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**Abstract:**

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**Introduction:** This section includes background information to introduce the abstract.

**Discussion:** This section outlines the purpose and intent of the abstract and it specifies what learning will be achieved.

**Conclusions:** This section highlights the implications and significance of the information.

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**Safe and independent mobility for visually impaired people**

Independent mobility is very important for social participation. This panel session focusses on rehabilitation services for motorized mobility and cycling, which includes driving personal cars, microcars, mobility scooters, mopeds and (pedal electric) bicycles. For visually impaired individuals, it is often not clear whether it is safe and responsible to use these vehicles. This feeling of doubt limits their independent mobility. This requires rehabilitation services providing evidence-based advice and training programmes.

We will start our ‘journey’ through the very interesting field of research on mobility with a presentation on the predictors of on-road driving performance in people with visual impairments. Next, we discuss the special requirements for patients with complex comorbidity due to acquired brain damage. A very important topic in this respect is the possible added value of using driving simulators in rehabilitation services. Along our ‘journey’ we will go into detail on driving personal cars, mobility scooters as well as cycling. On this trip, we will cover both visual impairment due to ocular diseases as well as visual complaints due to brain damage, including hemianopia. Please join us on this search for evidence-based information to improve safe and independent mobility for visually impaired people.

dr. Bart J.M. Melis-Dankers

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**1: Predictors of on-road driving performance in older people with visual impairment**

Alex M. Black, Joanne M. Wood

**Introduction:** Driving is important for maintaining the independence and quality of life of older people, including those with visual impairment. Importantly, driving ability involves the integration of a number of visual, sensorimotor and cognitive skills, which has implications for older people with visual impairment. The aim of this study was to evaluate how well visual, cognitive and motor tests can predict on-road driving performance in older drivers with visual impairment.

**Methods:** Participants included 234 drivers with visual impairment (mean age = 72.6 ± 7.2 years) arising from cataracts (n=55), glaucoma (n=113), age-related macular degeneration (n=45) and other retinal and neurological conditions (n=21). Participants completed a series of vision, physical and cognitive function tests. Driving exposure (distance driven in the previous year) was also recorded. On-road driving performance was assessed in a dual-brake vehicle along a 19.4 km route. Driving performance and safety was rated on a 10-point scale by a driver-trained occupational therapist who was masked to the vision status of the drivers. Univariate and stepwise multiple regression analysis identified which tests were significantly associated with driving performance.

**Results:** Univariate logistic regression models identified significant predictors of unsafe driving performance from each domain (vision, cognitive and motor). The best predictors were central motion (minimum displacement thresholds) and contrast sensitivity (Pelli-Robson test) from the vision tests, postural sway (eyes closed on foam) and Timed Up and Go (TUG) from the motor tests, and colour choice reaction time (CCRT) and Trail-Making Test part A (TMT-A) (p<0.01) from the cognitive tests. A stepwise multi-domain model using these predictors revealed significant independent contributions for motion sensitivity, sway, TMT-A, CCRT and driving exposure (full model R2=36.1%, F(1,71)=13.3, p<0.001), with sensitivity and specificity of 80% and 75%. A model including only the standard vision licensing tests (visual acuity and visual fields) had poor sensitivity and specificity of 59% and 59%.

**Discussion/Conclusion:** Driving is a complex task, and several visual, cognitive and motor tests, including novel tests of central motion sensitivity, were significantly associated with driving performance among older adults with visual impairment. However, standard vision tests included in driver licensing were not strongly predictive of driving performance. Further work is needed to refine a performance-based model for identifying unsafe driving performance in older drivers with visual impairment.

**2: Safe motorized mobility in visually impaired people with acquired brain damage**

Bart J.M. Melis-Dankers, Frank Westerhuis, Joost Heutink, Dick de Waard

**Introduction:** Royal Dutch Visio is a Centre of Expertise for blind and partially sighted people that offers rehabilitation services at multiple locations across the Netherlands. Training and advice with regard to safe and independent mobility is one of our main services. Twenty years ago, Visio started the rehabilitation programme *AutO&Mobility* which focusses on participation of visually impaired people in motorised traffic, including private cars, minicars, mobility scooters, (pedal electric) bicycles and agricultural vehicles. In the last 10 years, we have seen a vast increase of patients with relatively good vision who experience non-specific visual complaints due to acquired brain damage (ABI) and neurological disease (e.g. stroke, multiple sclerosis, Parkinson’s disease or dementia). Although these patients may formally fulfil the legal visual requirements for medical fitness to drive with respect to visual field and visual acuity, the visual problems they experience (e.g. blurry vision, glare, light adaptation problems, reduced visual attention) may hinder safe traffic participation in a motorised vehicle.

