Color and Shade Selection

Edmond R. Hewlett, D.D.S.

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Overview

- See
  - Color science & perception
  - Tooth optics
- Enable
  - The environment
- Communicate
  - Vita Shade Guides
  - Photos
What is Color?
What is Color?

Color is defined as the quality of an object or substance with respect to light reflected by it, usually determined visually by measurement of *hue*, *chroma*, and *value*.
The Munsell Color System

- Professor A.H Munsell
  - Basic principles first published in 1905
- Munsell Color Company
  - Est. 1918 to develop color standards
- Continued development at Nat’l. Bureau of Standards, Optical Soc. of America
The Munsell Color System

- 1940’s - Revised Munsell system standardized by:
  - International Commission on Illumination (CIE).
  - American Society for Testing and Materials

- Munsell System is an internationally-accepted standard for art, science, and industry
The Munsell Color System

- Color components:
  - Hue
  - Chroma
  - Value
Hue

- The color itself
- The attribute of a color by which we distinguish red from green, blue from yellow, etc
Chroma

- The intensity of the color
- Low chroma ≡ “weak”
- High chroma ≡ “highly-saturated”
Value

- The brightness of the color
  - High value = brighter (more white)
  - Lower value = darker (more gray)
- Value of 0 = black
- Value of 10 = white
Value (Brightness, aka Lightness)

- Brightness is the most important color variable in dental shade selection!
Munsell Color Space

- Arrangement of all colors according hue, chroma, and value in a 3-D space
Other Color Terms

- Opacity
  - impenetrable by light
  - *reflective* – neither transparent or translucent

- Transparency
  - capable of transmitting light

- Translucency
  - diffused transmission of light
Color Perception
Similar colors appear different under different conditions due to:
- Light source type and angulation
- Size and shape differences
- Influence of background color & lighting
- Perception angle (perception is altered by direction and reflection)
Perception

eye

environment

object surface
The Human Eye

- Receptors: rods and cones
- Rods convey shades of gray (value)
- Cones allow brain to perceive color hues and chroma
The Human Eye

- Colorblindness affects...
  - 1-in-300 females
  - 1-in-13 males
- Get tested
Illumination

- Everything that we see is *reflected light*
- *Full spectrum* light is needed to see color
- Color missing in the light source cannot be reflected

Image from Chu, et al 2004
Illumination Sources

- Daylight (6500° K)
  - Variable, depending on time of day, cloud cover, etc.
- Electronic flash (5500 ° K)
- Standardized light source (for industrial color measurement)
  - 5000° K
  - CRI 98 (Color Rendering Index)
Illumination Sources

- Recommended lighting for accurate shade taking in dentistry:
  - 5500 °K
    - Replicates northern natural midday daylight
    - Balances all hues in the spectral curve
  - Working distance: 12 to 15 inches
    - Arm’s length
  - Appropriate environment
Images from Chu, et al 2004

- Color corrected source (5, 500 K)
- Incandescent source (2,856 K)
- Fluorescent source (4,000 K)
Illumination

- Use the appropriate illumination source!

Images from Chu, et al 2004

incandescent  fluorescent

5,500 K
Metamerism

- Objects that appear similar under one condition but different under another.
- i.e., an object appears to be different colors when viewed under different light sources.
Color corrected source (5, 500 K)

Incandescent source (2,856 K)

Fluorescent source (4,000 K)

images from Chu, et al 2004
Metameric Pair

5,500 K  Fluorescent  Incandescent
Tooth #8 – unrestored  Tooth #9 – crown

images from Chu, et al 2004
Metamerism

- Easy to recognize, impossible to control
- Newer materials help
  - chameleon effect; fluorescence
- May need to explain to patient
- For dental ceramics:
  More opaque porcelain $\Rightarrow$ more metamerism!
Key Optical Properties of Teeth

- Fluorescence
- Opalescence
- Translucency

Images from Chu, et al 2004
Fluorescence

- Emission of visible light upon exposure to fluorescent light
- Dentin >> Enamel

images from Chu, et al 2004
Fluorescence

- Emission of visible light upon exposure to fluorescent light
- Dentin >> Enamel
- Opaque dental porcelains
  - Dentin-like fluorescence
  - Reduced metamerism effect

Images from Chu, et al. 2004
Opalescence

- Ability of a *translucent* material to…
  - appear blue in reflected light
  - appear red-orange in reflected light

Images from Chu, et al 2004
Opalescence

- Under direct illumination…
  - reflectance of short wavelengths (blue)
  - Absorption of long wavelengths (red-orange)

images from Chu, et al 2004
Opalescence

- Under transillumination...
  - reflectance of long wavelengths (red-orange)
  - absorption of short wavelengths (blue)

images from Chu, et al 2004
Opalescence

- Enamel >> Dentin
  - more translucent, more crystalline
- Incisal porcelains
  - Can mimic enamel opalescence

images from Chu, et al 2004
Translucency

- Transmission and diffusion of light
- Conveys depth and vitality

image from Chu, et al 2004
Translucency

- Avoid excessive translucency
  - lowers value
  - restoration is too grey/dark

image from Chu, et al 2004
Translucency

- Avoid inadequate translucency (excessive opacity)
  - too much reflectance
  - lifeless appearance
- Axial reduction!
Control the Environment

- Must surround teeth with color that aids color perception
- Use neutral colors in operatory
- Close blinds
  - window light = daylight = contamination
- Cover brightly-colored clothing
- No lipstick!

