Driving errors, accidents and their predictors in patients with cognitive disorders

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Athens, 26 June 2015

To drive or not to drive

To drive or not to drive

distrACT driverBRAIN

Introduction

- Life loss in elderly represent the **26% of all life losses from car accidents in the EU** (Eurostat, 2014)

- Cognitive functions contribute to a successful driving

- **Cognitive functions are compromised in ~25% of the elderly population.** Diverse etiologies:
  - Degenerative: AD (AD dementia – or prodromal AD -amnestic MCI), PD, DLB,…
  - Vascular (VaD or Vascular MCI),
  - Drug induced,….

- Taking into account that the % of the elderly in society is increasing while at the same time the level of motorization also increases (Yannis et al, 2010), **the need to investigate the impact of the above conditions on driver performance becomes critical**.

There is role for the neurologist

- ADVICE about the issue: “to drive or not to drive”
- ADVICE about the issue: “how and when to drive”

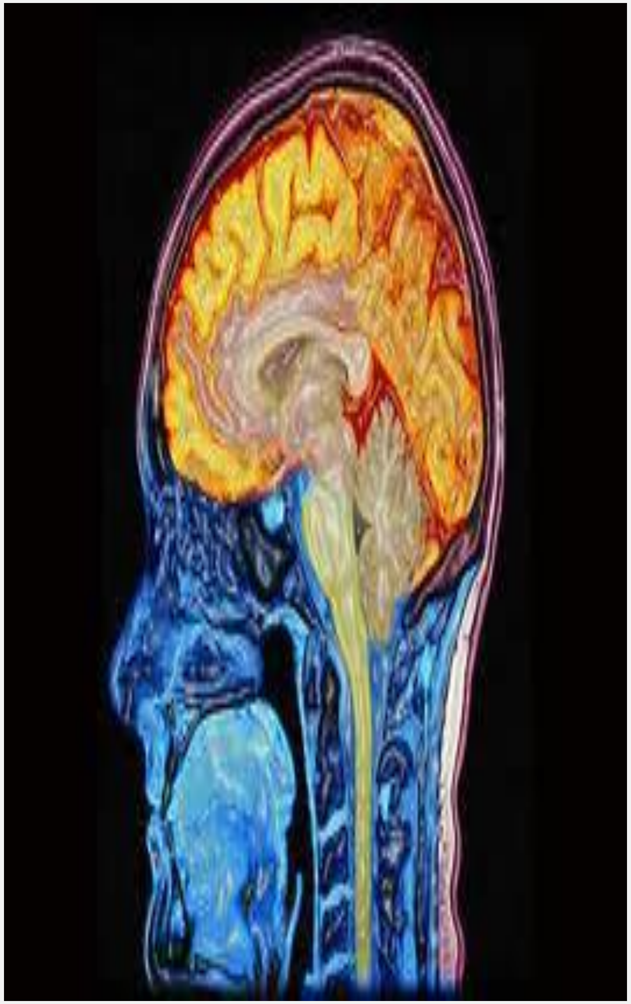
  (defining restrictions for safe driving in a patient)

- ADVICE for adaptations of national regulations
- ADVICE for adaptations of vehicles (e.g. reminders), adaptations of roads (e.g. frequency of road signals)

- In close collaboration with other scientists (multi disciplinary approach)

Cognitive functions critical for safe driving

- **Attention**
  - **quick perception** of the environment
- **Visuospatial skills**
  - **positioning** of the car on the road
  - manoeuvring the car in lane changes
  - judging **distances**, speed
- **Executive functions**
  - process multiple simultaneous environmental cues
  - **predicting** the development of traffic situations
  - make rapid, accurate and safe **decisions**
- **Memory**
  - journey planning
  - adapting behaviour
  - sign recognition, memorization



(adapted form Reger et al. 2004)

Age-related cognitive decline

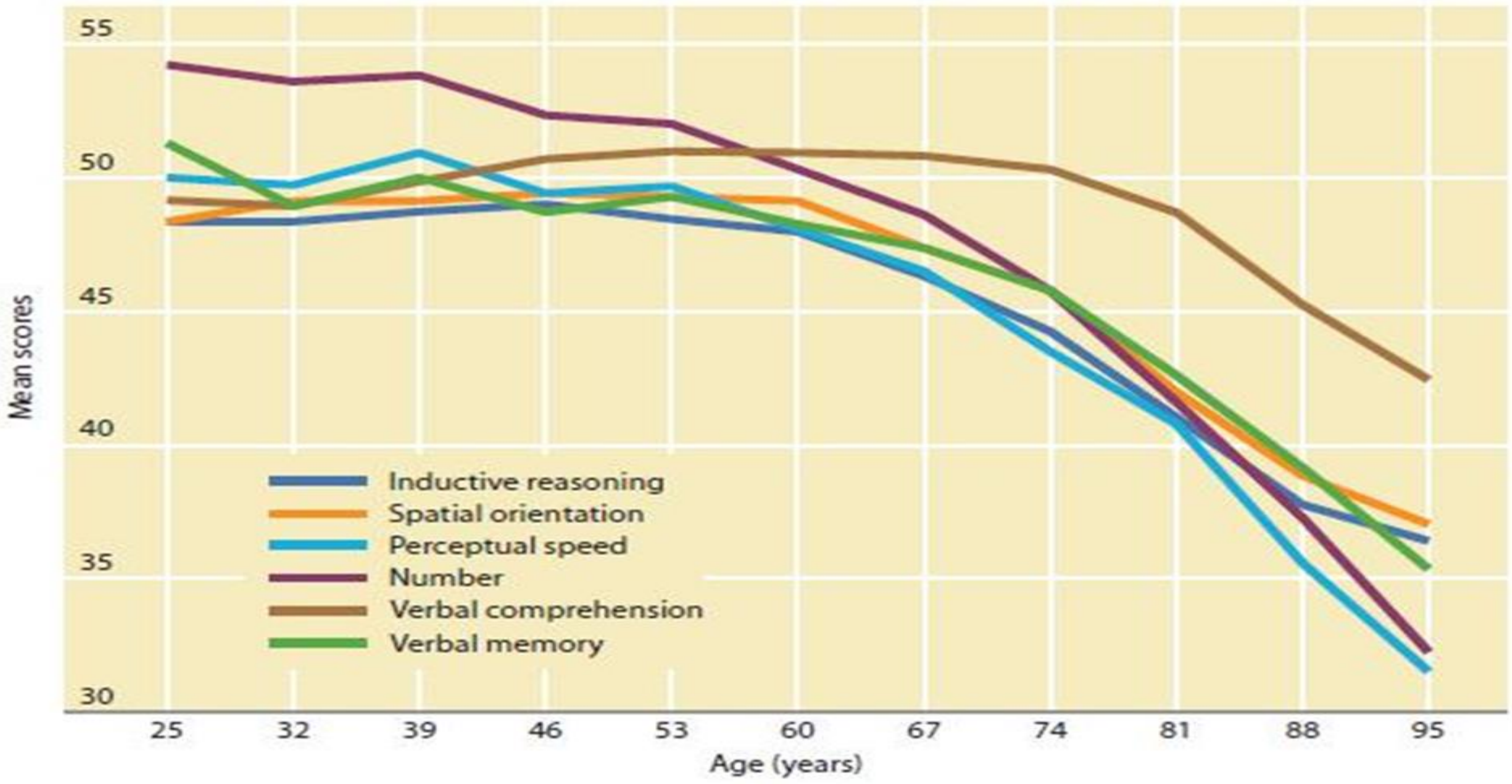


FIGURE **15.4**

LONGITUDINAL CHANGES IN SIX INTELLECTUAL ABILITIES FROM AGE 25 TO AGE 95

Source: Adapted from Schaie, K.W. (2012). Developmental Influences on Adult Intelligence: The Seattle Longitudinal Study (2nd ed.), Fig. 5.8. New York: Oxford University Press.

