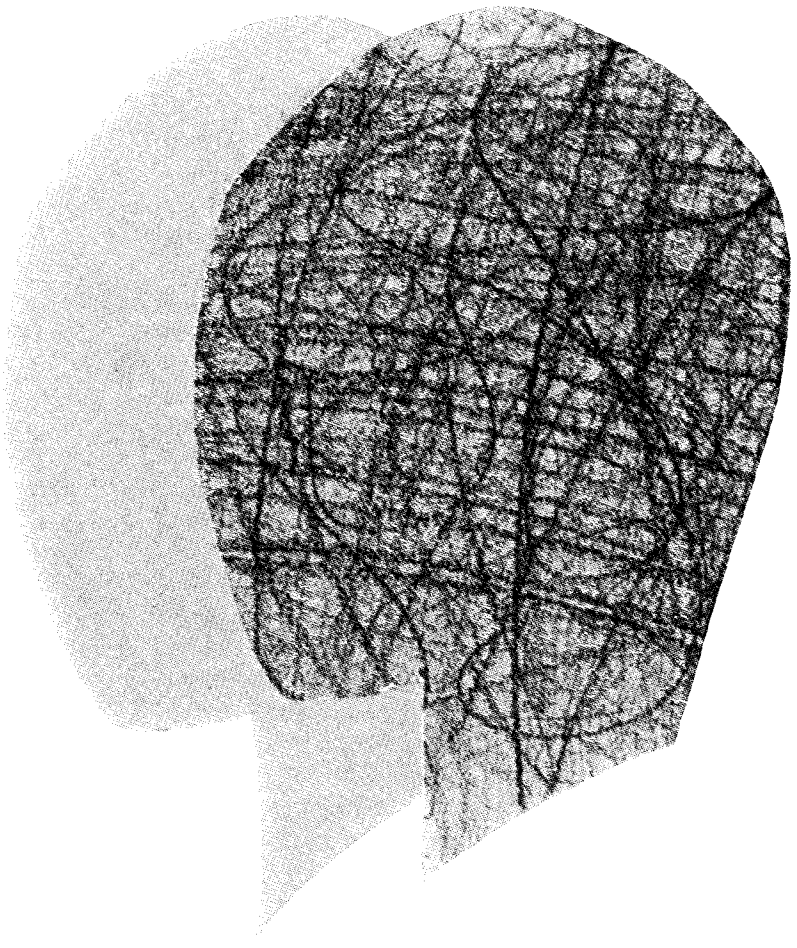

Psychological Implications of COLOR and ILLUMINATION

By Faber Birren

AS MAN spends increasingly more time within controlled environments, as he plans enclosed cities, undersea and underearth structures, as he ventures into space—all of which will take him away from natural surroundings—he must understand and indeed master the elements that have sustained his life. While it is obvious that he must deal with critical problems of air and water pollution, excessive use of chemical fertilizers, insecticides, and disposal of radioactive wastes, he must also give attention to one of the most vital of all cosmic energies—light.

In his development of artificial light sources, man for ages relied on fire and flame. The spectral quality of this light was roughly equivalent to that of dawn and dusk. However, he was a diurnal animal, spending most of his waking hours in daylight and very few in artificially illuminated darkness.

With the invention of petroleum oil, the paraffin candle, illuminating gas, the carbon filament electric lamp, he still had a spectrum of light not much different from that of sunlight, except perhaps for less violet and ultraviolet wavelengths. The carbon arc, which emitted a weird and wholly unnatural light was short-lived and little used except for street lamps and motion picture projectors.

Then with the metallic vapor and fluorescent lamps, abundant light was suddenly achieved, and with them man could spend more and more time indoors.

It is perhaps true that the predominant interest of makers of artificial illuminants has been to produce light, efficiently and economically, for the sole purpose of enabling people to see. This light could emit a continuous spectrum, as with incandescent, a discontinuous line spectrum, as with mercury and sodium vapor, or a discontinuous spectrum of both lines and bands, such as with fluorescent. To the maker or user, all rays were directed to the same end—vision.

