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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Outline

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  - Driving in urban areas
- Objectives
- Driving simulator experiment
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- 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

• 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

• 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
• 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
• Impaired drivers keep larger headways than controls (7% in QL and 27% in QH)
• Large variability of mean space headways for PD drivers in high traffic volume
Results 3/5

- Impaired drivers drive approximately 40cm to the right compared to the control group
- Control drivers show somewhat increased variability in lateral position
• Impaired drivers have worse reaction times than the control ones (0.25 sec worse overall)
• AD drivers have the worst reaction times
• 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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