COLOR PSYCHOLOGY AND COLOR THERAPY

Faber Birren

This is the first paperbound edition of Faber Birren's monumental study of the influence of color on human life.

Birren makes his living by prescribing color. He prescribes it to governments, to schools, to the armed forces, to architects, to industry and commerce. When green felt-topped billiard tables sold slowly, he increased their rate of sale by changing the color of the felt to a soft purplish tone. In Southern textile mills, Birren reduced fatigue by giving workers light green end-walls. He relieved monotony for telephone operators by introducing yellow into the decoration of exchanges. He reduced industrial accidents by devising new color schemes.

In fact, Birren's color code for safety has become internationally accepted in countries as remote from each other as England, Japan, Argentina and Italy. He is presently considered the world's foremost authority on color.

This book has become the standard reference work on color psychology.

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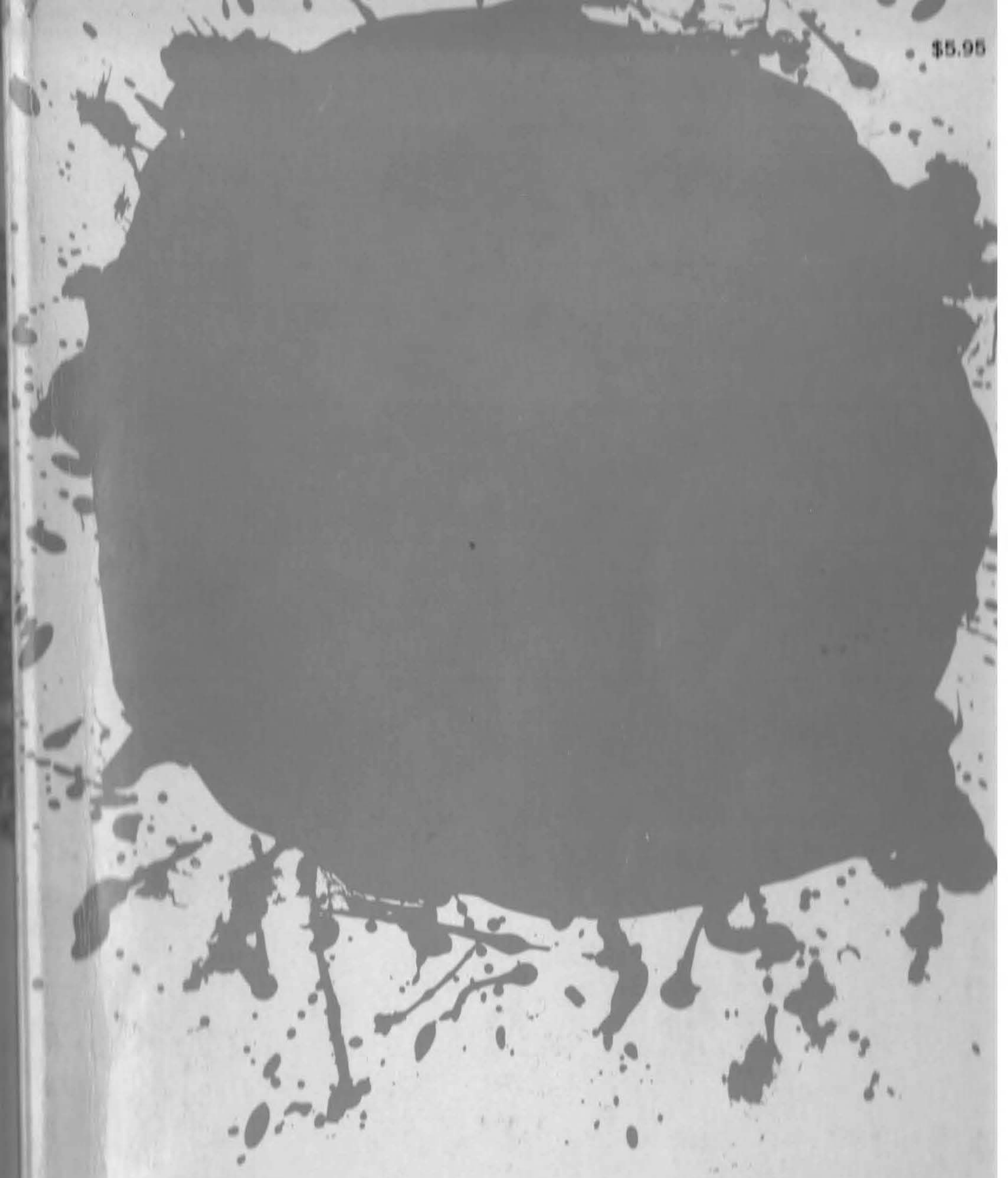


COLOR PSYCHOLOG AND COLOR THERAP

or when the animal has been without food for some time, light is the most important factor."

On up the scale, such creatures as worms are made uncomfortable by light. Some marine forms will continue to move until darkness is reached. Light from one direction may drive them the opposite way. General light overhead may cause them to waver about aimlessly. The earthworm, of course, fears the light even more than it does the robin and will remain in nether regions until actually flooded out.

When the "eyes" (ocelli) of a starfish are severed, the animal will respond to light through its skin. A slug with one eye removed will keep circling toward the eyeless side. Likewise does the cockroach scamper away from the light and a moth flutter toward it.

INSECTS

Color vision is not apparent in the lowest forms of animal life. It exists, however, in insects, fishes, reptiles, and birds. It is found lacking in most mammals, and restored again by nature in apes and men.

However, the color vision of insects differs from that of men. Scientists are largely agreed that the eye of the insect responds to the yellow region of the spectrum (but not the red), being sensitive to green, blue, violet, and on up into the energy of ultraviolet. E. N. Grieswood, in experimenting with fruit flies, noted a reaction to wave lengths invisible to man, which in shortness of frequency approached X rays. Such radiation must have come as a surprise to the insect inasmuch as it is not found in solar radiation. In similar tests Bertholf found the range of sensitivity in bees to extend from about 550 millimicrons (yellow-green), through green, blue, violet and into waves as short as 250 millimicrons (ultraviolet). The human eye is sensitive to a region extending from about 700 millimicrons to 400.

Ants placed in a box that is illuminated by a complete spectrum of sunlight will carry their larvae (always kept in darkness) out of the ultraviolet and into the visible red. Von Frish has demonstrated that the bee can be made to see the difference between a blue and a gray of the same brightness. It can also differentiate blue from violet or purple, and yellow from any of these. This has been shown by training the bee to fly to certain colors in order to obtain food. With red the bee is hopelessly confused and sees no difference in it from neutral gray targets. With wasps, however, Molitor found that in entering a nest, a black entrance was preferred to a blue one, and blue to red.

Frank E. Lutz has assembled many interesting facts about the "invisible" colors of flowers and butterflies. Not only does the insect have a sense of vision that differs from man's, but the patterns on its wings may also appear different to insects than to human beings. Quite obviously the butterfly finds real significance in ultraviolet energy. A red zinnia, for example, does not reflect ultraviolet, while the red portulaca does. Hence the two flowers, while alike to men and probably to birds, appear dark and light respectively to the butterfly.

Lutz writes: "While not all yellow flowers . . . are ultraviolet, most of them seem to be. In this connection a yellow spider much given to hiding in yellow flowers is interesting. According to theory, the yellow color of the spider prevents flower-visiting insects from seeing it against the background of a yellow flower in time to avoid being caught. However, the spider is only slightly ultraviolet and, so, to an insect that can see ultraviolet the yellow spider must be rather conspicuous as it sits on a yellow-ultraviolet flower."

Similarly the patterns of moths and butterflies differ under natural and ultraviolet light. The creatures thus "look" different to themselves than to men.

INSECT REPELLENTS

Experimenting with night-flying insects, L. C. Porter and G. F. Prideaux have found that brightness is a dominant factor in attraction power. Next to this, the more a source of illumination approaches the blue end of the spectrum, the more insects it will gather; the more it approaches the red end, the fewer it will gather. "The substitution of yellow lamps for white lamps of equal candle power reduces the number of insects attracted by approximately 50 per cent." Consequently, blue is the preferred hue, while red and yellow the least noticed. Thus a yellow lamp of low wattage over the porch, with a blue lamp of high wattage placed at a distance, will effectively divert invasion on a summer night.

For daylight insect traps, however, using paints and not light bulbs, yellow seems to be most useful. Frederick G. Vosburg reports, "For some reason a yellow trap will catch more Japanese beetles than any other color."

The "likes" and "dislikes" of flies and mosquitoes have been carefully studied with practical ends in view. The results given below are obtained from notes assembled by Deane B. Judd and presented in *News Letter* 45 of the Inter-Society Color Council.

For houseflies, several investigations have led to contradictory results. E. Hardy, for example, found yellow to be avoided and white to be preferred. On the other hand, P. R. Awati considered yellow to have the greatest attraction, red and violet the least. O. C. Lodge found no preference at all. S. B. Freeborn and L. J.

Perry found the fly repelled by pale colors, while R. Newstead had reason to conclude that light colors were preferred to dark colors. Something must be wrong somewhere. Either the methods of research are unreliable, or the flies with haunts in different parts of the world have different ideas about the matter. Possibly, the safest conclusion is that flies are more attracted to lightness than to darkness, for the weight of evidence seems to indicate as much.

In Holland, at least, horse stables and cow stalls are frequently treated with blue to get rid of the pests. So in Holland the flies must dislike that hue.

Regarding mosquitoes, however, the authorities are in far better agreement. Here light colors are the repelling ones. G. H. F. Nuttall and A. E. Shipley found that the common European malaria-bearing mosquito alighted most on dark blue, red, and brown, and least on yellow, orange, and white. (Subsequent to this particular report, the U.S. Army withdrew its regulation shirts in malaria districts and substituted lighter colors.) During five years in South Africa, Shariff found that pink and yellow mosquito curtains did not harbor insects. When boxes were lined with navy blue, pink, gray, and yellow flannel, the interiors of the blue and gray boxes were thickly covered with mosquitoes, while but two or three were found in the pink or the yellow boxes. Hoodless also found that New Caledonia mosquitoes prefer blue and avoid yellow.

FISHES

One of the most exhaustive books ever written on the vision of animals is that of Gordon Lynn Walls, *The Vertebrate Eye*. It offers a comprehensive review of visual phenomena and is replete with data on color as an influencing factor in animal survival and

Not many writers on the subject, however, seem to be aware of the fact that a color may have contradictory qualities, depending on the particular viewpoint of the observer. Green is an excellent case in point. As seen objectively, it is cool, fresh, clear, and altogether pleasing. But green illumination shining on the human flesh causes a subjective viewpoint that instantly makes the color repulsive. Thus no list of color associations is adequate unless it takes into consideration these subjective as well as objective aspects. For reactions will differ as a person associates color with the outside world or with himself.

While warm colors are not greatly different objectively and subjectively, cool hues may be antithetical. Red, however, may seem far more intense as applied to one's self than it does as applied to external objects. Blues and greens which appear peaceful in one aspect may be terrifying in another.

Thus the moods conveyed by a color may be rather diverse. A number of modern associations are presented in a separate tabulation. Here the major colors are described in their general appearance, their mental associations, direct associations, objective and subjective impressions.

RESEARCH IN COLOR PSYCHOLOGY

Research on the psychological aspects of color is difficult for the mere reason that human emotions are none too stable and the psychic make-up of human beings varies from person to person. However, there are a number of general and universal reactions to color which seem to be noted in most persons. Gilbert Brighouse in measuring human reactions under colored lights, tested muscular responses among several hundred college stu-

MODERN AMERICAN COLOR ASSOCIATIONS

Color	General appearance	Mental associations	Direct associations	Objective impressions	Subjective impressions
Red	Brilliant, intense, opaque, dry	Hot, fire, heat, blood	Danger, Christmas, Fourth of July, St. Valentine's, Mother's Day, flag	Passionate, exciting, fervid, active	Intensity, rage, rapacity, fierceness
Orange	Bright, luminous, glowing	Warm, metallic, autumnal	Halloween, Thanksgiving	Jovial, lively, energetic, forceful	Hilarity, exuberance, satiety
Yellow	Sunny, incandescent, radiant	Sunlight	Caution	Cheerful, inspiring, vital, celestial	High spirit, health
Green	Clear, moist	Cool, nature, water	Clear, St. Patrick's Day	Quieting, refreshing, peaceful, nascent	Ghastliness, disease, terror, guilt
Blue	Transparent, wet	Cold, sky, water, ice	Service, flag	Subduing, melancholy, contemplative, sober	Gloom, fearfulness, furtiveness
Purple	Deep, soft, atmospheric	Cool, mist, darkness, shadow	Mourning, Easter	Dignified, pompous, mournful, mystic	Loneliness, desperation
White	Spatial—light	Cool, snow	Cleanliness, Mother's Day, flag	Pure, clean, frank, youthful	Brightness of spirit, normality
Black	Spatial—darkness	Neutral, night, emptiness	Mourning	Funereal, ominous, deadly, depressing	Negation of spirit, death

CHAPTER 13

Associations and Analogies

Color associations exist by the score. Man finds in the hues of the spectrum emotional analogies with sounds, shapes and forms, odors, tastes. Color expressions work their way into language, symbolism, tradition, and superstition. The reason is probably that the sensation of color is of a primitive order. Reaction to it, appreciation of it, requires little effort of intellect or imagination. Color conveys moods which attach themselves quite automatically to human feeling. It is part and parcel with the psychic make-up of human beings.

