Ageing and Safe Mobility

International interdisciplinary conference

27th and 28th November 2014

at the

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Assessment of driving performance of drivers with brain pathologies in urban roads, using a driving simulator

Dimosthenis Pavlou, Eleonora Papadimitriou, Sophia Vardaki, Constantinos Antoniou, Panagiotis Papantoniou, George Yannis, John Golias, Ion Beratis, Alexandra Economou, Sokratis Papageorgiou

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Bergisch-Gladbach

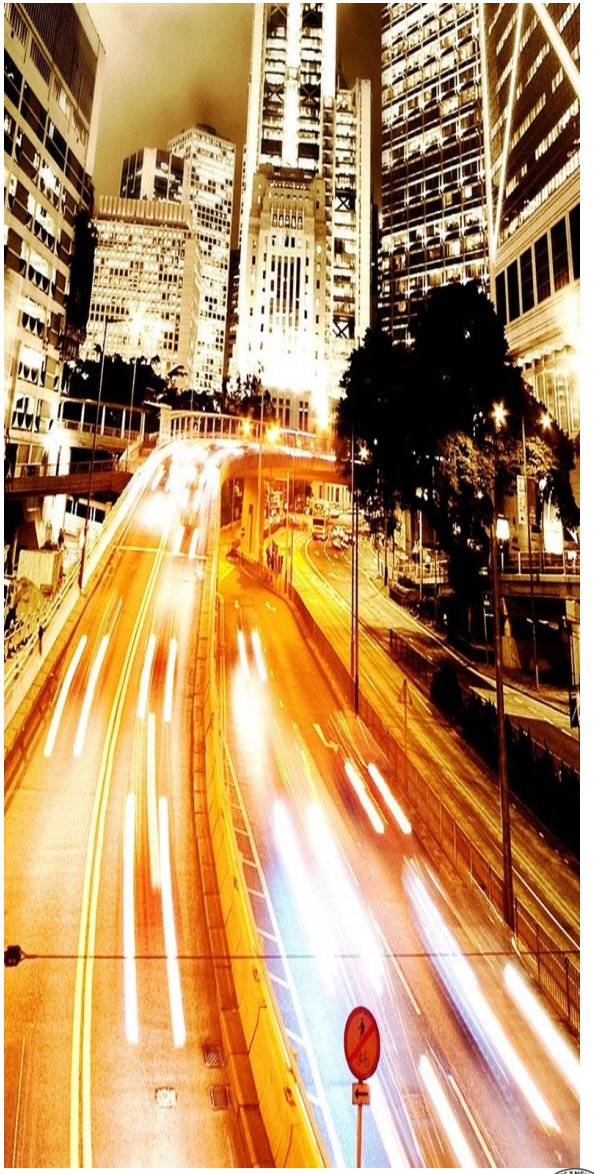
Outline

- Background
  - Cerebral diseases and driving performance
  - Driving in urban areas
- Objectives
- Driving simulator experiment
  - Overview of the experiment
  - Driving at the simulator
- Results
- Conclusions and discussion

Background

- Cerebral diseases and driving performance
  - Cognitive skills needed while driving:
    - concentration and attention
    - adequate visual and perceptual skills
    - Insight and judgment
    - memory
  - Cerebral diseases cause motor, visual, cognitive and perceptual deficits
- Driving in urban areas,

  requires several tasks performed simultaneously due to:
  - increased traffic
  - presence of bicyclists and pedestrians
  - traffic signs and frequent junctions



Objectives

Analyze the driving performance in urban roads of drivers with cerebral diseases by means of a driving simulator

- Cerebral diseases examined:
  - Mild Cognitive Impairment (MCI)
  - Alzheimer's Disease (AD)
  - Parkinson's Disease (PD)

- Driving performance measures:
  - mean speed
  - lateral position
  - space headway
  - reaction time and accident probability at unexpected incidents

Driving simulator experiment

- Distract research project

distrACT

- An interdisciplinary research team
  - Dpt. of Transportation Planning and Engineering NTUA
  - Dpt. of Neurology of the University of Athens (NKUA) Medical School, ATTIKON Hospital, Athens
  - Dpt. of Psychology, UoA School of Philosophy, Pedagogy and Psychology