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Control the Environment

- Always use a bib
  - Color space of natural teeth = Orange
  - Compliment to orange is blue
- Use *blue* patient bibs
Shade Determination

Shade Communication
Vita Shade Guide (Vitapan Classical)

- Introduced in 1956
  - A = Orange
  - B = Yellow orange
  - C = Grey orange
  - D = Brown orange
Limitations:
- not uniformly positioned throughout tooth color space
- no standard incremental difference between adjacent shades
- in-between shades (e.g. “A2.5”) are inaccurate
Shade Selection w/ Vitapan Classical

1. Select hue first
   - 70% will be A
   - 20% will be D
   - 10% will be B or C
   (Choosing lots of B and C?)
   (Check light source)
   (Check for colorblindness)

2. Select chroma for the chosen hue group

3. Verify value
Vita 3D-Master Shade Guide

- Introduced in 1998
- Reflects distribution of tooth shades in nature
- Systematic and *equi-distant* coverage of the natural tooth shade spectrum

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Vita 3D-Master Shade Guide

- Design:

  5 value levels (1-5) arranged left to right
Vita 3D-Master Shade Guide

Design:

3* chroma levels (1-3) in each value group, arranged top to bottom

*(only 2 chroma levels for value group #1)
Vita 3D-Master Shade Guide

- Design:

  (up to) 3 hue levels (L,M,R) for each chroma level, arranged left to right
Vita 3D-Master Shade Guide

Procedure

1. Select value (lightness)
Vita 3D-Master Shade Guide

- Procedure
  1. Select value (lightness)
Vita 3D-Master Shade Guide

Procedure

1. Select value (lightness)

Determining the value (lightness)

Group 1, 2, 3, 4 or 5
Select only from lightest to darkest.
Vita 3D-Master Shade Guide

**Procedure**

2. Select **chroma** from within the selected value group

- Use “M” tabs from the selected value group
- Choosing between diluted & saturated
Vita 3D-Master Shade Guide

Procedure
3. Select **hue** from within the selected value group

Is the natural tooth more reddish (R) or more yellowish (L) than the M group?
Vita 3D-Master Shade Guide

- Bleached shades now available
  - 0M1, 0M2, 0M3
- Bleached shades occupy the “leftmost” (brightest) value group (group #0) on the 3D-Master guide.
Shade Selection Keys

- Use correct environment and lighting
- Select shade at beginning of app’t.
- Patient sitting upright
- Viewing distance ~15 in. from teeth
- Patient’s teeth/dentist’s eyes at same level
Shade Selection Keys

- Photograph shade tabs which match specific segments of teeth
- Photograph texture
- Note special characteristics
Shade Selection Keys

- Look for variance between gingival, middle, and incisal thirds of teeth.

higher chroma & opacity

less chroma, higher value

high translucency, lower value

image from Chu, et al 2004
Photographs for Lab Communication

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Texture Photograph

- Close-up of anteriors with lens ⊥ to labial surface
- Emphasizes surface texture and luster
Color Photograph

- Close-up of anteriors with lens angled 15-20° to labial surface
- Reflections bounce away from camera, revealing color and characterization
Photographs with Shade Tabs

- Angle camera to avoid reflections from tab and teeth
- Show at least 6-8 teeth
- Tab at same angle as teeth
- Tab as close to teeth as possible
Photographs with Shade Tabs

- Tab and handle clearly visible, no reflections

- Shoot as many photos as necessary
  - different tabs for different areas of teeth
Photos for All-Ceramic Restorations

- Shade tab w/ teeth before preparation
- Shade tab w/ prepared tooth/teeth
- Desired shade(s) next to preparation(s)
Other Lab Communication Photos

- Photos of provisionals
  - Views 5, 6, 7, & 8 as indicated
- Shade photo of provisionals
- If restoration doesn’t match, photograph it in mouth with tabs

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Digital Shade-Taking Devices

images from Chu, et al 2004
Digital Shade-Taking Devices

What are they?

- RGB devices, spectrophotometers, or colorimeters designed or modified for dental use

images from Chu, et al 2004
Digital Shade-Taking Devices

- What can they do?
  - Provide detailed data on shades in different zones of a tooth’s surface

Images from Chu, et al 2004
Digital Shade-Taking Devices

■ Limitations

■ Not reliable for complex characteristics
  ■ sub-surface color
  ■ Translucency
  ■ Texture effects

image from Chu, et al 2004
Digital Shade-Taking Devices

- **Bottom Line**
  - NOT a replacement for traditional methods
  - Best used as an ADJUNCT to traditional methods and photography

Images from Chu, et al 2004