Experiment Methodologies

<u>On-road studies</u>

- **fitness to drive control** (by an instructor)
- **naturalistic driving** (instrumented vehicles in real traffic conditions)
- **field test** (instrumented vehicles in test site)

Driving simulator experiments

Their Advantages

- Collection of data which would be very difficult to collect under real traffic conditions
- Exploration of any possible driving scenario
- Driving conditions are identical for all drivers

Their Disadvantages

- Non totally realistic simulated road environment
- Simulator sickness (~25% drop-out)

Surveys and Questionnaires on Stated behaviour

- A reference questionnaire is built, based on the list of selected topics
- A representative sample of general or specific population is interviewed
- Information is asked **from the drivers** AND **from their close relatives.**

Comparison with the "objective" measures is interesting (Economou et al, EAN, Berlin, 2015)

Alzheimer's disease and driving

Alzheimer's
Disease
and
Driving

Alzheimer's disease and driving

- Patients with dementia at a moderate or severe stage **(CDR >1) are incapable of driving**

- **AD patients are 2.5 to 4.7 times more likely** to be involved in a car crash than age-matched controls

(Brown and Ott 2004; Dobbs et al. 2002; Ernst et al. 2010; Withaar et al. 2000, Brorsson, 1989; Massie & Campbell, 1993; Tuokko et al., 1995)

- But **50% of patients with AD continue driving for at least three years** after their initial diagnosis

(Adler and Kuskowski 2003; Seiler et al.2012)

(Johansson and Lundberg, 1997; Dubinsky et al., 1992; Rizzo et al., 2001; Charlton et al., 2004; Uc et al., 2005; Uc et al., 2006; Ott 2008; Ernst et al. 2010)

Driving ability & AD

However,

not all patients are incapable of driving, especially in the earlier stages of the disease

- Up to a **76% of patients with mild AD** are still able to pass an on-road driving test

AD is a progressive disease and the Neurologist has to decide:
which is the proper time for dissuading a patient from driving?

Duchek JM et al. J Gerontol Psychol Sci 1998
Ott BR et al. Neurology 2008, Brown and Ott 2004; Ernst et al., 2010; Withaar et al. 2000

Iverson DJ et al. Neurology 2010 (update of the AAN 2000 practice parameter on driving and dementia

Alzheimer's disease and driving

The Neurologist has to take also into account that:

Ability to drive is of primary importance for:

a) maintaining autonomy and **functional activity**

b) promoting **independence**

c) preserving **self-esteem**

- Loss of driving licensure can lead to an increase in **depression** symptoms

(Gardezi et al., 2006; Marottoli et al., 1997; Ragland et al., 2005)

Alzheimer's disease and driving errors

<u>On-road assessment</u> *(Uc et al., 2004)*

Drivers with mild AD made significantly:

- more incorrect **turns**
- **got lost** more often
- more at-fault **safety errors**

Although, **basic control abilities** of the vehicle were normal

<u>In-vehicle technology</u> *(Eby et al.,2012) continuous registration of driving parameters*

Drivers with mild AD had an <u>avoidance behavior</u>

- Drove smaller and **fewer distances**, at lower traffic roads
- **stayed closer at home** and had a preference for daylight driving
- **lower driving speed**
- less likely to use a safety belt and got lost more often

Predictors of driving ability in patients with AD

Performance on neuropsychological tests:

1. visuospatial
2. attentional,
3. executive
4. memory

is associated with driving competence in patients with AD

(Brown et al., 2005; De Raedt et al., 2001; Paccalin et al., 2005; Uc et al., 2004; Whelihan et al, 2005, Brown et Ott, 2004; Elkin-Frankston et al., 2003; Ott et al., 2003; Ott et al., 2008; Reger et al., 2004; Szlyk et al., 2002; Uc et al., 2005; Grace et al., 2005; Asimakopoulos et al., 2012; Etienne et al., 2013)

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Predictors of driving ability in patients with AD

Studies have suggested that:

- ***Neuropsychological tests in combination with neurological variables***

could be used to make driving recommendations in patients with AD

(Dawson J et al. Neurology 2009, Frittelli et al., 2009; Ott et al., 2008; Ott et al., 2003; Rizzo et al., 1997)

Published Ahead of Print on April 12, 2010 as 10.1212/WNL.0b013e3181da3b0f

SPECIAL ARTICLE

AMERICAN ACADEMY OF NEUROLOGY

Practice Parameter update: Evaluation and management of driving risk in dementia

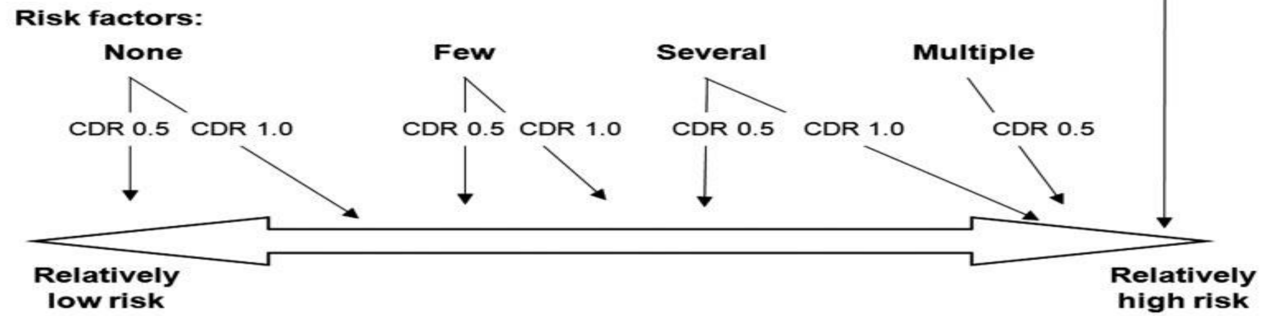
Report of the Quality Standards Subcommittee of the American Academy of Neurology

CDR 0.5-1.0

CDR 2.0

Evaluate for risk factors

	Risk factors
Level B evidence	Caregiver report of marginal or unsafe skills
Level C evidence	History of citations
	History of crashes
	Driving < 60 miles / week
	Situational avoidance
	Aggression, impulsivity
	MMSE ≤24
Other	Alcohol, medications, sleep disorders, visual impairment, motor impairment



Risk Management
- Encourage family support for alternate transportation.
- Strongly consider voluntary surrender of driving privileges.
- Consider DMV referral or professional driving evaluation, based on state guidelines.

Intervention pursuant to state guidelines

Practice Parameter of the AAN (2010)

(Iverson et al., Neurology, 2010)

•However, although useful, these guidelines are rather general

•The proposed algorithm for evaluating driving competence
includes only general cognitive measures (MMSE) which are not closely related to driving competence.

