Driving slow motorised vehicles with visual impairment

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"The only lightless dark is the night of ignorance and insensibility. We differ, blind and seeing, one from another, not in our senses, but in the use we make of them, in the imagination and courage with which we seek wisdom beyond our senses."

Helen Keller
Independent mobility is a highly valued part of life and has a great effect on an individual’s perceived quality of life. Limitations in mobility can therefore have an impact on one’s well-being leading to social isolation (e.g., Williams & Willmott, 2012) depression (e.g., Ragland, Satariano, & MacLeod, 2005), and a feeling of lower self-esteem (e.g., Carp, 1988). Especially for the elderly generation, maintaining independent mobility gets challenging, since physical and mental health can decline with increasing age. Many elderly people are very reluctant to give up driving as they want to maintain their independence. Even where public transport is widely available, the use of it is associated with a number of disadvantages (Golledge, Marston, & Costanzo, 1997). Public transport might not always be accessible or might be incompatible with people’s time schedules and often does not cover people’s intended destinations. Furthermore, people may have to cover additional distances to be able to make use of public transport (e.g., distance to a bus stop) which could be a hindrance for those who are less mobile.

One factor that can markedly restrict mobility is impaired vision. Alongside the normal processes of visual function deterioration that accompany aging, the prevalence of visual impairments resulting from eye as well as brain pathologies is increasing in the elderly population. According to the World Health Organization (WHO, 2017), approximately 253 million people suffer from visual impairment worldwide, of which 81% are aged 50 years and above. A study by Lopez et al. (2011) showed that visually impaired elderly have an increased risk of falling and being injured, which can lead to reduced mobility in daily life. In addition, the legal visual requirements for driving licenses contribute to reducing the independent mobility of the visually impaired. The European Directive (2015) demands a binocular visual acuity of at least 0.5 and a horizontal visual field of at least 120 degrees for group 1 driving licences (includes cars and motorcycles). A number of authors consider these guidelines as inadequate since they can potentially exclude from car driving visually impaired people who would be practically fit to drive1 (Owsley, 2010; Owsley & McGwin Jr., 2010; Shinar & Schieber, 1991). Since cars represent the main mode of transportation in Western countries, the revoking of one’s driving licence can lead to a severe decline in independent mobility and consequently independent living. It must be realised, however, that legal visual standards have been introduced to ensure the safety of drivers and other traffic participants. Finding a balance

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1 Fitness to drive is the ability to drive safely and fluently, despite impairments caused by disease and ageing, and when necessary, applying compensation in form of behavioural adaptations and/or auxiliary devices (Brouwer & Ponds, 1994).
between protecting the safety of traffic participants while supporting independent mobility is therefore an important challenge.

In contrast to car traffic, there are no or only very limited legal visual standards for the use of slow motorised vehicles in most countries. In this thesis, slow motorised vehicles are defined as the class of motor vehicles with a speed limit of 45 km/h (28 mph) and include for example microcars, mopeds, or invalid carriages (e.g., “Cantas” and mobility scooters). The absence of legal visual standards opens opportunities for visually impaired people who require a motorised vehicle for their everyday activities (e.g., living in rural areas and needing a vehicle to go food shopping) and those who depend on their mobility scooter due to motor impairment. A number of studies have demonstrated the value of mobility scooters. More specifically, mobility scooter users reported an increased feeling of independency and showed increased (social) participation in daily activities (e.g., shopping, visiting friends and family, going for a ride) and improved health (Edwards & McCluskey, 2010; Jedeloo, De Witte & Schrijvers, 2002; Löfqvist, Pettersson, Iwarsson, & Brandt, 2012; May, Garrett, & Ballantyne, 2010; Mortenson et al., 2006; Thoreau, 2015). Yet, it is important that traffic safety is warranted to protect both other traffic participants and the visually impaired users themselves. Edwards et al. (2010), for example, stated that 21% of the Australian mobility scooter and power wheelchair users participating in the study reported being involved in an accident in the previous year. Due to the relatively older age and increased fragility of the mobility users and the fact that vehicles such as the mobility scooters are open vehicles and offer less protection, accidents can have severe consequences (Leijdesdorff, Dijck, & Krijnen, 2014; SVOW, 2012).