COLORS AND SOUNDS

In a psychological phenomenon known as synesthesia (to be further discussed in Chapter 15) many persons are found who

innately and subconsciously "see" colors in sounds. The two arts —color and music—have freely exchanged terms. Tone, pitch, intensity, volume, color, chromatic are all a part of the nomenclature of art and musical composition. Christopher Ward suggested a number of emotional associations when he wrote: "From the faintest murmur of pearl-gray, through the fluttering of blue, the oboe note of violet, the cool, clear wood-wind of green, the mellow piping of yellow, the bass of brown, the bugle-call of scarlet, the sounding brass of orange, the colors are music."

In the seventeenth century Newton related colors to the notes of the diatonic scale: red for C, orange for D, yellow for E, green for F, blue for G, indigo for A, violet for B. Subsequent colorists and musicians have devised other scales. In his *Prometheus,* Alexander Scriabin developed a part for a color organ which he called "Luce." The composition was to be played in darkness, with colored lights thrown upon a screen.

Among other composers, Liszt is credited with several pet phrases: "More pink here." "This is too black." "I want it all azure." Beethoven called B minor the black key. Schubert likened E minor "unto a maiden robed in white and with a rose-red bow on her breast." To Rimsky-Korsakoff sunlight was C major, and F sharp was strawberry red.

MODERN RESEARCH

Color "hearing" has been extensively treated in a monograph written by Theodore F. Karwoski and Henry S. Odbert. In a study of 148 college students, at least 60 per cent experienced some kind of color response when music was heard, 39 per cent were able to "see" a color or colors, 53 per cent were able to "associate" a color, and 31 per cent "felt" a color response. "It seems safe to say that a good majority of the population in one way or another relates colors to music."

Karwoski and Odbert found that slow music was generally associated with blue, fast music with red, high notes with light colors, deep notes with dark colors, and that patterns as well as hues were involved. Most significant, "The horizontal dimension might be related to the development of music in time; the vertical dimension to changes in pitch. A third dimension of depth may eventually be available to denote volume or intensity." Surely most people who have given thought to correlation of music, form, and color will be in sympathetic agreement with this conclusion. Music moves along quickly or slowly depending on its tempo. It jumps into tints for high notes or drops down into shades for low notes. When it is fortissimo, the colors are near, intense, heavy, and bulky. When it is pianissimo, the colors are filmy, grayish, and far away.

Color hearing is common among children and probably exists extensively among primitive people. It is also discovered among psychotic persons, especially schizophrenic types. It may be induced by drugs such as mescalin. To quote Werner: "A subject under the influence of mescalin experiences color simultaneously with tone. High tones evoke vivid, garish colors, and deep tones engender duller colors. If there is a steady knocking on the wall, let us say, the subject will see optical images dancing before his eyes in a rhythm that synchronizes with the measured beat of the knocking. One subject described his sensations in this manner: 'I think that I hear noises and see faces, and yet everything is one and the same. I cannot tell whether I am seeing or hearing. I feel, taste, and smell the sound. It's all one. I, myself, am the tone.'" This confusion of the senses may be experienced in dreams or during extreme illness.

Men such as Thomas Wilfred and Tom Douglas Jones have endeavored to develop an art of color that is independent of music. In many respects, color is more fundamentally emotional than music and requires even less mental effort to enjoy. Such an art has been conceived by the great physicist Albert A. Michelson. In his *Light Waves and Their Uses* he writes: "Indeed, so strongly do these color phenomena appeal to me that I venture to predict that in the not very distant future there may be a color art analogous to the art of sound—a *color music,* in which the performer, seated before a literally chromatic scale, can play the colors of the spectrum in any succession or combination, flashing on a screen all possible gradations of color, simultaneously or in any desired succession, producing at will the most delicate and subtle modulations of light and color, or the most gorgeous and startling contrasts and color chords! It seems to me that we have here at least as great a possibility of rendering all the fancies, moods, and emotions of the human mind as in the older art."

An art of mobile color holds many possibilities. For example, the Chromaton of Tom Douglas Jones represents an advanced phase in the perfection of color organs. This particular instrument, still under development, has definite application to art teaching and art expression. However, its chief value (still to be properly capitalized) is in the study of human personality. A method such as the Rorschach test could be given added features of color, motion, time. All this should help provide even better and more revealing clues to neurotic and psychotic disturbances. Free-flowing or abrupt rhythms, mellow or hard forms, subdued or brilliant color could all be brought into play by the Jones Chromaton. If it served a useful purpose in diagnosis, it might also serve an appealing and pleasing purpose in some well-directed form of psychotherapy.

COLORS AND ODORS

Although associations between colors and odors are less obvious, they none the less enter into the experience of many persons. The most preferred odors are rose, lilac, pine, lily of the valley, violet, coffee, balsam, cedar, wintergreen, chocolate, carnation, orange, vanilla. The least liked odors are lard, rubber, olive oil, kerosene, fish, turpentine, vinegar, onion, gasoline, garlic, human perspiration.

In a simple way, pink, lavender, pale yellow, and green are perhaps the best "smelling" colors. Poor examples would be found in gray, brown, black, and deep shades in general. Odors resemble film colors and lack comparison with things structural.

Sensory relationships have been investigated by science. Attributes seem to be coordinated. The phrase "unity of the senses" expresses the concept that colors, sounds, odors, tastes, tactile experiences, all may be "heavy," or "light," or have "volume" and dozens of other psychological similarities. Edwin G. Boring writes, "Von Hornbostel in 1931, having regard to the fact that colors have brightness and that brightness is one of the vigorous candidates for attributehood with tones, undertook to equate the brightness of a gray to the brightness of an odor, and then the brightness of a tone to the same olfactory brightness. He found that things equal to the same thing equal each other, that the brightness of the gray and tone appear equal when both equal the brightness of the odor."

COLORS AND FOODS

Practically everyone is sensitive to the colors of foods. Appetite will be quickened or dismayed in almost direct relation to the observer's reaction to color. Among pure hues a spectrum red (vermilion) seems to be most appealing. This is the rich color of

the apple, the cherry, the rare cut of beef. Toward orange the appeal is still high. At yellow it begins to fall off decidedly, and at yellow-green it finds a low point. There is a pickup at clear green, the hue of freshness in nature. However, blue, despite its beauty in an esthetic light, is none too appealing in most foods. A similar attitude seems to be held for violet or purple. It will be noted that the greatest drops occur in small intervals of the spectrum—between yellow-orange and yellow-green, and between red and red-violet.

Tints are neither as upsetting nor as savory as pure hues. Although pure red is succulent, pink is by no means so. The best tint seems to be orange. A yellow tint is slightly better than a pure yellow. A green tint is also agreeable. Tints of blue and violet are not as "inedible" as pure hues or shades of the same colors.

Among shades, orange stands dominant. Here is the rich hue of brown associated with well-cooked meats, with breads, and wholesome cereals. Red shades tend to be purplish and thus lose out. A shade of yellow-green somewhat resembles a pure, clear green and picks up in appeal. But shades of blue and violet are by no means good food colors.

However, foods which might have a good taste with the eyes blindfolded (such as a black fig) may even take on a good appearance if the palate properly converts the eye. Yet where the association is well established, liberties cannot be taken with color. A Western baker who once tried to market bread in pastel tints such as blue and green found the venture a dismal failure.

For the most part, peach, red, orange, brown, buff, warm yellow, clear green, are the true appetite colors. Pink and tints of blue and violet are decidedly "sweet" and not for the entree or filling part of a meal.

Although blue is none too appetizing, its universal appeal comes to its rescue. If it is not in itself a suitable hue for things to eat, it is excellent as a background and will display foods harmoniously and pleasingly.

THE TACTILE SENSE

In associations with the sense of touch, colors will appear warm or cool, dry or wet. This reaction is inherent in the psychological make-up of most human beings. Perhaps it is built upon the association of warm things—the sun, fire—with red and orange colors, and of cool things—water, sky—with blue and green.

Yet despite the overwhelming evidence of the senses, attempts have been made to prove that the qualities of warmth and coolness in color were illusory. The *Lighting Handbook* of the Illuminating Engineering Society states, "This appears to have no foundation in fact." Tests in the psychological realm are all too frequently invalidated when the observer is made self-conscious of the test method and procedure. Appetite itself may be lost if an investigator deals soberly with it and perhaps goes about strapping electrodes to human tongues to measure flow of saliva.

In the *Bulletin of the American Physical Society* (February 5, 1940), S. M. Newhall writes, "Unless the test situation is sufficiently similar to the actual situation, the test results can have no practical value in application to the actual situation." In his study, Newhall exhibited 50 color samples to 297 observers. They were asked which colors appeared warmest and which appeared coolest. "The 'warmest' judgments show a minor mode in the violet . . . but a strikingly major mode in the red-orange region. . . . The 'coolest' judgments exhibit no such marked mode, but range irregularly all the way from yellow through green and blue to purple." In other words, a color such as red-orange is perceived

as unquestionably "warm" by most persons. A greater latitude is shown toward "cool" hues, for green may express the quality to some, blue to others, and violet to still others. "The relatively great hue-range covered by such perceptually cool objects provides opportunity for the psychological association of coolness with a relatively great range of hues."

As pointed out in the last paragraph of Chapter 10, colors may be warm or cool, active or passive on a purely physical and physiological basis. Red will stimulate the autonomic nervous system, while blue will tend to relax it. The equilibrium of the body, pulse rate, heart action, respiration, nervous tension, even digestion will all be affected.

If there is no warmth or coolness in color, as the editorial staff of the Illuminating Engineering Society and other skeptics insist, then there is no such thing as hunger. A child comes to dinner, drools at the sight of his food, and cries, "Gee, am I hungry!" Hunger is a feeling backed up by a flow of gastric juices. Yet when his father yells, "Sit up! Why are your hands dirty? Where the devil are your table manners!" the drooling ends, the juices stop flowing, and the hunger is gone. Indeed, there are few sensations in life which cannot be destroyed as above. Color must be approached in a human way, an organic way. To use it otherwise is to foster spurious and invalid research and to neglect the fact that the mental and psychic life of man is in every way as real (and as functional) as his physical life.

LANGUAGE

Man's emotional attitude toward color is well expressed in his language, his slang, his metaphors, his colloquial expressions.

To him red is an ardent and passionate color, assigned to saints and sinners, patriots and anarchists, love and hatred, compassion and war. He paints the town red, sees red when angry. When his business is without profit he is in the red—indeed, his bookkeeper uses red ink to indicate the loss. Politicians draw red herrings across the line and shout of reds and radicals. There are red-letter days, redheads, redcaps, and vagrants without a red cent to their names.

Yellow is a despised hue. Though it once referred to the heathen, it now marks the scoundrel or the coward. Yellow journalism (sensationalism) sprang up in 1895 when a New York paper ran the cartoon of a child—the Yellow Kid—as an experiment in printing.

Green is the color of jealousy. Greeners are inexperienced workers, and greenhorns are rustics from the country.

Blue has a meaning all its own as expressed in "feeling blue," or "blue music." The color once referred to the insane, then to mental depression in general. There are blue laws, blue gloom, blue Monday, blue-bloods. Man yells blue murder and curses the air blue. Things happen in life once in a blue moon or suddenly like a bolt from the blue.

In 1832 Dickens wrote in *Pickwick Papers,* "He'll come out done so exceeding' brown that his friends won't know him." Black connotes despair and an evil conscience. There are terms such as blackball, blackmail and black list. "White" expresses the vanity of the Caucasian race. To say that a man is white is an Americanism dating back to 1877, when it was supposed to cast aspersion on red men and black men. The white-haired boy, however, is Irish and the pride of someone.

COLOR AND FORM

In an abstract sense, colors are to be related to forms. Red, for example, suggests the square or cube. It is hot, dry, and opaque

in quality. Being advancing in character, it holds strong attraction and appears solid and substantial. Because it is sharply focused by the eye, it lends itself to structural planes and sharp angles.

Orange suggests the form of the rectangle. It is less earthly than red and more tinged with incandescence. Optically it produces a sharp image, is clearly focused by the eye, and lends itself to fine angles and details.

Yellow is abstractly related to the inverted triangle or pyramid. It is the color of highest visibility in the spectrum and therefore pointed and sharp. However, it is more celestial than worldly and it lacks substance and weight.

Green suggests the form of the hexagon or icosahedron. It is cool, fresh, soft. Because it is not sharply focused by the eye, it does not lend itself to much angularity.

Blue suggests the form of the circle or sphere. It is cold, wet, transparent, celestial. It is retiring in quality and creates a blurred image on the retina. Blue objects seen at a distance are never sharp to the eye.

Purple suggests the form of the oval. It is soft, flowing, and cannot be clearly focused. Unlike blue, however, it seems to cling more closely to the earth.

COLOR AND PERSONALITY

If the speculations of this present chapter are to be forgiven, a few more fanciful notes may be presented on the color relationships suggested by human personality. It has been said that athletic people prefer red, intellectuals blue, egotists yellow, while the convivial favor orange. Such "character analysis" may not be as meaningless as the reader might suppose. Color preference is something of a clue to personality.

When a number of people are questioned as to their predilections for color, it will be found that extroverts are inclined to favor red, while introverts are inclined to favor blue. Goldstein and others have stated that red stimulates the organism to action, while green and blue lead to meditation. Thus impulsive persons and conservative ones naturally express different color preferences. The same colors are not compatible with all people.