•The results are not reported in terms of a precise relative risk
based on the presence of a risk factor or a cutoff score

Mild Cognitive Impairment and Driving

Mild
Cognitive
Impairment
and
Driving

Driving performance in MCI - controversial

↔ Driving Ability	↓ Driving Ability
Wadley et al., 2009 *on-road*	Wadley et al., 2009 *on-road*
Jeong et al., 2012 *questionnaire*	Jeong et al., 2012 *questionnaire*
Devlin et al., 2012 *simulator*	Devlin et al., 2012 *simulator*

Driving errors in MCI

- **Left-head turns**
- **Lane control**

(Wadley et al., 2009)

- **Increased Mean time to collision**

(Fritteli et al., 2009)

- **Qualitative judgments**
- **Slower Reaction time**
- **Reduced ability to control speed**

(Duchek et al., 2003, Devlin et al., 2012)

- **"Pedal confusion"** (inappropriate motor response such as pressing the accelerator instead of the brake pedal)

(Snellgrove, 2005)

Predictors of driving ability in the MCI

•Measures associated with driving performance in patients with MCI

- **mental flexibility** (TMT-B)
- **inhibitory control** (modified Stroop test)
- **visual attention** (TMT-A)

* When controlling for memory impairment, TMT-B seemed to be the best predictor

(Kawano et al., 2012)

Driving and PD

Driving
and
Parkinson's
Disease

Risk of accidents in PD

•Increased risk for accidents:

Which is related to **Motor** symptoms but mostly to **Cognitive** alterations

•**15% of PD** patients with an active driving license were engaged in a car accident during a period that covered the past five years (Meindorfner et al., 2005)

Predictors-PD

Tests predicting driving competence in patients with PD:

- **executive,**
- **attentional, and**
- **Visuospatial**

(Amick et al., 2007; Classen et al., 2009; Classen et al., 2011; Uc et al., 2006; Uc et al., 2009)

Fitness to drive in patients with PD is associated also with

- **manual dexterity,**
- **contrast sensitivity,**
- **duration of the disease, and**
- **severity of the disease according to the H&Y scale** (Devos et al., 2007; Worringham et al., 2006)

Our data in patients with Cognitive Disorders

The
Large
Driving Simulator
Experiment

A large driving simulator experiment

- on driving behaviour including driver distraction (fall 2013 – fall 2015)

- An **interdisciplinary research team:**
Neurologists, Neuropsychologists, Transportation Engineers

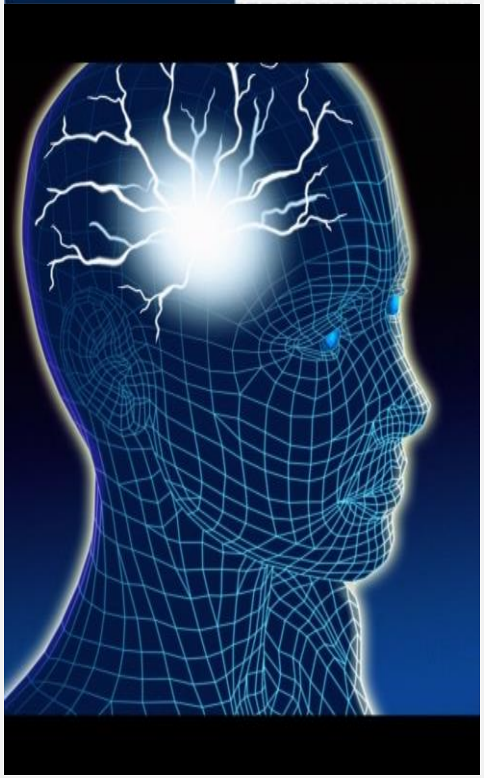
- **Phases of the Experiment**

- Part 1. **Medical, Ophthalmological & Neurological** evaluation (~2 hours)
- Part 2. **Neuropsychological** Assessment (~2,5 hours) and Questionnaire on driving habits (~20 minutes)
- Part 3. **Driving simulation** experiment (~1,5 hour)

- **Sample size: 225 persons examined > 55 years old**

(MCI = 59, AD= 25, PD= 25, Normal Controls= 45)

co-funded by the Greek Research Secretariat and the European Commission



Methodology

Inclusion Criteria

- **Valid driving license**
- **Regular driver without accidents**
- Clinical Dementia Rating (CDR): 0 to 1
- No history of psychosis or other Psychiatric or Neurological disease
- No dizziness, nausea while driving, either as a driver or as a passenger
- No alcoholism or drug addiction
- No visual disturbance preventing them from driving safely

In-vehicle distraction and brain pathologies: Effects on reaction time and accident probability

Dimosthenis Pavlou, Eleonora Papadimitriou, Sophia Vardaki, George Yannis, John Golias,
Sokratis G. Papageorgiou

Sample of the study:

- 140 participants of more than 55 years of age
- 31 controls (aver. 64.5 y.o., 20 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.)

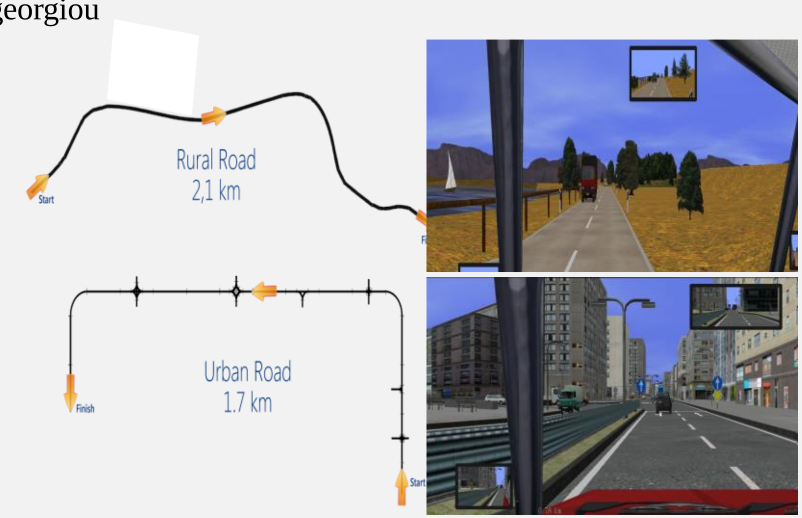


Figure 1. The two plans of the driving routes (rural and urban) and two screenshots for each driving environment

Sample of the study:

- 140 participants of more than 55 years of age
- 31 controls (aver. 64.5 y.o., 20 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.)

Figure 2. Two incidents screenshots - donkey entering the road in rural area and a child chasing a ball in urban area

Assessment of Distraction

- Undistracted condition
- Conversation with a passenger
- Conversation on the Mobile phone

True?

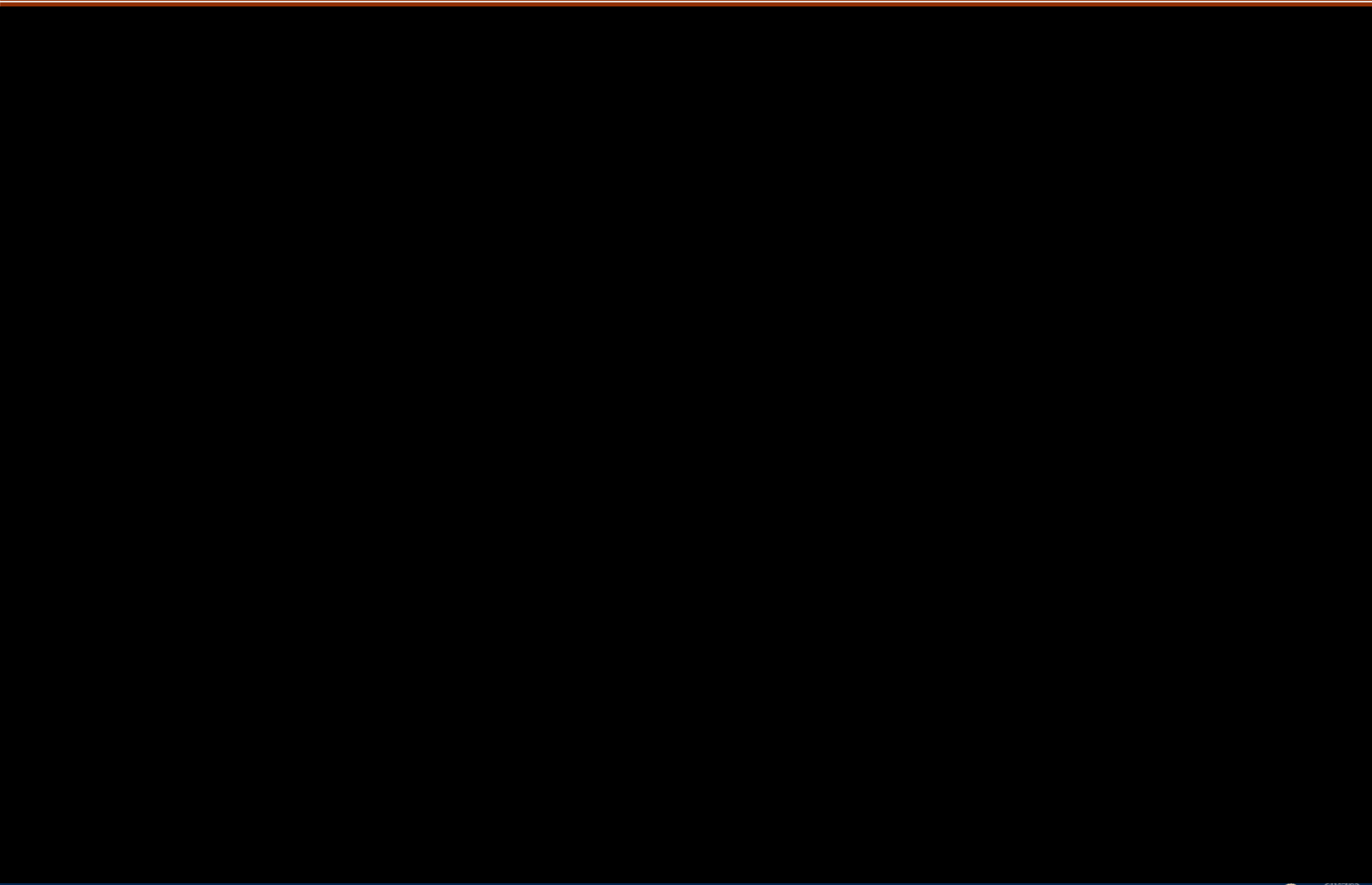
Driving Simulator - Quantitative Measures

