The effect of driver distraction on patients with brain diseases

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Overview

- Objectives
- "Driving at the simulator" experiment
- Sample Scheme
- Results
- Conclusions

Objectives

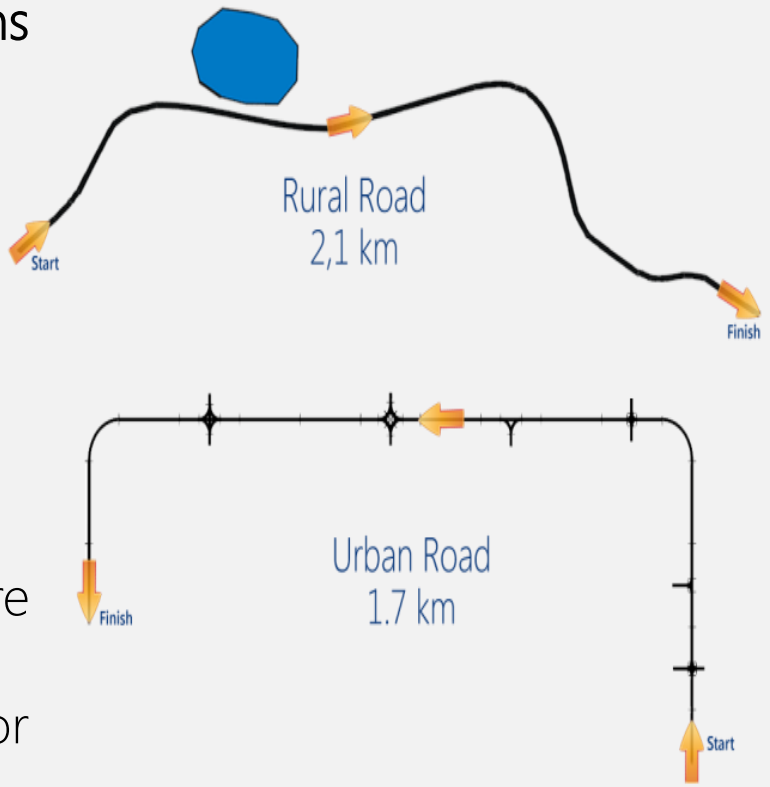
Assess the degree to which in-vehicle distraction affects drivers with cerebral diseases through a driving simulator task

The driving performance of drivers with cognitive impairments (MCI, AD and PD) is examined under three driving conditions:

- undistracted driving,
- driving while conversing with a passenger,
- driving while conversing on a handheld mobile phone

