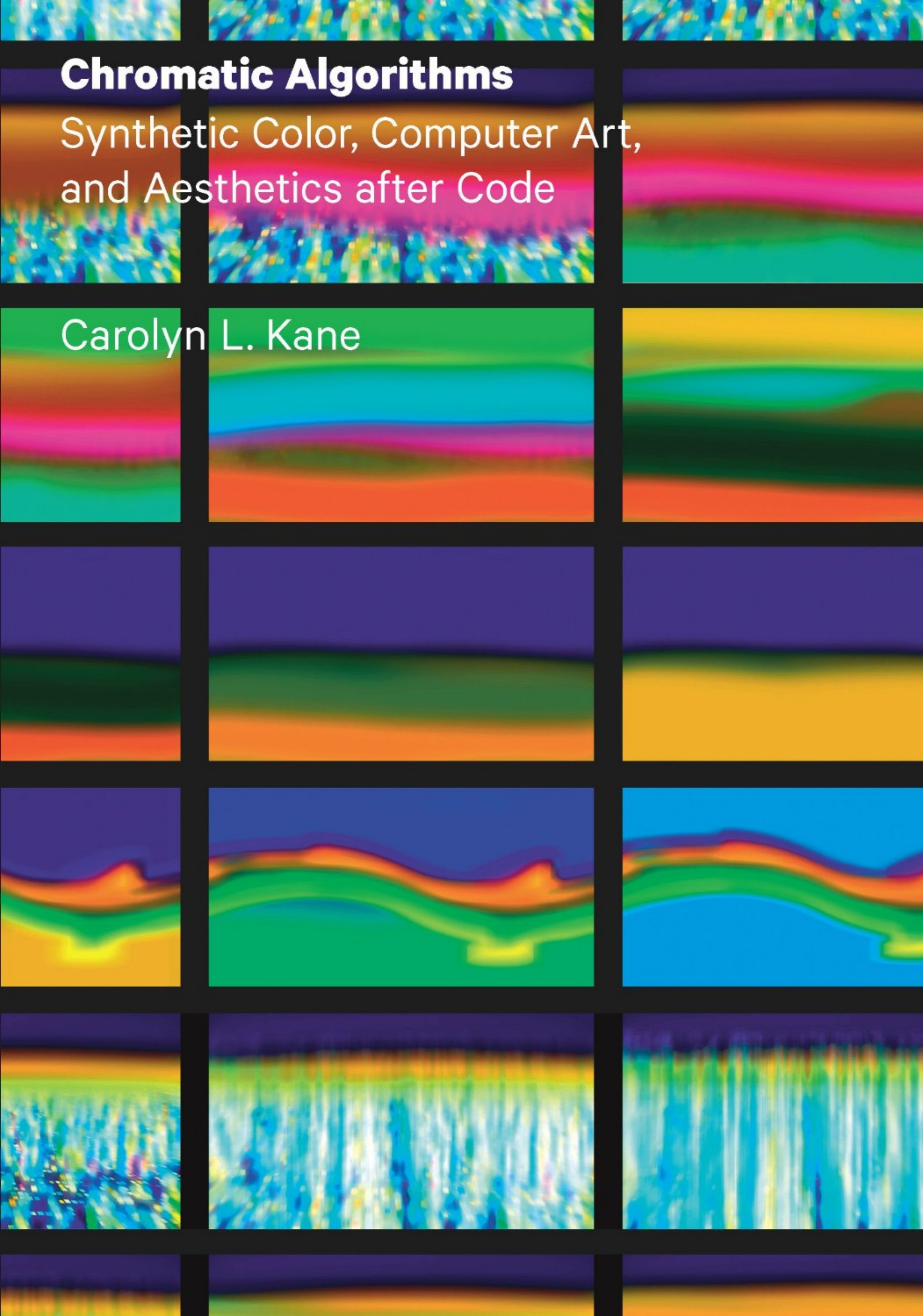


Chromatic Algorithms

Synthetic Color, Computer Art,
and Aesthetics after Code

Carolyn L. Kane



We live in an age of chromophobia, argues anthropologist Michael Taussig, carrying the values and traditions of a “dark Europe” where, as Goethe once suggested, “people of refinement avoid vivid colours in their dress, the objects that are about them, and seem inclined to banish them altogether from their presence.”¹ When Europeans import bright and bold dyes from southern, “primitive” countries, they subtly integrate them back into their “more refined” tastes. Only “uncivilized nations, uneducated people, and children,” Goethe wrote in 1810, “have a great fondness for colours in their utmost brightness.”²

