AN INVESTIGATION OF PSYCHOPHYSICAL COLOR PHENOMENA
AND THEIR APPLICATION TO INTERIOR DESIGN

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AN INVESTIGATION OF PSYCHOPHYSICAL COLOR PHENOMENA
AND THEIR APPLICATION TO INTERIOR DESIGN

THESIS

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

for the Degree of

MASTER OF ARTS

by

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August, 1970
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CHAPTER I

INTRODUCTION

Color is not separate; it is integral. It is not surface; it is substance. It is primary in human sensation, for everything seen by the eye—space included—is colored. Experience of it is constant, even with the eyes closed and in total darkness (3, p. 7).

Color must be classified as both a concern of science and art; without a thorough acquaintance of both the scientific approaches to color knowledge, the designer will be greatly handicapped in his endeavors. Physics relates the basic energy characteristics of color; chemistry formulates the principles of colorant mixture and use; psychology studies human emotional reactions to various colors; but, to realize his aesthetic intentions, the artist must understand the theory and application of all of these (1, p. 75).

Historically, the artist has not always been creative as the term is understood today. Until the Renaissance, he had little if any interest in stating his personal taste. Everything he colored was symbolic in nature, the hues prescribed by tradition. Although unknown by most persons, this tradition of symbolism in color has been abandoned by man only in the past 600 years. During the Renaissance, with the widespread use of oil painting and the great surge in the decorative arts, man sought freedom in expressing his individuality. Color expression was to become richer and more subdued, and yet, possess elegance, complexity, and elaborateness (2, pp. 1-5; 1, p. 85).
Since color is a personal thing, designers in the visual arts today are not in accord on the various approaches to the study of color. Many designers in color are convinced that an intuitive approach is best. On the other hand, many in the functional arts, such as interior design, consider man's pleasure, his efficiency, comfort, and well-being to be fundamental—hence, they feel something more reliable than intuition is essential. Nonetheless, disregarding the approach preferred, color, perhaps the foremost tool of the interior designer, plays a primary role in achieving the designer's goal.

The Problem and Its Purpose

While it has been asserted by such authors as Faber Birren, Fred Bond, and Paul Hartley that color has the ability to unify seemingly unrelated elements and objects, increase the sense of space in a small room, make a warm room seem cooler, and lighten and brighten a room without windows (2, 5, 9), only scant information can be found relative to the psychophysical phenomena of color as applied to interior design. These phenomena comprise the various relations between specific amounts and kinds of color stimuli and particular color responses.

In working with color, interior designers have tended to rely on formal "color schemes" mechanically derived from some established color order system, such as the Ostwald or the Munsell, or on one based on a three-primary colorant mixing system. While knowledge of this description has its value in color application, it largely ignores color experience as manifested in various psychophysical phenomena.

Since as long ago as 1839, when N. E. Chevreul published his book on simultaneous contrast of color, interest in the area of psychophysical
color phenomena has been increasing. The young Impressionist painters were taken quickly by the vital importance of Chevreul's work, as may be seen in the endeavors of Renoir and Monet (7).

Regrettably, this interest in the psychophysical effects of color has not spread to the interior designer.

Considering these facts, the purpose of this study is to analyze and select those psychophysical color phenomena adaptable to interior design. Among these are phenomena relating to variations in intensity and purity, visual stimulation, spatial relationships, and psychological factors; this study contains suggestions for possible application of these phenomena to strengthen the quality of interior environments.

The Method of Procedure

To investigate the possible applications of various psychophysical phenomena to interior design, it was first necessary to have an understanding of the visual experience of color (Chapter II) and basic information concerning interiors as color environments (Chapter III). With this information as a basis, Chapters IV, V, VI, and VII define the psychophysical color phenomena and suggest possible employment of them in interior surroundings. Chapter IV presents the variations in the intensity and purity of a color stimulus. Chapter V presents the spatial relationships of color phenomena: area effect, simultaneous color contrast, spreading effect. Chapter VI offers the effects of visual stimulation: after-images, retinal stimulation, chromatic adaptation. Chapter VII presents the psychological factors involved in psychophysical color phenomena: color constancy, mental set, memory
color. Each phenomena is defined and discussed in terms of its possible application to the elements which shape the interior environment: architectural surfaces, furniture and accessories, and illumination. The summary and conclusions of the thesis and recommendations for further study are stated in Chapter VIII.

Limitations of the Study

This thesis is limited to selected psychophysical color phenomena adjudged relevant to interior design. The study, by no means, includes all the possible applications of these phenomena to the design of interior environments.

Definition of Terms

For the purpose of clarity the following terms will be defined with reference to meaning in this particular study:

Abney Effect.—As the purity of a stimulus (with a dark surround) is changed, there is primarily a change in saturation, but there is also a change in the hue of the color response; this hue shift which results from changing purity is called the Abney effect (6, p. 57).

Absolute Threshold.—Color, other than idioretinal, is seen whenever enough light acts on the eye causing a response. The least amount of energy that it takes to evoke a visual response is called the absolute threshold (6, p. 53).

After-image.—When the eye has been fixed on a given color, and the color is then removed, the sensation of still seeing the original color may persist very briefly, if it is seen at all, in the so-called positive after-image. But whether it occurs or not, what quickly follows the
cessation of the colored light is a negative after-image, which is always very close to the complement of the original color, red and green replacing each other as do yellow and blue. The positive is sometimes called homochromatic after-image and the negative is often referred to as complementary after-image (12, p. 124; 6, pp. 68-70).

**Area Effect.**—Variations in the angular size, or the visual angle, of an object can cause a change in color, within limits, in much the same way as variations in the energy characteristics of the light coming from the object; this is called an area effect (6, p. 61).

**Bezold-Brücke Effect.**—Above the photochromatic threshold, the hues first seen for a given color stimulus will, with four notable exceptions, change as the intensity of the stimulus is increased. This hue shift is called the Bezold-Brücke effect. For example, stimulus-objects that produce orange or yellow-green hues appear yellower as the intensity of the stimulus is increased toward the level where saturation disappears (6, p. 54).

**Brightness.**—The quality of distinguishing a bright color from a dark shade of the same hue is called brightness. It may be measured on a scale of achromatic colors ranging from very dim (dark) to very bright (light) (6, p. 14).

**Chroma.**—Chroma is the saturation of the color, the degree of departure of the color sensation from that of white or gray (13, p. 99; 14, p. 184).

**Chromatic Adaptation.**—Chromatic adaptation is the general adjustment in spectral sensitivity of the retina, when stimulated by a stimulus, that normally produces a chromatic response. As chromatic adaptation
to a given stimulus progresses, there is a progressive decrease in saturation; it can affect the hue, saturation, and brightness of responses to subsequent stimuli (6, pp. 80-81).

**Color.**—Color is the attribute of visual experience that can be described as having quantitatively specifiable dimensions of hue, saturation, and brightness. It has a variety of aspects related to it—physical, chemical, physiological, psychophysical, psychological, and theoretical. Color is a phenomenon of light or visual perception that enables one to differentiate otherwise identical objects (6, pp. 11-16).

