

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)

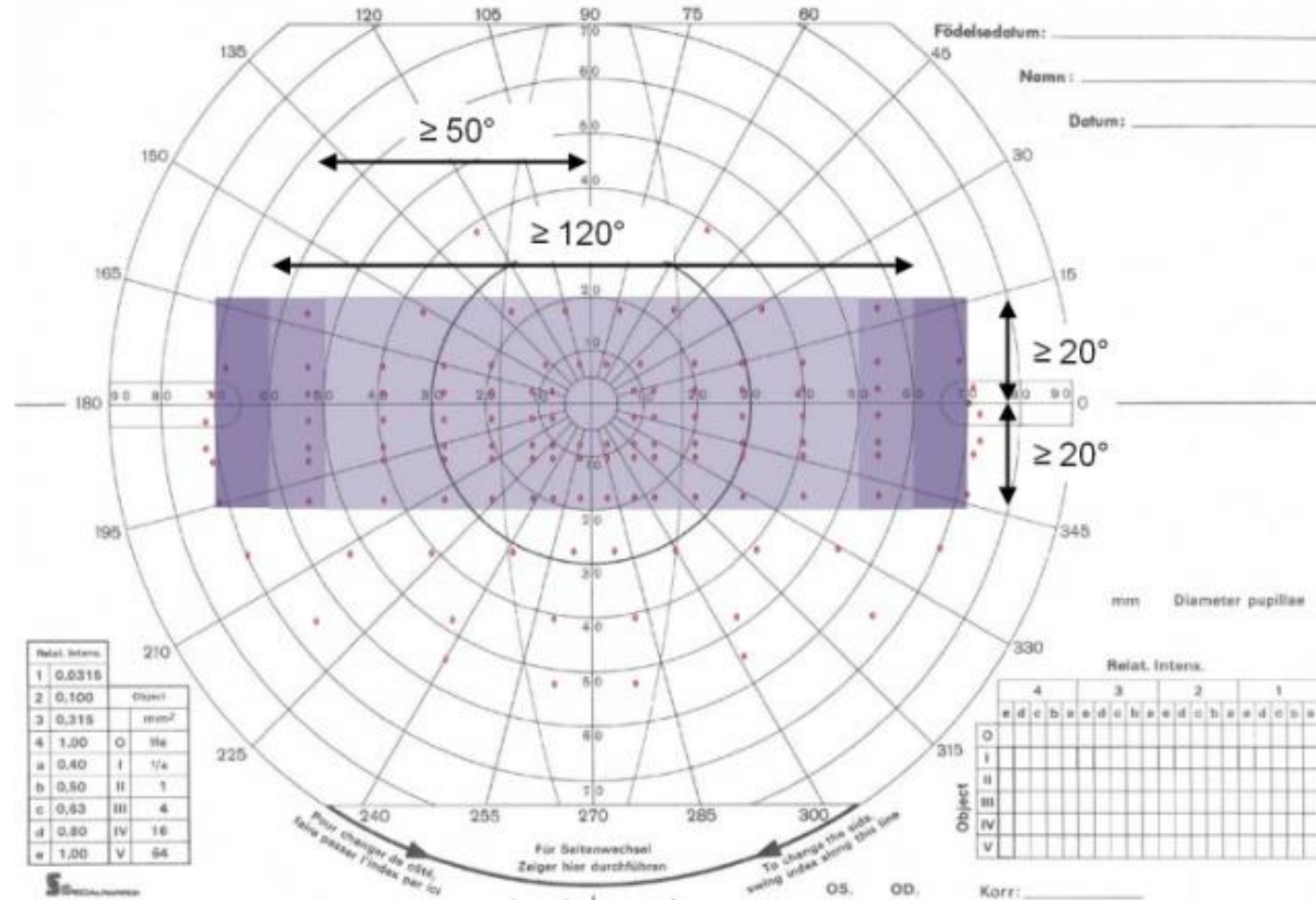
- Approximately 30000 people are affected by stroke every year
- 29% of them have visual field defect after recovering from stroke (hemianopia or quadrantanopia)