Perhaps Taussig and Goethe are in part correct. Many “first world” citizens work and play in black, white, and grey, punctuated by the occasional pink work shirt, red tie, or fashionable purple scarf. A splash of vibrant color is tolerated, so as long as one keeps it under control. The same set of generally unspoken rules apply to workspaces, domestic interiors, “tasteful” material objects, and especially to Modern art, the quintessential unleashing of bold colors within a sturdy and unwavering rectangular frame. And yet one wonders, in an age of ubiquitous electronic computing and global communications, do these old world values still apply? Does the imperialistic and colonial history of chromophobia continue to thrive on one’s desktop, television, or cell phone screen?

Chromatic Algorithms argues that they do not: since the 1960s the United States has embraced a new world of electronic, synthetic color. Decked from head to toe in electronic hues and digital screens, the cultural landscape abounds with color film, television, fluorescents, op art, billboards, Internet banner ads, screaming neon signs, dazzling fashion displays, postmodern architecture, luminous screen savers, and brightly colored multiscreen installations in pharmacies, shopping malls, airports, airplanes, gyms, and cars. The ongoing and accelerated struggle for consumer attention is increasingly played out through color media, further amplified by the ever-increasing size and scale of global urban centers. Chromophobia may have been valid in Western Europe during the nineteenth and early twentieth centuries, but today—at least in terms of the media environment—it is obsolete.³ How then can one account for this turn of events and explain how the longstanding tradition of chromophobia came to reverse itself in such a short period of time?

These questions are difficult to answer because color is not only difficult to see, it is even more challenging to analyze. And yet without it the world would look dim and incomplete. In 1963, Bauhaus colorist Josef Albers explained that “in visual perception a color is almost never seen as it really is—as it physically is. This fact makes color the most relative medium in art.”⁴ Given that color behaves on its own terms, irrespective of the codes, protocols, and ordering systems that attempt to discipline and contain it, how then should one approach it? Histories of color, such as this one, must chart the failures and successes of a new color technology while also explaining what color is and how one produces it. In this chapter, I provide a historical background and

context to understand color, first by describing some of the major color conundrums and paradoxes in the history of Western art, science, and philosophy and second by providing an archaeology of Day-Glo fluorescents, chemical colors that explode into high visibility at the end of the 1960s. The chapter serves as a second introduction to the book. Where the first introduction provided an overview of my themes and methods, this introduction provides an overview of color and its role in Western philosophy and aesthetics from Plato through the psychedelic 1960s. Both serve as primers to understand the emergence of luminous electronic color in the chapters that follow.

I. Classical and Modern Color: Plato through Goethe

The ancient and eternal question “what is color?” has not yet been fully answered. A preliminary set of problems arises from the fact that each individual, and group of individuals, sees color differently. Several people may be exposed to the same object—a computer screen, a can of Coke, a translucent earthworm—from the same vantage point and under the same viewing conditions, and yet each will see the object in a unique way. This is because a person’s physiology, history, culture, and memory structure his or her visual perception.

