sensation scaling functions
lightness L^* and luminous value Y

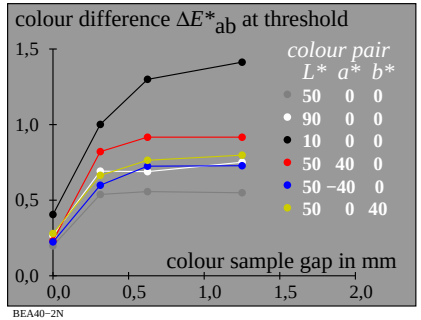
adaptation on surround white:
$L^* = 100\,(Y / 100)^{1/2,0}$

adaptation on surround gray:
$L^* = 100\,(Y / 100)^{1/2,4}$

description with CIELAB 1976:
$L^* = 116\,(Y / 100)^{1/3,0} - 16$

adaptation on surround black:
$L^* = 100\,(Y / 100)^{1/3,0}$

BEA40−1



BEA40−2N

line element of *Stiles*
(1946) with „color values" L_P, M_D, S_T
three separate color signal functions

$F(L_P) = i \ln(1 + 9 L_P)$
$F(M_D) = j \ln(1 + 9 M_D)$
$F(S_T) = k \ln(1 + 9 S_T)$

***Taylor*-derivations:**

$$\Delta F(L_P, M_D, S_T) = \frac{dF}{dL_P}\Delta L_P + \frac{dF}{dM_D}\Delta M_D + \frac{dF}{dS_T}\Delta S_T$$

$$= \frac{9i}{1+9L_P}\Delta L_P + \frac{9j}{1+9M_D}\Delta M_D + \frac{9k}{1+9S_T}\Delta S_T$$

BEA41−1N

***Weber-Fechner* law in CIE 230:2019 for threshold colour differences of surface colours and two ranges 0,2 <= L_r <=1 and 1 <= L_r <=5**

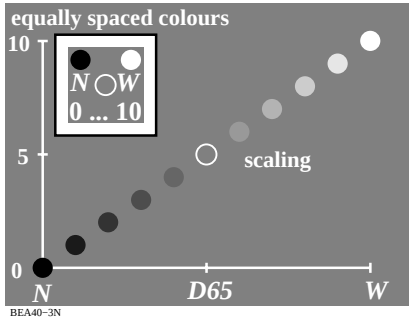
The *Weber-Fechner* law describes the lightness L^*_r as ***logarithmic*** function of L_r.
The *Stevens* law describes the lightness L^*_{CIELAB} as ***potential*** function of L_r=Y/5.
IEC 61966-2-1 uses a similar potential function $L^*_{IEC} = m\,L_r^{1/2,4}$.
The *Weber-Fechner* law is equivalent to the linear equation: $\Delta L_r \approx c_i L_{r\ (i=0,1)}$ [1]
Integration leads to the logarithmic equation: $L^*_r = k_1 \log(L_r)_{(i=0,1)}$ [2]
Derivation leads for $\Delta L^*_r = 1$ to the linear equation: $L_r/\Delta L_r = k_i$ (k_0=46, k_1=63) [3]
For colours in offices the **standard contrast range** is **25:1**=90:3,6.

Table 1: CIE tristimulus value *Y*, luminance *L*, and lightnesses *L

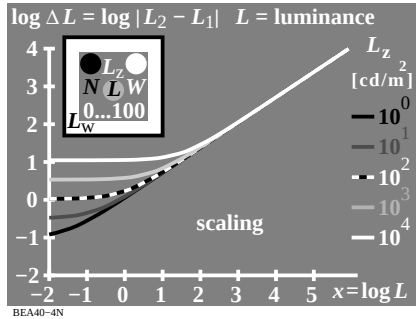
Colour (matte)	Tritimulus value	office luminance	relative luminance	CIE lightness	relative lightness
(contrast) (25:1=90:3,6)	*Y*	*L* [cd/m²]	$L_r = L/L_u$	$L^*_{CIELAB} \sim m\,L_r^{1/2,4}$	$L^*_r = k \log(L_r)$
White W (paper)	90 =18*5	142 =28,2*5	5	94 =50+44	44 =k_1 log(5)
Grey Z (paper)	18	28,2	1	50	0 =k_0 log(1)
Black N (paper)	3,6 =18/5	5,6 28,2/5	0,2	18 50−32	−32 =k_0 log(0,2)

For the two lightness ranges it is k_0=−32/log(0,2)=46 and k_1=44/log(5)=63.

