Color threshold formula LABJNDS 1985 for *NW* achromatic colours

$$\Delta E^*_{JND,NW} = Y_0\,[\,(\Delta Y_W)^2 + (\Delta c_{ab,W}\cdot Y_W)^2\,]^{1/2} \,/\, (\,s + q\cdot Y_W{}^t\,)$$
$$= Y_0\,[\,(\Delta Y_N)^2 + (\Delta c_{ab,N}\cdot Y_N)^2\,]^{1/2} \,/\, (\,s + q\cdot Y_N{}^t\,)$$

$a = x/y \quad a_n = x_n/y_n \quad b = -0{,}4\,z/y \quad b_n = -0{,}4\,z_n/y_n$

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

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

$p_{c,NW} = c_{ab} / c_{ab,NW}$ s = 0,0170 q = 0,0058 t = 1,0

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

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

Just noticeable difference of complementary (c) *NW* colours with:

$(a_W - a_n)Y_W = (a_N - a_n)Y_N$: $(b_W - b_n)Y_W = (b_N - b_n)Y_N$: $c_{ab,W}Y_W = c_{ab,N}Y_N$

ΔY_W = const (s + q ·$Y_W{}^t$) / Y_0 in luminance direction *WN*

$\Delta c_{ab,W}\cdot Y_W$ = const (s + q ·$Y_W{}^t$) / Y_0 in any chromaticity direction c_{ab} and for the *NW* purity $p_{c,NW}$=0

$\Delta c_{ab,N}\cdot Y_N$ = const (s + q ·$Y_N{}^t$) / Y_0

1-000030-L0 UE110~3N

Color threshold formula LABJNDS 1985 for *Ostwald* (o) colours

$$\Delta E^*_{JND,o} = Y_0\,[\,(\Delta Y_o)^2 + (\,a_0\,\Delta\,a_o\cdot Y_o)^2 + (\,b_0\,\Delta\,b_o\cdot Y_o)^2\,]^{1/2} \,/\, (\,s + q\cdot Y_o{}^t\,)$$
$$= Y_0\,[\,(\Delta Y_o)^2 + (\,\Delta\,c_{ab,o}\cdot Y_o)^2\,]^{1/2} \,/\, (\,s + q\cdot Y_o{}^t\,)$$

$a = x/y \quad a_n = x_n/y_n \quad b = -0{,}4\,z/y \quad b_n = -0{,}4\,z_n/y_n$

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

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

$p_{c,o} = c_{ab} / c_{ab,o}$ s = 0,0170 q = 0,0058 t = 1,0

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

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

Just noticeable difference of complementary (c) *Ostwald* (o) colours with:

$(a_o - a_n)Y_o = (a_{oc} - a_n)Y_{oc}$: $(b_o - b_n)Y_o = (b_{oc} - b_n)Y_{oc}$: $c_{ab,o}Y_o = c_{ab,oc}Y_{oc}$

ΔY_o = const (s + q ·$Y_o{}^t$) / Y_0 in luminance direction *WN*

$\Delta c_{ab,o}\cdot Y_o$ = const (s + q ·$Y_o{}^t$) / Y_0 in any chromaticity direction c_{ab} and for the *Ostwald* purity $p_{c,o}$=1