Visual responses to color also diversify across language, gender, and ethnic divides. While only 0.5 percent of Caucasian women are red-green colorblind, up to 8 percent of Caucasian men are. (Recall gender stereotypes of women and gay men knowing how to coordinate colors better than heterosexual men.)⁵ Memory alone betrays color. After exposure to a bright red dress, when one later attempts to recall it in the mind, it is usually remembered in a hue darker than it actually is. Language and nomenclature both alleviate and exacerbate color problems. Ludwig Wittgenstein argues that the English phrase “red-green” denotes a fundamentally insecure relationship between color and language by invoking a color reality that could not possibly exist.⁶ Color is an elusive “language game” where one assumes a color consistently denotes a hue like “grey-green,” but what this term actually means is “indeterminate and relative to specific contexts and situations.” For Wittgenstein ephemerality and indeterminacy lie at the heart of any color’s claims to sameness.⁷ As Albers put it:

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. And one can be sure that all these reds will be very different . . . When we consider further associations and reactions which are experienced in connection with the color and the name, probably everyone will diverge again in many different directions.⁸

And yet naming colors is one of the few methods humans have for arriving at any sort of agreement as to what a certain color is. Moreover, while

humans are in theory capable of seeing innumerable colors, on average, an English-speaking culture can only recognize and name about thirty different colors. While designers, color physicists, and artists train themselves to see and name more colors, these specialists are far from the majority. Seeing color is a matter of cultural and historical training.

In Western psychology, symbolic systems have been developed to decode the mysteries of color. These techniques tend to equate a color—usually one of Newton’s primary spectral colors: red, orange, yellow, green, blue, purple, or violet—with a number; a musical note (first attempted by Pythagoras); or a gestalt or mood, such as Charles Fère’s experimental treatment of hysterics with colored lights in the 1880s under the banner of chromotherapy. The well-known color consultant Faber Birren further developed such psychologies of color in his *Color Psychology and Color Therapy* (1950), *Color Perception in Art: Beyond the Eye into the Brain* (1976), and *Color and Human Response* (1978). These techniques, however, tend to designate a hue, such as red, as representative of a mood like anger or rage, or a note like F sharp, but, as noted, such a correlation is culturally coded and what red means in one culture may signify the opposite in another culture. For example, in China, white—not black—symbolizes death and mourning.⁹ Or consider the symbolic value of a Western man wearing a pink suit to the office. Today this might signify fashion and style, as it may have in the 1920s, but in the 1950s, it may have suggested something quite different. While these symbolic and indexical approaches to color can fascinate color knowledge, this chapter does not, nor does this book, employ them at length.

Instead, as I note in the introduction, *Chromatic Algorithms* analyzes electronic color through the material history of aesthetics and the philosophy of technology. Cutting across these approaches is a fundamental polemic: on the one hand it is argued that color inheres in objects in the external world while on the other hand it is argued that color is a phenomenon of interior, subjective perception. This polemic extends back to the origins of Western thought and to the history of aesthetics in particular.

Classical Color: Two Extremes

I begin with subjective color. Following Empedocles’ emission theory of vision, Plato (424–348 B.C.) approached color through the lens of subjective perception and proposed that the “pores of the eyes” consist of “fire and water” through which humans perceive white and black.¹⁰ In Plato’s creation myth, the *Timaeus*, Socrates argues that “the pure fire which is *within us* . . . flows through the eyes in a stream smooth and dense . . .” and later in this same passage that “the light that falls from within [travels to] meet an external object.”¹¹ In this way, a subject’s visual perception is mediated and shaped by

