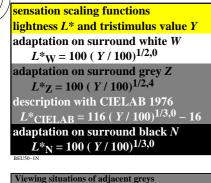
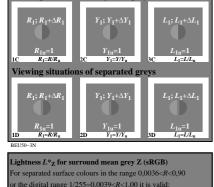
http://farbe.li.tu-berlin.de/BEU5/BEU5L0NP.PDF /.PS; only vector graphic VG; start output N: no 3D-linear





see similar files: http://farbe.li.tu-berlin.de/BEU5/BEU5.HTM technical information: http://farbe.li.tu-berlin.de or http://color

or http://color.li.tu-berlin.de

 $L_{\rm Z}^* = a \left( \frac{R}{R_{\rm n}} \right)^{\rm k}$ [1]  $a=100; R_n=1,00; k=0,42=1/2,4$ [2]  $b=a(R_{u}/R_{n})^{k}=50; R_{u}=0,18$  $= b \left( \frac{R}{R_{\rm n}} \right)^{\rm k}$ For  $R=R_{\rm n}$  it is valid:  $L*_{7\rm n}=50$ . Derivation of equation [2] gives with 1-k = 0,58:  $\delta(L*_{\mathbb{Z}})/\delta R = c \left(R/R_{\mathrm{u}}\right)^{1-\mathrm{k}}$ [3]  $c = (b k)/R_u = 21/18 = 1,17$ or for the threshold  $\delta(L^*_{\tau})=1$  $\delta R = d \left( R/R_{\rm m} \right)^{1-\rm k}$ [4]  $d = R_{\rm p}/(b \ k) = 18/21 = 0.86$ For the surround lightness  $L^*_{Zu} = 50$  with  $R = R_u$  the threshold is:  $\delta R_{Zu} = 0.86$ . This threshold is *independent* of *k*.

Lightness L\*z for surround mean grey Z (sRGB) For separated surface colours in the range 3,6<Y<90 or the digital range 100/255=0,39<Y<100 it is valid:  $L_{Z}^{*} = a \left( \frac{Y}{Y_{n}} \right)^{k}$ [1]  $a=100; Y_n=100; k=0,42=1/2,4$  $= b (Y/Y_{\rm m})^{\rm k}$ [2]  $b=a(Y_n/Y_n)^k=50; Y_n=18$ For  $Y=Y_{\rm m}$  it is valid:  $L^*_{\rm Zm}=50$ .

Derivation of equation [2] gives with 1-k = 0.58:  $\delta(L_{X}^{*})/\delta Y = c (Y/Y_{n})^{1-k}$  [3]  $c = (b k)/Y_{n} = 21/18 = 1,17$ or for the treshold  $\delta(L^*Z)=1$  $\delta Y = d \left( Y/Y_{\rm m} \right)^{1-\rm k}$ [4]  $d = Y_{\rm p}/(b \ k) = 18/21 = 0.86$ 

 $\delta Y = d \left( \frac{Y}{Y_{\rm n}} \right)$ 

For the surround lightness  $L^*_{Zu} = 50$  with  $Y=Y_u$  the threshold is:  $\delta Y_{Z_{11}} = 0,86$ . This threshold is *independent* of *k*.

