COLOR

Text abridged and adapted from *Art and Visual Perception* by Rudolph Arnheim (1974)

Color names and culture

No one will ever be sure that another person sees a particular color exactly the same way they do. When observers are asked to point out certain colors in the spectrum[1] the results vary somewhat. This is because the spectrum is a sliding scale, a continuum of gradations, and also because people mean different colors by different color names. Color names are somewhat indeterminate and depend not only on individuals but also on cultures.

A particular culture may distinguish the colors of plants from those of the soil or water, but may not have any other subdivision of hues (basically, a more technical word for colors). This classification will be reflected in the vocabulary. Some agricultural people may have many words to describe subtle differences in the colors of cattle, but none to distinguish blue from green. Certain occupations need refined color distinctions and a correspondingly sophisticated vocabulary. Others need none at all.

The most interesting difference in the conceptualization of color relates to cultural development. The basic color names, relatively few in number, are common to all languages, but they cover different ranges of hues and not all languages possess all these names. However, color names do not occur in arbitrary selection. The most elementary nomenclature distinguishes only between darkness and lightness, and all colors are classified according to this simple dichotomy. When a language contains a third color name, it is always red. This new category absorbs the reds and oranges and most yellows, pinks, and purples, including violet. The remainder is divided between darkness and lightness (black and white).

These data were gathered from twenty languages. So darkness and brightness[2] at first cover the whole spectrum of colors but eventually designate only the blacks, whites, and grays. But why should red always be the first to modify the dark-light dichotomy? Is it the most conspicuous or the most practically relevant hue? Why should the next addition always be green or yellow? When languages have six color names, they are dark, bright, red, green, yellow, and blue. Further differentiation completes the set of basic colors with brown, purple, pink, orange, and gray.

These findings support the observations of earlier writers, who discovered on the basis of such literature as the poems of Homer and of anthropological reports, that some civilizations seemed to lack certain color names. Red was well represented, but there was a deficiency of greens and blues.

Shape and color

Strictly speaking, all visual appearance owes its existence to brightness and color. The boundaries determining the shape of objects derive from the distinction between areas of

[1] From the lowest energy, frequency, vibration and the longest wavelength to the highest energy, frequency and vibration and the shortest wavelength, the light colors of the spectrum are red, orange, yellow, green, blue, indigo, and violet. Green comes in the middle of all the ranges.

[2] As can be seen, Arnheim doesn't use the word "brightness" (or the adjective "bright") to mean brilliance (or brilliant), but as a synonym of lightness (or light). In technical art vocabulary, the measurement of lightness and darkness in color or tone is called "value."

different brightness and color. This is true even for the lines that define shape in drawings; they are visible only when the ink differs in color from the paper. Nevertheless, we can speak of shape and color as separate phenomena. A green disk on a yellow ground is just as circular as a red disk on a blue ground, and a black triangle is as black as a black square.

Shape lets us distinguish an almost infinite number of different individual objects. This is especially true for the thousands of human faces we can identify with considerable certainty on the basis of minute differences in shape. But the number of colors we can recognize reliably and with ease hardly exceeds six: the three primaries (red-blue-yellow) plus the secondaries (green-orange-violet or purple) connecting them, even though the standard color systems contain several hundreds of hues. We are quite sensitive in distinguishing subtly different shades from one another, but when it comes to identifying a particular color by memory or at some spatial distance from another, our power of discrimination is severely limited.

By itself, shape is a better means of identification than color not only because it offers many more kinds of qualitative difference, but also because the distinctive characteristics of shape are much more resistant to environmental variations. Shape is almost entirely unaffected by changes of brightness or color in the environment, whereas the local color of objects is most vulnerable in this respect.

Under strong illumination the reds look particularly bright. Dim light will bring the greens and blues to the fore but also make them appear more whitish. For all these reasons, an artist's colors are very much at the mercy of the prevailing illumination, whereas her shapes are little affected by it. For instance, the color scheme of medieval murals is entirely altered when the original windows are replace with modern colorless glass. The church windows of the early Middle Ages had a greenish or yellowish tinge and were translucent but not transparent. Needless to say, the stained glass of later centuries influenced illumination spectacularly, and not only mural painting but also book illustrations (medieval illuminations) were adapted to the prevailing light conditions.