**Color Assimilation.**—Very simple changes in borders and boundary lines can result in striking changes in color perception. If two crosses are cut from the same strip of gray paper and placed on white and black backgrounds respectively, a marked brightness difference between the responses to the crosses can be noted until the crosses are connected by a strip of the same gray, at which time, the responses to them tend to become identical in brightness; this phenomenon has been called color assimilation (6, p. 86).

**Color Constancy.**—Under everyday conditions, most object-color perceptions are largely independent of changes in illumination and viewing conditions; this phenomenon is called color constancy. In general, a familiar object continues to arouse approximately the same color perception whether viewed in average daylight or in incandescent lamplight, even though the energy characteristics of the light from the object are quite different under the two conditions (6, p. 82).

**Color Harmony.**—Color harmony results when two or more colors are so arranged that when viewed simultaneously they create a sense of unity or interaction.
Color Perception.—Color perception is equivalent to the term color, which implies awareness of the non-spatial, non-temporal settings or contexts in which color is perceived (6, p. 50).

Color Stimulus.—Color stimulus represents the first step in seeing color; it comprises the physical aspects of a situation producing color (6, p. 17).

Colorant.—A colorant is typically pigment or dye which selectively absorbs light of various frequencies and is classed as an inorganic or organic chemical compound (6, p. 30).

Complementary Colors.—Colors are complementary to each other when they are most unlike. When color samples are arranged in a circle according to the hue responses that they elicit, complementary samples may be placed opposite each other on the circle, so that a line drawn diametrically between them will pass through the center, which represents the neutral achieved by mixing the two stimuli responsible for the complementary colors (11, p. 50; 6, p. 116).

Electromagnetic Spectrum.—Light comprises one small part of the electromagnetic spectrum of radiant energy, which also includes radio and television waves, infrared rays, ultraviolet rays, x-rays, and gamma rays (6, p. 18).

End Effect.—When a series of chromatic samples of the same dominant wavelength and luminance is arranged on a neutral ground in order of purity, the purest, or end sample, is likely to appear more saturated than it would if followed by still purer samples; this phenomenon is known as the end effect (6, p. 85).
**Figure-ground Relationship.**—The arrangement and meaningfulness of object patterns are called figure-ground relationships; they can affect the colors that are perceived (6, p. 85).

**Hue.**—Hue is the name of the color, such as red, which differentiates it from another color, such as green. It is the dimension of color that is referred to a scale of perceptions ranging from red through yellow, green, blue, and (circularly) back to red (9, p. 22; 6, p. 13).

**Idioretinal Light.**—When there is no light acting on a rested eye, it is not black that is seen but rather a dim color that may be interrupted by flashes of small colored dots. This is called idioretinal light and is caused by the continuous physiological activity in the eye (6, p. 53).

**Intensity.**—Intensity refers to brightness of the light source or color stimulus.

**Light.**—The usual initial stimulus for color is light. Light is defined as radiant energy capable of serving as a color stimulus (6, p. 18).

**Memory Color.**—Memory color has been defined as the color perception that, according to the judgment of the observer, a familiar object would arouse if that object were under the illumination in which it is customarily seen. These colors tend to accent dominant color characteristics (6, p. 87).

**Object-color.**—Object-color is defined as the color perceived as belonging to a particular object (6, p. 17).

**Photochromatic Interval.**—As the intensity of the color stimulus is increased above the absolute threshold up to a certain level, all
light except that of long wavelengths produces a brightness response essentially without hue or saturation. This energy range is called the photochromatic interval (6, p. 54).

**Photochromatic Threshold.**—The upper limit of the photochromatic interval is called the photochromatic threshold (6, p. 54).

**Primary Colors.**—Those colors from which nearly all other colors may be produced by additive combination or subtractive mixture are called primary colors. The additive or light primaries are red, green, and blue. The subtractive or colorant primaries are cyan (blue-green), magenta (blue-red), and yellow. Since the subtractive primaries are generally complementary in color to the additive primaries, they are sometimes referred to as minus-red, minus-green, and minus-blue. The term primary also refers to four unitary hues (red, yellow, green, and blue), each of which has no resemblance to any of the other three, called psychological primaries (6, pp. 56, 119).

**Retina.**—The retina contains the light-sensitive elements of the eye; it contains a vast number of rod and cone receptors and nerves which are important for initiating conscious color responses (6, p. 42).

**Saturation.**—Saturation refers to a scale of perceptions representing a color's degree of departure from an achromatic color (one lacking distinguishable hue) of the same brightness (6, p. 14).

**Simultaneous Color Contrast.**—The position of an object in relation to other objects within the visual field can cause color changes in much the same manner as do variations in the energy characteristics of the light coming from the object. In general, there is a tendency for the visual mechanism to accentuate differences in objects juxtaposed either
in space or in time. This phenomenon is known as simultaneous (spatial) or successive (temporal) color contrast (6, p. 63).

**Spreading Effect.**—In the case of certain complicated patterns, the changes that occur among the colors evoked by small, spatially juxtaposed areas are directly contrary to what would be generally expected as a result of simultaneous color contrast. They appear more alike rather than more different as in contrast; this phenomenon has been called a spreading effect, an assimilation effect, or a mixture effect (6, p. 64).

**Stimulus-object.**—An object, such as a colored paper that is seen or a sweet substance that is tasted, is often called a stimulus, but it is more properly called a stimulus-object (6, p. 17).

**Value.**—Value designates the brightness of a color, that is whether the color is light or dark (9, p. 22).

**Visual Angle.**—The angular size, or visual angle, of an object is defined as the angle which the object subtends at the eye, regardless of the distance of the object (6, p. 61).
CHAPTER BIBLIOGRAPHY


CHAPTER II

THE VISUAL EXPERIENCE OF COLOR

Definition of Color

Visual experience is one attribute of experience in general. It has basic aspects of extent, duration, and color. Color is the one attribute of visual experience that can be described as having quantitatively specifiable dimensions of hue, saturation, and brightness. Figure 1 illustrates the relation of visual experience to experience in general (1, pp. 11-12).

Color is thought to be a mental phenomenon which is evoked when light strikes the back of the eye; therefore, without light, except for idiometinal color, not the faintest color exists (2, p. 21; 3, p. 27).
Most authorities agree that an object itself does not have color, but that the apparent coloration is determined by the object's ability to absorb light rays selectively. Since all objects do not absorb the same quantity or wavelengths of light, different colors are produced; this process is called selective absorption. When a light source strikes an object, it penetrates the surface somewhat. The amount of penetration and quality of the absorption will vary with the surface of the object. If we call an object blue, the blue rays are reflected to the eye and the other colors are absorbed (2, p. 21).

Physical Aspects of Color

Sir Isaac Newton discovered that light is a mixture of all colors. He demonstrated that by passing a narrow beam of light through a glass prism, the light would be separated into its components—the colors of the spectrum—and further proved his view by passing the separated rays through a second prism and reuniting them into white light (3, p. 97). Figure 2 illustrates the method of the Newton experiment.
The physical aspects of a situation producing color are comprised of those characteristics of light (radiant energy) that stimulate the eyes to produce color (1, p. 11). The first step in seeing color is the color stimulus. The object seen is called the stimulus-object. As previously stated, light is the initial stimulus for color. The visible spectrum comprises one small part of the electromagnetic spectrum of
radiant energy, which, as illustrated in Figure 3, also includes radio and television waves, infrared rays, ultraviolet rays, x-rays, and gamma rays.