rization (OL) in file (F) or PS-startup (S), page 1/	
Viewing situations of adjacent greys $R; R + \Delta R$ $Y; Y + \Delta Y$ $R_{u}=0,20$ $Y_{u}=20$ $IA$ $R$ -reflection $A$ $ZAY$ =tristimulus value $A$ $L$ =luminance         Viewing situations of separated greys $R; R + \Delta R$ $Y; Y + \Delta Y$ $R; R + \Delta R$ $Y; Y + \Delta Y$ $L; L + \Delta L$	T Lightness L* <sub>Z</sub> for surrar For separated surface color or the digital range 100/2 L* <sub>Z</sub> = a (L/L <sub>n</sub> ) <sup>k</sup> = b (L/L <sub>u</sub> ) <sup>k</sup> For L=L <sub>u</sub> it is valid: L* <sub>Z</sub> Derivation of equation [2 $\delta(L*_Z)/\delta L = c (L/L_u)^{1-k}$ or for the treshold $\delta(L*_Z)$ $\delta L = d (L/L_u)^{1-k}$
$R_{ii}=0.20$ $Y_{ii}=20$ $L_{ii}=28 \text{ cd/m}^2$ 1B     R=reflection     2BY=tristimulus value     3B     L=luminance       BEU50-2N	For the surround lightness $\delta L_{Zu} = 0.86$ . This thresh BEU51-IN
Viewing situations of adjacent greys $\begin{array}{c} R_2; R_2 + \Delta R_2 \\ R_{2u} = 0 \\ IE \\ K_2 = \log[RR_u] \\ ZE \\ Y_{2u} = 0 \\ ZE \\ ZE$	Lightness $L^*_N$ for surror For separated surface color the digital range 1/255 $L^*_N = a (R/R_n)^k$ $= b (R/R_u)^k$ For $R=R_u$ it is valid: $L^{*-}_n$ Derivation of equation [2]
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\delta(L^*$ <sub>N</sub> )/ $\delta R = c (R/R_0)^{1-1}$ or for the threshold $\delta(L^*$ $\delta R = d (R/R_0)^{1-k}$ For the surround lightnes $\delta R_{Nu} = 0.95$ . This thresh BEU51-3N
Lightness $L^*_{JND}$ for the Just Noticeable Difference (JND) For adjacent surface colours in the range 0,0036- <i>R</i> -0,90 or the digital range 1/255=0,0039< <i>R</i> <1,00 it is valid: $L^*_{JND} = a (R/R_n)^k$ [1] $a=572; R_n=1,00; k=0,14=1/7,2$ $= b (R/R_u)^k$ [2] $b=a(R_u/R_n)^k=450; R_u=0,18$ For $R=R_u$ it is valid: $L^*_{JNDu}=450$ .	Lightness $L^*_N$ for surror For adjacent surface cole or the digital range $100/2$ $L^*_N = a (Y/Y_u)^k$ $= b (Y/Y_u)^k$ For $Y=Y_u$ it is valid: $L^*=$
Derivation of equation [2] gives with $1-k = 0.86$ : $(L^*_{JND})/\delta R = c (R/R_u)^{1-k}$ [3] $c = (b k)/R_u = 63/18 = 3.5$ or for the treshold $\delta(L^*_{JND})=1$ $\delta R = d (R/R_u)^{1-k}$ [4] $d = R_u/(b k) = 18/63 = 0.29$	Derivation of equation [ $(\delta(L^*_N)/\delta Y = c (Y/Y_u)^{1-k}$ or for the treshold $\delta(L^*_N)^{1-k}$ $\delta Y = d (Y/Y_u)^{1-k}$
For the surround lightness L* <sub>JNDu</sub> =450 with R=R <sub>u</sub> the threshold is <b>R<sub>JNDu</sub> = 0,29.</b> This threshold is <i>independent</i> of <i>k</i> . BELSO-6N	For the surround lightne: $\delta Y_{Nu} = 0.95$ . This thresh BEUSI-SN
Lightness $L^*_{JND}$ for the Just Noticeable Difference (JND)         For adjacent surface colours in the range $3.6 < J < 90$ or the digital range $100/255=0.39 < J' < 100$ it is valid: $L^*_{JND} = a$ ( $J'J'_{N})^k$ [1] $a=572$ ; $Y_n=100$ ; $k=0.14=1/7, 2$ $= b$ ( $J'J'_{N})^k$ [2] $b=a(Y_u/Y_n)^k=450$ ; $Y_u=18$ For $Y=Y_u$ it is valid: $L^*_{JND}=450$ .	Lightness $L^*_N$ for surred For adjacent surface colo or the digital range 100/2 $L^*_N = a (L/L_n)^k$ $= b (L/L_n)^k$ For $L=L_n$ it is valid: $L^*=$
Derivation of equation [2] gives with $1-k = 0.86$ : $\delta(L^*_{JND})/\delta Y = c (Y/Y_u)^{1-k}$ [3] $c = (b k)/Y_u = 63/18 = 3.5$ or for the treshold $\delta(L^*_{JND})=1$ $\delta Y = d (Y/Y_u)^{1-k}$ [4] $d = Y_u/(b k) = 18/63 = 0.29$	Derivation of equation [2 $\delta(L^*_N)/\delta L = c (L/L_u)^{1-k}$ or for the treshold $\delta(L^*_N)$