When a painting by Monet or Van Gogh done at strong daylight is seen under the color of electric lamps, we cannot pretend to perceive the hues intended by the artist; and as the colors change, so does their expression and organization. Artists of our time who assert that their pictures, produced under electric light, can be viewed in daylight without loss imply that color qualities and color relations matter to their work in the crudest, most general sense.

We conclude that for practical purposes shapes are a more reliable means of identification and orientation than color, unless color discrimination is limited to the fundamental primaries.

It has been said that color produces an essentially emotional experience, whereas shape corresponds to intellectual control. Such a formulation seems too narrow, particularly with reference to art. Instead of speaking of color responses and shape responses, we may more appropriately distinguish between a **receptive attitude** to visual stimuli, which is encouraged by color but also applies to shape, and a more **active attitude**, which is prevalent in the perception of shape but also applies to color composition.

It is tempting to explore these correlations between perceptual behavior and personality structure in the arts. The first receptive attitude might be called a romantic one; the second active attitude, classicist. In painting, we might think, for example, of the approaches of Delacroix, who not only bases his compositions on striking color schemes but also stresses the expressive qualities of shape, as against Jacques Louis David, who conceives mainly in terms of shape, employed for the relatively static definition of objects, and subdues and schematizes color.

Color and context

Remarkably little has been written about color as a means of pictorial organization. There are descriptions of the palette used by particular painters; there are critical judgments praising or condemning an artist's use of color. But on the whole, a large part of what has been written about painting has been written almost as if paintings were works in black and white.

Moreover, the reproductions cannot be trusted. Anyone working with color slides knows that no two slides of the same object look alike and that the differences are often far from subtle, and the color reproductions in art books and magazines vary from excellent to miserable. Most of the time the viewer cannot judge how much of a truth or a lie a reproduction is.

Apart from this, the originals themselves let us down. Most masterpieces of painting can be seen only through the layers of darkened varnish, which has absorbed the dirt of the ages. No one has seen the Titians and Rembrandts for centuries, and the cleaning and restoring of paintings lead to notoriously unreliable results. What is more, pigments are known to change chemically. By the time one has seen aggressive blues play havoc with the compositions of a Bellini or Raphael, or has seen a Harunobu print or Cézanne watercolor bleached beyond recognition by sunlight, one realizes that our knowledge of the pictures we possess is based to a considerable extent on hearsay and imagination.

It has been mentioned how thoroughly color is modified by illumination. Such modifications are not mere transpositions: light of a given color will affect different colors in a picture differently. Even more fundamental is the constant perpetual interaction among colors by **contrast** or **assimilation**. Place a triangle next to a rectangle, and you will find that they remain what they are, although the shapes influence each other somewhat. But a blue color placed next to a strong red veers toward the green, and two paintings hanging side by side on a wall may profoundly modify each other's colors.

A green hue that looked conservatively restrained in the sample booklet at the paint shop will overwhelm you when it covers the walls. A color seen in the context of its neighbors will change when placed in a different environment. In no reliable sense can we speak of a color "as it really is"; it is always determined by its context.

A white background is by no means a zero background but has strong idiosyncrasies of its own. In European paintings of the sixteenth to eighteenth centuries, the light is more important than the color, and therefore, they are badly served by being displayed on white or very bright walls. Such mistreatment occurs at museums, such as the Louvre, the Uffizi, the National Gallery in London, and the Hamburg Kunsthalle under the influence of modern painting, which stresses color rather than light —an effect enhanced by light-colored walls.

To all these uncertainties we must add the problems of perceptual and verbal identification. When observers are presented with a continuum of the rainbow colors, e.g. with a light spectrum, they do not agree on where the principal colors appear at their purest. This is true even for the fundamental primaries, especially for pure red. Accordingly, any color name refers to a range of possible hues, so that verbal communication in the absence of direct perception is quite imprecise.

