Closed circuit driving performance in persons with quadrantanopia and hemianopia in Sweden

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Commercial Relationships: No Commercial Relationships
Sweden (Sverige)

- **Statistics**
  - 9.6 million inhabitants
  - 120,000 visually impaired people (1.2%)
  - 4.4 million passenger cars are registered in Sweden
  - 6.08 million license holders in the country
  - Ageing population

- **Stroke/Traumatic Brain Injury (TBI)**
  - Approximately 30000 people are affected by stroke every year
  - 29% of them have visual field defect after recovering from stroke (hemianopia or quadrantanopia)
Homonymous Visual Field Loss
Swedish requirements for peripheral visual field for driving a car

Binocular Esterman screening test
Swedish requirements for central visual field for driving a car

Static threshold perimetry
(Humphrey 24-2 or equivalent)
Within 10° from fixation:
  Threshold in each corresponding test point should be 20 dB or more
Within 20° from fixation:
  Threshold in each corresponding test point should be 10 dB or more (one missing point is accepted)
The process in Sweden

- Mandatory for all physicians to report if medical requirement is not fulfilled or agree with the patient to refrain from driving (written consent)

- Swedish Transport Agency (STA) decides if requirements are fulfilled → OK, If not → revoked license
  - Agree → apply for exemption or Disagree → appeal in court 3 levels

- Apply for exemption → added evidence of fitness to drive required e.g.
  - Simulator Based Assessment
  - On-road assessment not sufficient
  - Demand for a new Simulator Based Assessment Method

- License with exemption – conditions can apply e.g. geographical restrictions (2012 – 103, 2013 – 110)
Introduction

- The ability to drive a car is one of the important aspect of a person’s independent lifestyle.

- Driving a car is a primary mode of personal transportation in developed countries.

- People with visual field defects after stroke or TBI have more limitations in driving.
Background

- European Union driving license directive states that “Driving license shall not be issued or renewed if during the medical examination, it is shown that the horizontal visual field is less than 120°, apart from exceptional cases justified by a favorable medical opinion and a positive practical test”

- In Europe, only Dutch and Belgium governments allow people with visual field defects to prove their practical fitness to drive after they had undergone a rigorous rehabilitation training.

- However, in Sweden people with visual field defect are not allowed to drive and their driving licenses are usually revoked.

- Furthermore, Swedish transport agency does not allow any on-road test for them to prove their practical fitness to drive even if they are capable to drive safely.
Literature

- De Haan et al. found that people with HVFDs also might have problems with visual scanning, steering stability, speed adaptation and anticipating environmental changes.

- Elgin et al. reported that although the drivers suffering from HVFDs received poorer ratings compared to normal drivers, they performed equally well with minor or no errors.

- Wood et al. reported that drivers with HVFDs who were rated safe to drive had greater compensatory ability by eye-head movements in their blind field, and had better vehicle control than those rated unsafe.

- Kasneci et al. also found that people with HVFDs could compensate for their deficit by effective visual scanning.
Aim

- The purpose of this project was to replicate the Dutch system in Sweden and to evaluate driving performance in participants with visual field defects after TBI in a closed circuit driving track.

- Since people with visual field defects in Sweden are not allowed to drive in traffic, the study was carried out in a closed driving circuit.

- Closed circuit track was 6 kilometer long and had a speed limit up to 70 km/h and simulated on-road driving.

- The participants completed a 10 week visual rehabilitation program for explorative saccadic training that was not related driving.
Methods

➢ Participants
  ▪ 11 participants were enrolled in this study.
  ▪ 7 males and 4 females
  ▪ Mean age: 58 ± 13.7 years (37 – 73 years)
  ▪ BCVA: 0.8 (6/7.5) or better in both eyes
  ▪ 7 participants had stroke, 3 had tumor surgery and 1 had traumatic brain injury.

➢ Visual field defect: 2 participants with hemianopia and 9 participants with quadrantanopia
  ▪ 2 with left sided homonymous hemianopia
  ▪ 2 with right sided superior quadrantanopia
  ▪ 2 with left sided superior quadrantanopia
  ▪ 3 with right sided inferior quadrantanopia
  ▪ 2 with left sided inferior quadrantanopia
Methods

- Driving License
  - All participants had a valid driving license before the onset of visual field defect.
  - Were driving regularly to work and other activities before the onset of the problem.
  - None of the participants were driving when they were recruited for this study.
  - All participants commented on the inability to drive a car even if they could because of the regulations.

