Driving performance profiles of drivers with brain pathologies in rural roads

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Introduction
Despite the fact that road traffic casualties presented a constantly decreasing trend during the last years, the number of fatalities in road accidents in several countries in Europe and in Greece in particular is still unacceptable and illustrates the need for even greater efforts with respect to better driving performance and increased road safety.

• Older drivers generally exhibit a higher risk of involvement in a road accident
• A number of brain pathologies may affect driving performance in the general population and particularly in the elderly. More specifically, diseases affecting a person's brain function (e.g. presence of specific brain pathology due to cerebral diseases such as Mild Cognitive Impairment (MCI), Alzheimer’s disease (AD), Parkinson’s disease (PD), may significantly impair the person’s driving performance, especially when unexpected incidents occur.

Objectives
• present and analyze the driving performance profiles of drivers with some brain pathology in rural driving environment, by means of a simulator experiment
  • brain pathologies examined are AD, PD, MCI, and others
  • driving performance measures examined: mean speed, lateral position, steering angle, time headway, reaction time, error rates, the driving performance of drivers impaired by the brain pathologies is compared to that of healthy controls by means of descriptive statistics

Driving simulator experiment
• Distinct and DriverBrain research projects
  ✓ Medical/neurological assessment (full clinical medical, ophthalmological and neurological evaluation)
  ✓ Neuropsychological assessment (a series of neuropsychological tests and psychological-behavioural questionnaires)
  ✓ Driving at the simulator (concerns the driving behaviour 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 FOERTST Company (3 LCD wide screens 42”, full HD, 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 one rural session (2.1 km long, single carriageway, zero gradient, mild horizontal curves, approximately 15 minutes)
• Two traffic scenarios examined:
  ✓ Low traffic conditions (Q=300 vehicles/hour)
  ✓ High traffic conditions (Q=600 vehicles/hour)
• Consequently, each participant drives 2 trials of the simulated route
• During each trial, 2 unexpected incidents are scheduled to occur:
  ✓ sudden appearance of an animal (deer or donkey) on the roadway (photo)

Results (longitudinal control measures)
Mean Speed
• Control drivers drove the trial road section at approximately 16% higher speed than impaired drivers in both low and high traffic volumes and have lower variability in their speed
• Impaired drivers keep much larger headways than control ones (more than 50% larger)
• Impaired drivers have very large variability in headways along the driving route. This means that they cannot adjust their speed and have difficulties in keeping constant and safe headways.
• The lateral position profiles present a large variability in impaired drivers’ lateral position along the route, which means difficulties in positioning the vehicle properly in the lane
• The higher the traffic is, the more variability in steering angle the control drivers have, whereas the lower traffic volume is, the more variability in wheeling angle the impaired drivers have.
• It is possible to explain that in high traffic volumes healthy drivers may try to overtake the vehicle ahead and thus they have variability in wheeling angle, whereas impaired drivers (who drive at lower speeds) may use the vehicle ahead as a “guide” and just drive behind them conservatively. In every case, this finding is very interesting and will be examined in the future in a larger sample
• Finally, drivers suffering from brain pathology have significantly larger reaction times in both traffic environments compared to the control group (almost 30% worse reaction times)
• All above results are quite promising and confirm the initial hypotheses of the research that brain pathologies may deteriorate driving performance in several ways
• Finally, the results are to be considered within the limiting context of driving simulator studies – driving performance is known to be more accurate and reliably estimable by means of on-road studies

Speed profiles
• All drivers present very similar speed profiles in terms of general shape
• Healthy drivers drove the trial road section at higher speeds than impaired drivers
• It is also observed that the difference between the two traffic volumes is obvious in both examined groups

Lateral Position Profiles
• Lateral position profiles between healthy drivers and impaired drivers exhibit more similarities in terms of overall shape of the profile and magnitude of the expected measures.
• It seems that high traffic conditions lead drivers to drive to the right border of the road

Conclusions and discussion
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• The lateral position profiles present a large variability in impaired drivers’ lateral position along the route, which means difficulties in positioning the vehicle properly in the lane
• The higher the traffic is, the more variability in steering angle the control drivers have, whereas the lower traffic volume is, the more variability in wheeling angle the impaired drivers have.
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