It will be evident why the discussion of color problems has so many obstacles and why so little useful discussion, therefore, takes place. However, these facts should not be taken to mean that what we see when we look at a painting is elusive, accidental, or arbitrary. On the contrary, in any successfully organized composition, the hue, place, and size of every color area as well as its brightness and saturation are established in such a way that all the colors together stabilize one another in a balanced whole. Ambiguities resulting from relations between parts compensate one another in the total context, and the complete work, when adequately observed, represents an objectively defined statement.

Individual colors resist abstract generalization. They are tied to their particular place and time. But within any given order they behave lawfully and obey structural rules, which we sense intuitively, but about which we so far know much too little.

The quest 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 configuration of colors in which all items blend readily and pleasantly. Their prescriptions were derived from the attempts to classify all color values in a standardized, objective system. The earliest of these systems were two-dimensional, depicting the sequence and some interrelations of hues by a circle or polygon. Later, when it was realized that color is determined by at least three dimensions —hue, brightness, and saturation— three-dimensional models were introduced.

These systems are supposed to serve two purposes: to allow an objective identification of any color, and to indicate which colors harmonize with one another. Harmony is indeed necessary, in the broad sense that all the colors of a composition must fit together in a unified whole if they are to be relatable to one another. It may also be true that all the colors used in a successful painting or by a good painter keep within certain limits, which exclude some hues, brightness values, or saturation levels. What is much less probable is that the colors used by artists will in many cases be found to fit any such simple rules as those suggested by the systems of color harmony.

The interrelation of colors is strongly modified by other pictorial factors. Taking, for instance, the influence of size, it was suggested that large surfaces should have subdued colors, whereas highly saturated colors should be used only in small patches. But it seems that even this factor of size would so complicate the proposed rules of harmony as to render them practically useless —and there are many other relevant factors, which cannot be controlled by quantitative measurement as comfortably as size.

There are, however, more fundamental objections to the principle on which the rules of color harmony are based. This principle conceives of a color composition as a whole in which everything fits with everything else. All local relations between neighbors show the same pleasant conformity. A color composition based on nothing but such a common denominator could describe only a world of absolute peace, devoid of action, and static in mood.

What is more, harmony depends on the taste of the period. Effects forbidden in the past are welcome today. Sometimes such rules are outmoded even as they are established. For example, in a 1919 comment on the rule which states that saturated colors should be presented only in small bits, a critic asserted that large-sized surfaces of pure vermilion, as found in Pompeii, are crude. In reading this today, we may recall a painting by Matisse in which nearly three square meters of canvas are covered almost completely and quite satisfactorily with a strong red, and we note that the painting was done in 1911.

Fresco from Vila dei Misteri, Pompeii.

Henri Matisse: *The Red Studio* (1911).

Furthermore, it goes without saying that separations are as essential to composition as connection. When there

are no segregated parts there is nothing to connect, and the result is an amorphous mass. The traditional theory of color harmony deals only with obtaining connections and avoiding separations, and is therefore at best incomplete.

The elements of the scale

How much do we know about the syntax of color —that is, about the perceptual properties that make organized patterns of color possible? First of all, what are the elementary units of color composition, and how many of them are there? The raw material comes in continuously gliding scales. The scale of hues is best known from the spectrum of sunlight. Brightness and saturation also produce scales, which lead from the lowest to the highest degrees of these properties. The maximum number of shades of gray the average observer can distinguish on the scale between black and white is about 200. It is worth noticing that the number of hues distinguishable in a spectrum of pure colors between the two extremes of violet and purplish red is apparently somewhat smaller, about 160.

If we examine the raw material of color gradations, for example, in a spectrum, we observe that even though the sequence leads seamlessly from one hue to the next, certain colors are distinguished by their purity. The word “purity” implies two qualities, which need to be kept distinct: (1) an orange or a green looks pure when it is only itself, e.g., without an admixture that would make us speak of a reddish orange or a yellowish green; (2) a blue or yellow or red is pure because it is an irreducible element, i.e., it does not look like a mixture in the sense in which green looks like a combination of blue and yellow or purple like one of red and blue.

