

Assessment of driving performance of drivers with cognitive impairments: which are the critical measures?

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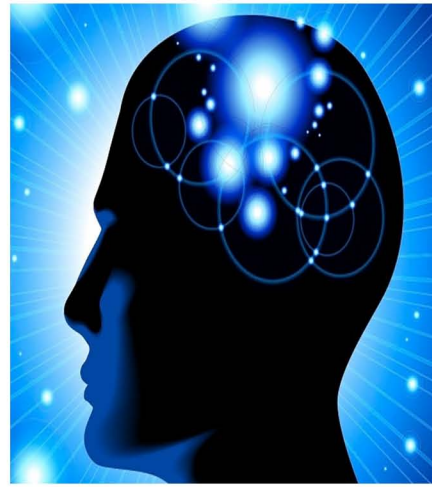
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OVERVIEW

This paper aims to identify driving performance measures in which drivers with cognitive impairments significantly deviate from the general population. The driving performance of 109 drivers with cognitive impairments (Mild Cognitive Impairment - MCI, Alzheimer's Disease - AD and Parkinson's Disease - PD) is compared to the driving performance of 31 healthy drivers of similar age, through a driving simulator experiment.

For each driver, the following driving performance measures are calculated: speed, speed variability, lateral position, lateral position variability, headway, headway variability, steering angle, steering angle variability, and reaction time at incidents. These are compared to the range of "typical" values of the respective distribution of healthy drivers, and significant deviations from the "typical" distribution are identified.

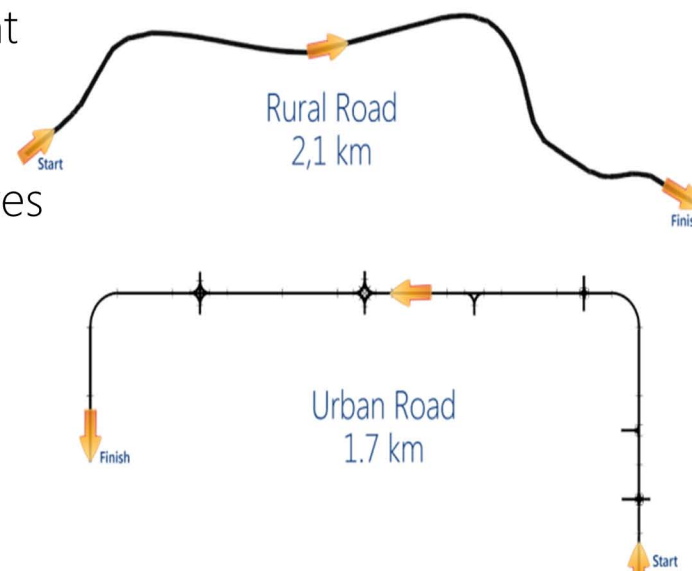


DRIVING SIMULATOR EXPERIMENT

- Distract and DriverBrain research projects
- Neurologists - Medical/neurological assessment: a full clinical medical, ophthalmological and neurological evaluation
- Neuropsychologists - Neuropsychological assessment: a series of neuropsychological tests and psychological - behavioural questionnaires to the participants
- Transportation Engineers - 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

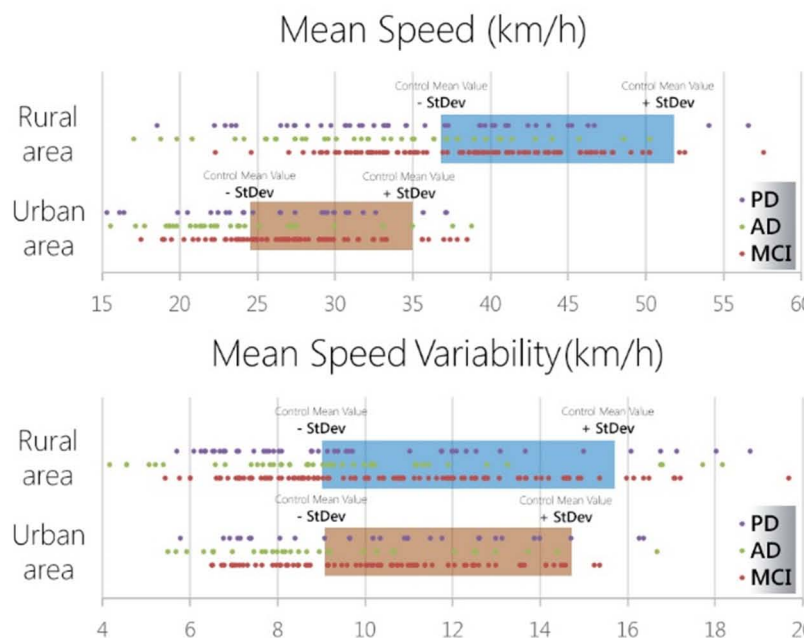
- quarter-cab driving simulator manufactured by the FOERST Company (3 LCD wide screens 42", full HD: 1920x1080pixels - total field of view 170 degrees, validated against a real world environment)
- At first, one practice drive (usually 10-15 minutes)
- Afterwards, the participant drives **two sessions** (approximately 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
 - sudden appearance of a child chasing a ball on the roadway or of a car suddenly getting out of a parking position.



