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DRIVING DIFFICULTIES AS REPORTED BY ELDERLY DRIVERS WITH MCI AND WITHOUT NEUROLOGICAL IMPAIRMENT: IMPLICATIONS FOR ROAD DESIGN

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OVERVIEW

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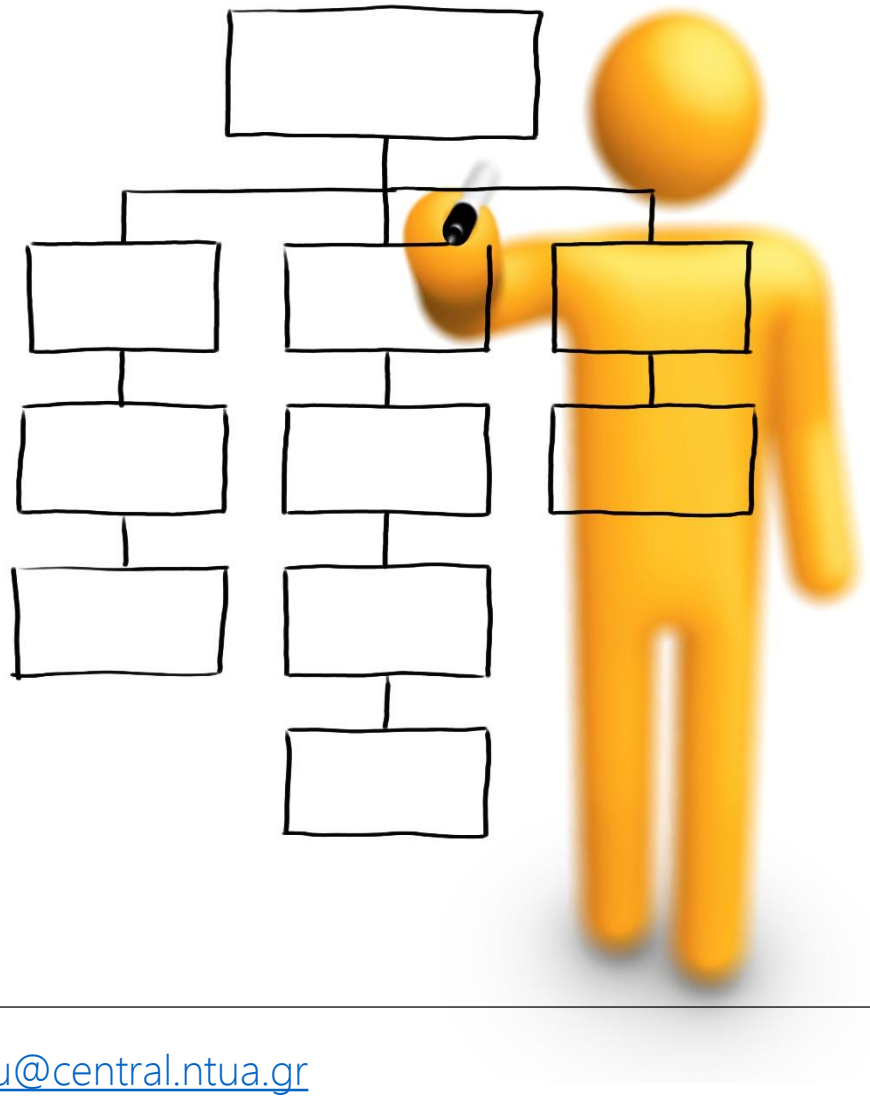

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INTRODUCTION 1/2

- Declines in cognition increase crash risk among older drivers, with a particular focus on neurological diseases such as dementia that can lead to driving impairments
- Individuals with MCI:
  - may be able to continue to drive safely for some time
  - are more likely to experience difficulties with driving
  - avoid unfamiliar areas and busy roads
  - exhibit lower ratings on driving performance in demanding tasks associated with intersection approach, time-to-collision and left turns, whether assessed on a simulator or by an on-road test

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INTRODUCTION 2/2

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- Driving-related discomfort is an important factor in the self-regulation of driving
- The main difference in avoidance between the lower functioning and higher functioning groups is found in situations that are cognitively demanding and relatively easy to avoid
- Although self regulation is generally considered a strategy of elderly drivers with self-insight, certain research findings suggest inconsistency between driving ability and self-regulation
- Self-regulation has also been related to motivational factors, preferences and lifestyle

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OBJECTIVE OF THE RESEARCH

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The purpose of this study is to explore the factors determining driving difficulties as seen from the viewpoint of elderly MCI drivers and age-matched controls, as well as to assess their relative importance using data from an extensive questionnaire