With attention called to the hazards of air and

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. . . a third science of light . . . for

water pollution, with prolonged undersea journeys in submarines and with the astounding flights of astronauts into space and around the moon, a still further possibility of hazard was foreseen in artificial light itself. What might happen if it were unlike sunlight, if its spectrum had gaps? Assuming that lack of light was inimical to humans just as it was to plants, what about unbalanced light, or light that was distorted from the normal?

Today the lighting industry and the world are aware that if there is a science of light for vision, there also is a science of light for biological well being. *And this article is concerned with still a third science of light, this for human psychological and psychic balance.*

In 1967 illuminating engineers at an international congress elected to undertake a four year study of the biological aspects of artificial light. The journal of the Illuminating Engineering Society in the United States has begun to publish articles on the subject. An outstanding one is that of Richard J. Wurtman[1] in which he writes, "The obvious significance of light in providing the substrate for vision has tended until recently to obscure the fact that light also exerts important biological effects which are not dependent upon vision."

The biological influences of light and color have been given extensive study as they affect plants, lowly organisms, insects, birds and beasts. An outstanding authority, E. F. Ellinger, lists over 4600 references in one of his books.[2] Universities and laboratories throughout the world are busily engaged in light and color research. The U. S. Atomic Energy Commission[3] has subsidized fifteen different investigations centering around what it terms photobiology. The Argonne National Laboratory in Illinois has a unique biological spectrograph "used in studies of non-ionizing radiation (light) upon living organisms."

Light is a sensitive and essential factor in controlling plant growth, gonad (sexual) activity in birds and animals. It affects the glands of the body, blood, hormones. Yet only lately have differential effects for color in light (*i.e.* red, yellow, green, blue) been given special attention. Wurtman remarks that "one can count on a single hand all of the papers which have attempted to examine which portions of the photic spectrum are biologically active."

However, the research is not quite so restricted. R. van der Veer and G. Meijer[4] found that with some plants red light caused maximum growth and action, followed by the action of blue light, but that the yellow and green were neutral. (Ultraviolet would destroy the plant.) John Ott[5, 6] has noted unusual effects of color in the breeding of mice, mink, chinchillas. In general he found that bluish light tended to lead to a high ratio of female offspring, pinkish light to a high ratio of male. According to Ott, chinchilla breeders commonly use bluish artificial light in an effort to produce more females.

In one very recent study (1968) sponsored by the Atomic Energy Commission, J. F. Spalding and Associates[7] investigated the influence of color on voluntary activity in albino RF strain mice. The rodents were placed in cubicles for periods of 18 hours, rested, and then placed for 18 hours in other cubicles until all environments had been tested. The measure of activity was determined by the revolutions of wheels (like those in a squirrel cage). The test resulted in these findings: there was most activity in darkness; next greatest activity was with red. "Activity in yellow light was significantly greater than in daylight, green, blue, and significantly less than in dark and red." Incidentally, blind mice showed little difference in activity, regardless of color, bearing out that the effects discovered were "due to visual receptors."

Mice, of course, are nocturnal animals who busy themselves at night and rest during the day. While their reactions to color can hardly be interpreted in terms of man, one point is significant—mammals definitely do react differently to different colors in an environment, and such reaction has nothing to do with mental opinions.

On the matter of illumination and color, the lighting industry today is seriously devoted to the development of sources that will duplicate light as encountered in average temperate zones and during most of the day. Such light is generally cool in tone and much like that showered from the sky around noon on a summer day. Most persons judge it as appearing bluish. However, the pink and orange light of dawn and dusk, and the yellow light of the sun, are also *natural* light. In arctic regions months will go by during which daylight is *always* pink or orange and *never* white. As far as human appearance goes, the warmer light sources are more flattering than the cool ones. This writer has matched colors for many years under north daylight. Although there is considerable variation in intensity and spectral quality summer and winter, on sunny days and cloudy ones, little trouble has been encountered in color discrimination—thanks to a phenomenon known as color constancy in which the eye (and brain) struggle to see the world as "normal" under widely different lighting conditions.

