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Brightness (Value) Sequence for the Vita Lumin Classic™ Shade Guide Reassessed

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Abstract - *The purpose of this study was to locate the 16 shade tabs from the Vita Lumin 'Classic' shade guide within the quantitative Luminosity, R, G and B scales (0–255 scales) using Photoshop® software. A new value order arranged according to the Photoshop® scale demonstrated a more linear relationship between the 16 shade tabs than the order given by the manufacturer. A Brightness Index representing the percentage difference in value between pairs of reordered shade tabs is suggested as a more realistic determinant of change in shade tab value.*

KEY WORDS: Brightness; value; shade guide

LITERATURE REVIEW

Three main attributes, hue, value and chroma are commonly used to describe a shade[1], where hue represents the specific color, chroma the intensity of a hue, and value the relative darkness and lightness (brightness) of a colour. Manufacturers' shade guides enable clinicians to describe patients' tooth shades in alphanumeric terms. This is valuable in documentation, communicating information between clinicians and technicians, and in patient information (such as determination of changes in brightness after tooth whitening procedures).

For many years the Vita Lumin 'Classic' shade guide (VLCSG) has been the gold standard in clinical dentistry, and many restorative materials are keyed to it[2]. This system allocates hue into four groups designated by letter A, B, C or D. Each hue group comprises tabs of increasing chroma and decreasing value designated in ascending numeric order[3,4]. This implies distribution of these factors in a linear scale. Visual determination of tooth shades has been found to be unreliable and inconsistent and is a continuing problem[5,6]. Concentration on value, which is the perceived brightness of teeth, is clinically useful in determining tooth shade and for this reason the manufacturer of the VLCSG offers clinicians an order of shade tabs specific to this characteristic. This value order is generally accepted by the profession, however, Paravina[7] found recently that an alternative tab arrangement of the VLCSG could enable better value-matching outcomes compared to the manufacturer-suggested array.

The purpose of this study was to locate the 16 shade tabs from the VLCSG within the quantitative Luminosity, R, G and B scales (0–255 scales) using digital imaging and Photoshop® software. These data would both provide a ranking of shade tabs in terms of value and establish the degree of value difference between individual shade tabs.

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MATERIALS AND METHODS

The shade tabs from four VLCSGs were sandblasted with 50 µm aluminum oxide to remove their surface glaze. Each shade tab was located in a fixed position on a blue table beside a 1cm square size grey card. This grey card was employed as the control for determining any photographic variations. A 'Dialite' shade matching light was mounted 10cm away from the blue table and this was used as sole light source for all the experimental recordings. A Nikon Coolpix 995 digital camera with a close-up lens was positioned centrally above the shade matching light using a rigid stand.

Five digital pictures were recorded of each shade tab at an aperture of F8.8 and shutter speed 1/60 second. Data were then downloaded to a Sony computer.

The digital pictures were interpreted using Adobe Photoshop® version-6.0 software. The whole shade tab was outlined for subsequent histogram analysis. Histogram command in Photoshop® software differentiated pixels within this defined area. This determined numerical parameters for Luminosity, R, G and B values, (defined in terms of red, green and blue pixel intensity on a scale from 0 to 255, 8 bit, dark to light for each tab). The mean values of the five determinations for each shade tab were recorded for final data analysis.

RESULTS

The Luminosity data for the grey card from the digital images ranged from 85 to 88 within a scale of 0–255. This indicated that the digital imaging was very stable throughout the experimental procedure.

The mean Luminosity, R, G and B data for all shade tabs are shown in *Table 1*.

Regression analysis was applied to this data set to deter-

Table 1. *Luminosity(L), R, G and B data by alphanumeric group for four shade guides*

	Shade guide 1				*Shade guide 2*				*Shade guide 3*				*Shade guide 4*			
	L	*R*	*G*	*B*	*L*	*R*	*G*	*B*	*L*	*R*	*G*	*B*	*L*	*R*	*G*	*B*
A1	140	138	143	131	141	139	144	132	140	140	142	130	140	137	143	132
A2	133	132	136	124	133	132	136	124	135	134	138	125	134	133	136	123
A3	130	130	132	116	128	128	131	116	130	133	133	110	129	128	132	117
A3.5	120	120	123	103	124	124	127	110	124	124	127	109	125	126	128	105
A4	114	114	117	98	115	115	117	99	115	120	116	91	114	116	116	96
B1	138	135	142	132	140	138	143	134	141	137	144	135	141	137	144	136
B2	133	133	136	122	134	133	136	122	133	131	136	122	133	130	140	121
B3	125	125	127	109	127	127	131	108	126	125	129	108	126	124	130	109
B4	125	126	129	107	126	128	129	106	125	126	128	105	126	126	129	106
C1	129	124	133	122	131	129	134	125	131	126	134	124	123	121	127	114
C2	125	126	127	111	124	122	127	113	118	116	121	109	123	121	127	109
C3	117	115	120	105	118	116	121	107	119	119	122	107	118	117	122	107
C4	109	109	111	96	108	108	111	94	110	110	112	96	110	110	112	97
D2	126	124	129	118	127	125	130	120	126	122	129	118	127	124	130	121
D3	124	123	127	114	123	122	126	112	124	123	127	113	126	124	129	117
D4	122	119	126	110	121	118	125	106	124	126	127	103	123	121	127	109