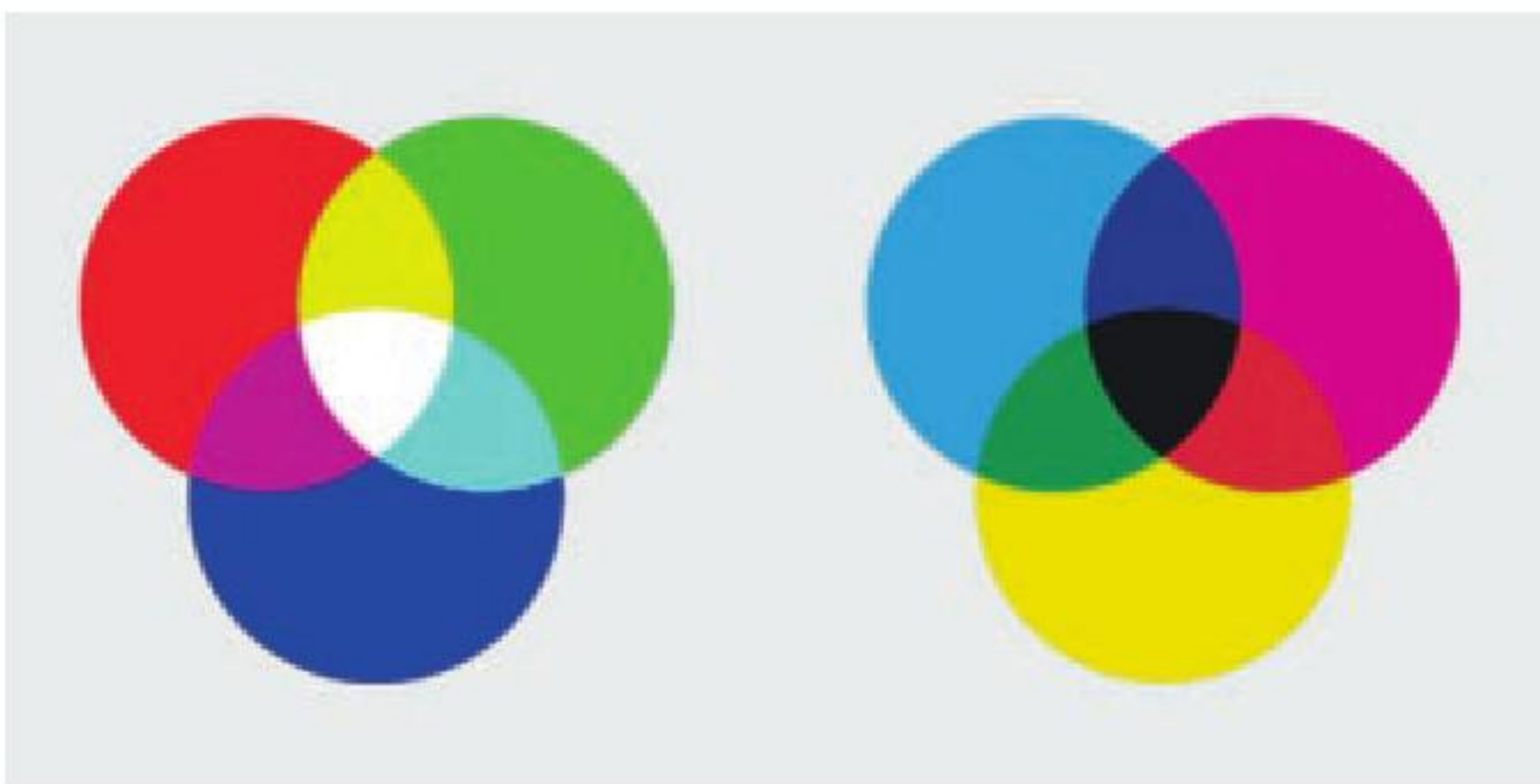
what he or she sees in the world. Given Plato's metaphysical prioritization of abstract mathematical Forms, it should come as no surprise that such mediated visions proved to be fundamentally deceptive and unreliable.

On the objective end, Aristotle (384–322 B.C.) formulated an empirical theory of vision rooted in the colors that he observed *in the world*, which he then classified into various systems. In his discussion of the rainbow he determined that light and color must necessarily move through a transparent medium in order to be seen: "Colour sets in movement not the sense organ but what is transparent, the air, and that, extending continuously from the object . . . sets the latter in movement."¹² Color for Aristotle was not *in* the subject—the "sense organ"—as it was for Plato, but rather, in the objective world. In his critique of Plato's emission theory, he explains: "If the visual organ proper were really fire, which is the doctrine of Empedocles, a doctrine also taught in the *Timaeus*, and if vision were the result of light issuing from the eyes like a lantern, why should they not have had the power of seeing even in the dark?"¹³ For Aristotle, and many after him (namely the tradition that builds from Newton onwards), light and color exist as physical properties of objects in the external world. Herein lie the seeds of the two dramatically distinct approaches to color in the West: the subjective and the objective.

