Optics*. Countless people since have grappled with the issue of colour perception because of the profound impact it has upon our interpretation of the external world; but it is with the 14th century that we first start to see the modern study of colour begin.

The study of colour is divided into two general phases. The first phase is prior to the 17th century and tried emphasize the *objective* status of colour in the development of a coherent system of relationships between objects and colour. Antiquity thought of light as 'activating' the colour inherent in objects. Aristotle developed the first known theory of colour postulating that the gods had sent colour via celestial rays to earth. He attributed four colours to the four elements: earth being associated with black, fire with white, water with yellow, and air with red (*Ill.3*). These were the 4 irreducible colours which then had the reducible colours of blue, green and violet added to their number. This theory remained in place (much as did a great deal of Aristotle's thought) for quite some time. When the Middle Ages



Ill.3: Aristotle's Classical Colour theory. The four elements and the four irreducible colours.

rolled around, its inhabitants did not necessarily disagree with Aristotle's theory, but, for them light was a homogenous entity that 'carried' light as a direct (and unchanging) representation of *one* God.

With the Renaissance the European world became more scientific in a modern sense; and in the 15th century the Italian artist and philosopher Leon Battista Alberti (1404-1472) researched light's effects, and his investigations laid the groundwork for the much more extensive ones of Leonardo da Vinci's (1452-1519) at the end of the century. Leonardo developed a basic system of six colours (not dissimilar to the ancient model of Aristotle) and again associated them with earthly substances: white, yellow (earth), green (water), blue (air), red (fire), and black. But he abandoned his effort to develop a coherent *objective* theory or colour because of its shifting nature. Fire was not always red, nor water green, nor air blue, etc. He recognized that colour was incapable of yielding an objective truth because colour seemed to be forever changing.

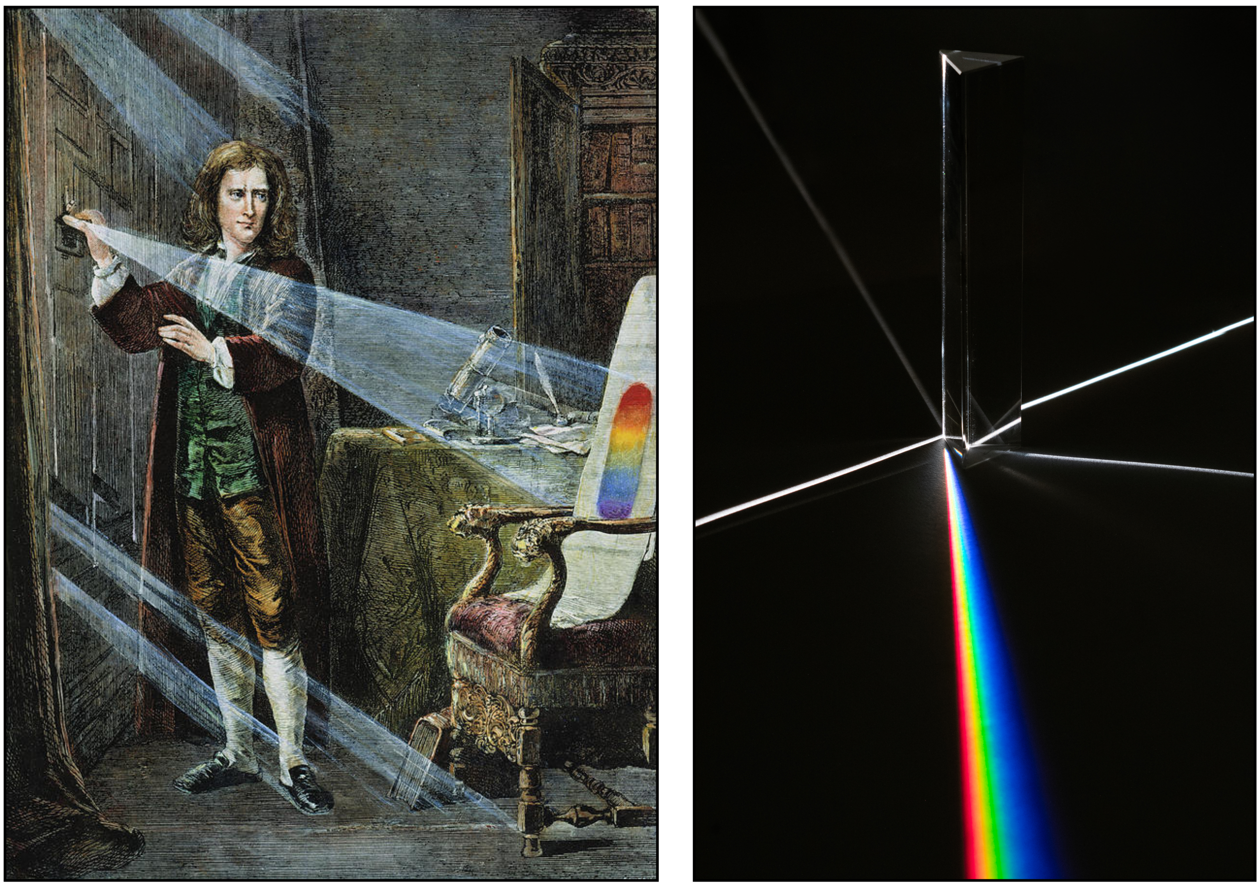
The second phase of colour study begins in the 1600s. The 17th century saw the writings of Leonardo published and evaluated for the first time, and many artists would attempt to expand upon them in order to develop a theory of colour during this century. But it is with Sir Isaac Newton (1643-1727) and his experiments with prisms that the modern study of colour really begins. From Newton onwards the emphasis in the study of colour was to become increasingly *subjective*, and our perception of colour was to become ever more contingent upon the physical mechanisms and limitations of our visual system.

