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International Congress
19.–20. June 2013 / Palais Ferstel Vienna
MOBILITY & ROAD SAFETY IN AN AGEING SOCIETY

A large driving simulator experiment on driver distraction of older drivers

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Outline

- Background
- Objectives
- Key research variables
- Overview of the experiment
- Medical assessment
- Neuropsychological assessment
- Driving simulator experiment
- Preliminary results
- Discussion

Background

- The **Distract** research project distrACT www.nrso.ntua.gr/distract
  - "**Analysis of causes and impacts of driver distraction**"
  - Causes: engodenous & exogenous, Impacts: driver behaviour & safety
  - Drivers from the general population, as well as drivers with altered cognition due to cerebral diseases with high prevalence: e.g. Mild Cognitive Impairment (MCI), mild Alzheimer's Disease.
- The **DriverBrain** research project driverBRAIN www.nrso.ntua.gr/driverbrain
  - "**Analysis of the performance of drivers with cerebral diseases**" altering cognition
  - Alzheimer's Disease, Parkinson's disease, Cerebrovasular disease - both in their MCI (pre-dementia) stages, but also in their mild dementia stages.
- An **interdisciplinary research team** Department of Transportation Planning and Engineering, NTUA; Department of Neurology, Psychiatry and Social Medicine, UoA; Department of Psychology, UoA
  - Dpt. of Transportation Planning and Engineering of the NTUA
  - Dpt. of Neurology of the University of Athens (NKUA) Medical School, ATTIKON General University Hospital, Athens
  - Dpt. of Psychology (NKUA) School of Philosophy, Pedagogy and Psychology
- A **common simulator experiment** 

Objectives

- To present the design and preliminary results of a simulator experiment which:
  - Has a twofold objective
    - Impacts of driver distraction
    - Performance of drivers
  - Targets two groups of drivers
    - Drivers from the general population
    - Drivers with a mild pathological condition

Key research variables

- Diseases & conditions targeted
  - Parkinson's (PD), Alzheimer's (AD), (patients must be still able to drive)
  - Mild Cognitive Impairment (MCI), mainly pre-dementia stage of AD
  - In terms of driving performance, but also as 'endogenous' causes of distraction

- Exogenous distraction causes
  - Use of mobile phone (hand-held)
  - Conversation with passenger

- Road and traffic variables
  - Area type (urban / rural)
  - Traffic volume (moderate, high)

Sample design & characteristics

- Healthy drivers & impaired drivers: oversampling of ages >55 years

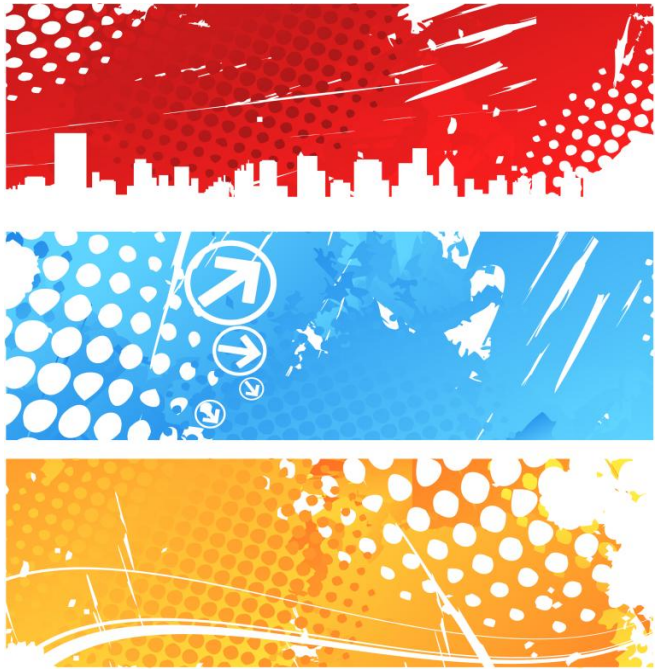
Age	Impaired	Healthy	Total
> 55	125	75	200
< 55	50	50	100
Total	**175**	**125**	**300**