While catoptrics and dioptrics were not formally distinguished as separate fields of study until Euclid's *Optics* (aprox. 300 B.C.), early traces may be identified in the two above theories. *Dioptrics* involves the study of refraction, or, as Plato suggested, light passing *through* transparent or translucent bodies.¹⁴ The field derives from the notion of *perspicere*, or "seeing through" and includes such phenomena as electronic displays, whether cathode ray tubes or liquid crystal, prisms, rainbows, and telescopes. Currently dioptric methods guide research in color physics, optics, and cognitive science.¹⁵ In contrast, *catoptrics* derives from the Greek *κατοπτρικός*, meaning specular, and refers to the branches of optical research concerned with "looking at" things and objects, such as projection screens (cinematography) or reflexive surfaces (mirrors), and as such, it is more in line with Aristotelian observation. Catoptrics are bound to the "illusionizing potential of projection [and] the production of artificial reality," Siegfried Zielinski explains, associated more with artifice and play than visual or interior truth.¹⁶ This is also why Alex Galloway suggests that catoptrics can be associated with the Greek god Hermes, known for trickery, deceit, and the origin of hermeneutics, while dioptrics can be aligned with Iris, the Greek goddess of the rainbow, for whom light and color are immanent and pure.¹⁷ Hermetic light must be decoded and interpreted (like a commodity fetish or religious text) but Iris-based colors are innate; a Spinozistic phenomenon available for immediate visual consumption.

The polemic between refracted (dioptric) and reflected (catoptric) light can also be extended to *lux* and *lumen*, concepts that derive from theological

sources like the Bible, the work of Abbé Suger or the history of Western optics.¹⁸ In the early seventeenth century, Jesuit mathematician Franciscus Aguilonius argued that *lux* characterized the properties of light from an *opaque* body while *lumen* connoted light activity in a *transparent* body.¹⁹ Opacity and transparency then concern two modes of mediation that, in their modern form, appear as “additive” and “subtractive” color systems. Additive color systems, such as television sets, rainbows, neon signs, and computer displays, *generate* and *emit* light. The primary colors of an additive system are red, green, and blue. When these primaries are combined, they produce transparent white light.²⁰ In contrast, subtractive color systems like paintings, books, apples, and cars, are chemically based color systems that *reflect* color from a material substrate. Blue, red, and yellow are the primary colors of a subtractive system—often referred to as cyan (C), magenta (M), and yellow (Y)—and when they are mixed together they produce black (figure 1.1).