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GENERAL INFORMATION

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- Samples of drivers diagnosed with MCI and controls without measurable cognitive impairment were recruited to participate in this study
- The study was part of a larger driving simulator investigation
- Designed for the purposes of the DriverBrain project ("Analysis of the performance of drivers with cerebral diseases") and the DISTRACT project ("Analysis of causes and impacts of driver distraction")

distrACT driverBRAIN

European Union European Social Fund
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STUDY PARTICIPANTS

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- MCI group: 30 subjects; 65.4 y.o. (s.d.=7.6)
- Control group: 30 subjects; 62.2 y.o. (s.d.=7.0)
- The two groups were not statistically different in terms of driver age, gender, driving experience and driving exposure
- The analysis revealed significant differences between the control group and the MCI group in measures of general cognitive functioning (MMSE), in specific executive cognitive function impairments (FAB), in measures of verbal episodic memory (Hopkins Verbal Learning Test), information processing speed (SDMT), psychomotor speed (TMTA), mental flexibility (TMTB), working memory (LNS) and selective attention (UFV3)

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QUESTIONNAIRE ADMINISTRATION

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Perceived Driving Difficulties

- Participants were asked to report the frequency with which they experienced driving difficulties related to functional deficits and knowledge of new traffic rules and traffic signs
- The functional abilities underlying these difficulties include visuo-perceptual abilities, useful field of view, reaction time, selective attention, divided attention, sustained attention, psychomotor performance, knowledge (of new traffic rules and signs) and mental flexibility
- A four-point scale (always; often; sometimes; never) was used

"Which of the following are true for you, and with what frequency?"

Q1. I have difficulty concentrating on more than one action at the same time (e.g. keeping the vehicle centered in the lane and concentrating on the position of other vehicles)

Q2. I have difficulty judging the distance and speed of approaching vehicles

Q3. I am surprised by vehicles and pedestrians appearing from the sides very close to me

Q4. I have difficulty focusing my attention on traffic signs where there are other signs

Q5. I have difficulty concentrating and maintaining attention

Q6. My reactions are delayed when I have to perform an emergency stop

Q7. I have difficulty moving my hands, feet and neck

Q8. My knowledge of new traffic rules and new traffic signs is not good enough

Q9. I have difficulty adapting to sudden changes in traffic control on one of my usual routes

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QUESTIONNAIRE ADMINISTRATION

Driving in Specific Situations

- Drivers were asked how often they drive in specific situations/conditions including driving at night, in heavy traffic, in urban roads, in heavy rain, on freeways, on unfamiliar roads, on rural roads, on urban roads, in the proximity of their homes and long distances
- A six-point scale (never; at least once every two months; at least once a month; at least once a week; at least twice a week; at least four times a week)

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RESULTS - MCI GROUP

- A principal component analysis (PCA) was initially conducted on nine items with oblique rotation
- FACTOR 1: represents driving difficulties associated with late detection and slowed response to relevant stimuli/targets in the peripheral field of view
- FACTOR 2: refers to driving difficulties associated with divided attention between tasks requiring switching from automatic to controlled responses, particularly of long duration

	Rotated Factor Loadings	
Question	Factor 1	Factor 2
I am surprised by vehicles and pedestrians appearing from the sides very close to me (Q3)	.852	.081
I have difficulty moving my hands, feet and neck (Q7)	.838	-.185
I have difficulty focusing my attention on traffic signs where there are other signs (Q4)	.757	.273
My reactions are delayed when I have to perform an emergency stop (Q6)	.579	.268
I have difficulty concentrating on more than one action at the same time (Q1)	-.121	.944
I have difficulty adapting to sudden changes in traffic control on one of my usual routes (Q9)	.073	.720
I have difficulty concentrating and maintaining attention (Q5)	.210	.701
Eigenvalues	3.79	1.03
%variance	54.11	14.68

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RESULTS - CONTROL GROUP

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- FACTOR 1: represents difficulties in estimating speed and distance of approaching vehicles in complex (attention-dividing) high-information load-conditions
- FACTOR 2: represents the ability to move head, neck and feet (motor performance)
- FACTOR 3: represents difficulties in switching from automatic to controlled processing in new or unexpected situation