In the Netherlands, there are no medical regulations with regard to fitness to drive slow motorised vehicles. Following article 5 of the Dutch traffic law, road users themselves are responsible for safe traffic participation. However, article 5 is rather broadly formulated. Therefore, it can be observed that there are still many questions and constraints with regard to the use of these vehicles. A driving licence or a mandatory driving examination is not necessary for individuals who wish to drive mobility scooters. Users as well as rehabilitation professionals, insurance companies or governmental scooter allocators are often unsure about the visually impaired users’ abilities to participate traffic safely using these vehicles. A survey

2 The Dutch traffic law states that “It is prohibited to behave in such a way that dangerous traffic situation are or can be caused or that traffic is or can be hindered.” (Article 5, Dutch Road Traffic Act 1994)
answered by professionals dealing with slow motorised vehicles (Healthcare & Science, Municipalities, Private Organisations) revealed that 35% had difficulties with assessing their clients’ abilities (associated with the professional’s feeling of responsibility) and 33% felt they did not have the necessary tests to execute such assessments (De Hoog, 2013). The participants of this survey agreed that visual, cognitive, and motor functions play an important role when it comes to driving safety, however, no specification was given of which precise factors they deem important for determining practical fitness to drive. In contrast to car traffic, there is little evidence-based knowledge available about the physical and mental requirements to drive slow motorised vehicles safely and research on this topic is scarce. Therefore, the goals of this thesis is to investigate driving safety in slow motorised vehicles in people with various visual impairments. More specifically, visual and cognitive factors that might influence safe traffic participation in these vehicles will be explored in a number of different experiments. Focus will be on mobility scooters and microcars, since these vehicles are most common in rehabilitative practices and cover both the upper and the lower limits of the possible speeds of slow motorised vehicles (5-45 km/h).

This thesis is part of the project Mobility4All: Slow motorised traffic for visually impaired people that was established at Royal Dutch Visio, Centre of Expertise for blind and partially sighted people, and executed in collaboration with the University of Groningen, the Netherlands. Mobility4All is subsidised by ZonMW (project number: 94309004). As part of the project Mobility4All, more information on slow motorised vehicles has already introduced to the rehabilitation programme at Royal Dutch Visio. Furthermore, more explicit attention has been given to client’s questions about slow motorised traffic to ease implementation of the outcomes at a later stage. In addition, a knowledge network for professionals working in different sectors with slow motorised vehicles (“Kennisnetwerk Langzaam Gemotoriseerd Verkeer, [KNLGV]”; e.g., municipalities, insurance companies, mobility scooter allocators) was established to discuss and share knowledge on important matters on this topic. This network was subsidised by the Novum Foundation (Stichting Novum).

This first Chapter functions as a general introduction to set a framework for the research reported in the following chapters and to introduce the concepts used throughout this thesis. Chapter 2 gives an overview of the design and the set-up of this research project and will describe the sample and the general methods.
In **Chapters 3** and **4**, the results of an on-road mobility scooter driving test will be discussed in terms of either driving ability/training or practical fitness to drive respectively. Chapter 5 presents the outcomes of several driving tasks in a mobility scooter and microcar driving simulator. The validity of these simulated driving tasks will be explored in **Chapter 6. Chapter 7** deals with the influence of cognitive impairment on driving performance and **Chapter 8** provides a general discussion, practical implications of this project and suggestions for future research.

![Figure 1.1. Mobility Scooter, Canta, Microcar (from left to right)](image)

**Mobility scooters**

Mobility scooters belong to the class of invalid carriages and are official mobility aids intended to support independent mobility for those with motor or cardiovascular impairments (see Table 1.1 for more information). Thus, individuals with visual impairment usually do not use these vehicles because of their visual impairments, but because of additional physical impairments. Although the exact numbers are unknown, the number of mobility scooters has grown over the past years (Research Institute for Consumer Affairs, 2014). Over 90% of the users is between 60 and 82 years old. The UK and the Netherlands are mentioned as the countries with the most mobility scooters in Europe with about 200,000 – 300,000 vehicles per country.