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

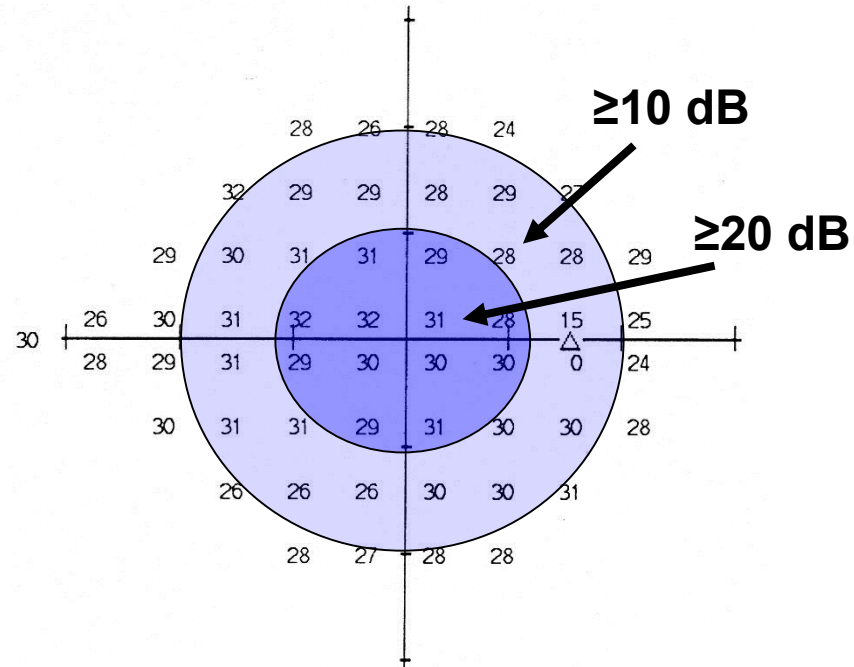
Static threshold perimetry
(Humphrey 24-2 or equivalent)

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 aspects 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