Table 2. *Mean Luminosity, R, G and B scales of the shade tabs*

Vita Lumin 'Classic' value alphanumerical order	*Luminosity scale*	*'R' scale*	*'G 'scale*	*'B' scale*
A1	140	138	143	131
A2	134	133	136	124
A3	129	130	132	115
A3.5	123	124	126	107
A4	114	116	117	96
B1	140	137	143	134
B2	133	132	136	122
B3	126	125	129	108
B4	126	127	129	106
C1	129	125	132	121
C2	123	121	126	110
C3	118	117	121	107
C4	109	109	111	96
D2	127	124	130	119
D4	122	121	126	107
D3	125	123	127	114

Table 3. *Brightness Index (derived from Photoshop® 'B' determinations)*

Shade	*x*	*%*
B1	134	100
A1	131	92
A2	124	73
B2	122	68
C1	121	66
D2	119	61
A3	115	49
D3	114	47
C2	110	38
B3	108	33
D4	107	30
A3.5	107	29
C3	107	28
B4	106	27
A4	96	1
C4	96	0

mine the relative contribution of the dependent variables. The R-squared values were: Luminosity, 0.7571; R scale, 0.6277; G scale 0.7551; and B scale 0.8457, making L, R, G and B of 76%, 63%, 75% and 85% respectively. This indicates that the B colour scale provides the "best fit" to the data set.

Means Luminosity, R, G and B data for each alphanumeric shade type obtained from all tabs in each of the four shade guides are listed in *Table 2*. The B order is listed in decreasing numeric value in *Table 3*. The manufacturer's value order is shown in *Figure 1* together with the four mean B scales for each alphanumeric shade tab.

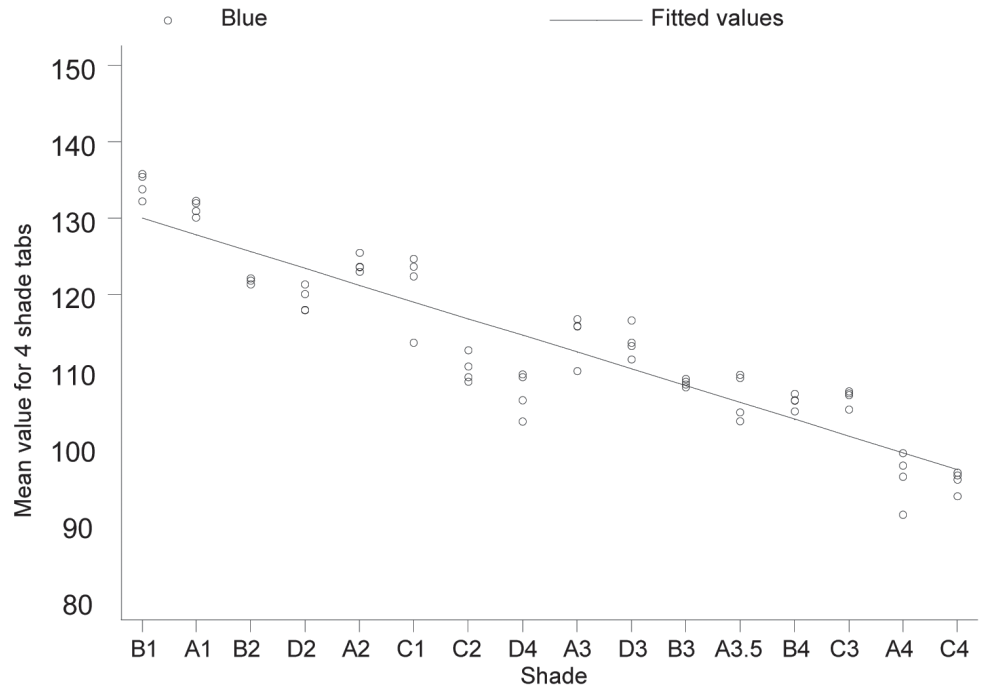

Figure 1. *Photoshop® B determinations by manufacturer's value order with line of best fit*

