SHADE GUIDES AND COLOR VISUALIZATION

By Todd Snyder, DDS

In our profession we're challenged every day with daunting tasks, which add to the already difficult job of fixing fidgeting patients' teeth while looking upside down, under water, and in the dark. In cosmetic dentistry, these challenging procedures can be further complicated by the limitations of technology.

There are many components involved with prescribing and fabricating restorations. One of the seemingly easy tasks is shade identification and communication. Although it appears to be simple, we all recognize how difficult it is to describe the shade of a tooth with shade guides that use outdated technology.

Shade evaluation and shade communication are crucial to fabricating a lifelike restoration. There are many reasons why it's so challenging to quantify the shade of a tooth. The first is the human eye. The eye is fallible because it can be tricked into seeing a different color just by changing lighting conditions or surrounding colors. Although an object may appear one color in one lighting condition, it may look subtly different under another lighting condition, a phenomenon known as metamerism. Furthermore, nearby colors can influence the eye, thus altering the appearance. The colors of adjacent walls, clothing, lipstick, and hair color can make a shade appear different.

How the eye perceives color

To make things more complicated, no two eyes see things the same. The eye perceives color through the rods and cones. The color we see is a wavelength of light that our eyes interpret using these rods and cones. The rods see black and white and the cones perceive colors.

Shade selection is best done with light most suited for our eyes. However, we often select shades under artificial light that doesn't allow us to properly assess tooth color. If exposed to light for too long, rods and cones will saturate and produce latent after-images of the complementary color to which they were exposed. Also, prolonged exposure to any color will decrease the receptors' sensitivity.

The rods and cones need to be recharged after lengthy exposures to perceive colors properly. This can be achieved by looking at an 18% reflective neutral gray card. An often-undiagnosed problem is color blindness, a condition characterized by the inability to distinguish between colors. Red/green color blindness is the most prevalent, affecting 8% of males and 0.5% of females. Additionally, as we age, a naturally occurring process known as brunescence changes the appearance of the colors we see. We typically have deterioration in vision and color perception as we age.

Proper illumination is important to help eyes function at their best. Operatory lights shouldn't be used for shade selection unless they've been replaced with color corrected lighting. Color corrected lights have a color temperature of approximately 5,500° Kelvin and a color rendering index of 90 or more. The human eye has optimal vision at 5,600º Kelvin. The intensity of the light is just as important as the color temperature. The ratio of intraoral to extraoral illumination should be 3 to 5:1, with an extraoral light intensity of 200 to 300 foot-candles, which can easily be measured with the light meter of a camera. Foot-candle intensity may also be listed on the illumination device's documentation.

Correct lighting a must

Color perception is more accurate and has fewer metamerism effects when color corrected lighting is used to evaluate the three components: hue, chroma, and value. Hue is a family or group of wavelengths that have a similar appearance (which we were taught is called "color"). Chroma is the level of saturation of any particular hue. The value is the level of whiteness or darkness.

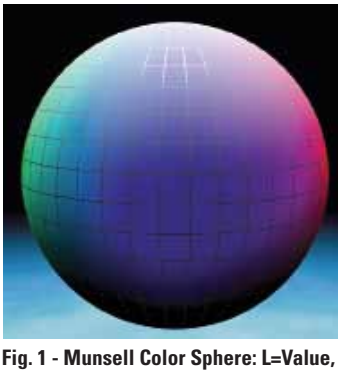

Fig. 1 - Munsell Color Sphere: L=Value, C=Chroma, H=Hue

Shade perception and color determination is a field of study defined by mathematics. Color interpretation is often defined scientifically in a mathematical 3-D format. The format can be plotted as seen in Munsell's color sphere (Fig. 1). Each color is a point in space represented by three components on X, Y, and Z planes and given the identification of L*a*b*, which has been defined by the International Lighting Commission (Commission Internationale de l'Eclairage; CIE). The distance between any two colors in 3-D space is defined as Delta E. When the difference in Delta E is large enough, the eyes can perceive a difference.