In the UK, the term invalid carriage is an umbrella term for different classes of mobility scooters and electric wheelchairs (UK Government, n.d.). In the Netherlands, another form of invalid carriage, known as a Canta, exists. In contrast to mobility scooters, Cantas are covered, have a maximum speed of 45km/h. Although they only have a width of 1.10m, they are often mistaken for microcars.
They are especially designed for people with (motor) impairment and are usually adapted to an individual's need and wishes (e.g., access via the rear of the vehicle for wheelchair users). Although this thesis will not directly discuss Cantas, findings will most likely be also applicable to these vehicles, since Cantas are similar to both mobility scooters (in terms of legal regulations) and microcars (in terms of physical capacity, e.g., speed). For this reason, Cantas are also briefly discussed in this section.

In 2017, 25 fatal accidents were registered involving users of invalid carriages in the Netherlands (Statistics Netherlands, 2018). In 2016, 2,700 people were reported to need emergency treatment after being involved in an accident with their mobility scooter (Van Rijn, 2016). Causes of the accidents were diverse and included, for example, road condition, mobility scooter stability, or the user’s driving ability. More specifically, in a report by Poort, den Hertog, Draisma, & Klein Wolt (2012), accidents were described to be caused by uneven surfaces resulting in the mobility scooter to tip, by other traffic participants colliding with the mobility scooter user, by collision of the mobility scooter user him/herself with an obstacle, or by incorrect operation of the mobility scooter (e.g., pushing the wrong lever by accident, intending to brake but accidentally accelerating, steering faults). Van Baalen & Boerwinkel (2011) reported that most difficulties were caused by the absence of an active brake and the different speed settings. In general, it is not known if and how visual impairment contribute to accidents.

Microcars

Microcars, light quadricycles, or light weight vehicles are small cars with a maximum speed of 45km/h and make up 1.1 % of the EU-defined category L (2- and 3-wheel vehicles and quadricycles; European Commission, 2010). Legally, microcars belong to the group of mopeds and therefore the traffic rules for mopeds apply. In contrast to mobility scooters and Cantas, a driving licence is necessary for these vehicles (Table 1.1). In 2017, there were 19,757 microcars (1 per 1000 inhabitants) registered in the Netherlands (Statistics Netherlands, 2017a), showing in increase of 20% since 2007. Other than mobility scooters, microcars are often used as an alternative by visually impaired people who had to give up their car driving licence due to their impairment. Thus, microcars play an important role for independent mobility for visually impaired people.

In 2016, 44 accidents involving microcars and mopeds were registered in
the Netherlands (Statistics Netherlands, 2017b). According to the Consumer Safety Commission (2008), accidents in microcars had a similar fatality rate (6.9%) compared to other vehicles (6.3%). In contrast, other risk assessment studies from Austria and Germany showed that the number of fatal accidents was much higher in microcars compared to regular cars due to the light weight of the vehicles and it was concluded that microcars are less safe compared to cars (Gwehenberger, J. Reinkemeyer & Kühn, 2008; Kühn, 2009).

Research on fitness to drive in slow motorised traffic

Driving is a complex task and driving safety is influenced by many different factors. Driving safety will be discussed from three different perspectives: driving behaviour, driving skill, and (medical and practical) fitness to drive (Brouwer, 2015).

**Driving behaviour** refers to observed everyday driving, including habits such as driving during rush hour, driving slightly faster than speed limits, never combining drinking and driving etc.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Description</th>
<th>Max. speed</th>
<th>Licence</th>
<th>Traffic rules</th>
<th>Other regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility Scooter</td>
<td>Official motorised mobility aid for people with mobility problems</td>
<td>8-25km/h</td>
<td>Nonea</td>
<td>Regulations depend on individual countries</td>
<td>Minimum age above a certain speed limit</td>
</tr>
<tr>
<td></td>
<td>Open vehicle</td>
<td></td>
<td></td>
<td>Usually free choice of way (allowed on pavements, bicycle lanes, and roads)</td>
<td>Driving tests not required</td>
</tr>
<tr>
<td></td>
<td>Max. width 1.10m</td>
<td></td>
<td></td>
<td>Speed has to be adapted to speed of particular road users, e.g., maximum speed on sidewalk: 6km/h (Germany, the Netherlands, UK)</td>
<td>Some institutions offer training</td>
</tr>
<tr>
<td></td>
<td>Three, four, or five wheels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Usually battery powered</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used indoors and outdoors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can be adapted to the needs of users (e.g., steering tiller)</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

a Germany: > 15km/h driving licence AM
Driving behaviour can be directly observed, in principle. A very crude direct measure is crash involvement and a more sophisticated direct measure is continuous monitoring of driving behaviour by camera systems, motion detectors and computer subsystems built into cars (“naturalistic driving”). More often, driving behaviour is measured indirectly with questionnaires.

