Driver distraction in patients with neurodegenerative diseases

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Athens, 26 June 2015

Objective-steps

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Identify neuropsychological variables predictive of driving ability and describe driving patterns of healthy and neurologically impaired individuals

Methodological steps

1. Literature review of potential neuropsychological correlates of driving and driving ability in individuals with MCI, AD and PD
2. Correlations between neuropsychological measures and driving ability in healthy individuals
3. Highly original driving simulator experiment: comparisons of healthy and neurologically impaired individuals (neurodegenerative diseases) on driving parameters

Human factors in accidents: Distraction

- Human factors are basic cause of motor vehicle accidents in 65-95% of cases

Sabey & Taylor (1980), Salmon et al. (2011)

- Driver distraction explains 12% of factors contributing to motor vehicle accidents
- Within-car factors explain 2/3 distraction incidents

US Department for Transport (2008)

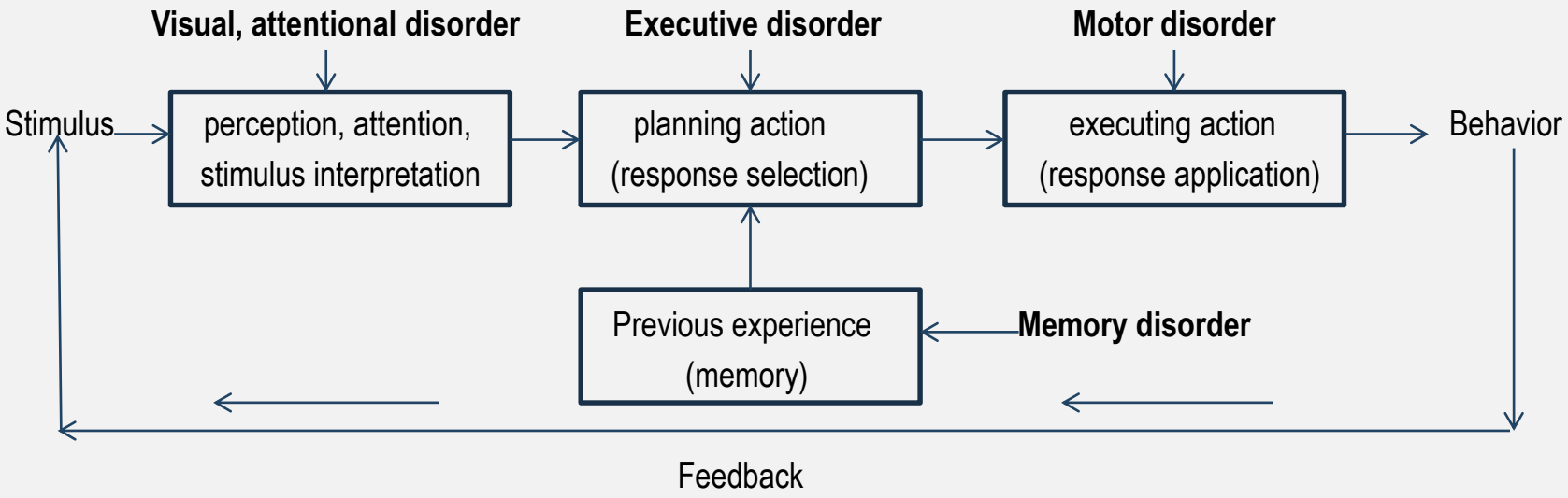
Driver distraction is the 3rd factor in lethal motor vehicle accidents in Greece

Hellenic Police (2014)

Conceptual framework

- Cognitive functions (and dysfunction) ➔ driving behavior ➔ driving errors ➔ safety risks

Information processing model for understanding driver error

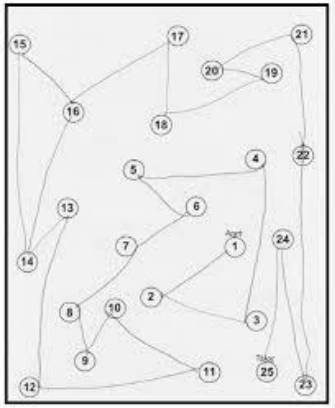


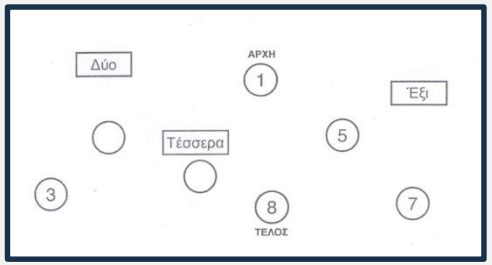
Rizzo & Kellison, 2010

Neuropsychological variables predictive of driving ability

- Test highly correlated with driving ability (i.e., TMT, CTMT)
- No test adequate alone
- Critical not to use age-corrected norms**
- Global deficit score – emphasize number and weight of impairment, below average performance
- Composite scores
- Screening tests (Clinical Dementia Rating, Mini Mental State Examination)
- Driving Scenes (Neuropsychological Assessment Battery)

