NW-achromatic, and RG- and YB-chromatic thresholds as function of Y

experiments and data: BAM-research report no. 115 (1985), page 72, see
$\log[\Delta Y, \Delta a \cdot Y, \Delta b \cdot Y]$ https://nbn-resolving.org/urn:nbn:de:kobv:b43-3350

tristimulus Value threshold ΔY, see **LABJND in TR CIE 230:219**

RG-chromaticity threshold $\Delta a \cdot Y$

YB-chromaticity threshold $\Delta b \cdot Y$

$\Delta a = x_1 / y_1 - x_2 / y_2$ *YB*-direction

$\Delta b = z_1 / y_1 - z_2 / y_2$ *RG*-direction

office-application range
according to ISO 9241-306

Colour-difference formula LABJND 1985 (JND=just noticeable difference)

$$\Delta E^*_{JND} = \Delta E^*_{85} = A_0 [(\Delta Y)^2 + (A_3 \Delta a'' \cdot Y)^2 + (A_4 \Delta b'' \cdot Y)^2]^{1/2}/(A_1+A_2 \cdot Y) \quad [1]$$

$a = x / y \quad a_n = x_n / y_n \quad b = -0,4 \, z / y \quad b_n = -0,4 \, z_n / y_n \quad [2]$

$a'' = a_n + (a - a_n) / (1 + 0,5 \left| a - a_n \right|) \quad$ n = D65 or A (background) [3]

$b'' = b_n + (b - b_n) / (1 + 0,5 \left| b - b_n \right|) \quad [4]$

$Y = (Y_1 + Y_2) / 2 \quad \Delta Y = Y_1 - Y_2 \quad \Delta a'' = a_1'' - a_2'' \quad \Delta b'' = b_1'' - b_2'' \quad [5]$

$A_1 = 0,0170 \quad A_2 = 0,0058 \quad [6]$

$A_3 = 1,0 \quad A_4 = 1,8 \quad A_0 = 1,5 \quad$ background D65 [7]

$A_3 = 1,0 \quad A_4 = 1,7 \quad A_0 = 1,0 \quad$ background A [8]

Just noticeable difference (JND) in four colour directions

$\Delta Y = const (A_1 + A_2 \cdot Y) / A_0 \quad$ in luminance direction WN [1a]

$\Delta a'' \cdot Y = const (A_1 + A_2 \cdot Y) / (A_0 \cdot A_3) \quad$ in chromaticity direction RG [2a]

$\Delta b'' \cdot Y = const (A_1 + A_2 \cdot Y) / (A_0 \cdot A_4) \quad$ in chromaticity direction YB [3a]

$\Delta c_{ab}'' \cdot Y = const (A_1 + A_2 \cdot Y) / (A_0 \cdot [A_3^2 + A_4^2]^{1/2}) \quad$ in chromaticity direction c_{ab} [4a]

Colour-difference formula LABJND 1985 for near achromatic colours

$$\Delta E^*_{JND} = \Delta E^*_{85} = A_0 [(\Delta Y)^2 + (A_3 \Delta a \cdot Y)^2 + (A_4 \Delta b \cdot Y)^2]^{1/2}/(A_1 + A_2 \cdot Y) \quad [1]$$

$a = x / y \quad b = -0,4 \, z / y \quad [2]$

$Y = (Y_1 + Y_2) / 2 \quad \Delta Y = Y_1 - Y_2 \quad \Delta a = a_1 - a_2 \quad \Delta b = b_1 - b_2 \quad [3]$

$A_1 = 0,0170 \quad A_2 = 0,0058 \quad [4]$

$A_3 = 1,0 \quad A_4 = 1,8 \quad A_0 = 1,5 \quad$ background D65 [5]

$A_3 = 1,0 \quad A_4 = 1,7 \quad A_0 = 1,0 \quad$ background A [6]

Just noticeable difference (JND) in three colour directions and line elements

$A_0 \cdot \Delta Y = (A_1 + A_2 \cdot Y) \quad$ in luminance direction WN [1a]

$A_0 \cdot \Delta a \cdot A_3 \cdot Y = (A_1 + A_2 \cdot Y) \quad$ in chromaticity direction RG [2a]