Too, a natural appearance for colors in an environ-

ment will require different "temperatures" in a light source, depending on the intensity of the light. In 1941 A. A. Kruithof[8] of Holland did a remarkable study in which he demonstrated that, "For every color temperature there exists a highest and a lowest level at which the illumination is considered 'pleasing'." What Kruithof so well established is that at *low* levels of intensity the tint of the light source must be warm (pink, orange) for the world of colors to appear normal. As light intensity is raised, the color tint needs to be cooler and whiter. Thus, for light to be *natural* in the eyes of man it should be warm at low levels and cooler at high. In effect, light sources (illuminants) of different color tint perhaps should be part of man-made environments, warm in some instances and cool in others. Assuming much time is spent indoors, such variation from area to area would be remindful of nature and quite pleasing.

To proceed with the effects of color and surface brightness, twenty or so years ago many lighting engineers reached the conclusion that an ideal seeing condition existed where all surfaces in the field of view were equal or approximately equal in brightness. This view was soon abandoned as being psychologically if not visually intolerable. Also, much skepticism was shown regarding certain emotional qualities in color. Were some colors warm and some cool? Were some exciting, some tranquil, some subduing? Fortunately, a more liberal attitude exists today, thanks largely to the rise of psychosomatic medicine in which psychic factors in the state of man's health are considered along with pathological ones. There are countless human feelings, reactions, emotions, moods that cannot be quantitatively or even qualitatively analyzed.

S. M. Newhall[9] years ago investigated the matter of warmth and coolness in color, emphasizing that, "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." Newhall found that some 297 observers definitely did see warmth and coolness in color. The mere "fact" that people for centuries have looked upon red as a warm color and blue as a cool color is evidence enough to a liberal-minded person. In other words, there *are* warm and cool colors, or there *are not*, depending on what attitude or test conditions a person adopts.

Psychologists, psychiatrists and others who have devoted attention to the emotional life of man have always had a rough time with the fact-finders. Does sight of a luscious dinner make a man hungry? Probably not if a tube is run down into his stomach to measure the flow of gastric juices. Neurotic and psychotic individuals—as well as normal ones—suffer many pains which perhaps could be called imaginary in that they may have no physiological basis. Suicide far more commonly follows mental agony than physical. In the field of illumination L .D. Morgan[10] has written, "As engineers we cannot shrug off complaints of bad lighting with the statement that the complaints are largely psychological. A patient or a client with a psychosis suffers just as acutely as one with a physical injury."

Environmental effects for color have been studied over many years. They are today being given very special attention due to urbanization and new modes of life in artificial and controlled spaces. Many references will be found in the works of this writer[11–15] pertaining to physiological and psychological reactions to color. It is to be admitted that wherever things psychological are involved, debate is often furious. Freud's empirical observations and many of his theories were bitterly attacked. Many institutions banned his works. Pioneers in the field of psychosomatic medicine had a difficult time getting their skeptical colleagues to admit that there was a difference between a live man and a freshly dead one, the difference being one of spirit and psyche.

What so often happens is that where a certain phenomenon relating to human reaction and response may be without much (if any) benefit of proof and fact, the skeptic may argue that the phenomenon itself does not exist. If one person does not judge red as a warm color and blue as a cool one, he hardly has the right to insist that anyone else who feels such qualities is sadly mistaken or is imagining things.

In dealing with illumination and color in man-made environments, the safe course to take, perhaps, is neither to accept nor deny the phenomenal, but to speak of *tendencies*. How should a hospital room be illuminated or decorated? If there is no warmth or coolness in color, should the room be gray? Would there be any difference to the patient if the room were gray? Yet if a warm color *tends* to be moderately exciting and if a cool color *tends* to be relaxing, this is justification enough to use color in certain ways rather than haphazardly.

