

## OBJECTIVES

The objective of this paper is to estimate the accident risk of drivers with cognitive impairments in a driving simulator task. The accident risk of drivers cognitively impaired due to specific pathologies (Mild Cognitive Impairment - MCI, Alzheimer's Disease - AD and Parkinson's Disease - PD) is calculated as the rate of the number of accidents to the number of unexpected incidents, both occurring during a driving simulator task in a rural and urban road environments. The accident risk rates of patients are compared to those of healthy drivers of similar age groups.

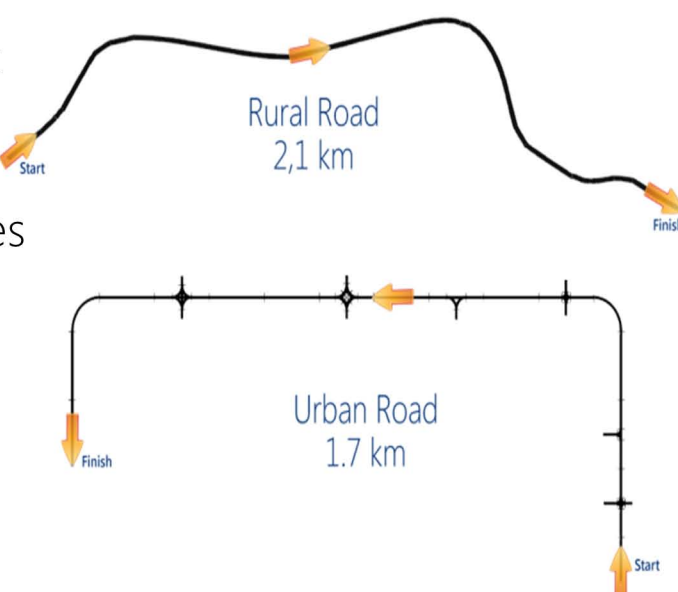


## DRIVING SIMULATOR EXPERIMENT

- Distract and DriverBrain research projects
- Neurologists** - Medical/neurological assessment: a full clinical medical, ophthalmological and neurological evaluation, in order to well document the characteristics of each of these disorders.
- Neuropsychologists**-Neuropsychological assessment: a series of neuropsychological tests and psychological - behavioural questionnaires to the participants which cover a large spectrum of Cognitive Functions: visuospatial and verbal episodic and working memory, general selective and divided attention, reaction time, processing speed, psychomotor speed etc.
- 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 15 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.



