

# Visual requirements for driving

By Catharine Chisholm PhD MCOptom, University of Bradford

Just over 70% of the population hold a driving licence, and in today's society, driving is viewed by the majority as a right. With an ageing population, however, the proportion of people who fail to meet the visual requirements is increasing and eye care practitioners need to be in a position to advise patients during the eye examination. Although visual input is essential for driving, it is a highly complex task, making it difficult to provide rigorous scientific evidence for the level of vision required for safe driving. The aim of this article is to review the current visual requirements for driving and consider their limitations, concentrating on the requirements for visual acuity and visual fields.

## Visual acuity

The visual acuity requirements to hold a Group 1 licence (ordinary car) are specified in terms of the number plate test. The exact wording of the requirement is 'To read in good light (with the aid of glasses or contact lenses if worn), a registration mark fixed to a motor vehicle and containing characters 79mm high and 50mm wide from 20m'<sup>1</sup>. For pre-2001 number plates with letters of 79mm by 57mm, the distance is 20.5m.

The number plate test is a crude and frequently criticised test of vision but does permit members of the public to monitor their own ability to meet the standard, in addition to allowing the police to check vision at the road side. The number plate test is, however, impractical for clinical situations and occupational vision standards. It suffers from poor repeatability and is very dependent on lighting levels and the condition of

the licence plate itself. Geometrically, a letter on a modern number plate subtends 13.4 mins of arc, corresponding to a Snellen acuity of 6/15, but differences in font design and letter spacing mean that there is no exact Snellen equivalent. The number plate available on some test charts should not be taken as the legal standard since such plates often fail to follow the standard design. They can, however, be used to demonstrate the approximate level of vision required and the detrimental effect of low illumination in patients you may wish to advise to drive during daylight hours only.

Drasdo and Haggerty using statistical modelling stated that a Snellen acuity of 6/9-2 has an equivalent failure rate to the number plate test.<sup>2</sup> They found that those with a binocular visual acuity of 6/7.5 had a 99% chance of passing the test, whereas those seeing 6/18 binocularly had only a 6% chance of passing. The model was based on a population of only 28 subjects, however, and used the pre-2001 number plate design. A more recent study by Currie and colleagues again using the old number plate design, found that the binocular visual acuity of those who only just read the number plate varied from 6/9+2 to 6/12-2, with an average of 6/10.<sup>3</sup> They reported that 26% with a binocular VA of 6/9 failed to correctly read the number plate and 34% of those with a binocular VA of 6/12 passed. Although this study has its limitations, these pass/fail percentages should be noted carefully since they highlight the problem we face advising patients based on their binocular Snellen acuity alone. As eye care

practitioners, we are regularly called to give our opinion on a patient's likelihood of meeting the visual requirements for driving. Some help on this difficult issue has been issued by the DVLA in the form of a statement indicating their policy is to assume that an individual with vision in their better eye of 6/12 or more is likely to pass the number plate test, whereas an individual with vision in their better eye of 6/24 or less is not likely to pass. Those in-between are considered borderline and should undergo a formal number plate test at a driving test centre<sup>4</sup>. It is only those with good, or conversely, very poor binocular acuity that we can be relatively confident in advising with regard to their likelihood of meeting the vision requirements for a Group 1 licence.

In this age of evidence-based standards, it is pertinent to consider whether the current visual acuity standards can be justified. Driving research is fraught with limitations associated with the multi-factorial nature of the task and the difficulties in accessing accurate accident data. Studies have failed to show anything more than a weak link between visual acuity and accident rates. A cut-off of approximately 6/12 can be derived from the vision required to read a number plate at the safe stopping distance (three car lengths) when travelling at 30mph<sup>5</sup>. This justification is dubious since cars are not driven at 30mph the majority of the time and reading the number plate cannot be considered a safety-relevant task.

### Visual fields

The visual field requirements for a Group 1 licence are 'A minimum horizontal field of vision of 120° and no significant defect within 20° of fixation'. Additional clarification of a significant defect is given:

The DVLA accepts the following central loss (Esterman protocol):

- Scattered single missed points
- A single cluster of up to three contiguous points

This is a change from the situation a decade ago when no missed points were accepted within the central ±20°. The change originates from a legal challenge by an individual missing three contiguous points. He successfully argued that his scotoma was no bigger than the blind spot of a monocular driver, who was, of course, allowed to hold a licence.

