Paper

Low vision driving in the USA: who, where, when, and why

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Abstract

Regulations regarding the visual requirements for driving are set individually by each state in the USA. Data on the visual requirements for driving licensing were collected and verified from all 51 jurisdictions. Results were tabulated and analysed with special attention to the regulations pertaining to driving with vision impairment. The results demonstrate a significant lack of uniformity across states that is attributed to the paucity of reliable information about the level of visual function needed for safe driving. Possible explanations for the differing regulations and visual criteria set by various states are discussed.

Keywords

Driving, vision-impairment, low-vision, bioptic, field-loss, regulations.

Introduction

For the purpose of vision rehabilitation, a person is considered to have low vision if his/her vision impairment limits normal activity. Vision requirements for driving, however, are typically defined at the impairment level (loss of visual acuity (VA), or loss of visual field (VF)), rather than the activity level, despite the paucity of information on the relations between these measures of vision impairment and limitations in driving performance. Due to the lack of reliable information on this topic, state legislatures and regulators, in being forced to reach decisions, make rules that often appear arbitrary. Thus the driving license regulations in the USA vary widely from state to state and in some cases differ significantly from those pertaining in the UK, most notably with regards to the visual field requirements for unrestricted driving, and the regulations regarding restricted driving with low vision, with or without visual aids.

In the USA, the Federal government sets regulations regarding interstate commerce and thus they set the vision requirements for truck drivers that operate across state lines. Each state is free to set its own regulations for private and intrastate commercial drivers. This paper reviews current regulations in all 51 jurisdictions. The data are summarized to highlight variations in vision criteria used to determine those who can drive in various states without restriction (unrestricted license), and the kinds of restrictions that are imposed on the visually impaired (restricted licenses). An attempt is also made to account for or explain possible reasons for specific regulations.

In the UK there is growing interest amongst the visually impaired in the possibility of driving with low vision devices, particularly bioptic telescopes, as evidenced by the recent formation of the BiOptic Driving Network UK (*www.biopticdriving.org/UK.htm*). It is, therefore, both timely and relevant to provide a review of the driving regulations relating to restricted licenses for the visually impaired and the use of bioptic telescopes in the various states of the USA.

Methods

A questionnaire was mailed to the driving licensing agencies of all 50 states and the District of Columbia (DC). The questionnaire requested updated information regarding vision requirements for unrestricted licensure, as well as specific requirements for restricted licensure with vision impairments. Responses were obtained from all 51 jurisdictions. State-by-state data tables were generated in an effort to maintain a uniform format across the states, although this goal was not always possible due to the variability of format and level of detail of regulations.

The completed tables were then mailed back to the corresponding agencies with a request for approval or correction of the interpretation of the previous responses as they appeared in the tables. Confirmation and corrections for the tables were received from 47 of the 51 jurisdictions. The complete tables appear in a recent book.[1] Here the data are summarized, analysed, and discussed.

Results

Visual acuity required for an unrestricted license

In most cases the visual acuity (VA) requirement for an unrestricted license is specified with refractive correction (or uncorrected, if correction is not needed)

in the better eye. Figure 1. illustrates the variation in VA criteria for unrestricted licenses (dark bars). In common with many countries around the world, 40 out of the 51 jurisdictions require 20/40 (6/12) for unrestricted driving. There is no known reason for the 20/40 VA requirement, a fact that has been discussed in many published reviews of vision and driving.[2,3] It is frequently stated that VA of 20/40 (6/12) is needed to enable reading of road signs on the highway in time to respond. However, it might be argued that the size of letters on road signs is designed to meet the 20/40 VA requirements and not vice versa.

A few states permit lower levels of VA for an unrestricted license, with Florida permitting as low as 20/70 (6/21) corrected. Many states have specific higher VA requirements for people with one blind (or "legally blind") eye (Florida requires 20/40 in the better eye). The reasons for a stricter VA requirement for monocular drivers are not known, but possible reasons are addressed in the discussion.

