

Vision at Levels of Night Road Illumination

XII. Literature 1966

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•FROM the 1966 literature on vision the following may be of use to those interested in the night visibility problem (52). Schmidt and Connolly (59) summarize many of the problems of seeing and driving. Connolly (20) reports on the London conference of the Illuminating Engineering Society. A detailed report on traffic safety became available (43). Richards (53) discusses the visual aspects of driver licensing. Two new books are available on the anatomy of the eye (50, 56). Bouman and Vos (66) edit the Delft 1965 Symposium on Vision at Low Luminances.

Information on the transmission of the eye media in vivo and in vitro are in good agreement and show the eye media to be more transparent than was found in earlier studies (2, 12). Gregory (33) introduces the psychology of seeing and Rubín (57) reviews the physiology of the eye. While Ratliff's (48) book has little direct application to night driving seeing it does contribute toward an understanding of eye movements, central nervous function and other aspects of vision.

Connolly (18) points out how modern automobile design reduces the information available to the driver and as a result overloads a handicapped visual system. Allen (1) warns against the 30 percent loss of seeing with tinted windshields which is of concern to driving at night and a handicap to drivers deficient in red color vision. A brief report of the London conference on mirrors (39) discusses rear view seeing and Carruthers (85) summarizes the problems of plane and convex mirrors for truck drivers.

A standing observer detects humans in full moonlight at about 29 yards and with no moon at about 19 yards (Taylor, 68). Blackwell, Schwab, and Pritchard (11) discuss highway lighting requirements; indicating that 1.3 ft-c would be required to see a small black dog 200 ft ahead in the driving lane and 1.85 ft-c to see a manikin in a long gray coat at the same distance. Clark (14) describes the characteristics of incandescent lamps including the tungsten-iodine lamps. The cost of lighting provides less light than the previously cited figures indicate (13). Logan and Siegel (83) give measurements of outdoor brightness and discuss glare. Transition lighting at tunnels requires more than 10 percent of the surround luminance to avoid the black hole effect and Schreuder (60) indicates the changes in lighting necessary for the adaptation of the eye without reducing traffic flow.

Cole and Brown (16, 17) report that red traffic signal lights need be four times brighter to be seen by protanopes who have severe red deficient color vision. Against a sky of 30,000 ft-L the red light should have a luminance of 160-260 cd and for protanopes should be 600 cd. A surround helped only when the brightness of the signal was less than optimum. Misalignment of headlights 1° - 2° upward decreased seeing distance 25 percent (Rumar, 55).

Reflectionization with glass beads is recommended to increase the brightness of white road lines (78) and lights embedded in ramps replace painted lines for parking guides (7). Spencer and Levin (67) discuss a button light system for traffic guidance on turnpikes.

Raised brake lights easily seen by following cars and switching coupled to the accelerator could aid orderly traffic movement (Crosly and Allen, 22). Yamaguti (79) states that sodium nitrate polarizers would give 2.7 times more light than Polaroid polarizers, which would meet SAE standards and provide no glare headlights.

Driving in fog is not likely to be improved by infrared viewing devices (9). Additional stronger 21 cp red rear lamps are recommended by Davey (23) to lessen rear end collisions in fog and Wilson (77) discusses daylight driving problems in fog.

Elenius and Karo (27) report that in stationary night blindness, mesopic were higher than photopic thresholds; the latter were within normal limits. Aulhorn and Harms (10) describe a mesoptometer for testing vision at 0.009 to 0.03 ft-L with a projector using 6 different contrasts of Landolt rings. Glare sensitivity is measured as recovery from 10 seconds exposure to auto headlights at 2° against a peripheral field luminance of 0.003 ft-L. Night myopia tests are made at 0.03 ft-L.

The visual system has a 40 msec period within which an eye movement response to a step stimulus can be canceled by responding to a following incompatible response (75). About 0.3 sec, Hempstead (35) reports, is the basic observation time for motion perception of a display, including observing and transmission through the central nervous system to realign the eye for the next transmission to the brain. Leibnitz and More (41) conclude that accommodation and convergence can mediate size constancy only to 1 m (3.3 ft).

A binocular, infrared pupillograph with an accuracy of 1 percent is described by Clarke et al (15). Pupil diameter according to Kahneman and Beatty (65) is a measure of the amount of material being processed in the memory system. Forbes et al (29) measure visibility of signs while the subject also works at another task, approximating a driving task. High brightness signs are seen first at night and lower brightness signs against a low background. Two different observer response patterns are being investigated. Many drivers fail to see signs according to Johansson and Rumar (37) raising the question of how many signs are too many. Eye movements during driving are reported by Connolly (19) to be 3-4° with an occasional 20° on superways, and 25-35° in slow traffic, with a few movements of 40° or even 50°. Acuity and contrast sensitivity decline with age (54).

Color vision is reviewed by de Valois and Abromov (69). The Ciba Symposium (51) is published and the duality doctrine is questioned therein by Pedler and Wilmer. Walraven and his associates (72) propose a color vision theory which assumes three receptors and transmission of a brightness signal summated from all and two antagonistic chromaticness signals. Deuteranomalous individuals have a different shaped relative sensitivity curve and the amount the adapted against green is shifted toward the red may be a useful measure of deuteranomaly (73).

Linksz (42) recommends the Farnsworth D-15 as a simple clinical test for color vision defects. Vos and Kishto (70) continue the discussion of the Stiles-Crawford effect and chromostereoscopy and give an example of green rather than red being the advancing color (low illumination and a large pupil).