Driving skill indicates how well a person can safely and smoothly manoeuvre a vehicle in various road and traffic conditions according to traffic rules. It involves the procedural and declarative knowledge of driving, is learned in driving lessons and is further enhanced with driving experience. Driving skill is usually assessed in a representative driving test, when a person attempts to perform at maximal level and where candidates know they are being assessed. This distinguishes driving skill from driving behaviour, which is assessed in natural conditions, when there is no incentive to perform as safe and agile as possible. Medical fitness to drive concerns the physical disposition, including inborn abilities and acquired impairments caused by disease.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Description</th>
<th>Max. speed</th>
<th>Licence</th>
<th>Traffic rules</th>
<th>Other regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canta</td>
<td>Official motorised mobility aid for people with mobility problems</td>
<td>45 km/h</td>
<td>None</td>
<td>Free choice of way (allowed to drive on pavements, bicycle lanes, and roads)</td>
<td>Min. age: 16 (&gt; 10km/h in the Netherlands)</td>
</tr>
<tr>
<td></td>
<td>Closed vehicle</td>
<td></td>
<td></td>
<td>Max. speed on sidewalk: 6km/h</td>
<td>Driving tests not required</td>
</tr>
<tr>
<td></td>
<td>Max. width 1.10m</td>
<td></td>
<td></td>
<td>Not allowed on motorways</td>
<td>Some institutions offer training</td>
</tr>
<tr>
<td></td>
<td>Four wheels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mostly used in the Netherlands</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can be adapted to the needs of users (e.g., for wheelchair users)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microcar</td>
<td>Four wheels</td>
<td>45km/h</td>
<td>AM4</td>
<td>Only allowed on the road</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. weight of 350kg excluding the mass of batteries in electric versions</td>
<td></td>
<td></td>
<td>Follows rules of car traffic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engine capacity of less than 50cm³ or max. power of 4kW</td>
<td></td>
<td></td>
<td>Not allowed on motorways</td>
<td></td>
</tr>
</tbody>
</table>

Germany: > 15km/h driving licence AM
and aging, that allow the acquisition and maintenance of safe smooth driving. Regulations have been made with regard to various medical conditions that can have significant effects on visual perception, sustained attention, reaction speed, and critical sense.

However, these regulations often do not take the possibility of compensation into account. To a certain extent, people are able to compensate for impaired fitness to drive. For example, someone who has difficulties with complex intersections could plan ahead and choose a route that does not contain such complexity. The model described in the following indicates how people with impairment could integrate compensational strategies to be able to drive safely despite their impairment.

Michon (1985) proposed a hierarchical model of driving, dividing the driving task into three levels: the strategic, the tactical and the operational level. The **strategic level** involves the planning and preparing of the drive whereas the **tactical level** includes manoeuvring of the vehicle, such as anticipation, adjusting speed, distance to other traffic and taking into account their possible future actions. If a car in front suddenly brakes, a crash can be avoided easily when a safe following distance is maintained. But tactical driving skill is not just driving slowly or keeping distance. It is important that speed and position are adapted to the road and traffic situation. Very large following distances and very low cruising speeds can also indicate poor driving skill on a tactical level, not properly anticipating other drivers’ reactions. **Operational aspects** concern control of the steering wheel, controls and pedals in relation to the changing road and traffic situations.

Driving behaviour is related to the strategic level of driving in so far as it includes the planning of a drive, such as choosing the route, and time of the day. It is also related to the tactical level in the choice of preferred cruising speed, following distance etc. Driving skill is linked to both the operational and tactical levels of driving.