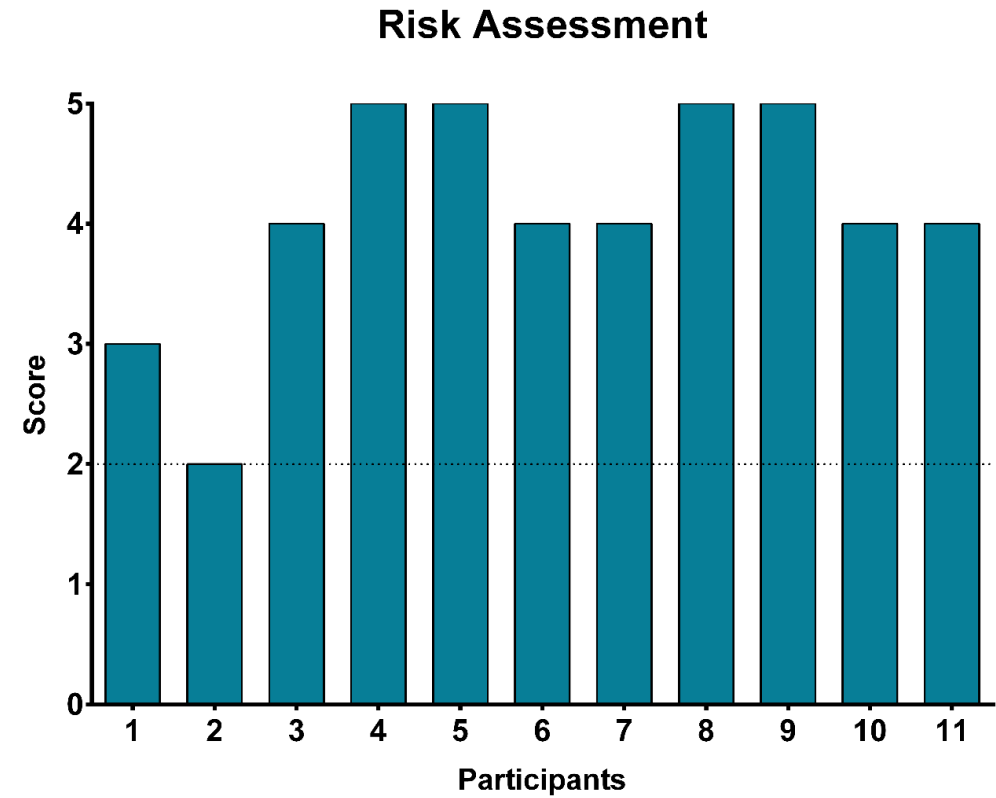
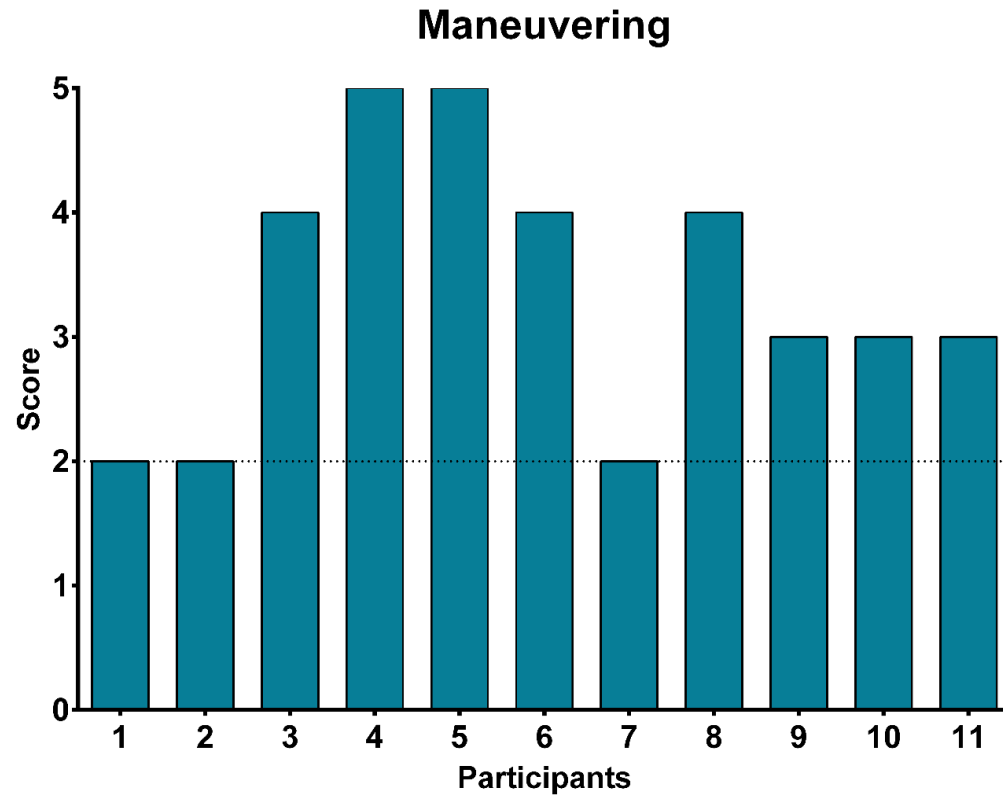
- Two qualified driving instructors assessed all the participants in the study.
- The assessment procedure was randomized.
- Participants were evaluated on a scale of 1 (poor) to 5 (excellent) on five different categories.