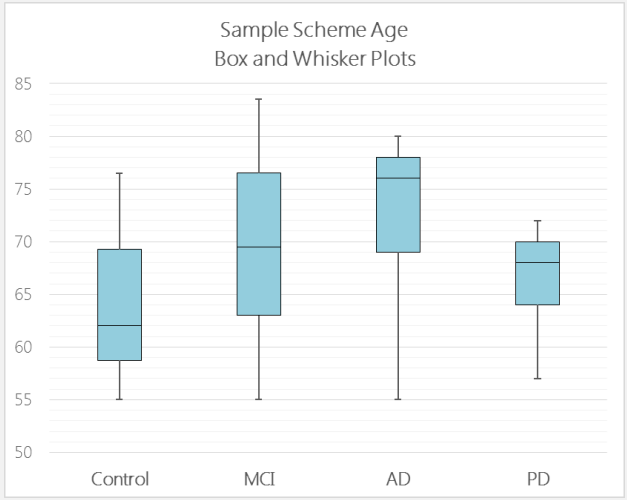
"Driving at the simulator" assessment

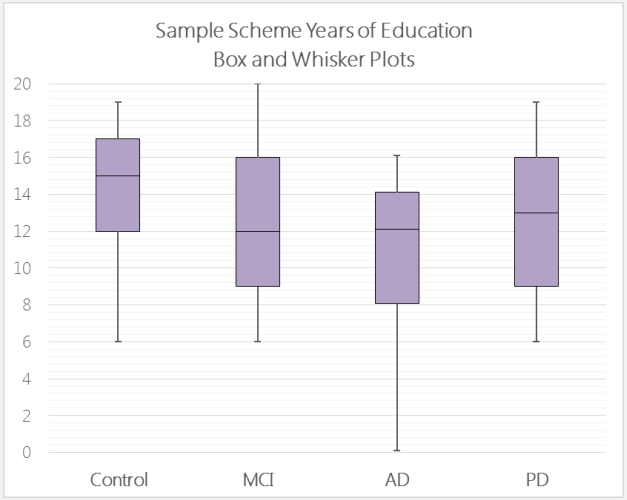
- At first, **one practice drive** (usually 10-15 minutes)
- Afterwards, the participant drives **two sessions** (approximately 15 minutes each)
- Each session corresponds to a different road environment:
  - **a rural route**, single carriageway, zero gradient, mild horizontal curves
  - **an urban route**, at its bigger part dual carriageway, separated by guardrails.
- 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.

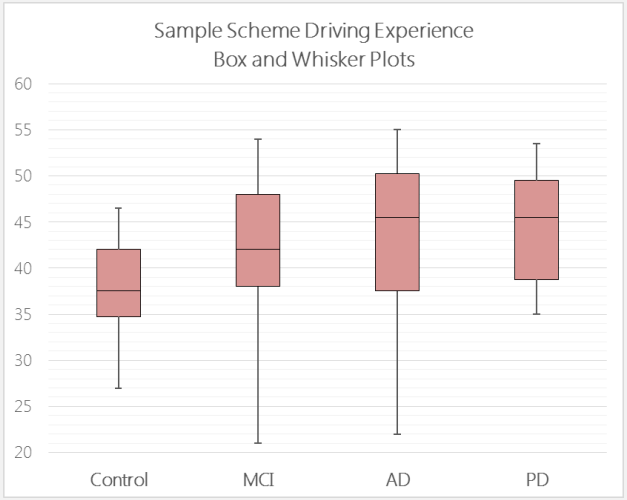


“Driving at the simulator” assessment

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):
  - 59 MCI patients (aver. 70.1 y.o.),
  - 25 AD patients (aver. 75.4 y.o.),
  - 25 PD patients (aver. 66.1 y.o.)

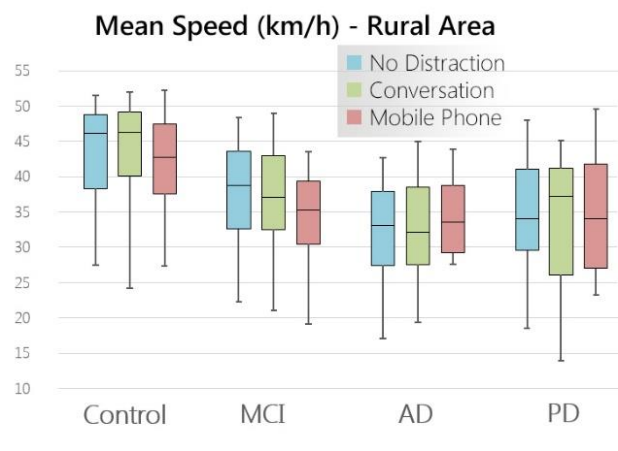
Results

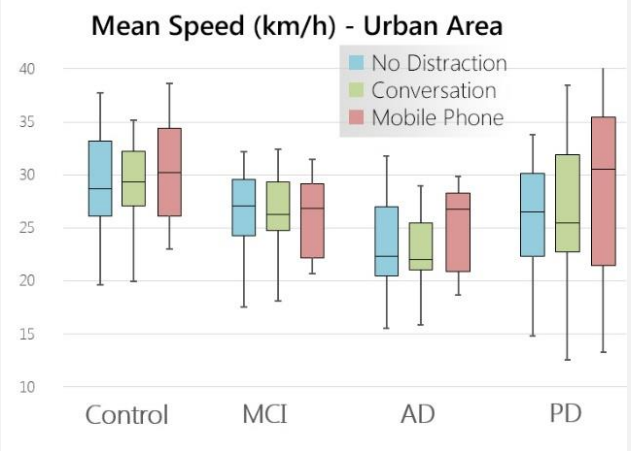
Driving performance measures examined for the three distraction conditions:

