RSS 2022
8th Road Safety & Simulation International Conference
Road Safety and Digitalization
08-10 June, 2022
Zappeion Megaron, Athens, Greece

National Technical University of Athens
Hellenic Institute of Transportation Engineers

Assessing Driving Performance of Older Drivers – A Literature Review

Dimos Pavlou, PhD

Transportation Engineer, Research Associate

Together with:
George Yannis

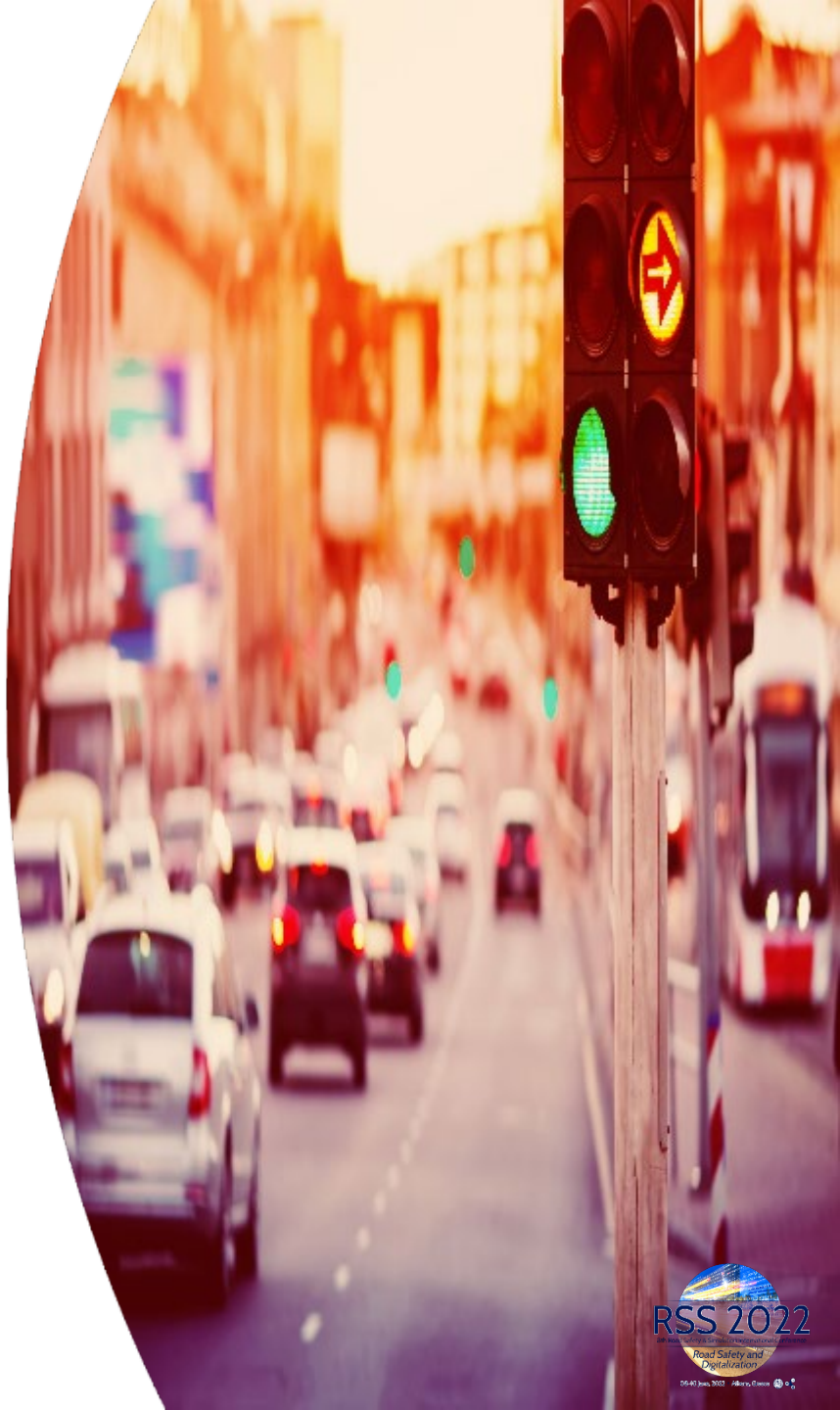
National Technical University of Athens
Department of Transportation Planning and Engineering