Categories

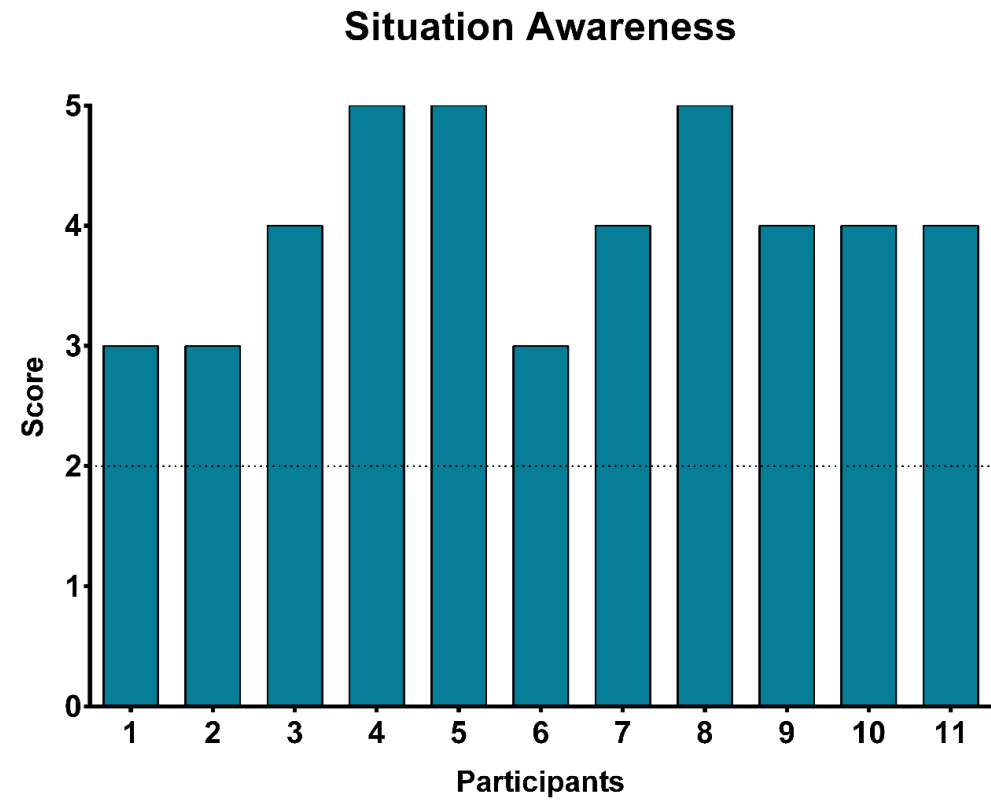
- **Maneuvering** of the vehicle.
- **Risk assessment** based on current road conditions.
- Knowledge of **traffic rules** in a on-road driving that was done by the instructor and the participant acted as passenger driver.
- **Scanning** of the field for potential hazards.
- Reacting to situations – **Situation awareness**