It is quite apparent that human beings, like all other living things, have a radiation sense. What is significant is that such sense may be independent of conscious vision itself. Awareness of the existence of light will be noted by completely blind individuals even where heat and ultraviolet energy are excluded. To those who see, color effects *tend* to be in two directions—toward red and toward blue—with the yellow or yellow-green region of the spectrum more

or less neutral. Further, these two major colors will induce different levels of activation both in the autonomic nervous system and in the brain.

Red tends to have an exciting influence. Kurt Goldstein writes, "It is probably not a false statement if we say that a specific color stimulation is accompanied by a specific response pattern of the entire organism." With reference to red, he mentions the case of a woman with a cerebellar disease who had a tendency to fall unexpectedly. When she wore a red dress such symptoms were more pronounced. Goldstein points out that tremor, torticollis and some conditions of Parkinsonism "can at times be diminished in severity if the individuals are protected against red or yellow, if they wear, for instance, spectacles with green lenses."

Goldstein has reached interesting, if largely empirical, conclusions regarding color and human reaction. In speaking of personal experience with his patients he notes that reaction to "red stimulation corresponds to the experience of being disrupted, thrown out, abnormally attracted to the outer world." On the other hand, reaction to green "corresponds to the withdrawal from the outer world and retreat to his own quietness, his center."

In similar view, Felix Deutsch writes, "Every action of light has in its influence physical as well as psychic components." Human beings are aware of "sensations and psychic excitations, which through the vegetative nervous system, boost all life functions: increase the appetite, stimulate circulation, etc., and through these manifestations the physical influence of light upon the disease process is in turn enhanced."

It may thus be generalized that color affects muscular tension, cortical activation (brain waves), heart rate, respiration and other functions of the autonomic nervous system—and certainly that it arouses definite emotional and esthetic reactions, likes and dislikes, pleasant and unpleasant associations.

Perhaps the following generalization by Kurt Goldstein on possible applications of color in modern environments may raise some eyebrows. But in it are *tendencies* and principles which would be better respected than ignored or denied. The italics are Goldstein's: "One could say *red is inciting to activity and favorable for emotionally-determined actions; green creates the condition of meditation and exact fulfillment of the task. Red may be suited to produce the emotional background out of which ideas and action will emerge; in green these ideas will be developed and the actions executed.*"

Before proceeding into matters of sensory deprivation and more psychic aspects of illumination and color, two points are perhaps worthy of mention.

First, there is in color and light what might be called a centrifugal action—away from the organism to its environment. With high levels of illumination, warm and luminous colors in the surroundings (yellow, peach, pink), the body *tends* to direct its attention outward. There is increased activation in general alertness, outward orientation. Such an environment is conducive to muscular effort, action and cheerful spirit. It is a good setting for factories, schools, homes where manual tasks are performed or where sports are engaged in.

Second, on the other hand, color and light also *tend* to have a centripetal action—away from the environment and toward the organism. With softer surroundings, cooler hues (blue, green, turquoise) and lower brightness, there is less distraction and a person is better able to concentrate on difficult visual and mental tasks. Good inward orientation is furthered. Here is an appropriate setting for sedentary occupations requiring severe use of the eyes or brain—offices, study rooms, fine assembly in industry.

What is new to consider these days is the potential value of illumination and color as vital forces for the preservation of man's sanity against perils of his own making. The controlled environments that are destined to come for him have already arrived for numerous animals. While an animal, protected from predators and natural enemies, can live the proverbial life of Riley, such bliss is rarely encountered. Confinement and monotony may lead the animal to starve itself, to overeat, to refuse to procreate, to devour and destroy its kind, or any other kind.