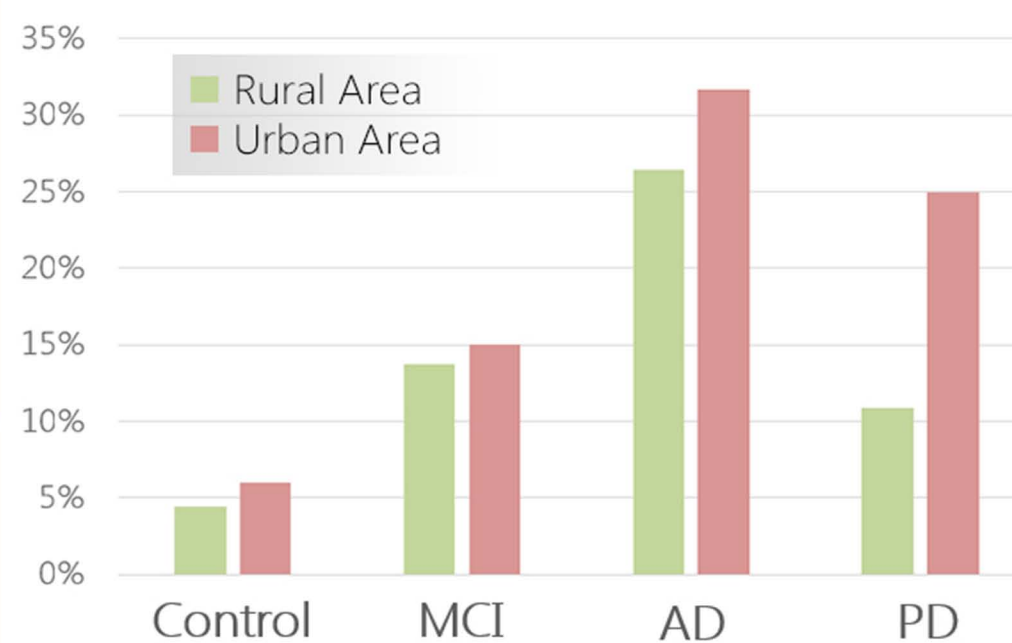
## SAMPLE SCHEME

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

Accident risk analyzed by descriptive statistics at first and then appropriate mathematical models were developed. The statistical analysis method selected is the mixed generalized linear model (GLM)

### Accident Risk



Parameter Estimates							
Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	0,083	0,017	0,049	0,117	22,9	1	,000
MCI	0,045	0,025	-0,003	0,093	3,4	1	,066 *
AD	0,173	0,033	0,108	0,238	27,0	1	,000 **
PD	0,078	0,034	0,011	0,144	5,3	1	,022 **
Control	0 <sup>a</sup>						
(Scale)	,071 <sup>b</sup>	0,004	0,063	0,079			

Dependent Variable: Accident Risk (rural area)

Model: (Intercept), Disease

a. Set to zero because this parameter is redundant.

b. Maximum likelihood estimate.

## RESULTS 1/2

- Descriptive statistics indicate that all drivers with cerebral diseases have higher accident risk than the control group in both driving areas.
- AD group has 5 times higher accident risk than the control one.
- PD group has more than double accident risk in urban area than in rural area.
- MCI group has more than double accident risk in both driving environments than the control one.

## RESULTS 2/2

GLM in rural area indicates statistically significant differences between the control drivers and the AD and the PD drivers, whereas in urban area the accident risk is significantly higher in all groups of patients, compared with the control one.

Parameter Estimates							
Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	0,052	0,018	0,016	0,088	8,0	1	,005
MCI	0,082	0,026	0,031	0,133	10,0	1	,002 **
AD	0,217	0,036	0,146	0,287	36,2	1	,000 **
PD	0,122	0,037	0,048	0,195	10,6	1	,001 **
Control	0 <sup>a</sup>						
(Scale)	,052 <sup>b</sup>	0,004	0,045	0,059			

Dependent Variable: Accident Risk (urban area)

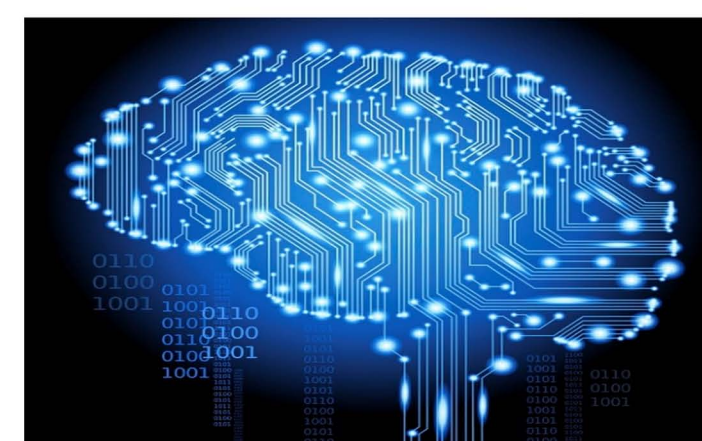
Model: (Intercept), Disease

a. Set to zero because this parameter is redundant.

b. Maximum likelihood estimate.

## CONCLUSIONS

- Accident risk is slightly increased in urban driving environment than rural one, in all examined groups
- AD drivers have the higher accident risk compared with all other examined groups
- AD drivers crashed more than 1 out of 4 incidents
- PD drivers in urban area have more than 100% higher accident risk than rural area
- Overall, patients have significantly higher accident risk than the control ones.
- Even they drive slower (Pavlou et al., 2015); they are more likely to crash the incident that unexpectedly happens in front of them.



## ACKNOWLEDGEMENT

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