Minimum visual acuity required for a restricted license

Many states provide restricted licensure to drivers who cannot meet the unrestricted license requirements. Some of the more typical restrictions include: daylight driving only, no highway driving, driving within a limited distance from driver's home, as well as many other restrictions. Many of these cases are decided individually by an advisory board or are recommended by the eye care provider. In some states the restrictions are built into the regulations. In Massachusetts, for example, where 20/40 (6/12) is required for unrestricted license, daylight-only driving is permitted with VA of 20/70 (6/21) or better. In a number of states, restricted driving with even lower VA is permitted with bioptic telescopes (20/100 in Massachusetts). Most states specify a minimum level of VA below which driving is not permitted under any circumstance. These minimum VA levels vary significantly across the states (Figure 1, light bars) and there is no known justification for any of the levels selected.

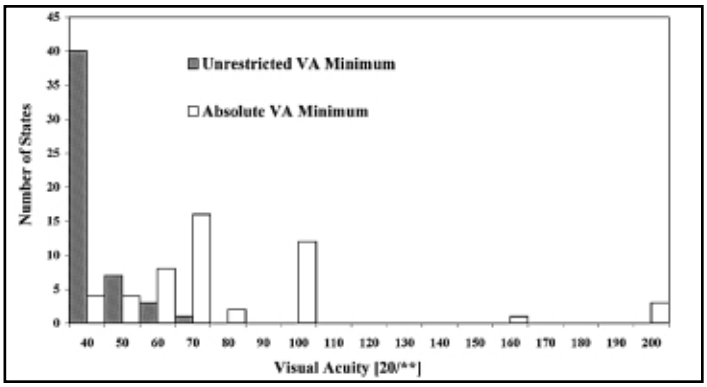

Figure 1. The distribution of visual acuity (VA) required for restricted and unrestricted licensure in the various states. Only a few states permit VA worse than 20/40 (6/12) for unrestricted driving. Absolute minimum VA levels permitted for restricted licenses vary over a much wider range. The restrictions and conditions attached to driving with the absolute minimum acuity also vary substantially from state to state.

Driving with a bioptic telescope

Bioptic telescopes are miniaturized telescopes mounted in the spectacle lens (usually over one eye only). They are typically mounted at the top of the carrier lens and are used intermittently to compensate for VA loss.[4] In driving, bioptic telescopes are used to read road signs, to examine traffic lights, and to scan ahead for potential road hazards.[5] Most of the time the driver is viewing through the carrier lens, which provides a wide field of view. However, the field of view through the telescope is narrow (10 to 15 deg.) and is surrounded by a ring scotoma.[6] Driving with bioptic telescopes is permitted in 34 out of the 51 jurisdictions, but in 6 of the states the VA requirement (through the carrier lens) for licensing with a telescope is the same as without one (Figure 2). These states probably implemented such a regulation in response to federal regulation, or interpretation of anti-discrimination federal laws, that suggested that one could not prohibit people from driving with bioptics.

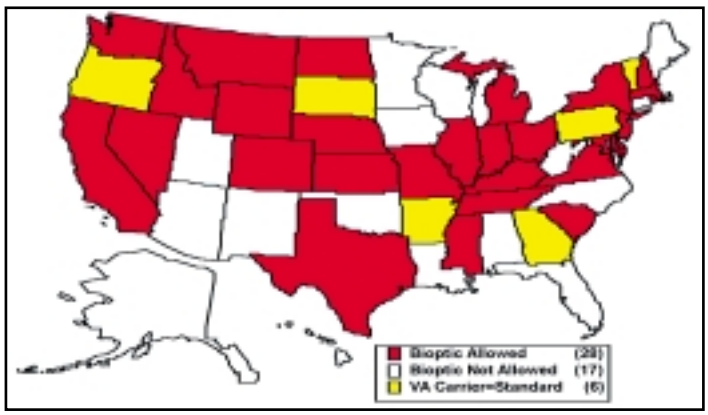

Figure 2. The states that permit driving with bioptic telescopes are shown in red. In some states bioptic driving is permitted, but only if the standard VA requirement can be met without the telescope (yellow). The states that do not permit bioptic driving (white) appear to be clustered together illustrating regional differences.