- Procedure
  - Two qualified driving instructors assessed all the participants in the study.
  - The assessment procedure was randomized.
  - Participants were evaluated on a scale of 1 (poor) to 5 (excellent) on five different categories.
Categories

- **Maneuvering** of the vehicle.

- **Risk assessment** based on current road conditions.

- Knowledge of **traffic rules** in a on-road driving that was done by the instructor and the participant acted as passenger driver.

- **Scanning** of the field for potential hazards.

- Reacting to situations – **Situation awareness**
Results

**Maneuvering**

![Bar chart showing maneuvering scores for participants 1 to 11.]

**Risk Assessment**

![Bar chart showing risk assessment scores for participants 1 to 11.]

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Results

Traffic Rules

Situation Awareness

Participants

Score

Participants

Score
Results – Scanning

![Bar chart showing scanning scores for different participants.](chart.png)
Results – Summed Score

Summed score of five categories

<table>
<thead>
<tr>
<th>Participants</th>
<th>Maneuvering</th>
<th>Man/Risk/Scan</th>
<th>Scanning</th>
<th>Maneuvering</th>
<th>Scanning</th>
<th>Scanning</th>
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<tr>
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</table>
Field defect correlated with pass/fail

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/Gender</th>
<th>Driving experience (in years)</th>
<th>Ceased driving due to brain injury (in months)</th>
<th>Pass/Fail (Summed Score)</th>
<th>Visual Field Defect</th>
<th>Failed Category</th>
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<tbody>
<tr>
<td>1</td>
<td>73/F</td>
<td>55</td>
<td>10</td>
<td>Failed (15)</td>
<td>Right quadrantanopia superior</td>
<td>Maneuvering</td>
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<tr>
<td>2</td>
<td>72/M</td>
<td>54</td>
<td>15</td>
<td>Failed (12)</td>
<td>Left quadrantanopia superior</td>
<td>Maneuvering</td>
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<tr>
<td></td>
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<td></td>
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<td>Risk assessment</td>
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<td>Visual scanning</td>
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<tr>
<td>3</td>
<td>67/M</td>
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<td>4</td>
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<td>6</td>
<td>Passed (25)</td>
<td>Left quadrantanopia superior</td>
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<td>5</td>
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<td>26</td>
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<td>Passed (25)</td>
<td>Right quadrantanopia inferior</td>
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<td>50/M</td>
<td>32</td>
<td>15</td>
<td>Failed (17)</td>
<td>Right quadrantanopia Inferior</td>
<td>Visual scanning</td>
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<tr>
<td>7</td>
<td>54/F</td>
<td>36</td>
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<td>Failed (16)</td>
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<td>Maneuvering</td>
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<tr>
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<td>55/F</td>
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<td>Passed (24)</td>
<td>Right quadrantanopia superior</td>
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<td>37/M</td>
<td>19</td>
<td>16</td>
<td>Passed (20)</td>
<td>Left hemianopia</td>
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<tr>
<td>10</td>
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<td>Failed (17)</td>
<td>Left quadrantanopia inferior</td>
<td>Visual scanning</td>
</tr>
<tr>
<td>11</td>
<td>73/M</td>
<td>55</td>
<td>25</td>
<td>Failed (16)</td>
<td>Left hemianopia</td>
<td>Visual scanning</td>
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</table>
Simulator evaluation of three participants who passed closed circuit driving

<table>
<thead>
<tr>
<th>Driver</th>
<th>SYAB</th>
<th>VTI</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>44/M</td>
<td>PASS</td>
<td>PASS</td>
<td>More training with double stimuli</td>
</tr>
<tr>
<td>55/F</td>
<td>PASS</td>
<td>FAILED</td>
<td>Many mistakes due to simulator sickness</td>
</tr>
<tr>
<td>68/M</td>
<td>PASS</td>
<td>--------</td>
<td>Cancelled due to simulator sickness</td>
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</table>
Discussion

- Five (45%) out of 11 participants passed the driving test and they were adjudged as fit to drive.

- Remaining six (55%) participants failed at least in one category. Three of them failed in visual scanning, two failed in maneuvering and one failed in both the aforementioned categories as well as risk assessment.

- After completion of a rehabilitation program aimed at improving safe driving, an on-road assessment of fitness to drive should be allowed in Sweden in future.

- Study shows that the decision on practical fitness to drive cannot be based solely on the presence of visual field defect and an on-road assessment is required.
References


Thank You