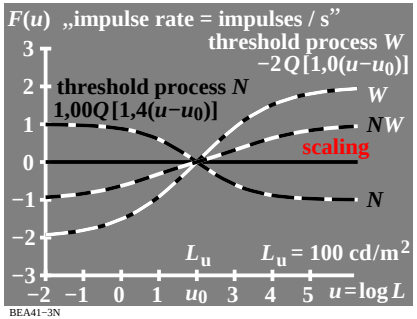
BEA41−2N



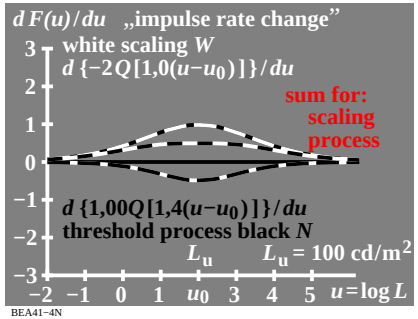
BEA40−3N



BEA40−4N



BEA41−3N



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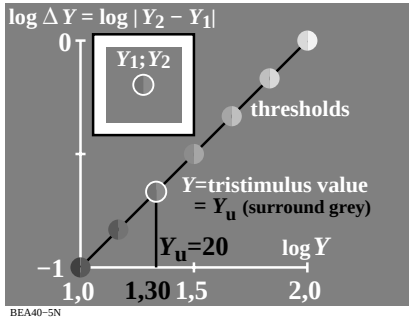
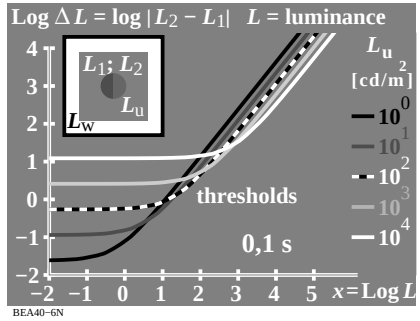


BEA40−5N



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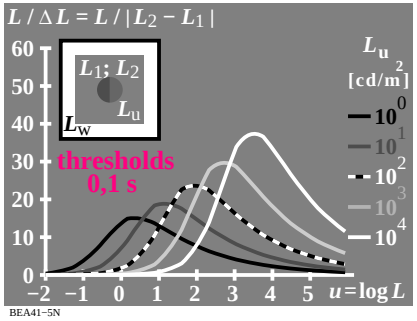

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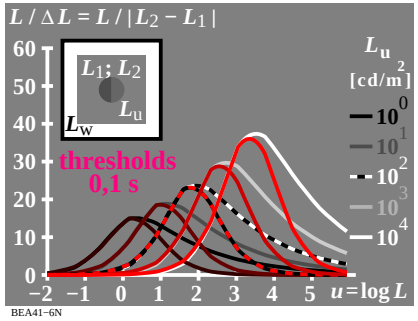

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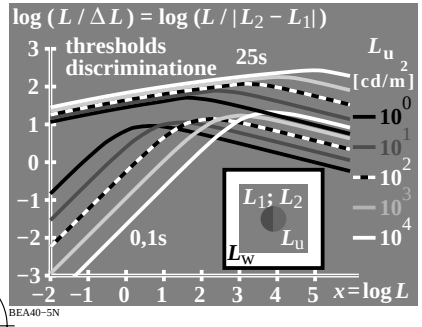

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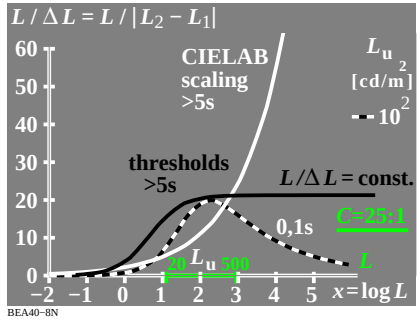
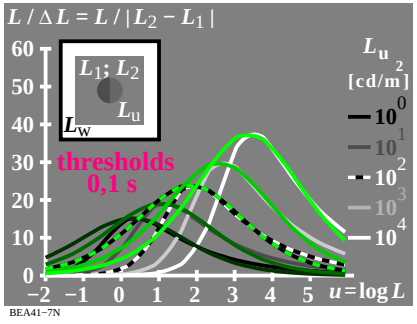
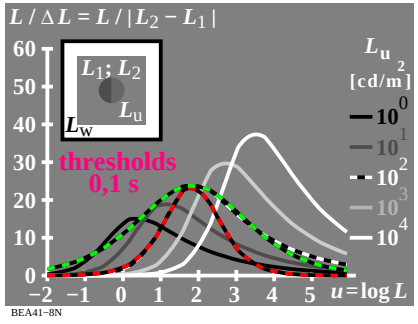


BEA40−8N



BEA41−7N



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