Significant central loss is defined as:

Visual acuity	Binocular requirement only Read standard number plate in good light with the aid of glasses or contact lenses if worn, at 20m
Unaided vision	No requirement
Visual fields	Binocular requirement only A minimum horizontal field of vision of 120 degrees and no significant defect within 20 degrees of fixation
Colour vision	No requirement
Diplopia	Cease driving on diagnosis but acceptable if controlled by spectacles or patching
Monocularity	Individuals with one eye must inform the DVLA. Individuals can drive once adapted if they meet the acuity and visual field standards

Table 1: Visual requirements for a group I (ordinary car) licence set by the United Kingdom Driver Vehicle and Licensing Agency (DVLA)

- A cluster of four or more contiguous points that is either wholly or partly within the central 20° area
- Loss consisting of both a single cluster of three contiguous missed points up to and including 20° from fixation and any additional separate missed point(s) within the central 20° area
- Central loss of any size that is an extension of a hemianopia or quadrantanopia

The functional scoring system developed by Esterman is the current gold-standard for testing binocular visual fields and is used by many national driving authorities<sup>6</sup>. National visual field requirements for fitness to drive differ significantly between countries<sup>7</sup>. There is a European-wide minimum requirement of 120° along the horizontal but Germany is the only other country to require the central visual field to be examined. The binocular Esterman visual field test is most commonly run on the Humphrey Visual Field Analyzer. It is a suprathreshold test that presents a single, very bright stimulus (10dB) at each of 120 locations within the visual field. The subject is required to fixate centrally and press a button when a stimulus is detected. The Esterman test has the advantage of being relatively quick compared to other 'full field' tests (4-5 minutes for a normal subject), and is by far the most frequently available binocular field test in ophthalmology and optometry

clinics. The 120 points in the stimulus array are spread over a large area extending approximately ±75° horizontally, 35° superiorly and 55° inferiorly (Figure 1).

Occasionally, an asymptomatic binocular visual field defect is picked up by the optometrist during a routine visual field screening when a patient reaches the age of 40. In a fair proportion of the cases with a negative medical history, the lesion is likely to be congenital in origin. If these individuals have no driving accident record, the DVLA may reissue a Group

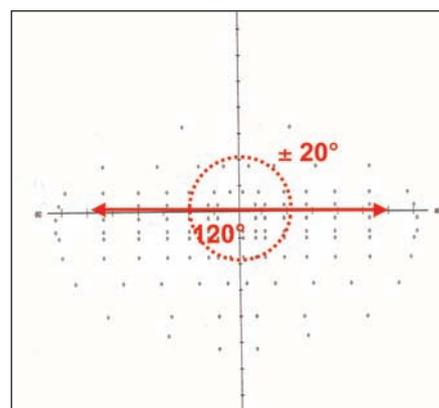


Figure 1: A normal binocular Esterman plot showing the location of 120 points across the visual field. The Group 1 licence visual field requirements specify that no points must be missed along the horizontal meridian over an area subtending 120 degrees, and no significant defect within the central ± 20 degrees

1 licence after a period of 12 months if the patient's neurologist or ophthalmologist can provide evidence that the lesion was caused by an isolated event that is unlikely to reoccur, or a non-progressive condition, and that there is no other pathology present that is likely to progress resulting in further visual field loss. The DVLA also requires the individual to undergo an on-road assessment at a specialist centre to prove that full functional adaptation to the visual field loss has taken place<sup>1</sup>.

An example I encountered a few years ago was a 60 year old patient whom I shall refer to as patient A. A stroke at the age of 30 resulted in lesions to the left optic radiations and the left visual cortex and hence a partial upper right quadrantanopia (Figures 2 and 3). At the time there were no visual field requirement for driving a car and patient A was advised by their GP to cease driving for one month as a matter of caution. Following this period of time, he drove safely for 20 years before being contacted by DVLA during a review of medical records, as a result of which, his license was revoked. Patient A has since regained his license on the basis of 20 years of safe driving and the regularly drives around the busy streets of central London. Figure 4 simulates the effect of the visual field loss on a sample driving scene.