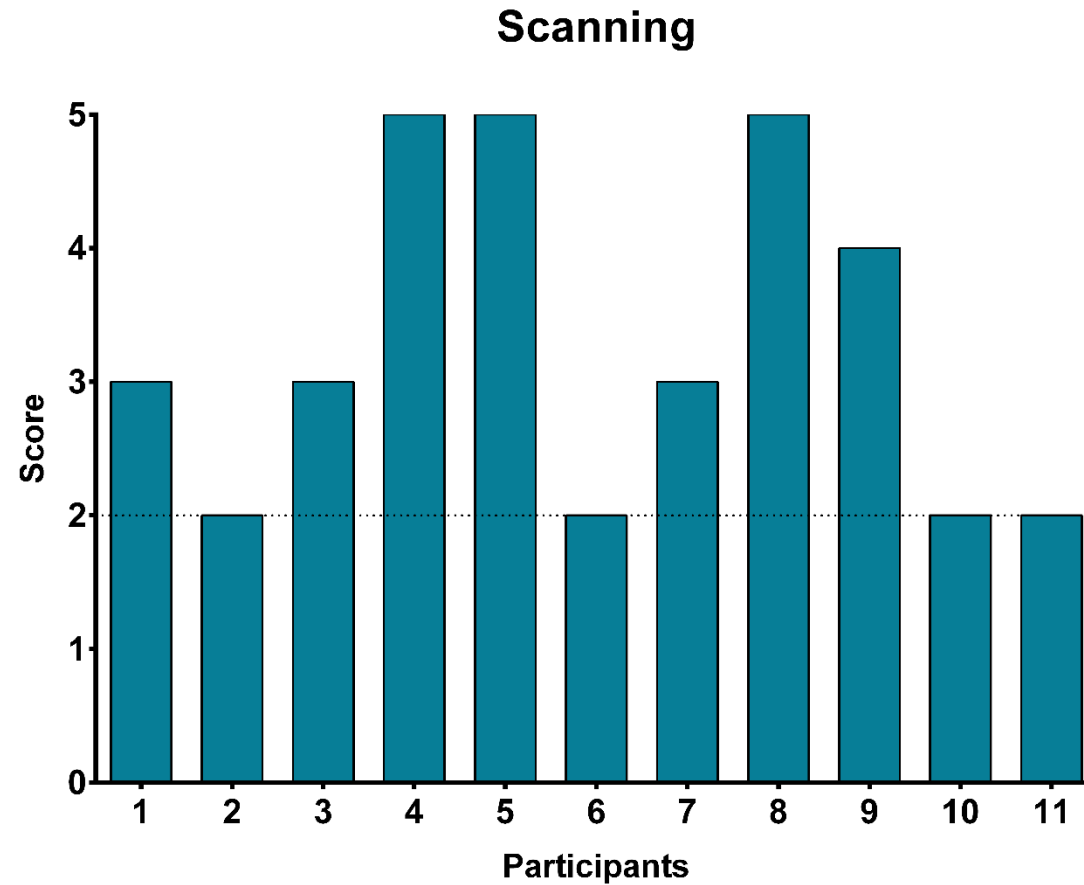
Results



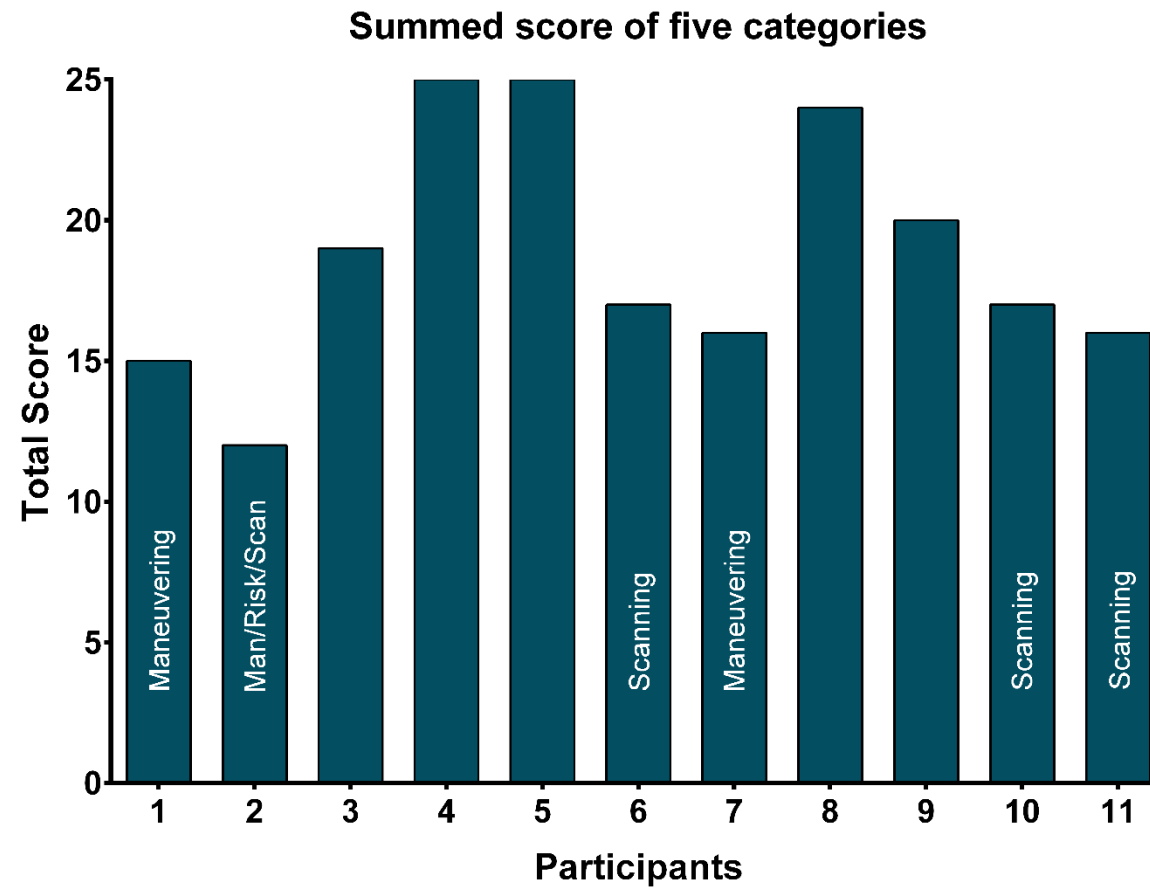
Results



Results – Scanning



Results – Summed Score



Field defect correlated with pass/fail

Patient	Age/Gender	Driving experience (in years)	Ceased driving due to brain injury (in months)	Pass/Fail (Summed Score)	Visual Field Defect	Failed Category
1	73/F	55	10	Failed (15)	Right quadrantanopia superior	Maneuvering
2	72/M	54	15	Failed (12)	Left quadrantanopia superior	Maneuvering Risk assessment Visual scanning
3	67/M	49	23	Passed (19)	Right quadrantanopia inferior	
4	41/M	23	6	Passed (25)	Left quadrantanopia superior	
5	44/M	26	9	Passed (25)	Right quadrantanopia inferior	
6	50/M	32	15	Failed (17)	Right quadrantanopia Inferior	Visual scanning
7	54/F	36	96	Failed (16)	Left quadrantanopia inferior	Maneuvering
8	55/F	37	13	Passed (24)	Right quadrantanopia superior	
9	37/M	19	16	Passed (20)	Left hemianopia	
10	71/F	53	25	Failed (17)	Left quadrantanopia inferior	Visual scanning
11	73/M	55	25	Failed (16)	Left hemianopia	Visual scanning



Simulator evaluation of three participants who passed closed circuit driving

Driver	SYAB	VTI	Comments
