Older driver's self-assessment and cognitive impairments

Dimosthenis Pavlou[a,*], Dionysia Kontaxopoulou[b], Stella Fragkiadaki[b], Sophia Vardaki[a], Eleonora Papadimitriou[a], Panagiotis Papantoniou[a], George Yannis[a], John Golias[a], Sokratis G. Papageorgiou[b]

[a]*National Technical University of Athens, Athens, Greece*
[b]*National and Kapodistrian University of Athens, Athens, Greece*

Abstract

The objective of this paper is the analysis of the self-assessment of driving behaviour of older drivers, with particular focus on the comparison between healthy individuals and individuals with cognitive impairments due to various brain pathologies. More specifically, the brain pathologies examined include early Alzheimer's disease (AD), early Parkinson's disease (PD), and Mild Cognitive Impairment (MCI). An extensive questionnaire was developed and used, in which older drivers were asked about their driving experience and behaviour, the self-assessment of their skills, their distracted driving behaviour, their emotions while driving and their past history incidents or accidents. In the self-assessment part of the questionnaire in particular, older drivers were asked, for various driving conditions or tasks: (i) to assess whether their driving performance has declined over the last five years and (ii) to indicate whether they avoid driving. More specifically, the driving conditions examined concern driving on motorway, in busy urban areas, in rainy conditions, at night-time, in unfamiliar area, etc. The driving tasks examined concern lane changing, driving through uncontrolled junctions, positioning the vehicle on the lane and maintaining lateral position, overtaking, keeping safe headways, adjusting speed etc. The questionnaire is filled in by the participants of a large experiment aiming to assess the driving performance of drivers with cerebral diseases; which includes a medical/neurological assessment, a neuropsychological assessment and the filling-in of the above questionnaire. So far, 77 participants have completed all phases of the experiment, out of which 38 healthy individuals and 39 impaired. The results suggest that there are significant differences in the self-assessment of healthy and drivers with cognitive impairments. Impaired drivers appear to be aware of the decline in their driving performance; they have increased avoidance rates as a means of self-regulation for a higher number of driving situations and tasks.

Keywords: older drivers, self-assessment, questionnaire, Alzheimer's disease, Parkinson's disease, Mild Cognitive Impairment.

[*]Tel.: +30 210 7721380; fax: +30 210 7721454.
E-mail address: dpavlou@central.ntua.gr

1. Background and objectives

As the population around the world generally grows, the number of older drivers has also increased, imposing a greater risk for potentially hazard driving behaviors due to visual, cognitive and psychomotor decline that are a common outcome of ageing (Eby et al., 2009; Molnar et al., 2007). Older drivers with functional decline often self-regulate their driving more than older drivers without functional impairments (Charlton et al., 2006; Ross et al., 2009).

Self-regulation typically refers to the notion that older drivers may adjust or reduce their driving in response to changes in their physical capacities and functional or mental capabilities. Such a practice, however, is often triggered by psychological factors surrounding independence, self-worth and confidence (Donorfio et al., 2009). Self-regulation of driving can also serve as a means of avoiding a range of negative outcomes that have been associated with driving cessation such as social isolation and increased depressive symptoms (Fonda et al., 2001). However, the extent to which older people regulate their driving and how they do so remains unclear (Baldock et al., 2006).

Driving confidence is a key factor in determining why some older drivers regulate their driving but others do not (Myers et al., 2008; Rudman et al., 2006) and seems to be significantly related to subjectively-assessed driving self-regulation (MacDonald et al., 2008). For example, the Multifactorial Model for Enabling Driving Safety (Anstey et al., 2005) posits that the driving behavior 9and hence crash risk of older adults is determined by both their capacity to drive safely and their beliefs about this capacity. In addition, recent findings that younger drivers also engage in avoidance behavior (Naumann et al., 2011) support the notion that driving avoidance is not always related to declining abilities associated with ageing. In accordance to this finding, Blanchard and Myers (2010) observed significant correlations between older drivers' driving confidence and actual changes in their driving patterns (avoidance of complex driving situations and reduced total miles driven). In other words, self-regulation of driving is associated with lower levels of driving confidence on older adults (Baldock et al., 2006). Awareness of functional difficulties may be another critical factor for determining self-regulation among older drivers (Charlton et al., 2006).

However, a large number of those drivers do not always respond to their functional decline and therefore regulate their driving. Baldock et al. (2008) verified those findings by reporting no differences in the driving habits of older drivers especially when faced with difficult driving situations. What is more, Ackerman et al. (2010) found that self-rated driving ability failed to predict older drivers' functional performance on measures of cognitive, visual and physical abilities.

