AUGUSTO GARAU

COLOR HARMONIES

TRANSLATED BY

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WITH A FOREWORD BY

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FOREWORD

IT IS INSTRUCTIVE to look at the history of Western art in light of the relation between the two great antagonists and allies—shape and color. Ever since the Florentine painters of the Renaissance, who based their style on neatly defined shape, contended with the Venetians, whose compositions depended so heavily on color relations, each generation of painters has had to settle for a particular ratio between the two aspects of pictorial form. The variations of style characterizing the history of Western art through the centuries have been strongly determined by their emphasis on either shape or color.

It is true that as long as narrative representation dominated the arts as their primary purpose, shape tended to have the upper hand because of its superior ability to distinguish things. Consider only the art of portraiture, where an infinity of highly articulate shapes lets painters define the individual likeness of persons. Shades of color all by themselves barely allow us to tell water from foliage and would certainly fail us if we wanted to rely on them for telling the portrait of Mona Lisa from one of Napoleon.

Generally speaking, color can hardly manage without the help of shape, which supplies the framework for the placement of colors, whereas shape can attain high levels of representation and expression all by itself. Consequently, in the writings of art theorists color has often been considered subservient to shape. Intuitively they anticipated the findings of some modern psychologists such as Hermann Rorschach, who associated shape with reasoning and color with emotion. In an age of reason, this put shape in a kingly position. Color was considered the handmaiden of shape; it merely provided a pleasing garment for the essential structure of the image. It was the feminine companion of a masculine ruler. Only with the advent of Romanticism and with the development of colorism as one of the conspicuous stylistic trends of painting in the nineteenth and twentieth centuries did the problems of color begin to be admitted to serious theoretical discussion.

It remains true, however, that the serious study of color, as compared with that of shape, faces almost insurmountable difficulties. We know the exact shapes used by Greek painters for the figures on their vases over two thousand years ago, whereas the pigments of as recent a painter as Van Gogh have already changed color. Anyone privileged to view the restorations in progress in the Sistine chapel in Rome has witnessed Michelangelo's lively greens and blues reemerging miraculously from the thick layers of grime and irresponsible retouching that have obscured them for centuries. Similarly, scholars can use

reproductions of paintings to study shapes fairly reliably, whereas color can be investigated only by direct inspection of the originals. A study of subtle nuances, such as the ones offered in this book, depends on the faithful rendering of the illustrations.

Nevertheless, a respectable literature on color problems exists. It concerns, first of all, the optical, chemical, and physiological factors determining the production and perception of colors. Anthropologists and psychologists have studied the selection of, and preference for, particular colors under given cultural conditions. Historians have investigated the various forms of symbolism by which colors have been related to religious and social conventions. More particularly, we have learned much about the color schemes adopted by artists in different periods and their techniques for applying them to the various tasks of the painter.

Closer to what may be called the perceptual or phenomenological aspects of color theory are two problems, namely, expression and structural organization. This book is devoted to the latter subject, but the former needs to be mentioned here briefly. Expression concerns the ability of colors to offer perceptual equivalents of what are often described as emotional states. The German expressionists of the twentieth century have referred explicitly to this power of pictorial color. I will limit myself to one quotation, taken from the memoirs of Emil Nolde, in which he refers to the screams of pain uttered by hares that were captured in traps or attacked by weasels. Those screams obsessed the painter's ears, he says, and were soon condensed to colors symbolizing the cruel nature of animal life, "the shrieking yellow of the screams and the dark violet of the hooting owls." Attempts to associate colors with specific forms of expression have been made by many writers, notably Goethe and Kandinsky, but there is little general agreement on the subject.

The same is true for a basic feature of pictorial expression, namely, the difference between warm and cold colors. I mention it here because there is some evidence to support a suggestion of mine that the temperature quality of colors is determined not so much by the dominant hues as by subordinates in tertiary colors, which play such a prominent role in this book. Johannes Itten in his treatise on the art of color identifies the "poles of cold and warm" as blue green and red orange, and Augusto Garau has dealt with the problem in recent experiments derived form those he describes here; he, too, finds that the tertiary hues are crucial for the determination of color temperature.

Of more central importance for the painter's work is structural organization. This has always been obvious for the composition of shape, while much less attention has been paid theoretically to the corresponding problem of color. Organization creates order and, as Matisse has said, "to put the colors in order means to put order in the ideas." In his *Notes d'un peintre,* Matisse explains that when colors are combined in a painting they "diminish one another." He says that "the different marks [*signes*] I employ must be balanced in such a way that they do not destroy one another."