Structure

- Introduction
- Background
- Objectives
- Methodology
- Preliminary Results
- Conclusions
- Future Insights

Introduction

- Driving is a complex task that requires the utilization of a wide range of individual skills as well as practical and psychological abilities
- Drivers should have good spatial perception and well-coordinated control in order to manage multiple activities simultaneously, make timely judgments or responses and react quickly in case of an emergency when completing the driving processing
- The normal aging process is associated with increasing motor, cognitive, visual, perceptual and sensory impairments



Background

- Older adult drivers are more likely to experience not only complicated conditions but also challenging driving situations that can directly affect their ability to control a motor vehicle safely
- Elderly people have the second highest fatality rate in traffic of all age-groups
- While today, over 20% of road crash fatalities involve drivers aged 60 years and above in Europe and it is expected that by the year 2050, the rate of elderly road crash fatalities will increase to more than 40%
- In the upcoming years, the problem's magnitude may further increase due to the expected increase in the total number of people more than 65 years of age, the mobility of elderly people and the rates of licensed older drivers

Objectives

- To date, almost no systematic review exists that synthesizes the literature on which are the most crucial parameters that affect driving behavior, nor how older adults assess their perception and their driving abilities

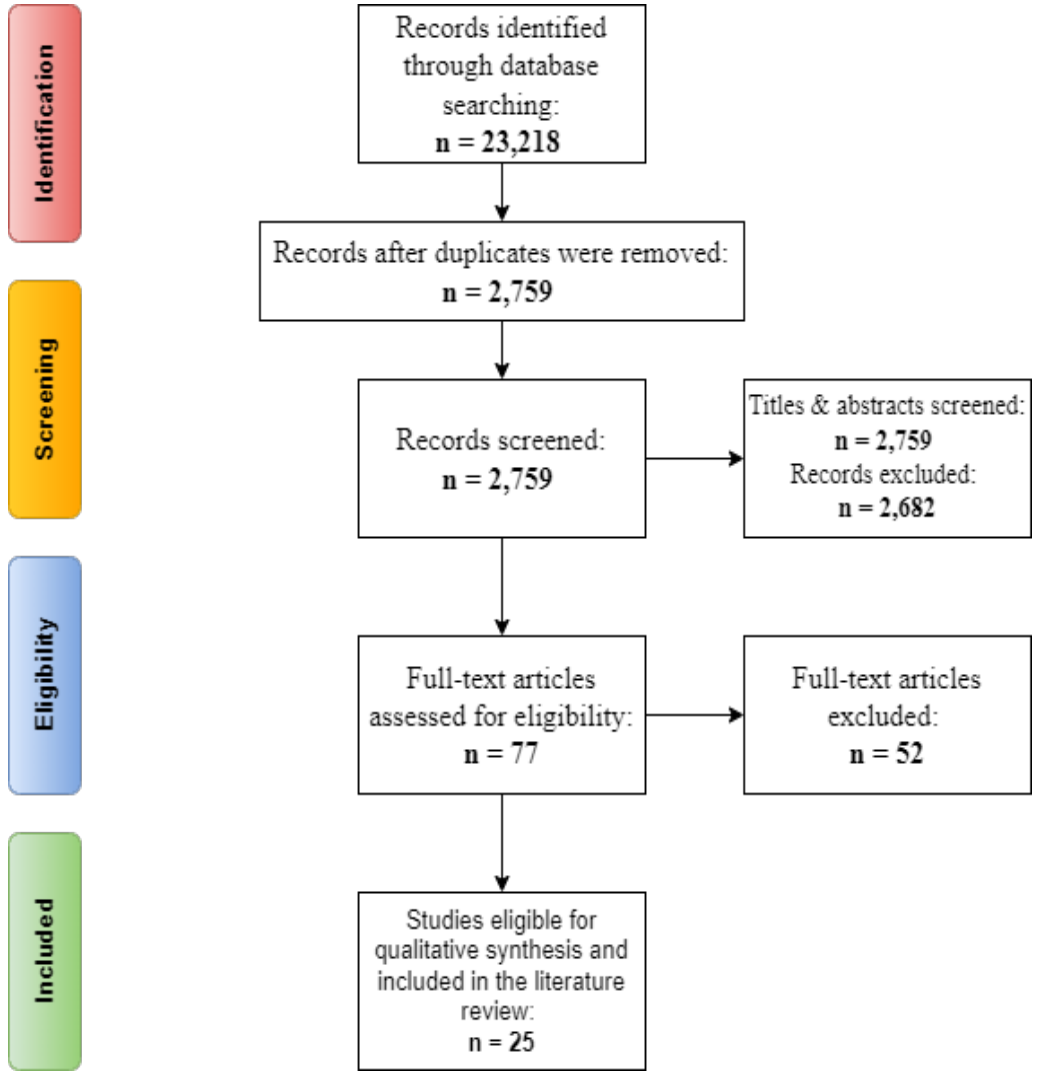
- The aim of the present study is to identify the critical driving parameters that can assess and predict the driving performance