The strategic and tactical level in particular are suitable levels to employ compensation effectively, since these two level allow more time to react in a particular situation compared to the operational level. Whereas there might be relatively little time for visually impaired people to react on the operational level (action is required instantly, milliseconds), there is a little more time available on the tactical level (seconds) and even much more time on the strategic level (hours, days). Avoiding the rush hour or night time whilst planning a drive or
keeping a safe distance from other traffic participants, for example, can decrease exposure to challenging situations and add more time to react in case of a hazard. Traditionally, regulations on medical fitness to drive did not take into account the opportunities that drivers have on the tactical and strategic level to adjust driving behaviour, and for driving skill to compensate for the impairments, including the use of technology. In the last 50 years it has been shown in scientific studies that many drivers with significant impairments in visual functions, visual perception, and reaction speed could nevertheless be safe and fluent drivers (e.g., Brouwer & Witvaar, 1997; De Haan et al., 2014; Lundqvist & Alinder, 2007; Melis-Dankers et al., 2008; Owsley, 2011; Tant, Brouwer, Cornelissen, & Kooijman, 2002; Van Zomeren, Brouwer, & Minderhoud, 1987; Wadley et al., 2009). In response to that, the new concept of \textit{practical fitness to drive} has been included in the regulations. Drivers that do not meet the medical requirements for driving have the safety and fluency of their driving skill assessed in a special on-road test, even in the case of significant visual and cognitive limitations. During that assessment they are expected to use and demonstrate the compensations (behavioural, tactical and technological) they have learned to use. Practical fitness to drive thus refers to driving skill and driving behaviour adapted in such a way that the impairments are sufficiently compensated, and resulting in safe and smooth driving.

Whereas fitness to drive is well studied in car driving, very few studies address the concept in slow motorised traffic (see a depiction of the existing studies below). Most literature on slow motorised traffic is descriptive or focuses on training programmes for mobility scooters or electric wheelchairs (Erren-Wolters, van Dijk, de Kort, Ijzerman, & Jannink, 2007; Hasdai, Jessel, & Weiss, 1998; Jannink, Erren-Wolters, de Kort, & van der Kooij, 2008) and on the development of driving assessments (Dawson, Kaiserman-Goldenstein, Chan, & Gleason, 1995; Letts, Dawson, & Kaiserman-Goldenstein, 1998). The importance of visual and cognitive factors is generally highlighted when determining eligibility to drive slow motorised vehicles (De Hoog, 2013; Mortenson et al., 2005), but the influence of these factors on safe driving performance has not been shown yet, and neither have the opportunities for compensation.

**Visual functions**

Very few studies have looked at the relationship between visual functions and driving performance in mobility scooters. Therefore, also literature describing driving safety
in electric wheelchairs are considered. Massengale, Folden, McConnell, Stratton, & Whitehead (2005) studied the effect of visual acuity, ocular motor functions (pursuits and saccades), stereo depth vision, field of vision, binocularity, and colour vision on power wheelchair driving performance measured by the Power Mobility Road Test (PMRT). The PMRT consists of a structured part, such as performing several driving manoeuvres, and an unstructured part, in which participants have to react to unexpected occurrences. Performance was measured on a 4 point scale, with 4 equivalent to optimal performance and 1 indicating that the element could not be completed. Sixty-one adults using a joystick operated wheelchair for a minimum period of three months and with a minimal visual acuity of 0.1 were included. The authors found that ocular motor functions (medium to large effect), field of vision (medium effect), stereodepth perception (medium effect), and far binocular vision (medium effect) had a significant correlation with driving performance. Furthermore, near visual acuity (medium effect), stereodepth perception (medium effect), far binocular vision (medium effect), ocular motor functions (medium to large effect) and visual field (large effect) correlated significantly with the time required to complete the PMRT. Colour vision did not affect driving performance.

Another study by Letts et al. (2007) examined the visual field of 34 adult drivers of power mobility devices using the confrontational method\(^3\) as part of their validation process for the Power-Mobility Community Driving Assessment (PCDA). The PCDA was developed as a tool to assess adults’ driving performance in powered mobility devices and to identify further training necessities. The authors stressed, however, that the PCDA is not a test to determine fitness to drive. Instead, improving mobility through identifying difficulties and training them was emphasised. With regard to visual field assessment, no relationship between visual field size and PCDA score could be found.