There are three attributes of light which are related to the role light plays as a color stimulus. The first attribute is wavelength; light wavelengths generally lie within the visible spectrum. The second attribute of light is its intensity; to serve as a color stimulus, the intensity of light must be above the absolute threshold. The third attribute of light, related to its role as a color stimulus, is its wavelength composition; a color response may be initiated by light of a single wavelength or by light of several wavelengths in an infinite number of combinations (1, pp. 11-12, 17-21).

Non-self-luminous stimulus-objects may transmit or reflect light, with or without change in wavelength composition. When light strikes a non-self-luminous stimulus-object and thus passes into a medium that contains large numbers of small particles differing in refractive index from the medium, the direction of the light is changed as illustrated in Figure 4. In addition, if the particles are spectrally selective, the color of the light will be changed. If the diameters of the particles are many times as large as the wavelength of the light and if the material of the particles is spectrally non-selective, the action of the particles themselves is also substantially non-selective, and there is essentially only a directional change; this action is called diffusion. Much of the light that is diffused within an object again reaches the surface of the object and leaves diffusely, so that the surface may appear almost uniformly luminous from all directions.
When light is not diffused by an object, the reflectance or transmittance usually is called specular. Reflection that is principally specular is associated with objects having optically smooth surfaces, and these objects are typically called glossy as seen in Figure 5.
Light passing through a medium that contains a large number of particles may be scattered if the particles are such that their minimum dimensions are approximately the same size as (or smaller than) the

Fig. 6—When a beam of light represented by the arrows travels a distance of $x$, the light at B is less than that at A because of the scattering that takes place as it travels the distance of $x$. (Source: Wright, W. D., The Measurement of Color, New York, Van Nostrand Reinhold Company, 1969, Fig. 1.5, p. 13.)

wavelength of the light (1, pp. 35-37). Figure 6 illustrates this method of scattering.

Physiological Aspects of Color

Activities induced by a color stimulus in the visual receptors of the eye and their attached nerves represent the second step in seeing colors and comprise the physiological aspects of a situation producing color. These visual receptors are the parts of the eyes that are stimulated when light passes into the eyes; they are contained in the eyeball, which consists of the several parts illustrated in Figure 7 (1, p. 40).
Fig. 7—Horizontal section of the eye. (Source: Burnham, Robert W., Randall M. Hanes, and C. James Bartleson, Color: A Guide to Basic Facts and Concepts, New York, John Wiley & Sons, Inc., 1963, Fig. 2.17, p. 41.)

Of these parts, the retina contains the light-sensitive elements. The actual light receptors, the rods and the cones, are located in the layer of retinal tissue most remote from the cornea. Together with the optic nerves, the rods and cones are most important for initiating conscious color responses (4, p. 33; 1, p. 42).

Psychological Aspects of Color

Awarenesses of color, that is, conscious color responses made by an individual when his eyes are stimulated by radiant energy, represent the third and final step in seeing color and comprise the basic psychological aspects of color. Basic color responses are awarenesses of hue, saturation, and brightness, which may be abstracted from a total visual experience and scaled along quantitatively specifiable dimensions of color.
as seen in Figure 8. Hue refers to a scale of perceptions ranging from red through yellow, green, blue and (circularly) back to red. Saturation

![Diagram of color dimensions](image)

Fig. 8—Dimensions of color. (Source: Burnham, Robert W., Randall M. Hanes, and C. James Bartleson, Color: A Guide to Basic Facts and Concepts, New York, John Wiley & Sons, Inc., 1963, Fig. 1.2, p. 13.)

refers to a scale of perceptions representing a color's degree of departure from an achromatic color (one lacking a distinguishable hue) of the same brightness. Brightness refers to a scale of perceptions representing a color's similarity to some one of a series of achromatic colors ranging from very dim (dark) to very bright (light). The object-color may vary in hue, saturation, and brightness, but in no way that cannot also be described in terms of combinations of these three visually abstractable dimensions. The terms brilliance, strength, depth, shade, cleanliness,
tint, tone, and intensity which are visually abstractable combinations of saturation and brightness, have been used to describe striking aspects of color (1, pp. 12-15).

Color is an abstraction from a visual type of conscious response which depends directly upon activity in the nervous system typically produced by stimulation of the retina by light as illustrated in Figure 9 (1, p. 49).

![Diagram of the visual system](image)

**Fig. 9**—Conditions required for the perception of a red object with a blue top. There must be a light source, an illuminated space, the object and its top, and an observer with at least approximately normal color vision (1, p. 49). (Source: Burnham, Robert W., Randall M. Hanes, and C. James Bartleson, Color: A Guide to Basic Facts and Concepts, New York, John Wiley & Sons, Inc., 1963, Fig. 2.21, p. 49).

**Psychophysical Aspects of Color**

The psychophysical aspects of a situation producing color comprise all the various relations between specific amounts and kinds of color stimuli and particular color responses. Color response in the normal observer can be affected by energy variations in the color stimulus, spatial relationships within the stimulus field, the areas of the retina
stimulated, the state of the observer's visual mechanism, and the obser-
ver's mental attitude (1, pp. 12, 53). These factors constitute the
nucleus of this study and will be discussed in detail in Chapters IV,
V, VI, and VII.
CHAPTER BIBLIOGRAPHY


CHAPTER III

INTERIORS AS COLOR ENVIRONMENTS

Introduction

The human perceptual world "is extended in distance and modeled in depth; it is upright, stable, and without boundaries; it is colored, shadowed, illuminated and textured; it is composed of surfaces, edges, shapes, and interspaces; and most important of all, it is filled with things which have meaning" (5, p. 10). Color must work together with other visual environmental elements—space, form, texture, and lighting—in such a way that they relate to each other without competing (2, p. 16; 6, p. 55).

Space is defined as the distance, void, or interval between things. It suggests the possibility of change, freedom to move bodily, visually, or psychologically. Defined as three-dimensional shape or structure, or as intrinsic character, form is the counterpart of space. We live and move in space, but we live with and move around form. The two are inseparable, just as color and light are inseparable; form gives space whatever shape it has and space reveals, even determines, form. Generally, form suggests a feeling of permanence, whereas space implies the possibility of change (4, pp. 101-105).

Probably the most important changes that occur in an interior environment result from the reorganization of interior spaces (surrounds) as defined by architectural surfaces (grounds). The forms that occupy
interior spaces create object-surround or figure-ground relationships. The first essential stage in perception is the emergence of one principal part of the visual field, which is called the "figure," from the remainder, which is called the "ground." In each of the three sketches of Figure 10, the geometrical floral pattern is seen as the figure, while the space around it appears as the ground (2, pp. 22-24).

Before an understanding of the psychophysical color phenomena and their application to interior design can be attained, a knowledge of the objects used in interiors and their function as sources of color stimuli is needed. Stimulus sources may be categorized as: architectural surfaces, furniture and accessories, and illumination.

Color Aspects of Architectural Surfaces

Architectural surfaces include walls, floors, ceilings, and window treatments. Since the structural walls or their coverings elicit the greatest amount of color in a room, they should be carefully considered before color selections are made for the interior.
The most common wall covering is paint, which can be obtained in virtually any color desired. In order to supervise the painter in the mixing of special colors, the interior designer must know the principles of color mixture.