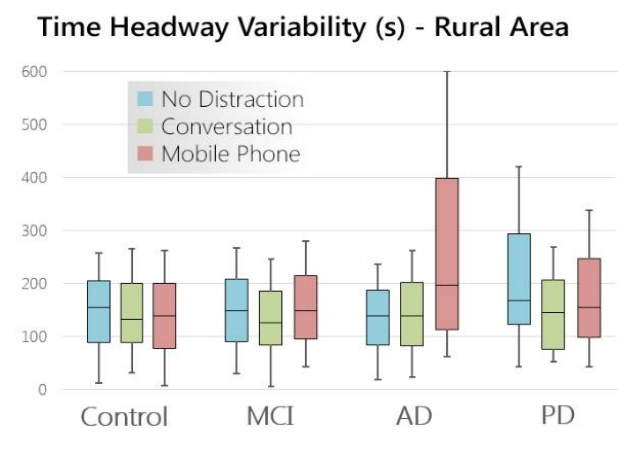
- speed
- time headway variability
- lateral position variability
- steering angle variability
- number of driving errors per trial (speed limit violations, hit of sidebars, outside road lines, and traffic sign violations)
- reaction time
- accident probability

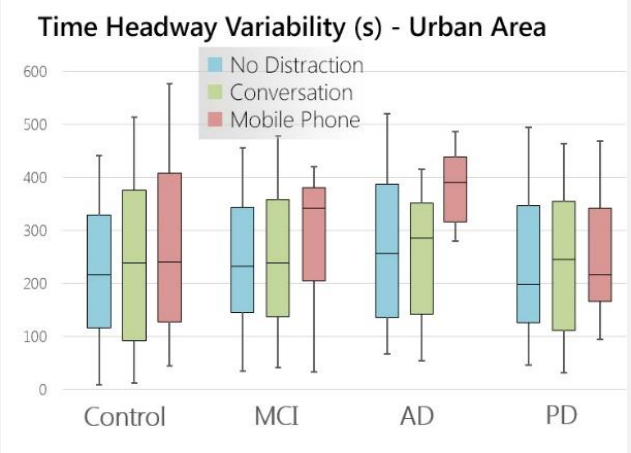
Results

- Conversing with passenger appears to have **no significant effect** on speed in all examined groups
- Mobile phone use leads to **increased speed** for the AD group in urban area
- AD drivers when using the mobile phone have **a large variability in time headways** in both rural and urban environments