Apes have been observed to withdraw within themselves in the manner of schizophrenics if left alone or surrounded by blank walls. Other creatures may lapse into a fatal lethargy. So it is that zoos are rapidly building better and more spacious environments with splendid results. Cubs are entering the world from parents who previously refused to breed in more austere captivity. Life spans are being increased. No doubt important lessons are being learned for days in the future when man, too, will be an enclosed mortal needing not only proper food and exercise, but agreeable visual sights and colors to help him maintain a pleasing and sane normality.

There is just as much color within man as there is in the world beyond. While space-age scientists busy themselves with interplanetary travel, other scientists in psychological realms are equally occupied with inner space. Indeed, man's knowledge of himself, his perception, mind, spirit, has been increased vastly within recent years and vies in magni-

tude with enlightenment on the physical aspects of the universe.

For example, with psychedelic drugs (LSD, marijuana, mescaline) colors are turned on from the inside. The brain projects them out front, so to speak, and the spectacle may be an astounding one. Ordinary objects will take on the luster of gems. There may be spectral fountains, riotous hallucinations, and a fantastic interplay of sense responses in which colors, sounds, tastes, odors all become one animate kaleidoscope.

To discuss two extremely different directions for a possible new world of light and color, in the early forties Cecil Stokes of California created what he called Auroratone films for use in the treatment of mentally disturbed patients. Flowing, abstract forms in full color were thrown upon a screen and accompanied by the singing of Bing Crosby and the music of André Kostelanetz. Sanctuaries of music and color were established in the neuropsychiatric facilities of a number of army hospitals and results documented by Herbert E. Rubin and Elias Katz.[16]

Disfigured or crippled patients, not to overlook hosts of other mortals beset by fears and inner terrors, often will resist medical or psychiatric aid. As depression grows worse, serious pathological disturbances may result. What is to be done? In the instance of the colorful films of Mr. Stokes, as reported by Rubin and Katz, "Most patients became more accessible. . . . Those whose speech was previously blocked or retarded, spoke more freely. . . . In this state of accessibility it was possible for the psychiatrist to establish rapport." Here light and color were used for sedative effects.

Today in the modern discothèque, the light festival and light circus, precisely the opposite effects sought by Stokes are being visited upon an excited generation, mostly young. All this may be judged as undisciplined nonsense to the staid of heart, but it is highly meaningful and promising.

Psychedelic lighting and color have not come from the lighting industry but from artists and a few scientists. Anyone who has had his senses accosted will admit that the results were pronounced—either wonderful or awful.

Reversing the procedure of psychochemical ingestion, psychedelic art and psychedelic discothèques using flashing lights, colors, fluid designs and patterns, roaring sounds, attempt with fair success to blank out the real world for one of nightmarish fancy—without the taking of drugs. Let it be appreciated that, in clinical studies, flashing red lights have been found to induce epileptic seizures; pulsating, stroboscopic lights are hypnotic, can produce headaches, nausea, and forms of nervous breakdown.

There is little doubt but that somewhere between the Auroratone films of Cecil Stokes and the discothèque of today lie new functions for light and color in the controlled environments of the future. This future centers around problems being encountered in what is termed sensory deprivation or perceptional isolation.

Man has recently been made aware that if the sense of sight (along with other senses) is *not* stimulated, reactions will take place anyhow. Prisoners in solitary confinement or in prison camps, monks in the seclusion of cells, sailors who venture the oceans alone in small boats, men lost in woods or deserts, are often visited by colorful apparitions for no external cause. Likewise affected are persons confined to iron lungs, or otherwise immobilized by fractures and cardiac disorders. Schizophrenia is also like this. Withdrawn from humanity, hunched in a dark corner, the patient may leave his immediate world for a dream world of his own. As the psychologist R. L. Gregory[17] states, "It seems that in the absence of sensory stimulation the brain can run wild and produce fantasies which may dominate." In the contemporary world, such hallucinations may become an occupational hazard for men who sit at automated machines or who travel into empty space confined to a crowded projectile. Colors and visions from inside them may block perception of actual environment.