Thirteen states prohibit driving with a bioptic at night (2 states prohibit night driving only during the first year of bioptic driving). A few states have no specific regulations, and a few states explicitly permit night driving. In most states, meeting the required VA levels through the telescope and the carrier lenses are sufficient to grant a license. Only 18 states require a special road test with the telescopes and 12 states require special driver training for bioptic drivers (Michigan recommends such training). The reason for these limited requirements is not known, but it appears that most states impose only requirements that result in little cost. Special testing and training may be fairly expensive, and are therefore usually not required.

Most states permitting bioptic driving do not impose any restriction on the type or characteristics of the telescope to be used. Thus, in many states one could meet the VA requirement with a dim Galilean telescope of 6.0X and a field of 2 deg. or less. Only a few states restrict the maximum power (magnification) of the telescope. The field of view through the telescope is not defined to our knowledge in any state, a factor that is understandable as information on the field of view is sparse and a method of measuring the field would have to be defined. We found recently that in most cases the measured field of view of a telescope closely matched the field specified by the manufacturer.[6]

Visual field required for an unrestricted license

Intuitively it seems apparent to all that a wide peripheral VF is needed for safe driving. While it is quite obvious that a person who is legally blind due to VF restriction of 20 deg. or less in diameter cannot drive safely, it is far less obvious what VF would be consistent with safe driving. Danielson[7] evaluated 680 drivers selected to be at high risk because of VF defects or because of an extensive accident history. He noted: "Suffice it to say that no

cases were encountered in which the defective field of vision was believed to have caused an accident". A number of other studies found no correlation between crash rate and VF deficits.[8-10] One study did find a doubling of crashes and traffic violations in people with severely reduced VF in both eyes.[11]

Thirty-six jurisdictions have peripheral VF requirements for licensing (Figure 3), ranging from a minimum binocular VF of 20 deg. to 150 deg. (Figure 4). Two states (New York and New Mexico) require a minimum VF only if the VA standard (20/40) cannot be met. The Federal government requirement for commercial drivers is for a VF of 70 deg. horizontally in each eye, considerably less than the requirement imposed by many states for professional or for private drivers.

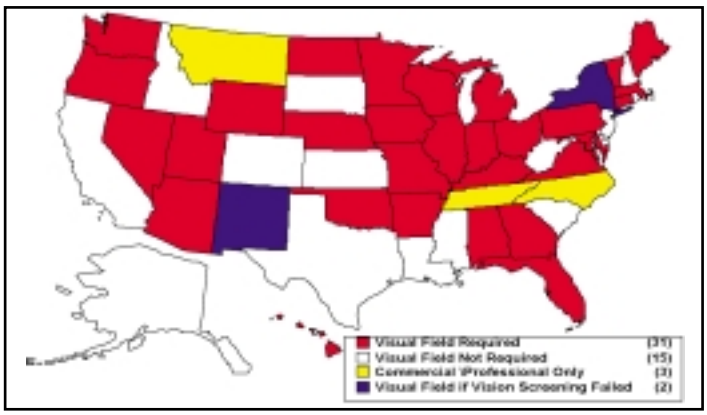

Figure 3. A map of the USA showing those states that have a visual field (VF) screening requirement for non-commercial drivers (red) and those that require such testing for commercial drivers only (yellow). Two states require a minimum VF extent only if the visual acuity screening standard is not met (blue). All other states (white) have no field requirements for private drivers and only impose the federal requirement for commercial drivers.

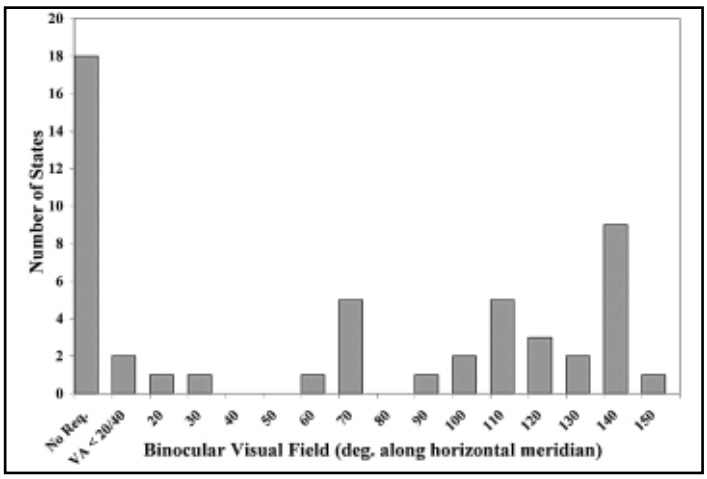

Figure 4. The width of the binocular horizontal visual field (VF) required for unrestricted license and the number of jurisdictions having each specific VF requirement. Eighteen jurisdictions have no requirements for non-commercial drivers and two only require a minimum VF extent if the acuity does not meet the screening standard. Note distribution peaks at 70, 110 and 140 deg.