- Duration: 3 years

  Fall 2012 – Fall 2015 (incl. analysis)

Phases of the experiment

- **Part 1. Medical, Clinical & Neurological evaluation**
  Attikon General Hospital, (~1,5 hours)
- **Part 2. Neuropsychological Assessment**
  Attikon General Hospital, (~2 hours)
- Questionnaire on driving habits
  At home (~20 minutes)
- **Part 3. Driving simulation experiment**
  NTUA Driving Simulator (~1,5 hour)



- Part 1B. Medical evaluation, Part 2B. Neuropsychological Assessment
  Attikon General Hospital, (~1 hours)

Medical/neurological assessment

- **Comprehensive Clinical Evaluation** (general medical and neurological)
  - Present & past history, pharmacological treatment, life habits (alcohol consumption, smoking, etc)
  - Detailed neurological examination (neurological signs: markers for a disease)
  - Psychiatric assessment for depression, anxiety, behavioral disturbances
  - Ophthalmological evaluation: visual acquity, visual fields, fundoscopy

  - **Motor ability-tests in Fitness to Drive**: Specific clinical tests examining motor control, balance, visual fields etc. related to driving skills

Neuropsychological assessment

- **Comprehensive Neuropsychological Evaluation**
- Tests covering a large spectrum of Cognitive Functions:
  - Visuo-spatial, verbal episodic and working memory
  - General, selective and divided attention
  - Reaction time
  - Processing speed, psychomotor speed
- Associated with fitness to drive:
  - MMSE: General Cognitive State
  - Clock Drawing Test
  - Hopkins Verbal Learning Test
  - Trail Making Test
  - Useful Field of View

Driving simulator experiment (1/2)

- 2 blocks with up to 6 trials each
- 1,7 km for each urban trial - 2,0 km for each rural trial (3 ,0 - 3,5 minutes on average)
- Randomized between and within block-trials
- Incidents at fixed points

Block	Trial	Area type	Traffic	Distractor	Length (km)	Duration (min)
1	1	Urban	Moderate	None	1,7	3,5
	2	Urban	High	None	1,7	3,5
	3	Urban	Moderate	Cell phone	1,7	3,5
	4	Urban	High	Cell phone	1,7	3,5
	5	Urban	Moderate	Passenger conversation	1,7	3,5
	6	Urban	High	Passenger conversation	1,7	3,5
2	1	Rural	Moderate	None	2,0	3,0
	2	Rural	High	None	2,0	3,0
	3	Rural	Moderate	Cell phone	2,0	3,0
	4	Rural	High	Cell phone	2,0	3,0
	5	Rural	Moderate	Passenger conversation	2,0	3,0
	6	Rural	High	Passenger conversation	2,0	3,0
				Total	**22,2**	**39,0**

Driving simulator experiment (2/2)

- Traffic scenarios
  - **Input**: Vehicle headways drawn from a Gamma distribution with a given mean and variance
  - **Output**: The specific traffic volume experienced per trial for each participant
- Quantitative indicators - Trial specific (automatically recorded)
  - Reaction time
  - Speed (& difference from mean)
  - Lateral position (& difference from mean)
  - Steering angle (& difference from mean)
  - Accident probability at specific incident
    - Urban drive: parked car enters the road, a child with a ball crosses the road
    - Rural drive: sudden appearance of animal

Preliminary results (1/5)

- Basic facts
  - Participants so far: **31** [aver. **63,6 years old**-(stdev 13,1), **22 males**]
  - Impaired: **20** (**9 MCI, 4 AD, 7 PD**)
  - Control: **11**
  - Duration: **15 weeks**
- Simulator driving: (completed by)
  - No distraction drive: **31/31 rural area, 27/31 urban area**
  - Distraction: Conversation with passenger: **30/31 rural area, 24/31 urban area**
  - Distraction: Mobile phone: **9/31 rural area, 8/31 urban area (6 controls)**
- Questionnaires:
  - Driving behaviour questionnaire (filled in at home)
  - Self-assessment and memory questionnaire (filled in after the experiment)