Purple is frequently popular among artists, if not by innate choice then at least by training, for purple has subtle qualities not found with most other hues. Yellow may be preferred by persons with a strong spiritual or metaphysical bent. Where the choice may be for an intermediate color such as blue-green, a finical nature may be exposed. Logic would indicate that average people like simple colors; when the preference is at all fastidious, the person is one who may not get along well with others.

SYMBOLISM

A symbolism for color, in every way psychological, has been built upon many centuries of history, religion, tradition, and superstition. This deserves brief mention simply because it represents an expression of man's feelings and associations as developed in the course of his civilization.

In the Roman Catholic rite, for example, the color of the vestments has a definite significance:

White is the symbol of light and signifies innocence and purity, joy and glory.

Red, the symbol of fire and blood, signifies charity and generous sacrifice.

Green, the symbol of nature, signifies the hope of eternal life.

Purple, the gloomy cast of the mortified, represents affliction and melancholy.

Black is symbolic of the sorrow of death and the somberness of the tomb.

Another old survival of tradition is found in the symbolism of heraldry:

Here red ("gules") means courage and zeal.

Blue ("azure") signifies piety and sincerity.

Yellow or gold ("or"), stands for honor and loyalty.

Green ("vert") means growth and hope.

White, or silver ("argent"), represents faith and purity.

Black ("sable") signifies grief and penitence.

Orange ("tenné") means strength and endurance.

Purple ("murrey") represents royalty or rank.

In America (since 1893) the universities and colleges have recognized a code of color to identify their major faculties. Scarlet represents theology, blue is for philosophy, white is for arts and letters, green is for medicine, purple is for law, golden yellow is for science, orange is for engineering, pink is for music.

"The body of man is red, his mind is yellow, and his spirit is blue." The fact that man has given color so important a role in his life since the dawn of history is in itself of psychological interest. For in many respects the emotions and attributes encountered in the historic symbolism of color meet with verification in the scientific research of a modern age. Only now the knowledge is more complete and the control more enlightened.

CHAPTER 14

The Anatomy of Beauty

ALTHOUGH A PERSON may feel that his particular likes and dislikes for color are personal to him—a part of his spiritual make-up—an astonishing similarity of preferences is noted when thousands of opinions are analyzed. Even the elusive qualities of beauty seem to follow universal laws.

Because of extensive research in æsthetics, it becomes possible to discuss the artistic side of color and color harmony on a scientific basis—not alone to define those colors and color arrangements having most appeal, but to explain a number of emotional reactions in physiological terms. This viewpoint is rather new to the literature of color and has seldom been presented. It naturally holds an important place in this book because it contributes still more factual data on the enigmas of color. Indeed, it

may well be that predilections for color may be in a person's glands as much as in his soul.

A UNIVERSAL COLOR ORDER

At least fifty authoritative tests have been made of human color preferences. The literature is so complete and the results are so uniform that one is hardly able to question the conclusions reached.

To give some order to this matter of color choice, consider first the reaction of babies. In the first months of life it is difficult enough to learn to see, to fix both eyes on the same object, and to make sense out of visual experience. Some authorities declare that touch and form are dominant in infants, and that a real love for color does not become evident until well after the second year. Then color perception begins to rival form perception. R. Staples exposed disks to infants and measured the duration of visual concentration. The babies looked longer at bright colors than they did at dull tones. Their favorites, judged by certain eye fixations and reaching efforts, were red and yellow. Apparently the infant is most attracted to brightness and richness of hue.

C. W. Valentine likewise exposed colored skeins two at a time to three-month-old babies and measured the length of time each skein was given attention. The babies stared longest at yellow, then white, pink, red. Least attention was paid to black, green, blue, and violet.

At six months a baby may be able to distinguish the primary colors. As he grows, he will continue to be intrigued by color and will be more sensitive to it than to form. David Katz has reported a very unusual experiment on color-form abstraction among children from three to five years of age. They were given a number of red triangles and green disks and asked to select those which were the "same" as a *red disk*. Curiously, the children did not hesitate to group the red triangles with the red disk and to consider "sameness" a matter of color, not form. With older children and adults, the same test was too ambiguous and too confusing, no doubt because of a more advanced appreciation of shape and form.

In larger children, a liking for yellow begins to drop away—and to keep dropping with the years. Now the preference is for red and blue, the two universal favorites, which maintain their fascination throughout life. The order in childhood, therefore, is red, blue, green, violet, orange, yellow.

With maturity comes a greater liking for hues of shorter wave length (blue, green) than for hues of longer wave length (red, orange, yellow). The order now becomes blue, red, green, violet, orange, yellow. And it remains thus, the eternal and international ranking.

That color preferences are almost identical in human beings of both sexes and in persons of all nationalities and creeds is substantiated on every side.

T. R. Garth found that American Indians preferred red, then blue, violet, green, orange, yellow.

Among Filipinos, the order was red, green, blue, violet, orange, yellow.

Among Negroes the order was blue, red, green, violet, orange, yellow—the same as for practically everybody else.

Even among insane subjects, S. E. Katz found almost the same rankings—blue, green, red, violet, yellow, orange. Green was best liked by male inmates, and red by female. Warm hues seemed to appeal to morbid patients, and cool hues to the more hysterical ones.

To summarize the whole picture, H. J. Eysenck tabulated a

mass of research involving some 21,060 individual judgments. Blue ranked first, then red, green, violet, orange, and yellow. In a similar recapitulation of sex differences, the order was the same, except that while men put orange in fifth place and yellow in sixth, women put yellow in fifth place and orange in sixth.

COLOR COMBINATIONS

A great deal of research has also been devoted to color combinations. In working with children, M. Imada found that color preference was not haphazard, even though good discrimination was not highly developed. Given black crayons, the youngsters were inclined to draw inanimate things, vehicles, buildings. When the same children were given colored crayons, their fancies were more inspired to attempt human beings, animals, and plants. Red with yellow and red with blue were favored combinations.

In similar experiments, Ann Van Nice Gale found yellow popular in combination with red-violet or blue. The combination of blue and green also was liked. Contrast, naturally, was more exciting than analogy or subtlety.

In testing adults, using colored lights thrown upon a screen, William E. Walton and Beulah M. Morrison found the combination of red and blue highest in ranking, then blue and green, red and green, clear and blue, amber and blue, amber and green, red and amber, with clear and amber last.

THE WORK OF GUILFORD

Among the ablest investigators in this field is J. P. Guilford, who has conducted numerous tests with colors and color combinations. As to harmonious arrangements, he writes, "There is some evidence that either very small or very large differences in hue give more pleasing results than do medium differences. This tendency is much stronger for women than for men." Thus a person is likely to see harmony either in colors that are closely related, or in those which are antithetical and opposite—not in other relationships. To visualize a color circle, yellow, for example, will seem harmoniously combined with yellow-orange and yellow-green; with blue, blue-violet or violet. It will not be particularly well liked in combination with orange, with green, or even with red.

Guilford has likewise determined through research that where the choice is between grayish tones and pure hues, the pure forms will be preferred. Where the choice is between dark tones and light tones, the light tones will be preferred.

NATURAL LAWS OF HARMONY

According to Guilford, people like color combinations based on (1) closely related colors and (2) complementary colors.

With single colors other facts are noted. Those variations are best which represent clear-cut expressions of color. That is, pure hues should be rich and intense; pastel tints should have a light, delicate quality; shaded colors should be deep and autumnal. Where a color may lie on a borderline, compromising the above "forms," ugliness may result. Thus a little white added to red may weaken its appeal. However, if enough white is added to shift the sensation from that of a full color to that of a pastel tint (pink), appeal may be restored. A red with a touch of black in it may seem nondescript and "dirty." When enough black is added to shift the form to a deep shade of maroon, beauty may again be evident.

I. H. Godlove has noted a "natural order" for color combinations. When light and dark variations of different hues are combined, the appearance is best when the light variation is derived

from a full color that is normally light, and the dark variation derived from a full color that is normally dark. Thus pale green looks better with dark blue than pale blue looks with dark green. As full colors, blue is deeper than green.

Orange buff looks better with deep violet than lavender looks with brown (which is a deep shade of orange).

Pink looks better with dark blue or purple than lavender looks with maroon.

Pale yellow looks better with brown or blue or violet than any pale greens, blues or lavenders would look, for instance, with olive green (which is a deep shade of yellow).

In harmonizing modified colors, natural sequences also hold most appeal. Thus pure hues combine beautifully with tinted colors and white. They all have elements in common. Pure hues combine well with dark shades and black. Grayish tones are the most neutral of all color forms. Because they contain pure hue, white, *and* black in their make-up, they naturally blend well with other types of colors.

SCIENTIFIC THEORIES

It has already been mentioned in the last chapter that extroverts prefer red and introverts prefer blue. This also seems to apply to brunets and blonds, the former preferring red and the latter blue. In explanation E. R. Jaensch, in his book *Eidetic Imagery,* mentions the difference between a predominance of "sunlight" in the more tropical regions of the world, and of "skylight" in the more polar regions. As one travels from cold to hot climates sunlight increases and skylight decreases. Intense light requires sun adaptation, or "red-sightedness," and this may be accompanied by a strong pigmentation on the foveal area of the retina.

Red-sighted persons are typical brunets, such as the Latins. They are likely to have dark eyes, hair, and complexion. Their natural preference is for red and all warm hues, a predilection which may be far from spiritual in origin and probably due to a physiological process of accommodation to long waves of light.

Blonds, on the other hand, are green-sighted and may have a different pigmentation on the retinas of their eyes. They are the Nordic and Scandinavian types, with bluish eyes, light hair, and light complexion. Their preference is for the blue and green.

To support Jaensch's theory, it is an observable fact that the deciding factor in color preference seems to be sunlight (or lack of it). Where sunlight is abundant, people are likely to show a preference for warm, vivid hues. Where there is relatively less sunlight, preference for cooler colors and softer tones will be found. The influence of length of day on plant growth and on the sex cycles of animals, already mentioned, suggests that man's feelings and reactions to color may similarly have a biological basis. One authority has posed the hypothesis that there may be a connection between the more active functioning of the endocrine glands in the spring of the year (when length of day increases) and the rise in preference for light, clear tints which most persons exhibit at this particular season.

The fact that a preference for blue increases as a person grows older has also inspired explanation. The fluids in the human eye grow yellowish with age. The lens of the eye of a child will absorb about 10 per cent of blue light; that of an old man, 85 per cent. It therefore might be assumed that another sort of accommodation takes place. Human eyes may grow "thirsty" for blue as the lens proceeds to filter more of it out.

One authority who prefers not to be quoted has noted a relation between diet and color discrimination. Working with Mexican school children, he observed a preference for simple c such as red, yellow, green, blue to exist where there was calcium deficiency. When diets were corrected, color preferences appeared to change in the direction of finer discrimination and appreciation for more subtlety in color.

THE ELEMENTS OF SENSATION

In human vision there is a marked tendency to simplify all experiences and sensations. Because this process is in the brain, it is highly psychological. How many colors are there? Estimates by some authorities have ranged into the millions. Yet in a broad sense there are surprisingly few colors.

To speak of "all the colors of the rainbow" is to deal with finite numbers. Selig Hecht writes, "The normal eye can separate the visible spectrum with complete certainty into about 180 patches of hues which cannot be made to look like one another by varying their intensities." Spectral colors, of course, are pure ones and do not include variations in which white, gray, and black are a part.

Indeed, in looking at the spectrum (or the rainbow), human vision tends to "bunch" things together. Although the eye may be stimulated by innumerable wave lengths of light, a person sees a red area which blends into an orange area, then into yellow, green, blue, violet. Although red and violet represent extreme opposites in wave length, they appear psychologically related and may be brought into sequence through purple. Purple, which is not a spectral hue and has no wave length of its own (it is a blend of red with violet or blue), thus makes the color circle possible.

In the psychology of vision there are four primary or primitive color sensations: red, yellow, green, blue (and also black and white). Though yellow in light mixtures may be formed by combining red with green, the sensation of yellow is unique and certainly shows no hint of red or green in it. Red, yellow, green, blue are the simplest of colors and cannot be formed through *visual* mixtures of other hues. Further, while orange may look something like red and like yellow, both red and yellow do not resemble orange.

This type of psychological simplification is also observed when white, black, and gray are introduced into color mixtures. The reader's own experience will probably check with the following notes. The natural form of color is a triangle, with pure hues (any and all) on one angle, white on the second and black on the third. White and black are unique as sensations; they differ from each other and differ from pure hue.

Whitish colors, which may be called tints, follow mixtures of pure hue with white. Blackish colors, which may be called shades, follow mixtures of pure hues with black. The combination of white and black forms gray. When all three are combined —pure color with white and black—a grayish tone is exhibited.

In the main, all color sensations fall into these seven classifications: pure hue, white, black, whitish tints, blackish shades, gray, and grayish tones. Thus do the human eye and brain find common denominators for multitudinous color sensations.

If the eye can distinguish a million colors, as some authorities aver, they are observable only under the most ideal conditions of illumination and background. When colors are examined in average or dim light, viewed from a distance and held slightly apart, fine differences are tremendously reduced.

Language itself gives further evidence of this human tendency to see few rather than many colors. Within a reasonable length of time the average person can mention only about thirty distinct color names. And most of these will be synonyms (scarlet, red,

crimson) or borrowings from other things, such as orange and violet. If language is an expression of man's interest in his environment, then fine differences in color are of no great concern to him, for his dictionary has very few words for color.

MODES OF APPEARANCE

It is conceivable that a patch of blue sky, a piece of blue paper, and a bottle of blue liquid could all be made to "match" in the physical sense. All could have the same wave lengths and brightness. Yet the visual impression of each would be unique from the psychological standpoint.