Another type of wall covering, wallpaper, was originally used as a cheap substitute for decorative hangings and wall paintings. Today it is valued for its own intrinsic properties; wallpapers come in unlimited designs and colors. Vinyl is used a great deal in commercial interiors as a substitute for wallpaper since it can be cleaned easily and wears well. It varies in weight as well as in color and pattern. Grasscloth is often used as another type of wall covering. Although it may be dyed to match a particular color, it is most frequently used in its natural color.

Of all the materials available to the interior designer, wood probably offers the greatest number of possibilities. It can be worked easily, obtained in an almost limitless number of colors and patterns, and has an inherent beauty that is impossible to match. An examination of various kinds of wood reveals the wide spectrum of colors which are available, ranging from pale yellow pink through pink and medium yellow to brownish orange, pinkish brown, reddish brown, and black brown (9, p. 62).

Of all the plastics that are available to the interior designer, plastic laminates are perhaps the best known and most widely used. They are usually made of extremely durable plastic which is mounted as a veneer on plywood. Plastic laminates are not only used on walls, but
also on counters, table tops, and furniture. They come in various colors, patterns, and finishes.

Because of their beautiful colors and textures, stone, marble, and brick are often used in wall treatments. Many kinds of stone are available in various colors: whites, yellows, oranges, browns, reds, and grays. Marble can be obtained in almost unlimited colors and its finishes—polished, honed, sand-rubbed, or abrasive—are extremely pleasing. Bricks are made of natural ceramic materials in natural clay colors but may be tinted or glazed almost any color; their surfaces may be rough or smooth.

A very distinctive wall covering is one made entirely of mirrors. Used in a contemporary interior, mirrors are designed to reflect not only the images but also the colors and patterns of areas around them. Very pleasing effects may be achieved with the utilization of mirrors.

Another variation in color and texture for a wall may be seen in the use of ceramic tiles. Utilized in both the unglazed (natural) and glazed (artificially colored) forms, these tiles are decorative as well as functional. Ceramic tiles may also serve as a type of flooring.

The flooring of an interior is another major area of color concentration. If carpet is chosen for the floor covering, it is important to understand that the texture present in all carpeting will make it appear darker than the color of its yarn. Since many carpet companies will dye carpets to special order, virtually any color can be obtained.

Asphalt tile, vinyl asbestos tile, vinyl sheet flooring, and vinyl tile are all types of resilient flooring. In most cases the designs for resilient flooring are taken from expensive materials that many people
cannot afford to use. They come in a wide variety of colors, patterns, and often have simulated textures.

Wood flooring may be classified into four basic types: plank, strip, parquet, and fabricated wood blocks. The beauty of wood flooring is due, not only to the colors that are available, but also to the variations of color and pattern which the natural product supplies.

Ceilings are still another important color area to consider with built-in materials. Plaster ceilings may, of course, be painted any color; however, ceilings in general should be given a relatively light color. To wallpaper a ceiling is often very effective, but this technique must be studied carefully to avoid a closed-in or heavy feeling. Acoustic materials and translucent materials, usually in a near-white color, serve functionally as ceilings in both commercial and residential interiors.

In the past, draperies were used to cover a cold wall or doorway; it was not until mid-Renaissance times that windows were curtained. In contemporary architecture, window treatments may be used as a means of obtaining privacy, or as a decorating device, or as both. The colors of the materials used for this purpose vary from solid neutrals to bold, bright prints. If he desires, the interior designer can substitute for textile curtains any number of other items—shades, bamboo blinds, vertical venetian blinds, woven aluminum blinds—to create any effect he may want.

Color Aspects of Furniture and Accessories

Furniture, the design and construction of which is one of the oldest arts known to man, plays a major role in the selection of colors for
interiors, not only because of the various colors applied to it in the form of fabrics and paint, but also because of the beautiful wood tones produced in many fine pieces of furniture. The term furniture may include such pieces as storage units, upholstered and unupholstered seating, tables, screens, and room dividers.

Very often these pieces of furniture are manufactured from wood and therefore possess the rich colors of wood; however, today, they may also be made of metal, plastic, or other man-made material. Naturally, the colors used in the latter can be dictated by the designer.

Upholstered furniture can be the source of the greatest color variation in the interior environment. Fabrics lend themselves to infinitely varied coloration through the weaver's, dyer's, and printer's arts. They are available in solid colors, woven color mixtures, stripes, and various printed patterns. Both leather and vinyl are also used for upholstery; here, the color possibilities are slightly limited. Leather may be dyed or left with its natural brown color. Vinlys are sometimes made to imitate leather, but manufacturers have now developed a range of color and finishes of their own. In addition to solid colored vinlys, embossed, printed, and woven patterns are available.

Portable screens and stationary room dividers have been utilized as a means of decoration for centuries. Screens are frequently covered in fabrics, wallpapers, or translucent materials using a wide variety of colors and patterns. In most cases, the frames are made of wood, plastic or metal. Recently, such materials as decorative beads of wood, glass, or plastic have been used as room dividers. Extremely satisfying color effects can be obtained with the utilization of these beads, especially with the transparency of the glass and plastic.
The accessories of an interior refer to such things as: paintings, sculpture, vases, ashtrays, and lamps. A painting can play a major role in the interior or it can be a mere accessory of the room. The colors used in many paintings have inspired interior color schemes. A painting, therefore, can create the mood of a room and be the major influencing factor in the choices of colors for the interior. On the other hand, it can be unnoticed if no consideration is given to it in relation to the interior.

The selection of colorful accessories for an interior environment can enhance a color scheme. The designer must consider the fact that many pieces used as accessories have unchangeable color properties. Accessories such as plants, fruits, and flowers are relatively constant in color as are many of the built-in materials like wood, stone, and marble.

Both accessories and lamps may be used to produce exciting effects with the use of metals, woods, glass, and other materials. Although functional in use, they may be considered pieces of sculpture; their shape, form, and color must be treated as integral parts of the total three-dimensional composition in which they are to be used (9, pp. 53-120).

Color Aspects of Illumination

In all applications of color to the interior environment, the designer must not only consider the architectural surfaces, the furniture, and the accessories, which are invariable in color, but he also must consider illumination which is inseparable from color. Without light there is no color. Light changes the general appearance of a room,
as well as the prevailing mood, from morning to noon, from afternoon to sunset. The changes are even more marked under artificial light. Artificial light can create new colors by softening or intensifying existing areas of color. Acting as the predominant color stimulus, it can activate painted and papered walls and enhance their texture and color. It can make velvet piles look deeper, softer, and more luxurious, cause metallic fabrics to acquire additional glitter, and make natural wood take on the warmth of the other colors in the room.

Color is light and light is color. When properly balanced, light and color intensify each other and are more effective than either alone. Color is made more vibrant with light, and light itself becomes more colorful (3, pp. 29-31).

The interior designer must be sure that the interior has enough light for clear vision. The environment is inadequate if it needlessly distracts rather than aids vision (1, p. 120).
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CHAPTER IV

THE PSYCHOPHYSICAL PHENOMENA RESULTING FROM
VARIATIONS IN THE INTENSITY AND PURITY
OF A COLOR STIMULUS

While hue changes are normally associated with changes in wavelength, the intensity and purity of the stimulus are also factors in determining the prevailing hue. Whether or not a color response is elicited is dictated by the intensity (brightness) of the stimulus. The intensity also will be a component, along with wavelength, in regulating the hue of the color response.