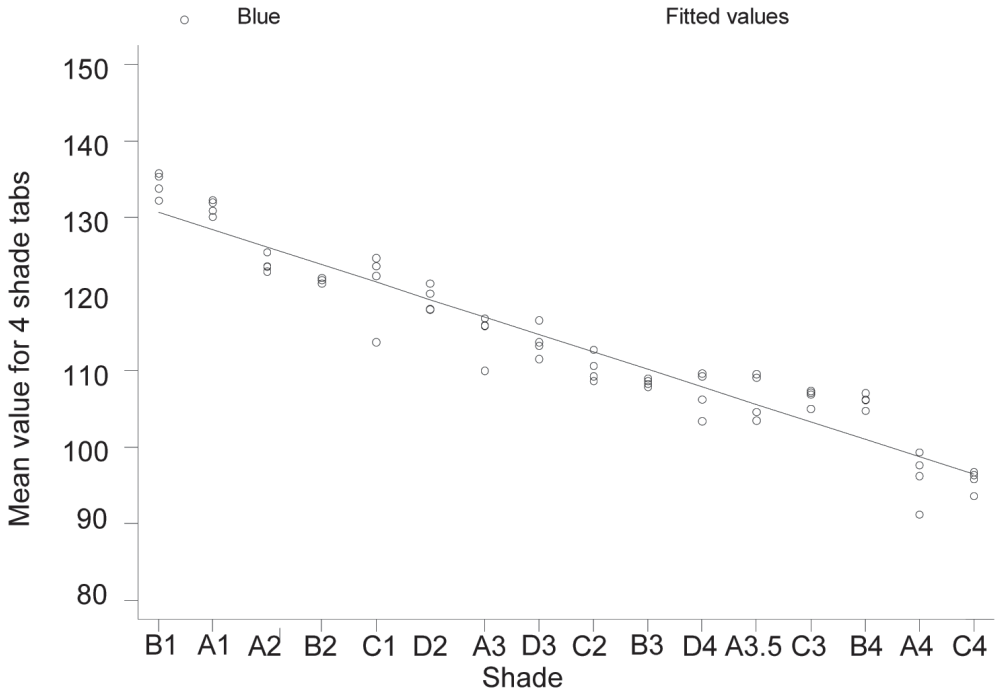

Figure 2. *Photoshop® B determinations by revised value order with line of best fit*

Figure 2 shows a revised value order in which the B data are closest to a line of best fit.

DISCUSSION

Clinicians and laboratory dental technicians have long been searching for a simple method to describe the brightness of teeth in numerical terms. Digital imaging coupled with Photoshop® analysis software has the potential to meet this need. Instrumental colour analyses using spectrophotometers[8] and colourimeters[6,9] are objective methods to measure the spectral reflectance or spectral transmittance of an object. Most of these devices are extremely expensive and bulky so they are not readily suited clinical use. The advent of high resolution digital cameras has opened up the possibility of capturing clinical data in a relatively easily managed form. The image management system Photoshop®, in this study, suggested that the recommended value order arrangement of the VLCSG may not be completely correct. A minor variation in value

order may not have great clinical significance in the process of transferring information from clinician to technician but it may be of greater significance in the determination and presentation of relative tooth brightness – as in tooth whitening procedures.

As well as identifying a need for reordering some shade tabs by value the data from this study show considerable variation in the numeric point on the B scale between adjacent shade tabs. For this reason the presentation of value difference by "shade guide units"[10] is at best naïve.

To present the difference between any two points on the B scale in a meaningful, semi-quantitative manner a "Brightness Index" presenting the percentage difference between these points would have merit. With respect to the data presented in the revised B value scale the highest point is 134.27 and the lowest is 95.61. Simple arithmetic allows the calculation of a specific point on a 0–100% scale for each shade tab where: a = highest point and b = lowest point.

For any value x, the percentage point on this scale is given by

$$\frac{(x-b)\times 100}{a-b}$$

where x is the mean value for any shade tab. These calculations are presented in *Table 3*.

Simply through determination of the appropriate tabs from the VLCSG, a simple subtraction provides the percentage value difference which may be presented as a measure of brightness change. *Table 3* shows a "Brightness Index" for the 16 shade tabs arranged in increasing value according to Photoshop®. This is not in a linear relationship. Some shade tabs, for example the means for D4, A3.5 and C3 are extremely close to each other with respect to B scale readings and individual determinations show a degree of overlap. These are only separated in this table with respect to decimal points – which is unlikely to be of great clinical significance. Tavares *et al*.[11] claimed that on average, the change in tooth value was at least 8.35 shades with reference to the VLCSG. This could be misleading. Using or data, four shades difference from B3 to B4 was 6% (33% to 27% respectively) whereas three shades difference from D3 to D4 was 17% (47% to 30% respectively). The proposed Brightness Index as a percentage change would provide a more accurate and possibly clinically meaningful determination.

CONCLUSIONS

Within the limitations of this study it was shown that digital imaging and analysis with Photoshop® may be a useful objective method of recording tooth value.

Data suggest that the value order for the Vita Lumin Classic shade guide should be re-evaluated and that value differences between tabs are not linear.

A Brightness Index based upon these data is proposed as a method of presenting value differences in a quantitative manner.

MANUFACTURERS' DETAILS

- Vita Lumin Classic shade guide (VLCSG), Vitapan®-System, Vita Zahnfabrik, H. Rauter GmbH & Co. KG, Postfach 1338, D-7880 Bad Sackingen, Germany
- 'Dialite' shade matching light, System Eickhorst 22453 Hamburg, Germany
- Nikon Coolpix 995 digital camera, Nikon corporation, Tokyo 100-8331, Japan
- Sony computer, Sony corporation, Vaio Pentium 3, Japan

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