

Color threshold formula LABJNDS 1985 (JND=just noticeable difference)

$$\Delta E_{JND}^* = Y_0 [(\Delta Y)^2 + (a_0 \Delta a^* \cdot Y)^2 + (b_0 \Delta b^* \cdot Y)^2]^{1/2} / (s + q \cdot Y^6)$$

$$a = x/y \quad a_n = x_n/y_n \quad b = -0.4 z/y \quad b_n = -0.4 z_n/y_n$$

$$a'' = a_n + (a - a_n) / (1 + 0.5 |a - a_n|) \quad n = D65 \text{ or } A \text{ (surround)}$$

$$b'' = b_n + (b - b_n) / (1 + 0.5 |b - b_n|)$$

$$Y = (Y_1 + Y_2) / 2 \quad \Delta Y = Y_1 - Y_2 \quad \Delta a'' = a_1'' - a_2'' \quad \Delta b'' = b_1'' - b_2''$$

$$s = 0,0170 \quad q = 0,0058 \quad g = 1,0$$

$$a_0 = 1,0 \quad b_0 = 1,8 \quad Y_0 = 1,5 \quad \text{surround D65}$$

$$a_0 = 1,0 \quad b_0 = 1,7 \quad Y_0 = 1,0 \quad \text{surround A}$$

Just noticeable difference (JND) in four colour directions

$$\Delta Y = \text{const} (s + q \cdot Y^6) / Y_0 \quad \text{in luminance direction } WN$$

$$\Delta a'' \cdot Y = \text{const} (s + q \cdot Y^6) / (Y_0 \cdot a_0) \quad \text{in chromaticity direction } RG$$

$$\Delta b'' \cdot Y = \text{const} (s + q \cdot Y^6) / (Y_0 \cdot b_0) \quad \text{in chromaticity direction } YB$$

$$\Delta C_{ab}'' \cdot Y = \text{const} (s + q \cdot Y^6) / (Y_0 \cdot [a_0^2 + b_0^2]^{1/2}) \quad \text{in any chromaticity direction } C_{ab}$$

1-000030-L0

VE280-3N

Color threshold formula YCHJNDS 1996 for all colours o&oc, N&W

$$\Delta E_{JND}^* = Y_0 [(\Delta Y_{\text{eff}})^2 + (\Delta C_{ab} \cdot Y_{\text{eff}})^2]^{1/2} / (s + q \cdot Y_{\text{eff}}^6)$$

$$Y_{\text{eff}} = Y \cdot [1 - p_{c,o} \cdot (1 - Y_0 / Y_n)]; \quad Y_0 = \text{tristimulus value Ostwald colour}$$

$$a = x/y \quad a_n = x_n/y_n \quad b = -0.4 z/y \quad b_n = -0.4 z_n/y_n \quad Y_n = 100$$

$$C_{ab} = [a_0^2(a - a_n)^2 + b_0^2(b - b_n)^2]^{1/2} \quad n = D65 \text{ or } A \text{ (surround)}$$

$$Y = (Y_1 + Y_2) / 2 \quad \Delta Y = Y_1 - Y_2 \quad \Delta a = a_1 - a_2 \quad \Delta b = b_1 - b_2$$

$$p_{c,o} = C_{ab} / C_{ab,o}; \quad p_{c,oc} = C_{ab} / C_{ab,oc} \quad s = 0,0170 \quad q = 0,0058 \quad t = 1,0$$

$$a_0 = 1,0 \quad b_0 = 1,8 \quad Y_0 = 1,5 \quad \text{surround D65}$$

$$a_0 = 1,0 \quad b_0 = 1,7 \quad Y_0 = 1,0 \quad \text{surround A}$$

Just noticeable difference of all complementary (c) colours o&oc, N&W

$$(a_o - a_n)Y_o = (a_{oc} - a_n)Y_{oc}; \quad (b_o - b_n)Y_o = (b_{oc} - b_n)Y_{oc}; \quad C_{ab,o}Y_o = C_{ab,oc}Y_{oc}$$

$$\Delta Y_{\text{eff}} = \text{const} (s + q \cdot Y_{\text{eff}}^6) / Y_0 \quad \text{in luminance direction } WN$$

$$\Delta C_{ab} \cdot Y_{\text{eff}} = \text{const} (s + q \cdot Y_{\text{eff}}^6) / Y_0 \quad \text{in any chromaticity direction } C_{ab}$$

$$\Delta C_{ab} \cdot Y_{\text{eff}} = \text{const} (s + q \cdot Y_{\text{eff}}^6) / Y_0 \quad \text{and for any purity } 0 < p_c \text{ or } p_{c,c} < 1$$

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VE280-3N

Colour space LINYAB 1985 (color data: linear relation to CIE 1931 data)

linear color terms	name and relationship to CIE tristimulus or chromaticity values	notes
tristimulus values	X, Y, Z	
chromatic value	linear chromatic value diagram (A, B)	$n=D65$ (background)
red-green	$A = [X/Y - X_n/Y_n] Y = [a - a_n] Y$ $= [x/y - x_n/y_n] Y$	
yellow-blue	$B = -0.4 [Z/Y - Z_n/Y_n] Y = [b - b_n] Y$ $= -0.4 [z/y - z_n/y_n] Y$	
radial	$C_{AB} = [A^2 + B^2]^{1/2}$	
chromaticity	linear chromaticity diagram (a, b)	compare to linear cone excitation
red-green	$a = X/Y = x/y$	$L/(L+M) = P/(P+D)$
yellow-blue	$b = -0.4 [Z/Y] = -0.4 [z/y]$	$S/(L+M) = T/(P+D)$
radial	$c_{ab} = [(a - a_n)^2 + (b - b_n)^2]^{1/2}$	

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VE281-3N

Colour space CIELAB 1976 (color data: nonlinear relation to CIE 1931)

nonlinear color terms	name and relationship with tristimulus or chromaticity values	notes
lightness	$L^* = 116 (Y/Y_0)^{1/3} - 16 \quad (Y > 0.8)$ approximation: $L^* = 100 (Y/Y_0)^{1/2.4} \quad (Y > 0)$	CIELAB 1976
chroma	nonlinear transform of chromatic values A, B	
red-green	$a^* = 500 [(X/X_n)^{1/3} - (Y/Y_n)^{1/3}]$ $= 500 (a' - a_n') Y^{1/3}$	CIELAB 1976
yellow-blue	$b^* = 200 [(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}]$ $= 500 (b' - b_n') Y^{1/3}$	CIELAB 1976
radial	$C_{ab}^* = [a^{*2} + b^{*2}]^{1/2}$	$n=D65$ (background)
chromaticity	nonlinear transform of chromaticities x/y, z/y	compare to log cone excitation
red-green	$a' = (1/X_n)^{1/3} (x/y)^{1/3}$ $= 0.2191 (x/y)^{1/3} \quad \text{for D65}$	$\log[L/(L+M)]$
yellow-blue	$b' = -0.4 (1/Z_n)^{1/3} (z/y)^{1/3}$ $= -0.08376 (z/y)^{1/3} \quad \text{for D65}$	$\log[P/(P+D)]$
radial	$c'_{ab} = [(a' - a_n')^2 + (b' - b_n')^2]^{1/2}$	$\log[S/(L+M)]$ $= \log[T/(P+D)]$

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VE281-3N

TUB-test chart VE28; Colour thresholds and colour spaces LABJND, ABY, CIELAB, and colour threshold experiment input: w/rgb/cmyk -> w/rgb/cmyk-
output: no change