European Union
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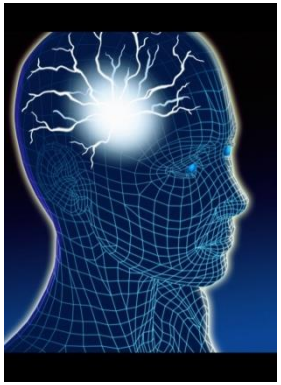
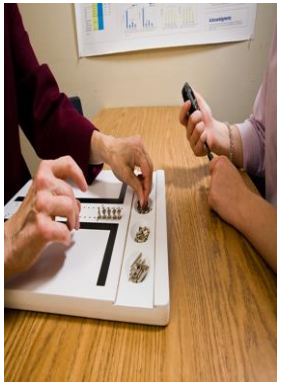
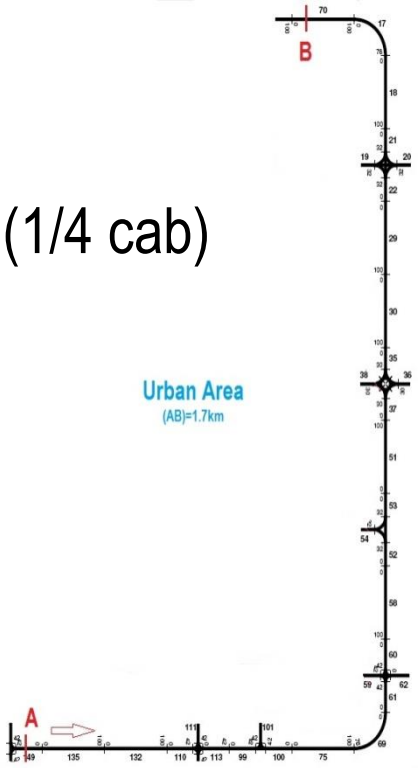
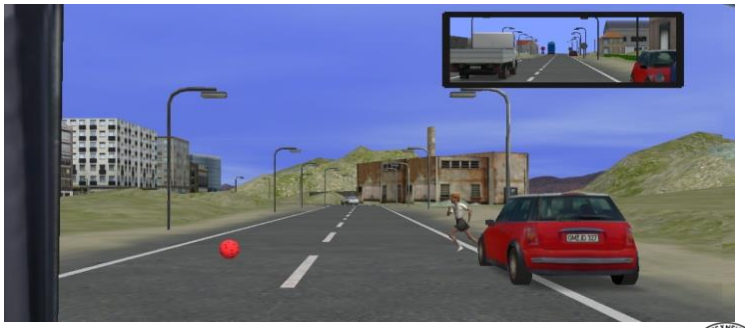
- A large simulator experiment
  - Medical/neurological assessment
  - Neuropsychological assessment
  - Driving at the simulator


Driving at the simulator

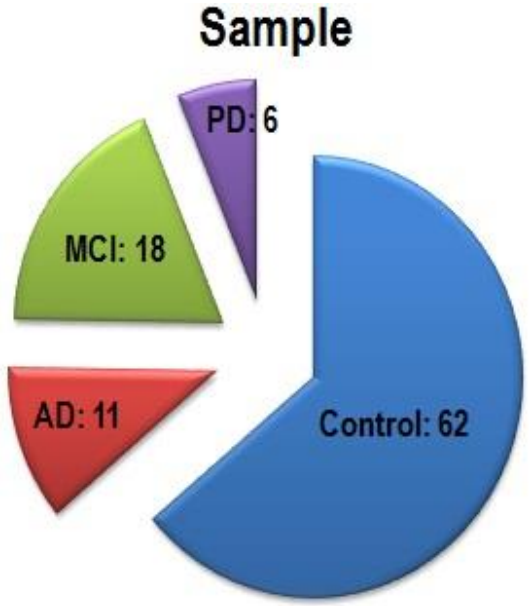
- 1 driving simulator
  - Foerst Driving Simulator FPF (1/4 cab)
- 1 road environment
  - Urban: divided urban arterial
- 2 traffic scenarios
  - Q_L: Low traffic volume
  - Q_H: High traffic volume
- 2 unexpected incidents at each trial
  - Child crossing the road
  - Sudden appearance of a car