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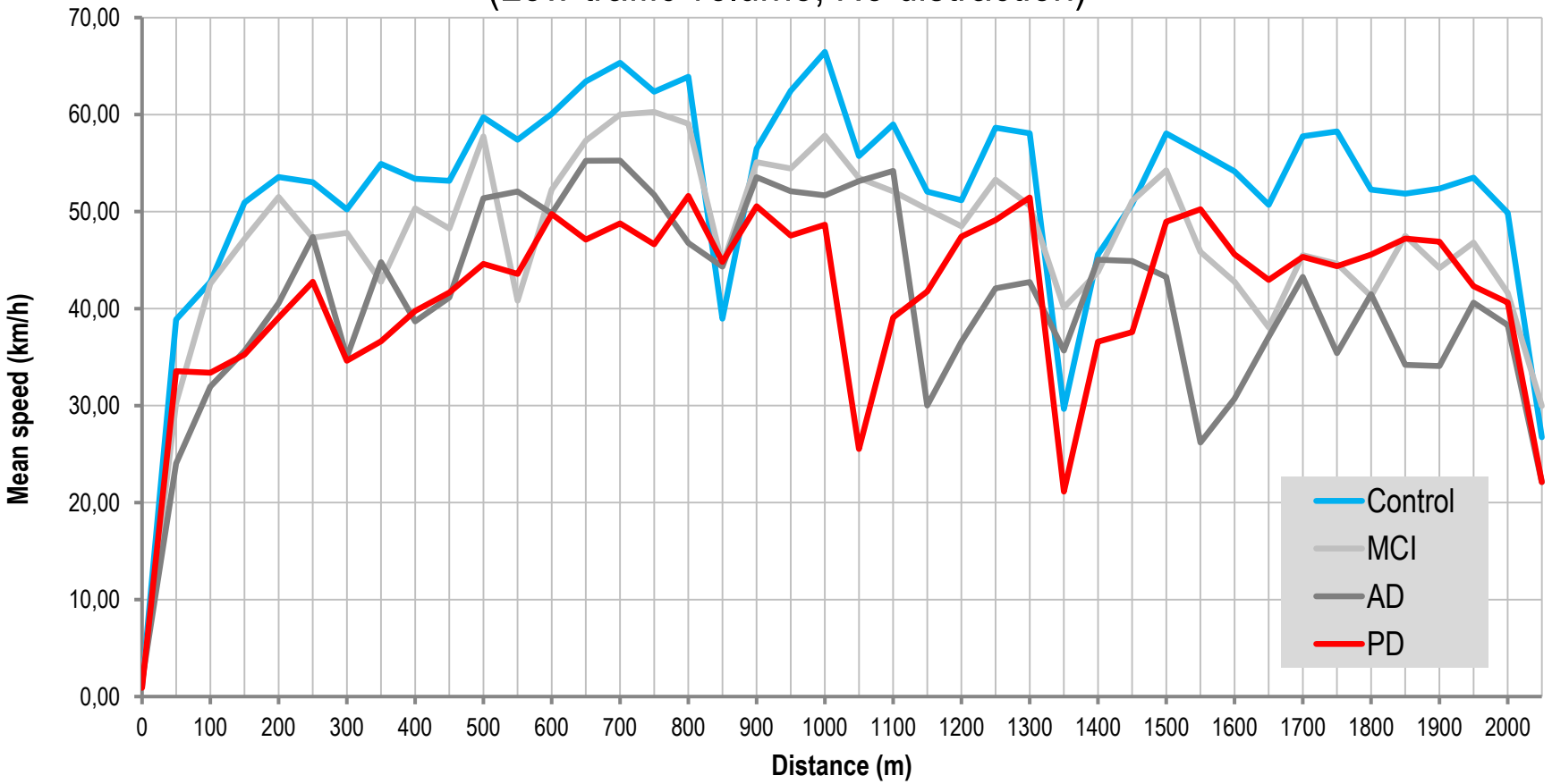
Preliminary results (2/5)