Newton was to show in the 1660's that the properties of rays of light that are responsible for colour, not objects themselves. He did so via experiments with prisms which recreated the visual phenomenon of the rainbow. The rainbow was of course nothing new, it was familiar to Antiquity although they did not understand what created its occurrence; and had even been previously associated with rock crystals because of their ability to project rainbow-like colours on other surfaces by intercepting rays of light. But, and importantly for the *subjective* case, it gradually became apparent to both the Middle Ages and Renaissance that the rainbow and its colours seemed to be dependent upon the position of the viewer as opposed to some innate quality of the rainbow itself.

Ill.4: A rainbow is caused by the refraction of light in atmospheric water droplets which reveals the visible spectrum of colour.

A rainbow is a multi-coloured arc in the sky which is caused by the refraction of light in atmospheric water droplets (*Ill.4*). Rainbows are not located at a specific distance from a viewer, but occur when water droplets are viewed from a certain angle relative to the Sun's rays. Thus, a rainbow is not an object, and cannot be physically approached. It is physically impossible for an observer to see a rainbow at any angle other than 42 degrees from a position opposite the Sun.

A rainbow is created when light is refracted while entering a droplet of water, then reflected inside on the back of the droplet and refracted again when leaving it. This refraction separates white light into its component parts: the colours of the visible spectrum (*see Introduction*). Newton's experiments with triangular prisms discovered that colour is a function of the refraction of white light, and are divided into a spectrum of general chromatic areas. Newton presented his findings in a letter of 1675 to the Royal Academy in London showing that red light was subject to the least amount of refraction and violet the most, and that these constituted the poles of the colour spectrum when light was passed through a triangular prism (*Ill.5*). These prisms had been devised specifically for the purpose of studying the nature of light in 16th century Italy, and had no equivalent in nature, or historical precedent. Newton used these tools to uncover the nature of light itself. This was an entirely new way of imagining colour, light, and the world.