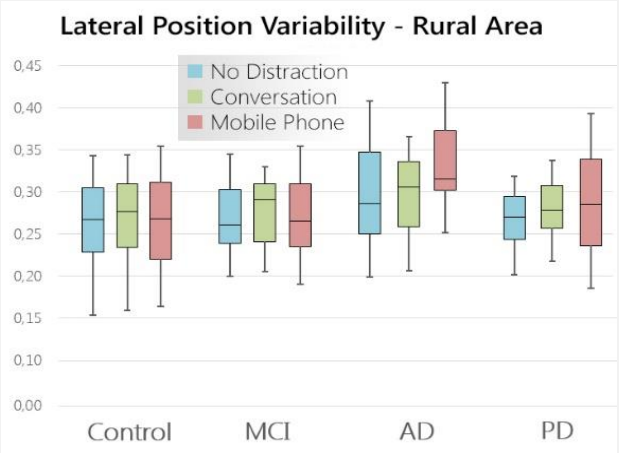


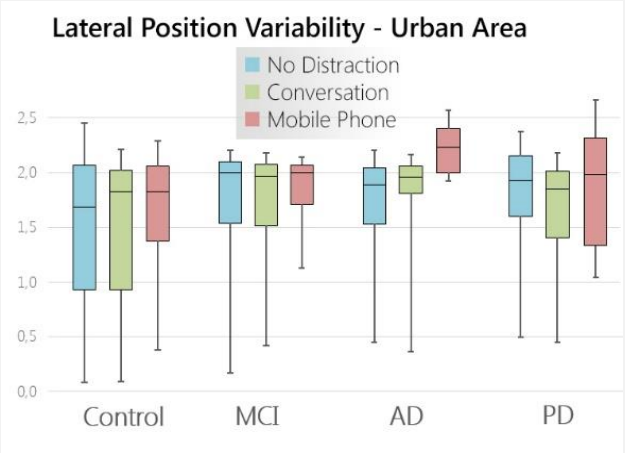




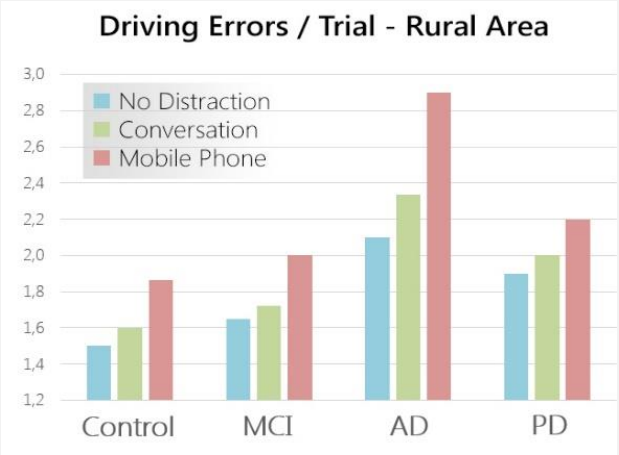
Results

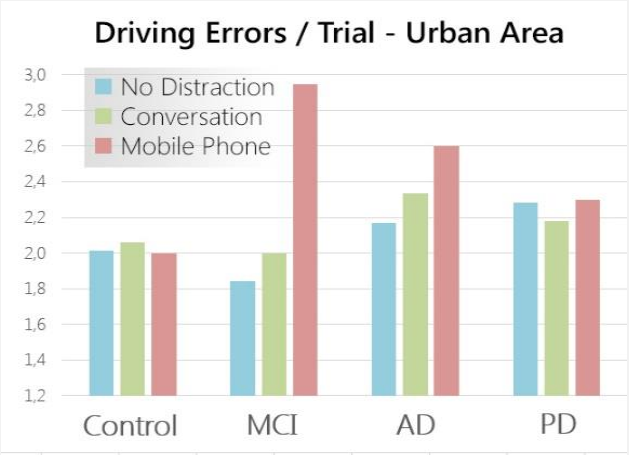
- AD and PD drivers have **higher vehicle lateral position variability** when using the mobile phone while driving.





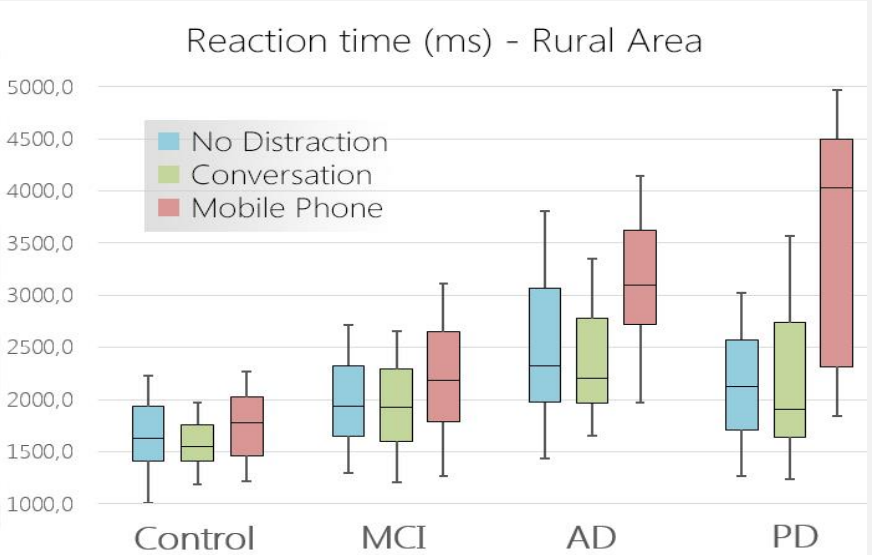
- Regarding the driving errors, mobile phone use leads to **more than 40% increase in errors** than the undistracted condition, for the groups with brain pathologies (especially the MCI group in urban area)