1.1

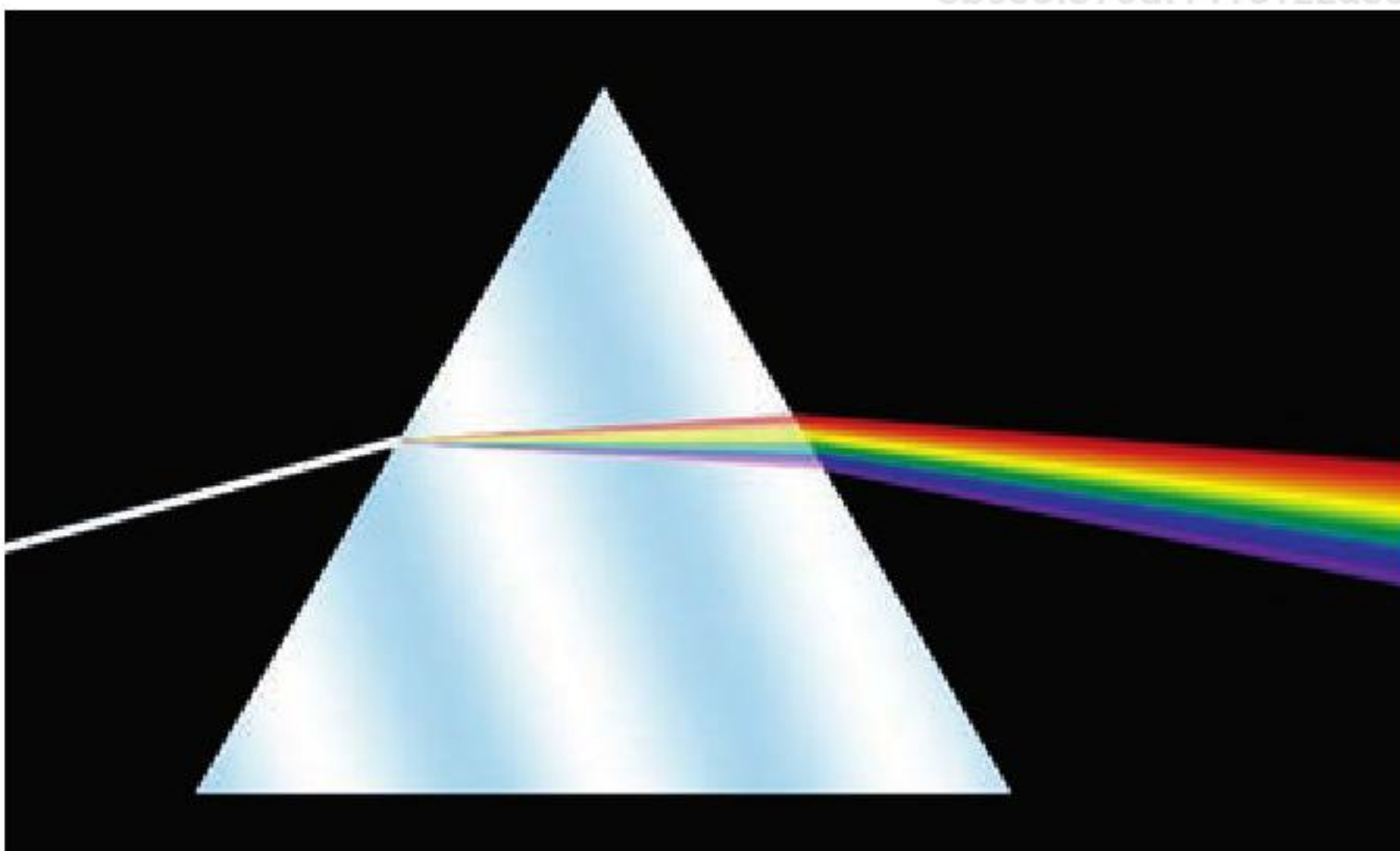
In sum, color is and has always been a highly ambivalent phenomenon, perpetually oscillating between the extremes of spirit and matter; light and pigment; white and black; subject and object; and the sacred and the synthetic. A number of color’s mysteries and ambivalences remain active and unresolved in Western culture; however, in the age of Reason and the Enlightenment many of their ambiguities and uncertainties were seemingly frozen, split, and solved under the reifying gaze of technics, industry, and modern science.

Clear White Light

The clarity of modern Reason appeared to lift the cloudy veil cast over sacred color. Complemented by developments in optical technologies, Reason became a metonym for pure light and truth that, together, restructured the

1.1 Additive (left) and subtractive (right) color systems. In the additive system colors combine to create white, in the subtractive system colors combine to create black.

conditions of possibility for (visual) knowledge. In the late sixteenth and seventeenth centuries alone Giovanni Battista della Porta (1537–1615) developed the *camera obscura*; Johannes Kepler (1571–1630) developed the first theory of optic lenses; Galileo Galilei (1564–1643) advanced work with telescopes; and René Descartes (1596–1650) employed geometry to illustrate the principles of light refraction in dioptric media. As light and space were territorialized through carefully crafted optical experiments, that complex and unreliable thing called color became a mere subordinate to pure and true white light. The shift was furthered through the work of Sir Isaac Newton (1643–1727), who, working in a dark chamber sealed off from the (life)world, demonstrated in 1704 that all spectral colors combined into white light (figure 1.2).²¹ As a derivative of light, color could be measured and quantified into seven distinct hues, a theory that laid the foundation for future color science and the physical study of color.²²