Providing evidence to justify the visual field requirements is fraught with difficulty. There is no doubt that in the limit, binocular visual field loss impacts driving safety since the limit is blindness, but determining the cut-off point has proved impossible. A driver with normal or near-normal visual fields would be expected to detect and identify peripheral and paracentral hazards more quickly than someone with impaired fields. North reviewed the literature on this subject and reported no significant relationship between visual field loss and driving safety<sup>8</sup>. She attributed this finding in part to the numerous methodological limitations of many of the papers published in this area, which almost exclusively considered only the horizontal extent of the peripheral binocular visual field. Studying the effects of isolated scotomata is complicated since they vary in terms of size and location, as well as depth and aetiology.

One option has been to look at monocular drivers who all show an

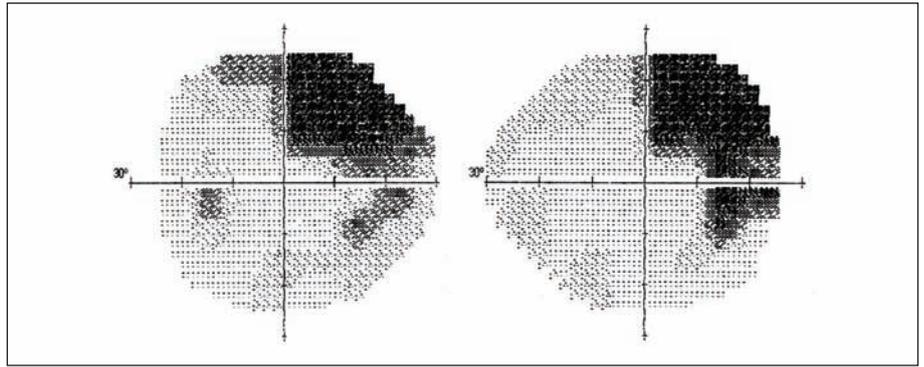


Figure 2: Monocular HFA 24-2 SITA Standard plots for a patient A showing a bilateral partial upper right quadrantanopia following a stroke 30 years previously

identical 'binocular' visual field defect resulting from the physiological blind spot, approximately two metres in diameter at a viewing distance of 20 metres. Refixation during driving occurs in an area smaller than the blind spot<sup>9</sup>. Theoretically this could affect the perception of, for example, a hand signal from another driver within the monocular driver's blind spot<sup>9,10</sup>. However, no increase in accident rate has been found for monocular drivers<sup>11-13</sup>.

Since real scotomas are so difficult to study, researchers have examined the effect of simulated scotomata in normal subjects<sup>14-17</sup>. Such studies allow functional performance to be assessed in a sufficiently large group of subjects with identical field defects. However, only studies simulating constriction of the visual field have been undertaken, because of the practical difficulties in simulating paracentral visual field loss that moves with fixation.

Applying the findings of such experiments using simulated scotomata to real visual field loss is problematic. The main limitation is

the inability to account for adaptation/compensatory eye movements<sup>18</sup>, which can develop in some individuals over time and may result in safe driving behaviour<sup>19</sup>.

In addition to the difficulties in providing justification for the visual field requirements, the gold standard visual field test for driving, the binocular Esterman test, is not really up to the job. By testing each of the 120 points at a single very extreme suprathreshold level, only the deepest scotomas are revealed. The stimulus array was not designed to relate to driving, but rather personal mobility, with more locations tested in areas judged to be of importance for negotiating obstacles when walking. The sampling density is particularly sparse within the central  $\pm 20^\circ$ , with 12 locations examined above the midline and 22 below, and no stimuli within  $\pm 7.5^\circ$  of fixation. The Esterman Efficiency Score (EES) is simply based on the percentage of stimuli seen and is therefore biased towards the inferior visual field due to the greater density of stimuli within this area.