**Methods**: By the rehabilitation programme *AutO&Mobility* Visio offers a one-stop service model for visually impaired patients who require advice with respect to motorised traffic participation. This programme is based on a model of strategical, tactical and operational driving tasks. Patients receive extensive visual function assessment (90 min), observation of practical orientation and mobility (90 min) and neuropsychological screening (45 min). Finally, based on the results, they directly get tailored individual advice (60 min) with respect to their personal mobility options, legal situation, own responsibility, training options and alternative transport modalities. This service is part of the national health care system.

**Results**: We extended the *AutO&Mobility* service by including patients with visual complaints due to ABI and neurological disease. Together with the Dutch National Driving Licence Authority (CBR) and the University of Groningen, we introduced a referral protocol for ophthalmologists, neurologists and medical specialists for the elderly. In addition, we developed a tablet-based screening protocol for neuro-psychological testing (DiaNAH) and we trained rehabilitation specialists (e.g. optometrists, occupational therapists, driving instructors, driving examiners) to deliver the required services. Nowadays roughly 35% of the patients who are referred to the *AutO&Mobility* rehabilitation programme have complex comorbidity.

**Discussion/Conclusion:** Delivering advice with respect to safe and independent traffic participation in motorised vehicles for visually impaired people with acquired brain damage requires a holistic and interdisciplinary approach and a protocolled rehabilitation service.

**3: Driving simulation to provide mobility advice for visually impaired people**

Frank Westerhuis, Bart Melis-Dankers, Joost Heutink, Dick de Waard

**Introduction:** Safe and independent mobility is crucial for everyone, although it should not be taken for granted for visually impaired people. For this reason, Royal Dutch Visio provides personal advice concerning safe mobility of visually impaired people. This is based on scientific research together with the University of Groningen and the Dutch Driving Licence Authority (CBR). Being able to give this advice is becoming more complicated because an increased number of visually impaired people has additional impairments (i.e. complex comorbidity). In some cases, the original test procedures do not provide sufficient information for conclusive final advice, in particular if atypical behaviour is observed that can compromise traffic safety while test results do not provide evidence for severe impairment that prohibits driving. In practice, this has led to a desire for additional assessment methods in a safe and realistic driving setting.

**Methods**: It was investigated whether a driving simulator is useful to provide information about individual driving behaviour of people with visual and cognitive or motor impairments. A new simulator scenario was developed, specifically aimed at the assessment of viewing behaviour. In this virtual world, the driver is asked to drive towards a specific destination following road signs. Safe driving and risk-taking are measured by means of successfully following the route, decision making in busy traffic, negotiating an intersection with cyclists coming from multiple directions, driving on narrow roads, and avoiding objects on or near the road. These measures were complemented by vehicle control level measurements such as driving speed, position on the road, and amount of swerving.

**Results:** Nine participants drove five scenarios in a driving simulator, including this new scenario. Apart from visual complaints, these participants also reported problems with attention, concentration, fatigue, information processing speed, memory, and sensory overload. Each participant was observed and simulator parameters were compared with normative scores.

**Discussion & Conclusion**: The driving simulator can provide a safe environment in which people can use their driving skills and demonstrate to what extent they can compensate for their impairments while driving. Normative scores were used to screen for problem areas, although the practitioner’s observations of the driver’s behaviour should be leading. Simulator data should be interpreted as part of an interdisciplinary assessment consisting of visual, observational, and neuropsychological assessments, consisting of visual, observational, and neuropsychological assessments. A driving simulator can be useful to provide additional information for giving mobility advice to visually impaired people with complex comorbidity.

**4: Driving with visual field defects in Sweden: Chance to Dispensation**

**Krister Inde, Linnaeus University, Kalmar, Sweden**

**Introduction: In 2013 we started the SMS Project in order to develop methods for training of hemianopia due to stroke (supported by the Swedish Heritage Fund). In 2015 the results were presented in collaboration with the Linnaeus University in Kalmar, The Swedish National Road and Transport Research Institute VTI and the advanced driving school SYAB. Five out of 11 persons passed driving tests in a closed circuit track. A full program for training in six categories of vision problems due to visual field defects (VFD) has been implemented in stroke and vision rehabilitation. In 2018 we continued developing training and testing of driving skills in persons with VFD due to glaucoma, stroke and diabetic retinopathy. Sweden does not follow the EU Directive of permitting driving tests and makes judgements only from Esterman and Humphrey perimetry with very strict definition of pass and fail after mandatory reports from ophthalmologists.**

**Method: Chance for Dispensation (CTD) has trained and tested 19 subjects with explorative saccadic training (EST) for 6-8 weeks at home, driving training for four days and testing in a closed circuit track, followed by testing in an advanced simulator. The whole program lasted for five months during spring 2019.**

