Color: Its Science and Esthetics-A Review

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Abstract: To restore a tooth to its functional health, four basic determinants of dental esthetics; position, contour, texture and colour in the said sequence are required. Clark1 said, “Color, like form, has three dimensions, Hue, Value, and Chroma. An understanding of the science of color and color perception is crucial to success in the ever-expanding field of esthetic restorative dentistry. It is possible to arrange color in a manner that makes this three-dimensional enigma understandable. The Munsell Color Order System is recommended as the system of choice for dentists who wish to gain a working knowledge of color.

Keywords: esthetics, pigment colors, psychologic, psychophysical

1. Introduction

To restore a tooth to its functional health and provide it with a natural appearance is a combination of skill, talent and knowledge acquired by the dentist. This involves considering the four basic determinants of dental esthetics; position, contour, texture and colour in the said sequence. The purpose of this article is to explore the three-dimensional nature of colour.

Esthetics is the science of sensitive perception; in a narrower sense: the science of beauty. According to Microsoft "Encarta 97" encyclopedia (1997) esthetics is a branch of philosophy concerned with the essence and perception of beauty and ugliness. A German philosopher Baumgarten introduced the term esthetics in 1753, but the study of the nature of beauty had been pursued for centuries.

Albert Einstein is reported to have said, "If you cannot explain it simply, then you do not understand it well enough." This appears to be the problem regarding color matching. In a time of growing interest in cosmetic dentistry, there is a need for adequate training and communication for better and more life-like results.

Forty years ago, Clark1 said, “Color, like form, has three dimensions, but they are not in general use. Many of us have not been taught their names, nor the scales of their measurement. In other words, we as dentists are not educationally equipped to approach a color problem.” This statement is unfortunately still valid.2

Color is complex and encompasses both subjective and objective phenomena, but there are laws of color just as there are other laws in nature.3 For a good analogy concerning some of the problems of color, we can consider the entity known as heat. “Heat” is objective and can be measured, but “hot” and “cold” are subjective attributes and cannot be objectively measured.4 Our perception of color is accepted as subjective,5,9 and problems in its measurement can be anticipated. In an effort to translate from the physical facts of color, such as measurement of reflectance as a function of wavelength, to the psychologic (i.e., perceptual) facts of color, the science of color measurement (colorimetry) has established an international psychophysical method of color specification which includes a “standard observer” and standardized light sources.10-12 This approach has supplied an operating base for our attempts to measure objectively this subjective phenomenon.

2. Color in Dentistry

Pigment Colors
Inherent hues of an object. They are inherent in restorative materials (EG, ceramics, composites and acrylic resins.)
• Primary colors
• Secondary colors
• Complementary colors 13

Dimensions of Colors
A) Munsell Color Order System: The most popular method for describing color is the Munsell system. Despite certain disadvantages, the Munsell system has been widely used in the dental literature.14,15 The three attributes of color in this system are called Hue, Value, and Chroma.

Hue: Hue, the first dimension, is the easiest to understand, and in Munsell’s10 words, “it is that quality by which we distinguish one color family from another, as red from yellow, green from blue or purple.” The color wheel is a familiar form of this dimension and consists of the Hues that are arranged sequentially around the central axis of the Munsell Color Solid (Plate II, C). To refer to a Hue in the Munsell system, the initials are used: R for red, YR for yellow-red, Y for yellow, and so on.
Plate I. The Munsell color tree.
Plate II. (A) Value scale—theoretical white and black included in addition to the nine Value steps. (B) Munsell Book of Color, (C) Color wheel.

**VALUE**: Value “is that quality by which we distinguish a light color from a dark color,”¹⁸ Light energy is measured in photons, and it is possible for objects of different Hues to reflect the same number of photons and thus have the same brightness or Value. This fact created a popular misconception that the Value of a color quantified the amount of grayness. In the Munsell method of describing color, Value is divided into 10 gradations, with 0 being black and 10 being white. Natural teeth range in Value from 5.5 to 8.5 (Fig 2). A restoration that has too high a Value (is too bright) may be easily detected by an observer and is a common esthetic fault in metal-ceramic prosthodontics.¹⁹

**Chroma**: Chroma, the remaining dimension, “is that quality by which we distinguish a strong color from a weak one; the departure of a color sensation from that of white or gray; the intensity of a distinctive Hue; color intensity.”²⁰ In the Munsell color system, maximum Chroma depends on the particular Hue but can range from 10 to 14.

Achromatic shades have a Chroma near 0 (Fig.3). Natural teeth are found with Chroma ranges from 0.5 to 4 (Fig 2).¹⁹
problems in a logical manner. This will enable the practitioner to make the best choice and communicate it accurately to the laboratory.

References