Ostwald, Katz, and others have pointed out a difference between "related" and "unrelated" colors. This distinction, a highly important one to the psychologist, has not been fully appreciated until modern times. Indeed, as great a physicist as Helmholtz was apparently unaware of it.

Unrelated colors are the hues of light. They are celestial in quality, uninfluenced by environment, and usually contain no black. They are *film* colors and in human perception have the quality of seeming to fill space.

Related colors are *surface* or *object* colors. They are usually seen in relation to an environment and are the colors which distinguish paints, textiles, and other material substances. They are definitely localized by the eye, are structural and palpable, and generally have black in their makeup. Surface colors may be changed to the appearance of film colors by viewing them through an aperture screen—a card with a hole in it.

A third type of color (Katz) may be called a *volume* color. This has a three-dimensional quality; it occupies a definite position within space. For example, fog is a film color until objects are seen through it. Then it is perceived as a volume color.

The chief difference between related and unrelated colors is observed in the phenomenon of black. To the psychologist all visual sensations involve color. Because black is perceived in vision and is as unique as any hue, it is, of course, a color. Peddie writes, "Physiologically *black* implies the absence of stimulation: psychologically the recognition that illumination is absent is itself a positive perception." Helmholtz also understood this: "Black is a real sensation, even if it is produced by entire absence of light. The sensation of black is distinctly different from the lack of all sensation."

Black is a color that is in every way as definite and unique as red or blue or white. It mixes in with other colors to change their appearance. An orange light (unrelated) in a dark room will maintain its same general appearance whether the intensity of the light is strong or weak. It will merely be a bright or a dim orange. But when the intensity of an orange paint is lowered by adding black to it, the mixture will change to brown which is not very much like orange. In light rays black seldom plays much of a role. There is no such thing as brown or maroon in a rainbow or a sunset. Yet in life, black is found everywhere, an integral part of other full hues, modifying their aspect and forever making itself apparent in vision. Southall says, "To argue that because a black body apparently does not deliver a specific physical stimulus to the retina, therefore black is a mere negation or complete lack of sensation, is not only to beg the question from the start but to deny the evidence of our senses."

PHYSICS AND PSYCHOLOGY

The study of color is essentially a psychological one. Southall writes: "From the standpoint of psychology, colors are the properties neither of luminous objects nor of luminous radiations but

are contents of consciousness, definite qualities of vision." In discussing the psychological aspects of vision, it is of interest to point out a few phenomena in which color as energy differs from color as sensation. It should be appreciated that human beings do not respond to light stimulation in a matter-of-fact way. The eye is far from a mere light-responding medium.

First of all there is no close, orderly, or measurable relationship between light energy and the sensation of color. It is impossible to seize upon certain wave lengths or intensities and to establish them as fixed stimuli, forever the same to the eye. What, for example, is the difference between black and white or between gray and white? This cannot be answered satisfactorily with spectrometers or in terms of brightness or reflectance alone. White is not synonymous with bright light or black with feeble light—or even with no light at all.

With the eyes tightly closed in a dark room one does not see black but a deep "subjective" gray that seems to fill space—the so-called "retinal chaos." This gray has not the depth or solidity of a black surface. Again, black will appear blacker the stronger it is illuminated. No average surface absorbs all light; what the eye sees as black may reflect 5 per cent or more of the light shining upon it. Yet a surface like this looks increasingly blacker when more light strikes it—and when, in truth, more light is reflected into the eye.

More curious than this phenomenon is the transformation of a white surface into the appearance of a gray surface without changing in any way the volume of light reflected by it. In a classical experiment devised by the great psychologist Ewald Hering, a piece of white cardboard is placed upon a window sill with the observer facing the light. Now a second white card is held on a horizontal plane over it. In the center of this latter card is a square hole through which the lower card can be seen. If both pieces are exactly horizontal, and if the upper piece does not cast a shadow over the lower, they both will appear white.

Now, however, if the upper card is tilted away and down on its horizontal axis toward the window sill, it will immediately reflect more light. Result—the card seen through the hole will appear gray or even black. By changing the conditions of the experiment the lower card can be made to shift from white to gray—yet the amount of light it reflects will not be modified in the least! Color as radiant energy and color as sensation are different.

OTHER PSYCHOLOGICAL PHENOMENA

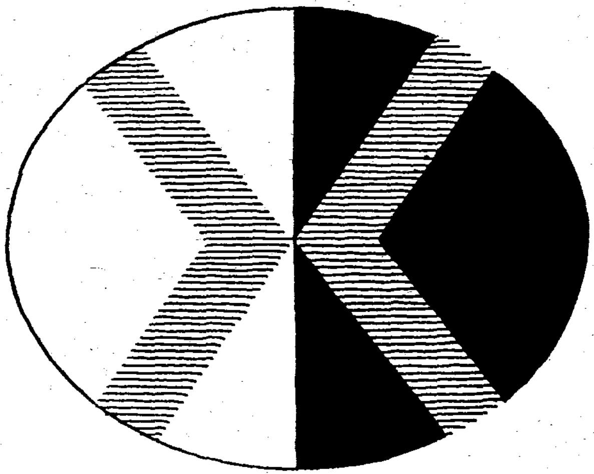
There are further peculiarities of vision not to be answered in terms of light energy alone. The human eye cannot distinguish and separate the component elements of a dominant hue. When several notes are struck at once on the piano, the trained ear can easily identify each one. But when light rays are mixed, the eye sees one result only.

This means that the eye pays little heed to the physical composition of colors. Polarized light looks the same as ordinary light. Colors which owe their existence to the absorption and reflectance of pigments are not greatly different from opalescent and iridescent colors which may owe their existence to diffraction, interference, the scattering of light rays. Grays mixed through a combination of white and black may not be visually different from grays formed with red and green, or orange and blue.

Again, a yellow surface will appear brighter on a black background than it will on white. Highlights appear opaque to the eye; shadows appear transparent. Conjoined shadows seem to melt into an object and to become part of it. Cast shadows seem to cover a surface like a transparent membrane.

Finally, there are a number of subjective illusions which do not have much relationship to electromagnetic energy as such. Pressure on the eyeball will produce sensations of hue. The visualization of an area of red may bring out a response to its opposite, green. Lustrous surfaces such as silks involve other visual phenomena. The eye sees a difference between white cotton and white silk; one has gloss or luster, the other does not. Cottons will still look like cotton in brilliant light, and silk will look like silk in shadow. Amount of light reflected is of minor consequence.

Certain sensitive persons are able to hold a mental picture of a red area in their minds and then actually see a green afterimage. Likewise color appearances are affected by mind and imagination. It is human to see blue eyes as bluer and red hair as redder than they actually are. Always the sense of color struggles actively within the body of man, working itself outward to influence the things he sees.



CHAPTER 15

This Illusory World

SEEING IS AS MUCH in the brain as it is in the organ of sight. Perception is often a matter of interpretation rather than a simple reaction to stimuli. While there are innumerable curiosities associated with human vision, one of the most interesting is that centering around the more or less stable appearance of the world under varying conditions of illumination.

As a rule a person is not greatly conscious of the fact that natural daylight changes considerably from dawn to dusk, both in intensity and hue. Dawn may be yellowish; reflected light from the sky may be bluish; sunset may be a rich pink. There may be 10,000 foot-candles of light in the open at midday, 1,000 under the shade of a tree, and less than 100 in twilight. Yet for all these

differences (which would be marked indeed if measured with a photometer) human vision operates with remarkable uniformity, giving the world a normal appearance at all times and simplifying and coordinating a complex array of optical stimuli.

COLOR AND ILLUMINATION

There is something highly mysterious about the interrelations existing between illumination and color. David Katz writes, "Seeing is not a matter of looking at light waves as such, but of looking at external things mediated by these waves; the eye has to instruct us, not about the intensity or quality of light coming from external objects at any one time, but about these objects themselves." Light itself is rarely seen. Its presence is made known by the appearance of surfaces upon which it shines. The eye may recognize the existence of dim light, for example, by the appearance of objects in its field of view; it does not have to examine or analyze the light source itself. Conversely, impressions of bright illumination may be gained from the general appearance of areas and surfaces being perceived. Obviously, high surface brightness is associated with intense light, and low surface brightness with dim light.

Regardless of light intensity, however, colors tend to maintain a "genuine" appearance at all times. Here is the phenomenon of color constancy, one of the most remarkable of all facilities of vision. Technically speaking, a white surface is one that effects a total (or almost total) reflection of light. Such a surface if viewed under isolated conditions can be made to appear gray, as demonstrated in Hering's experiment (described in the last chapter). However, if the white surface is viewed under conditions of general illumination over the field of view, it will remain white whether the light be strong or weak! White surfaces set at difwhen viewed under chromatic light. However, they seemed to lose saturation or purity and to be more filmy.

SYNESTHESIA—"COLOR THINKERS"

Chapter 13 has told of persons who "see" colors in sounds. The varieties of this phenomenon, known as color synesthesia, are many. The hues of the spectrum may be associated with lines, forms, figures, letters, numbers, words. They may relate to tastes, odors, or sounds. Even cutaneous and organic sensations have by some persons been said to resemble colors.

Over fifty years ago Francis Galton wrote his *Inquiries Into Human Faculty* and established himself as the first serious investigator of the phenomenon. Galton noted that his "color-thinkers" held no common agreement. Yet they insisted that the color associations experienced were quite innate and were for the most part not to be explained. Further research also led to the belief that synesthesia was hereditary and that it followed the laws of heredity.

Many of Galton's reports are entertaining and will serve to illustrate a few typical experiences. One of his correspondents wrote: "I do not know how it is with others, but to me the colors of vowels are so strongly marked, that I hardly understand their appearing of a different color, or what is nearly as bad colorless to anyone. To me they are and always have been, as long as I have known them, of the following tints:

"A, pure white, and like china in texture.

"E, red, not transparent; vermilion with china white would represent it.

"I, light bright yellow; gamboge.

"O, black, but transparent; the color of deep water seen through thick clear ice.

"U, purple.

"Y, a dingier color than I.

"The shorter sounds of the vowels are less vivid and pure in color. Consonants are almost or quite colorless to me, though there is some blackness about M. . . . .

"Of my two daughters, one sees the colors quite differently from this (A, blue; E, white; I, black; O, whity-brownish; U, opaque brown). The other is only heterodox on the A and O; A being with her black, and O white. My sister and I never agreed about these colors, and I doubt whether my two brothers feel the chromatic force of the vowels at all."

Another correspondent, the head teacher in a school for girls, wrote: "The vowels of the English language always appear to me, when I think of them, as possessing certain colors. . . . Consonants, when thought of by themselves, are of a purplish black; but when I think of a whole word, the color of the consonants tends towards the color of the vowels. For example, in the word 'Tuesday,' when I think of each letter separately, the consonants are purplish black, *u* is a light dove color, *e* is a pale emerald green, and *a* is yellow; but when I think of the whole word together, the first part is a light gray-green, and the latter part yellow. Each word is a distinct whole. I have always associated the same colors with the letters, and no effort will change the color of one letter, transferring it to another. Thus the word 'red' assumes a light green tint, while the word 'yellow' is light green at the beginning and red at the end. Occasionally, when uncertain how a word should be spelt, I have considered what color it ought to be, and have decided in that way. I believe this has often been a great help to me in spelling, both in English and foreign languages. The color of the letters is never smeared or blurred in any way. I cannot recall to mind anything that should have first caused me to associate colors with letters, nor can my mother remember any alphabet or reading book colored in the way I have described which I might have used as a child. I do not associate any idea of color with musical notes at all, or with any of the other senses."

Galton also wrote of a man who associated colors with numerals in this fashion: 1 was black, 2 was yellow, 3 was a pale brick red, 4 was brown, 5 was blackish gray, 6 was reddish brown, 7 was green, 8 was bluish, and 9 was reddish brown. "These colors appear very distinct when I think of these figures separately; in compound figures they become less apparent. But the most remarkable manifestation of these colors appears in my recollections of chronology. When I think of the events of a given century they invariably appear to me on a background colored like the principal figure in the dates of that century; thus events of the eighteenth century invariably appear to me on a greenish ground, from the color of the figure 7."

Galton presents several charts in which these color associations are illustrated. He shows the appearance of words like "London," "argue," "agree," "grind," "grand," "range," "sweet" in which hues express the particular letters or vowel and consonant sounds as experienced by one individual.

Synesthesia is inborn. Almost always these curious associations are discovered in early years and will persist, without change, during the entire course of a person's life. It is difficult to attribute them to childhood memories or to any definite experiences which might have provided a basis for them.

THE FLIGHT OF COLORS

There are many subjective effects to be noted in the study of color. Two thousand years ago Aristotle mentioned a "flight of

colors" upon looking into the sun. He wrote, "If after having looked at the sun or some other bright object, we close the eyes, then, if we watch carefully, it appears on a right line with the direction of vision, at first with its own color, then it changes to crimson, next to purple, until it becomes black and disappears."

Goethe saw the sequence as brightness first, then yellow, purple, blue. Sun gazing is a dangerous pastime. With less risk a person may gaze at a frosted electric-light bulb or a strongly illuminated piece of white paper. If the stimulus is of high intensity, the sequence may begin at green and proceed through yellow, orange, red and purple, then to blue, fading out in green and black. If the stimulus is weaker, the sequence may begin at purple and proceed through blue, green, into black. Though these hues have no external existence they are quite real to the senses and will move with the eyes, have form, and be localized.