In most cases, the VF requirements are defined in terms of the extent of the binocular VF along the horizontal meridian. Only two states, Kentucky and Utah, specify the extent of the VF vertically to include at least 25 and 20 deg., respectively, above and below fixation. This specification is much less detailed than that used in the British regulations.[12] There was no specific mention of central or paracentral scotoma in any jurisdiction. While the regulations may be interpreted to imply no interruption of the VF along the horizontal meridian, this is clearly not the case. All states permit driving with monocular vision, and in these cases the physiological scotoma (optic disc) will interrupt the VF along the horizontal meridian.

Minimum visual field for restricted license

Figure 5 presents the VF requirements for an unrestricted license along with the minimum VF requirements needed for a restricted license in the 12 states that permit such licenses. As can be seen, only small reductions in the VFs are permitted for restricted licenses in these states. The impact of such small changes in visual fields on driving is not known, but is unlikely to be meaningful. In some states, requirements for the extent of temporal and nasal field in each eye are specified. The state of Missouri requires 70 deg. binocular VF for both the restricted and unrestricted licenses. The restrictions are imposed if the VF of one eye is below 55 deg. (the VF of the other eye then has to be larger than 85 deg.) and may be imposed even if the binocular field is wider than the minimum 70 deg. The state of Wisconsin requires at least 20 deg. of temporal field in each eye. With this requirement, a patient with monocular complete temporal field loss will be disqualified even if his binocular field is sufficiently wide to meet the binocular VF requirement. The reason for monocular field requirements in the presence of a wide binocular field is unclear.

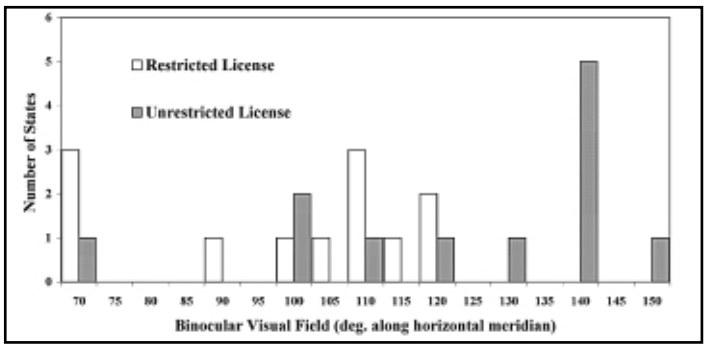

Figure 5. The distributions of visual field requirements for restricted and unrestricted licenses for the 12 states that offer such restricted licenses. Note that only a minimal reduction in field is permitted for the restricted license.

Driving with hemianopia

Most states' regulations implicitly treat hemianopic field loss as any other restricted peripheral field. Thus, the VF requirement refers only to the total horizontal extent of the field. People with hemianopia can frequently be measured to have a horizontal field of 90 deg. with standard clinical procedures, and thus qualify for licensure in states requiring less than 90 deg. of horizontal field, but fail to qualify in 22 other states (see Figure 4). In fact the temporal field may extend more than 90 deg., although a modified test procedure is required to document such a field with most clinical perimeters.[7] Thus, some individuals with hemianopia might even meet a field requirement of 110 deg. At least one state (Utah) specifies that drivers with hemianopia be evaluated individually for driving qualification. In comparison, driving with hemianopia is explicitly prohibited in the UK and a special road test is required for licensing a person with hemianopia in The Netherlands. Because many USA jurisdictions do not prohibit driving with hemianopia and because many patients can easily pass the VA screening, many of them are driving but their driving records are unknown.

