Traffic Safety Facts

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Drivers With Visual Field Loss Tested on NADS Simulator

Drivers rely on peripheral vision to support a number of driving tasks including maintaining speed and lane position and detecting potential hazards such as pedestrians or other vehicles. The visual field, the area within which a person focusing on a central point can detect a stimulus, is normally about 180 degrees. A number of medical conditions result in visual field loss (VFL), including reduced peripheral vision; however, it is not clear whether drivers with VFL can drive safely.

The purpose of this study was to use the National Advanced Driving Simulator (NADS) to compare simulated driving performance of people with VFL to that of drivers with normal vision. A second objective was to determine whether those with VFL use strategies to compensate for their reduced peripheral vision.

NADS is a high-fidelity driving simulator that replicates the visual, auditory, and haptic (tactile) experience of real-world driving. The simulated driving tasks were designed to capture increased head movements, eye scanning patterns, frequent mirror glances, or other strategies that a driver with VFL might use to compensate for a limited visual field. NADS also automatically sampled and recorded driving performance measures.

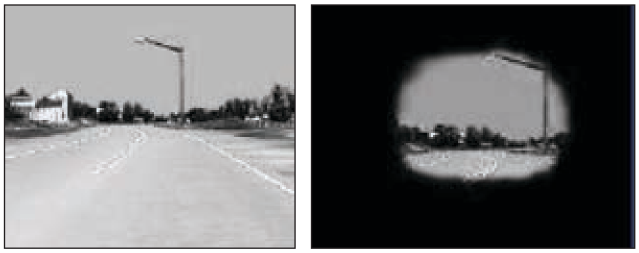
Methods

Sixteen licensed drivers participated in the study; their average age was 42. VFL group members had horizontal visual fields <100 degrees while the control group participants had normal visual fields. The groups did not differ in miles driven per year (10,000), driving frequency, driving years, self-ratings of driving quality, driving preferences, driving locations, avoidance of driving conditions or situations, or number of self-reported crashes within the past five years.

Participants completed a 12-minute simulator drive that included five scenarios: a sign recognition task, merging (on and off the freeway), straight and curved sections of roadway, two lead vehicle braking events, and an intersection incursion event. Speed limits were 45 mph on the rural highway and 65 mph on the freeway.

Participants were asked to identify eight signs on both sides of the road during one segment of roadway. An eye tracker collected data on participants' glance frequency and duration to the roadway, mirrors, and the speedometer.

Figure 1. NADS Simulated Rural Roadway



Normal vision, left frame; retinitis pigmentosa, right frame.

Results

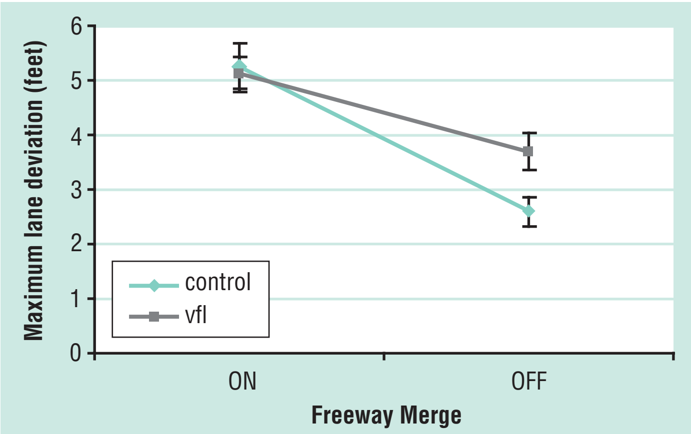
Glances

The groups performed similarly in most eye glance behaviors, but there were differences in the duration of glances toward two areas of interest. The VFL group made significantly longer glances toward the speedometer and the control group made longer glances toward the rearview mirror. The drivers with VFL may have spent more time looking at the speedometer in order to maintain their speed, a dimension where the use of peripheral vision has been shown to be relevant.

Lane Position

The groups' driving performance measures were similar on most sections of the roadway; however, the VFL group showed greater variability in lane position, particularly during the latter part of the drive. Figure 2 shows that, when exiting the freeway, the control group's mean maximum lane deviation was 2.6 ft; that of the VFL group, 3.7 ft, was significantly greater.

Figure 2. Maximum Lane Deviation at Freeway Entrance and Exit



Maximum lane deviation on and off the freeway.

Lead Vehicle Braking

There were two lead vehicle braking events. Each began when the brake lights of a lead vehicle (the car ahead of the participant's vehicle) turned on, and ended when the participant depressed the accelerator pedal following the braking response. The groups responded similarly to the events with the exception that in the second event, the VFL group exhibited more variation in lane position during this event.

Intersection Incursion Event

At the end of the simulator drive participants faced a hazardous event when a vehicle on an intersecting roadway failed to stop at a stop sign. Participants could avoid colliding with the vehicle by stopping or by swerving around it. This intersection incursion event was defined as the time interval that started when the incurring vehicle was three seconds from the intersection stop-line to the time the participant either came to a stop or crossed through the intersection (for those who chose to drive around the oncoming vehicle). Ten participants came to a stop and six steered around the incurring vehicle. There were no significant differences between the groups for the action taken (steering or braking) to avoid the incursion event. The VFL group took longer on average to release the accelerator in response to the incurring vehicle; among those who stopped, the VFL group had a smaller (riskier) time to collision.

Head Movements

Although studies have shown that drivers with VFL may compensate for their limited visual fields by moving their heads more than other drivers, this effect did not occur in the current study. The participants with VFL and control groups made about the same number of head movements.

Sign Recognition Task

The groups did not differ significantly in the number of correct responses to the road signs, in the distance from which the signs were identified, or in the number of signs they recognized after the simulation.

Conclusions

The results from this study indicate that, while performance was similar in most tasks, participants with VFL exhibited some difficulty maintaining lane position on curves and when departing the freeway. This group also took longer to respond to the vehicle incursion, an unanticipated hazard that originated in the periphery during the simulated driving task.

Limitations

The number of participants, particularly in the VFL group, was small. This is of particular concern given differences in characteristics of visual field restrictions within the VFL group; some had symmetrical field loss while others had restriction on only one side. It is also important to note that participants may behave differently in a simulated driving task than in real-world driving.

How to Order

For a copy of *Driving With Visual Field Loss* (29 pages plus appendices) write to the Office of Behavioral Safety Research, NHTSA, NTI-130, 1200 New Jersey Avenue SE., Washington DC 20590, send a fax to 202-366-7394, or download from www.dot.gov. Kathy Sifrit, Ph.D., was the contract manager.

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