To which extent the driving behavior of older drivers with neurological diseases affecting cognition is different after an unexpected incident?

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Introduction

- **Driving in traffic** is not just knowing how to handle the basic operating mechanisms of the vehicle.
- **It is a task of high cognitive complexity** which requires the driver to receive sensory information, process this information quickly, and make proper, timely judgments and responses.
- **Cognitive functions** which decline over age are of critical importance regarding driving performance.
- **Diseases** affecting a person's brain functioning, may **significantly impair the person's driving performance**.

This study's objective is **the comparison of driving behaviour of elderly drivers before and after an unexpected incident**, through a large driving simulator experiment.

Overview of the experiment

- **Medical/neurological assessment**: a full clinical medical, ophthalmological and neurological evaluation
- **Neuropsychological assessment**: a series of neuropsychological tests and psychological - behavioural 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.
- The impact of several risk factors namely, **the presence of a neurological disease affecting cognition**, and the **mobile phone use** while driving is investigated.
- The driving behaviour was examined in terms of **lateral position and mean driving speed** of the vehicle and the neurological diseases affecting cognitive functions concern diseases with high prevalence in the general population: Alzheimer's disease (AD), Parkinson's disease (PD), and Mild Cognitive Impairment (MCI).

Driving at the simulator assessment

- FOERST **Quarter-cab driving simulator** 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 **at a rural route** (approx. 10 minutes), single carriageway, zero gradient, mild horizontal curves
- **One route with mobile phone use** and one without distraction.
- During each trial, **2 unexpected incidents** are scheduled to occur:
  - sudden appearance of an animal (deer or donkey) on the roadway

Sample size

- **125 participants** (76% males) (>55 y.o. and of similar demographics)
- **34 Healthy Controls, 28 AD, 43 MCI, 20 PD patients**

Methodology

- Simulator Data **40 seconds before** the start of the event and **40 seconds after the event** is fully completed, **were isolated**
- **2 General Linear Mixed Models** in order to mathematically quantify the impact of the examined cerebral diseases and of other risk factors to the **mean speed and the lateral position of the vehicle** before and after an incident.

Table 1. GLM parameter estimates for **mean speed before and after an unexpected incident**

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	**-28.39**	0.50	-56.98	< 2e-16 ***
Mobile Phone	**-1.72**	0.47	-3.66	0.000265 ***
Parkinson's Disease	**-4.56**	0.67	-6.77	1.76e-11 ***
Alzheimer's Disease	**-3.48**	0.66	-5.23	1.85e-07 ***
Mild Cognitive Impairment	**-1.98**	0.54	-3.70	0.000219 ***
Gender	**-1.03**	0.41	-2.52	0.011914 *
Experience	**0.10**	0.01	7.45	1.41e-13 ***
Signif. codes:	*0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*			

Table 2. GLM parameter estimates for **lateral position before and after an unexpected incident**

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	**-0.11**	0.7	-2.08	0.048123*
Mobile Phone	**-0.07**	0.02	-3.43	0.000619***
Parkinson's Disease	**-0.05**	0.26	-2.17	0.041772*
Gender	**-0.06**	0.17	-3.68	0.000241***
Experience	**0.002**	0.001	3.30	0.000984***
Signif. codes:	*0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*			

Discussion

- The existence of an unexpected incident seem to **alternate the driving behaviour** of the elderly drivers: **Their mean driving speed is reduced** and also they **tend to drive more closely to the right border of the road**.
- What should be highlighted though is the impact of **MCI, AD, PD, and mobile phone use** to the model. All these risk factors **significantly reduce driving speed after an unexpected event, even more** (PD had the greatest influence on the model)
- Regarding the lateral position, the **use of mobile phone and the existence of PD** lead to drive **even more closely to the right border** of the road after the incident.
- Patients with cerebral diseases and **especially PD follow a more conservative pattern of driving behavior**, compared to the control group, in order to compensate the driving difficulties such as an unexpected incident or/and mobile phone use.

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