THE WORK OF JAENSCH

In recent years the psychologist has studied mental imagery in general and has discovered numerous and astonishing phenomena. A notable investigator in this field has been E. R. Jaensch. The images experienced by human beings fall into three types— memory images, afterimages, eidetic images. The first of these is the product of mind and imagination, having the quality of an idea or thought. The afterimage is more literal. It is actually seen and may have shape, design, dimension, precise hue. Its size will vary as the eye gazes at near or far distances. Generally it is a complementary image, white being seen where black was originally, red being replaced by green, and so on.

The third type, the eidetic image, is the most remarkable of all. Jaensch writes: "Eidetic images are phenomena that take up an intermediate position between sensations and images. Like ordinary physiological afterimages, they are always *seen* in the literal sense. They have this property of necessity under all conditions and share it with sensations."

Eidetic imagery seems to be the gift of childhood and youth. While somewhat akin to the supernatural, it is none the less a nsory reality. The child playing with his toys may be able to t living pictures of them in his mind. These may not be roducts of the imagination. They may be far more tan- ith dimension, color, movement in their make-up. They rn slides" of the eye and brain, projected into definite, localiz space. They are images as real as projected lantern slides.

The phenomenon for the most part was given little attention up to recent years. Because it vanishes with age and is likely to disappear at puberty, the adult mind, capable of dealing with it, relegates it to the fervid period of childhood. Nevertheless images are seen. Pictures stand before the eyes and details are distinguished in them which may be counted and identified in hue. According to Jaensch, eidetic images are subject to the same laws as other sensations and perceptions. They are, "in truth, merely the most obvious sign of the structure of personality normal to youth." And they make for fascinating study.

THE EIDETIC FACULTY

For most persons there is an admitted gap between sensation and imagery. However, Jaensch says, "Some people have peculiar 'intermediate experiences' between sensations and images." They are true eidetics whose responses are quite frank and spontaneous. To them sensation and imagination may go hand in hand and be closely united in some literal and graphic visual experience.

To discover this eidetic personality Jaensch has outlined three test procedures. Although he is aware of the faculty in small children, he prefers youngsters of ten years or more, because they are better able to comprehend what the psychologist is trying to find out and to express themselves coherently.

First, the individual (or group of individuals) is cautioned that literal images and not memory pictures are to be recorded. To reveal the character of the true eidetic image simple experiments are made with afterimages. A square of red paper is concentrated upon for 20 seconds against a gray background. The individual then sees a green area of similar size. He is told that this is a real experience and has a physiological basis.

Repeating the experiment, but shortening the exposition time of the color sample, individuals are found who continue to see afterimages of prolonged duration. To a few, the afterimage will no longer be complementary (a green afterimage for red), but an image that is the *same* hue as the sample. Here the eidetic faculty is of relatively high degree.

Second, the eidetics, now detected, are shown a fairly complicated silhouette picture having numerous details and being slightly larger than a postcard. This is fixated for 15 seconds. The average person will see a somewhat blurred image, having bright and dark areas that are complementary to the original (and more like a normal afterimage). The eidetic, however, will see the whole picture or a greater part of it, and in colors that correspond to the original!

Third, the above experiments are continued with other pictures having an interest to attract the child. The fixation period is shortened still more. The true eidetic is revealed, and the pictures continue to live for him, projected before his eyes as literal things and experiences!

Eidetic images are filmy like afterimages. Although the original objects which prompt them may be of textured hues, the eidetic image is more like light. It is, as mentioned, a positive rather than a negative "picture." In some instances it may be tridimensional. Jaensch reports that the eidetic image is easier to recall than the memory image and will, of course, be more "real" when it is recalled.

He also found that treatments with calcium caused the eidetic disposition to be weaker. The image seen under this circumstance was likely to be complementary in hue and brightness to the original. Conversely, treatments with potassium occasionally made a latent type active and considerably heightened the eidetic disposition, giving it greater intensity.

PSYCHOLOGY AND PSYCHIATRY

The phenomenon of eidetic imagery has much of the fascination of extrasensory perception. In a more practical light, however, it may serve useful ends. Jaensch writes, "The eidetic investigators have already shown that the closest resemblance to the mind of the child is not the mental structure of the logician, but that of the artist." In education, the forcing of an adult viewpoint, mind, and manner upon the child may suppress the eidetic personality and consequently may stand in the way of creative and natural expression. Heinrich Klüver, an American investigator, writes: "For example, an eidetic child may, without special effort, reproduce symbols taken from the Phoenician alphabet, Hebrew words, etc. Or a person with a strong eidetic imagery may look at a number of printed words for a while and then go to the dark room and revive the text eidetically. It is possible to photograph the eye-movements occurring during the reading of the eidetic text."

The eidetic faculty is known to exist among primitive people and is unquestionably experienced by human beings under the influence of drugs. The curious hallucinations of the insane, the "miraculous" statues that move, speak, bleed, the "visions" of religious ascetics, may be traced in part to the phenomenon. Werner writes, "It is furthermore probable that the so-called naturalistic art of primitive hunters (Eskimos, Bushmen, etc.) is based on eidetic images which are actually seen as projected on the surface of the material on which the picture is to be drawn or painted."

Some authorities have striven to relate eidetic imagery to personality. Introverts are said to show a tendency to see meaningful, interrelated wholes. Extroverts tend to have reactions that are more objective and analytical in character. In psychiatry the eidetic image has been termed an "undertone of psychosis." No doubt the subject has psychiatric importance. It may, for example, have bearing on theories of hallucinations. It may also throw new light on the mysteries of human perception and on the dynamics of life in general.

PSYCHIC PHENOMENA

Explanations of psychological and psychic phenomena are not always easy—and indeed unnecessary. There are in man many strange and inexplicable mysteries regarding color. Thus to end this chapter, here are quotations from an article written by John J. O'Neill for the *New York Herald Tribune.*

"A telepathic antagonism to the color red has been revealed by experiments in extra-sensory perception conducted by Professor Gardner Murphy and Ernest Taves, of the Department of Psychology, Columbia University, as part of the research program of the American Society for Psychical Research. . . .

"In many of the experiments the choice was limited to two possibilities—yes-no, heads-tails, black-white. Other tests employed the ordinary extra-sensory-perception cards and a deck called 'Rook cards,' fifty-six cards made up of four suits, each suit numbered from one to fourteen and each suit in a different color. . . .

"When the readings of the Rook cards were tabulated and analyzed, it was found that the group as a whole had a slightly above-average record. When the results were subdivided by the color of the cards it was found that when calls were made of the suit in which the figures were printed in red on a white background the scoring dropped significantly lower than in any other test. . . .

"This effect involving red was considered so interesting that Professor Murphy communicated with several professors of psychology in universities throughout the country asking that the test be repeated by them. He made more extensive tests with the red cards among the American Society for Psychical Research group, running the total readings up to 6,975. Again the antagonism to red was found. . . .

"Despite the fact that the subjects were not informed when they were working with red cards, they became aware of it. Somewhere below the level of consciousness they sensed that involved was some faculty which prevented them from making a record as good as usual in identifying the cards by telepathy. This faculty had the same effect on the telepathic process as a red traffic light or a red danger sign. . . .

"The Columbia scientists, in commenting on the unusually low record on the red cards, declare: 'We have tentatively adopted a hypothesis, but further research is necessary before much can be said about it. It would appear, at least, that there

may be something about the red-white situation which arouses negativism. This may be because of obscure effective factors—the symbolic values of red and white are deeply ingrained in our culture, at least, and this general effective tone of the material used may have something to do with the type of results obtained.' "

eye due to stimulation of other receptors should then be attributed to an immediate action of the sympathetic nervous system upon the visual center in the cerebrum" (Kekcheev). Not only does man find his vision reacting to the stimulation of his other senses, but mental effort, a will to see clearly, will in itself improve the acuity of his eyes.

CHAPTER 18

Problems of Eyestrain

It is generally understood these days that abuse of human eyes has many baneful consequences. Problems of eyestrain, glare, illumination, brightness, and color have become so acute that applied sciences known as "brightness engineering" and "color conditioning" have been developed within the past decade to cope with them. Here is a new field of utility for color, based on a functional approach and proved through measurable facts, technical research, and reliable engineering methods.

Where the eye is unduly fatigued, a long chain of reactions takes place within the body. The purpose of this chapter is to state the major causes of eyestrain, to deal with physiological reactions, and to set forth a number of scientific principles which have wide practical application in the correction of adverse seeing conditions. Such study has wide practical value.

WHAT IS EYESTRAIN?

The term "eyestrain" is perhaps none too well chosen. However, its use is so common, even among scientists, that it has become indispensable in writing of what may more properly be called "ocular fatigue." In a broad sense, constant and even excessive use of the eyes is no more harmful than a corresponding use of other organs or muscles of the body. One seldom thinks of physical exercise as strain. There is little reason to conclude that a man who uses his eyes extensively during his working day is any worse off than a man who, during the same period, digs a ditch.

Except where there may be conditions of extreme brilliance or glare, the eyes are not easily "worn out." Indeed there is plenty of evidence to indicate that vision is improved with use. Many persons are of the false opinion that "eyestrain"—where it may be found to exist in some bad situation—has to do with fatigue of the nerves on the retina. On the contrary, it is of muscular origin. This will shortly be explained. It is almost impossible to "tire" the eyes by exposing them to reasonable changes in brightness. Obviously, direct peering at the sun will cause damage. Yet as Luckiesh states, "Since the compensating mechanism of the visual process may mediate brightness changes of perhaps a million to one, it is reasonable to assume that changes of less than a hundred to one do not tax the eyes sufficiently to induce ocular strain or any other human undesirable effects." The human eye may quite safely go about any normal tasks of seeing, as it has been doing for millions of years, and be all the better for its exertions—unless, of course, the tasks set upon it exceed the stress intended by nature.

The eyes of man are quite capable of prolonged work and hard work. To say that too much seeing causes eyestrain becomes as illogical as similar references to "earstrain," "touchstrain," or "tastestrain" because of too much hearing, touching, or tasting. If the eyes are abused, this is not as a rule traceable to overwork or overuse but rather to a harmful exposure to stimuli which make normal visual functions difficult or impossible.

FREQUENCY OF EYE DEFECTS

Figures compiled by the U.S. Public Health Service indicate that about 22 per cent of public school students have defective vision. In colleges the percentage rises to 40. A percentage of 50 is reached in persons between the ages of thirty and forty. At the age of fifty, defective vision reaches a frequency of 70 per cent. At the age of sixty, the frequency is above 90 per cent.

D. B. Harmon, however, writes of even higher percentages compiled during recent studies of elementary school children. He states that "59.0 per cent of the Anglo-American children in the elementary schools have refractive eye defects or various disturbances that are affecting or distorting their visual sensation." Like other authorities, Harmon has noted a relationship between faulty vision and other physical and psychological disturbances with an individual. For example, 62 per cent of school children with low physiological ages and low educational ages had visual defects. The backward child, not the bookish one, may need glasses.

THE CAUSES OF EYESTRAIN

Many authorities, particularly in the lighting field, unfairly quote figures on visual deficiency and imply that impaired eyesight is caused chiefly by difficult seeing tasks and by inadequate levels of illumination. It seems easy to convince the layman that his eyes will go bad if he uses them too much or if he doesn't have enough light over his tasks. However, it would be far more accurate to state that good eyesight springs first from heredity. Parents with good eyes are likely to have children with good eyes. Further than this, visual defects are to be traced to (1) serious illnesses, (2) poor diet, (3) critical seeing tasks which severely tax the eyes, (4) an environment which is extreme in glare or brightness contrasts, and (5) insufficient illumination.

It will be noted that in the above order of things, lighting is placed last. Indeed, its importance to safe and comfortable seeing is too frequently overrated. Too much light and too much glare are often worse than too little illumination. Besides, level of illumination is seldom the right criterion of an ideal seeing condition. In a very comprehensive study made by Ernst Simonson and Josef Brozek the conclusion was reached that, "In general, illumination engineers tend to exaggerate the effect of variations in the illumination level." These two investigators failed to note much difference in eyestrain under different light levels ranging from 5 to 300 foot-candles. After a very complete set of tests they wrote, "The only possible interpretation is that fatigue trends resulting from visual work must be produced by components which are common to all illumination levels. The illumination level is by no means the all-important variable for the development of visual fatigue."

Yet despite the fact that the human eye can do a prodigious job of seeing, it can be harmed by extreme glare, by excessive brightness extremes, by exposure to harmful fumes and harmful radiation. Tasks that require prolonged convergence of the eyes, that involve minute details, exacting mental judgment, and discrimination may all produce fatigue and directly as well as indirectly affect the human organism in general.

Where the eye is taxed, where seeing is attempted under severe tension or strain, a number of physiological and psychological reactions are to be observed.

The eye itself may increase its rate of blinking.

There may be a dilation of the pupil after several hours, even though the intensity of light may not change.

Power to hold the eyes in convergence, to distinguish small brightness differences, to focus for a clear image may be reduced.

There may be a reduction in sensitivity on the outer boundaries of vision. The eye may be less able to see clearly on the peripheral areas of the retina.