$A_0 \cdot \Delta b \cdot A_4 \cdot Y = (A_1 + A_2 \cdot Y) \quad$ in chromaticity direction YB [3a]

$dE^*_{85,L} = \frac{\partial}{\partial Y} L^*_{85} = \frac{\partial}{\partial Y}[(A_0 / A_2) \cdot ln (A_1 + A_2 \cdot Y)] = A_0 \, dY/(A_1 + A_2 \cdot Y) \quad [4a]$

$dE^*_{85,a} = \frac{\partial}{\partial a} a^*_{85} = \frac{\partial}{\partial a}[(A_0 \cdot A_3 \cdot Y \cdot a)/(A_1 + A_2 \cdot Y)] = A_0 \, da \cdot A_3 \cdot Y/(A_1 + A_2 \cdot Y) \quad [5a]$

$dE^*_{85,b} = \frac{\partial}{\partial b} b^*_{85} = \frac{\partial}{\partial b}[(A_0 \cdot A_4 \cdot Y \cdot b)/(A_1 + A_2 \cdot Y)] = A_0 \, db \cdot A_4 \cdot Y/(A_1 + A_2 \cdot Y) \quad [6a]$

Colour-difference formula TUBJND 2023 (JND=just noticeable difference)

$$\Delta E^*_{JND} = \Delta E^*_{22} = A_0 [(\Delta Y_r)^2 + (A_3 \Delta a \cdot Y_{rc})^2 + (A_4 \Delta b \cdot Y_{rc})^2]^{1/2}/(A_1 + A_2 \cdot Y_r) \quad [1]$$

$a = (x - x_c) / y, \quad a_n = (x_n - x_c) / y_n, \quad b = -0,4 B_c \, z / y, \quad b_n = -0,4 B_c \, z_n / y_n, \quad x_c = 0,11 \; [2]$

$c_{ab} = [(a - a_n^2) + (b - b_n^2)]^{1/2}, \quad Y_r = Y / Y_u, \quad Y_u = 18$: tristimulus value of grey[3]

$Y_{rc} = Y_r - (c_{ab} / c_{ab,0})(Y_r - Y_{r,0}) \quad c_{ab,0}, Y_{r,0}$: Ostwald chromaticity and Y_r[4]

$Y_r = (Y_{r1} + Y_{r2}) / 2 \quad \Delta Y_r = Y_{r1} - Y_{r2} \quad Y_r$: relative tristimulus value [5]

$A_1 = 0,0170 \cdot Y_u \quad A_2 = 0,0058 \cdot Y_u \quad B_c = 0,8 \text{ (D65)}, 1 \text{ (D50)}, 2,5 \text{ (A)} \; [6]$

$A_3 = 1,0 \cdot Y_u \quad A_4 = 1,8 \cdot Y_u \quad A_0 = 1,5 \cdot Y_u \quad$ background D65 [7]

$A_3 = 1,0 \cdot Y_u \quad A_4 = 1,7 \cdot Y_u \quad A_0 = 1,0 \cdot Y_u \quad$ background A [8]

Just noticeable difference (JND) in four colour directions

$\Delta Y_r = const (A_1 + A_2 \cdot Y_r) / A_0 \quad$ in luminance direction WN [1a]

$\Delta a \cdot Y_{rc} = const (A_1 + A_2 \cdot Y_{rc}) / (A_0 \cdot A_3) \quad$ in chromaticity direction RG [2a]

$\Delta b \cdot Y_{rc} = const (A_1 + A_2 \cdot Y_{rc}) / (A_0 \cdot A_4) \quad$ in chromaticity direction YB [3a]

$\Delta c_{ab} \cdot Y_{rc} = const (A_1 + A_2 \cdot Y_{rc}) / (A_0 [A_3^2 + A_4^2]^{1/2}) \quad$ in chromaticity direction c_{ab} [4a]

eeg10−7n CEA21−3N

eeg11−3n CEA21−3N

eeg10−7n CEA21−7n

eeg11−7n

Test chart eeg1; Colour thresholds and colour spaces with *Ostwald* optimal colours as reference
Line elements for achromatic and chromatic colours for different applications, new TUBJND 2023