Variations in Intensity

When there is no visible light acting on a rested eye, it is not black that is seen but rather a dim color that may be interrupted by flashes of small colored dots. This phenomenon, called idioretinal light, is caused by the continuous physiological activity in the eye. Color, other than idioretinal, is seen whenever there is enough light acting on the eye to cause a response. The least amount of energy that evokes a visual response is called the absolute threshold. As the intensity of the color stimulus is increased above the absolute threshold up to a certain level, all light except that of long wavelengths produces a brightness response essentially without hue or saturation. Photochromatic interval is the term used to denote this energy range and the upper limit of it is called the photochromatic threshold.
As the intensity of a small color stimulus with a dark field is increased above this photochromatic threshold, all hues are produced with progressively increasing saturation up to a certain intensity level; beyond that level saturation decreases, until again all hues disappear and only brightness remains. Above the photochromatic threshold, the hues first seen for a given stimulus will, with four notable exceptions, change as the intensity of the stimulus is increased; this hue shift is called the Bezold-Brücke effect (1, pp. 53-54).

Since the hue shift that characterizes the Bezold-Brücke effect applies to only certain colors of the spectrum, it would seem that a color scheme containing a variety of hues might be altered in its harmonic relationship by variations in the level of illumination that might occur in an interior space. The colors would also undergo changes in brightness and saturation as a result of the changes in the intensity of the light source; however, these attributes of the color scheme would remain harmonic in relation to each other since only the attribute of hue undergoes relative change. Thus, a monochromatic scheme, intrinsically lacking hue variation, would maintain its original relationships under different levels of illumination.

Colors subject to the Bezold-Brücke effect, orange, yellow-green, purple, and blue-green, change hue relationships when viewed in a dark field under variable lighting conditions. Unitary red, yellow, green, and blue are not subject to the hue-shift phenomenon when changes in the light source occur; hence, color schemes based on combinations of these unitary colors would remain constant in their harmonic relationship, regardless of the illumination level in the photochromatic interval.
In order to experience the Bezold-Brücke effect in the interior environment, the color stimulus (figure or object) must be small, the field (ground or surround) must be dark, and the illumination must be variable. These conditions might be met in the case of a pattern which contained small colored figures against a dark ground (Figure 11). This type of pattern might be applied to various materials used for such things as wall coverings, floor coverings, or upholstery of furniture. Other conditions favorable to the Bezold-Brücke effect would occur in the case of small colored objects selectively illuminated or spot lighted so as to be seen against relatively dark surroundings—architectural surfaces or space. With the rapid development of innovative lighting products, the interior designer may choose from many variable luminaires. Using the Bezold-Brücke effect in conjunction with these changing light sources, he may produce new versatility in his color schemes.

To illustrate a specific way to apply the Bezold-Brücke effect, consider the designer who is choosing a color scheme for a multipurpose, variably lighted, room such as a ball room for a country club. If, for example, a small orange or yellow-green pattern with a dark ground (Figure 11) should be used for the furniture covering in the ball room, and the solid colored walls or carpets should match the orange or yellow-green hue of the furniture, the light intensity would have to be constant at all times. If the colors were chosen under the low mood lighting of a dance, the orange or yellow-green of the wall covering would appear yellower when the light intensity was raised during a bridge tournament, thus no longer matching the colors of large surface areas. If there are invariant hues in the scheme, these colors would not change when the intensity of the light was raised.
Fig. 11—Demonstration of the Bezold-Brücke effect
Variations in Purity

Another type of hue shift takes place in the so-called Abney effect. In this phenomenon, as the purity of a color-stimulus with a dark ground is changed by the addition of white light, there is primarily a change in saturation, but there is also a change in the hue of the color response.

As with the Bezold-Brucke effect, the Abney effect might change the hue relationships of a color scheme devised by the interior designer. Inasmuch as this effect applies to responses resulting from spectrum light rather than those elicited by pigmented surfaces, the influence of this phenomenon would seem to be considerably more restricted; nevertheless, in some very special cases, interiors might be designed so that the color environment depends upon illumination rather than upon coloration of the architectural surfaces and objects of the interior. This type of approach especially might be used in a theatrical production. A color scheme developed for the medium of colored lights employed in dark surroundings would be altered upon change of the purity of the stimuli, namely by the introduction of white light. Expectedly, there would be a change in saturation of the colors, but also and perhaps unexpectedly, there might be a change in the hue of the colors: a near greenish yellow hue would appear more greenish yellow, while a near greenish blue would become increasingly different from greenish blue. If an exact hue relationship or harmony is important to the color scheme, then, the designer's intent would be distorted because of his failure to take into account the Abney effect.
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CHAPTER V

THE PSYCHOPHYSICAL PHENOMENA RESULTING FROM
SPATIAL RELATIONSHIPS WITHIN THE
STIMULUS FIELD

The hue, saturation, and brightness of colors are all affected by spatial relationships within the visual field. The position of the stimulus-object in relation to other objects as well as to the position of the observer is a major determinant in the color response perceived by the observer. In this case, changes in hue, saturation, and brightness can occur in much the same manner as do changes resulting from variation in the energy characteristics of the light coming from the object.

Area Effect

Variation in the angular size of an object, the angle at which the stimulus-object subtends from the eyes of the observer (Figure 12), can cause a change in color, within limits, in a similar way as changes caused by variations in the energy characteristics of the light coming from the subject. This phenomenon, called an area effect, takes place up to a certain angular size, or visual angle. The larger the visual angle (twenty degrees or more under some conditions) the more saturated is the color produced; beyond that size, the color becomes progressively less saturated. Furthermore, the larger the visual angle subtended by an isolated object, up to a certain angular size, the brighter is the
Fig. 12—Example of the angular size, or the visual angle, of an object.

Figure 13 illustrates this effect (1, pp. 61-62). Frequently, the layman is misguided by a small color chip or sample of a particular color to be used, for instance, on a wall. When the paint has been applied to the wall, the color seems much more saturated than it did in the color chip because of this area effect. It is therefore difficult to convince anyone that the wall is the same color as the color chip.

Relatively small accessory objects or small isolated design areas in fabrics, wall coverings, and flooring are other examples of the existence of an area effect in interior design. Unless the observer
Fig. 13—Example of color changes due to an area effect
is aware of this phenomenon, and is actively looking for its effects, the color changes may not be perceived. This is due to the memory that the observer has concerning the color associated with a particular object. Chapter VII will include the phenomenon of memory color which causes this lack of sensitivity to a color-stimulus. Because of memory color, it is the visitor who will often notice an irregularity in a color scheme. However, since an area effect is a function of the position of the stimulus-object in relation to the observer, the color discord resulting from this effect will be temporary as the observer moves within the interior surroundings and changes his relative distance to objects. Perhaps the designer may make color adjustments according to the angular sizes of objects placed in an interior environment based on a mean distance between the observer and most objects as they would be normally seen (Figure 1.4).