1.2

There are, however, problems with Newton's theory of color and his account of white light. Despite the fact that he was well aware of the subjective aspects of color, his thesis—at least the way in which it has been repeated through history—disavows many of the paradoxes and ambiguities that make color a dynamic and contextual phenomenon. Any pursuit of pure “transparent” knowledge, it has long been acknowledged, is doomed from the start, clouded by its own ideals and abstract methods. Such misguided beliefs in anything like a readily available “pure white light” or “transparent truth,” Heidegger has argued, applies to the Enlightenment at large, and to Descartes and Kant in particular.²³ In this paradigm the production of (theoretical) “knowledge” and (calculated) “truth,” while connected to empirical vision and optics, were

so abstracted from the lifeworld and lived experience that they ultimately *blocked* rather than enriched one's capacity to access truth, in a phenomenological sense.

And yet beliefs in pure white light and scientific truth remain intact. Moreover, pure white light continues to carry anachronistic theological associations with the brilliance of the rising (Apollonian) sun, a Christian God, and the transcendental (masculine) spirit. It's symbolic value runs so deep into the practices of Western, patriarchal, Caucasian culture and its claims to authenticity, origin, innocence, and truth that it has become "natural" to view color as its dirty and degraded counterpart. Where light comes from God and the divine universe, color seeps in from the discarded residue and waste of the fallen, material world.

In Western aesthetics, color is not only secondary and supplemental to Reason and truth but also to the unwavering strength of line, form, and structure. This particular polemic came to a head during the height of the Italian Renaissance, even though its roots, as noted, can be traced back to Plato's theory of images and Western chromophobia in general. The particular form it assumed in the mid-sixteenth century was through the discursive and artistic oppositions between Florentine *disegno* (line, form, or design) and Venetian *colore* (colorism, or, brushstroke), that is, whether or not "painting should be organized around meaning or affect," as Sylvia Lavin puts it.²⁴ In contrast to *colore*, the (unstructured) use of color and brushwork, *disegno* privileges line, form, draftsmanship, and rational compositional space. The two camps of *colore* and *disegno* straddled either side of Michelangelo, where *disegno* was emblematic of the work of Pontormo and Raphael, and *colore* of Giorgione and Titian. Writers and critics from Leon Battista Alberti through Paolo Pino, Giorgio Vasari, Lodovico Dolce, and later Heinrich Wölfflin helped reaffirm one camp over the other and thus perpetuate the assumed metaphysical distinction between them. Vasari, for instance, founded the Florentine Academia del Disegno in 1563, an institution that formally acknowledged, taught, and merited the prominence of *disegno*. Vasari valued *disegno* for its links to the clarity of the mind (in conceiving of certain forms) and their corresponding realization in material form. Vasari believed he was living in a period of perfect art, lost since Antiquity, but reembodyed in Michelangelo's *disegno*. It should come as no surprise that *disegno* won this debate and remained dominant in Europe until well into the nineteenth century. (In chapter 7, I bring this tension between *disegno* and *colore* into my analysis of the Photoshop cinema.)²⁵

Privileging light as clarity and truth over that which is feared and unknown is also the story of color in Immanuel Kant's (1724–1804) aesthetic theory. For his "transcendental aesthetic," Kant reserved only those a priori properties of the mind that excluded color. In 1781 he wrote that

1.2 Working in a dark chamber in the late seventeenth and early eighteenth centuries, Sir Isaac Newton demonstrated that color derived from pure white light.

colors are not necessary conditions under which alone objects can be for us objects of sense. They are connected with the appearances only as effects accidentally added by the particular constitution of the sense organs. Accordingly, they are not *a priori* representations, but are grounded in sensation . . . Further, no one can have *a priori* a representation of a color.²⁶

