

AESTHETICS

Shade-Matching Challenge: A Single Central Incisor

Achieving a good color match when restoring a single incisor is probably among the most difficult aesthetic challenges for any dentist (Figure 1). While the latest technology can be found in most modern dental offices such as CBCT; laser; CAD/CAM; and less common, the more expansive spectrophotometric instruments,¹ the vast majority of clinicians still conduct dental shade selection by using a nearby window for a natural light source or, if they are fortunate, pass the buck by simply sending the patient to the dental laboratory technician to take and map the shade. There must be a better way and, in the authors' opinions and experience, *there is!* A simple and inexpensive handheld portable LED light source, the Rite-Lite2 HI CRI Shade Matching Light (AdDent), is now available help achieve an excellent restorative shade match.²⁻⁴

DESCRIBING A SHADE

Shade matching is an interdisciplinary process that requires the clinician to communicate with the dental laboratory team using a common language and images (shade-mapping and photographs). Thus, shade matching relies on perception and interpretation of the evidence.

Color, commonly referred to as the *shade*, is divided into 3 components.

- *Hue* refers to the basic color (eg, red, blue, green).
- *Chroma* refers to the intensity of the color (eg, fire-truck red versus pastel pink).
- *Value* refers to the brightness of the color (eg, the range of gray from black to white).

All these components should not be overlooked, or else a wrong interpretation of color may lead to an undesired result. For example, how often have you told your ceramist to make the cuspids slightly darker when restoring an anterior case? However, your



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real intent was to make the cuspids *warmer* with more chroma but *not darker* (lower value).

It is important to realize that the correct language helps in the interpretation of the evidence. Acquiring the evidence relies on the physiology of our eyes and the transmitted light.⁵

How We Perceive Color

We perceive color using *cone cells* that are located in the fovea in the middle of the retina. Cone cells are few in numbers and are divided into 3 groups. Each group responds to a specific color: red, blue, or green.⁶ Cone cells fatigue extremely fast, since they are limited in number. For example, if you stare at a color, such as red lipstick, the red cone cells will shut down after 30 seconds. This will leave you seeing only the combination of colors provided by the green and blue cells. This is why it is necessary to create a neutral background for your eyes before selecting a shade. Ideally, the walls in the room should be gray or white. Ask



Figure 1. Pre-op photos of mismatched crown on nonvital central incisor with gingival inflammation.



Figure 2. Handheld Rite-Lite2 HI CRI Shade Matching Light (AdDent).



Figure 4. Final results—new crown on central incisor.

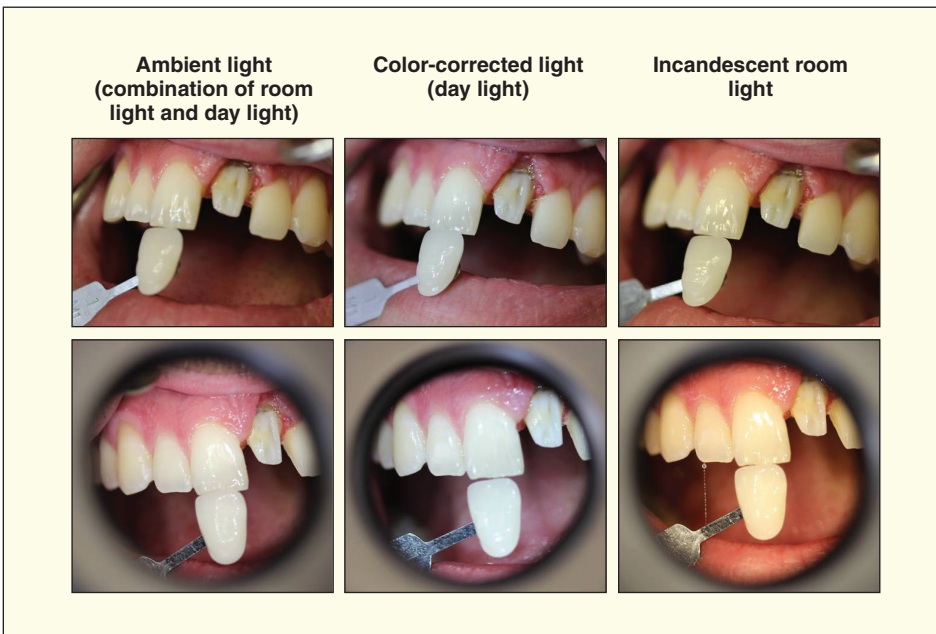


Figure 3. Examples of shade taken in different color temperatures.

your female patients to remove their lipstick and place a pale blue or grey bib over their clothes.⁷

How We Perceive Value

We perceive value (shades of gray from black to white) through *rod cells*. These cells are on the periphery of the retina and outnumber the cone cells by 30 times.