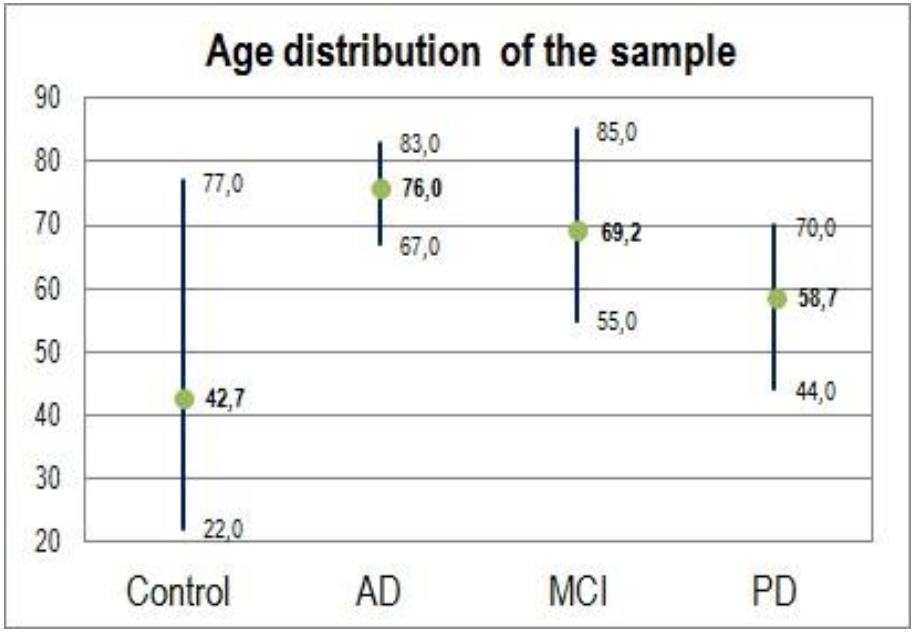




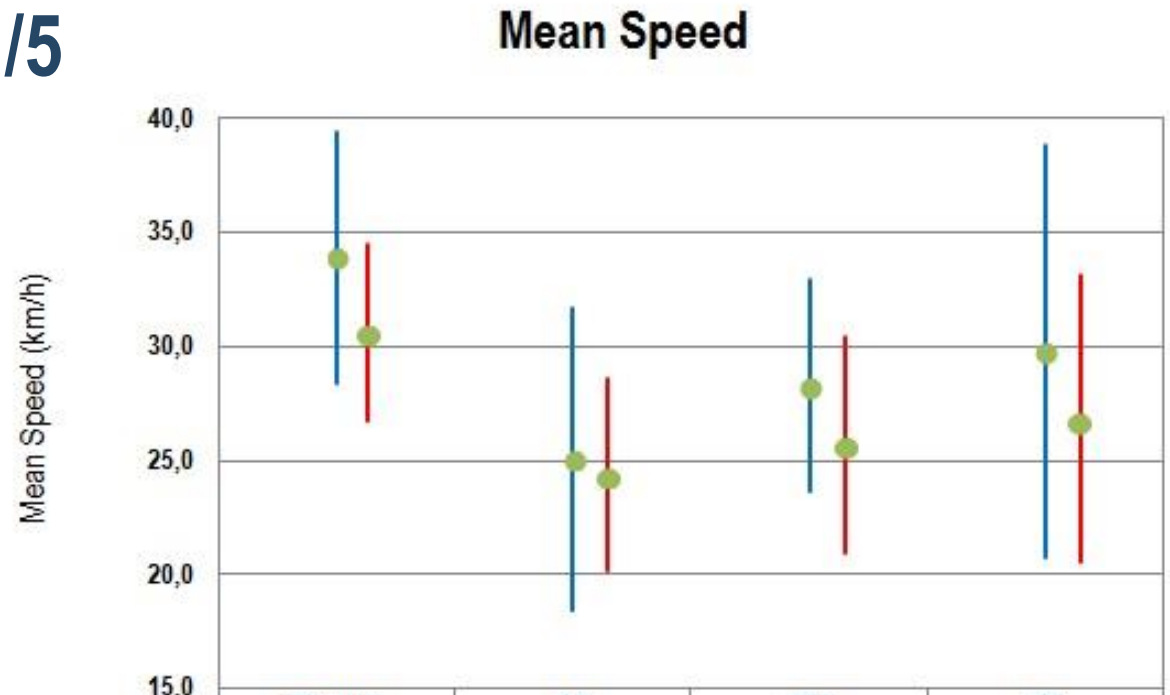
Sampling scheme

- 97 participants
  - 62 healthy controls
  - 35 impaired





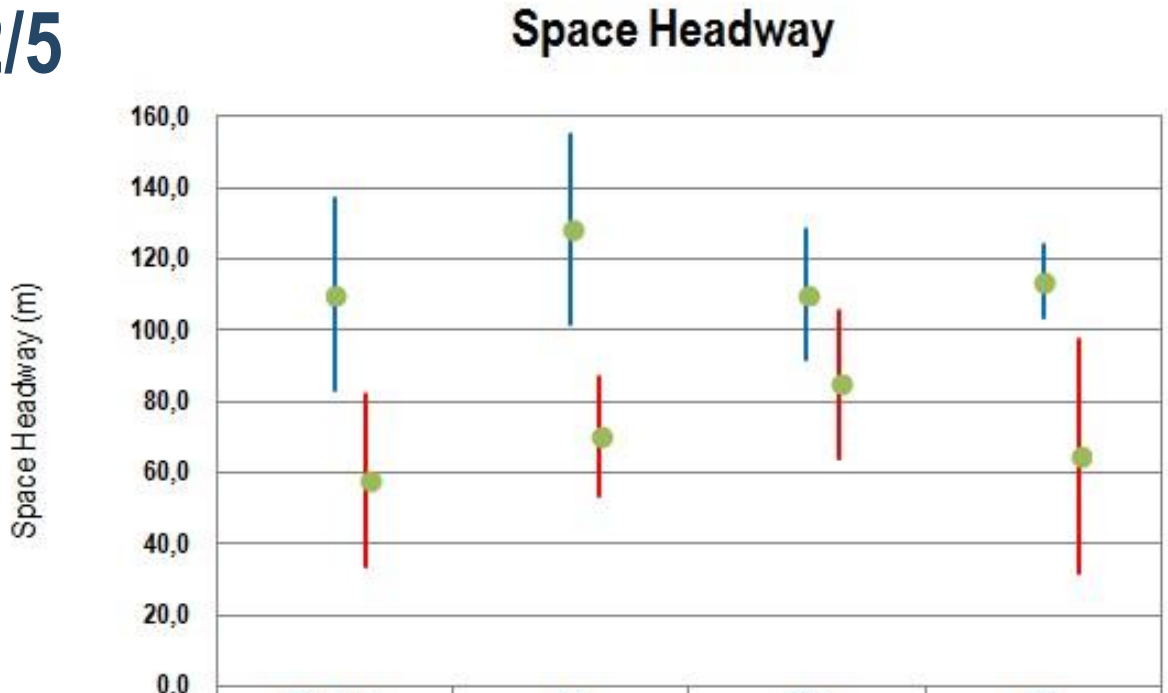
Results 1/5



	Control	AD	MCI	PD
QL aver+stdev	39,42	31,71	32,92	38,79
QL aver-stdev	28,37	18,42	23,64	20,75
QL aver	33,89	25,06	28,28	29,77
QH aver+stdev	34,50	28,63	30,46	33,14
QH aver-stdev	26,78	20,26	20,99	20,59
QH aver	30,64	24,44	25,72	26,87

- Control drivers drove at 17% higher speed than impaired ones
- At high traffic volume, impaired drivers' mean speed is over 50% lower than the speed limit