Simultaneous Color Contrast

Without regard to the position of the observer, color changes can be caused by the position of an object in relation to other objects within the visual field. In general, the visual mechanism of the eye tend to accentuate differences in objects juxtaposed to each other either in space or time. This phenomenon, known as simultaneous (spatial) or successive (temporal) color contrast or contrast enhancement, makes juxtaposed objects which produce high and low brightness seem to appear respectively brighter and darker than they would if viewed with a separation in space or time (Figure 15). Under the same conditions, colors of the same hue with high and low saturation appear more and less saturated respectively as seen in Figure 16. The same principle applies
Fig. 14—Demonstration of area effect. If the observer stands at point A, the same color at points B, C, and D may appear more or less saturated.
Fig. 15—Effect of contrast on brightness. The same gray colored strip appears either dark or light depending upon whether it is surrounded by a light or dark area.
Fig. 16—Effect of contrast on saturation. The two yellow strips are the same color; the differences observed in their relative saturation results from the difference in contrast with their backgrounds.
to juxtaposed objects producing complementary or nearly complementary hues; Figure 17 illustrates that the hues appear more saturated than they would if viewed with separation in space or time. Juxtaposed objects that produce non-complementary hues, on the other hand, appear to be more different in hue as represented in Figure 18 (1, p. 68).

The effects of simultaneous color contrast are especially relevant, perhaps more so than any other single psychophysical color phenomenon, to the design of color environments. The objects of the interior space, with their infinite juxtapositions in figure-ground relationships generate many situations favorable to the occurrence of the phenomenon. Furniture and accessories are seen against architectural surfaces and in relation to one another. Decorative surface patterns display an interplay of figure and ground shapes. The resultant interaction will often result in different color perceptions of identical objects. A bright yellow pillow will seem to change in hue if moved from a cool gray sofa to a tan chair. The color of the fabric on a chair will appear to change if the chair is moved from one background (wall or floor) color to another as illustrated in Figure 19 (2, p. 22).

Oftentimes the interior designer can use this effect as a tool in creating extremely vibrant color schemes. Likewise, fabric designers employ this technique to achieve an unusually high saturation and brightness in bold patterns. In reversal, simultaneous color contrast can subdue a color scheme that has disharmony. This toning down process is achieved by concentrating on similarities rather than differences in the individual colors: to use corresponding saturation and brightness in each color chosen, to eliminate the stress of juxtaposed objects of complementary colors.
Fig. 17—Effect of contrast with different hues on saturation. The same green colored strip appears more or less saturated depending upon its surround.
Fig. 18—Effect of contrast on hue. The two strips have the same color; they produce different hues because of contrast with the surrounds.
Fig. 19—Fabric colors appear to change when moved from one background to another.
Used by itself, a color will often appear pleasant to the eye, but when used near another color, perhaps its complement or one of like saturation and brightness, it will suddenly seem to change. Simultaneous color contrast can make a color scheme come alive, or if left unconsidered, can make the colors in a scheme clash and cause each color in the scheme to appear to be inharmonious. In short, colors affect one another whenever they are viewed in the same visual field (2, pp. 22-23).

While the quality of the illumination will have some bearing on how juxtaposed colors will be seen, under normal lighting the spatial and position factors are the principal determinants of how colors will be seen in simultaneous color contrast.

**Spreading Effect**

Directly contrary to what would generally be expected as a result of simultaneous color contrast, colors appear to be more similar rather than more different in the phenomenon called spreading effect, assimilation effect, or color-mixture effect. This effect can be observed in the case of certain complicated patterns, such as the wallpaper reproduction in Figure 20, in which colors appear to be akin rather than more alien in small spatially juxtaposed areas. The small areas interwoven with fine black lines usually appear darker while the same areas interwoven with fine white lines appear lighter (1, p. 64). Independent of variations in illumination, this phenomenon is caused partly because of lack of resolution or scattering brought about by eye media. In interior design a spreading effect usually occurs without the knowledge of the observer since there is normally nothing except the other colors in the color scheme with which to compare the colors perceived. In choosing a
particular complicated pattern, whether it be for a wall or floor covering, or a furniture covering, the interior designer should consider not only the individual colors but the total effect elicited by the combined color stimuli.

If he does not realize the effects of this phenomenon, in a pink, black, and white color scheme, for instance, the designer might choose a wallpaper with a complicated pattern as the example in Figure 20. Under close observation the pink color appears to be the same as the color chosen for the scheme. However, after completion of the interior, the color may appear to be a darker or lighter pink in color due to spreading effect; this, of course, would alter the whole color scheme.

Spatial-averaging

Closely associated with the phenomenon of spreading effect is the phenomenon of spatial-averaging color-stimulus synthesis. It may be produced by the juxtaposition of stimuli that are so small they cannot be individually resolved by the observer. Spatial-averaging is the basis of most modern printing methods and pointillistic painting (1, p. 115). This effect is demonstrated in numerous fabric designs where the observer experiences a single color response, although two different thread colors were used in the construction of the fabric (Figure 21). Wall and floor coverings with extremely small patterns of color or small multicolored woven areas also produce the phenomena of spatial-averaging.

As in spreading effect, this phenomenon usually occurs without the knowledge of the observer. The interior designer should be careful to consider the total effect elicited by the combined color stimuli, disregarding the individual colors.
Fig. 20—Demonstration of spreading effect

Fig. 21—Demonstration of spatial-averaging of two colors of yarn
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CHAPTER VI

THE PSYCHOPHYSICAL PHENOMENA
RESULTING FROM VISUAL
STIMULATION

After-Images

Depending on the characteristics of the color stimulus, the after-effects of visual stimulation can result in a variety of colors. These after-effects, which persist for varying lengths of time after the stimulus has been removed, are called after-images. These complex perceptions not only can vary in hue, brightness, and saturation as do many other color phenomena, but they also can vary in shape, pattern, texture, focus, latency, duration, and developmental sequence (1, p. 68). Depending upon viewing conditions, after-images are a result of persistence or fatigue of the visual process (2, p. 128). They are characteristically less objective and compelling than perceptions produced by the original stimulus; in general, they drift and move with the eyes and are filmy in appearance.

After-images may be classified according to the manner of their appearance: positive or negative and homochromatic or complementary. Positive after-images are those in which the brightness relationships (the distribution of light and shade) remain the same as those found in the original response to the stimulus-object. They have a latency of only a fraction of a second and are mostly flash-like in duration.
In the more common negative after-images (Figure 22) brightness relationships are reversed. These after-images typically have a latency of about a second and a duration of half a minute.

![Demonstration of negative after-image. Stare at the dot in the white profile for about thirty seconds, and then shift the gaze to the dot in the white square. You should see a negative after-image in the white square, that is, a dark profile instead of a white one. (Source: Burnham, Robert W., Randall M., Hanes, and C. James Bartleson, Color: A Guide to Basic Facts and Concepts, New York, John Wiley & Sons, Inc., 1963.)](image)

After-images in which the hues are about the same as those found in the original response of the stimulus are called homochromatic. These have a latency and duration similar to those for the achromatic positive after-image. Complementary after-images are those in which the hues are approximately complementary to those of the original response (Figure 23). The latency and duration of these vary with the stimulus-object (1, pp. 68-70; 3, pp. 104-108).