A typical view when driving is shown in figure 5. It highlights the areas of functional importance, in particular the central  $\pm 20^\circ$  field and the region along the horizontal meridian. The lower visual field, beyond about  $10^\circ$ , is not particularly relevant to driving as it overlays the dashboard. The driver will be aware of the presence of the dashboard display, but will only be able to resolve detail when fixation is momentarily transferred to the display area itself. The visual field to the driver's side is partially obscured by the window A-pillar. The upper visual field is obscured within  $30-45^\circ$  by the rear-view mirror<sup>20</sup>, although the exact location of these obstructions varies between cars and with the position of

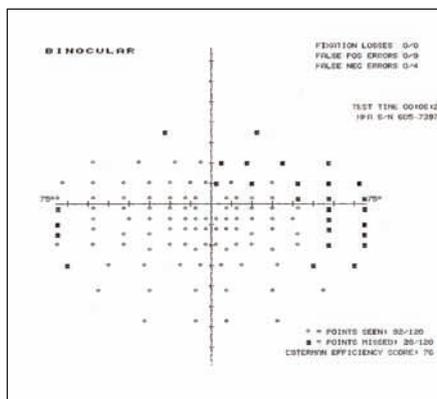


Figure 3: Binocular Esterman plot for patient A (also showing ring scotoma from spectacles)

the driver<sup>21</sup>. An object such as a cyclist or pedestrian moving from the side into the driver's path is in danger of collision. Early recognition of such moving objects is important but only 25% of the measured points fall within the eloquent area because the Esterman overrates the lower field. A single cluster of three contiguous points in the upper visual field would not prevent an individual from holding a Group 1 licence, despite the fact that such a pattern of missed points would probably represent a substantial paracentral visual field loss due to the scarcity of points tested in this area.

### Examining drivers

Other than ensuring we are familiar with the visual requirements for driving, what more should we be doing for our patients who drive? Previous surveys have shown that about 10% of individuals tested fail the number plate test due to an incorrect prescription. Even a small increase in monocular visual acuity in one eye may be enough to allow a patient to meet the visual acuity requirements under binocular conditions. Checking for binocular problems is also important, to ensure that where possible, binocular acuity is at least as good, if not better, than the monocular acuity in the better eye. With the latest advice from the DVLA being that those with less than 6/12 in their better eye should undergo the number plate test, perhaps we should be giving out leaflets explaining the self-assessment process and listing contact details for local driving test centres. Some practitioners may even consider mounting a number plate outside their practices where practical.

With regard to visual fields, should we be performing some form of peripheral visual field check in all drivers (the majority of patients)? Binocular visual fields are tested routinely in drivers in 55% of European countries. Not all practices have access to the binocular Esterman test but any practitioner can perform a good quality gross perimetry or confrontation test combined with a central visual field screening. Like any visual field test the outcome of the Esterman test is subject to learning effects, fatigue and concentration. Individuals who fail should firstly be given the opportunity to repeat the test on a different day.

Monocular visual field loss is



Figure 4: Simulated effect of visual field loss on a real driving scene for patient A

