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Visual functions of older people and visibility of traffic signs

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K. Sagawa, Visual functions of older people and visibility of traffic signs, Gerontechnology 2002; 1(4): 296 - 299. Two age-related changes of visual functions such as luminous efficiency and visual acuity were investigated in relation to visibility of traffic signs. The loss of luminous efficiency in the short-wave region (blue lights) and the decrease of visual acuity in near sight are remarkable changes of the functions with aging. Visibility change of visual signs associated with these changes was evaluated quantitatively.

Keywords: Spectral Efficiency Function, Minimum Legible Character, Visual Acuity

Visibility of traffic signs is vitally important for safety for car driving. Because the functions of human visual system change with age more or less, the visibility changes with age. These changes must be taken into account in designing traffic signs to assure safe driving for older people. In this paper, some age related changes of visual functions are to be described in relation to visibility of traffic signs.

AGE-RELATED CHANGE OF SPECTRAL LUMINOUS EFFICIENCY FUNCTION

Because of yellowing of human eye lens with age, the transmittance for the short-wave region in the visible range (blue lights) decreases with age and this causes loss of luminous efficiency in this spectral region. Figure 1 shows two efficiency curves, one for the younger persons (average of the 20s) and the other one for the older ones (average of the 70s). The two curves are normalized to unity at 555 nm. It is clear in this figure that the efficiency in the short-wave region is decreased for the older persons. This means blue lights look darker for the older persons than for the younger. The maximum efficiency difference reaches about 0.8 log unit (84% loss) which is quite large[1] .

In order to evaluate this efficiency loss in the visibility of visual signs, an example is given at the top of Figure 2, where blue characters are written on a dark yellow background. Assume that the characters are made by blue phosphor and the background by a combination of green and red phosphors of an ordinary CRT display, the radiance data of these two fields being given also in Figure 2. By photometric definition, the luminance, L (cd/m^2) is calculated as:

$$L = K_m \int L_{e,\lambda} V(\lambda) d\lambda \qquad (1)$$

Where $L_{e,\lambda}$ is the spectral radiance, i.e. physical energy emitted from the light source or objects, $V(\lambda)$ is the spectral luminous efficiency of the eye, and K_m is a constant of 683 lumen/watt. Using the efficiency curve of the 20s in Figure 1 we calculated the luminance for characters and background and a contrast of these. The results was 34%,

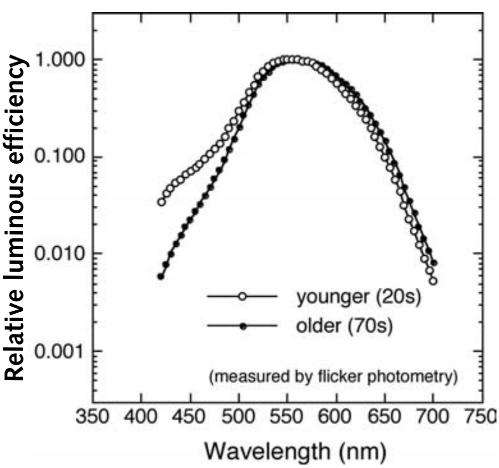

Figure 1. Spectral luminous efficiency function of younger persons (open circles; average of the 20s) and older persons (closed circles; average of the 70s).

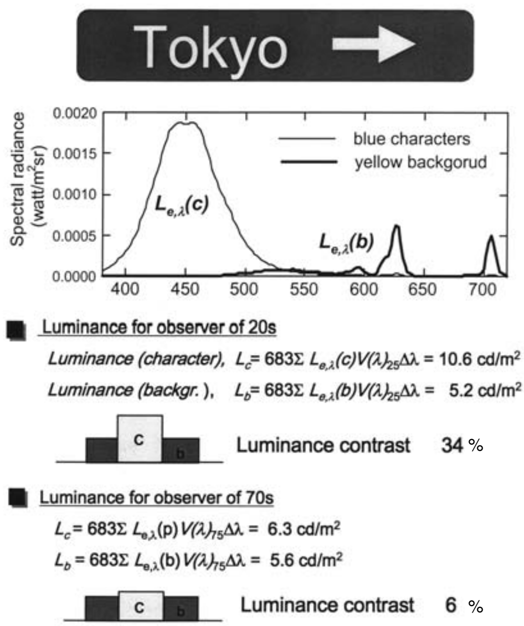

Figure 2. An example of calculation of age-dependent luminance and evaluation of visibility of a sign.

which means quite visible. Similarly, the contrast was calculated to be 6 % for older persons by using the efficiency curves of 70s, the value indicating very poor visibility. Thus, with physical data of light, we can quantitatively estimate the visibility of visual signs of any color seen by older people[2] .