Most of these effects will disappear if the eyes are rested. However, prolonged abuse may result in permanent damage. The pathology of eyestrain has been treated at length by Ferree and Rand. The chief cause of distress is usually traceable to high and disturbing brilliancies in the field of view. Such brilliancies may constrict the pupillary opening and hence deprive the eye of sufficient light to see clearly. As a consequence, there may be unhealthy congestion within the blood vessels of the eye. In young persons these congestions may actually cause elongation of the eyeball and thus nearsightedness. As Ferree and Rand conclude, there may be disturbances in the mechanism of the eye, the iris and lens. There may as well be damage to the retina itself which may take the form of inflammation or detachments. "The eye has grown up under daylight. Under this condition only three adjustments have developed, and indeed only three are needed: the reaction of the pupil to regulate the amount of light entering the eye and to aid the lens in focusing the light from objects at different distances, and accommodation and convergence to bring the object on the principal axis of the lens and the image on the fovea. . . ." These adjustments tend to be coordinated. When they are separated, trouble is encountered. High brightness in the field of view, if isolated from the task, may cause disruption. The eye will thereupon struggle to set things right. *"This striving to clear up its vision by ineffectual maladjustments is the cause of what is commonly called eyestrain."*

OTHER MANIFESTATIONS

Where a wretched seeing condition may prevent the eye from seeing clearly, the eye will none the less try to do its best. Out-of-focus motion pictures, for example, may cause the lens of the eye to struggle without avail. When any kind of eyestrain persists, muscular tension throughout the body will be found to increase. Again, blood pressure and pulse rate may rise. The individual may experience headache, nausea, nervousness, and irritability.

Luckiesh has suggested a possible relationship between critical seeing tasks and the prevalence of heart disease in modern times. "A recent study of occupational morbidity and mortality by the United States Public Health Service revealed that in one company, with approximately 6,000 workers doing precision assembly of small parts, almost 80 per cent of the mortality cases in five years involved heart trouble. The trend with the rest of the 59,000 industrial workers whose occupational and illness records were studied was quite similar. It is conceivable that the reflex effects of critical seeing and the prevalence of mortality causes from heart trouble in occupations demanding critical seeing may be related."

At times the indication of eyestrain may be almost wholly mental or psychological. In one case study made by the author, nausea and illness among a group of women employees were

found to be caused by an inability to classify colors in a complicated electrical wiring task, not by insufficient light. Because management had stressed the need for accuracy, and because the employees had great difficulty in distinguishing certain colors from each other (orange from tan, blue from blue-green, etc.) the severe mental effort needed to perform the job wore out human patience and sent the workers to the plant dispensary to rest and recuperate.

That the mind will contribute to eyestrain may be commonly experienced when a person decides to read or to perform some difficult seeing task in extremely dim or extremely brilliant light. It is no strain to sit on a beach at noon or on a porch at night and gaze into distance. Yet an attempt to read under either of the above situations may promptly cause fatigue and distress until some adjustments are made.

Tremendous fear, as well, may raise havoc with the sense of sight. Psychological blindness has been encountered in soldiers. Although the eyes may be quite normal, the brain may pay no attention to the messages it receives. Thus while the eyes may "see," there is no vision because the sensations recorded in the brain have not the slightest meaning. Psychological blindness may follow sudden shock and may be restored through shock.

ILLUMINATION

Most living things, plants as well as animals, orient themselves to brightness. Harmon notes that posture disturbances in children may follow poor distribution of light within a classroom. The pupil may bend his spine, slant his shoulders, twist his head in an effort to see more easily. If such practices are maintained day after day, there may be visibly bad posture and even change in the normal shape of bone growth.

Amount of illumination is never the most important factor in establishing an ideal seeing condition. Ferree and Rand have stated, "If, for example, the light is well distributed in the field of vision and there are no extremes of surface brightness, our tests seem to indicate that the eye, so far as the problem of lighting is concerned, is practically independent of intensity." This is obviously true because of the phenomenon of color constancy and the fact that the eye, through millions of years of development, can adjust itself quite efficiently and effectively to widely different degrees of light intensity.

Aside from intensity, however, how is the eye affected by illuminants having different color qualities? The human eye has evolved under sunlight which is yellowish in tint. This region of the spectrum marks the point of highest visibility. Yellowish light is excellent light, creates clear images, is relatively free of aberration or blur, and is æsthetically pleasing.

Contrary to popular belief, ability to see clearly diminishes as the illumination approaches the blue end of the spectrum. Ferree and Rand write: "The clearest seeing, also the greatest speed, power to sustain, etc., are given by the wave lengths in the mid-region of the spectrum—the yellow, the orange-yellow and the greenish yellow." The colors least desirable in a light source are green, red, and blue, the last being the most objectionable.

Ordinary incandescent lamp bulbs and fluorescent tubes of 3500 degrees color temperature are wholly satisfactory for good and comfortable seeing. Because of the action of color on the focus of the eye, farsighted persons may prefer a warm tint and nearsighted persons a cool tint. Warm light will tend to make the lens of the eye convex and thus aid the farsighted eye. Conversely, cool light will tend to make the lens flatter and to aid the nearsighted eye.

Some authorities have suggested that fluorescent lamps and other light sources which emit ultraviolet radiation may be harmful through the rapid destruction of vitamins in the fluids of the eye—leading in turn to certain nutritional disturbances within the body. Such speculations have been hotly contested but still find occasional reference. As Luckiesh states, "There is no more fruitful field for quacks and quackery than in the field of light, color and radiant energy."

None the less, lights and light sources that differ markedly from sunlight or daylight are likely to be rejected by the average person. Whether the objection be psychological in origin or have its basis in a physiological effect as yet unknown, it is safe to conclude that illumination should, in color quality, be as like nature as possible.

BRIGHTNESS ENGINEERING

Luckiesh has written, "A visual task is inseparable from its environment. . . . High visibility, ease of seeing and good seeing conditions are overwhelmingly the result of good brightness engineering." Eyestrain thus finds its master not solely in illumination, nor in proper diet and medical care, but also in color and the ability of color to add efficiency and comfort to seeing. It is obvious, for example, that if great brightness extremes exist within the field of view, the pupil of the eye will be forced to undergo constant changes of adjustment. Areas too light in color may set up psychological distractions and pretty well defy concentration on other objects and tasks. "The eyes often adjust themselves to a bright peripheral object notwithstanding the fact that the attention is directed elsewhere" (Luckiesh). Seeing would be as difficult under this condition as would be the attempt to hear a speaker while someone kept ringing a bell.

To summarize the requirements of good seeing and to anticipate the principles of functional color and the case histories to be set forth in the next chapter, here are a series of general conclusions:

The problems of illumination, brightness, and color in the creation of ideal seeing conditions are complex. They cannot be solved from the standpoint of optics alone, for important physiological, neural, and psychological factors must all be considered.

Seeing efficiency and comfort are not to be assured merely through light intensity. In fact, it cannot authoritatively be said that dim light is any worse on the eyes than brilliant light. Without question the eye needs light in order to see, and high levels seem more desirable than low levels. However, high levels, without attendant adjustments in the brightness of the environment, often cause glare and unfavorable extremes which waste light and handicap vision.

Ferree and Rand have reported: "The presence of high brilliancies in the field of view produces a strong incentive for the eyes to fixate and accommodate for them, which incentive must be controlled by voluntary effort. The result of this opposition of voluntary control against strong reflex incentive is to tire the eye quickly and to make it lose the power to sustain the precision of adjustment needed for clear seeing of the work."

In the main, if the equipment of a room is dark in color and cannot be changed and if surrounding walls are pale in tint, light levels beyond 25 or 35 foot-candles may cause trouble. If higher brightnesses can be introduced (but not beyond reflectances of 60 per cent, except on ceilings) higher light levels may also be introduced and very excellent seeing conditions may be achieved.

Thus great increases of light intensity in average American offices, factories, and schoolrooms will not be practical unless a

tremendous amount of cooperative effort in brightness engineering is shown by fabricators of flooring materials, desks, filing cabinets, machinery, woodwork, paints, etc.

Until then, and for average seeing tasks encountered today in average interiors, light intensities approaching 25 foot-candles are satisfactory. Fairly critical seeing tasks may be performed under 25 to 50 foot-candles.

In the opinion of the author, general room illumination should not—except under very carefully controlled conditions—exceed 100 foot-candles. Where high light intensity seems necessary, supplementary illumination sources should be introduced directly over the workplace or task.

On the matter of reflectance, one point should not be overlooked. Average human complexion among Caucasians reflects about 50 per cent of light. Because practically all interiors are engineered for human occupancy, wall tones (and the colors of floors, equipment or machines) should not be very high in brightness. If they are, human appearance will suffer. Halos may appear about faces, and skin tones may grow deep and muddy. Too, the compelling attraction of the bright surrounding may set up annoying distractions to make the concentration of attention on tasks quite difficult. For a really ideal interior, no colors should reflect less than 25 per cent nor more than 60 per cent (except ceilings).

Low brightness contrasts are desirable. Glare should be overcome. Seeing is at its best where the brightness of the task moderately exceeds the brightness of its surroundings. Monotony should be avoided. Careful study must be given to the psychologic aspects of vision, to such phenomena as color constancy. For the seeing process is in the brain, in the psychic make-up of the individual, as well as in the organ of sight.

CHAPTER 19

Functional Color

THE TERM "FUNCTIONAL COLOR" is generally applied to uses and applications of hue in which beauty or appearance are secondary to more practical purposes. Where color may be employed to aid visual acuity—as in a hospital surgery—it is obvious that an objective rather than subjective attitude must be taken; good vision must be served, not the likes and dislikes of an individual. In other words, a great number of color problems are to be handled through technical rather than artistic methods. Functional color is concerned with measurable facts. It is founded on research, on known visual reactions, on data which may be statistically analyzed. It differs from so-called "interior decoration" in that personal preferences or emotional attitudes are denied for well-ordered scientific prac-

tice. A further difference may be stressed as follows: *beauty* in a decorative color scheme has no criterion other than taste or opinion; *functionalism* in a color scheme is entirely dependent upon tangible evidence.

VISIBILITY

Visibility is one factor in color that may be readily measured. The ability to see clearly may be determined by experiment and test and requires neither feeling nor judgment. As has previously been mentioned, the eye sees best in white, yellowish, or yellowish green light and worst in blue light. Thus sunglasses are best when tinted either yellow or yellow-green. These colors may not only increase visibility and acuity by cutting down the excess brilliance of full sunlight, but they will screen out the disturbing influence of ultraviolet. In fact, on a sunny day yellow glasses may actually improve vision and help the eye to see more clearly into distance.

In light signals, bright lights are obviously more readily seen than dim lights. Where intensities are kept uniform, however, red light is the easiest to recognize, followed by green light, then yellow, then white. Blue and purple are not well focused by the eye and tend to appear blurred. Such radiation is also "scattered" by atmosphere.

As to the apparent size of colors, yellow and white will be seen as largest, then red, green, blue. The quality of dimension (nearness or farness) is directly influenced by the optics of the eye. Red, for example, focuses normally at a point behind the retina. To see it clearly, the lens of the eye grows fat (convex), pulling the color nearer. Conversely, blue is focused normally at a point in front of the retina, causing the lens to flatten out and push the color back. Walls writes, "Since the dioptric [refractive] apparatus ordinarily places the yellow focus in the visual-cell layer, we must actually *accommodate* when diverting our attention from a blue object to a red one at the same actual distance from the eye, and must relax accommodation upon looking back at the blue object."

Yellow is the color of highest visibility not only in light sources but in surface colors such as paints. Combined with black it is the most legible of all color combinations. Next in order are green on white, red on white, blue on white, and white on blue, with black on white sixth. This particular order of superiority, however, is better adapted to posters or road signs than to book papers. Where the problem may also involve *ease* of seeing (not visibility alone) other factors must be reckoned with. For one thing, a bright color such as yellow would tire the eyes after prolonged concentration and would create a disturbing afterimage.

TINTED BACKGROUNDS

A great deal of scientific study has been given to the development of ideal backgrounds for critical seeing tasks such as reading. One common assumption that a green tint is easy on the eyes has been disproved by several authorities. Ferree and Rand write, "Any toning of the paper towards green is unfavorable in that it increases the tendency to ocular fatigue and discomfort." As with light sources, papers or backgrounds are quite ideal when white. Where a tint might be desired the yellow, yellow-orange, or yellow-green region of the spectrum would be suitable. "All coloring is inferior to white if the printed characters are to be black" (Ferree and Rand). Next in order would be a pale ivory or cream, then a pale yellowish green. However, because legibility is directly related to degree of contrast, black on white or black on ivory are hardly to be excelled.

Visibility may differ as light intensity differs. In strong light, white objects or details on a black background seem most favorable. In weak light, black objects on a white ground are best. These facts were examined by the author during the Second World War in a study of instrument dials for the U.S. Navy. Under low levels of illumination the white dial not only was easier to locate visually, but its markings could be more quickly read. In this connection Ferree and Rand have written, "Our results on speed of vision have shown that near the threshold of acuity, *i.e.,* for small visual angles and low intensities of illumination, speed of discrimination is higher for such objects as a black letter on white . . . than for a white letter on black."

COLOR CONDITIONING

The applied science known today as "color conditioning" is greatly concerned with problems of visibility, acuity, and ocular fatigue. It deals with seeing conditions encountered in factories, offices, schools, hospitals, and it seeks to give them perfection through the specification of tried scientific principles.

For a brief historical review, color conditioning had its beginning in the mid-twenties of this present century. At that time studies were made in hospitals to lessen glare and improve the vision of the surgeon. To accomplish this, new techniques were worked out whereby the degree of fatigue could be measured by instrumental means. Results were achieved in the control of brightness and hue that quite definitely established the value of color in aiding human efficiency and well-being.