$\Delta c_{ab,oc}\cdot Y_{oc}$ = const (s + q ·$Y_{oc}{}^t$) / Y_0

1-000030-L0 UE110~7N

Complementary optimal colours: Relation *XYZ* and chromatic values *A, B*

nonlinear color terms	name and relationship with tristimulues values *XYZ* , and the chromatic values *(A, B)*	notes
Threshold space *ABY–JND1* equation (1)	$\Delta E^*_{ABY} = Y_0\{[a_0\Delta A_{01}]^2 + [b_0\Delta B_{01}]^2 + [\Delta Y_{01}]^2\}^{1/2}$ $= Y_0\{[c_0\Delta C_{ab,01}]^2 + [\Delta Y_{01}]^2\}^{1/2}$	A=(a−a$_n$)·Y ·=(x/y−x$_n$/y$_n$)·Y Normalization similar to CIELAB: $X_{01} = X/X_0$; $Y_{01} = Y/Y_0$; $Z_{01} = Z/Z_n$ Relation for complementary (c) colours: X_{01c}=1−X_{01}; Y_{01c}=1−Y_{01} Z_{01c}=1−Z_{01} Chromatic values: A_{01}=(a$_{01}$−a$_{01n}$)·Y_{01} =(x$_{01}$ / y$_{01}$ − 1)·Y_{01} =(X$_{01}$ / Y$_{01}$ − 1)·Y_{01} =X$_{01}$ − Y$_{01}$ = −A$_{01c}$
Threshold space *ABY–JND2* equation (2)	$\Delta E^*_{ABY} = Y_0\{[a_0\Delta A_{01}]^2 + [b_0\Delta B_{01}]^2 + [\Delta Y_{01}\,/\,Y_{01}]^2\}^{1/2}$ $= Y_0\{[c_0\Delta C_{ab,01}]^2 + [\Delta Y_{01}\,/\,Y_{01}]^2\}^{1/2}$	
Threshold space *ABY–JND3* equation (3)	$\Delta E^*_{ABY} = Y_0\{[a_0\Delta A_{01}/A_{01}]^2 + [b_0\Delta B_{01}/B_{01}]^2 + [\Delta Y_{01}/Y_{01}]^2\}^{1/2}$ $= Y_0\{[c_0\Delta C_{ab,01}/C_{ab,01}]^2 + [\Delta Y_{01}/Y_{01}]^2\}^{1/2}$	
Properties complementary colours	$a_{01c} = -a_{01}$; $b_{01c} = -b_{01}$; $C_{ab,01c} = C_{ab,01}$; $\Delta a_{01c} = \Delta a_{01}$: $\Delta b_{01c} = \Delta b_{01}$: $\Delta C_{ab,01c} = \Delta C_{ab,01}$: $\Delta Y/Y$=const	

1-000030-L0 UE111~3N

Complementary optimal colours: Relation *XYZ* and chromatic values *A, B*

nonlinear color terms	name and relationship with tristimulues values *XYZ*, and the chromatic values *(A, B)*	notes
Threshold space *ABY–JND1* equation (1)	$\Delta E^*_{ABY} = Y_0\{[a_0\Delta A_{01}]^2 + [b_0\Delta B_{01}]^2 + [\Delta Y_{01}]^2\}^{1/2}$ $= Y_0\{[c_0\Delta C_{ab,01}]^2 + [\Delta Y_{01}]^2\}^{1/2}$	A=(a−a$_n$)·Y ·=(x/y−x$_n$/y$_n$)·Y Normalization similar to CIELAB: $X_{01} = X/X_0$; $Y_{01} = Y/Y_0$; $Z_{01} = Z/Z_n$ Relation for complementary (c) colours: X_{01c}=1−X_{01}; Y_{01c}=1−Y_{01} Z_{01c}=1−Z_{01} Chromatic values: A_{01}=(a$_{01}$−a$_{01n}$)·Y_{01} =(x$_{01}$ / y$_{01}$ − 1)·Y_{01} =(X$_{01}$ / Y$_{01}$ − 1)·Y_{01} =X$_{01}$ − Y$_{01}$ = −A$_{01c}$
Threshold space *ABY–JND4* equation (4)	$\Delta E^*_{ABY} = Y_0\{[a_0\Delta A_{01}/Y_{01}]^2 + [b_0\Delta B_{01}/Y_{01}]^2 + [\Delta Y_{01}/Y_{01}]^2\}^{1/2}$ $= Y_0\{[c_0\Delta C_{ab,01}/Y_{01}]^2 + [\Delta Y_{01}/Y_{01}]^2\}^{1/2}$	
Threshold space *ABY–JND5* equation (5)	$\Delta E^*_{ABY} = Y_0\{[a_0\Delta a_{01}\cdot Y_{01}]^2 + [b_0\Delta b_{01}\cdot Y_{01}]^2 + [\Delta Y_{01}]^2\}^{1/2}/(c+d\cdot Y_{01})$ $=Y_0\{[c_0\Delta c_{ab,01}\cdot Y_{01}]^2 + [\Delta Y_{01}]^2\}^{1/2}/(c+d\cdot Y_{01})$	c=0,017; d=0,580
Properties complementary colours	$a_{01c} = -a_{01}$; $b_{01c} = -b_{01}$; $C_{ab,01c} = C_{ab,01}$; $\Delta a_{01c} = \Delta a_{01}$: $\Delta b_{01c} = \Delta b_{01}$: $\Delta C_{ab,01c} = \Delta C_{ab,01}$:	

1-000030-L0 UE111~7N

TUB-test chart UE11; Colour threshold spaces *LABJND* & *ABYJND*, and modifications

input: *w/rgb/cmyk* –> *w/rgb/cmyk*–
output: no change