1. average driving speed (km/h)
2. speed variation (variation of average speed)
3. Average wheel position
4. wheel position variation (variation of wheel steering angle in degrees)
5. lateral position (average vehicle distance from the central road axis in meters)
6. lateral position variation (the standard deviation of lateral position)
7. average headway (average time to cover the distance from other vehicles in meters)
8. headway variation (the standard deviation of headway)
9. Sudden brakes
10. Engine Stops
11. Speed limit violations
12. Hits of side bars
13. number of crashes
14. reaction time in unexpected incidents (in milliseconds)

- Urban Driving: i) parked car enters suddenly the road, a ball and a child cross suddenly the road
- Rural Driving: sudden appearance of animal

With and Without DISTRACTION

Driving Simulator Experiment



Driving Simulator Experiment Results

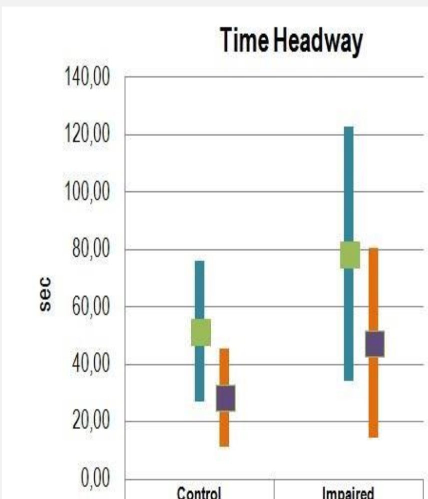
Driving
Simulator
Experiment
Results

Driving performance profiles of drivers with brain pathologies

Dimosthenis Pavlou, Ion Beratis, Eleonora Papadimitriou, George Yannis, John Golias, Sokratis G. Papageorgiou

Sample of the study:
114 participants of more than 55 years of age

- 34 controls (aver. 66.0 y.o.)
- 17 AD patients (aver. 75.4 y.o.)
- 35 MCI patients (aver. 70.1 y.o.)
- 16 PD patients (aver. 66.1 y.o.)



	Control	Impaired
QL aver+stdev	76,07	122,78
QL aver-stdev	27,29	34,19
QL aver	51,68	78,48
QH aver+stdev	45,58	80,56
QH aver-stdev	11,47	14,31
QH aver	28,53	47,44

Fig. 2. *Time Headway (sec)*
(blue column refers to low traffic, orange column refers to high traffic)

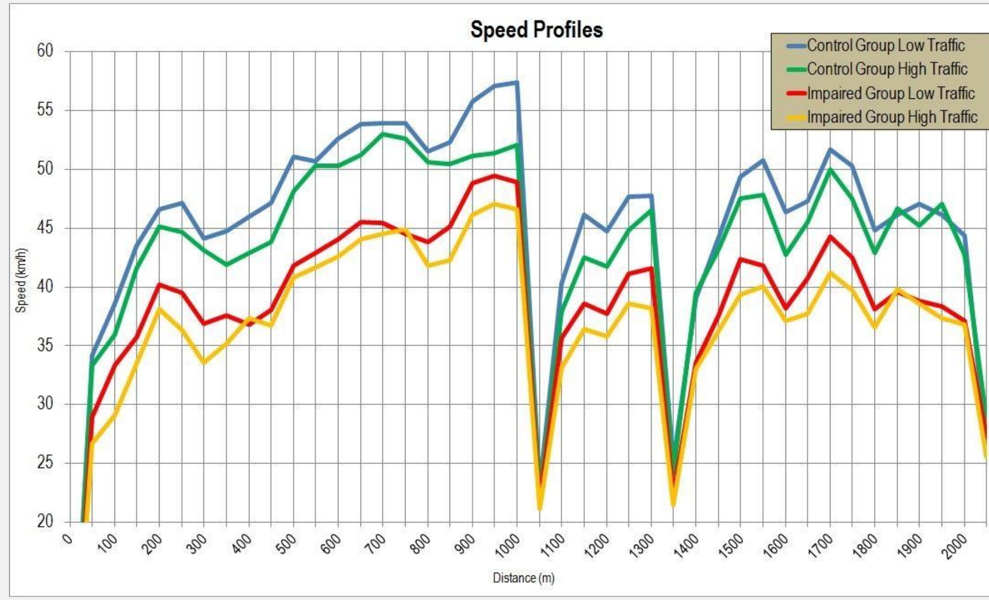


Fig. 1. *Average Speed Profiles of examined groups*

- **16% lower average speed in impaired drivers** in both low and high traffic volumes and **higher variability of speed**
- **higher time-headway (more than 50%)** in impaired drivers
- **large variability in impaired drivers' headways along the driving route.** This means **that they cannot adjust their speed** and have difficulties in keeping constant and safe headways.

Driving performance profiles of drivers with brain pathologies

Dimosthenis Pavlou, Ion Beratis, Eleonora Papadimitriou, George Yannis, John Golias, Sokratis G. Papageorgiou

Lateral position :

- Lateral position results appear to be the same between the two groups

- However **large variability in impaired drivers' lateral position,**

That means difficulties

- **in positioning the vehicle properly in the lane**.