What, however, are the properties that make it possible for colors to interrelate and thereby to create order or disorder? Essentially, they are relations between hues, just as musical structure depends largely on the pitch relations between tones. And just as to understand tonal music one has to be aware of the structure of the scale, it is necessary to understand the system of color relations if the color composition of paintings is to make sense.

Before I refer to the color system on which Augusto Garau's investigation is based, it will be useful to anticipate certain misunderstandings that have often interfered with communication in this area. When it comes to the theory and practice of color relations, there is still a widespread lack of distinction between two problems. One of these problems concerns the question of how the colors we see come about physically or physiologically. The other asks how colors, once they have been produced in whatever manner and exposed to the eyes, behave phenomenally when they are viewed in their interrelation, for example, in pictorial composition. The first problem deals with the chemistry of pigment mixtures and the physical optics of color analysis and color combination. It also deals with the physiological mechanisms by which the eyes and the nervous system record and process light stimuli. It is an approach that studies receptor mechanisms, afterimages, contrast, color fusion, and so forth. The second problem has nothing to do with how colors come about. Whether produced by pigments or lights and whether these are mixed or unmixed, the resulting colors are taken as given and observed as to how they behave when they are organized in patterns. This problem concerns the painter and designer as composer, and it is this which is the subject of Garau's book.

Another related but more limited issue has created considerable controversy. It is the question of how many primary or fundamental colors there are, and specifically whether green should be added to the ranks of red, yellow, and blue. This debate has nothing to do with how many and which colors are

needed to generate the total range of colors. Nor are we asking by what physical or physiological means the color green comes about. The question is exclusively: Once I see green, what do I see—a pure color or a combination of two primaries, blue and yellow? In his influential book on the theory of the light sense, Ewald Hering asserted that green was a primary color. He had worked out a physiological theory of the reception of light stimuli based on the interaction of two pairs of antagonistic receptors, green versus red and blue versus yellow. This mechanism led him to propose by analogy that a similar system of four fundamental elements governs color perception. It is important to recognize that this is an entirely phenomenological matter. When Hering maintains that "no color is both yellowish and bluish at the same time," the statement is based on no other authority than what he says his eyes told him. A physiological mechanism of how colors come about does not prescribe the appearance of what is perceived. It is true that recent studies of the Italian psychologist Osvaldo da Pos have shown that under certain experimental conditions subjects report being unable to discern elements of blue and yellow in the color green. Weightier, however, is the historical fact that the assertion made by Hering and his followers is opposed by the majority of painters, who can be expected to know something about how colors look and who, from Philip Otto Runge and Delacroix to Paul Klee and Johannes Itten, have based their color systems on red, blue, and yellow as the pure primaries. Garau's book follows this well-established pictorial tradition.

For the exploration of principles it is useful to work with a system that contains neither too few nor too many colors. A circle of twelve hues, first proposed by Paul Klee and Johannes Itten, suffices to describe the phenomena discussed in this book (fig. 1). The system subdivides into the following three hierarchical levels:

1. The three primaries, red, blue, and yellow, which are pure hues and therefore unrelatable to one another, except by their adding up to a complementary triad. The realm of each primary reaches around half of the color circle.

2. The three secondaries, violet (BR), orange (RY), and green (YB), each of which consists of two of the primaries and therefore creates a bridge between them. The two components are balanced, in the sense that their pull toward the primaries is equally strong in both directions.