nd mean grey Z (sRGB) Lightness L\*<sub>JND</sub> for the Just Noticeable Difference (JND) ours in the range 3,6<L<90 For adjacent surface colours in the range 3,6<L<90 55=0,39<L<100 it is valid: or the digital range 100/255=0,39<L<100 it is valid: [1]  $a=100; L_n=142 \text{ cd/m}^2; k=0,42$  $L_{\text{IND}}^* = a (L/L_n)^k$ [2]  $b=a(L_n/L_n)^k=50; L_n=18$  $= b \left( \frac{L}{L_{\rm m}} \right)^{\rm k}$ For L=L<sub>n</sub> it is valid: L\*<sub>INDn</sub>=450. ] gives with 1-k = 0.58: Derivation of equation [2] gives with 1-k = 0.86:  $\delta(L^*_{\text{IND}})/\delta L = c (L/L_n)^{1-k}$  [3]  $c = (b k)/L_n = 63/18 = 3,5$ [3]  $c = (b k)/L_{\text{m}} = 21/18 = 1,17$ or for the treshold  $\delta(L^*_{JND})=1$  $\delta L = d \left( L/L_{\rm n} \right)^{1-{\rm k}}$ [4]  $d = L_{y}/(b k) = 18/21 = 0.86$ as  $L_{Zu}^* = 50$  with  $L = L_u$  is the threshold:  $L_{JNDu} = 0,29$ . This threshold is *independent* of *k*. old is independent of k. Lightness L\*W for surround white W nd black N For separated surface colours in the range 0,0036<R<0,90 ours in the range 0,0036<R<0,90 or the digital range 1/255=0,0039<R<1,00 it is valid: =0,0039<R<1,00 it is valid:  $L_{W}^{*} = a \left( \frac{R}{R_{W}} \right)^{k}$ [1]  $a=100; R_n=1,00; k=0,33=1/3,0$  $= b \left( \frac{R}{R_{\rm u}} \right)^{\rm k}$ [2]  $b=a(R_n/R_n)^k=56; R_n=0,18$ For *R***=***R*, it is valid: *L*\*=42. Derivation of equation [2] gives with 1-k = 0,50: gives with 1-k = 0,67:  $\delta(L^*_W)/\delta R = c (R/R_u)^{1-k}$  [3]  $c = (b k)/R_u = 21/18 = 1,17$ [3]  $c = (b k)/R_{\rm H} = 19/18 = 1,05$ or for the threshold  $\delta(L^*W)=1$  $\delta R = d \left( R/R_{\rm m} \right)^{1-k}$ [4]  $d = R_{\rm p}/(b \ k) = 18/19 = 0.95$ For the surround lightness  $L^*_{Wu} = 50$  with  $R = R_u$  the threshold is:  $L_{N_{\rm III}}^* = 50$  with  $R = R_{\rm III}$  the threshold is  $\delta R_{Wu} = 0.86$ . This threshold is *independent* of k. old is independent of k. ind black N Lightness L\*W for surround white W urs in the range 3,6<Y<90 For adjacent surface colours in the range 3,6<Y<90 255=0,39<Y<100 it is valid: or the digital range 100/255=0,39<Y<100 it is valid:  $L_{W}^* = a (Y/Y_W)^k$ [1]  $a=100; Y_n=100; k=0.33=1/3.0$ [2]  $b=a(Y_n/Y_n)^k=56; Y_n=18$  $= b (Y/Y_n)^k$ For  $Y=Y_u$  it is valid:  $L^*=42$ . [] gives with 1-k = 0.67: Derivation of equation [2] gives with 1-k = 0.50:  $\delta(L^*W)/\delta Y = c (Y/Y_n)^{1-k}$ [3]  $c = (b k)/Y_u = 19/18 = 1,05$ or for the treshold  $\delta(L^*w)=1$  $\delta Y = d \left( \frac{Y}{Y_{m}} \right)^{1-k}$ [4]  $d = Y_{\rm p}/(b \ k) = 18/19 = 0.95$ For the surround lightness  $L^*_{Wu} = 50$  with  $Y=Y_u$  the threshold is: s  $L^*_{N_{II}} = 50$  with  $Y = Y_{II}$  the threshold is ld is independent of k.  $\delta Y_{Wu} = 0.86$ . This threshold is independent of k. Lightness L\*W for surround white W nd black N For adjacent surface colours in the range 3,6<L<90 irs in the range 3,6<L<90 or the digital range 100/255=0,39<L<100 it is valid: 55=0,39<L<100 it is valid:  $L_{W}^{*} = a \left( \frac{L}{L_{W}} \right)^{k}$ [1]  $a=100; L_n=142 \text{ cd/m}^2; k=0,33$  $= b \left( \frac{L}{L_{\rm n}} \right)^{\rm k}$ [2]  $b=a(L_n/L_n)^k=56; L_n=18$ For  $L=L_n$  it is valid:  $L^*=42$ . Derivation of equation [2] gives with 1-k = 0.50: gives with 1-k = 0,67:  $\delta(L^*_W)/\delta L = c (L/L_n)^{1-k}$ [3]  $c = (b \ k)/L_{\rm m} = 19/18 = 1,05$ or for the treshold  $\delta(L^*w)=1$  $\delta L = d \left( L/L_{\rm n} \right)^{1-\rm k}$  $\delta L = d \left( L/L_{\rm m} \right)^{1-\rm k}$ [4]  $d = L_{\rm p}/(b \ k) = 18/19 = 0.95$ For the surround lightness  $L^*_{Wu} = 50$  with  $L=L_u$  the threshold is: For the surround lightness  $L^*_{Nu} = 50$  with  $L=L_u$  the threshold is:  $\delta L_n = 0.86$ . This threshold is *independent* of k.  $\delta L_{Nu} = 0.95$ . This threshold is *independent* of k. TUB-test chart BEU5; Viewing situations of colours in 3 surrounds N, Z, and W input: rgb/n