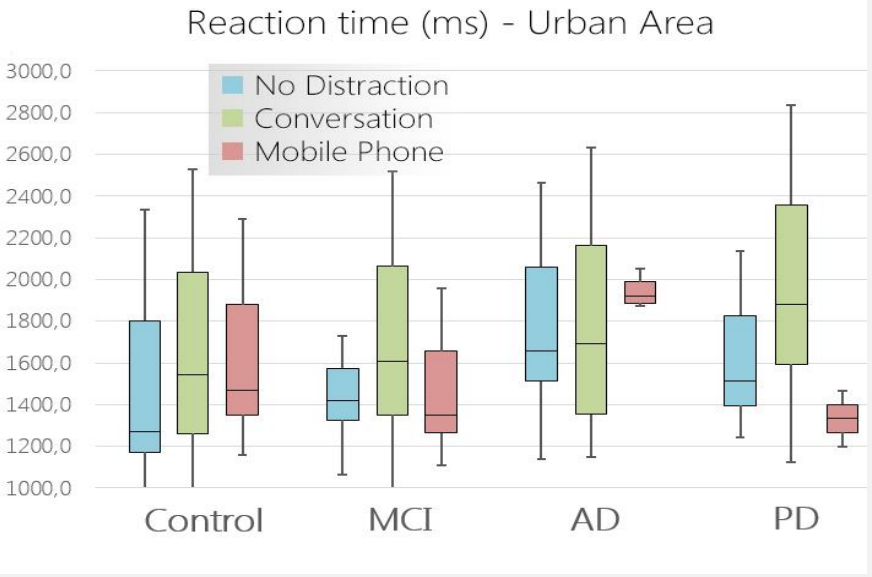




Results - Reaction time

- In rural area AD and PD groups have the **worst reaction times** (more than 40% worse reaction times than the control group)
- Mobile phone use seems to have a **significant effect** on reaction time for AD and especially PD groups
- AD and PD sample in mobile phone use in urban areas **was very small,** thus the mobile phone use results for these two groups are not significant
- Conversing with passenger **doesn't seem to have an important effect** on reaction time in all examined groups





Results - GLM Reaction time (millisec)

Parameter Estimates

	Parameter	B	Std. Error	95% Wald Confidence Interval Lower	Upper	Hypothesis Test Wald Chi-Square	df	Sig.	
Disease	(Intercept)	1679,1	71,3	1539,3	1819,0	554,1	1	,000	
	MCI	**372,8**	100,4	176,1	569,5	13,8	1	**,000**	**
	AD	**884,4**	129,8	630,0	1138,7	46,4	1	**,000**	**
	PD	**575,9**	134,5	312,4	839,5	18,3	1	**,000**	**
	Control	**0[a]**							
Disease*Distractor	**MCI Mobile Phone**	**338,4**	135,4	73,1	603,8	6,2	1	**,012**	**
	MCI Conversation	-46,1	100,1	-242,4	150,1	0,2	1	,645	
	MCI No distraction	**0[a]**							
	AD Mobile Phone	**1171,8**	332,4	520,4	1823,2	12,4	1	**,000**	**
	AD Conversation	-74,5	154,2	-376,9	227,8	0,2	1	,629	
	AD No distraction	**0[a]**							
	PD Mobile Phone	**1014,1**	240,5	542,6	1485,6	17,8	1	**,000**	**
	PD Conversation	108,8	164,6	-213,8	431,4	0,4	1	,509	
	PD No distraction	**0[a]**							
	Control Mobile Phone	91,6	122,3	-148,1	331,3	0,6	1	,454	
	Control Conversation	-109,3	103,4	-312,0	93,4	1,1	1	,291	
	Control No distraction	**0[a]**							
	(Scale)	493591,96[b]	27571,1	442406,6	550699,3				

Dependent Variable: Reaction Time (ms) (Rural area)
Model: (Intercept), Disease, Disease * Distraction

a. Set to zero because this parameter is redundant.

b. Maximum likelihood estimate.

