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Cataract halos: A driving hazard in aging populations. Implication of the Halometer DG test for assessment of intraocular light scatter

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ABSTRACT

Objective and background: Cataract, regardless of etiology, results in light scatter and subjective glare. Senile cataract is emerging as a crucial factor in driving safely, particularly in night driving and adverse weather conditions. The authors examined this visual impairment using a new Halometer DG test in the eyes of older adult drivers with and without cataract.

Method: Examined subjects consisted of $n = 65$ older adults with cataract in one or both eyes and $n = 72$ adult drivers who did not have a cataract in either eye. Subjects were examined for distance high contrast visual acuity (VA) and red/green disability glare (DG) with a new halo generating instrument. Subjects also completed a subjective Driving Habits Questionnaire (DHQ), designed to obtain information about driving during the past year.

Results: DG increased with age of the driver. VA and Halometer DG testing of better and worse eyes prognosticated impairments which significantly affect driving performance. Cataract subjects demonstrated increased Halometer DG scores and were two to four times more likely to report difficulty with driving at night and with challenging driving situations than were cataract-free drivers.

Conclusion: DG is a specific cataract-induced functional age-related risk factor of driving difficulty, easily measured by a technician with a new Halometer DG device.

Application: Optometrists and ophthalmologists should incorporate Halometer DG testing in their pre-examination vision testing rooms for patients over age 55, and also perform this test on others who complain about glare. Traffic safety engineers should incorporate automotive optical-microprocessor-aided tests for DG into cars, to alert drivers of mild functional impairments and progressive degrees of DG sensitization.

1. Introduction

A substantial fraction of the population drives under adverse conditions due to glare. Glare is broadly defined as representing those effects of light that impair visual efficiency (Babizhayev et al., 2003). The word glare is given to a problematical distribution of luminance and/or excessive luminance contrast in the field of vision which causes disturbed vision. The name "glare" does not describe the visual processes involved.

Glare is differentiated by the International Commission on Illumination CIE into Discomfort Glare and Disability Glare (CIE 146: 2002; CIE 117: 1995). Discomfort Glare is glare perceived solely as subjective discomfort without causing any significant loss in visual performance while Disability Glare (DG) results in functional impairment. However, it is usually considered that these are descriptions rather than strict definitions, and that they do not necessarily precisely define the condition that we call "Glare". In the German language these are known as Physiologische Blendung and Psychologische Blending Physiological (Glare & Psychological Glare).The terms "optical glare", "physiological glare", "direct glare", "reflected glare" are also used interchangeably. Fig. 1a and b illustrate these principles. These terms give some indication of the nature of the glare process. In this paper, the CIE term Disability Glare (DG) is used to represent retinal exposure from a glare source that results in diffused intraocular light scattering within the ocular media. This diffused light induces an unwanted optical veil of luminance that reduces contrast and target visibility.