[1] a=572;  $L_{\rm n}$ =142cd/m<sup>2</sup>; k=0,14 [2]  $b=a(L_n/L_n)^k=450; L_n=18$ [4]  $d = L_{\rm p}/(b \ k) = 18/63 = 0.29$ For the surround lightness  $L^*_{JNDu}$ =450 with L= $L_u$ the threshold is [1]  $a=100; R_W=1,00; k=0,50=1/2,0$ [2]  $b=a(R_u/R_W)^k=42; R_u=0.18$ [4]  $d = R_{\rm p}/(b \ k) = 18/21 = 0.86$ [1]  $a=100; Y_W=100; k=0.50=1/2.0$ [2]  $b=a(Y_n/Y_W)^k=42; Y_n=18$ [3]  $c = (b k)/Y_u = 21/18 = 1,17$ [4]  $d = Y_{\rm p}/(b \ k) = 18/21 = 0.86$ [1]  $a=100; L_W=142 \text{ cd/m}^2; k=0,50$ [2]  $b=a(L_u/L_W)^k=42; L_u=18$ [3]  $c = (b k)/L_n = 21/18 = 1.17$ [4]  $d = L_{\rm p}/(b \ k) = 18/21 = 0.86$ 

TUB registration: 20201101-BEU5/BEU5L0NP.PDF /.PS application for evaluation and measurement of display or print output TUB material: code=rha4ta

Lightness functions and derivations for separated and adjacent colours in three surrounds

[4]  $d = Y_u/(b k) = 18/63 = 0,29$ 

For the surround lightness  $L_{JNDu}^*=450$  with  $Y=Y_u$  the threshold is

 $\delta Y_{\text{INDu}} = 0,29$ . This threshold is *independent* of *k*.