Parameter Estimates

	Parameter	B	Std. Error	95% Wald Confidence Interval Lower	Upper	Hypothesis Test Wald Chi-Square	df	Sig.	
Disease	(Intercept)	1341,9	52,8	1238,4	1445,3	646,5	1	,000	
	MCI	130,6	73,6	-13,6	274,8	3,2	1	,076	*
	AD	**463,4**	94,4	278,4	648,5	24,1	1	**,000**	**
	PD	**262,2**	100,7	64,9	459,6	6,8	1	**,009**	**
	Control	**0[a]**							
Disease*Distractor	MCI Mobile Phone	55,8	110,9	-161,6	273,1	0,3	1	,615	
	MCI Conversation	**247,5**	74,2	102,1	392,8	11,1	1	**,001**	**
	MCI No distract	**0[a]**							
	AD Mobile Phone	141,0	191,7	-234,8	516,8	0,5	1	,462	
	AD Conversation	4,6	127,8	-246,0	255,1	0,0	1	,971	
	AD No distraction	0[a]							
	PD Mobile Phone	-257,6	230,9	-710,1	194,9	1,2	1	,265	
	PD Conversation	**438,0**	128,6	185,9	690,1	11,6	1	**,001**	**
	PD No distraction	**0[a]**							
	Control Mobile Phone	147,9	96,7	-41,7	337,4	2,3	1	,126	
	Ctrl Conversation	**160,2**	76,5	10,3	310,0	4,4	1	**,036**	**
	Ctrl No distract	**0[a]**							
	(Scale)	183824,602[b]	12838,9	160307,2	210792,0				

Dependent Variable: Reaction Time (ms) (Urban area)
Model: (Intercept), Disease, Disease * Distraction

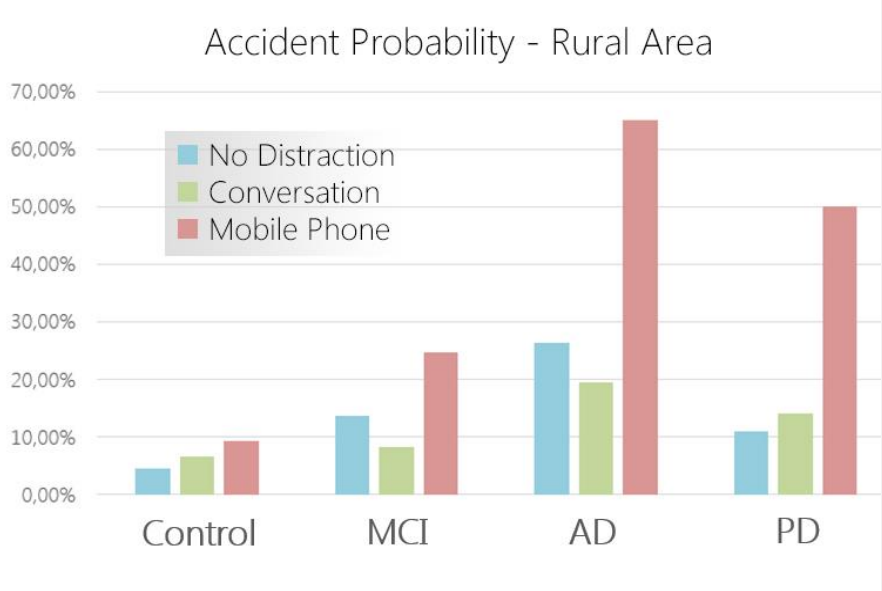
a. Set to zero because this parameter is redundant.