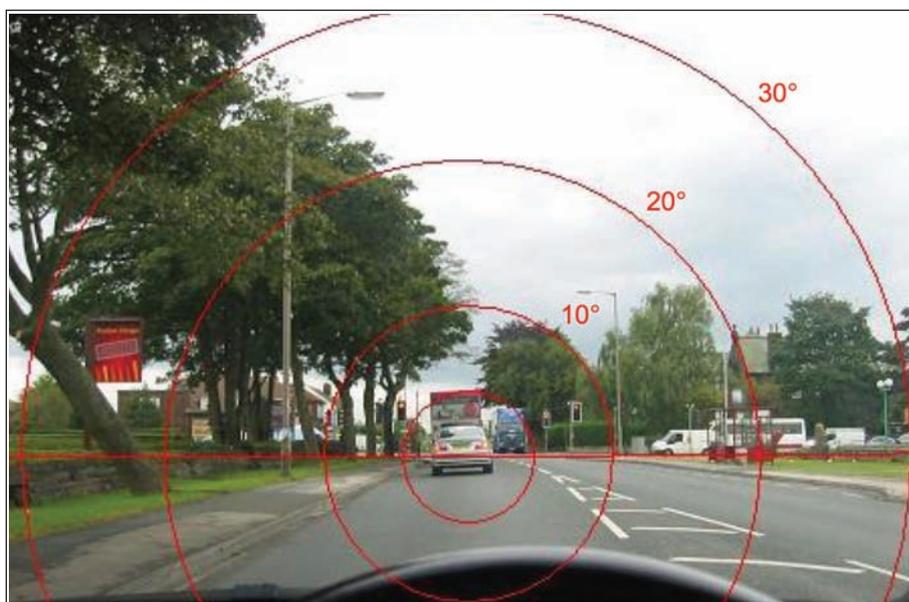


Figure 5: A typical scene when driving showing the functionally-important areas of the visual field

thought to occur in between 3-5% of the population with around two-thirds of such individuals unaware of their deficit<sup>11,22,23</sup>. Binocular visual field loss (not necessarily overlapping) was reported in 1.1% of subjects in one study of 20,000 drivers<sup>11</sup>, but this rises to around 5% in patients with a history of cerebrovascular accident<sup>24</sup>. My own experience of recruiting neurological patients for driving studies has taught me that the classic quadrantanopia or hemianopia so often associated with cerebrovascular accidents involving the visual pathway, is more often than not, a partial defect and in 10-15% of cases, does not involve the central 30° at all. A central visual field test is therefore

inadequate in such individuals.

### Managing patients who fail to meet the requirements

It is not a pleasant job explaining to a patient that they no longer meet the visual requirements for driving. As pointed out earlier in this article, it may not be possible to issue firm advice with respect to visual acuity. Patients should be advised to inform the DVLA, their GP and their insurance company. Insurance cover becomes void in many cases if an individual fails to meet the medical requirements to hold a driving licence. It is the responsibility of the driver to ensure they meet all standards, although some insurance companies

are more lenient than others. A patient who fails to meet the visual requirements but makes it clear they will not inform the DVLA or cease driving, should be treated with caution. Record your discussion with the patient in their notes and if possible, ask them to sign your notes. You are advised to seek the advice of the Association of Optometrists before taking any further action. Although patient confidentiality is an issue, the College of Optometrists code of conduct indicates that where the public are put at risk, you have a responsibility to report the individual. An occasional, short distance driver who is likely to self-regulate is probably less of a risk to public health than a bus driver. Those of us who are drivers also have a responsibility to report individuals if we actually see them driving unsafely.

### The future

Harmonisation at European Union (EU) or even EU/US level is likely at some point over the next few years. Recent reports by both the EU Eyesight Working Group (May 2005) and the International Council of Ophthalmology (ICO) Feb 2006<sup>25</sup> recommended a visual field standard of 120° along the horizontal meridian with no defect within ±20° of fixation. Interestingly, both reports oppose binocular visual field tests such as the Esterman because of the lack of fixation monitoring, fusional problems and the large, bright stimulus, all of which lead to the test being too lenient. The fusing of monocular measurements has been recommended as an alternative<sup>26</sup>, although this is not without its problems<sup>27</sup>.

Safe driving requires a combination of good vision, adequate visual field, ability to spread attention over the field of view and motor skills. There is no doubt that current clinical tests do not in anyway reflect this. It remains to be seen whether more suitable tests that more closely relate to the driving task, will be developed. Attempts so far have been relatively fruitless. In the meantime, all we can do as eye care practitioners is work to the current visual requirements and keep our patients informed as best we can.

### About the author

Catharine Chisholm is a lecturer in Optometry at Bradford University (c.m.chisholm@bradford.ac.uk). Her research covers a range of topics, often

employing psychophysical techniques to investigate visual performance in relation to occupational issues.