Research studies have found that, regardless of cognitive abilities, older drivers thought that they possessed good health and driving abilities and were confident in a range of potentially hazardous situations (Wong et al., 2012, Sullivan et al., 2011). Horswill et al. (2012) found that older drivers have little insight into their hazard perception ability and found close to zero correlations between self-ratings and objective measures of hazard perception.

Older adults with cognitive impairments due to neuropathological changes such as Alzheimer's disease (AD) and Mild Cognitive Impairment (MCI) exhibit poorer performance on objective driving tests (Stein & Dubinsky, 2011) as well as an accident rate two to five times higher than that of age-matched controls (Breen et al., 2007). Those drivers tend to qualitatively limit their driving as part of a gradual progress of driving cessation (Croston et al., 2009). However, some continue to drive when it is no longer safe, and exercise poor judgment about their abilities (Brown et al., 2005). Regarding the clinical population of MCI, it seems that they exhibit diminished performance on cognitively-demanding functional tasks compared to a control group (Weston et al., 2011) but perform better when evaluated with functional tasks and judge their abilities more accurately than those with dementia (Farias et al., 2005). On the other hand, in study by Frittelli et al. (2009) MCI patients performed better than drivers with AD but worse than normal controls in a driving simulator experiment. These findings suggest that complex driving situations could pose safety concerns for MCI patients. However, it is not clear whether individuals with clinically-defined MCI report that they reduce their driving to compensate for declines of their abilities.

In a study by O'Connor et al. (2013), even though dementia patients acknowledged a decline in their driving skills and may even have limited their exposure to difficult driving situations, 75% of them were current drivers with an average driving frequency of 4.4 days per week. In the same study, participants with MCI reported

similar behaviors to normal controls in some situations, but in other situations exhibited similar driving habits to demented patients. Similar to the reported of patients with dementia, MCI participants reported perceived complex driving situations as more difficult, however, 78% of them were current drivers with an average driving pattern of 5 days per week. It is important to note that some older adults with MCI or mild dementia do remain capable of driving during the first three years following clinical diagnosis (Ott & Daiello, 2010), however according to several research studies (Ott et al., 2008; Dawson et al., 2009; Stein & Dubinsky, 2011) driving performance and safety may begin to decline during the early stages of cognitive impairment. Thus, it is of critical importance to monitor fitness of patients with MCI and dementia from the early stages of the disease.

According to Meng & Siren (2012), driving-related discomfort critically affects the self-regulation of driving in older adults, indicating a link between driving-related stress, driving self-regulation and riving cessation. What is more, discomfort as an outcome of complex driving situations may also act as a type of indirect self-monitoring of driving ability and motivate acts of self-regulation of driving.

Thus, it is important to address the aforementioned factors when examining self-awareness of driving abilities in the elderly population, both normal controls and individuals with cognitive impairments, and investigate how these factors ultimately determine driving behavior on those people.

The aim of the current study is to investigate the self-assessment of driving performance between healthy drivers and drivers with cerebral diseases, such as Mild Cognitive Impairment, Alzheimer's disease and Parkinson disease. First it will be examined the self-evaluation of perceptual motor and safety skills and second the self-assessment of driving skills in comparison to their abilities 5 years ago.

2. Methodology

2.1. Introduction

Within this research, a large driving simulator experiment is carried out, common for two research projects: the DISTRACT and the DriverBrain research project.

- The **DISTRACT research project**, entitled "Analysis of causes and impacts of driver distraction", concerns endogenous and exogenous causes of driver inattention and distraction (http://www.nrso.ntua.gr/distract).
- The **DriverBrain research project**, entitled "Analysis of the performance of drivers with cerebral diseases", concerning drivers with Alzheimer's disease, Parkinson's disease, Cerebrovascular disease - both in their MCI (pre-dementia) stages, but also in their mild dementia stages (http://www.nrso.ntua.gr/driverbrain).

2.2. Participants

The sample for this study consisted of 77 participants comprising two distinct groups:

- **39 participants** were included in the "impaired" group of participants. This group included individuals with cognitive impairments due to various brain pathologies. More specifically, the brain pathologies examined include early Alzheimer's disease (AD), early Parkinson's disease (PD), and Mild Cognitive Impairment (MCI). Clinical diagnosis was made by the established criteria.
- **38 participants** were included in the "healthy" group. This group included participants with no pathological condition.