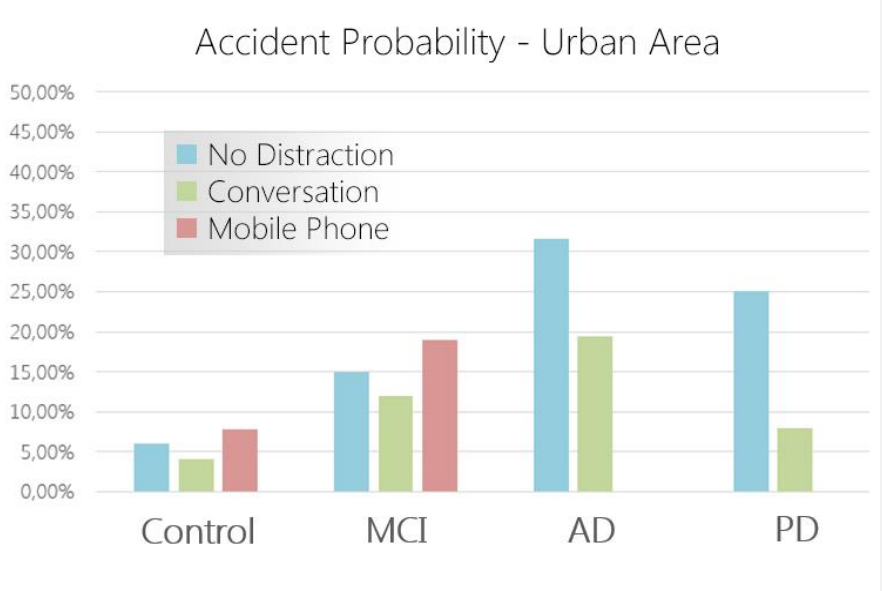
b. Maximum likelihood estimate.

- Rural area: Although conversing with a passenger doesn't seem to affect reaction time, the use of the mobile phone has significant effect on all groups of patients
- Urban area: all participants (except for the MCI group) were affected by the "conversation with passenger" task, and their reaction time was significantly deteriorated; even the control group

Results - Accident probability

- AD drivers have in all conditions the **higher accident probability**, and especially when conversing on the mobile phone (more than 60%)
- PD participants have also **a significant effect** in accident probability when using the mobile phone
- Conversation with passenger **doesn't increase** the possibility of causing an accident
- In urban area the differences between the groups are **approximately the same** with the rural area





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Results - GLM Accident Probability

Parameter Estimates

	Parameter	B	Std. Error	95% Wald Confidence Interval Lower	95% Wald Confidence Interval Upper	Hypothesis Test Wald Chi-Square	df	Sig.	
Disease	(Intercept)	0,077	0,026	0,026	0,128	8,82	1	,003	
	MCI	0,068	0,027	0,016	0,120	6,61	1	,010	**
	AD	0,185	0,047	0,092	0,277	15,19	1	,000	**
	PD	0,015	0,049	-0,081	0,111	0,09	1	,763	
	Control	0[a]							
Disease*Distractor	MCI Mobile Phone	0,125	0,049	0,029	0,222	6,45	1	,011	**
	MCI Conversation	-0,055	0,037	-0,126	0,017	2,25	1	,134	
	MCI No distract	0[a]							
	AD Mobile Phone	0,438	0,121	0,200	0,676	13,04	1	,000	**
	AD Conversation	-0,067	0,056	-0,177	0,044	1,41	1	,236	
	AD No distraction	0[a]							
	PD Mobile Phone	0,362	0,088	0,190	0,535	17,04	1	,000	**
	PD Conversation	0,051	0,060	-0,067	0,168	0,71	1	,398	
	PD No distraction	0[a]							
	Control Mobile Phone	0,051	0,060	-0,067	0,168	0,71	1	,398	
	Control Conversation	0,025	0,038	-0,049	0,099	0,44	1	,509	
	Control No distraction	0[a]							
	(Scale)	,066[b]	0,0	0,1	0,1				

Dependent Variable: Accident probability (Rural area)
Model: (Intercept), Disease, Disease * Distraction
a. Set to zero because this parameter is redundant.
b. Maximum likelihood estimate.