Equally disturbing is the possibility of a vast neurotic population of human beings cooped up in massive housing projects and plagued by blank walls, a trend which is now taking place and which cannot conceivably be reversed.

In *The Psychology of Perception,* M. D. Vernon[18] describes research and clinical studies having to do with sensory deprivation. In one investigation of the effects of a monotonous environment, persons were voluntarily and individually confined to small rooms for periods up to five days. There was little sound; their eyes were covered with translucent goggles to cloud their view; and long cuffs were put over their hands to limit the sense of touch. Not all could endure the isolation for the full five days. All became bored and restless. Most significant, they suffered visual and auditory hallucinations. When they emerged objects appeared blurred, distorted. They experienced dizziness, and when their intelligence was tested it was found to have deteriorated.

In a study of hospitalized infants under seven months of age, a monotonous environment led to confusion and blank stares. As Vernon summarizes,

"Thus we must conclude that normal consciousness, perception, and thought, can be maintained only in a constantly changing environment. When there is no change, a state of 'sensory deprivation' occurs; the capacity of adults to concentrate deteriorates, attention fluctuates and lapses, and normal perception fades. In infants who have not developed a full understanding of their environment, the whole personality may be affected, and readjustment to a normal environment may be difficult."

There seems to be a connection between the results of isolation and the taking of psychochemicals such as LSD. Woodburn Heron and associates[19] observe, "It appears that exposing the subject to a monotonous sensory environment can cause disorganization of brain function similar to, and in some respects as great as, that produced by drugs or lesions."

Finally, another group of researchers (Herbert Leiderman *et al.*[20]) have reported on hazards of isolation in medical care. Hospitals in particular need color as well as they need other sensory interests (music, TV, visitors). Leiderman and his group had volunteers willingly confine themselves up to 36 hours in a respirator in which they were able to see only a small area of ceiling. Only five of 17 could endure the confinement for the full 36 hours. "All reported difficulty in concentration, periodic anxiety feelings, and a loss of ability to judge time. Eight of the seventeen reported some distortion of reality, ranging from pseudosomatic delusions to frank visual hallucinations. Four subjects terminated the experiment because of anxiety; two of these in panic tried to release themselves forcibly from the respirator."

What is highly pertinent here is that disturbed or ill people (not to mention sane ones) are often expected to spend long hours and days in confined and drab quarters. Assume that a surgical operation may correct a man's illness or set a man's bones, what then if his confinement leads to other and unexpected maladies? "If normal persons can develop psychotic-like states . . . how much more likely it is that sick patients, perhaps already perilously near the mental breaking point, can be tipped into psychopathological states by the stress of sensory deprivation. Delirium may be imminent for patients weakened by fever, toxicity, metabolic disturbance, organic brain disease, drug action, or severe emotional strain; sensory deprivation may tip the balance. We have accumulated clinical evidence that sensory deprivation may be one element of importance in the etiology of mental disturbance as a complication of various medical and surgical conditions."

Not only hospitals, sanitariums, but convalescent homes, nursing homes, retirement homes need to be planned to combat the frightening dangers of isolation. If old people, for example, can't stand being together with others of their kind—a situation which is usually good for them—and if they prefer solitude, such privacy must of necessity be equipped with colors, sounds, motion, or they will surely encounter neurotic disturbances.

So the art and science of illumination and color should follow up inquiries into things biological with like inquiries into things psychological and psychic. Man has fought with fair success to conquer or at least guide the forces of nature. Now that he is leaving nature for surroundings of his own design, he is, as Carl Jung says, "exposed to the elemental forces of his own psyche."

Light isn't enough, certainly not bleak white light of unvarying intensity. There must be movement, change, variety, color. Likely there will be programmed light, shifts from soft pink and orange to yellow and cool white of high brilliance. There will be mobile color, lumina, the electric circus domisticated for average and everyday habitats—light and color for the body, the eye, the mind and the soul.

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