In an interior environment, for an after-image to be perceived by the observer, the stimulus-object must be strong in brightness and/or saturation. In subtle, relatively neutral surroundings, under average
Fig. 23—Demonstration of complementary after-image. Stare at the white dot in the center of the chromatic areas for about thirty seconds, then look at the black dot in the bottom half of the figure. A complementary after-image should appear. (Source: Burnham, Robert W., Randall M. Hanes, C. James Bartleson, Color: A Guide to Basic Facts and Concepts, New York, John Wiley & Sons, Inc., 1963).
conditions, the stimulus would not be of sufficient strength for an after-image to occur.

In much the same way, an interior with low illumination might not have any areas strong enough for an after-image to be perceived. However, the light sources, themselves, in many contemporary interiors are the brightest stimulus-objects in the room, and therefore, often produce the strongest after-images. In any case, after-images generally are dependent upon illumination.

Under certain conditions of visual stimulation, after-images may be irritating to the visual mechanism of the observer. In an interior, where certain areas of the surroundings, such as wall coverings or window treatments, have been given bright, bold patterns, the observer may experience the phenomenon of after-images when he shifts his gaze from one of these strong pattern areas to a relatively neutral visual field. He may also experience this phenomenon by shifting his gaze from a bright accessory to a neutral wall in the interior.

This same phenomenon is used advantageously by artists as a means of sensation enrichment. Oftentimes, after-images are used as a technique to increase the color and image interaction in an op or psychedelic painting. An action of this type may be experienced by staring at the spots of the painting reproduced in Figure 24, in a short period of time, the ovals begin to jump violently as a result of the after-images.

Retinal Stimulation

Differences in hue, saturation, and brightness of a given color stimulus can be produced by application of the stimulus to various areas of the retina. Normally, blue and yellow responses can be elicited by
stimulation farther from the center of the retina than can red and green responses (Figure 25); these areas of different chromatic response have been given the name, color zones of the retina. Varying with visual adaptation and characteristics of the stimulus (particularly its luminance), the color zones are not sharply defined.

Fig. 24—A large painting by Larry Poons, Nixe's Mate. Stare at the colored spots; in a short period of time, the dots should begin to jump violently as a result of the after-images. (Source: Faulkner, Ray and Sarah Faulkner, Inside Today's Home, New York, Holt, Rinehart and Winston, Inc., 1968.)
Fig. 25—Typical polar representation of the limits within which chromatic sensation resulting from stimulation by reasonably large, typically luminous stimuli are elicited in the right eye. (Source: Burnham, Robert W., Randall M. Hanes, C. James Bartleson, Color: A Guide to Basic Facts and Concepts, New York, John Wiley & Sons, Inc., 1963.)

Today, artists often create murals of such size, that, unless the distance between the observer and the stimulus is extremely great, the observer is required to shift his gaze from one part of the painting to another in order to experience the full impact of the work. This phenomenon is best explained by examining the mural, which is composed of geometric circles, reproduced in Figure 26. If the mural is placed too short a distance from the observer, and he looks directly at the center of the concentric circles, with normal vision, his visual mechanism
Fig. 26—Demonstration of retinal stimulation. The observer will not perceive the green areas in the extreme periphery of the mural.
would not perceive the green areas in the extreme periphery of the design because of this color zoning of the retina. The interior designer must know how the artist requires his work to be viewed—from one viewpoint or perhaps with a series of gaze shifts. If the interior designer is unaware of the artist's aesthetic intent, he may create an unsuitable environment for the work of art.

The designer of interiors must possess a knowledge of the different areas of chromatic response in the retina in order to achieve satisfactory color relationships in the interior environment. He not only should consider the size of the room, the architectural surfaces, and the furniture and accessories, but also the placement of the colors on these areas. Depending upon the position of the observer, the room may lose some of the intended color because of the insensitivity of certain zones of the retina. If the observer remains in one area of the room, he may fail to experience the total impact of the color scheme because of poor placement of color areas within the interior.

Chromatic Adaptation

Color responses can be affected by variation in the state of adaptation of the visual mechanism. Chromatic adaptation refers to the general adjustment in spectral sensitivity of the retina to a given stimulus. As chromatic adaptation to a given stimulus progresses, there is a progressive decrease in saturation and a shift in brightness toward a middle value in the sensation. A stimulus that normally produces a neutral response will, following chromatic adaptation, produce a response which is nearly complementary to the hue produced by the adaptation stimulus before adaptation.
The predominant color, which causes this adjustment in spectral sensitivity, may exist in pigmented surfaces such as walls, floors, furniture and accessories; or it may be part of the source of illumination.

To illustrate chromatic adaptation, if an interior, as might happen in the case of a night club, should be illuminated by deep red light, causing a red reflection on the walls and surrounding areas, the eye would virtually perceive red and only red to the point of fatigue of the visual process. Upon emerging from this room, going into one normally lighted, the observer would react by seeing the second room colored a greenish tint. Shifting the gaze to white lighted areas within the predominantly red interior would produce a similar green imagery (2, pp. 124-125).

Chromatic adaptation may be used as a means of display enhancement. To create richer tones in color of individual items in a display setting, a complementary color should be used as the background. For instance, if the walls of a meat market were painted in a bluish-green color, the meats in the cases would appear to be a richer red.
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CHAPTER VII

THE PSYCHOPHYSICAL PHENOMENA RESULTING FROM PSYCHOLOGICAL FACTORS

Color Constancy

Color response of the human eye can be affected by several complex psychological factors. The phenomenon called color constancy refers to the fact that most object-color perceptions are largely independent of changes in illumination and viewing conditions when viewed under everyday circumstances. In general, a familiar object continues to arouse approximately the same color perception whether viewed in daylight or incandescent lamplight, even though the energy characteristics of the light from the objects are very different under the two conditions.

A relatively high reflectance in the surroundings of the stimulus object as well as a complex visual field (because of the numerous clues afforded by shaded and unshaded areas) is favorable for color constancy. However, the attitude of the observer is most important; he must recognize the object and remember the color associated with it (2, pp. 82-84).

This phenomenon may be observed in the complex field afforded by an interior space with its highly organized figure-ground relationships, especially if the surroundings are of high reflectance. In a room in which the occupants are familiar with the surroundings, the observer would perceive the colors as being constant under most illumination.
conditions. In other words, color harmony may exist under many variable lighting conditions. Observers who are not familiar with the interiors, on the other hand, might experience non-constancy in the colors, especially if some of the figure-ground relationships are of a non-objective nature or if the surroundings are lacking in high reflectance.

Color constancy is ordinarily enhanced by all factors which tend to heighten the object character of the perception. If the observer sees familiar objects, whether or not in a familiar environment, he will experience color constancy. Objects of everyday life, such as plants, fruits, flowers, woods, and stone will elicit the same color under various lighting conditions.

The interior designer, himself, because of his familiarity with the materials and objects of his profession, is probably most susceptible to the phenomenon of color constancy. He must try to perceive objects with an analytic attitude rather than an object-directed attitude; he must permit the spectral characteristics of the stimulus to play a major part in the perception, rather than recognizing an object as such and remembering the color associated with it (2, p. 84). In other words, he should work with color abstractly (1, pp. 100-107).