- A comprehensive literature search on driving performance of older people was conducted in order to investigate the most important indicators examined in the scientific field of driver behavior

- Methods of assessing driving, including on-road trials, driving simulator experiments, driving behavior questionnaires, neurological and neuropsychological tests or a combination of them and related results of the literature are provided

Methodology

- The review was adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) steps to identify relevant research articles
- The search resulted in a total of 23,218 papers with 2,759 duplicates
- In case that older adults were not included in the studies examined, these papers were excluded
- 77 articles were selected for full-text review, including full papers suggested from a subject matter expert
- In total, 25 papers were included in the final review



On-Road Trials

- Driving performance of older drivers on naturalistic driving experiments was consistently worse than that of cognitively intact and younger individuals (reaction time, driving errors, steering wheel use)

- Older drivers had different acceleration/deceleration habits and therefore, different turning time, which also varied depending on whether the vehicle on the main road came from the left or the right

- Distraction, inattention, visuospatial skills and executive functions have been noted as the most critical parameters for safe driving in several studies, as they appeared to affect important driving tasks, such positioning and maneuvering the vehicle, predicting the development of driving situations, judging distances, adapting speed or estimating crash risk

Driving Simulator

- Simulated driving experiments allow study complex driving behaviors in a controlled, realistic and safe driving environment, which might be impractical, hazardous, or risky under real driving conditions

- A large range of test conditions (e.g. night and day, different weather conditions or road environments) can be implemented in the simulator with relative ease compared with on-road experiments

- Older drivers with brain pathologies drove at significantly lower speeds, presented higher lateral position variability, kept larger headways as well as demonstrated larger reaction times than healthy drivers

Questionnaires

- The self-reported driving behavior of elderly people with and without brain pathologies affecting cognition was assessed through a driving behavior questionnaire evaluation
- Patients tended to report to be more likely to avoid using their vehicle because they were afraid of their driving abilities compared to healthy drivers
- With respect to distraction, patients claimed that it was too dangerous to converse with a passenger and even more so, to use the mobile phone and thus, they reported avoiding to do so

Neurological and Neuropsychological Tests

- Driving indicators on tests measuring selective visual attention, sleeping abnormalities, motor fitness, visuospatial abilities, and, to a lesser extent executive functioning and working memory, can predict the ability to drive safely