The three indivisible, pure colors —blue, yellow, red— are the *fundamental primaries*. The secondaries and other mixtures of the primaries derive their character from being perceived as hybrids. They have a vibrating duality, straining toward the stronger of their two poles or trying, by constant dynamic interplay, to maintain the balance between their two parent hues. In a pictorial composition based on the secondary triad of orange, purple, and green, there is unceasing interaction among the three. Each color has a primary in common with each of the other two, so that each of them is pulled in two different directions. For example, the orange is pulled toward the yellow in the green and toward the red in the purple. Because of this common element, each paring overlaps the other, and they can be said to slide into each other. At the same time, however, both neighbors of orange contain the third fundamental primary, namely blue, from which orange is excluded but toward which it moves for complementary completion. Hence the highly dynamic pattern of attractions and repulsions in such a scheme.

When the pure primaries act as subordinate elements in a composition based on the three secondaries, they supply the framework for the various combinations and also increase the tension by showing the foundation from which the mixtures deviate. When, on the contrary, the three primaries constitute the dominant theme, a classicist stability is obtained, as favored for instance by Poussin. In this case, the secondaries in a subordinate position help to animate the static structure of the theme.

Syntax of combinations

More specifically, this section will refer to the difference between mixtures that keep the fundamental primaries in balance and those in which one of the fundamental primary dominates. If for the sake of simplicity we exclude the additional hues resulting from combinations with black or white —such as the shades of brown— we obtain a system of nine principal mixtures:

Fundamental Primaries	Nine Principal Mixtures			Fundamental Primaries
	Tertiary Colors	Fundamental Secondaries = Balance of Primaries	Tertiary Colors	
Blue	violet	blue + red	purple	Red
Red	yellow red	orange	red yellow	Yellow
Yellow	green yellow	green	green blue	Blue

These mixtures can serve as stages of transition between the fundamental primaries. Compared with the first and third columns of mixtures, the balanced mixtures in the center column are fairly stable and self-contained. The other six mixtures, in which one fundamental primary dominates the other, have the dynamic properties of "leading tones," so in the red-yellow scale a red yellow presses toward yellow, and a yellow red toward red.

We have observed that mixtures connect because of their common elements but may repel each other at the same time. Here we must consider the rule of the constituents in each mixture. Let us speculate about the combinations in the table above.

Similarity of the subordinate

Think of the juxtaposition of a reddish yellow and a reddish blue. This pair seems to combine smoothly because the red holds the same structural position in both colors; it is subordinate. The correspondence of structural similarity lets the red establish a bridge between yellow and blue.

Structural contradiction in one common element

Think of the juxtaposition of a reddish yellow and a bluish red. This pair seems to produce mutual repulsion because the structural positions are reversed; red is subordinate in one color, dominant in the other. Apparently this structural contradiction often produces a conflict or clash and therefore mutual repulsion.

Similarity of the dominant

We may place a yellow red in relation to a blue red (purple, in the table). This time the two mixtures lie close to that pole, that it, they share the dominant. One color is torn into two different scales, i.e. red into the red-yellow scale and the red-blue scale. The effect seems to produce some mutual repulsion.

The difference between "Similarity of the subordinate" and "Similarity of the dominant" is that the former produces two essentially different colors related by the same admixture, and the latter produces two essentially identical colors distinguished by different admixtures.

Structural inversion

This takes place when two elements exchange positions, that is, when the color that serves as subordinate in one mixture is the dominant of the other and vice versa. For instance, we combine a red blue (violet, in the table) and a blue red (purple, in the table).

At first glance one might expect that the double contradiction will lead here to a doubly strong repulsion. It should be observed, however, that in "Structural contradiction in one common element," the two mixtures lie in two different scales, whereas here they lie in the same scale. This may lead to a harmonious relationship.

Fundamental primary as dominant

For example, when one combines yellow and blue yellow. The two colors lie on the same scale and they are essentially alike. One hue dominates the pair. But when two such colors are

coordinated, some disturbance arises from the fact that one of them is a pure fundamental primary, whereas the other has an admixture of another color. They are asymmetrical.

Fundamental primary as subordinate

For example, when yellow is combined with a yellow blue. In this pair the pure fundamental primary reappears as the subordinate in the mixture, which produces structural contradiction in addition to asymmetry. So there is even greater cause for a clash than in the case of the "Fundamental primary a dominant."

