EXPLORATION OF ACCIDENT PROBABILITY OF DRIVERS WITH BRAIN PATHOLOGIES

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Background

- Driving requires the ability to receive sensory information, process the information, and to make proper, timely judgments and responses.
- Various motor, visual, cognitive and perceptual deficits can affect the ability to drive and lead to reduced driver fitness and increased accident probability.
- More specifically, diseases affecting a person’s brain functioning may significantly impair the person’s driving performance.
- Parameters associated with driving performance are reaction time, visual attention, speed of perception and processing, and general cognitive and executive functions.
- Driver distraction is estimated to be an important cause of vehicle accidents, and when combined with a brain pathology it can lead to significant deterioration in driving performance.

Objective and scope

- The analysis of the accident probability of drivers with cognitive impairments due to brain pathologies, through a large driving simulator experiment.
- The investigation of the impact of driver distraction on the accident probability.
- The brain pathologies examined include early Alzheimer’s disease (AD), early Parkinson’s disease (PD), and Mild Cognitive Impairment (MCI).
- Groups of patients are compared to a control group with no brain pathologies of similar age, driving experience and education.

Experimental Design

- Distinct and DriverBRAIN research projects.
- Neurologists - Medical/neurological assessment:
  - administration of a full clinical medical, ophthalmological and neurological evaluation
- Neuropsychologists - Neuropsychological assessment:
  - administration of a series of neuropsychological tests and psychological - behavioural questionnaires to the participants which cover a large spectrum of Cognitive Functions.
- Transportation Engineers - Driving at the simulator

“Driving at the simulator assessment”

- Concerns the assessment of driving behaviour by means of programming of a set of driving tasks for different driving scenarios.
- Quarter-cab driving simulator manufactured by the FOERST Company.
- 3 LCD wide screens 42” (full HD: 1920x1080 pixels) - total F.O.V. 170 degrees.
- Validated against a real world environment.

Sample Scheme

- 125 participants (all more than 55 years of age and of similar demographic characteristics):
- 34 Healthy Controls (aver. 64.1 y.o., 25 males)
- 91 Patients (aver. 71.2 y.o., 59 males):
  - 43 MCI patients (aver. 70.1 y.o.)
  - 28 AD patients (aver. 75.4 y.o.)
  - 20 PD patients (aver. 66.1 y.o.)

Results - Overview

- We examined and compared the accident probability of:
  - 4 examined groups (Controls vs MCI vs AD vs PD)
  - 2 driving areas (Rural vs urban)
  - 2 traffic volumes (Moderate vs high traffic)
  - and then in 3 distraction conditions (No distraction vs Conversation with passenger vs Mobile phone use).
- Regression analysis by generalized linear modeling (GLM) techniques.

Accident probability GLMs

- AD participants in all 4 driving conditions had significantly higher accident probability by more than 15% compared to healthy controls of similar demographics.
- PD participants had significantly higher accident probability than controls only in urban area in high traffic volume (the most complex driving environment of all four).
- MCI patients didn’t have significant differences with the control group in rural road, but on the other hand they had higher accident probability in urban driving environment.

The effect of distraction

- Mobile phone use had a detrimental impact on the accident probability of all patient groups whereas conversation with passenger had significant impact on the accident probability in urban area for PD group.
- MCI drivers’ accident probability was more than 20% while conversing through mobile phone.
- The accident probability of AD drivers was 43%(!) and of PD drivers was 38% in rural area while conversing through mobile phone.

Conclusions

- The presence of a brain pathology had a detrimental impact on accident probability and especially for the AD patients who crashed approximately 1 out of 5 incidents.
- The traffic volume didn’t have any significant effect on the accident probability.
- Urban area leads to increased accident probability for the group of patients with brain pathologies (especially for the PD patients).
- The control group seemed unaffected regarding their accident probability when being distracted.
- The use of the mobile phone had a deleterious effect on the accident probability of all three groups of patients in almost every examined condition.

- AD drivers had the worst “accident probability profile” followed by the PD group but only in urban area which constitutes a more complex driving environment. MCI group had an overall lower accident probability compared to AD and PD groups, but not compared to the healthy drivers.