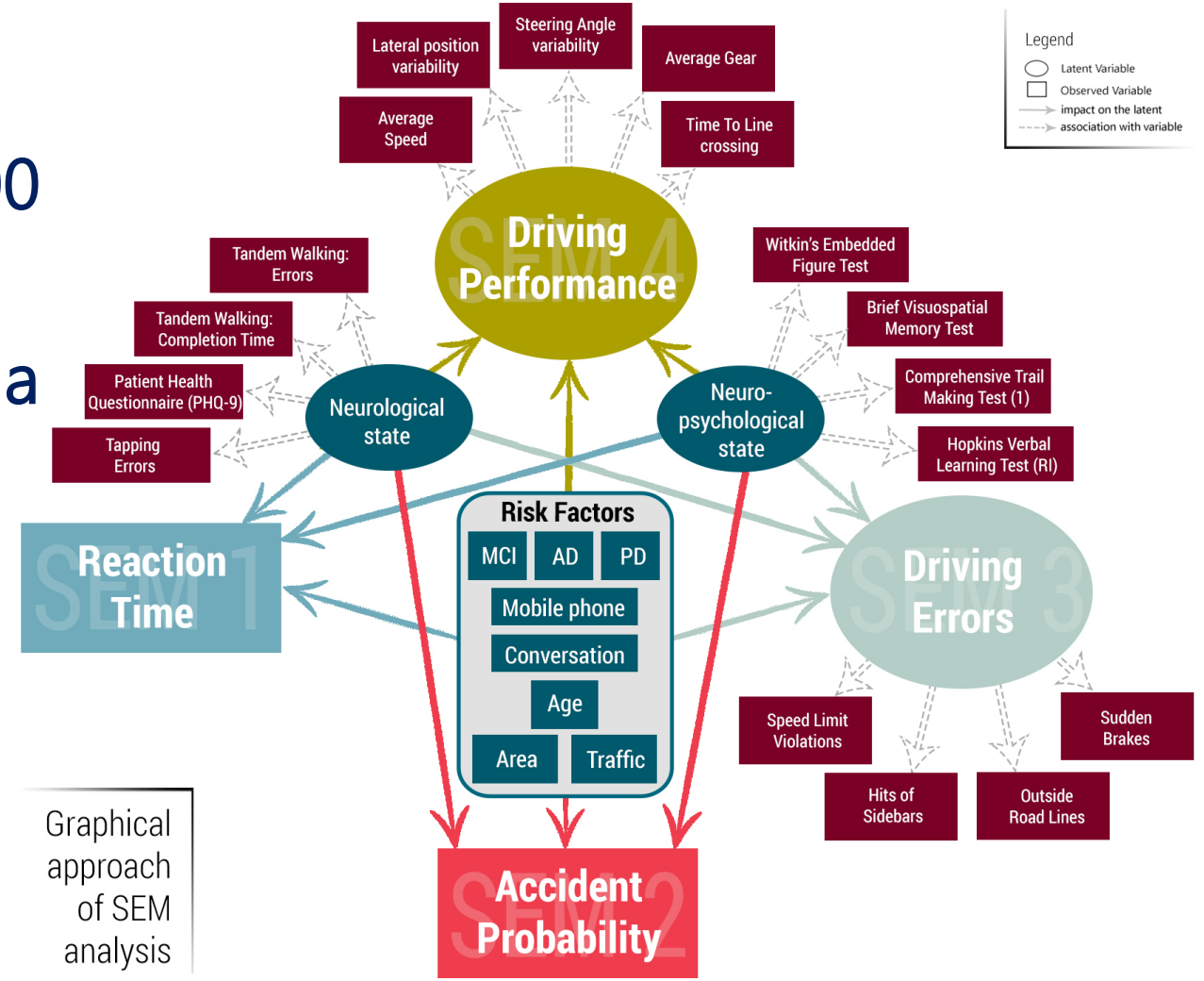
- These neurological and neuropsychological measures could be helpful in detecting individuals with questionable or problematic driving ability

- Nonetheless, neuropsychological and neurological tests should be viewed as one part of the screening process that is accompanied when necessary by simulated or on-road driving assessment