Conclusion

The effect of clash or mutual repulsion is not "bad," or forbidden. On the contrary, it is a precious tool for the artist who wishes to make an articulate statement in color. It can help in detaching the foreground from the background or the leaves of a tree from its trunk and branches, or keep the eye from traveling a compositional undesirable road. However, the discord must fit the overall structure of the work as established by the other perceptual factors and the subject matter. If a discord occurs where a connection is required, or if the juxtaposition seems arbitrary, the result is confusion.

The fundamental complementaries

When certain pairs or triplets or larger groups of hues are presented, we may notice the effect of mutual completion. Any number of such combinations can produce the same effect, but all of them can be ultimately reduced to one, namely the triplet of red, yellow, and blue.

These fundamental primaries behave like the three legs of a stool. All three are needed to create complete support and balance. When only two of them are given they demand the third. The tension aroused by incompleteness of the triplet subsides as soon as the gap is filled.

This encourages us even now to generalize and to conclude that there is something incomplete about any particular color whatever. Such incompleteness can be said to upset the equilibrium of the visual field as soon as a color appears by itself. The unique character of that color, its coldness or warmth, its protruding or remote character, affects us one-sidedly and points by its mere presence to the existence of a counterpart, which could re-establish balance in our visual experience.

Among all the groups of colors producing completeness the three fundamental primaries are unique. They are the only set of complementaries in which all constituents are pure hues and therefore totally exclude the other two. There is nothing yellow in the pure blue, nothing blue in the pure red, and so forth. At the same time the three colors require one another. This particular structural combination of mutual exclusion and attraction is the basis of all color organization.

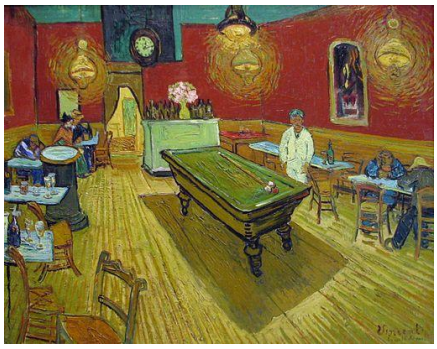
We see this color structure evolve from its base of fundamental primaries when we find that at the next higher level of organization, it groups each two primaries (a secondary) against the third primary. This produces a symmetrical system of three intertwining pairs of complementaries. Each pair consists of a pure hue and the balanced mixture of the other two: blue and orange, yellow and purple (or violet —whichever word one prefers for describing a balanced red-blue), blue and orange. This amounts to a two-level hierarchy, consisting of the three primary pure hues and three secondary balanced mixtures.

Goethe describes the interrelations of these six hues in his *Theory of Color*: "Single colors affect us, as it were, pathologically, carrying us away to particular sentiments. Vividly striving or softly longing, we feel elevated toward nobility or lowered toward the ordinary. However, the need for totality inherent in our organ guides us beyond this limitation. It sets itself free by producing opposites of the particulars forced upon it and thus brings about a satisfying completeness."

This is the painter's system of the three basic complementary pairs. When we listen to artists describing their use of complementaries, we notice that there are two apparently quite contradictory applications, as we can see in the following example.

Van Gogh's example

On the one hand, complementary pairs depict the peaceful unity of opposites. Thus Van Gogh thought of expressing the moods of the four seasons through four pairs: red and green (the apple blossoms and young corn of spring), blue and orange (the summer sky and the golden bronze of the ripe grain), yellow and violet (the autumn leaves), and the black and white of winter. He also wrote in 1888 that the affection of two lovers could be depicted by "the marriage of two complementary colors, their mixture, their mutual completion, and the mysterious vibration of the affined tones."



Vincent Van Gogh: *The Night Café* (1888).

Eugène Delacroix: *Christ on the Lake of Gennezaret* (1854).