Rod cells do not fatigue as easily or as quickly as the cone cells. They can determine the difference in value without getting overworked, while the cone cells quickly fatigue and colors seem to blend

together. This is why selecting the correct value on a shade is critical. If the value is correct, hue and chroma can be slightly off without affecting the final result.

While our eyes can differentiate between colors and value of an object, modifying the light source can affect the way our eyes perceive the color of the object.⁶

Color Rendering Index

The color rendering index (CRI) is the measure of the ability of a light source to reveal the colors of various objects

faithfully in comparison with an ideal light source (ie, the sun, as opposed to LEDs or fluorescent lamps). Therefore, a light source with a high CRI is desirable in color critical applications.⁸ Hence, in our practice we use the Rite-Lite2 HI CRI Shade Matching Light. This tool is easy to use and highly effective, and will help to ensure a cosmetically pleasing restoration even when treating complex clinical cases.

Color Temperature

Each light source has its own individual color, called *color temperature*, which varies from red to blue. Sunsets, candle flames, and light from tungsten bulbs all emit light that is close to red, thus imparting a “warm” look to photos. On the other hand, clear blue skies give off a “cool” blue light.

Color temperature is recorded in Kelvin (K), the unit of absolute temperature.

The color temperatures of cool colors, such as blue and bright white, typically have color temperatures of more than 7,000°K. Red and orange, with warmer color temperatures, have measurements near the 2,000°K mark. Many references on shade matching in dentistry suggest the use of 5,500°K north white light at 12:00 noon as the standard to be used for shade matching as a basis to taking a shade.^{9,10}

This handheld device provides 3 different light options to replicate the different sources of light that we come across on a daily basis (Figures 2 and 3). The 3 lighting modes are as follows:

1. Color corrected light at a color of 5,500°K. This represents north white light at 12:00 noon as the standard to be used for shade matching.

2. Incandescent room light at 3,200°K, found most commonly in many indoor environments.

3. Ambient light at 3,900°K, a combination of both indoor and daylight.

Metamerism

In the field of color science, there is a principle called *metamerism*. It is a phenomenon that occurs when colors change when viewed in different light sources. This means that if a shade is a perfect match, it should match in multiple wavelength spectra (ie, in different lighting environments). Making sure that the shade tab matches the tooth in all 3 light

sources has the following purposes:

- It helps prevent metameric mismatch, which is a phenomenon by which 2 objects may appear different under different light sources. The Rite-Lite2 can be used also after bonding the crown in place to verify the shade under the different color temperatures.

- It helps select the correct value. The low-intensity light is preferable to select the value as the high intensity may be too bright and wash out the value. A crown that looked good in the sunlight or in your office under a 5,500°K may end up looking different in the patient's bathroom mirror at 3,200°K, resulting in a costly remake.

CLINICAL CASE EXAMPLE

A complex clinical case for which a single restoration needs to be replaced on tooth No. 9 (left maxillary central incisor) will now be briefly described.

The treatment plan included the preparation and placement of an aesthetic layered pressed porcelain full crown. It is worth mentioning that tooth No. 9 had a dark root with a gray hue permeating throughout the gingival area as well as gingival irritation and 5.0 to 6.0 mm periodontal pockets.

The shade that matched the tooth in all 3 settings was identified to be the 1M1 shade tab from the value-based shade guide VITA 3D-Master (VITA North America). In today's dentistry, where

the majority of shades selected are on the bright side of the color spectrum, selecting the correct value is critical. The ideal distance to select a shade using the Rite-Lite2 HI CRI Shade Matching Light is 6 to 8 inches from the patient (Figures 2 and 3).

My golf analogy to matching a single central is that it is a par 3 hole. It takes 2 to 3 tries to get a good match. The result, when using this shade selection technology, is as close to a hole in one as one can get (Figure 4).

IN SUMMARY

As explained in this article, there are many factors to consider when matching the shade of a restoration to an adjacent tooth, especially in the aesthetic zone. The shade selection process entails more than simply picking the shade tab that looks the closest in color. It is important to look at shades under multiple lighting conditions with a high CRI light source to get the best match in several common lighting environments.♦

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