A/A	Author	Year	Sample Characteristics				Methodology				Driving Performance Measures								
			Sample size	Males	Females	Age	On-road trial	Driving simulator	Questionnaire	Neurological/ Neuropsychological tests	Speed	Attention/ Distraction	Maneuver	Reaction time	Lane position	Acceleration/ Deceleration	Driving errors	Crash risk	Fitness to drive
1	Toepper et al.	2021	74	47	27	67 – 94	x		x	x								x	x
2	Feng et al.	2021	71	40	31	≥ 65	x		x		x							x	
3	Son & Park	2021	15	15	0	60 – 69		x	x		x	x			x				
4	Kosuge et al.	2021	191	184	7	> 70	x		x		x		x		x				
5	Schulz et al.	2020	74	48	26	≥ 65	x			x	x	x							x
6	Shen et al.	2020	136	102	34	> 70	x	x		x	x			x	x	x		x	x
7	Paire-Ficout et al.	2020	145	96	49	> 70	x		x		x	x		x					x
8	Chen et al.	2019	50	34	16	74 – 96	x		x		x		x		x		x	x	
9	Vardaki et al	2019	60	35	25	60 – 70		x	x		x	x		x					
10	Urlings et al.	2018	136	97	39	> 70	x	x	x		x			x	x			x	
11	Payyanadan et al.	2018	29	14	15	65 – 82	x		x		x					x	x	x	
12	Willstrand et al.	2017	80	48	32	72 – 83	x		x		x	x	x		x	x	x		x
13	Doroudgar et al.	2017	38	20	18	≥ 60		x			x			x	x			x	
14	Pavlou et al.	2017	114	72	42	≥ 55		x			x			x	x			x	
15	Pavlou et al.	2017	137	82	55	≥ 60			x			x					x		x
16	Chevalier et al.	2016	344	204	140	75 – 94	x				x							x	
17	Lucidi et al.	2014	485	297	188	60 – 90			x		x						x	x	
18	Park et al.	2011	55	40	15	≥ 65		x	x		x		x		x	x		x	
19	Wadley et al.	2009	105	50	55	≥ 65	x		x	x	x				x			x	
20	Baldock et al.	2007	90	36	54	60 – 91	x		x	x	x	x					x		x
21	Baldock et al.	2006	104	39	65	60 – 92	x		x								x	x	x
22	Henderson et al.	2005	25	17	8	65 – 83		x					x		x			x	
23	Lee et al.	2003	129	100	29	60 – 88	x	x	x		x	x	x		x		x		
24	Lee et al.	2002	53			65 – 85		x			x	x	x		x			x	
25	De Raedt & Ponjaert-Kristoffersen	2000	84	60	24	65 – 96			x	x	x		x		x			x	
						Total	15	10	18	6	21	9	8	6	14	4	8	16	8

Previous simulation study with older drivers

- SEM analysis from a simulator experiment including more than 300 individuals indicated that advanced age as an individual risk factor had a significant negative impact on:
  - reaction time *(+190ms, p<.001)*,
  - driving errors *(+0.11, p<.001)* and
  - driving performance (as a latent variable) *(-1.3, p<.001)*



Graphical approach of SEM analysis

Current on-road study with older drivers

- On-road driving experiment in Athens with 100 active drivers
- Although older drivers had lower speeds and less harsh accelerations compared to their younger counterparts, they had more harsh brakings, especially in urban areas and in highway
- Older drivers had lower scores (insufficient or bad) in the road test checklist in the following indicators:
  - Speed adaptation
  - Lane change capability
  - Mirror use
  - Steering firmness

Conclusions

- It seems than older drivers have some difficulties in adapting to demanding driving situations, they try to compensate that by lowering their driving speed but the probability of getting involved in an accident is high

- Next steps include sophisticated statistical analyses and classification of older drivers to safe and at-risk along with the most critical driving parameters that differentiate them from the younger

Future Insights

- The findings from this review may help to inform policy recommendations to keep older drivers safe on the roadway
- The development and promotion of interventional programs can make elderly people more aware of, and appreciate, their actual driving abilities, and could help them to (re)calibrate their perceptions in order to become more aligned with reality
- Further instructions and educational programs that either require senior participants or that engage senior drivers in training using a real-world driving or driving simulation, may be considered as part of (re)licensing in older age
- Policy makers should also support legislation that require all automobiles, produced after a certain year, to be equipped with minimum assisted-driving and safety features and technologies (Advanced Driver Assistance Systems) which will significantly benefit older drivers

RSS 2022
8th Road Safety & Simulation International Conference
Road Safety and Digitalization
08-10 June, 2022
Zappeion Megaron, Athens, Greece

National Technical University of Athens
Hellenic Institute of Transportation Engineers

Assessing Driving Performance of Older Drivers – A Literature Review

Dimos Pavlou, PhD

Transportation Engineer, Research Associate

Together with:
George Yannis

National Technical University of Athens
Department of Transportation Planning and Engineering