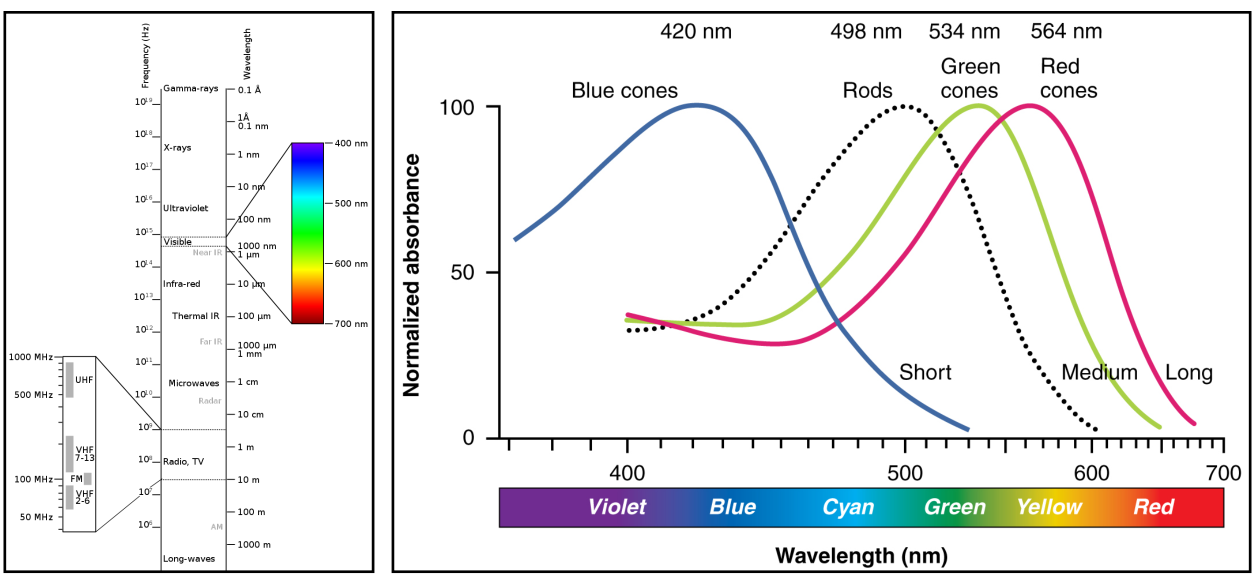


Ill.5: Newton's diagram of his prism experiment of 1666-72 showing the division of white light into its spectrum by a first prism. If these bands were to then pass through a second prism they would be reconstituted into white light once more. Left Image: Sir Isaac Newton experimenting with a prism. Engraving after a picture by J.A. Houston, ca. 1870, The Granger Collection, New York. Right Image: Full Spectrum Wavelength Dispersion for Educational Purposes, Thomas Nugent, 2020.

The number and order of colours in the rainbow has always been in dispute, and originally Newton had decided upon 5 colours for the visible spectrum: red, yellow, green, blue and violet. He later changed his mind and opted for a 7-colour spectrum (adding orange and indigo) out of a desire to maintain an analogy with musical octaves. Red and violet constitute the poles of our visible spectrum. In a *primary rainbow* red appears on the outer part of the arc and violet on the inner side. In a *double rainbow* (*Ill.6*), a second arc is seen outside the primary arc, and has the order of its colours reversed, red facing toward red in the primary arc. This second rainbow is caused by light reflecting twice inside water droplets. The 'bands' of a rainbow are an artefact of human colour vision, i.e. they are a function of how our visual system works. No banding of any type is seen in a black-and-white photo of a rainbow, only a smooth gradation of intensity to a maximum (occurring at yellow), then fading towards the other side (*Ill.6*). The rainbow (along with sunsets) is simply the most widely recognized example of the visible colour continuum.

Ill.6: Black and white photos of rainbows show no bands, only a gradient from dark to light.

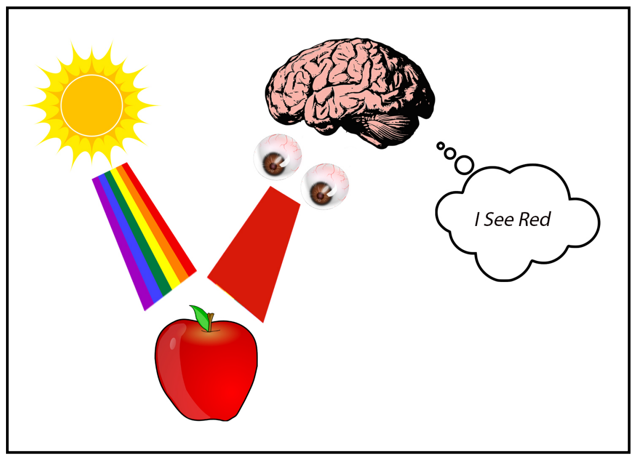
Colour as we experience it is actually electromagnetic radiation, and as it turns out, a very small portion of its entire spectrum. The *electromagnetic spectrum* represents all possible frequencies of electromagnetic radiation (*Ill.7*). It extends beyond the low frequencies (long-waves) used for radio communication to gamma radiation at the short-wavelength (high-frequency) end. This range constitutes wavelengths that are in principle the size of the universe itself down to those that are a fraction of the size of an atom (although in principle the spectrum is infinite and continuous). When Newton passed



Ill.7:The electromagnetic spectrum extends from high frequency short-waves such as gamma rays to low-frequency long-waves such as radio waves. A very small portion of this electromagnetic radiation are the colours of our visible spectrum.

white light through a prism it was split up in to the several bands of electromagnetic radiation that occur between 380 nanometres (violet) and 780 nanometres (red) and constitute our visible spectrum. The Sun emits its peak power in the visible region, and by definition, visible light is the part of the electromagnetic spectrum to which the human eye is the most sensitive (infrared - if you could see it - would be located just beyond the red side of the rainbow and ultraviolet would appear just beyond the violet end).