Memory Color

In a similar way the memory that an observer has concerning the color associated with a particular object, which is not necessarily part of a complex field, can influence the color perceived. The phenomenon called memory color refers to color perception that, according to the judgment of the observer, a familiar object would arouse if that object were under the illumination in which it is customarily seen. Memory
colors tend to accent dominant color characteristics. On the basis of memory color it has been found that an observer usually selects a color which is too bright to match a bright memory-object, too dark to match a dark memory-object, and too saturated to match an object known to arouse distinct hue.

When viewing a painting or photograph, an observer will be more satisfied if the color of a familiar object corresponds to his memory color for that particular object. He is not contented in seeing the actual color aroused by the original subject (2, pp. 87-88).

All objects used in the interior environment are affected by memory color. The eye must be trained to view familiar objects in an objective manner.

Mental Set

Color perception is largely determined by the intent or mental set of the observer. In many cases, a visual phenomenon may not be perceived at all unless the observer actively looks for it; a skeptical or negative attitude can prevent its occurring at all. For example, when an object is perceived as belonging to one part of a figure or ground (Figure 27), the response to the object may be different from that response aroused when the object is perceived as belonging to a different part of the figure or ground.

The phenomenon of mental set depends a great deal upon the observer's individual differences and individual variability in perception. As in the phenomenon of color constancy, the observer may have an object-directed attitude (one that normally leads to the natural and naive type of perceptual response); or he may have an analytic attitude (one in which
Fig. 27—Figure-ground effect. The appearance of an area may depend to a significant extent upon attitude. If the center of the Maltese cross is assumed to be related to the blue cross, it appears to be bluish gray. If it is assumed to be the center of the yellow cross, however, it appears as a yellowish gray. Similarly, the black circular sectors serve to imply the presence of a white triangle. (Source: Burnham, Robert W., Randall M. Hanes, C. James Bartleson, Color: A Guide to Basic Facts and Concepts, New York, John Wiley & Sons, Inc., 1963.)
the observer is not so much concerned with remembered properties of the object as he is with interpreting the actual physical stimulation coming to him from that direction) (2, pp. 86-87).

One of the major problems encountered by the interior designer, concerning mental set, is the fact that most individuals associate in their minds a particular response when a particular color is mentioned. For instance, if the designer suggests a turquoise hue for a special treatment in an interior environment, the individual to whom he makes the suggestion, may associate a displeasing color response with turquoise, and, therefore, reject this hue without discussion. Conversely, the same individual may see a blue-green hue that he especially likes, but when the designer suggests that this color is turquoise, the individual begins to find objections for the color.

With concern for all of these psychological factors, the interior designer must realize that these phenomena exist, in order to achieve satisfactory results in an interior designed for a specific type of person or group of persons. Individual differences (likes or dislikes) must be considered in any phase of interior design. The color perceptions of all the elements of the interior environment—architectural surfaces, furniture and accessories, and illumination—are influenced by these phenomena resulting from psychological factors.
CHAPTER BIBLIOGRAPHY


The fact that colors look different in different surroundings is well known in the interior design field; however, it is difficult to find systematic information regarding the relationships of this and other psychophysical color phenomena to the design of interiors. Because of the paucity of information of this type, this study examines the body of psychophysical color effects as they have been described in scientific literature in an effort to relate them to interior design. Certain of the phenomena have been selected for study and discussion based on their seeming relevance to some of the problems encountered by designers of interior environments. Each phenomenon is defined and discussed in terms of its possible application to the elements which shape the interior environment: architectural surfaces, furniture and accessories, and illumination. It is pointed out how these elements serve as color stimuli, an indispensible link in psychophysical color experience.

In this thesis the psychophysical aspects of a situation producing color refer to the relations between specific amounts and kinds of color stimuli and particular color responses. For purposes of discussion, the kinds of phenomena have been grouped into four categories according to their characteristics: the psychophysical phenomena resulting from variations in the intensity and purity of a color stimulus, the
psychophysical phenomena resulting from spatial relationships within
the visual field, the psychophysical phenomena resulting from visual
stimulation, and the psychophysical phenomena resulting from psychologi-
cal factors.

The Bezold-Brucke effect and the Abney effect exemplify color
phenomena resulting from changes in the intensity and purity of a sti-
mulus. The Bezold-Brucke effect demonstrates that in a small color
stimulus with a dark field, the hue will often change as the intensity
of the light source increases. The hue is also changed in the Abney
effect, when there is a change in the purity (saturation) of the stimu-
lus with a dark ground, by the addition or subtraction of light. The
prevailing source of light in an interior will determine whether or not
these effects will exist.

The spatial relationship of the color stimulus within the visual
field can affect the color perceived. A variation in the color elicited
by the stimulus object may be viewed in the phenomena of area effect,
simultaneous color contrast, spreading effect, and spatial-averaging.
In an area effect, the saturation and brightness of a color vary with
the angular size of the color stimulus. The position of an object in
relation to other objects in the visual field can cause a color change.
Simultaneous color contrast causes the visual mechanism to accentuate
differences in the hue, brightness, and saturation of objects juxtaposed
to each other either in space or time. In the case of small complicated
patterns, the effects of simultaneous color contrast are reversed, and
this phenomenon is called a spreading effect. Spatial-averaging takes
place in the visual mechanism when stimulus-objects, adjacent to each
other, are so small that they cannot be individually resolved with normal vision. The position of stimulus-objects in relation to other stimulus-objects and/or the observer in an interior environment, that is, variations in sizes, patterns, and figure-ground relationships of furniture and accessories, create these effects.

The phenomena of after-images, retinal stimulation, and chromatic adaptation, caused by visual stimulation, are responsible for other changes in the color response of the observer. The after-effects with changes in hue, brightness, and saturation that persist after the stimulus-object has been removed are called after-images. In retinal stimulation, various areas of the retina produce different chromatic responses when exposed to color stimuli. Chromatic adaptation to a stimulus leads to a decrease in saturation and a brightness shift toward a middle value, causing the hue to become more neutral in appearance. These effects may be used in interiors to expand color relationships through variation and to accentuate stimulus-objects. If used without understanding, they may tire the eyes rapidly.

The psychological phenomena of color—color constancy, memory color, and mental set—affect color responses. In the observations of everyday life, the phenomenon of color constancy causes object-color perceptions to remain essentially the same even when changes in illumination and viewing condition occur. Memory color refers to the color perception that, according to the judgment of the observer, a familiar object would elicit under normal viewing conditions. Changes in the mental set of the observer is a major factor in determining what color is perceived; skepticism or negative suggestions concerning any visual phenomenon can
prevent its occurrence. The interior designer must be aware of these effects in order to understand human likes and dislikes for various colors and color relationships.

Color is probably the most valuable tool of the interior designer. It is the greatest single unifying factor, having the ability to blend seemingly unrelated elements and objects. Along with lighting, color can completely change the appearance and mood of an interior environment.

This study suggests only a few of the possible applications of selected psychophysical color phenomena to interior design. Additional adaptations might be developed to apply to the many varied conditions encountered in interior environments. It is recommended that other investigators study some of the psychophysical color phenomena not selected for study in this thesis for possible application by designers. It is further recommended that full-scale room settings might be developed to test some of the suggested applications.
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Books


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