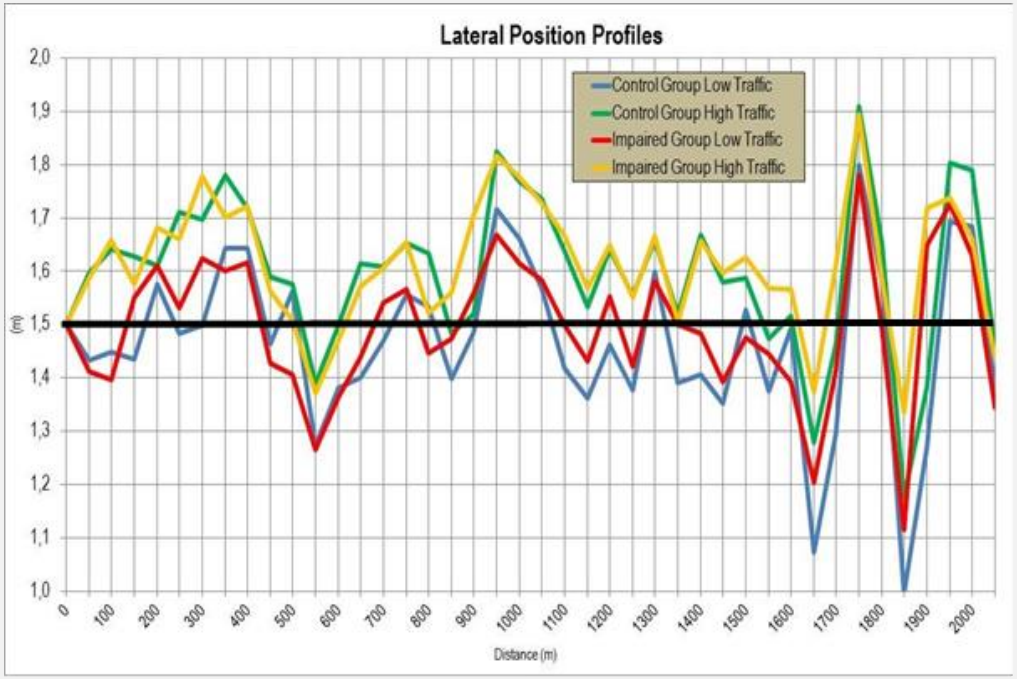


Fig. 3. Average Lateral Position Profiles of examined groups

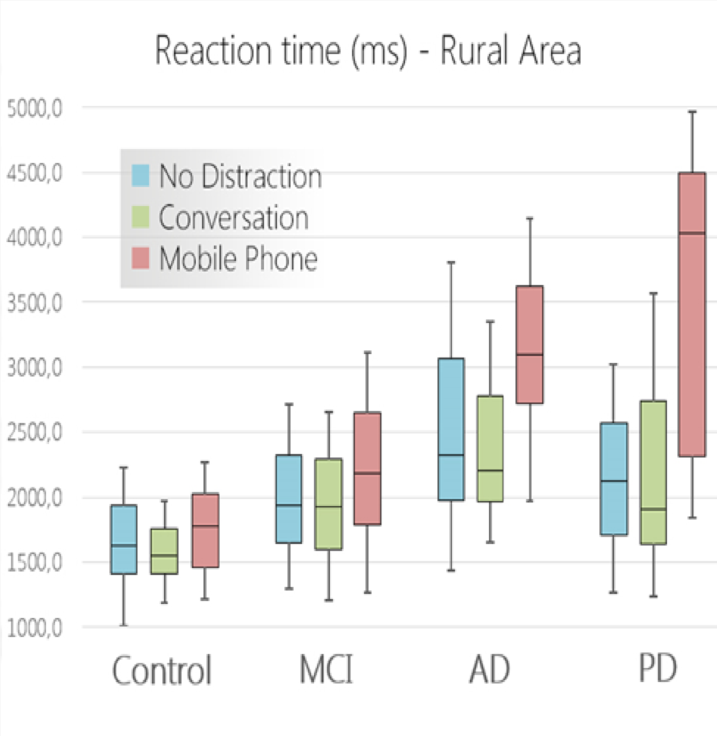
Driving performance profiles of drivers with brain pathologies

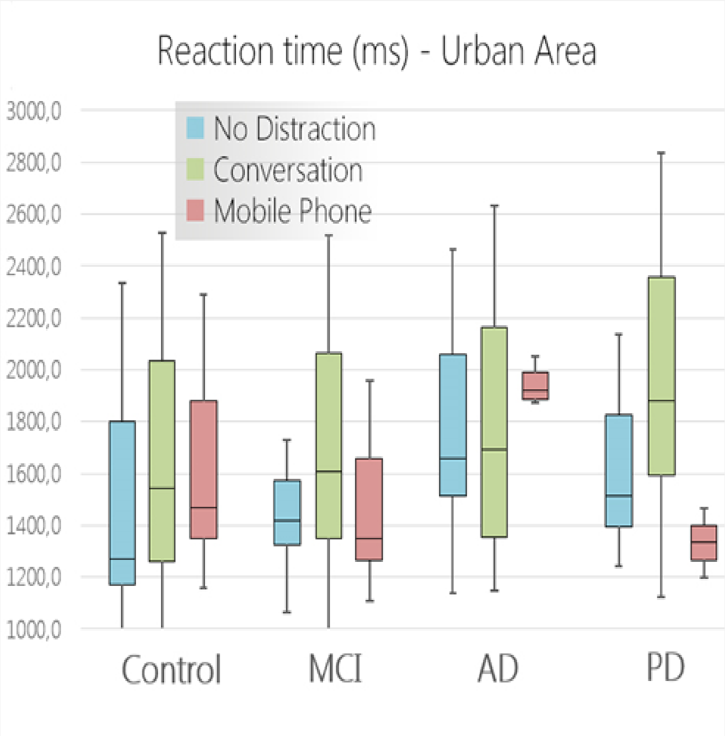
Dimosthenis Pavlou, Ion Beratis, Eleonora Papadimitriou, George Yannis, John Golias, Sokratis G. Papageorgiou

REACTION TIME

AD group had the worst reaction times compared to all other groups (no distraction)

- No Significant effect of "conversation with passenger", **in rural and urban roads for all** participants.
- **Significant effect** of the **mobile phone** on all impaired groups in rural road, especially for the **AD and PD groups (increase of reaction time > 1 sec)**

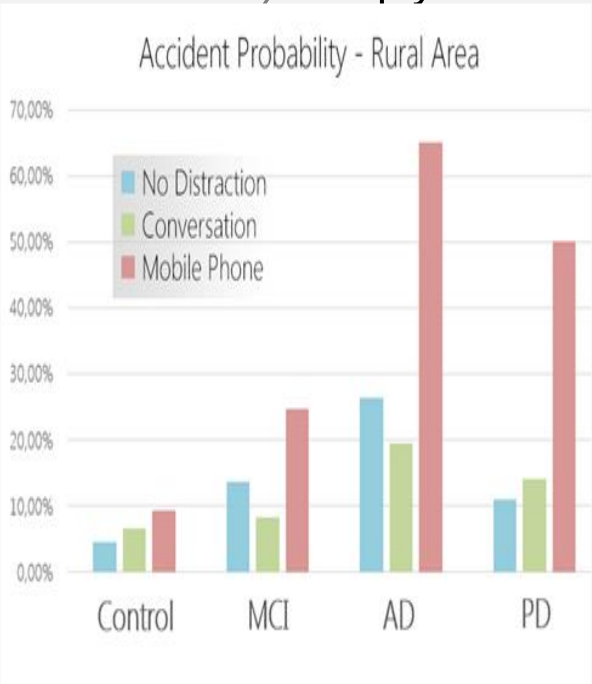


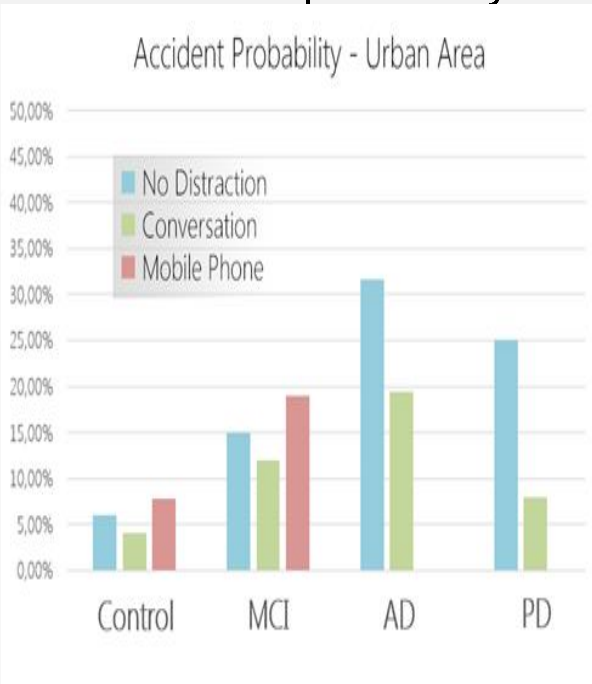


Dimosthenis Pavlou, Ion Beratis, Eleonora Papadimitriou, George Yannis, John Golias, Sokratis G. Papageorgiou