Participants were mostly patients or relatives of patients who came for medical/neurological assessment at the Behavioral Neurology Unit at the 2nd Neurological Department of Medical School, at "Attikon" General Hospital in Athens. We also examined a group of university students. People who participated in the experiment met certain basic inclusion and exclusion criteria. All the participants should have a valid driving license, drive for more than 3 years, have driven more than 2500km during the last year, drive at least once a week during the last year and drive at least 10km/week during the last year. Participants should not have important psychiatric history for psychosis or any important kinetic disorder. Furthermore, they should neither have dizziness or nausea while driving, either as a driver or as a passenger, nor be pregnant or alcoholic or have any other drug addiction, nor have any important eye disorder that prevents them from driving safely and they should not have any disease of the Central Nervous System beyond those examined in the study. Participants who failed in even one of the above criteria were eliminated from the experiment.

2.3. Procedure

For the purposes of these two research projects, a common driving simulator experiment was designed by an interdisciplinary research team of transportation engineers, neurologists and psychologists
The experiment included three types of assessment:

- **Medical / neurological assessment:**
  The first assessment concerns the administration of a full clinical medical, ophthalmological and neurological evaluation, in order to well document the presence of a disorder and its characteristics.
- **Neuropsychological assessment:**
  The second assessment concerns the administration of a series of neuropsychological tests and psychological-behavioral questionnaires to the participants.
- **Driving at the simulator:**
  The third assessment concerns the driving behavior by means of programming of a set of driving tasks into a driving simulator for different driving scenarios.

2.4. Self-assessment evaluation

After the completion of the medical and neurological assessment, participants were asked to complete two questionnaires of self-assessment.

- **Questionnaire of Self-evaluation of the perceptual-motor and safety skills:**
  The questions require the self-evaluation of the perceptual-motor and safety skills of the driver. The questions of the section are derived from the Driver Skill Inventory (Lajunen & Summala, 1995), with adaptations and modifications by the research team. The section employs a 4-point scale (from weak to strong), in order to prevent the bias of responses that cluster in the middle.

Table 1. Questionnaire of Self-evaluation of the perceptual-motor and safety skills

Which of the below skills do you think <u>you are weak at</u> and which do you think <u>you are strong at</u>?

	**Fill in with √ the box of your choice*	Weak	Slightly weak	Quite strong	Strong
1	To drive long distances	(1)	(2)	(3)	(4)
2	To quickly realize the hazards on the road	(1)	(2)	(3)	(4)
3	To drive in slippery roads	(1)	(2)	(3)	(4)
4	To change lanes comfortably	(1)	(2)	(3)	(4)
5	To take quick decisions when driving	(1)	(2)	(3)	(4)
6	To remain calm in stressful situations when driving	(1)	(2)	(3)	(4)
7	To control your vehicle	(1)	(2)	(3)	(4)
8	To leave enough distance from the front car	(1)	(2)	(3)	(4)
9	To adjust the speed to suit the road conditions	(1)	(2)	(3)	(4)
10	Overtaking, if necessary	(1)	(2)	(3)	(4)
11	To give priority when needed	(1)	(2)	(3)	(4)
12	To obey speed limits	(1)	(2)	(3)	(4)
13	To park your vehicle in reverse gear	(1)	(2)	(3)	(4)
14	To be mindful of the other vehicles in the road	(1)	(2)	(3)	(4)
15	To drive quickly, if necessary	(1)	(2)	(3)	(4)
16	To drive at night	(1)	(2)	(3)	(4)
17	To be mindful at pedestrians and bicyclists	(1)	(2)	(3)	(4)

- **Questionnaire assessing driving performance decline over the last five years:**
  This is a questionnaire about changes in driving ability, developed by the research team, which assess driving skills of the participants compared to the same skills 5 years ago. It includes 18 questions which are scored in a 3-point scale (1=significantly worse, 2=slightly worse, 3=no difference). The questions of the questionnaire included driving on different driving situations (on a highway, at night, in heavy traffic, etc.). The inclusion of driving performance self-assessment in general and in various situations was based on the findings of a previous study investigating perceptions of safe-driving ability in relation to actual and self-assessed performance of a group of older adults during an on-road trial: Perceived safe-driving ability in general, as well as in various situations and under various conditions contained in the present questionnaire, were correlated to several variables of driving performance (including compensatory behavior), self assessed performance and feeling of danger during an on-road trial (Vardaki and Karlaftis, 2011).

Table 2. Questionnaire assessing driving performance decline over the last five years

How do you assess your driving behaviour today in comparison with 5 years ago?