TMT





CTMT 4

Neuropsychological domains

Participants

- Participants: *N*=238 healthy adult drivers (women: *n*=128) from Athens & Thessaloniki
- Mean age=45.41 (SD=17.55) years, range=20-90 years

Results

Factor analysis (promax rotation loadings > or = .40) yielded 5 cognitive domains:

Sustained/focused attention	Verbal memory	Working memory	Visuospatial perception & memory	Visual recognition
CTMT2	HVLT Descr Index	Spatial span forward	JOL	BVMT recognition
CTMT1	HVLT recognition	Spatial span backward	BVMT delayed	BVMT Desc index
CTMT3	HVLT delayed	Letter-number sequencing	Embedded figure total	
CTMT4	HVLT total		BVMT total	
CTMT5				
Psychomotor Vigilance				

distrACT driverBRAIN

Which neuropsychological variables predict driving ability?

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	42.203	1.135		37.172	.000		
	Selective attention	-1.668	.463	-.309	-3.606	.000	.593	1.686
	Verbal memory	.812	.328	.179	2.480	.014	.835	1.197
	Working memory	.188	.349	.041	.540	.590	.739	1.353
	Visuospatial perception/memory	.813	.357	.195	2.279	.024	.595	1.681
	Visual recognition memory	.083	.695	.008	.120	.905	.991	1.009

a. Dependent Variable: NAB Driving Scenes

Factors predictive of Driving Scenes difference detection: selective attention, verbal memory and visuospatial perception/memory (not working memory or visual recognition memory)

Human factors in motor vehicle accidents: Neurological impairment and driving

- MCI: driving difficulties (maintaining speed, steering wheel, lateral position)

  Wadley et al. (2009)

- MCI: lane position, distraction by external sounds, inadequate response to sudden events, irritability

  Frank-Garcia et al. (2009)

- Dementia: adequate driving in early stages

  Harvey et al. (1995)

- AD: more safety-related driving errors (lane position)

  Dawson et al. (2009)

- PD: distraction (conversation while driving) more driving errors with and without distraction, drive more slowly and variations during distraction

  Uc et al. (2006)

Participants

- *N*=225 community-dwelling adults (22-90 ετών) currently driving (32% women)

Group	*n*	Mean age (SD) (years)
Healthy	90	46.97 (16.04)
Mild Cognitive Impairment	56	69.30 (10.14)
Alzheimer's Disease	24	73.54 (6.69)
Parkinson's Disease	24	63.46 (10.01)
Total	225	59.24 (16.46)