But the same Van Gogh said that in his *Night Café* he tried to express the terrible passion of men by means of red and green. He was probably influenced by Delacroix who frequently used the contrast of red and green as a symbol of violence and terror. In fact, Van Gogh describes Delacroix's *Christ on the Lake of Gennezaret* as follows: "Christ with his halo of pale lemon yellow, asleep, luminous in a setting of dramatic violet, somber blue, and blood-red, formed by the groups of frightened disciples, on the terrifying emerald sea, which rises, rises all the way up to the frame."

Conclusion

The contradiction between two such different applications of the same device will seem less puzzling if we remember that the completion attained by complementarity involves not only maximum contrast but also mutual neutralization. Contrast is most evident when large areas of the colors are confronted with each other. When the same colors are combined in many small doses, as for example in the brushstrokes of divisionist paintings, or when viewed from a distance, they combine by addition to a silvery gray. The variety of vital forces, displayed in many gentle steps, produces richness rather than contrast.

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. However, a strong complementary duo or triad tends to be so self-contained and self-sufficient that it not only helps to hold the picture together but also poses a compositional problem. Like a perfect circular shape, which does not fit easily into a context and therefore is often given a central or frankly isolated position, the complementary pattern subordinates itself only with difficulty to a larger color scheme. It functions best as a relatively independent sub-whole, or as a central core or theme around which further color values are arranged.

Interaction of color

The section "Color and context" has already touched the perplexing instability of colors. They are the most impressive demonstration of the fact that the same part in two different wholes is not the same thing. The same color in two different contexts is not the same color.

This means that the identity of a color does not reside in the color itself but is established by relation. We are aware of this mutual transfiguration, which makes every color dependent on the support of all the others, just as the stones of an arch hold one another in place. But whereas the stones counterbalance one another's weight physically, the web of interacting colors is created only by the eye, and this subjectivity —quite different from the strong objectivity of shapes— gives them the quality of apparitions.

The most prominent among the phenomena of interaction is, of course, *color contrast*. The effect of color contrast operates in the direction of physiological complementarity. For example, when a greenish yellow and a reddish yellow are inspected separately, they look like pure yellows, but when they are brought together they tend to emphasize their distinction, looking clearly greenish and reddish. But if a third yellow of intermediate hue is placed between the two, the contrast diminishes and the total arrangement shows a more unified yellow. Such effects of *assimilation* are also observed when, for example, one strongly red patch in a painting brings out subtly red components in the colors around it.

Much attention has been paid to color contrast. It has been superbly demonstrated in Josef Albers's book *Interaction of Color*. The countereffect assimilation is rather neglected, although the antagonism of the two perceptual mechanisms makes it imperative that the one should not be considered without the other. Since perceptual patterns tend toward the most clear-cut organization available, a configuration of colors will move either toward contrast or toward assimilation.

Assimilation is closely related to the combination of colors. When the hues bordering on each other are sufficiently similar or when the areas carrying the hues are sufficiently small, the colors will approach each other rather than emphasize contrast. When the stimulus areas are small, e.g., when they form a fine-grained dot pattern, as would reach the eye from a divisionist painting, there will be no resolution and the result will be a true mixture. When the units are somewhat larger, however, assimilation may result.

Color analysis of Matisse's *Luxury*

Matisse's painting *Luxury* shows three women in a landscape. Two of the figures are in the near foreground, the third is farther back. A slight overlap connects the frontal figures and also defines their spatial relation. The third is smaller; but in order to play down the difference in depth, overlapping is deliberately avoided for this figure. Their identical coloring also tends to place all three women in the same plane.

Henri Matisse: *Le Luxe II* (1907-1908).

The environment is divided into three main areas: the orange foreground with the white drapery, the green water in the center, and the background with its slightly violet sky, white cloud, and two mountains, one bluish red, the other orange. There is, then, a kind of color symmetry between top and bottom. The white garment in the nearest foreground corresponds to the white cloud in the farthest background; the orange appears in both areas, and so does the yellow of the nude bodies.

The approximate center of this symmetry is indicated by the bouquet of flowers. We cannot help feeling that the small woman is expending all her surprising energy and concentration in

holding the pivot of the picture in her hands. The bouquet is small, but it attracts attention because its shape has the simplicity of a circle, outlined in a pure dark blue that is unique in the painting. The bouquet parallels the navel of the tall figure, thus making it clear that the center of that figure helps to establish the symmetry axis of the total composition.