	**Fill in with √ the box of your choice*	significantly worse	slightly worse	no difference
1	Low traffic - Quiet road	(1)	(2)	(3)
2	City with high traffic	(1)	(2)	(3)
3	Highways	(1)	(2)	(3)
4	Motorway	(1)	(2)	(3)
5	Night	(1)	(2)	(3)
6	Heavy rain	(1)	(2)	(3)
7	Driving in slippery roads	(1)	(2)	(3)
8	Winding road	(1)	(2)	(3)
9	Unknown region	(1)	(2)	(3)
10	Lane change	(1)	(2)	(3)
11	Long distances (>2hr)	(1)	(2)	(3)
12	Left turns	(1)	(2)	(3)
13	Driving while being tired	(1)	(2)	(3)
14	Driving alone	(1)	(2)	(3)
15	Conversation with passenger	(1)	(2)	(3)
16	Conversation by mobile phone	(1)	(2)	(3)
17	Intersections without traffic lights	(1)	(2)	(3)
18	Overtaking on rural roads with two lanes	(1)	(2)	(3)

3. Results

As mentioned before, the sample of 77 participants is divided in two groups: 39 impaired drivers (AD, PD or MCI) and 38 “control” drivers.

The demographic characteristics of the participants are presented in Table 3. The group of impaired participants consisted of patients with MCI, AD and PD. The demographic characteristics of these diagnostic categories are presented separately in Table 4.

Table 3. Demographic characteristics of all participants

	Healthy Participants (n=38 , Males=19,Females=19)		Impaired Participants (n= 39, Males=28, Females=11)	
	Mean	SD	Mean	SD
Age	43,9	15,6	66,2	10,1
Years of education	14,6	2,8	11,7	4,4

Table 4. Demographic characteristics of the impaired participants

	MCI Participants n=25 (Males=14,Females=11)		AD Participants n=4 (Males)		PD Participants n=10 (Males)	
	Mean	SD	Mean	SD	Mean	SD
Age	66,4	9,7	70,2	11,3	64,2	11,1
Years of education	14,6	2,8	7.2	6,6	12,7	3,7

In order to examine if there are significant differences in self-assessment in the driving skill, an analysis of covariance was conducted in order to control whether age was a factor that affected the results.

When we compared the score of the questionnaire referring to self-assessment of the driving skills no significant differences were found, $F(1) = 2,64$, $p=0,11$. It seems that impaired participants assessed their perceptual-motor and safety skills the same as the healthy participants. In addition, analysis of covariance was conducted for each question of the self-assessment of driving skills questionnaire in order to examine if there are significant differences in specific driving skills. Significant differences were found only for question 1 (ability to drive long distances), $F(1) = 7,3$, $p=0,009$ and for question 16 (ability to drive at night), $F(1) = 10,2$, $p=0,002$. Table 5 presents the finding for each question of self-assessment of driving skills questionnaire.

Table 5. Analyses of covariance of each question of the self-assessment of driving skills questionnaire

	Healthy		Impaired				
	Mean	SD	Mean	SD	*F*	*df*	*p*
Question 1	**3,5**	**0,8**	**2,9**	**1,2**	**7,3**	**1**	**0,009**
Question 2	3,5	0,6	3,4	0,7	0,1	1	7,700
Question 3	2,9	0,9	2,7	0,9	0,6	1	0,430
Question 4	3,6	0,8	3,3	0,8	1,2	1	0,300
Question 5	3,6	0,7	3,6	0,6	0,008	1	0,930
Question 6	3,4	0,6	3,3	0,9	0,12	1	0,740
Question 7	3,6	0,5	3,5	0,6	0,5	1	0,450
Question 8	3,5	0,8	3,7	0,6	1,4	1	0,240
Question 9	3,8	0,5	3,8	0,5	0,4	1	0,530
Question 10	3,6	0,6	3,5	0,8	1,3	1	0,260
Question 11	3,8	0,5	3,8	0,6	0,24	1	0,620
Question 12	3,5	0,7	3,5	0,8	0,00	1	0,980
Question 13	3,7	0,5	3,5	0,6	3,3	1	0,074
Question 14	3,8	0,4	3,7	0,5	0,03	1	0,860
Question 15	3,5	0,6	3,3	0,6	0,6	1	0,420
Question 16	**3,6**	**0,6**	**2,7**	**1**	**10,2**	**1**	**0,002**
Question 17	3,9	0,3	3,8	0,5	0,08	1	0,770

These findings show that although impaired participants seem to assess their driving skills as the healthy individuals they seem to doubt about their ability to drive for long distances (question 1) and their ability to drive at night (question 16).

Analyses of covariance where conducted in order to investigate whether participants assess their driving performance as declined over the last five years. Significant differences were found when we compared the total

score of the questionnaire, F(1) = 4,7, p=0,03. In addition, analyses of covariance were conducted for each question of the questionnaire in order to specify where the impaired drivers detect the decline of their driving performance. Table 6 presents the results for each question separately.