In dentistry, some shade guides are available for color interpretation of restorative materials — tooth colors that have a Delta E difference between shade tabs so close together that the human eye cannot perceive a difference. Other times, neighboring tabs are so different it seems that tabs have been removed and are needed to fill the gap between two tabs. This explains why most shade guides can make the subjective evaluation and shade

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identification process difficult or impossible.

Many shade guide systems use hue as the basis to define color. Within each hue there are various levels of chroma (or saturation) to select from with no consideration for the Delta E difference between tabs. The third and most critical component for color selection (value) typically has no accountability and is not addressed in most shade guides. The VITA Classical Shade Guide (Fig. 2) is the most commonly used shade guide, but it's flawed because it does not address value.

Fig. 2 - VITA Classical Shade Guide

Fig. 3 - VITA 3D-Master Shade Guide

It was not until 1997 that value was added to a shade guide and used as the primary source of shade selection, with chroma and hue having less impact on the selection process. The VITA 3D-Master Shade Guide (Fig. 3) revolutionized shade selection, making the process easier by basing color selection on value. With the 3D-Master Guide, as each color component is selected, it is held constant while the next color component is found. There's no other system available that allows this to be done.

However, simply knowing the correct color will not provide a perfectly matching restoration. It's easier to understand where to place ceramic when fabricating a restoration if there is some visual input. This is why a photograph is used to help determine where color changes occur. This information is invaluable for the technician to see color shifts, regardless of whether or not a photograph is color accurate.

When viewing shade guides, the color differences can be visually detectable by 50% of human observers in controlled conditions when Delta E values are greater than one unit. The difference between 2.0 and 3.7 Delta E are visually detectable under clinical conditions.

The traditional VITA Classical Shade Guide has 16 shade tabs with Delta E's close together, and can be difficult for proper shade selection. It's also unable to produce all of the colors necessary in dentistry. The total VITA Classical Shade Guide range has a coverage rated at 17 Delta E* divergence. The 34 Delta E coverage of the VITA Bleachedguide 3D-Master (Fig. 4) allows for considerably more interpretation.

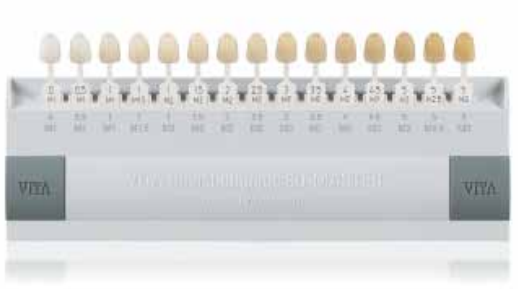

Fig. 4- VITA Bleachedguide

The VITA Bleachedguide Shade Guide has 15 tabs and provides better color space coverage and wider distinguishable color choices with broader Delta E's, making it easier for doctors, staff, and patients to perceive color changes and shade interpretation.

The VITA Bleachedguide 3D-Master is designed primarily for observing and monitoring the patient's whitening process. The tabs are set in a simple to compare linear order, which allows for easier identification of value when selecting shades.

Fig. 5 - The VITA Linearguide

VITA has also introduced the VITA Linearguide (Fig. 5), which simplifies the arrangement of the original VITA 3D-Master by separating the value tabs into their own holders. The chroma and hue tabs are arranged separately within each value group. This allows the dentist to quickly determine the value of the restoration before moving on to chroma and hue, and removes any potential confusion caused by the nonlinear arrangement of shade tabs in the current 3D-Master system.

Understanding the shortcomings of current shade guides, your eyes, lighting conditions, and your surroundings when selecting tooth shades will improve your ability to perceive colors. By using modern research tools that assist the eyes to work easier and under proper lighting conditions, you can simplify the shade selection process and allow for fewer remakes, chair time, and cost. **DE**

References available upon request.

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