- Mean age = 59.24 (SD=16.46) years

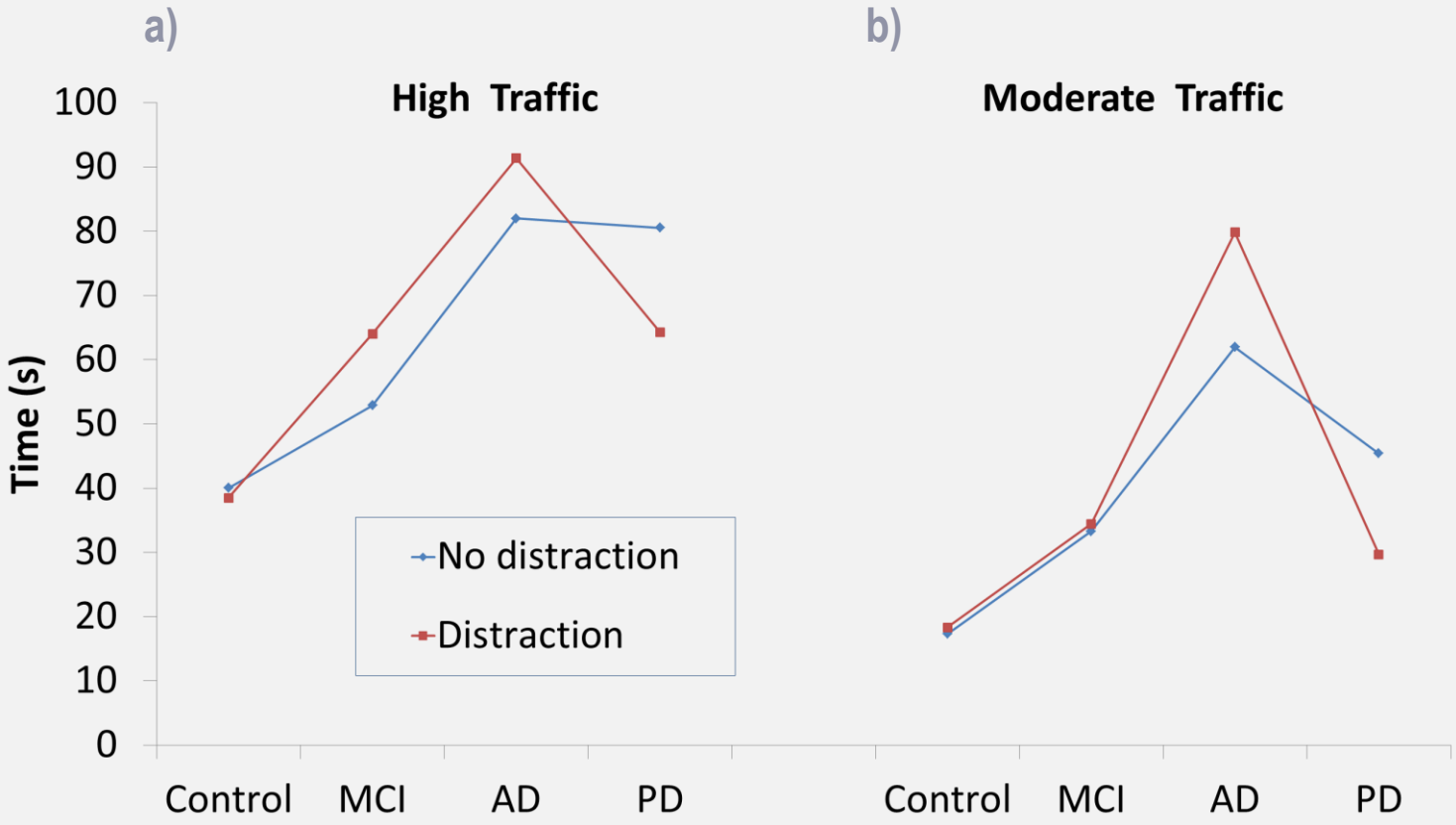
Procedure

- All participants drove simulator under 4 rural conditions:

Traffic	Distraction
Moderate	None
High	None
Moderate	Conversation
High	Conversation

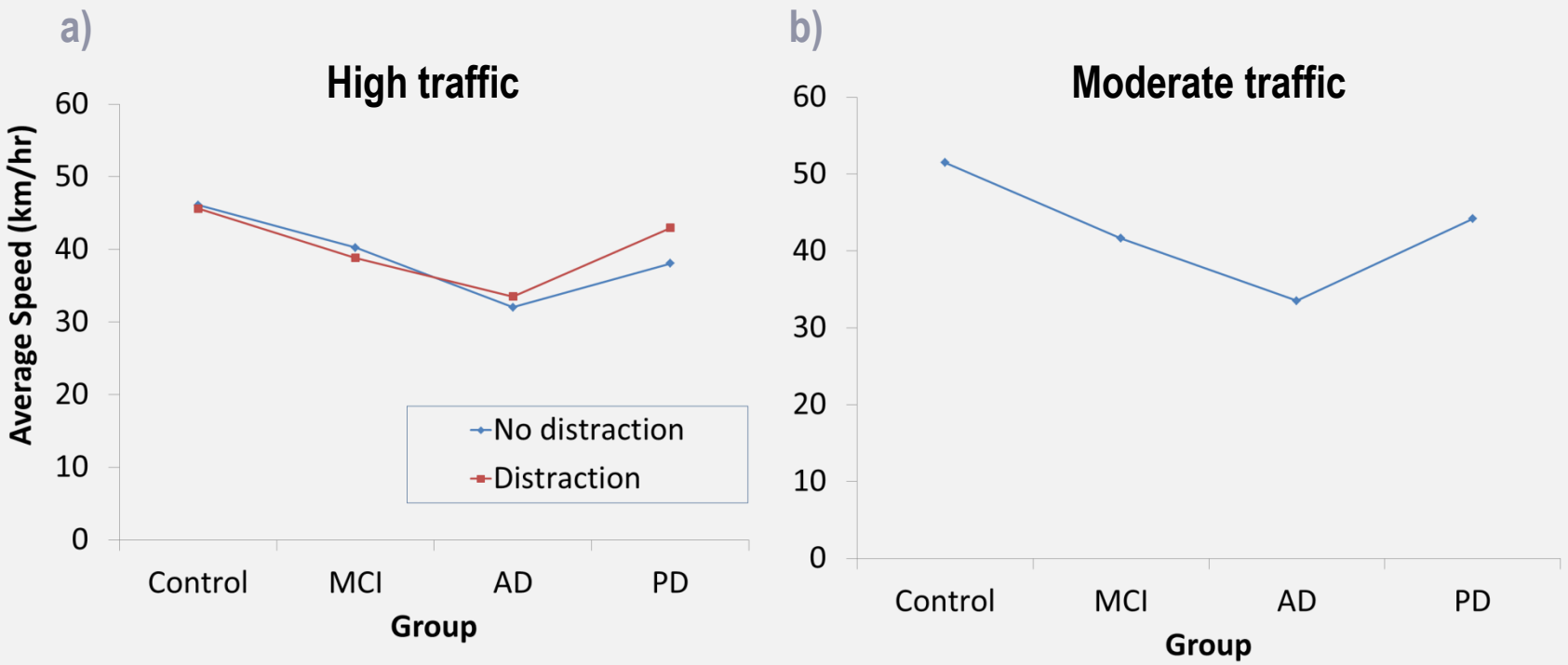
- Driving ability variables:
  - Lateral position of vehicle relative to right-sided road limit (m)
  - Average speed (km/hr)
  - Thead (average time to potential collision with preceding vehicle) (s)
  - Sudden braking (frequency)
  - Speed violation (frequency)