Results 2/5

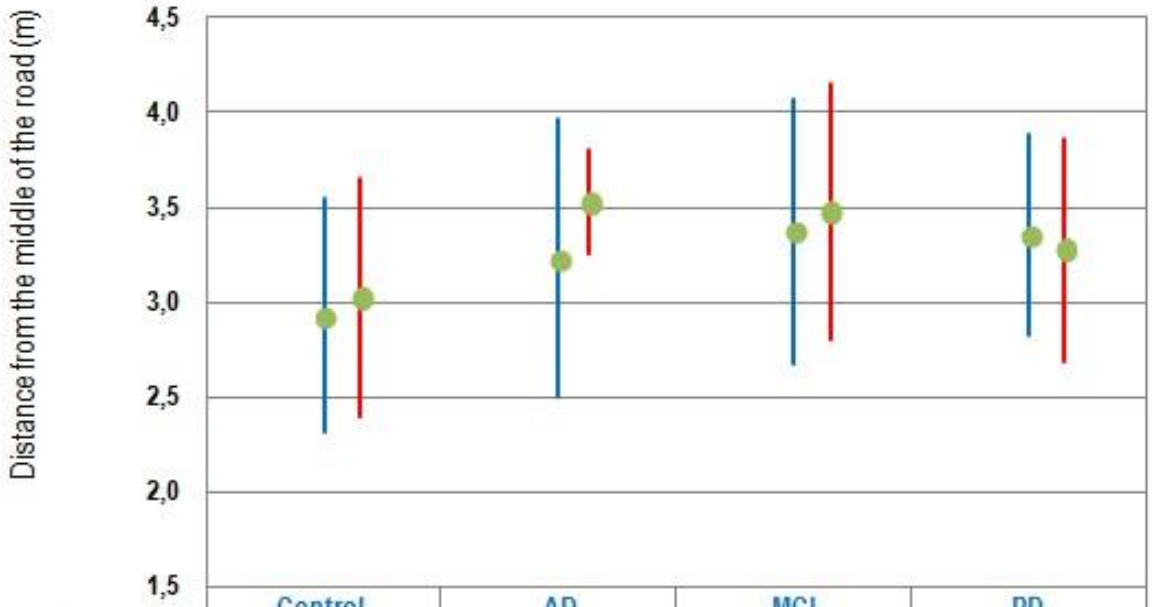


	Control	AD	MCI	PD
QL aver+stdev	137,33	154,86	128,58	124,15
QL aver-stdev	83,06	101,93	92,15	103,35
QL aver	110,20	128,40	110,36	113,75
QH aver+stdev	81,80	86,95	105,53	97,23
QH aver-stdev	33,76	53,40	64,18	31,77
QH aver	57,78	70,18	84,85	64,50

- Impaired drivers keep larger headways than controls (7% in Q_L and 27% in Q_H)
- Large variability of mean space headways for PD drivers in high traffic volume

Results 3/5

Lateral Position



	Control	AD	MCI	PD
QL aver+stdev	3,54	3,96	4,07	3,88
QL aver-stdev	2,31	2,51	2,68	2,83
QL aver	2,93	3,23	3,38	3,36
QH aver+stdev	3,66	3,80	4,15	3,87
QH aver-stdev	2,40	3,26	2,81	2,69
QH aver	3,03	3,53	3,48	3,28