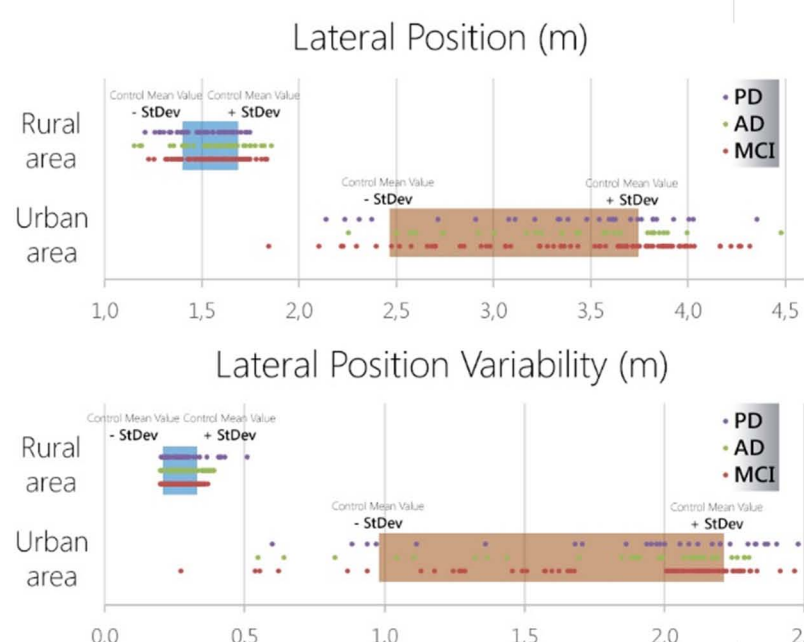
SAMPLING SCHEME AND ANALYSIS METHOD

- Sample - 140 participants (all more than 55 years of age 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 patients (aver. 75.4 y.o.), 59 MCI patients (aver. 70.1 y.o.), 25 PD patients (aver. 66.1 y.o.)
- Analysis method - Control groups' mean values minus one standard deviation and plus one standard deviation include 68.2% of the values (according to the normal distribution). This area is considered to be the "typical" area. The driving performance values of the 3 groups of patients are compared with the "typical" values of the control group.

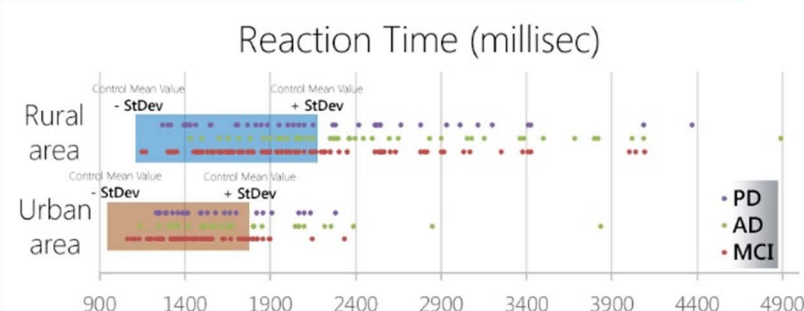
RESULTS



- 52% of the patients have extremely low mean speeds (especially the AD group-69%)
- Drivers with a brain pathology have significantly lower speed variability (42% of the cases) than controls
- 11% of PD drivers have significantly high speed variability



- 44% of the drivers with a brain pathology in rural area have keep very large time headways
- In urban area this percentage is significantly lower (12%)
- 20% of the patients have very large variability in their time headways whereas 12% has significantly lower



CONCLUSIONS

- Patients' driving speed is **very low** in most cases
- Regarding the lateral control measures, the drivers with cerebral diseases tend to **have difficulty in positioning the vehicle on the lane**
- All drivers with brain pathologies have significantly worse reaction times
- **All patients (and especially the AD drivers) have difficulties in various driving performance measures compared with the "typical values" of control drivers.**

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