Distracted driving and Effective Field of View in drivers with glaucoma on a novel panoramic Driving Simulator Visual Field task

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Introduction

- Glaucoma affects 2% of the U.S. population over 40 and significantly increases the risk of Motor vehicle crashes (1-3).
- A key question is whether Humphrey visual fields (HVF), administered with careful control over eye fixation, accurately reflect patients’ visual performance and safety behavior in context, on the road.
- We define “effective field of view” (EFOV) as the dynamic field of view in naturalistic conditions of eye and head movements.

Objective

- Our goal is to understand the critical relationship between standard HVF (static visual fields) and EFOV (dynamic visual fields) during driving under varying cognitive loads.
- We hypothesize that EFOV will decrease with tasks that increase cognitive load.

Methods

Driving Simulator Visual Field (DSVF)

- Implemented in SEN2EI (Simulator for Ergonomics, Neuroscience, Safety Engineering and Innovation), a DriveSafety RS-600 high fidelity driving simulation system with a 290 degrees display environment, retinal level display and a full-size automobile cab.
- DSVF tests total 60° horizontal and 20° vertical visual field at 2.5 m. Forty grid test locations are placed 6° apart, straddling the horizontal and vertical meridian similar to HVF 30-2 strategy.
- Red supra-threshold stimulus images (0.5° visual angle, similar to HFA stimulus size) are presented randomly 4 times at each locus with stimulus duration 200 ms. Grid test locations are straddled by blank locations with full and compromised visual fields.
- A-pillar scotoma: In all DSVF trials (aim 1 and 2), there was a vertical scotoma in the left hemifield 21-27 location in the DSVF corresponding to the vehicle’s A-pillar (green circle – figure 3). This was calculated as HVF-DSVF VFI in glaucoma suspects and caused a 7±2% decrease in VFI OD, 9±3% decrease in VFI OS and 2±3% decrease in VFI OU.

Blind spot mapped correctly (17° location) in all monocular fields (Figure 3 light blue circle).

Results

Conclusions

- The DSVF is a novel technique to study the EFOV in a naturalistic setting. Global VF on DSVF correlated well with HVF.
- In cab geometry, particularly the A-pillar decreased the EFOV by 7% binocularly and 7% monocularly for the right eye and 9% for the left eye.
- EFOV shrinks with driver distraction and increasing attention demand in subjects with full and compromised visual fields.
- The decrease in EFOV with increasing cognitive load is more pronounced in the glaucoma group than in the control group.
- EFOV mapping may guide rehabilitation strategy design for safer driving.

References


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