Thead (average time to potential collision)



Group X distraction interactions in (a) high and (b) moderate traffic conditions

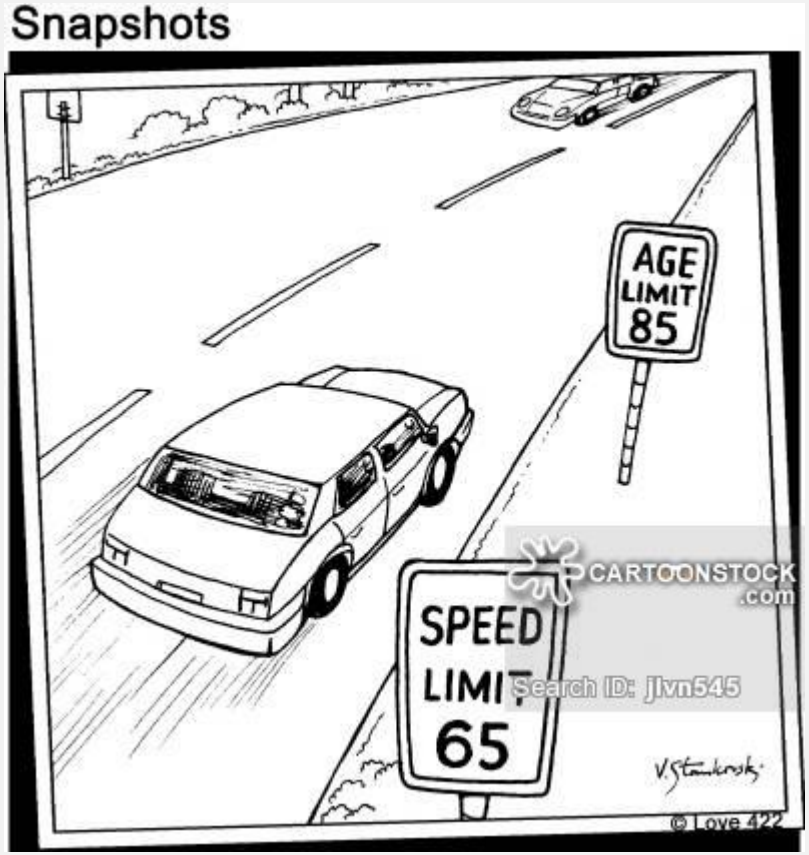
Average speed (km/hr)



(a) Group X distraction interaction in high traffic condition
(b) Group main effect in moderate traffic condition

Conclusion

- Healthy and MCI groups drove consistently despite distraction
- The AD group compensated, driving more slowly and further from preceding vehicle
- The PD group did not compensate



General conclusions

- Particular neuropsychological domains – selective attention, verbal memory and visual perception/memory -- are predictive of driving behavior and should be part of standard neuropsychological assessments regarding driving ability

- Driving patterns of neurologically impaired individuals differ based on brain regions/neuropsychological domains involved in the pathology (e.g., frontal-subcortical regions vs. temporal-parietal regions)

- Implications for driving difficulties in non-degenerative neurological disorders or trauma

- Exploration of personality, in addition to cognitive factors regarding driving ability

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