The classification of electromagnetic radiation is in increasing order of wavelength, but there are no precisely defined boundaries between the bands of the electromagnetic spectrum; rather they fade into each other just like the bands in a rainbow. Electromagnetic radiation with a wavelength between 380 nanometres (nm) and 780 nm is detected by the human eye and perceived as visible light. Other wavelengths, especially near infrared (longer than 780 nm) and ultraviolet (shorter than 380 nm) are also sometimes referred to as light, especially when the visibility to humans is not relevant. Radiation of each frequency and wavelength (or in each band) will have a mixture of the properties of either region of the spectrum that bound it (i.e. red light resembles infrared radiation in that it can excite and add energy to some chemical bonds and must do so to power the chemical mechanisms responsible for the operation of the visual system and photosynthesis).



Ill.8: The apple's surface absorbs the blue and the green light and reflects the red. Thus we perceive a red apple.

If radiation having a frequency within the visible region of the electromagnetic spectrum reflects off an object, an apple for example, and then strikes our eyes, this results in our visual perception of that object. Our brain's visual system processes the multitude of reflected frequencies into different colours, and through this insufficiently-understood psychophysical phenomenon, most people perceive an apple. Not only do they perceive the apple, those same people will agree (within the limits of our language) on the *colour* of that apple: red. We have three different colour photoreceptors in our eyes: blue, green and red cones (see *Introduction* for more information on the physiological nature of vision), and depending on the amount of each type of colour absorbed by these receptors we perceive differently coloured objects. Because the surface of the apple in *Ill.8* absorbs both blue and green light we perceive the remaining colour reflected to us: red.

Painting in the 17th century placed ultimate importance both practically and theoretically on the successful balance of lightness and darkness when discussing *value*. Colour was seen as important, but secondary to that of *value*. But, with Newton showing that colour was the child of light, both light and colour found themselves part of a *unified theory of value*. One could not balance one without considering the other. Colour theory was discussed regularly in the French Academy of the 1660's; and increasingly, a sea-change in societal knowledge dependency began. Until his point historically, the scientist held the artist in esteem as an expert on colour, now, it was the artist who would turn to the scientist for their advice on the complexities of colour. There is evidence to suggest that by the end of the 18th century, the *Opticks* of Newton had become an obsession of painters as they grappled with the newly found science of light and colour in their efforts to balance a picture. Colour Theory became a central part of the lives of artists.

Colour Theory

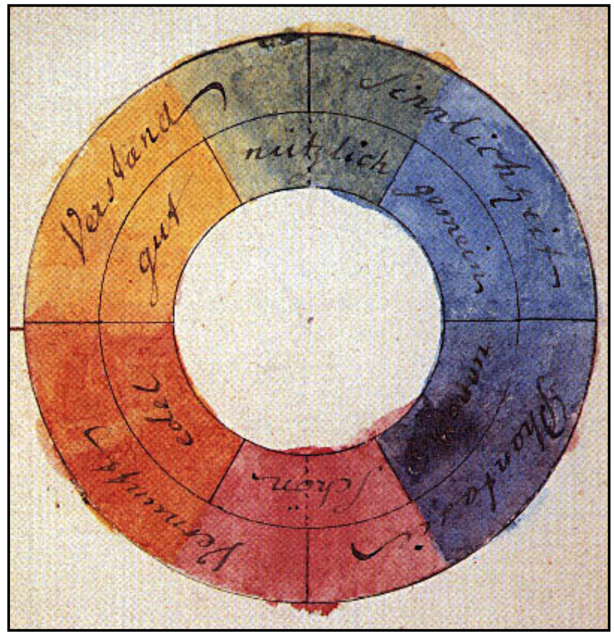
Colour theory is confusing at first, and confusing for good reason. Part of this confusion results from the fact that there are a number of interrelated variables that must be considered when colours are combined with each other, as opposed to the single variable of *value* when working *achromatically*. This multi-variable confusion is amplified due to the added fact that there are *multiple colour theories*, some more correct and updated than others, others correct depending on the context, some more relevant depending on the aspect of the perceptual system that is being referred to, and because it is a robust area of contemporary research which is continually evolving. Because of this, we need to look at *what* we mean when we refer to colour theory, *which* colour theory we are referring to, and how it is *relevant* to its practical application.