- Simulator sickness
  - Simulator sickness: **11/31** (5PD, 1AD, 3 MCI, 2 Control)
  - Soft symptoms: **5/31**
  - Intense symptoms: **6/31**
  - Would like to continue the driving despite the symptoms: **3/31**
  - Completed only 1 or 2 trials: **4/31** (3PD, 1AD)
  - Drop out: **only 1** (Intense symptoms and stop from the beginning)

Preliminary results (3/5)

Mean speed profile along the route in the **rural area**

(Low traffic volume, No distraction)



Preliminary results (4/5)

Reaction time at unexpected incident in **Rural area** and with **Low traffic volume**

Reaction Time (sec)	Participants	Events	No distraction	Distraction*
Healthy drivers	**11**	**52**	**1,73**	**1,52**
Impaired drivers	**20**	**71**	**2,02**	**2,06**
MCI	*9*	*36*	*1,94*	*1,60*
AD	*4*	*13*	*2,32*	*3,04*
PD	*7*	*22*	*2,00*	*2,46*
			* Conversation with passenger	

Mean Speed in **Rural area** and with **Low traffic volume**

Mean Speed (km/h)	Participants	Trials completed	No distraction	Distraction*
Healthy drivers	**11**	**25**	**49,01**	**50,71**
Impaired drivers	**20**	**35**	**41,13**	**41,29**
MCI	*9*	*17*	*44,53*	*39,77*
AD	*4*	*7*	*37,63*	*39,31*
PD	*7*	*11*	*39,34*	*47,29*
			* Conversation with passenger	

Preliminary results (5/5)

Average Lateral Position in **Rural area** and with **Low traffic volume**

Lateral Position* (km/h)	Participants	Trials completed	No distraction	Distraction**
Healthy drivers	**11**	**25**	**0,77**	**0,81**
Impaired drivers	**20**	**35**	**0,82**	**0,89**
MCI	*9*	*17*	*0,82*	*0,90*
AD	*4*	*7*	*0,72*	*0,86*
PD	*7*	*11*	*0,87*	*0,89*
* Distance from the right road board			** Conversation with passenger	

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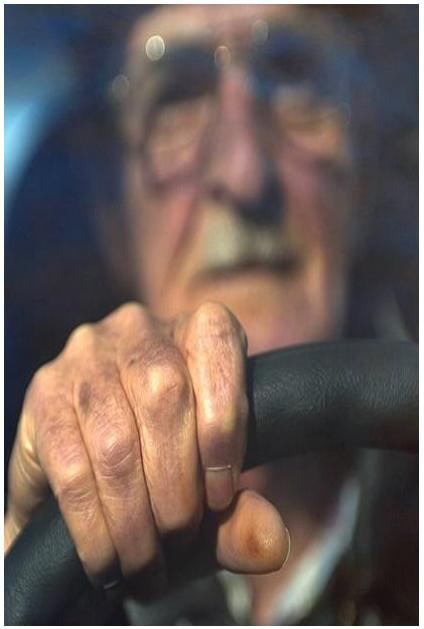
Conclusions

- An interdisciplinary approach by engineers, doctors and psychologists allows for better insight on driver behaviour.
- **The fundamental research challenge is the separation of the age effect from the cerebral disease effect to older driver behaviour.**
- Analysis of behaviour of several driver sub-groups requires a large sample, with identical experiment conditions. The optimum number of parameters to examine should be defined.
- Analysis results from driving simulator experiments do not always represent real driving behaviour, however the relative behaviour between the different sub-groups examined can be well demonstrated.



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