The symmetry serves to counteract the depth of the landscape created by the superpositions of shape. The two whites, at the extremes of the total range of space, tend to lie in the same plane and thus to compress the three-dimensional expanse. The orange areas do the same. The three yellow figures overlap the entire landscape and lie in front of it. But they are brought back into the spatial context by the distribution of the brightness values. The two white areas, being the brightest spots in the picture, protrude most strongly —that is, they move the somewhat darker human figures back to a place inside the distance scale, enclosing them between the brightest and darkest tones.

Except for the whites and the small spots of black and blue, there are no pure primaries in the picture. The yellow of the bodies is warmed by a reddish tinge. Yellow, established as the dominant color of the composition by the three figures, is also contained in the orange and the green, but is probably absent from the sky and the bluish-red mountain. Thus in the upper left corner the common color element is limited to red, which, however, is weak in the sky and quiet faint in the figure. Essentially the colors in that area are distinct to the point of being mutually exclusive.

Just as yellow is excluded from the upper corner of the background landscape, so blue, most clearly expressed in the sky and contained in the bluish-red mountain and the green water, is absent from the lower part of the picture. The two colors meet in balanced proportion in the central green. The only clash of hues seems to occur between the yellow red of the mountain and the blue red next to it (“Similarity of the dominant”). Is this conflict justified by its function in the total composition or is it an unresolved problem?

The only example of an approximate exclusive distinction occurs between the sky and the yellow face and shoulders. Here is also the greatest depth interval. The figures are most intimately connected with the landscape at the bottom of the picture, where yellow and, to a slight extent, red are shared. The hair of the kneeling figure even picks up the orange.

In the middle ground there is greater distinction. The bodies and the water contain yellow as one common fundamental primary, but the reddish admixture of the skin and the blue contained in the green emphasize mutual exclusion. The black hair of the small figure and the colors of the bouquet add to the feeling of detachment. The crescendo of separation reaches its climax in the upper left corner. The spatial leap between the head and shoulders and the sky is compensated, however, by an approximate complementarity between the reddish yellow of the human skin and the violet blue of the sky. The colors produce a strong gap and at the same time bridge it by the harmony of their mutual completion.

Reactions to color

Nobody denies that colors carry strong expression, but nobody knows how such expression comes about. To be sure, expression is widely believed to be based on association. Red is said to be exciting because it reminds us of fire, blood, and revolution. Green recalls the refreshing idea of nature and blue is cooling like water. But the theory of association is no more illuminating here than it is in other areas. The effect of color is much too direct and spontaneous to be only the product of an interpretation based on experience.

On the other hand, we do not even have a hypothesis to offer about the kind of physiological process that might account for the influence of color. Strong brightness, high saturation, and

the hues of long-wave vibration[3] produce excitement. A bright, pure red is more active than a subdued, grayish blue. But we have no information on what intense light energy does to the nervous system or why the wavelength of vibrations should matter.

Nevertheless, this physical reaction is paralleled by Kandinsky's remarks on the appearance of colors. He asserted that a yellow circle will reveal "a spreading movement outwards from the center which almost markedly approaches the spectator"; a blue circle "develops a concentric movement (like a snail hiding in its shell) and moves away from the spectator."

Warm and cold

Hardly any attempt has been made to group the various colors in terms of their general expressive qualities, but the distinction between warm and cold colors is fairly common. Artists use these terms, and references to them are found in books on the theory of color. However, sketchy remarks based on subjective impressions do not get us very far. Nevertheless, under these conditions it may be permissible to put forward a suggestion. It has not been tested systematically and may turn out to be quite wrong; but at least it is something to shoot at.

The pure fundamental primaries can hardly be called either warm or cold. Is a pure red clearly more warm than a pure blue of equal saturation? Is a pure yellow cold or warm? But temperature quality seems to be more meaningful when applied to the admixture of a color. A bluish yellow or red tends to look cold, and so does a yellowish red or blue. On the contrary, a reddish yellow or blue seems warm. This suggestion is that not the main color but the color toward which it deviates may determine the effect. This would lead to the perhaps unexpected result that a reddish blue looks warm whereas a bluish red looks cold.