VISUAL ACUITY AND A MINIMUM LEGIBLE CHARACTER SIZE

Visual acuity is also important in driving as we always obtain information from characters and figures in traffic signs that require spatial resolution. Figure 3(a) and 3(b) are visual acuity data for younger (20s) and older persons (60s) as a function of luminance and viewing distance respectively. Throughout the luminance range investigated, the acuity for the aged is lower than for the younger. The relative change of acuity with luminance is very large for both young and aged people. Remarkable age-related change is seen in the decrease of visual acuity at a viewing distance less than 1 m as shown in Fig. 3(b). Designing of the car inside panel for older driver should consider this distance dependency.

Practically it is important to directly know a minimum size of legible characters. Figure 4 shows this for older and younger persons at a light (100 cd/m^2) and a dark condition (0.5 cd/m^2) respectively for Japanese hiragana (simple phonetic signs) and numeric characters. At the light condition, the minimum legible size is about 10 point for younger persons and 14 point for the older at a distance of 2 m. This size should proportionally reduce or enlarge at any distance if visual acuity is kept constant, as shown in lines in the figure. This is true for the younger but breaks for the older at a short distance such as 0,5 m. The same is true for the dark condition. Character size in traffic signs and in any information display should be appropriately designed for older persons in any viewing condition.

SUMMARY

Age related changes of two fundamental visual functions, luminous efficiency and

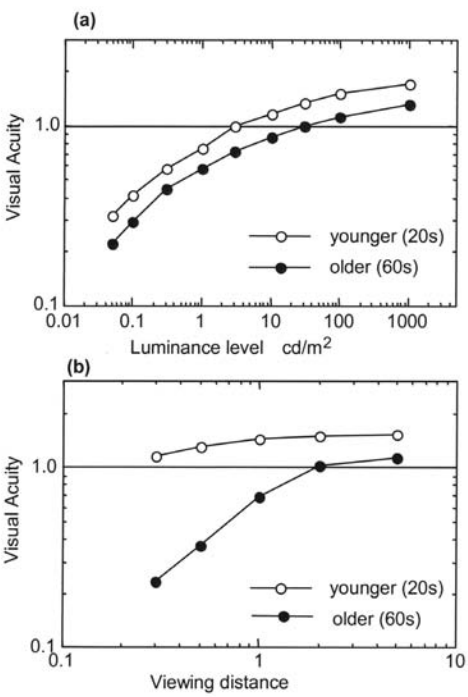

Figure 3. Visual acuity as a function of (a) luminance and (b) viewing distance for younger (average of the 20s) and older (average of the 60s) persons.

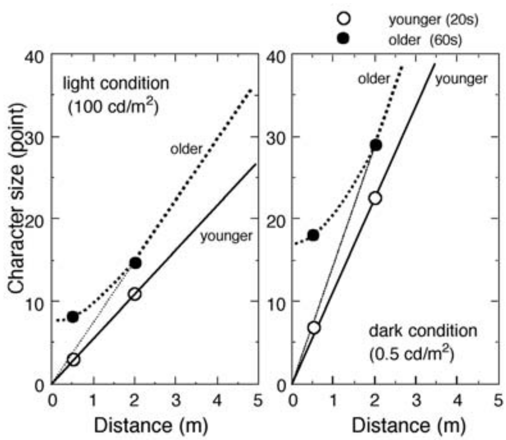

Figure 4. Minimum legible size of Japanese Hiragana (phonetic sign) characters at two viewing distances, 0.5 m and 2 m, in a light and a dark condition for younger and older persons.

visual acuity have been presented together with evaluation of visual signs seen by older people. Other visual functions such as useful visual field size, for example, should also be investigated in a similar quantitative way for a better visibility of traffic signs for older drivers.

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The Assessment of Fitness to Drive in the Elderly

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H.H. Warnink, The assessment of fitness to drive in the elderly, Gerontechnology 2002; 1(4): 299 - 303. In the assessment of fitness to drive, especially in the elderly, a medical examination and a practical driving test in daily traffic are indispensable. Many kinds of physical insufficiency and ineffectiveness can be compensated with technical adaptations in the car. Field of vision deficits can be compensated by eye and head scanning movements. There is no age bar to the holding of a driving licence. With compensatory strategies, the older driver can be a safe or even safer driver than a younger one.

Keywords: car adaptations, driving test, physical handicaps, vision disorders

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Also the Dutch society has a rising quantity of aging people[1]. The number of car drivers beyond the age of 65 is increasing as well, because driving assures an active and independent life style. However, with increasing age, sensory, perceptual, cognitive, and motor functions that are relevant for car driving will decline in efficiency, particularly in the 75+ age group[2-4]. Decline in ability and fitness to drive does not necessarily mean stopping driving, but recognition of decline should lead to an acceptance of the situation, positive adjustment, and ultimately less worry. There is no age bar to the holding of a driving licence. Changes with age vary from one person to another, with no necessary correspondence between biological age and age in years[5]. Old age has its infirmities, but older drivers are judged without discrimination in the Netherlands. Only 2 to 3% of the 70+ drivers are assessed as unfit to drive at the time of renewing their licence!

In the current Dutch system, the road-users bear a lot of responsibility. To obtain/renew a drivers licence for passenger cars the applicant only needs to complete a medical statement ('personal declaration'). The form