Types of restrictions imposed with reduced visual fields

Those states that permit a restricted license for drivers with reduced VFs almost uniformly require outside rearview mirrors. In five states, mirrors are required on both sides, while in the District of Columbia, only the left side mirror is required. In some states, the mirror is required on the side of the eye with the limited field (or the blind eye). The reasons for the mirror requirements are not known and are addressed in the discussion. No state explicitly permits meeting the VF requirement through the use of a field enhancement device (analogous to the use of a bioptic telescope to meet VA requirements). A few states explicitly prohibit such devices. In 2001 the state of Massachusetts granted a driving license to a hemianopic patient using a novel design of peripheral prism correction.[13] The license was awarded since the patient met the language of the law and demonstrated his ability to drive safely with these prisms during a lengthy road test.

Visual fields test methods

Although the required VF is usually defined in terms of binocular degrees of visual angle along the horizontal meridian, the method of measurement is rarely well defined. Measurements may be obtained by careful confrontation (District of Columbia) or by clinical perimetry, although the specific targets are rarely specified (e.g., 6 mm target as specified in Michigan, or Goldmann III4e as specified in Kentucky). Most commonly the VF is evaluated using a single light on each side of the VF using the various screening devices (e.g., Optec 1000, Keystone View, Stereo Optical DMV 2000). These tests are easy to defeat unless applied with great care and attention, which is rarely the case. In the most recent renewal of my own driving license in Massachusetts, no VF test was administered.

Discussion

The extreme variability of the rules regarding visual requirements for driving licensure cannot be consistent either with public safety or with fair treatment of impaired or disabled citizens. The variability in the regulations in the USA highlights the arbitrary nature of such regulations, which might be more difficult to note in other countries where only a single arbitrary rule is being applied. As a result of the variability of regulations in the USA, people with widely varying types and levels of vision impairments are permitted to drive with varying types and levels of restrictions across the country. With a license from one state, a person can legally drive in another state, even though he/she would not actually meet the vision requirements for licensure in that state.

The wide variability in vision requirements for driving found between the states is an indication of the lack of consensus in both the scientific and the driver licensing communities about the extent of VF and level of VA that is needed for safe driving.[2,3,14] Faced with such a lack of consensus and reliable data, regulators are forced to make what appear to be arbitrary decisions. It is interesting to try and hypothesise how such decisions are formulated.

One way for regulators to make such decisions is to look to neighbouring states for guidance. These regional tendencies are clearly notable in the maps (Figures 2 & 3). Conforming to guidelines in neighbouring states is a less than optimal way of making decisions that have a significant impact on the quality of life of many citizens, and the safety of all, but it may be a politically safe approach.

Figure 4 shows that for those states that require a minimum VF extent for unrestricted licensure, the binocular VF requirements are distributed around 110 deg. with an additional 6 states requiring 70 deg. and 9 more states requiring 140 deg. The reason for the distribution around 110 deg. is not known. The requirement for 70 deg. appears to reflect the Federal requirement for commercial interstate drivers (70 deg. in each eye, although the source of this particular requirement is not known either). The reason for the peak in the distribution at 140 deg. is probably a result of misinterpreting the Federal requirement for commercial drivers to mean a binocular field of 140 deg. (the sum of two monocular fields of 70 deg.). While it may seem unreasonable to make such an assumption in view of the large overlap of the VFs of the two eyes, such mistakes are not rare, even in the ophthalmic literature.[15]

A few jurisdictions have VA-dependent VF requirements. For example in the state of Maryland a VF of 140 deg. is needed for an unrestricted license. However, a field of 110 deg. is sufficient for a restricted license, but only if the VA is better than 6/21 (20/70). In the District of Columbia, a VF of 130 deg. is required if VA is better than 6/12 (20/40). However, if the VA is reduced (but still better than 6/21 (20/70)), a field of 140 deg. is required. The rationale for such VA-dependent VF requirements is unclear. Reduction in VA usually results from loss of central vision, which, in the ranges addressed by these regulations, would only affect a few degrees around the fovea. Can such a loss interact or could it be compensated for by an increase in the required VF? Figure 6 illustrates the relations between the views afforded in a driving scene with 140 and 130 deg. fields and the central 10 deg. of the field of view. It is apparent that the small increase in peripheral field is unlikely to affect in any way the driving ability of a person suffering from modest loss of central vision.