Accident Probability

- **Increased accident probability** for the **MCI, AD and PD** groups in rural and urban area
- No Significant effect of "conversation with passenger", **in rural and urban roads for all** participants.
- The use of the **mobile phone** in the MCI and especially the AD and PD groups (in rural driving environment) sharply increased the accident probability



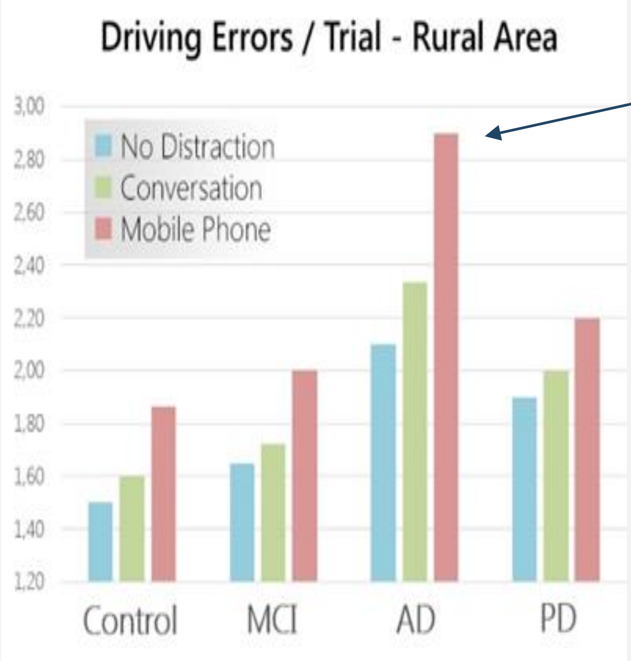


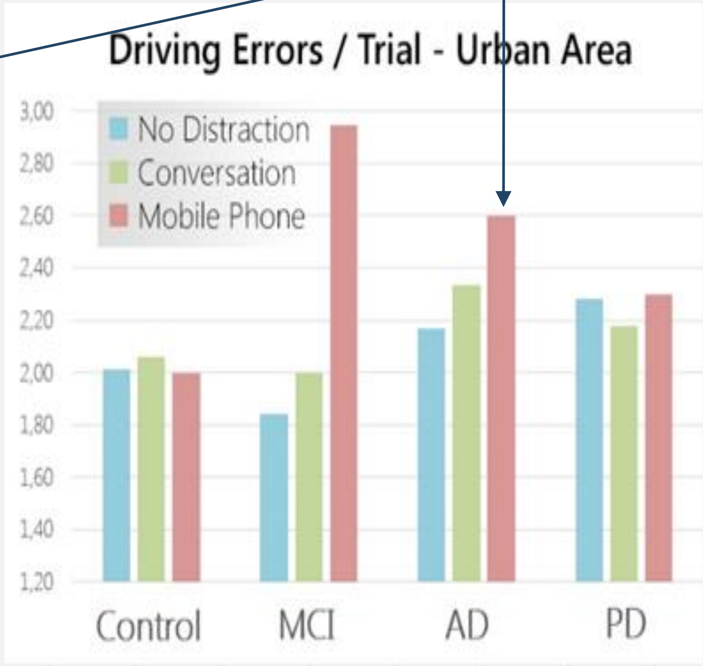
Driving performance profiles of drivers with brain pathologies in rural roads

Dimosthenis Pavlou, Ion Beratis, Eleonora Papadimitriou, George Yannis, John Golias, Sokratis G. Papageorgiou

Driving Errors **(composite score including: speed limit violations, driving on outside road lines, hit of side bars, traffic sign violations)**

- **No significant difference in the "undistracted" and the "conversation" condition.**
- In the **rural** area the use of **mobile phone mostly affected the drivers with AD**
- In the **urban** area the use of **mobile phone affected the drivers with MCI**





Alzheimer’s Disease

Alzheimer's
Disease

Percentage of AD drivers that exhibited similar driving performance to the Control group (±1SD)

Average Speed

47% of AD patients were on the range (±1SD) of normal performance

	AD (normal performance)		AD (impaired performance)		t-test	
	Mean	SD	Mean	SD	T	p
MMSE	24.6	3.2	21.6	3.7	1.80	.090
CTMT1-5	103.8	29.6	176.9	77.8	-2.46	.029*

Percentage of AD drivers that exhibited similar driving performance to the Control group (±1SD)

Reaction Time

55% of AD patients were on the range (±1SD) of normal performance

	AD (normal performance)		AD (impaired performance)		t-test	
	Mean	SD	Mean	SD	T	p
MMSE	23.5	3.7	23.1	2.1	.41	.691
NPI	7.3	8.8	28.1	16.1	-3.29	.005**
FBI	7.5	5.9	17.4	11.2	-2.18	,048*
CDT	6.00	1.2	4.00	2.2	2.42	.028*
PHQ-9	1.9	1.1	7.4	5.3	-3.49	.004**

Mild Cognitive Impairement

Mild
Cognitive
Impairement

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Predictors of driving performance in individuals with MCI: preliminary results

EFNS EUROPEAN FEDERATION OF NEUROLOGICAL SOCIETIES

ENS

Sokratis Papageorgiou[1], Ion Beratis[1], Nikolaos Andronas[1], Alexandra Economou[2], Dimosthenis Pavlou[3], Anastasios Bonakis[1], George Tsivgoulis[1], Leonidas Stefanis[1], George Yannis[3]

[1]2nd University Department of Neurology, “Attikon” University General Hospital, [2]Department of Psychology, University of Athens,
[3]Department of Transportation Planning & Engineering, National Technical University of Athens

Number of Crashes in the MCI

- ***Predictors:***

- (1st level) general cognitive functioning (**MMSE**)
- (2nd level) **visuospatial memory** (**BVMT_Recognition**, β=-.40, *p*=.056) and speed of **attention** (UFV_1, β=.48, *p*=.027)

The model explained 77.3% of the variance in number of crashes

- R^2=.773, $F(3,10)$=11.35, p=.001

- In the cognitively intact group the same regression model did not contribute to the prediction of number of crashes

- R^2=.279, $F(3,10)$=1.29, p=.330

- Normal Group (*Mean*=.43, *SD*=.65) vs MCI Group(*Mean*=.56, *SD*=.81) $t(28)$=.49, p=.25

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Predictors of driving performance in MCI

- **Depressive** symptoms questionnaire
  - Patient Health Questionnaire (PHQ-9)

- **Sleeping** abnormalities questionnaires
  - Epworth **sleepiness** scale
  - Athens **insomnia** scale

	MCI		Controls		NS
	Mean	SD	Mean	SD	*p*
PHQ-9	4,58	4,02	3,31	4,14	0,339
Epworth	5,97	2,98	5,23	4,04	0,440
Athens	4,21	3,72	3,19	2,99	0,261