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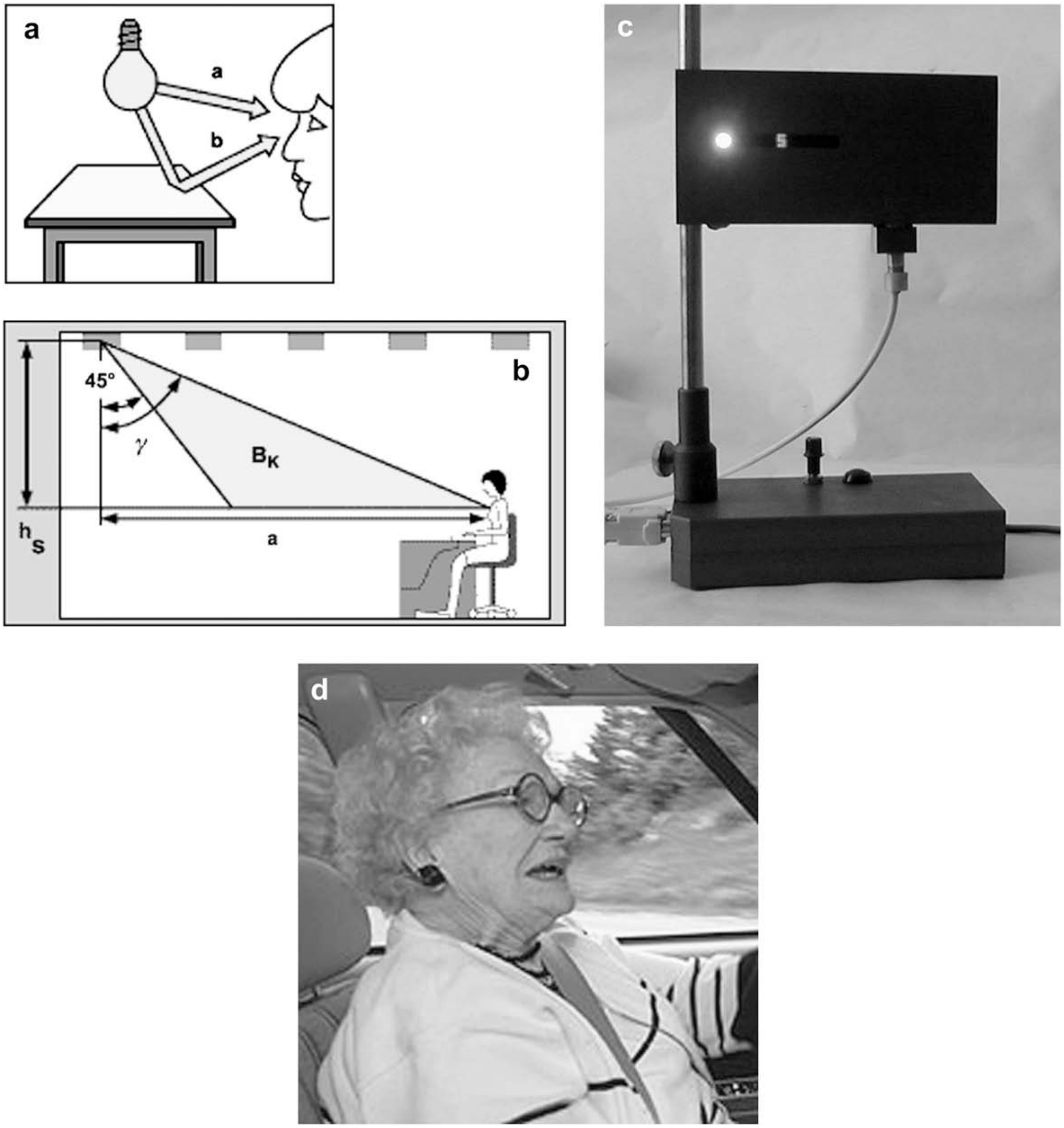

Fig. 1. (a) Disability Glare (DG) is glare that causes a loss of visual performance (e.g. reduced perception of shapes and capacity for discrimination). It results from direct or reflected light. (b) Direct Glare originates directly at the light source, where B_K is the critical emission angle. The degree of direct glare depends on the size and luminance of the visible luminous areas of all the luminaires in the field of vision, but also on background luminance. Direct glare is considered adequately controlled where the mean luminance of the luminaires at the critical emission angle B_K of 45°–85° does not exceed the values of the luminance limiting curves. Reflected glare (not shown) represents loss of contrast caused by reflections from luminous objects (e.g. on glossy paper or computer screens). In general, reflections lead to reduced contrast perception, which hinders character recognition of letters on printed paper, for example. (c) Photograph of working prototype of the Halometer DG tester. The instrument can be used in the pre-testing examination room of optometrist and ophthalmologists offices, at Department of Motor Vehicle licensing facilities or incorporated within automobiles, for self testing. (d) The Halometer DG tester is vital for aging drivers with poor vision resulting from aging, cataract and ocular diseases). Glare testing provides secondary information concerning cognitive and physical performance. The Halometer DG is sensitive even to mild impairments. Such information is often ignored or denied until it is advanced with marked functional impairment resulting in a serious accident.

In contradistinction to DG, transient glare or photostress recovery glare is due to retinal adaptation problems in an environment with rapidly changing ambient luminance. The sensitivity to DG is amplified as scattering in cornea or lens increases: Intraocular Light Scatter in Normal Eyes (Babizhayev et al., 1999).

Cornea 30%
Lens 70%
Aqueous & vitreous $<1\%$

Currently, there are no good instruments for measuring DG, and there is no good "metric" for quantifying DG. Despite the fact that several tests designed to "penetrate" lens opacification in order to assess visual function at the retinal-neural level are in use clinically, each has rather severe limitations, particularly in cases where the need for clear definition of functional integrity is greatest. For patients with cataract, visual function in everyday conditions is poorly predicted by classical Snellen acuity, grating acuity, and grating contrast sensitivity when test measurements are made under "minimal-glare" conditions (Bailey and Bullimore, 1991). This statement was supported by the Committee on Ophthalmic Procedures Assessment of the American Academy of Ophthalmology on contrast sensitivity and glare testing in the evaluation of anterior segment disease (American Academy of Ophthalmology,