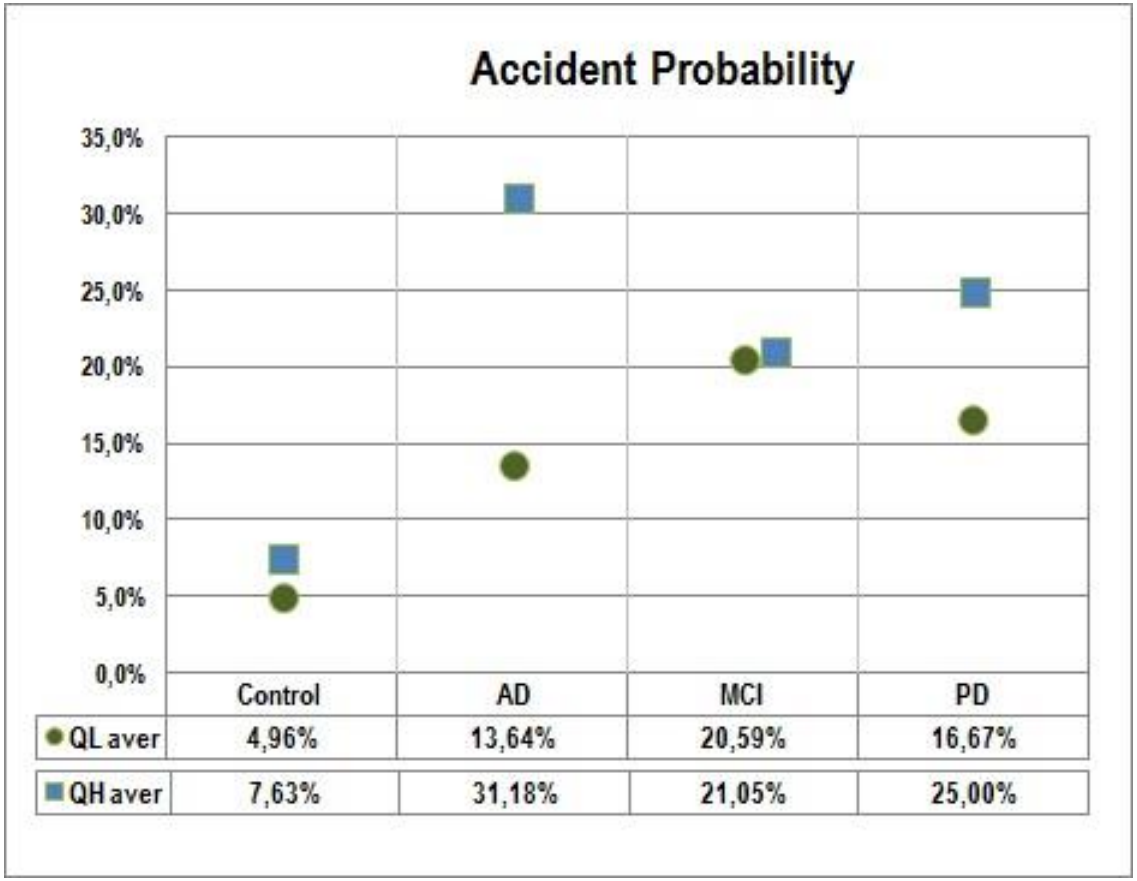
- Impaired drivers drive approximately 40cm to the right compared to the control group
- Control drivers show somewhat increased variability in lateral position

Results 4/5

	Control	AD	MCI	PD
QL aver+stdev	1,88	2,33	1,92	2,03
QL aver-stdev	0,73	1,12	0,95	1,23
QL aver	1,30	1,72	1,43	1,63
QH aver+stdev	1,74	1,92	1,95	1,46
QH aver-stdev	0,79	1,24	1,10	1,14
QH aver	1,27	1,58	1,52	1,30

- Impaired drivers have worse reaction times than the control ones (0.25 sec worse overall)
- AD drivers have the worst reaction times

Results 5/5



	Control	AD	MCI	PD
QL aver	4,96%	13,64%	20,59%	16,67%
QH aver	7,63%	31,18%	21,05%	25,00%

- Impaired drivers have higher accident probability than the control group (12% higher at low traffic, 18.1% at high traffic and 15% overall)
- It seems that high traffic volume has an effect on the accident probability at all drivers
- PD and AD drivers seem to be affected from the more difficult driving environment

Conclusions

- Cerebral diseases appear to have considerable impact on longitudinal driving performance measures, but less identifiable impact on lateral driving performance measures
- AD drivers seems to have the worse driving behaviour:
  - very low speeds
  - very large space headways
  - don’t adjust to the traffic environment
  - bad reaction times
  - very high accident probability
  - difficulties in high traffic conditions

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