While Kant's third critique altered some of his earlier views on color, overall color remained secondary. For instance, in this third critique from 1789, he wrote that the "colors which light up the sketch belong to charm; they may indeed enliven the object for sensation, but they cannot make it worthy of contemplation and beautiful."²⁷ In the tradition of Plato, Descartes, and Newton (to name only three) Kant thus further authorized color as a secondary and inessential phenomenon; as a mere ornament and adjunct to "The Beautiful and the Sublime." I will not go into further detail about color in the history of aesthetic philosophy here.²⁸ Suffice it to note that from Antiquity through the nineteenth century, color was subject to rampant aesthetic, epistemological, and ideological chromophobia. "Bound up with the unreliability of the human senses," as Jonathan Crary puts it, color "could tell [philosophers] little or nothing about what they believed to be the most important 'permanent' truths about reality."²⁹

Dirty Color

The dark (feminine) view of color is frequently held responsible for color problems, while it is also applauded for inciting visual delight. Such a view allows pigment-based colors to concurrently act as symbols of pleasure, deception, and deceit. One may show one's "true colors" in a moment of vulnerability, intimacy, or the expression of raw emotion, but just as easily one may hide behind a mask of colorful makeup and concealer. In Latin, the term *colorem* is related to *celare*, which means to hide or conceal, but in Middle English "to color" means to embellish or adorn as well as to disguise, "render specious," or "misrepresent."³⁰ The situation becomes one where, as Albers puts it, "In order to use color effectively it is necessary to recognize that color deceives continually."³¹

Color's capacity to simultaneously conceal and reveal, or attract and repulse, invokes the ambivalence of the *pharmakon*. In critical theory the *pharmakon* is traditionally associated with the *Phaedrus*, where Socrates aligns it with the then-new technology of writing. As a new medium, the *pharmakon* is a prosthetic that both preserves and replaces human memory; both a remedy and poison. But as both Derrida and Stiegler point out, as a supplement technics is also originary and therefore fundamental to being. The same logic applies to color as a *pharmakon*. For example, in Plato's *Philebus*, *Republic*,

and *Cratylus*, Derrida notes, scholars have translated the term *pharmakon* as “color.” In the *Philebus*, the colors in a painter’s palette are seen to be both constructive and destructive: used to create a new world and to deceive the eye with artifice and illusion. In the *Republic*, color is translated to *pharmakon* to imply witchcraft or magic, a “cosmetic concealing the dead under the appearance of the living.”³² Color is dangerous because it is too potent and attractive, preventing one from turning away from it, yet also essential for life, vitality, and creation.

To say that color is a *pharmakon* is to say that color is and has always been a kind of technology. So while my focus in the following chapters lies with computer-generated color, it is nonetheless crucial to note here that *color of any kind is also always a matter of technics*. That this has been acknowledged only in certain fields since the Industrial Revolution is beside the point. Color used in cave painting is still a matter of chemistry, just as color in the atmosphere involves actual water droplets, sunlight, and dioptric media. If, as I discussed in the introduction, human life, history, and culture must in the first instance be approached alongside and through technics, then so too must color. Whether through its ochers, its minerals, or its silicon graphics chips, color’s dirt and matter connects us, however reluctantly or ambivalently, to technics and artifice, just as it does to metaphysics and theology, politics and ideology, and the depths and darkness of the earth, the world of chaos, eroticism, and Dionysian ecstasy.

But equating color, and generally pigment-based color, with dirt, darkness, deception, and the feminine, is only half the story.³³ Not only does the feminization and foreignization of substance-based color speak directly to ongoing fears and a fundamental distrust of certain kinds of color in Western culture, it also points to one of the ways in which Western chromophobia extends to almost any substance or being that is “other” than white, patriarchal, or Christian. As David Batchelor puts it, in Western culture:

[t]he purging of color is usually accomplished in one of two ways. In the first, colour is made out to be the property of some “foreign” body—usually the feminine, the oriental, the primitive, the infantile, the vulgar, the queer or the pathological. In the second, colour is relegated to the realm of the superficial, the supplementary, the inessential or the cosmetic. In one, colour is regarded as alien and therefore dangerous; in the other, it is perceived merely as a secondary quality of experience, and thus unworthy of serious consideration.³⁴

Color must therefore be seen as something deeply historical, material, and ideological, at the core of the always already Other that perpetually threatens to unveil and undermine the notions of truth, purity, origin, and order that underwrite Western culture.