3. The tertiaries, each of which is located between a primary and a second-

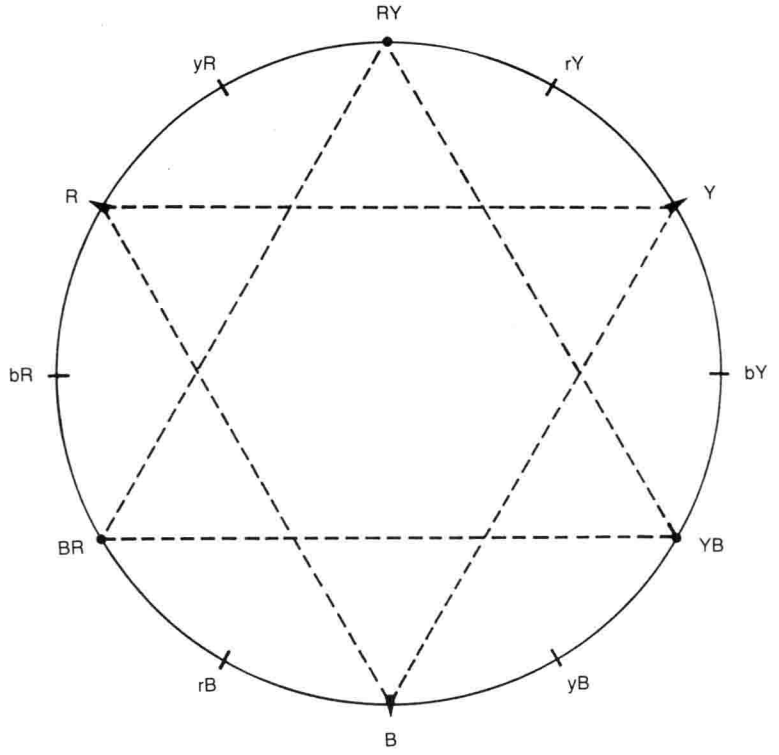

Figure 1. Circle of 12 hues, developed by Paul Klee and Johannes Itten.

ary color. An unequal ratio results between the two components, for example, bluish red or reddish yellow. Being thus unbalanced, tertiaries are highly dynamic, prone to interact with other colors and, for this reason, particularly inviting for pictorial composition. In some ways they resemble the "leading tones" in music. They are perceived as approaches to and deviations from their stronger component. Thus a reddish blue strains toward the stable base of the pure blue or, conversely, tries to liberate itself by pulling away from that base.

The structural organization of colors relies essentially on connections and segregations, just as a human or animal body is structured by its joints, tendons, and muscles. The simplest principle serving this purpose is that of similarity and dissimilarity. Viewers see connections between similarly colored areas of a painting, even when these are at a distance from one another, and they see dissimilar areas as detached, even when they border on each other.

A more complex structural relationship is created by complementarity. Perceptually, colors are complementary when, together, they contain all three pri-

maries in equal proportion. Thus the three primaries themselves form a complementary triad. In the color circle of figure 1, colors are arranged in such a way that all opposite pairs are complementaries. There are three pairs formed by a primary and a secondary, for example, blue (B) and orange (YR), and three formed by tertiaries, for example, bluish yellow (bY) and bluish red (bR). Complementarity makes for a curiously ambivalent relationship. Since the paired colors complete each other, they are attracted to each other by a kind of visual magnetism. On the other hand, however, they can also be mutually exclusive, as, for example, when a red is set against a green, in which case attraction is counteracted by detachment.

In an even subtler way, structural organization is based on the relative weight of the primaries in tertiary mixtures. This makes for connections and segregations, to which much of *Color Harmonies* is devoted. As a preparation fore Garau's own demonstration in plates 11–14 I offer figure 2, where white, shading, and black stand for the three primaries. The quantitative relationship between dominant and subordinate color in each tertiary mixture is given the arbitrary ratio of 2 : 1.

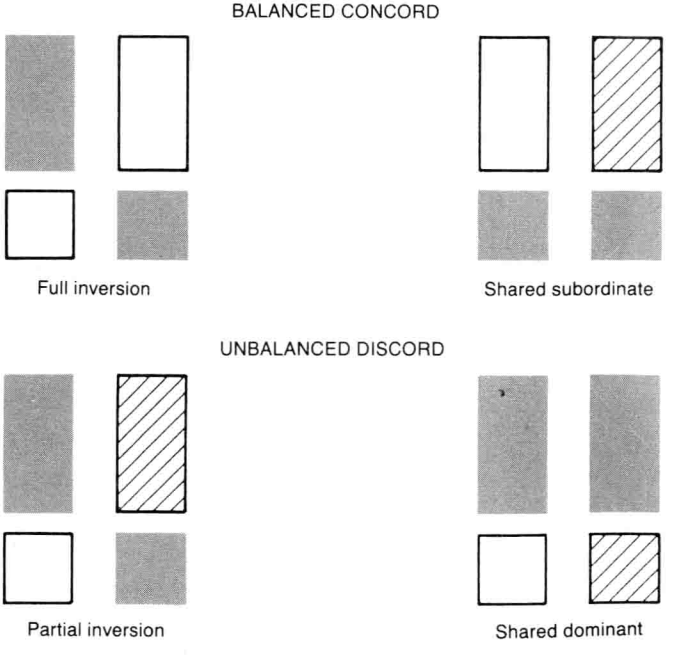

Figure 2. Structural organization based on relative weight of primaries in tertiary mixtures (ratio of dominant to subordinate in tertiary mixtures arbitrarily set at 2:1).