**Results: Judging from both driving and simulator tests we found that 14 out of 19 participants passed and should receive dispensation from the Swedish Transport Agency. However, their applications have not yet been handled (January 2020). Six persons had normal saccadic movements (EST) and another three received normal eye movements after training. Out of nine persons with normal EST eight passed the driving tests. The five persons who failed the tests in the simulator were older, had larger VFD and had multiple problems due to diagnosis or other health features. A book and a film have been published (see:** [**www.ctdkalmar.se**](http://www.ctdkalmar.se)**).**

**Discussion/Conclusion: From an earlier project VTI found that 221 persons out of 340 passed simulator tests without training. In our project 14 out of 19 persons passed the same tests. This suggests that training could have a positive effect on safe driving. Having one’s driving licence revoked is hard to accept, especially if it is done by only judging a visual field test. The Swedish rules are in that respect unfair and should be changed and relate to the EU Directive where driving tests are recommended.**

**5: Application of the capability approach to low vision users of mobility scooters.**

Mary Butler, Keri McMullan

**Introduction**: Visual impairment is the primary reason for people losing their driving licence and the use of mobility scooters is a solution used by some enterprising individuals. Mobility scooters are a ‘frontier’ technology that exists in a liminal space in the transport continuum. There is ambivalence about whether mobility scooters help or hinder users (Thoreau, 2015) and barriers on the pavements make it difficult for occupational therapists who want to prescribe their use (Maywald and Stanley, 2015; McMullan and Butler, 2019). These tensions are exacerbated by negativity on the part of the public and general disregard by urban and transport planners. This paper explores how people with low vision use mobility scooters to enhance capabilities, in the context of these tensions and barriers.

**Methods**: An interpretive description method was used. Fifteen participants with low vision were recruited around New Zealand using purposive sampling. Data collection started with a ‘go-along’ and a sit-down interview followed this in the participant’s home. Secondary analysis of transcripts used the Qualitative Analysis Guide of Leuven.

**Results**: Low vision mobility scooter users draw on a variety of self-regulation methods including the use of ‘positive risk-taking’ as a strategy to balance multiple capabilities. They answer questions about what they are really able to do in this context; they also answer questions about the kind of person that they feel that they are able to be.

**Discussion & Conclusion**: The loss of transport mobility can result in a catastrophic loss of capabilities for many older individuals. It is, therefore instructive to understand the capabilities that are retained by individuals with visual impairment who integrate the mobility scooter into their ongoing mobility needs. The capabilities that are elucidated in this way can inform the current debate about the pavement as a civic space; accessibility and universal design; understanding of decision-making and self-regulation; community mobility; ways of understanding the influence of visual impairment on general function; highlighting the value of ongoing mobility and the known risks. A nuanced understanding of the capabilities expressed by people with visual impairment using mobility scooters is important for training health professionals and opening up possibilities of mobility justice for new users.

**6: Naturalistic Cycling with Low Vision**

Bart Jelijs, Joost Heutink, Dick de Waard, Karel Brookhuis, Bart Melis-Dankers.

**Introduction**: Bicycling for daily transport is being promoted around the world, e.g. for sustainability and health reasons. For people with visual function impairments, cycling may strongly contribute to independent mobility and social participation, particularly to those who are not allowed to drive a passenger car. It is, however, unclear how visually impaired people adapt their riding behaviour in natural settings to cope with their vision-related cycling difficulties. The present study aimed to obtain insight into whether visually impaired cyclists adjust their speed downward, for example to generate more time when overviewing traffic and anticipating accordingly. Mobility instructors of vision rehabilitation centres can use this information when advising visually impaired people who wish to cycle independently.

**Methods**: Nineteen pairs of cyclists (aged 50+ years) each consisting of a visually impaired cyclist and a normally sighted peer from the same neighbourhood (control) participated in our study. All individuals cycled their own naturalistic routes for one week in their natural environment. Cycling speed and distance were registered using a GPS camera, which was mounted on each participant’s own bicycle at the start of the week. In addition, we measured binocular visual acuity, visual field and contrast sensitivity.

**Results**: Based on the preliminary results, visually impaired cyclists maintained a significantly lower preferred cycling speed (*M* = 14.6 km/h) than the normally sighted controls (*M* = 16.1 km/h) when cycling without a companion. Additionally, the proportion of speed samples below 10 km/h was significantly larger in the visually impaired cyclists (16%) compared to the normally sighted controls (10%).

**Conclusion**: The results indicate that maintaining a conservative speed may help visually impaired people when cycling independently in their natural environment.