Color names influence reports of signal color recognition as Das (24) has shown when "difficult" is substituted for "white" and problems occur in blue and yellow recognitions. A German report (8) indicates successful use of color coded traffic lanes. Yellow glasses, Dobbins (25) reports, make detection of humans more difficult and cause them to appear further away in jungle surroundings than with unaided vision. Deuteranomalous people in traffic see colors slower and less accurately than normals, more so when their vision was not corrected to a 20/20 normal. Certain defectives should be limited to speeds not over 50 mph (Spiecker, 66).

French statistics also indicate that younger and older drivers have more accidents than those of middle age. Jani (36) finds stereoscopic vision to decline after 45 years of age.

Possible drug effects on driving continue to raise questions. Lynn (44) summarizes the regulations for aeroplane pilots and his advice should be extended to automobile driving at night when there are less clues to keep the driver alert. Schreuder (61) would allow only tea or coffee as stimulants for pilots.

Selzer and Weiss (62) based on Michigan experience report that alcoholics were responsible for more than half of the fatal accidents, and that a program is necessary to protect society from the inevitable results now labeled "accidents." Similar information from Illinois (5) shows that drinking is associated with accidents, often with one-car collisions and recommends the reduction of the 0.1 percent blood alcohol

standard to 0.08 percent. Walker (71) emphasizes the conclusion that chronic alcoholism is a larger factor in accidents than previously thought. Gramberg-Danielsen (30) found eye movements to be slower and more irregular after alcohol intake, but sensory effects did not correlate with blood alcohol concentration and the effect of alcohol resembled that of oxygen lack.

Green (31), Green and Spencer (32), Ellis (82), and Walsh (88) describe ocular side-effects of drugs and Werner (74) of tranquilizers. Molson (46) reports that, an antihistaminic, Phenergan, had no effect on an eye-hand coordination test for 1 to 2 hours, but caused a significant deterioration beginning at 3 hours. The 17th Nordic Ophthalmological Congress (20) discusses drugs, reporting side-effects, cataracts, pressure changes, retinopathy and little change in visual acuity or contrast. Oxygen does not always improve night vision, and Kent (38) reports that after fasting, the administration of glucose improves thresholds while breathing oxygen at one atmosphere.

Porter (47) comments that it is remarkable that no part of the driving test is given at night. Some 92 factors contributed to 17 fatal accidents making difficult assigning the major causes of the accidents. Haile (34) reports on visual factors, such as not looking, couldn't see the obstacle, or individuals with defective vision, but unaware of it. General attitudes may be testable and useful for detecting accident proneness (McFarland, 45). Shaw (63) reports personality tests useful for selecting bus drivers in Africa. Richards' discussion on the vision testing aspect of a driver examination was summarized (58). The AOA-AAMVA driver screening booklet is revised (80).

A survey in Wisconsin found 35 percent of the driving public to have deficient vision; 15 percent dangerously low (6).

Smith and Weale (64) show that some British spectacle frames are unsuitable for driving because the visual fields are reduced. Photographs and field plots reveal how vision is obscured as the head is tilted, turned, or when looking to the rear. Some frames even obstructed the area of the pupil.

Porter (47) recommends the British Supra frame for auto drivers with no lower rims and high up temples. Antireflection coating is desirable, likewise splinter-proof lenses. An anonymous article (4) recommends for driving: the best possible prescription (for the nearsighted the usual distance prescription is not adequate for night driving) coated lenses, lenses fitted close to cornea to give a wide field of view, frame adjusted so that it will not slip down the nose, light weight (plastic lenses), thin rims (preferably metal) and with a good case that will keep the spectacles clean when not in use and stored in the automobile. It is suggested that some firm should make a suitable frame for motorists.

The question of whether driving is a right or a privilege is analyzed and Reese (49) indicates that better regulation could follow the concept that it is a right. Time-lapse motion picture photography is useful for traffic analysis (21). Ezel (28) reports on the contributions from Indiana University sponsored by the American Optometric Foundation. The ten million dollar grant (3) to the University of Michigan should contribute useful research on problems of motoring.

Greenshields (89) finds steering-rate patterns and proposes using them as measures for driver fatigue. Gordon (87) analyzing eye position and movements reports that the center and side lines on a road are the main references for guidance of the vehicle. The Pulfrich effect from unequal amounts of light to the eyes can be a danger in driving and a source of accidents (Wilson, 76). Dynamic visual acuity is related to age and sex and may need differential treatment if it should become a test for a license (84). Extrafoveal acuity falls off rapidly. Milladot's (90) measures reveal a slow decrease peripherally to about 30 minutes of arc and then a more rapid fall off to 7°. He found acuity 77 percent at 30 min, 62 percent at 1°, 42 percent at 2.5°, and 32 percent at 5°. Accident proneness is not necessarily a result of 0.66-0.75 vision. More accidents occurred when the right rather than the left eye had the poorer vision. "Probably the ocular changes in question are due to a traffic-endangering, central suppression of the image of the impaired eye. If a speed limit is imposed, an increased minimum braking retardation should also be demanded," concludes Gramberg-Danielsen (91). Pollock (92) reports visual acuity to average 20/50 ages 79-95, 20/40 to 20/50 ages 79-85, and 20/60 ages 86-95 years.

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