As adapted to hospitals and schools—and later to industrial plants and offices—color conditioning was applied to increase production, improve quality of workmanship and normal skill, reduce "seconds" and "rejects," cut down accident frequencies, raise standards of plant housekeeping and machine maintenance, reduce absenteeism, and improve labor morale.

Tremendous impetus came during the war period when production had to be increased, when labor was scarce, when finer tolerances were demanded in product manufacture. The value of color conditioning was widely tested and accepted.

THE CASE AGAINST WHITE

The optical system of the human eye is regulated by the amount of light that enters it. This makes brightness an important factor in the action of seeing. While uniformity of brightness is highly desirable for efficient and comfortable vision, extreme departures from such uniformity cause trouble.

With illumination, for example, two lighting systems may deliver the same number of foot-candles on a working surface. Yet if in the one system the fixtures are exposed and if in the other system the fixtures are concealed, eye adjustments will differ. Where the fixtures are exposed, the pupil of the eye may be unduly constricted and seeing may be difficult and probably painful. In an authoritative study made by R. J. Lythgoe of England, it was found that visual acuity increases at a steady rate as the surrounding brightness is raised to equal the brightness of the task. However, where the surrounding brightness *exceeds* the brightness of the task, acuity immediately collapses. Luckiesh has stated, "It may be concluded that brightnesses somewhat lower than those of the central field are generally most desirable. All experimental evidence indicates that peripheral brightnesses higher than those of the central field are definitely undesirable."

Despite the fact that some lighting engineers may freely recommend white and off-white colors for working environments (to gain as much light as possible per watt consumed) the bright

environment is quite objectionable. White walls may close the pupil opening, make seeing difficult, and set up annoying distractions. For the sake of a 5 or 10 per cent increase in lighting efficiency, there may be a drop of 25 per cent or more in human efficiency. Where a working environment may have dark floors, dark equipment, or dark materials, wall colors must be soft in tone to have the seeing condition right.

A REVIEW OF PRINCIPLES

It is quite possible to set forth ideal brightness specifications for factory and office conditions. Ceilings—almost without exception—should be white. This will be essential to the efficiency of indirect lighting systems. In direct systems, the white overhead will reduce contrasts between fixtures and their surroundings. Being "neutral," white will also attract less psychological notice and hence prove nondistracting.

Upper walls (generally to a line level with the bottom of roof beams or trusses) should have a reflectance between 50 and 60 per cent (if floors and equipment are on the dark side) or between 60 and 70 per cent if most areas and surfaces in the interior are (or can be made) fairly light. Wall brightnesses higher than 70 per cent seem to be allowable only where the most perfect and modern lighting system is installed and accompanied by pale floors and equipment—or for unimportant spaces such as storage where critical seeing tasks are not performed. It must not be forgotten, however, that bright walls are by no means flattering to human appearance.

If a dado is required to conceal stains, the color tone should reflect not less than 25 per cent and perhaps not more than 40 per cent. Floors should reflect at least 25 per cent if such is practical. Machines, equipment, desks should have a reflectance factor between 25 and 40 per cent, lighter when the floor is light and deeper when the floor is dark.

These ratios and percentages have been successfully applied in numerous plants and thus have the benefit of widespread trial and research.

Certain refinements are also to be introduced. Window sash ought to be white or a light tint to lessen contrast with outside brightnesses. Machinery may be highlighted in accordance with the principles of du Pont three-dimensional seeing to reflect more light at important parts and concentrate the attention of the worker. In numerous fine seeing tasks, background shields may be constructed to (1) reflect light and provide immediate contrast with materials, (2) confine the vision of the worker and hold eye adjustments relatively stable, (3) blank off shadows or movements in the distance, and (4) give the worker a better sense of isolation. Normally such shields should cover from 45 degrees to 60 degrees of the visual field.

End-wall treatments in medium tones also have widespread application. Where most workers may be engaged at difficult eye tasks and may be so oriented as to face in the same direction, the wall ahead may be colored in a pleasing tint having a reflectance of from 25 to 40 per cent. The end wall will help to overcome an unfavorable constriction of the pupil. Upon glancing up, it will afford relaxation rather than the stimulation of glare. It will likewise relax the strain of prolonged convergence and be psychologically pleasing and restful. Here again is a principle widely and successfully employed in industry.

TYPES OF COLORS

For industrial purposes, soft, delicately grayish hues are best. They are lacking in aggression, less distracting, and they most

effectively conceal dust and soiling. Ordinarily, primitive colors such as blue and yellow are tiresome. Where subtlety exists (bluish green, peach, etc.) a more comfortable environment will be found and one that will "wear well" over prolonged periods.

It is logical to use "cool" colors such as green or blue where the working condition exposes the employee to relatively high temperatures. Conversely, "warm" tones of ivory, cream, or peach are suitable to soften up a vaulty or chilly space and compensate for lack of natural light.

In purely casual spaces, such as washrooms, rest rooms, cafeterias, lighter and cleaner hues may be used. In view of average color preferences, blue becomes ideal for facilities devoted to men, and rose for facilities devoted to women. In stairwells and corridors, usually deprived of natural light, bright tones of yellow are effective. In storage areas, white is best and will make the most of existing lighting installations.

Where critical seeing tasks are performed, however, and where distractions are to be avoided, the best colors to use are soft variations of green, gray, and blue. Large, vaulty spaces may be enlivened with ivory, cream, or peach over all walls, or yellow over end walls. Gray machinery highlighted with buff on important parts and working areas will prove effective. Medium gray is also ideal for unimportant elements such as bins, racks, shelving. One must remember that color is more compelling than neutrality. Hence, if it is strategically applied, it can make order out of chaos, distinguish important from unimportant elements, and help the worker in his mental effort to concentrate on his task. In theory as well as practice, the purpose of color is not so much to "inspire" the worker; too much of this attitude may lead to distractions and irrelevancies. On the contrary, color becomes integral with the task, not foreign to it. Improved efficiency and relief from fatigue become automatic because the human eye can see more easily, with less strain. Color is made to fit in rather than stand out. It contributes to better visibility and to an agreeable and cheerful frame of mind.

THE MEDICAL PROFESSION

Wherever possible the applied science of color conditioning deals with facts—production records, accident statistics, instrumental measurements of the eye. It is not promoted to sell paint or new equipment in brighter finish. It is intended to pay dividends in increased efficiency and the conservation of human energy. Hence it is of interest to review some of the more palpable facts of functional color and to quote the results of a few competent research studies.

The author has been privileged to present the scientific aspects of color conditioning before national conventions of the medical profession. Through books and special publications, the best principles of color have been assembled for use in the graduate training of ophthalmologists. By and large the medical profession recognizes that color is intimately related to safe and hygienic seeing. Physicians and surgeons in the field of vision are today devoting special attention to the industrial aspects of color in practically every leading medical school in America.

NATIONAL INDUSTRIAL CONFERENCE BOARD

A thorough investigation into the value of color in industry has been published by the National Industrial Conference Board. Over 350 companies which had used color on a small or large scale were asked to comment on a long series of questions. It was found, however, that many "companies were unprepared to

evaluate their programs primarily because of the difficulty involved in measuring the effects of a service as intangible as color."

Yet despite the newness of the science of color conditioning, the facts divulged were quite impressive.

64.7 per cent of companies stated that color had improved lighting.

27.9 per cent reported production increases.

30.9 per cent noted an improvement in the quality of work performed.

19.1 per cent commented favorably on reduced eyestrain and fatigue.

14.7 per cent credited color for reduced absenteeism. This is also an indication of better morale.

All in all, 75 per cent of companies were entirely or well satisfied with their color programs; 5.9 per cent were not satisfied; 19.1 per cent had no opinion one way or the other.

U.S. PUBLIC HEALTH SERVICE

A competent and reliable evaluation of color has been prepared by the Public Buildings Administration in Washington and the U.S. Public Health Service. This involved a two-year investigation of work production in a government office and was singular in that all details of it were carefully guided by authorities in the fields of vision, illumination, and color. Production data were assembled by the Bureau of Internal Revenue.

A controlled study was undertaken to measure the working efficiency of a group of employees using business machines. Three conditions were analyzed: (1) the original room; (2) the room with the addition of new lighting fixtures; (3) the room with the further addition of color.

The fact that uniform brightness is essential to efficient and comfortable seeing has been confirmed by the above report. Under the first condition, the highest brightness in the room measured 1,195; under the second condition it was 47, under the third condition it was 20. Even more significant, brightness ratios under the first condition were over 100 to 1. The addition of new lighting (condition 2) reduced the ratio to 40 to 1—this being still excessive. Where proper color conditioning was done (condition 3) the brightness ratio was lowered to an ideal 4.7 to 1.

As to worker efficiency, one task had an improvement of 37.4 per cent. However, a fair and conservative figure of 5.5 per cent has been set as the general improvement shown.

In cash value, this 5.5 per cent production improvement was equivalent to a saving on gross payroll of $13,229 among some 95 government employees. If this figure is a credible one—and the author fully believes that it is—one may state that right illumination and right color are worth about $139.25 annually per average employee in American industry today! An organization having 100 employees would thus realize a year's saving of $13,925. For 1,000 employees, the annual saving would be $139,250. These dollar figures, of course, would apply only where the conditions before and after were comparable to those of the government study. However, because countless factories and offices are found that are as bad or worse, the dollar value of color is substantial and is hardly to be overlooked as a sound business investment.

SAFETY

A color code for safety was developed in 1944 by the writer in collaboration with du Pont. It was later accepted in substantial part as a national standard by the American Standards Association and has since had an impressive history. Its general organization is as follows:

Yellow (or yellow and black bands) is standard to mark strike-against, stumbling, or falling hazards. It is painted on obstructions, low beams, dead ends, the edges of platforms and pits. Being the color of highest visibility in the spectrum, it is conspicuous under all lighting conditions and well adapted to the above purposes.

Orange is standard for acute hazards likely to cut, crush, burn, or shock the worker. It is painted around the edges of cutting machines and rollers. On the inside areas of machine guards and electric switch boxes, it "shouts loudly" when such devices are removed or left open.

Green is standard to identify first aid equipment, cabinets for stretchers, gas masks, medicines, and the like.

Red is reserved entirely and exclusively for the marking of fire protection devices. It is painted on walls behind extinguishers, on floors to prevent obstruction, on valves and fittings for hose connections.

Blue is standard as a caution signal. The railroad industry employs it to mark cars which should not be moved. In factories it is placed as a symbol on equipment, elevators, machines, tanks, ovens, etc., cut down for repair. It may be used on switch control boxes as a silent and unobtrusive reminder for the worker to see that his machine is clear before he operates it.

White, gray, or black are standard for traffic control and good housekeeping. They are used for aisle marks, painted on waste receptacles. White corners and baseboards may be used to discourage littering and to get the sweeper to dig into corners.

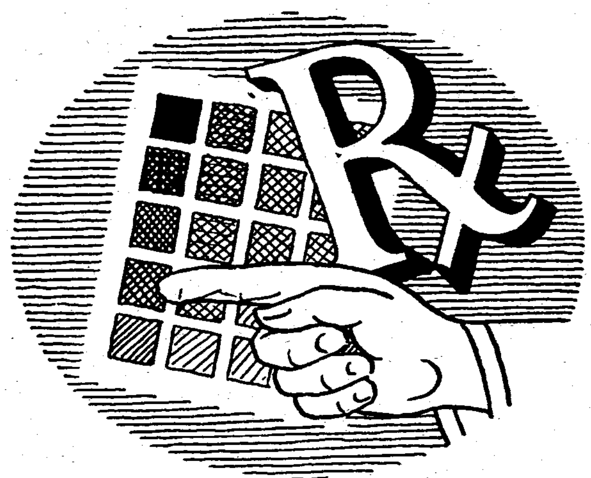
This code was widely employed during the Second World War and is today mandatory in all shore establishments of the U.S.

Navy. In a release issued by the U.S. Army Service Forces, a reduction in accident frequencies was reported in some government plants from a rate of 46.14 to 5.58 per cent. In one quartermaster depot, disabling injuries were cut from 13.25 to 6.99 per cent.

A carefully supervised and installed safety color code similarly reduced accident frequencies 42.3 per cent for the New York Transit System, which employs 38,000 workers. In this instance the color application was supplemented by a concentrated program of safety training and has had very dramatic results. In terms of cash value, a 42.3 per cent reduction in accidents among 38,000 workers is equivalent to a saving of $500,000 in one year as figured by compensation insurance statistics.

Government records place an average value of $1,044 on every industrial accident. Obviously, adequate protection against loss of life or limb not only is imperative from the human standpoint but is financially sound as well.

No doubt as the factual story of color is further enlarged and as added case histories are assembled, practical applications will be broadened and increased. Man's control over his environment will be better and more intelligently directed. He will find many of his problems lessened, for color is sorely needed in many places and will be found to repay its investment many times over when put to the test.



CHAPTER 20

The Prescription of Color

A PRACTICAL ART and science of color holds great potential benefit. From a study of the therapeutic and psychological aspects of the hues of the spectrum, it becomes possible to exert greater control over color mediums and to attain many vital ends. Taste and temperament may be supplemented by a surer knowledge of the influences of color in human life. Where formerly an artist or decorator might search his soul for inspiration, he may now—if he will educate himself—write prescriptions which have a basis in fact rather than fancy and which add definite functions to beauty. Although the progress of research must be endless, it is possible today to summarize and apply a tremendous fund of available data and to improve upon the principles and practices of yesterday.