Figure 6. An illustration of the impact of the increase in VF (from 130° - 140°) required in the District of Columbia for patients with visual acuity in the range of 6/12 to 6/21 on the field of view in a driving scene. The circle of 10° in the centre represents the maximum area that might be affected to cause such a reduction in acuity.

It is possible that these kinds of cross requirements are derived from the computations of vision efficiency or vision disabilities used for insurance, social security, or legal compensation for vision loss. In many of these situations the visual "disability" (activity limitation) is computed using a linear weighting formula such as

$$Disability = K \cdot (visual\ acuity\ score) + C \cdot (field\ score), \quad (1)$$

where, K and C are the weighting coefficients. This formulation implies that an improvement in the VF may compensate for a loss of VA and vice versa. An example of such explicit thinking is present in Fishman *et al*'s[15] study on driving with retinitis pigmentosa, a study that compared driving records with

various measures of visual efficiency. They implemented such a linear weighting formulation to determine visual efficiency. While such formulations might be appropriate for various social or medical-legal applications, they should not be interpreted to mean that one of these functions could compensate for a loss in the other for the purpose of driving. There is no evidence to support such accounting in driving, and therefore, they should not be applied in licensing decisions.

All states permit people with one blind eye to drive. However, many require the remaining eye to satisfy a higher standard on VA tests than that required from people with two functioning eyes. The basis for that cross-linked requirement is not known, but is likely to be related to the reasoning associated with the VF cross-linked requirements discussed above. A study that compared binocular and monocular truck drivers found the monocular drivers to be deficient on various visual functions but concluded that "monocular drivers are not significantly worse than binocular drivers in the safety of most day-to-day driving functions".[16] In some countries, an adaptation period of a few months is required before driving is resumed after a loss of vision in one eye. This requirement appears to be much more reasonable than the more stringent VA requirement. However, the author is not aware of any study that determined the time needed for recovery of safe driving following acute loss of vision in one eye.

The use of bioptic telescopic devices as a visual aid for driving is permitted in 28 states, however, there is no equivalent allowance for a visual aid that could be used to expand the VF while driving. A few states require outside rear view mirrors for drivers with reduced VFs. However, rear view mirrors do not compensate for the loss of VF suffered by most patients. Rear view mirrors can only be used to view the area behind the driver, where vision is not afforded even by the widest extent of the VF. Mirrors mounted in different ways could possibly provide VF expansion for drivers with field loss,[17] but such applications are neither required nor permitted in any states.

A reversed (minifying) telescope might be used to expand the VF of patients with concentric restriction. It provides an expansion of the horizontal field of view but reduces VA. A recent study[18] evaluated the Amorphic minifying telescope mounted in the lower part of the lens while driving. An overall improvement in a range of driving visual skills was measured with the use of the Amorphic lens and extensive training. The Amorphic lenses were mounted to "obtain a full view of the dashboard and peripheral landscape while driving". The need for the expansion of the lower VF covering the instrument panel is not clear. However, intermittent bioptic use of a minifying telescope to probe the roadway may be an effective way of expanding the field for driving purposes.

The level of variability across states could have served as an ideal environment for testing the impact of various vision impairments and restrictions on safe driving. However, there is little data available on the impact of the variable regulations. Unfortunately, most states do not collect any statistics on their visually impaired drivers and even the level of enforcement of existing regulations is not clear. The large state of California does maintain such records and a study conducted in the early 1980s provides some insight.[19] At the time there were only 229 bioptic drivers out of 21 million drivers in California. Bioptic drivers had a higher rate of accidents and injury accidents than the total population. However, when the computations were corrected to account for age and gender differences and excluded drivers with invalid licenses from both groups, the difference was not statistically significant. The bioptic drivers added a total of 3 accidents to the 1.1 million accidents per year rate.

The driving records of patients with vision impairments from those states that permit low vision driving should be collected and compared to matching populations in the other states. The data to be generated from such studies should provide a more solid basis for the determination of the vision requirements for safe driving and the possible role of vision aids for driving with impaired vision. With better information, the variability in licensing requirements between states and even countries could be reduced, thus improving safety and the fair treatment of visually impaired drivers.

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