Table 6. Analyses of covariance of each question of the questionnaire assessing the driving ability decline over the last five years

	Healthy		Impaired				
	Mean	SD	Mean	SD	*F*	*df*	*p*
Question 1	2,9	0,2	2,8	0,4	0,39	1	0,530
Question 2	2,9	0,2	2,7	0,4	3,1	1	0,084
Question 3	**2,9**	**0,4**	**2,6**	**0,6**	**6,1**	**1**	**0,017**
Question 4	**2,9**	**0,4**	**2,7**	**0,5**	**4,1**	**1**	**0,046**
Question 5	2,8	0,4	2,4	0,5	1,9	1	0,160
Question 6	**2,8**	**0,3**	**2,4**	**0,5**	**7,8**	**1**	**0,007**
Question 7	**2,9**	**0,2**	**2,5**	**0,6**	**7,1**	**1**	**0,010**
Question 8	**2,9**	**0,3**	**2,5**	**0,6**	**6,5**	**1**	**0,013**
Question 9	2,8	0,3	2,6	0,5	2,2	1	0,140
Question 10	2,9	0,2	2,8	0,5	1,5	1	0,230
Question 11	**2,9**	**0,3**	**2,7**	**0,5**	**5,1**	**1**	**0,027**
Question 12	**2,9**	**0,2**	**2,7**	**0,4**	**7,8**	**1**	**0,007**
Question 13	2,8	0,4	2,3	0,6	3,1	1	0,086
Question 14	3	0	2,7	0,5	3,8	1	0,054
Question 15	2,9	0,4	2,6	0,5	1,7	1	0,190
Question 16	**2,9**	**0,2**	**2,5**	**0,7**	**8,2**	**1**	**0,006**
Question 17	2,9	0,2	2,6	0,6	1,5	1	0,220
Question 18	2,9	0,2	2,6	0,6	3,6	1	0,064

Significant differences were found only for the questions: 3, 4, 6, 7, 8, 11, 12 & 16. These findings indicate that drivers with cognitive impairments seem to observe a slight deterioration in their driving performance in driving situations like in highways (question 3), motorways (question 4), with heavy rainfall (question 6) on slippery roads (question 7), in roads with many turns (question 8), driving for long distances (question 11), on left turns (question 12) and driving while talking on the mobile phone (question 16).

4. Conclusions and discussion

The aim of the present study was to investigate the self-assessment of driving performance between healthy drivers and drivers with cerebral diseases, such as Mild Cognitive Impairment, Alzheimer's disease and Parkinson disease. In order to investigate the self-assessment patterns of the two groups every participant was given two questionnaires. The first asked the participant to self-evaluate their perceptual motor and safety skills and the second to assess their driving skills in comparison to their abilities 5 years ago.

Regarding the first questionnaire, according to the results of the analysis, no significant differences were found between the two groups for the total number of the skills assessed. However, when examining every question separately through an analysis of covariance, significant differences were found only for the questions examining driving long distances and driving at night. Those results indicate that, in general, impaired drivers are not particularly aware of having increased difficulties in their driving skills compared to healthy drivers. The only exception derived from the two questions where significant differences were found (driving long distances and driving at night), indicated that they recognized some increased difficulties in those conditions but the level of difficulty admitted was relatively small.

When examining the assessment of driving ability compared to 5 years ago, significant differences were found in the score of the questionnaire; in other words, impaired drivers admit a small impairment in their driving skills compared to 5 years ago. In order to further examine whether specific conditions described in the questionnaire are rated as worse compared to 5 years ago by impaired drivers, we examined each question of the questionnaire separately through analysis of covariance. The results of the analyses indicated differences in the following driving conditions: driving in highways (question 3), in motorways (question 4), with heavy rainfall (question 6)

on wet roads (question 7), on roads with many turns (question 8), driving for long distances (question 11), on left turns (question 12) and driving while talking on the phone (question 16).

In spite of the fact that impaired drivers acknowledge some deterioration of their skills in specific driving conditions, this is not always representative of their actual impairment of driving skills (Eby et al., 2009; Molnar et al., 2007).

These results could either indicate that impaired participants are actually not aware of their driving abilities or that they are reluctant of publicly disclosing any particular problems in their driving skills.

Further research should include the comparison of the driving patterns of impaired drivers (through a simulator experiment or an on-road test) with their self-evaluation of their driving skills in the particular conditions where they reported perceived difficulties and investigate whether in those areas they actually perform worse than other driving conditions.

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