Where the use of color relates to human comfort and well-being, color may have no great intrinsic value unless it is tastefully and artistically employed. Red, for example, may be exciting to most persons. Yet if in a hospital or a home it is painted on bare walls, any physiological effect may be canceled by a natural revulsion for crudeness. Red—or any other hue—to be therapeutically or psychologically stimulating must also be æsthetically pleasing.

Needless to say, many tests of color have failed because the above requirement has not been met. To seat human beings in cubbyholes or booths finished in different hues and attempt to measure their reactions would be both ludricous and futile. Unless the test procedure compares favorably with the eventual condition under which color will be applied, and unless it may be agreeably undertaken, the human equation may destroy the scientific one.

Many applications of color to factories, offices, schools have been unsuccessful because they have been "engineered" as if people were sensitive to blank areas of color alone and not also to form, proportion, harmony, and the like. Nor will color accomplish many marvels if other factors influencing the other senses—heat, cold, glare, noise, odor, fumes, physical and occupational hazards—are not simultaneously dealt with.

On the other hand, the prescription of color cannot lean too heavily on the artistic. Here too color has often failed. When its use is overdone, when the colors chosen are too bright, the combinations too "dramatic," the effect may be wholly out of place, and the observer may actually be distracted from his tasks or made uncomfortable in his environment.

Although the author has had extensive experience in the use of color to accomplish well-defined ends, he is quite aware of the fact that a great world of energy remains untouched. A tremendous opportunity exists today to build a new therapy of color totally divorced from the esoteric, to coordinate the efforts of the biologist, the ophthalmologist, the psychiatrist, and the psychologist, and to follow method rather than mere feeling in getting color to serve the best interests of humankind.

In a few crowded years the author has met problems of eyestrain in factories and institutions. He has employed color to cope with accidents. He has cooperated with educators, hospital administrators, organizations devoted to the prevention of blindness. Though he has performed little of pure research, he has had practical occasion to interpret and apply a large number of the findings and principles reviewed in this book.

Method is important in color specifications. Indeed, trial and error often seem needless in view of the mass of evidence that has come out of the medical field. If the spectrum is to be utilized intelligently and if the color artist or color engineer is to consider himself qualified to deal with human problems, then more of system and less of insight will be necessary. The capable persons will be those who have an understanding of the strange workings of color, its direct effects upon the organism, and its influence through vision. For with a background of research data, results will be easier to anticipate and assignments may be approached with greater reason and regularity.

THE EFFECTS OF THE MAJOR HUES

Here are a few notes on the efficacy of the major hues of the spectrum. They will serve to bring together some of the chief points of this book and to define the outstanding qualities of individual colors for convenient reference.

The Significance of Red

Red is perhaps the most dominant and dynamic of colors. Its energy has a strong influence on the growth of plants. It has been found to accelerate the development of certain lower animals, to increase hormonal and sexual activity, and to heal wounds.

In its action upon the human organism, red tends to distract the equilibrium of the body. It has been prescribed to treat sunburn, inflammation, rheumatism. It will act to raise blood pressure and pulse rate but may be followed by a reversal of these effects after a period of time.

Psychologically, red is exciting and increases restlessness and nervous tension. It represents an attraction to stimulus and as such provides an excellent environment for the creation (but not execution) of ideas. Under the influence of red, time is overestimated and weights seem heavier. The color is most pronounced when strong light intensities are also involved. (Red is the first of all colors to fade out in dim illumination.)

Under practical stituations, however, pure red can seldom be used; the full hue is too imperious and has too strong an afterimage. Brilliant red has its value in commanding human attention, although a high frequency of color blindness among men introduces limitations. Modified forms of red—rose, maroon, pink—are beautiful and expressive, universally appealing, and deeply emotional. Variations of red are preferred by extroverts; therefore the color has a place in psychotherapy to bolster human moods and counteract melancholia. It helps to distract attention from within and to direct it outward.

Variations of Orange

Orange partakes of the same qualities as red. It is not generally preferred in its pure form but highly pleasing in its tints (peach, salmon) and shades (brown). For the most part tints of orange (peach) are ideal for the interiors of hospitals or homes, factories, or schools. The color is mellow, less primitive than red, and it therefore has a more "livable" charm. It has high appetite appeal and is quite suitable for food service. Where it may be reflected upon human skin, it casts a cheerful and flattering glow.

Yellow

Yellow has been said to have a favorable effect upon human metabolism. In many studies of the biological action of light, however, it is generally found to be neutral (together with yellow-green). Because of the high visibility of yellow, it serves many purposes in safety. The hue is sharply focused by the eye, cheerful and incandescent in appearance.

In color conditioning, yellow will tend to appear brighter than white. It thus is useful in meeting unfavorable conditions of dim illumination or large, vaulty spaces.

Greens in General

Yellow-green is generally neutral from the biological standpoint. Greens and blue-greens, however, are pacific and tend to reduce nervous and muscular tension. Psychologically, green represents a withdrawal from stimulus. It provides an ideal environment for sedentary tasks, concentration, and meditation.

Bluish greens lack a primitive quality and are both pleasing and "livable." The same virtues have been expressed for peach, and indeed the two hues beautifully enhance each other. Because blue-green is complementary to the tint of average human complexion, it provides a very flattering background.

The Significance of Blue

Blue has qualities that are antithetical to red. It seems to retard the growth of plants, to decrease hormonal activity, and to inhibit the healing of wounds. In its action upon the human organism it lowers blood pressure and pulse rate, though this effect may later be reversed.

Under the influence of blue, time is underestimated and weights are judged as being lighter. Because the color has a naturally low saturation it may be used in almost any form—light, dark, pure, grayish. Being visually primary, however, it tends to be bleak if applied in too large an area. While blues are suitable for homes, they have not proved very successful in offices, industries, schools, hospitals, except as incidental areas and then in medium or deep tones. (Pale blue seems to "bother" human eyes and to give a blurred appearance to adjacent objects.)

Because blue is a difficult color to focus, it is objectionable as a light source and low in attention-value. Yet blue is associated with dim light, is restful and sedate, and is an outstanding favorite throughout the world.

Purple, Gray, White, and Black

Purple being a blend of red and blue, the two extremes of the spectrum, is more or less neutral biologically. It is not suitable for large areas because it disturbs the focus of the eye. Of all hues, it seems to be the one dominantly esthetic in its appeal.

White is the perfectly balanced color, clear and natural in its influence. Black is negative; gray is passive. All three are

found to be emotionally neutral and fail to have much psychotherapeutic application except where negation may be the particular expression desired.

MONOTONY VS. VARIETY

Just as warm colors are exciting and cool colors are tranquilizing, so is brightness stimulating and darkness relaxing. Change, variation, sequence are all vital in the use of color. In fact, no human sense—including vision—can respond consistently to fixed stimuli. Human sensations ebb and flow, probably because average experiences ebb and flow. The eye, like any other organ of the body, is in a constant state of fluctuation. Changes in the diameter of the pupil will take place even before an area of unvarying brightness. Images on the retina (or sounds in the ear) will seem to fade in and out, despite the fact that they actually may be constant.

If chaos and disorder are mentally and emotionally distressing, unrelieved monotony is probably worse. The theory is personal with the author, but the superstition that bizarre designs and gaudy colors will "drive people crazy" has less verity to it than the one that attributes the same effect to situations which are precisely the reverse. That is, any human being forced to work in an office or home surrounded by nothing but ivory or buff will hazard his good disposition and sanity even more. A circus is less likely to make a person neurotic than the tan waiting room of a railroad depot!

In this connection, colors of brilliant intensity arranged in garish patterns were used after the First World War to treat "shell shock" (now termed "battle fatigue"). The principle involved was simple enough: in some forms of mental illness the senses tend to have widened thresholds and to be easily upset and "set on edge." In such unfortunate persons, nervousness may be aggravated by monotony and relieved through excitation. Because bright color may equal the intensity of the person's own turbulence, it may be agreeably distracting and therefore restful and therapeutic.

THE IMPORTANCE OF SEQUENCE

After many of the facts of the physiological and psychological action of visible light are weighed, it would appear that color is most potent, most efficacious, and most therapeutic where there is sequence rather than sameness. The reader may recall that red had the immediate effect of increasing blood pressure and pulse rate *above* normal, but that after a period of time the blood pressure and pulse rate fell *below* normal. Similarly, noise caused a decrease in the apparent intensity of red colors but was followed later by a reversal of sensitivity.

On the other hand, blue lowers pulse rate but later causes it to rise. Dim light also tends to increase the sensitivity of the eye to blue colors.

Brightness, loudness, and stimulation of the senses in general are to be associated with the most active effects of red and all warm colors.

Dimness, quietness, and sedation of the senses in general are to be associated with the most active effects of blue and all cool colors.

Neutrality is found in yellow and yellow-green.

Here, then, are two hypothetical principles of color therapy:

For excitation, begin with warm colors, bright illumination, fairly loud but pleasing noises. Blood pressure and pulse rate should rise. Follow with *sudden* exposure to cool colors, dimmer illumination, and quietude. End with sudden restoration of the

first condition or exposure to pale yellow or white in bright illumination.

For sedation, begin with cool colors, dim illumination, quiet environment. Blood pressure and pulse rate should drop. Follow *gradually* with shift to warm color, brighter illumination, and moderate sound. End with gradual restoration of first condition or exposure to pale yellow or white in dim illumination.

The author wishes to repeat that his two principles are sheer supposition and based on logic rather than clinical test. Yet the reverse effect encountered in the action of color should, in the above two procedures, neatly balance each other and lead to a prolonged rather than temporary state of animated or passive spirit.

Where dramatic and highly emotional effects are wanted from color sequences—such as in motion pictures—deep blue colors should be "cut" abruptly into bright red colors for maximum excitation. However, bright red colors should be "faded" or "dissolved" into soft, cool hues when more melancholy moods are desired. Red has fast tempo; blueness, and greenness are "slow."

COLOR SPECIFICATIONS

Hospitals

In applying color for psychotherapeutic purposes, simple devices may be safely and successfully followed. The lobby or reception room of the hospital, visited chiefly by visitors, should have a variety of hues both warm and cool, the object being to avoid any one specific "mood." Where the public may be exposed to such hue contrast, the effect will be pleasant and cheerful. Yet any precise reaction, either ecstatic or lugubrious, will be compromised. The general impression will be visual rather than emotional in quality.

Warm tones such as peach and rose are desirable for the maternity division where the patient may not be seriously ill and where a will to get well is the spirit to be encouraged.

Cool tones of blues, greens, grays become appropriate for chronic patients who should be reconciled to a more prolonged stay.

In the surgery, the walls should be green or blue-green to overcome glare, relax the eyes, and complement the red hue of human blood and tissue.

Lavender, cool yellows, and yellow-greens are to be avoided, such hues being "sickly" in aspect and casting unfavorable reflections which give human complexion a ghastly appearance.

Schools

Elementary schoolrooms are best "color conditioned" in warm tones of yellow, peach, pink. These colors are stimulating to young minds and are favorable for "emotionally determined actions," as Goldstein has noted. In secondary grades, tones of green, blue-green, blue, and gray are recommended to avoid emotional distraction and to aid mental concentration.

The impulsive nature of children is essentially related to warm hues. Maturity is to be associated with the cool region of the spectrum which seems to be conducive to thought.

Airplanes and Ships

Where color is meant to reduce apprehension or nervousness, as in air or ocean travel, moderately warm tones, such as peach, may be best for general areas.

First of all, a warm tint will counteract the blurring effect of wide expanses of blue which seem to distress the eye. Again, the warm tint, being moderately stimulating, will more nearly

agree with the passenger's own mood. It will offer a "bright smile" and not a "glum frown."

For variety and harmony, blue-green may be further introduced, such as in carpeting or upholstery fabrics. This color will complement peach. When steadily fixated by the eye it has a pinkish afterimage that gives the objects of the world a mellow and attractive appearance.

Homes

Color in the home may be functionally considered. A convivial mood will follow the use of a warm tone in the living room. (Or if the owner wishes a more formal atmosphere, he or she may use blue.) Peach, the most appetizing of all tints, may be suitable for the dining room. The kitchen may be in cool tones of green or turquoise, such colors tending to shorten the apparent passage of time.

Yellow may be appropriate for rooms deprived of abundant natural light, for the basement and playroom. The den or library should be in some deep hue—warm or cool—to prevent the environment from distracting from the task or book. Bathrooms should be pink to give the skin a luminous glow through reflection. Bedrooms may be in any color, preferably of light tint. Strong contrasts and large patterns may encourage early rising. Late sleepers will value plain areas and less aggressive tones.

COLOR AND MEDICAL SCIENCE

Consciously or unconsciously, man has always held an innate faith in the efficacy of color. The great significance he has attached to it is everywhere evident in the surroundings of his life. For the hues of the spectrum have always been associated with his history and civilization.

Science may substitute protons and electrons for red and blue, but the appeal of color still persists. Those who have studied the growth of plants, the biological effects of color on lower organisms, the behavior of insects and animals, the physiological and psychological reactions of the human body, are aware that real "magic" exists.

Indeed, color has a required need in human life. It may be prescribed like medicines or drugs and its effects anticipated. Yet to work in this intelligent fashion, the qualities of the spectrum should be thoroughly understood. It is not enough to believe in the virtues of color; orderly and diligent research is needed to clarify its therapeutic values and to develop reliable techniques for its use.

The intimate role which color may play should become increasingly vital as man turns from an æsthetic and esoteric attitude to one more rational and clinical; as recognized medical science forgets its prejudices and appreciates that color is physiologically and psychologically beneficial and may be put to effective human service.