In contrast to Letts et al. (2007), Nitz (2008) developed an instrument to actually determine the skills that are necessary to safely drive mobility scooters. The driver’s competency test includes an obstacle course comprising a number of unexpected elements and an unstructured part on the road. Fifty adults with no prior mobility scooter driving experience completed the test. Visual acuity in a high and a low contrast condition was assessed, but was not correlated with driving performance.

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\(^3\) A quick method without the use of equipment to detect peripheral visual field defects. The individual to be assessed fixates centrally whereas the examiner stands opposite the subject at approximately 1 meter distance and moves their hands in and out of a patient’s visual field to find the extensions of the visual field.
as measured by the driver’s competency test.

As described above, attempts have been made to identify visual functions and impairment that might be important for slow motorised driving safety. Yet, research is still scarce and studies vary widely in experimental design which makes them difficult to compare and therefore to draw robust conclusions. There is thus a need for more experimental studies that investigate the effect of visual functions and impairment in a controlled way.

Cognitive functions

Apart from looking at visual functions, a number of the studies described above also attempted to determine the cognitive functions thought to be relevant for traffic safety in slow motorised vehicles. Massengale et al. (2005) included several cognitive measures which they linked to power wheelchair driving performance as assessed by the PMRT. Specifically, they included the revised Motor Free Visual Perception Test (MVPR-R; spatial relationships, visual discrimination, figure-ground perception, visual closure, and visual memory), the Test of Nonverbal Intelligence (TONI-3; problem solving, abstract reasoning, aptitude, and intelligence), and the revised Wechsler Adult Intelligence scale (WAIS-R; subtests: Digit Span, Comprehension, and Picture Completion). Sixty-one adults performed these tests. The authors showed that wheelchair driving performance was significantly correlated to all cognitive measures applied, with strengths of the relationships varying from low to moderate. Visual perception (MVPT-R; r = 0.591), Picture Completion (WAIS; r = 0.418), and TONI-3 (r = 0.392) showed the strongest relationships. Likewise, all measures were significantly correlated to the average time participants needed to complete the PMRT. Again, visual perception (r = -0.707) and picture completion (r = -0.418) showed the strongest correlation, suggesting that visual cognitive abilities as well as getting an overview of a visual scene are associated with a better use of powered wheelchairs.

In their study on intensity and duration of powered mobility training to ensure safe use of slow motorised vehicles, Hall, Partnoy, Tenenbaum, & Dawson (2005) looked at the relationship between general cognitive functioning and visual neglect and powered mobility indoor use. The Mini Mental Status Examination (MMSE) was used as a measure of cognitive functioning and the Bell’s Test was incorporated to assess visual neglect. Indoor use of powered mobility was measured using the Power-Mobility Indoor Driving Assessment (PIDA). Thirteen adults from two
different care institutions with different kinds of mobility limitation took part. Results revealed no statistically association between the cognitive measures and driving performance. There are, however, several drawbacks in the design of the experiment, which could have contributed to the non-conclusive results. Apart from the small sample size, the experimenters used different training protocols in the two institutions taking part in the study, and the demographics of participants in the two institutions differed, which could have had an undesired influence on the results.

Apart from visual factors, Letts et al. (2007) examined various cognitive functions in 34 participants in order to assess the construct validity of the PCDA. General cognitive functioning was measured with the Standardised Mini Mental Status Examination (SMMSE), visual perception with the Motor Free Visual Perceptual Test and problem solving was assessed using the Behavioural Assessment of the Dysexecutive Syndrome. None of the measures were related to driving performance.

Summarizing, there are indications in at least one study that cognitive functions contribute to traffic safety. Especially visual perception was found to have a relationships with safe driving performance. However, findings about the relationship between cognitive functions and driving performance are not very robust between studies. Reasons could be the different characteristics of the samples chosen (age, type of vehicle, driving experience), or the tests used to measure driving performance. Therefore, there is a need for more controlled experiments to investigate the role of cognitive functions in slow motorised traffic.