44/M	PASS	PASS	More training with double stimuli
55/F	PASS	FAILED	Many mistakes due to simulator sickness
68/M	PASS	-----	Cancelled due to simulator sickness

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

- de Haan GA, Melis-Dankers BJM, Brouwer WH, Bredewoud RA, Tucha O, Heutink J. *Car driving performance in hemianopia: an on-road driving study*. Invest Ophthalmol Vis Sci. 2014;55:6482–6489. DOI:10.1167/iov.14-14042.
- Hamel, J., Kraft, A., Ohl, S., De Beukelaer, S., Audebert, H.J., Brandt, S.A. *Driving Simulation in the Clinic: Testing Visual Exploratory Behavior in Daily Life Activities in Patients with Visual Field Defects*. J. Vis. Exp. (67), e4427, doi:10.3791/4427 (2012).
- Elgin, J., McGwin, G., Wood, J. M., Vaphiades, M. S., Braswell, R. A., Decarlo, D. K., et al. (2010). *Evaluation of on-road driving in people with hemianopia and quadrantanopia*. American Journal of Occupational Therapy, 64, 268–278.



Thank You

A black and white photograph of a chalkboard. The word "QUESTIONS" is written in large, white, chalky capital letters. Below the word, a large white question mark is drawn. The chalkboard has a slightly textured, dark surface.