WHICH ARE THE CRITICAL MEASURES TO ASSESS THE DRIVING PERFORMANCE OF DRIVERS WITH BRAIN PATHOLOGIES?

D. Pavlou, I. Beratis, E. Papadimitriou, C. Antoniou, G. Yannis, S.G. Papageorgiou

Department of Transportation Planning and Engineering, NTUA, 5 Heroon Politechniou str., GR-15773, Athens, Greece

2nd Department of Neurology, “Attikon” University General Hospital, NKUA, 75 Mikras Asias str., GR-11527, Athens, Greece

Overview

• The objective is to identify the driving performance measures in which drivers with brain pathologies significantly deviate from the general population.
• A driving simulator experiment: 109 drivers with cognitive impairments (MCI, AD and PD) vs 31 healthy drivers of similar demographics, compared at the following parameters: mean speed, time headway, lateral position, reaction time at incidents
• Hypothesis: the presence of a brain pathology has a negative effect on the driving performance measures.
• All driving indexes were compared to the range of “typical” values of the respective distribution of healthy drivers. Thus, we expected that the group of patients significantly deviate from the range of “typical values” of the control group, in most cases.

Overview of the experiment

• Medical/neurological assessment: a full clinical medical, ophthalmological and neurological evaluation
• Neuropsychological assessment: a series of neuropsychological tests and psychological - behavioura! questionnaires to the participants
• Driving at the simulator: assessing the driving behaviour of participants by means of programming of a set of driving tasks into a driving simulator for different driving scenarios.

Driving at the simulator assessment

• Quarter-cab driving simulator manufactured by the FOERST Company
• 3 LCD wide screens 42”, full HD: 1920x1080pixels
• total field of view 170 degrees, validated against a real world environment
• At first, one practice drive (usually 10-15 minutes)
• Afterwards, the participant drives two sessions (approx. 10 minutes each)
• Each session corresponds to a different road environment:
  - a rural route, single carriageway, zero gradient, mild horizontal curves
  - an urban route, at its bigger part dual carriageway, separated by guardrails.
  Two traffic controlled junctions, one stop-controlled junction and one roundabout are placed along the route.
• During each trial, 2 unexpected incidents are scheduled to occur:
  - sudden appearance of an animal (deer or donkey) on the roadway
  - appearance of a child chasing a ball on the roadway or of a car suddenly getting out of a parking position.

Sampling size

• 140 participants (all more than 55 y.o.
  and of similar demographic characteristics): 31 Healthy Controls (aver. 64.5 y.o., 20 males)
• 109 Patients (aver. 69.0 y.o., 80 males)
• 25 AD (aver. 75.4 y.o.), 59 MCI (aver. 70.1 y.o.), 25 PD (aver. 66.1 y.o.)

Analysis method

Control groups’ mean values minus one standard deviation and plus one standard deviation include 68.26% of the values of healthy controls (according to the normal distribution). This area is defined by our research team as the “typical area”. The individual driving indexes of all participants with cerebral diseases were compared to this “typical area”.

Results

The between-group comparisons in the 7 key driving performance indexes indicated significant differences between the two groups in mean speed in both driving areas, headway in rural area, and reaction time. Patients with brain pathologies drove at lower speeds, had less variability in their mean speed, kept larger headways and had significantly worse reaction times than their cognitively intact counterparts.

• 44% of the drivers with a brain pathology in rural area have keep very large headways.
• In urban area this percentage is significantly lower (12%) and 20% of the patients have very large variability in their time headways whereas 12% has significantly lower
• 45% of the patients in rural area and 26% in urban area have larger reaction times than the control group (especially the AD group: 50%)

Conclusions

• The low mean speed of the group of patients and their low variabilities, indicate conservative driving behaviour and self-regulation of their driving behaviour.
• The more complex the driving environment is, the more difficult is for the patients to maintain the position of the vehicle in the lane.
• Participants with brain pathologies had significantly longer reaction times in both rural and urban areas in comparison to the control group.
• 70% of the patients with cerebral diseases had reaction times larger than 2 sec.
• The critical road safety measures to assess the driving performance of drivers with brain pathologies are the mean speed, the lateral position variability and the reaction time, but more importantly the critical measure is the combined assessment, in order to have a complete driving profile of each driver.
• This driving performance profile could provide quite useful information for the formulation of efficient driving recommendations which have the capacity to reduce the accident risk in a sensitive group of car drivers, such as MCI, AD or PD.

Acknowledgements

This paper is based on two research projects implemented within the framework of the Operational Program “Education and Lifelong Learning” of the National Strategic Reference Framework (NSRF), namely the Research Funding Program: THALES; Investing in knowledge society through the European Social Fund, and the Action: ARISTEIA (Action’s Beneficiary: General Secretariat for Research and Technology), co-financed by the European Union (European Social Fund) and Greek national funds.