	Rotated Factor Loadings		
Question	Factor 1	Factor 2	Factor 3
I have difficulty judging the distance and speed of approaching vehicles (Q2)	.913	-.146	.020
I have difficulty concentrating on more than one action at the same time (Q1)	.864	.061	.003
I have difficulty focusing my attention on traffic signs where there are other signs (Q4)	.857	-.122	.113
I have difficulty concentrating and maintaining attention (Q5)	.559	.384	.379
I have difficulty moving my hands, feet and neck (Q7)	-.249	.939	.016
I am surprised by vehicles and pedestrians appearing from the sides very close to me (Q3)	.339	.460	.011
I have difficulty adapting to sudden changes in traffic control on one of my usual routes (Q9)	.325	.181	.767
My reactions are delayed when I have to perform an emergency stop (Q6)	.548	.383	-.615
Eigenvalues	3.78	1.2	1.01
%variance	47.17	15.10	12.57

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RESULTS - PATTERNS OF CURRENT EXPOSURE

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- Both groups have similar patterns of exposure regarding the frequency of driving in certain conditions: they rarely drive long distances and often in the proximity of their homes
- Although both groups drive frequently in urban areas, it is notable that MCI drivers do not drive so often in heavy traffic and in a lesser extent than controls
- Neither group drives so often on freeways, but drivers with MCI do so to a lesser extent

		At night	Heavy traffic, urban roads	In heavy rain	Freeways	Unfamiliar roads	Rural roads	Urban roads	Proximity	Long distances
		%	%	%	%	%	%	%	%	%
Controls										
Never		6.7	3.3	3.3	10.0	43.3	16.7	0.0	3.3	30.0
At least once every two months		0.0	10.0	20.0	13.3	26.7	30.0	0.0	0.0	43.3
At least once a month		20.0	6.7	20.0	23.3	23.3	23.3	6.7	3.3	16.7
At least once a week		23.3	20.0	26.7	20.0	0.0	3.3	6.7	3.3	6.7
At least twice a week		26.7	33.3	23.3	16.7	3.3	23.3	23.3	33.3	3.3
At least four times a week		23.3	26.7	6.7	16.7	3.3	3.3	63.3	56.7	0.0
MCI										
Never		10.0	6.7	10.0	6.7	30.0	20.0	0.0	3.3	20.0
At least once every two months		10.0	6.7	6.7	13.3	33.3	6.7	0.0	0.0	43.3
At least once a month		30.0	23.3	36.7	43.3	26.7	30.0	13.3	6.7	26.7
At least once a week		16.7	23.3	26.7	16.7	10.0	23.3	10.0	10.0	6.7
At least twice a week		23.3	20.0	10.0	13.3	0.0	13.3	26.7	20.0	0.0
At least four times a week		10.0	20.0	10.0	6.7	0.0	6.7	50.0	60.0	3.3

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CONCLUSIONS 1/3

- The analysis revealed certain patterns of difficulties perceived by the two groups and significant differences in measures assessing episodic memory operations as well as executive, attentional and working memory resources
- The demands of road environments as perceived by vulnerable road users were revealed:
  - → difficulties that dominate MCI perceptions relate to late detection of targets in the peripheral view being also worsened by slowed movement and problems in selecting relevant information:
    - → *Complex intersections in urban areas with cars, pedestrians, cyclists crossing the driver's path, with very cluttered surroundings, place high demands on these abilities*

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CONCLUSIONS 2/3

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→ Other concern for MCI seem to be difficulties with attention sharing combined with the executive skill of switching from automatic to controlled actions and sustained attention:
  → *Driving at busy intersections, merging to highways with high traffic volumes with a way-finding task, workzones, and high-low speed transitions (rural-urban transitions)*

→ difficulties that dominate perceptions of control drivers relate to problems in estimating speed and distance of approaching vehicles combined with problems in attention sharing in high-information-load conditions:
  → *Uncontrolled intersections and entering and exiting maneuvers at highways that involve way-finding are examples of demanding situations*

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CONCLUSIONS 3/3

- Both groups have similar patterns of exposure regarding the frequency of driving in certain conditions
- The exposure pattern of drivers with MCI represents urban - close distance - driving
- Neither group drives so often on freeways, but drivers with MCI do so to a lesser extent than controls
- Elderly controls seem more exposed to high-speed driving than MCI patients, a finding which is consistent with their primary concern

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LIMITATIONS - FUTURE STEPS

- This work does not directly translate into design values or specific infrastructure countermeasures
- Perceptions of driving difficulties and problems may be important when auditing or designing improvements of particular benefit to the most vulnerable subgroup of elderly drivers who might still be able to drive
- Public involvement in RSA's: As affected groups might be involved in road safety audits particularly at an operation stage, helping auditors acquire a better understanding of their perceptions, needs and expectations in respect of specific roads or road features

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