Parameter Estimates

	Parameter	B	Std. Error	95% Wald Confidence Interval Lower	95% Wald Confidence Interval Upper	Hypothesis Test Wald Chi-Square	df	Sig.	
Disease	(Intercept)	0,068	0,027	0,016	0,120	6,61	1	,010	
	MCI	0,182	0,037	0,109	0,254	24,18	1	,000	**
	AD	0,248	0,047	0,155	0,341	27,42	1	,000	**
	PD	0,172	0,051	0,073	0,271	11,53	1	,001	**
	Control	0[a]							
Disease*Distractor	MCI Mobile Phone	-0,197	0,056	-0,307	-0,088	12,54	1	,000	**
	MCI Conversation	-0,219	0,037	-0,292	-0,146	34,45	1	,000	**
	MCI No distract	0[a]							
	AD Mobile Phone	-0,150	0,096	-0,339	0,039	2,423	1	,120	
	AD Conversation	-0,094	0,064	-0,220	0,031	2,16	1	,142	
	AD No distraction	0[a]							
	PD Mobile Phone	-0,115	0,116	-0,342	0,112	0,98	1	,322	
	PD Conversation	-0,140	0,065	-0,267	-0,013	4,69	1	,030	**
	PD No distraction	0[a]							
	Control Mobile Phone	-0,015	0,049	-0,110	0,081	0,09	1	,764	
	Control Conversation	-0,035	0,038	-0,110	0,040	0,82	1	,365	
	Ctrl No distract	0a							
	(Scale)	,046[b]	0,0	0,0	0,1				

Dependent Variable: Accident probability (Urban area)
Model: (Intercept), Disease, Disease * Distraction
a. Set to zero because this parameter is redundant.
b. Maximum likelihood estimate.

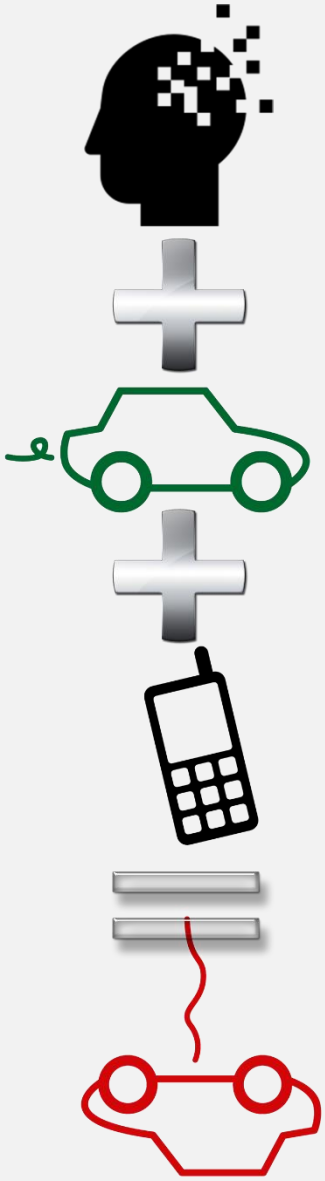
- Mobile phone use has a significant effect in **increasing the accident probability** in the MCI and the PD groups in rural driving environment
- In urban area, the effect of **the presence of distraction is not significant**, probably because of the small sample size of the impaired participant who use mobile phone in such an environment.

Conclusions 1/2

- Overall, the brain pathologies examined (MCI, but especially AD and PD) lead to important deterioration in road safety in several ways:
  - lower mean speed
  - larger headway variability
  - larger lateral position variability
  - more driving errors
  - worse reaction times
  - higher accident probability
- "Conversing with passenger" doesn't have a significant effect on the participants in any driving performance measure (except for reaction time in urban areas)

Conclusions 2/2

- "Mobile phone use" has a significant effect on almost every driving performance parameter examined, at all groups with cerebral diseases, in both traffic environments:
  - even lower mean speed
  - ADs' much larger headway variability
  - ADs' and PDs' much larger lateral position variability
  - 40% increase in driving errors
  - reaction times over 3 seconds
  - accident probability approximately 50%
- Control group doesn't seem to be affected by the distraction conditions



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