### References

1. 'At a glance', DVLA website <http://www.dvla.gov.uk/medical/>
2. Drasdo N and Haggerty CM (1981) "A comparison of the British number plate and Snellen vision tests for car drivers". *Ophthalmic and Physiological Optics*; 1: 39-54
3. Currie Z, Bhan A and Pepper I (2000) "Reliability of Snellen charts for testing visual acuity for driving: prospective study and postal questionnaire" *British Medical Journal*; 321: 990-2
4. AOP website [http://www.aop.org.uk/uploaded\\_files/11-drivers\\_sep\\_06.pdf](http://www.aop.org.uk/uploaded_files/11-drivers_sep_06.pdf)
5. Sheedy JE (1980) "Police vision standards". *Journal of Police Science and Administration*; 8: 275-285
6. Esterman B (1982) "Functional scoring of the binocular field". *Ophthalmology*; 89: 1226-1234
7. Charman WN (1997) "Vision and driving - a literature review and commentary". *Ophthalmic and Physiological Optics*; 17: 371-391
8. North RV (1985) "The relationship between the extent of visual field and driving performance - a review". *Ophthalmic and Physiological Optics*; 5: 205-210
9. Mourant R and Rockwell T (1970) "Mapping eye movement patterns to the visual scene in driving: an exploratory study". *Human Factors*; 12: 81-87
10. Westlake W (2001) "Is a one-eyed racing driver safe to compete: formula one (eye) or two?" *British Journal of Ophthalmology*; 18: 619-624
11. Johnson CA and Keltner J (1983) "Incidence of visual field loss in 20,000 eyes and its relationship to driving performance" *Archives of Ophthalmology*; 101: 371-375
12. Kite CR and King JN (1961) "A survey of factors limiting the visual fields of motor vehicle drivers in relation to minimum visual fields and visibility standards". *British Journal of Physiological Optics*; 18: 85-107
13. Leismaa M (1973) "The influence of driver's vision in relation to his driving ability". *Optician*; 166: 10-13
14. Wood JM, Dique T, and Troutbeck R (1993) "The effect of artificial visual impairment on functional visual fields and driving performance". *Clinical Vision Science*; 8: 563-575
15. Wood JM and Troutbeck R (1992) "Effect of restriction of the binocular visual field on driving performance". *Ophthalmic and Physiological Optics*; 12: 291-298
16. Wood JM and Troutbeck R (1994) "Effect of visual impairment on driving". *Human Factors*; 36: 476-487
17. Wood JM and Troutbeck R (1995) "Elderly drivers and simulated visual impairment". *Optometry and Vision Science*; 72: 115-124
18. Lovsund P, Hedin A and Tornros J (1991) "Effects on driving performance of visual field defects: A driving simulator study". *Accident Analysis and Prevention*; 23: 331-342
19. Schulte T, Strasburger H, Muller-Oehring E, Kasten E, and Sabel BA (1999) "Automobile driving performance of brain-injured patients with visual field defects". *American Journal of Physical Medicine and Rehabilitation*; 78: 136-142
20. Schiefer U, Hofer R, Vischer PM, and Wilhelm H (2000) "Perimetriebefund und fahrtauglichkeit". *Ophthalmologe*; 97: 491-497
21. Vargas-Martin F and Garcia-Perez MA (2005) "Visual fields at the wheel". *Optometry and Vision Science*; 82: 675-681
22. Bentsson B and Krakau CET (1979) "Automatic perimetry in a population survey". *Acta Ophthalmologica*; 57: 929-937
23. Keeney AH (1974) "Significance of visual problems in Pennsylvania drivers". *Pennsylvania Medicine*; 77: 49-51
24. van Newkirk MR, Weih L, McCarty CA and Taylor HR (2001) "Cause-specific prevalence of bilateral visual impairment in Victoria, Australia - The visual impairment project". *Ophthalmology*; 108: 960-967
25. International Council of Ophthalmology website [www.icophth.org/standards](http://www.icophth.org/standards)
26. Crabb DP, Fitzke FW, Hitchings RA and Viswanathan, AC (2004) "A practical approach to measuring the visual field component of fitness to drive". *British Journal of Ophthalmology*; 88:1191-1196
27. Chisholm CM, Rauscher, FG, Crabb, DC et al. (2007) "Assessing visual fields for driving in patients with paracentral scotomata". *British Journal of Ophthalmology*; doi 10.1136