The philosopher and historian Arthur Lovejoy (1873-1962) referred to the term *romanticism* as being nearly meaningless because it had too many potential meanings. Instead, he thought, we should refer to the 18th century aesthetic and philosophical phenomenon in its plural only: *romanticisms*. We can think of colour theory as being divided into similar categories as is history: there is not one colour theory, but many colour theories, and they all contribute to our understanding of our perception of colour and its practical application.

Colour theory can be roughly divided into two umbrella categories: traditional and contemporary. Certain historical institutions still maintain influence in our culture simply because of a lengthy pedigree (be they political, religious, or philosophical), even though they may not be as 'current' or accurate as more modern ways of doing things. Regardless of whether or not we agree with these more traditional modes of existence or paradigms of thought, they are still of use to know, since they still have a purchase on the intellectual and cultural trajectory of our modern world, in that they directly affect people that exist within it, both through thought and action. Colour theory is much the same in this sense: there are both traditional and contemporary versions of colour theory, and they are both useful to know…if for very different reasons.

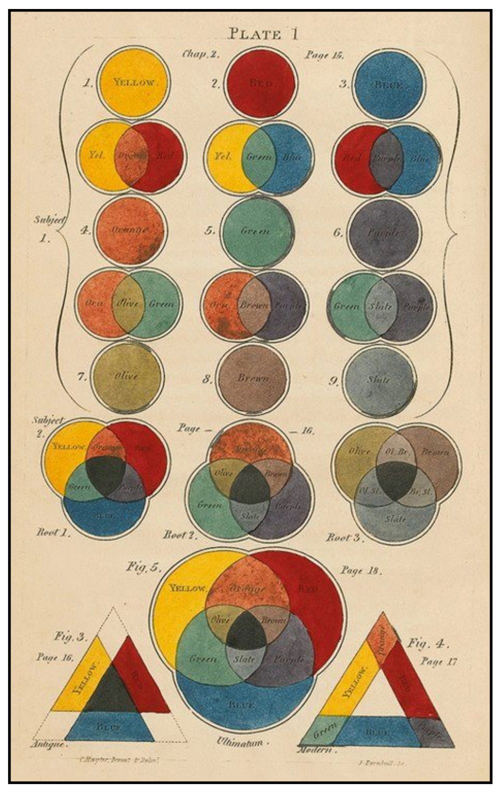
Traditional colour theory is probably that which is most familiar to most people, simply because it has been hanging around for such a long time. This fact alone makes this colour theory extremely useful, even if it may not be as up-to-date as contemporary colour theories. If you are familiar with colour at all, you probably know that the primary colours of this colour theory are Red, Blue, and Yellow. The *RYB primary colours* were the basis of early developments in 18th century colour theory, as it was believed that through the blending of these colours gave rise to the perception of all possible colours physiologically, and as a result were also responsible for the physical mixing of all possible colours, whether they be through the medium of paint pigments or dyes.

The period was rich in experimentation regarding the psychological effects of colour perception, which ultimately resulted in the production of numerous seminal texts on *RYB colour theory.* Johann Wolfgang von Goethe (1749-1842), a poet and one of the leading intellectual figures of Europe at the time, was the first to publish findings that stated the surfaces light rays interacted with contributed to the colour we perceived (*Theory of Colours* - 1810 (Ill.9)); and Arthur Schopenhauer (1788-1860) foresaw the function of retinal responses as being a contributing factor to the perception of colour. A French industrial chemist, Michel-Eugene Chevreul (1786-1889) made game-changing discoveries with respect to the psychophysiological phenomenon of colour contrast and was for a time the world's leading colour theorist for painters, publishing *The Law of Simultaneous Contrast* in 1839 (*Ill.10*). And *A New Practical Treatise of the Three Primitive Colours Assumed as a Perfect System of Rudimentary Information* was published in 1826 by Charles Hayter, which stated that all perceivable colours could be created by mixing just the three primaries of Red, Yellow and Blue (*Ill.11*).



Ill.9 Goethe's Colour Wheel, 1810.

Ill.10: Chevreul's Colour Wheel, 1861.



Ill.11: A page of Hayter's Treatise, 1826.