Driving With Central Field Loss

SHOULD PEOPLE WITH CENTRAL FIELD LOSS (CFL) be on the road driving? Independent travel is an important prerequisite for full participation in modern society. Reduced mobility and its associated social isolation and depression are among the most severe consequences of vision impairment. Research on mobility with vision impairment has focused primarily on pedestrian travel, but there is a growing interest in the impact of vision disorders on driving, including cataract,[1] retinitis pigmentosa,[2] hemianopia,[3] and macular degeneration.[4,5] In this issue of *JAMA Ophthalmology*, Bronstad et al[6] describe how specific characteristics of CFL affect driving performance.

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With the aging of the American public, the number of people with macular degeneration is growing, expected to reach nearly 3 million by 2020.[7] A substantial number of these people will experience irreversible CFL. They will face life-changing questions: Should I continue to drive? Is it legal for me to drive? This population of aging drivers, their families, their eye care professionals, and the state authorities responsible for driving licensure will need to contend with the tension between protecting public safety and allowing people with impaired vision the freedom to drive.

Currently, acuity is the primary visual criterion used for determining licensure, typically requiring drivers to have 20/40 (6/12) letter acuity or better.[8,9] Remarkably, the evidence for an association between acuity and driving safety in the range of 20/40 to 20/200 is weak or absent.[9-11] We know that people with CFL have reduced acuity, but what additional consequences are there for driving from damage to the macula? We need research showing how specific characteristics of visual field loss impact driving performance, as well as how they interact with cognitive and health variables, environmental conditions, and the ergonomic demands of driving.

Bronstad et al[6] used a driving simulator to test 11 subjects with bilateral CFL (7 from age-related macular degeneration, 1 from Stargardt disease, and 3 from other disorders), and 11 normally sighted age-matched controls. During rural and city driving scenarios, the subjects were required to detect virtual pedestrians crossing the road ahead on a collision course with the driver's vehicle. Reaction times were measured and the number of "pedestrians" not detected (missed) were counted. Prior to the driving tests, each CFL subject's visual field was mapped to determine the size of the central scotoma and the location of the preferred retinal locus (PRL). The PRL is a region of retina, typically adjacent to the central scotoma, adopted by people with CFL for fixation and other visual functions.[12-14] Subjects with CFL were screened to include only those with PRLs located left or right of the central scotoma (rather than above or below the scotoma).

The goal of the study was to determine if the size of the scotoma and position of the PRL relative to the scotoma would influence detection of the virtual pedestrians. If drivers with CFL are assumed to use their PRLs for looking straight ahead down the road, it might be expected that virtual pedestrians on the side of the road corresponding to the direction of the scotoma in the visual field would be temporarily occluded, resulting in a prolonged reaction time or even a miss. But it is also possible that the relative locations of PRL and scotoma would have no effect; the individual with CFL may have learned compensatory eye or head movements to minimize the impact of an adjacent scotoma.

Bronstad et al[6] found that the subjects with CFL responded more slowly to and missed more virtual pedestrians than the controls. They also found that the detection performance of subjects with CFL was poorer for virtual pedestrians appearing on the scotomatous side of the PRL than on the seeing side. The slower reaction times of the subjects with CFL were not correlated with their acuities but were correlated with the size of their scotomas. These results are important in showing that the configurations of PRL and scotoma have more impact on driving performance than does acuity.

The Bronstad et al[6] findings are compelling and raise several additional questions. First, will their results generalize to on-road hazard detection outside the simulator? Simulators are limited in the fidelity and range of naturalistic lighting conditions they can produce and typically use scenarios in which subjects are primed to expect hazards (in this case, the virtual pedestrians). We might speculate that the differences in detection found by Bronstad et al[6] between their subjects with CFL and their normally sighted controls would be amplified in real driving.

Second, will people with PRLs above or below their central scotomas exhibit better hazard detection in driving? Bronstad et al[6] considered only PRLs lateral to the central scotoma and found that this configuration hindered the detection of hazards approaching from the left or right. Some subjects with central scotomas spontaneously adopt or are trained to adopt PRLs above or below the scotoma.[14] Preferred retinal loci below the scotoma in the visual field are thought to be more advantageous for reading than lateral PRLs because the scotoma is less likely to occlude text left or right of the PRL. But in driving, a scotoma above or below the PRL might occlude cars or other features on the road straight ahead.

Third, drivers with CFL must rely on their peripheral retina for visual input. Bronstad et al[6] focused on the configuration of PRL and scotoma, but what are the effects of other properties of peripheral vision on driving behavior? These properties include crowding,[15] deficiencies in eye-movement control,[16,17] and reduced accuracy in estimating time to contact.[18]

Since most people with CFL are older than 65 years, factors influencing aging vision more generally come into play, such as decreased contrast sensitivity (especially under scotopic conditions), slower light and dark adaptation, and slower visual processing overall.[19] In particular, aging vision seems less able to detect salient targets in a cluttered peripheral visual field, and this reduced useful field of view[20] is associated with greater risk for motor vehicle collisions.[10,21-23] A mitigating factor is the tendency for older drivers to self-restrict their driving exposure, especially at night.[24] DeCarlo et al[25] reported that some patients with age-related macular degeneration visiting a low-vision clinic were still licensed drivers, but most had drastically restricted their driving activity. For example, 80% reported not driving at night, and most drove only about 10 miles per week.

Most research on driving and low vision, like the work reported by Bronstad et al,[6] has focused on safety-related measures. But, from the driver's perspective, another important aspect of driving is wayfinding, following a route to a destination. Wayfinding in unfamiliar environments often puts a high demand on good acuity because of the need to read street signs and building addresses or watch for landmarks. Drivers with reduced acuity from macular degeneration or other eye disorders may minimize wayfinding problems by limiting their driving to familiar neighborhoods. Some may use bioptic telescopes—a small telescope (power typically in the range of ×2 to ×4) mounted on the upper portion of the driver's normal spectacle lens—for spotting and reading signs. For reasons that are not yet clear, few people with macular degeneration actually use bioptic telescopes.[26] A recent advance in technology for assisting wayfinding is the use of talking GPS systems for route following, now widely used by normally sighted drivers and potentially of great value to people with reduced acuity. The future development of intelligent systems in which cars communicate wirelessly with other vehicles and the transportation infrastructure, and provide spoken feedback to drivers, could be particularly beneficial for wayfinding with visual impairment. We can also look forward to the brave new world of Google's driverless cars, which might extend driving accessibility to everyone with visual impairment. Advocates of this technology point out that most traffic accidents are due to human error and propose that driverless cars will be safer and more economical while extending the benefits of driving to more people.[27]

In the near future, we should expect to find more drivers on the road with CFL and other forms of visual impairment. Findings such as those reported by Bronstad et al[6] begin to shed light on individual vision-related factors that can guide ophthalmologists, optometrists, vision rehabilitation specialists, and their patients in making driving decisions. The findings also offer opportunities for improved educational and intervention programs for driving safety and for the development of onboard technology to assist driving mobility.

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Ophthalmic Images

Oral Fluorescein Staining in Mucous Membrane Pemphigoid

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A 60-year-old woman presented with a 2-year history of severe ocular mucous membrane pemphigoid (A). Single-use fluorescein, 2%, was successfully used to visualize associated oral mucosal ulcers (B and C), including those not immediately apparent to the naked eye (arrows).