Full inversion can be obtained when only two primaries are involved. By combining them in inverse ratio—for instance, a bluish red (bR) and a reddish blue (rB)—the two tertiary colors are symmetrically related to the same secondary color, in this case violet (RB). This makes for two closely interrelated colors, which form a bridge between the two primaries, in this case red and blue. Structurally this relationship produces concord.

The relationship is less simple when all three primaries are at play. *Partial inversion* prevails when the share of one of the primaries is inverted and combined with the other two. This produces an asymmetrical combination, for example a yellowish red (yR) and a reddish blue (rB). The result is a distinctly discordant clash between two unbalanced tertiary combinations. A similar effect of detachment is obtained by a *shared dominant,* for example, by the combination of a yellowish red (yR) with a bluish red (bR). It is as though two neighbors were torn in different directions, causing considerable tension. In the opposite case, however, a *shared subordinate* makes for complementarity, already mentioned above. A bluish yellow (bY) and a bluish red (bR) add up to equal weights for all three primaries, covering the full range of the color system—the strongest bond available between colors.

The principles thus far discussed refer to color relations in the pictorial plane. Together with the structural relations between shapes, they enable the artist to articulate a composition. The simplest of these principles—the distinction between similarity and dissimilarity—was used by medieval painters to combine and separate elements of their compositions. At times they may consciously have resorted also to concord and discord for the same purpose. Garau uses a few examples of recent paintings to show how artists rely on the organization of color, just as they rely on shape, to translate intended meaning into visual form.

Perceptual segregation can also be applied in the third spatial dimension, that is, in pictorial depth. This involves the spatial features of overlapping and transparency. Gestalt psychologists showed many years ago that perceptual transparency occurs when the tendency toward simplest structure causes a pattern of shapes to be seen as a combination of elements overlapping in depth rather than bordering contiguously on each other (pls. 43, 44). The resulting superposition of shapes forces the shared area to split up into two planes, one of which is perceived as lying in front of the other. When the planes are in black and shades of gray, the brightness value of the shared area should equal

the arithmetic means of the luminosities in the contributing areas. The conditions to be met when patterns are in color are more complex. Here Garau has done pioneering work by applying the principles of structural concord and discord to the conditions producing transparency.

I have tried to set the stage for Augusto Garau's report on his ingenious experiments. If I may be permitted to add a personal comment, I would like to say how delighted I was to learn that the author, who combines experience as an artist, designer, and art educator with the ability to conduct systematic research, was willing to test experimentally some of the principles I had developed earlier from mere intuition. In an area of the psychology of art where reliable guidance is still so hard to come by, these well-supported contributions to the theory of color composition ought to be welcomed by practitioners and scholars alike.

RUDOLF ARNHEIM

PRELIMINARY NOTE

In this book, figures, plates, and text often refer to colors and color mixtures by means of a simplified notation, as follows:

Y = yellow	O = orange (YR)
R = red	G = green (BY)
B = blue	V = violet (RB)

For the tertiary mixtures, uppercase letters refer to dominant colors, and lowercase letters indicate subordinate colors.

bY = bluish yellow	rY = reddish yellow	yB = yellowish blue
bR = bluish red	yR = yellowish red	rB = reddish blue

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CONTENTS

INTRODUCTION

A Theory of Color Mixtures

THE EXPERIMENTS PRESENTED in this work investigate problems I have encountered during my activity as a painter. The starting point for the experiments was found in some hypotheses and conclusions presented by Rudolf Arnheim when he examined classical theories of color from the viewpoint of their use in painting.

THE SEARCH FOR HARMONY

"How are colors related to one another? Most theorists have dealt with this question as though it meant: Which colors go together harmoniously? They have tried to determine the assortments of colors in which all items blend readily and pleasantly" (Arnheim 1954).

Most color systems have been elaborated along three dimensions, because three are the perceptual dimensions of color. Some of these systems are the pyramid of Lambert, the double cone of Ostwald (1922), and the sphere of Philipp Otto Runge (1810) later adopted by Itten (1965). In the last of these, colors, maximally saturated at the equator of the sphere, are gradually desaturated along horizontal axes, are lightened going upward, and are darkened going downward. This arrangement makes it possible to connect colors in harmonic progressions of triangles and diameters. At the vertexes of the triangles and along the diameters, colors are graduated in hue, brightness, and saturation.

Arnheim observed that harmony is essential, because all colors in a composition must be mutually compatible and must form a unified whole, if they are to be put in relation to one another. Probably, said Arnheim, in most cases colors employed by artists do not agree with rules as simple as those put forward by systems of chromatic harmony.