Beratis et al, 1st EAN Congress, Berlin, 2015

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Depressive Symptoms

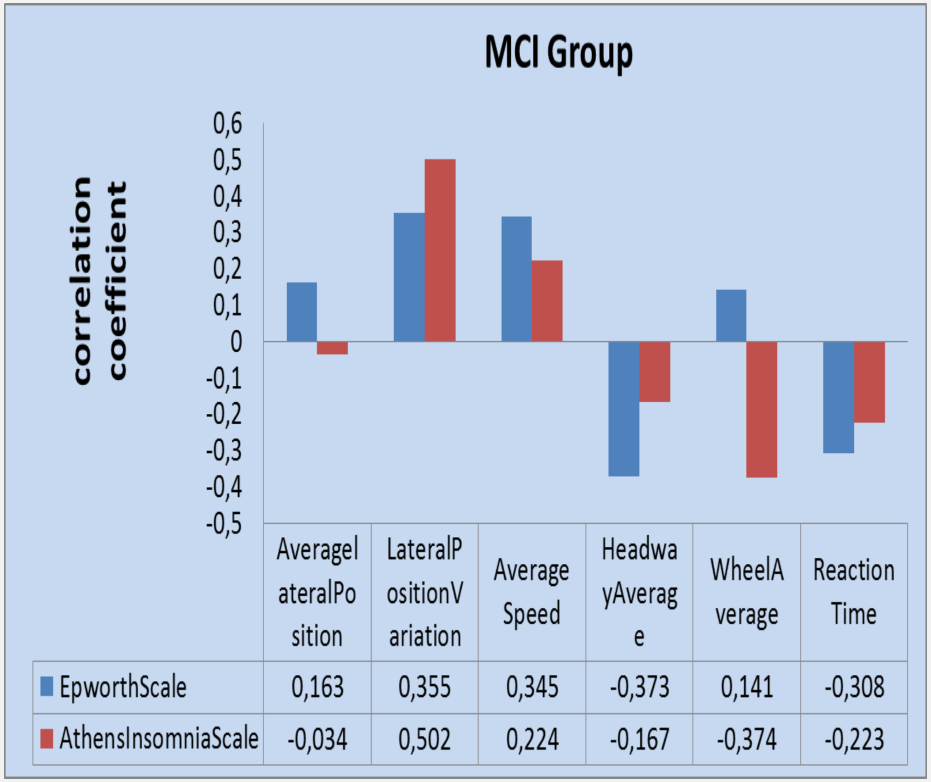
There was a unique contribution of **DEPRESSIVE SYMPTOMS** (PHQ-9) on predicting various indexes of driving performance only in the MCI group even *after controlling for the role of neuropsychological measures and sleep disturbances*

Outcome measure	PHQ-9 contribution			
	β	*t*	*p*	R^2 *Overall*
Model				
Lateral Position Variation	.60	2.89	.011*	.635
Average Speed	.62	2.52	.023*	.490
Average Headway	-.61	2.43	.028*	.468
Headway Variation	-.59	2.34	.034*	.463
No. of Crashes	.70	2.84	.012*	.485
Hits of Side Bars	.39	2.11	.052	.705
Speed Limit Violation	.61	2.84	.012*	.613
Average Wheel Position	-.59	2.50	.025*	.524

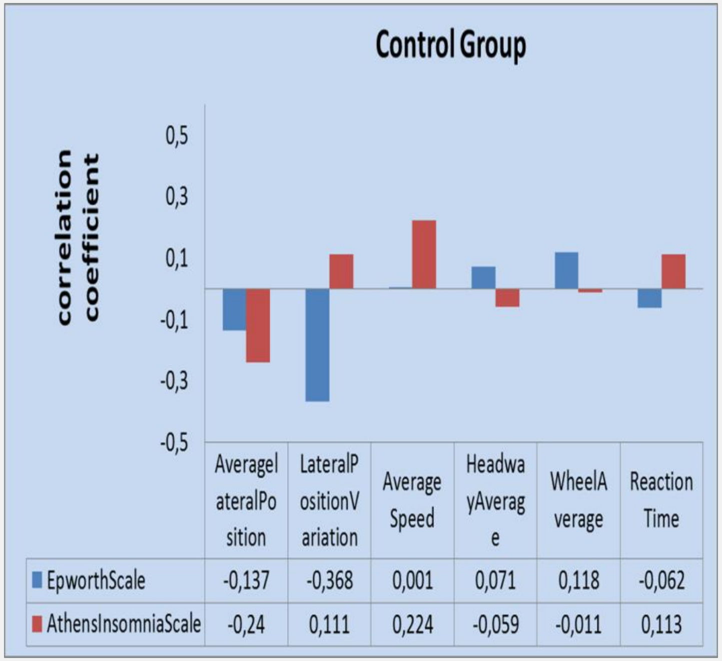
Beratis et al, submitted, 2015

Sleep Disturbances

sleep disturbances (sleepiness - insomnia) were correlated with Driving variables, only in MCI patients



	AverageLateralPosition	LateralPositionVariation	Average Speed	HeadwayAverage	WheelAverage	Reaction Time
EpworthScale	0,163	0,355	0,345	-0,373	0,141	-0,308
AthensInsomniaScale	-0,034	0,502	0,224	-0,167	-0,374	-0,223



	AverageLateralPosition	LateralPositionVariation	Average Speed	HeadwayAverage	WheelAverage	Reaction Time
EpworthScale	-0,137	-0,368	0,001	0,071	0,118	-0,062
AthensInsomniaScale	-0,24	0,111	0,224	-0,059	-0,011	0,113

Beratis et al, 1st EAN Congress, Berlin, 2015

Parkinson's Disease

Parkinson's Disease

distrACT driverBRAIN

Predictors of driving performance in patients with Parkinson's disease: preliminary findings on the role of the Comprehensive Trail Making test

I.N. Beratis, N. Andronas, A. Economou, D. Pavlou, A. Liosidou, R. Antonellou, G. Yannis, L. Stefanis, S. G. Papageorgiou

EFNS-ENS Joint Congress of European Neurology,2014

AVERAGE SPEED	SPEED VARIATION	REACTION TIME	HEADWAY DISTANCE
TMA: R^2=58.3, F(1,9)=12.59, p=.006	TMA: R^2=48.3, F(1,9)=8.40, p=.018	TMA: R^2=28.9, F(1,9)=3.67, p=.088	TMA: R^2=53.4, F(1,9)=10.32, p=.011
TMB:R^2=55.7, F(1,9)=11.34, p=.008	TMB:R^2=48.6, F(1,9)=8.52, p=.017	TMB:R^2=9.4, F(1,9)=0.93, p=.360	TMB:R^2=40.6, F(1,9)=6.15, p=.035
CTMT1:R^2=80.3, F(1,9)=32.67, p<.001	CTMT1:R^2=70.2, F(1,9)=19.80, p=.002	CTMT1:R^2=54.2, F(1,9)=9.46, p=.015	CTMT1:R^2=64.1, F(1,9)=14.31, p=.005
CTMT2:R^2=73.4, F(1,9)=22.09, p=.002	CTMT2:R^2=49.4, F(1,9)=7.82, p=.023	CTMT2:R^2=27.4, F(1,9)=3.02, p=.120	CTMT2:R^2=58.2., F(1,9)=11.15, p=.010
CTMT3:R^2=62.3, F(1,9)=13.20, p=.007	CTMT3:R^2=32.7, F(1,9)=3.89, p=.084	CTMT3:R^2=20.3 F(1,9)=2.04, p=.191	CTMT3:R^2=59.5, F(1,9)=11.73, p=.009
CTMT4:R^2=82.3, F(1,9)=37.29, p<.001	CTMT4:R^2=82.8, F(1,9)=38.38, p<.001	CTMT4:R^2=47.4, F(1,9)=7.22, p=.028	CTMT4:R^2=65.7, F(1,9)=15.31, p=.004
CTMT5:R^2=66.9, F(1,9)=16.15, p=.004	CTMT5:R^2=53.1, F(1,9)=9.05, p=.017	CTMT5:R^2=10.3, F(1,9)=0.915, p=.367	CTMT5:R^2=45.9, F(1,9)=6.79, p=.031

- The present findings support the application of the CTMT by future driving studies as an alternative option to the classical TMT

FTD

Frontotemporal
Dementia

Clinical Case, E.V.