Johannes Itten has designated the complementary pair of red orange and blue green as temperature poles. This would support our observation that an admixture of red will warm the color whereas a tinge of blue will chill it. Mixtures of two evenly balanced colors should not show the effect clearly, although a blend of yellow and blue might be closest to coldness. Balanced combinations of red and blue or red and yellow might tend to be neutral or ambiguous.

Naturally, the instability of colors will influence their temperature. As a color changes its hue in response to the hues of its neighbors, its temperature may change as well. Brightness and saturation may also have influence on the phenomenon. In Albers's color circle the aspects of cold and warm coincide roughly with those of dark and bright, and Itten associates cold with shady, warm with sunny.

If this approach is viable it may apply more generally to the expressive qualities of colors. Perhaps it is not so much the dominant hue, but its admixtures that give a color its character. We noted that the pure fundamental primaries lack the dynamic qualities of mixtures; they may also be more neutral in expression whereas a color producing a dynamic tension effect by leaning toward another color may be more expressive. Reddishness, yellowishness, bluishness, by drawing another color away from its own fundamental character, may produce the tension without which no expression is possible. Here, then, are suggestions that invite verification.

Finally, let us puzzle for a moment over the habit of using temperature sensations to describe colors. What is the common denominator? We are hardly reminded of a hot bath or summer heat when we perceive the dark red of a rose. Rather the color brings about a reaction also provoked by heat stimulation, and the words "warm" and "cold" are used to describe colors

[3] Red light has the lowest energy, frequency, vibration and the longest wavelength of all the visible light. Violet light has the highest energy, frequency and vibration and the shortest wavelength of visible light (see Footnote 1).

simply because the expressive quality in question is stronger and biologically most vital in the concept of temperature.

We are describing a quality emanating from the object as well as our reaction to that quality. The experience need not be perceptual. We also speak of a cold person, a warm reception, and a heated debate. A cold person makes us withdraw. We feel like defending ourselves against some power —we close up and shut the gates. We are ill at ease, inhibited from expressing our thoughts and impulses. A warm person is one who makes us open up. We are attracted, willing to expose freely whatever we have to give. Our reactions to physical chill or warmth are obviously similar. In the same way, warm colors seem to invite us whereas cold ones keep us at a distance. Warm colors are outgoing; cold ones draw back. For the purposes of the artist, of course, both are welcome. They express different properties of reality calling for different responses.

If we wanted to discuss the expression of colors beyond what has been said so far, we would have to report on the character attributed to particular colors by various artists, writers, civilizations. It is an entertaining subject, and the observations of Goethe or Kandinsky on the character or red or yellow are attractively poetic. But no sufficiently good purpose seems to be served by such anecdotes. For one thing, these characterizations are so heavily overlaid with personal or cultural factors that they cannot claim much general validity.

When Kandinsky taught in his Bauhaus seminar that the color yellow was akin to the shape of a triangle, blue to a circle, and red to a square, was he voicing more than a personal impression? And when yellow symbolized imperial splendor in China but indicated shame and contempt in the European Middle Ages, can we be sure that, as Goethe assumes, the Chinese referred to a golden yellow, whereas the color of the prostitutes and the persecuted Jews had a mean, greenish tinge?

In the case of shape, we can analyze formal characteristics with considerable precision. The analogies between what shapes look like and what they express can therefore be explored with some confidence. We would accordingly be on relatively firm ground if we asked, as art historians have done, why Raphael's shapes differ from those of Dürer. But when it comes to color, can we do better than reflect vaguely on why Picasso preferred blue in the early years of our century or let Van Gogh tell us what he meant by yellow?

Quantitative studies on the color preferences of various populations have been numerous, partly because passing fashions are of interest to market researchers, partly because reactions to unanalyzed stimuli are easier for the experimenter to handle than studies requiring structural analysis. It is also true that the notion of "aesthetic pleasure," considered important in the traditional philosophy of art, has been impressed upon psychologists by philosophers. It was thought relevant to find out who was pleased by which colors. The results have been singularly unrewarding. Nothing of general validity emerged.