MUSICAL COMPOSITION

Comparing painting with musical composition, Arnheim turned to Schönberg and his doctrine of music. Describing the subject matter of musical composition, Schönberg (1963) divided it into three areas: harmony, counterpoint, and the theory of form. *Harmony* is the doctrine of the chords and their possible connections with regard to their tectonic, melodic, and rhythmic values, and their relative weights. *Counterpoint* is the doctrine of the movement of voices with regard to motivic combination. The *theory of form* deals with the rules for constructing and developing musical thoughts.

"In other words," said Arnheim, "musical theory is not concerned with which sounds go together nicely, but with the problem of giving adequate shape to an intended content. The need for everything to add up to a unified whole is only one aspect of this problem, and it is not satisfied in music by drawing the composition from an assortment of elements that blend smoothly in any combination" (Arnheim 1954, p. 349).

Turning again to pictorial composition, Arnheim observed that compositions need as many separations as they need connections, for if there are no separated parts there is nothing to connect. He noted that Schönberg knew that "the musical scale can serve as the composer's palette precisely because its tones do not all fit together in easy consonance but also provide discords of various degrees" (Arnheim, 1954, p. 350). Arnheim concluded that the traditional theory of color harmony provides only a method for creating connections and avoiding separations. Thus, the traditional theory is at best incomplete.

UNBALANCED MIXTURES (TERTIARY HUES)

Concerning pictorial composition, traditional theories of color focus on the three fundamental primaries, yellow, blue, and red; on their balanced mixtures, green, violet, and orange; and on three pairs of tertiary complementaries, reddish yellow and reddish blue, yellowish red and yellowish blue, bluish yellow and bluish red. When achieved by means of complementaries (as when mixing a primary and a secondary, or two tertiaries), chromatic interactions satisfy a need of the human organism, because our vision needs the presence of the three fundamental primaries either pure or mixed.

These three primaries are completely autonomous, for each shares no chromatic similarity with the other two. Thus, interactions among primaries are only possible by means of the bridging function of secondaries. At the same time, the equal, or balanced, mixture of two primaries sets up a relationship of contrast and of connection with the third color. This relationship binds the three colors dynamically, accomplishing a chromatic completion. "Since the eye spontaneously seeks out and links complementary colors, they are often used to establish connections within a painting between areas that lie at some distance from one another" (Arnheim 1954, p. 360).

Chromatic completions can be obtained by arranging the three pure colors in different areas of the visual field. In some cases, these completions will sat-

isfy the painter. In his last period, Mondrian used only the three primaries in his compositions, arranging them sparsely, and surrounding them with achromatic areas: white, grays, blacks. His choice was meaningful. Starting from the most elementary degree of its use, he strove to treat color as an essential building element of painting. According to Arnheim, the crucial function of color as building element is precisely the weakness of classical theory. If the problem of composition is to establish separations as well as connections, then a theory of color cannot limit itself to chromatic completions and consonances. To develop a theory of color, we also need to ask how to establish negative relationships, capable of articulating the visual field by divisions as well as conjunctions.

Thus, articulation requires tensions of two kinds: diverging and connecting. Both kinds of tension originate from a lack of balance. Both can be used to convey unity to the composition. Arnheim suggested that the capacity of activating tensions is to be found in the tertiary hues, which are unbalanced mixtures of primaries that are present in different quantities.

This peculiar relationship between tertiaries must be distinguished from the interaction of complementary colors that occurs when primaries and secondaries are coupled. The tensions that arise from maximal contrast and from the strong demand for a chromatic completion join complementary colors. Thus, two or three complementaries are quickly united, even if they are in different areas of the field (recall the example of Mondrian). The tensions that arise between pairs of tertiaries, however, are of a different kind. They unfold only when the members of the pair are juxtaposed. Recall that pairs of tertiaries are, for the most part, noncomplementary. This generates univocal, less dialectical relationships than those between pairs of complementaries, for here attraction and contrast no longer coexist. Only one or the other is active.

Still another kind of interaction takes place when one juxtaposes tertiaries containing complementary colors. In this case, the dynamics of attraction and contrast add to the tension between the two asymmetric hues, enriching the relationship. In this way, one can also activate a relationship between a tertiary mixture and a pure color that is contained in it (as with red [R] and reddish yellow [rY]), producing a relationship that is different in kind from that between a primary and a secondary color containing it (as with red [R] and orange [RY]). By the same token, it is different to juxtapose pure red (R) with a mixture that contains it as a subordinate (think of reddish yellow [rY]), or as a dominant (such as yellowish red [yR]). In the latter case, the tension in the