Diagnosis: FTD

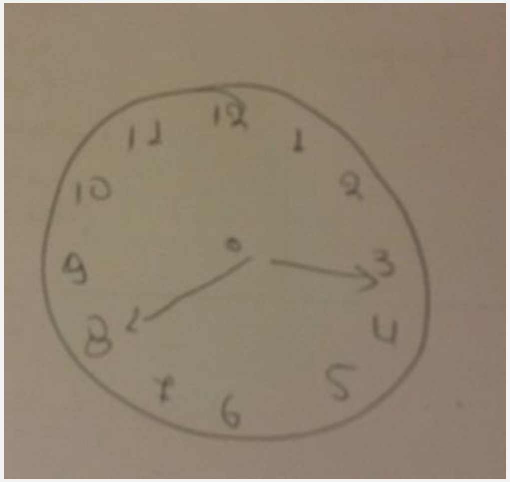
- A 49 year old right handed woman
- 9 years of education
- Housewife

- Speech disorders (verbal apraxia, logopenia)
- Apathy, Loss of Insight
- Frontal atrophy, Mild hippocampal atrophy (L)

<u>Neuropsychological findings</u>

MMSE: 25/30 (-4 calculation, -1 language)

- MoCA: 22/30
- CDT Free: 6/7
- FAB: 12/18
- Verbal Fluency: 11/1 min
- TMT A: 33 sec
- TMT B: >5 min



SummaryIndividualDataofDrivingattheSimulator

Simulator Data

UrbanRoad		Driver**Control group**				Assessment
	LongitudinalParameters	D263	**MT**	St.Dev.	Rangesofvalues	
A1	AverageMeanSpeed	30,53	31,84	5,46	26,38 - 37,30	Typical
A2	StandardDeviationofMeanSpeed	12,00	12,66	3,09	9,57 - 15,55	Typical
A3	AverageHeadway	40,45	36,21	-	- - -	
	LateralParameters					
A5	AverageLateralPosition(fromrightborder)	2,33	2,46	0,60	1,86 - 3,06	Typical
A6	StandardDeviationofLateralPosition	2,09	1,69	0,39	1,30 - 2,08	No typical
A7	AverageSteeringAngle	7,21	7,11	1,77	5,34 -8,88	Typical
A8	StandardDeviationof SteeringAngle	29,26	22,50	5,45	17,05 -27,95	Nottypical
	Unexpectedincidentsparameters					
A9	ReactionTime	2,05	1,37	0,63	0,74 -2,00	Nottypical
A10	Accident probability	25,00%	5,60%	-	- - -	Nottypical
	GeneralParameters					
A11	Speedlimit violations	2				
A13	Totalaccidents	2				Nottypical

RuralRoad		Driver**Control group**				Assessment
	LongitudinalParameters	D263	**MT**	St.Dev.	Rangesofvalues	
Y1	AverageMeanSpeed	46,63	46,37	7,41	38,96 -53,78	Typical
Y2	StandardDeviationofMeanSpeed	13,82	13,39	3,61	9,78 -17,00	Typical
Y3	AverageHeadway	42,12	34,87	-	- -	
	LateralParameters					
Y5	AverageLateralPosition(fromrightborder)	0,76	0,80	0,15	0,65 -0,95	Typical
Y6	StandardDeviationofLateralPosition	0,35	0,27	0,07	0,20 -0,34	Not typical
Y7	AverageSteeringAngle	-1,49	-1,93	0,71	-2,64 - -1,22	Typical
Y8	StandardDeviationof SteeringAngle	19,46	17,56	1,50	16,06 -19,06	Nottypical
	Unexpectedincidentsparameters					
Y9	ReactionTime	2,23	1,56	0,56	1,00 -2,12	Nottypical
Y10	Accident probability	50,00%	8,78%	-	- - -	Nottypical
	GeneralParameters					
Y11	Speedlimit violations	3				
Y13	Totalaccidents	4				Nottypical

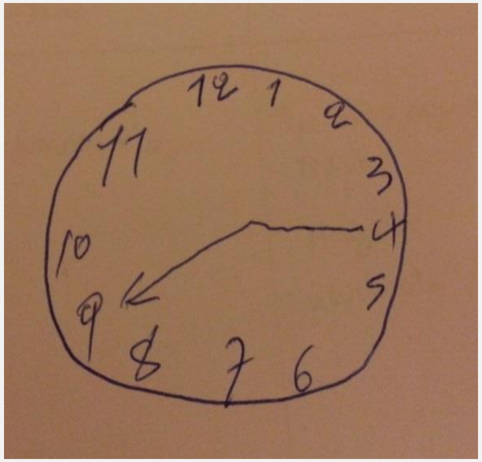
Clinical Case, E.F.

Diagnosis: tv-FTD

- A 63 year old right handed man
- 7 years of education
- pastry chef (retired)

- Memory complaints
- mild disinhibition (overfamiliarity +)
- Temporal atrophy asymmetric (L> R). Mild hippocampal atrophy
- No impulsivity

<u>Neuropsychological findings</u>
MMSE: 22/30 (-2 orientation in space, -1 orient in time, -1 calculation, -3 recall, -1 3-step command)
- MoCA: 14/30
- CDT Free: 5/7
- FAB: 12/18
- Verbal Fluency: 2/1 min
- TMT A: 77 sec
- TMT B: >5 min



Summary Individual Data of Driving at the Simulator

Simulator Data

Urban Road

		Driver	Control group			Assessment
	Longitudinal Parameters	D259	MT	St. Dev.	Ranges of values	
A1	Average Mean Speed	20,14	31,84	5,46	26,38 - 37,30	Not typical
A2	Standard Deviation of Mean Speed	8,46	12,66	3,09	9,57 - 15,75	Not typical
A3	Average Headway	56,65	36,21	-	- - -	
	Lateral Parameters					
A5	Average Lateral Position (from right border)	1,89	2,46	0,60	1,86 - 3,06	Typical
A6	Standard Deviation of Lateral Position	1,48	1,69	0,39	1,30 - 2,08	Typical
A7	Average Steering Angle	5,25	7,11	1,77	5,34 - 8,88	Not typical
A8	Standard Deviation of Steering Angle	22,97	22,50	5,45	17,05 - 27,95	Typical
	Unexpected incidents parameters					
A9	Reaction Time	1,53	1,37	0,63	0,74 - 2,00	Typical
A10	Accident probability	0,00%	5,60%	-	- - -	
	General Parameters					
A11	Speed limit violations	0				
A13	Total accidents	0				

Rural Road

		Driver	**Control group**			Assessment
	Longitudinal Parameters	D259	**MT**	St. Dev.	Ranges of values	
Y1	Average Mean Speed	33,69	46,37	7,41	38,96 - 53,78	Not typical
Y2	Standard Deviation of Mean Speed	9,53	13,39	3,61	9,78 - 17,00	Not typical
Y3	Average Headway	59,32	34,87	-	- - -	
	Lateral Parameters					
Y5	Average Lateral Position (from right border)	0,73	0,80	0,15	0,65 - 0,95	Typical
Y6	Standard Deviation of Lateral Position	0,29	0,27	0,07	0,20 - 0,34	Typical
Y7	Average Steering Angle	-1,84	-1,93	0,71	-2,64 - -1,22	Typical
Y8	Standard Deviation of Steering Angle	16,38	17,56	1,50	16,06 - 19,06	Typical
	Unexpected incidents parameters					
Y9	Reaction Time	1,73	1,56	0,56	1,00 - 2,12	Typical
Y10	Accident probability	0,00%	8,78%	-	- - -	
	General Parameters					
Y11	Speed limit violations	0				
Y13	Total accidents	0				

There is role for the Neurologist

- ADVICE about the issue: "to drive or not to drive"
- ADVICE about the issue: "how and when to drive"

(defining restrictions for safe driving in a patient)

- ADVICE for adaptations of national regulations
- ADVICE for adaptations of vehicles (e.g. reminders), adaptations of roads (e.g. frequency of road signals)

- In close collaboration with other scientists (multi disciplinary approach)

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Cognition, Behaviour and Driving

26 June 2015, Athens
Amphitheater NIMTS

distrACT
driverBRAIN

Driving errors, accidents and their predictors in patients with cognitive disorders

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Athens, 26 June 2015