Predictors of driving performance in individuals with MCI: preliminary results

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Frequency of driving in older individuals

- The number of drivers in Europe that are older than 65 is constantly increasing (Yannis et al., 2011)
- Elderly individuals keep their driving license longer and drive larger distances
- The percentage of older drivers that are at risk due to cognitive or physical impairments remains unknown

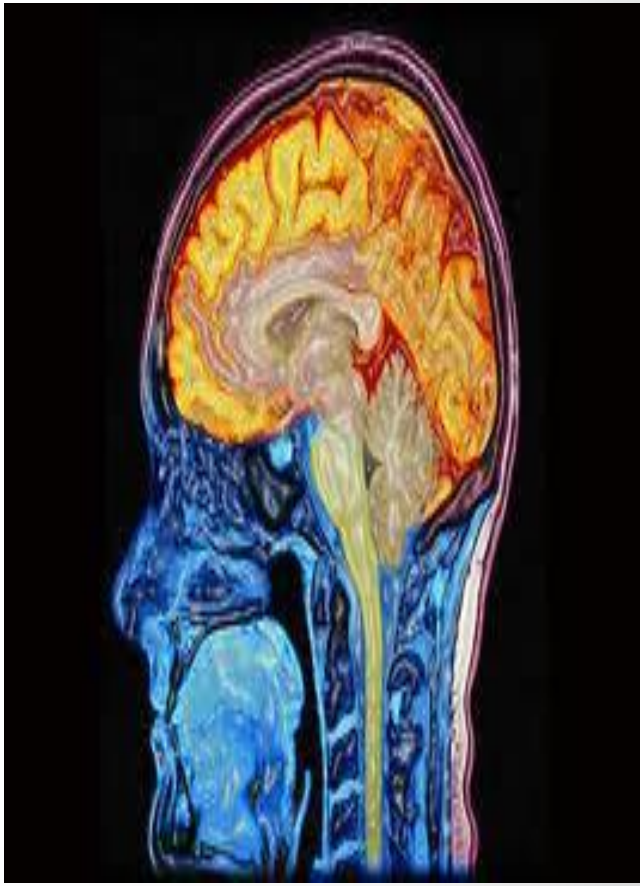
Cognitive functions critical for safe driving

Attention
quick perception of the environment

Executive functions
process multiple simultaneous environmental cues
make rapid, accurate and safe decisions

Visuo-spatial skills
position the car accurately on the road
manoeuvre the vehicle correctly
judging distances and predicting the development of traffic situations

Memory
journey planning
adapting behaviour



(Reger et al., 2004)

Cognitive Ageing

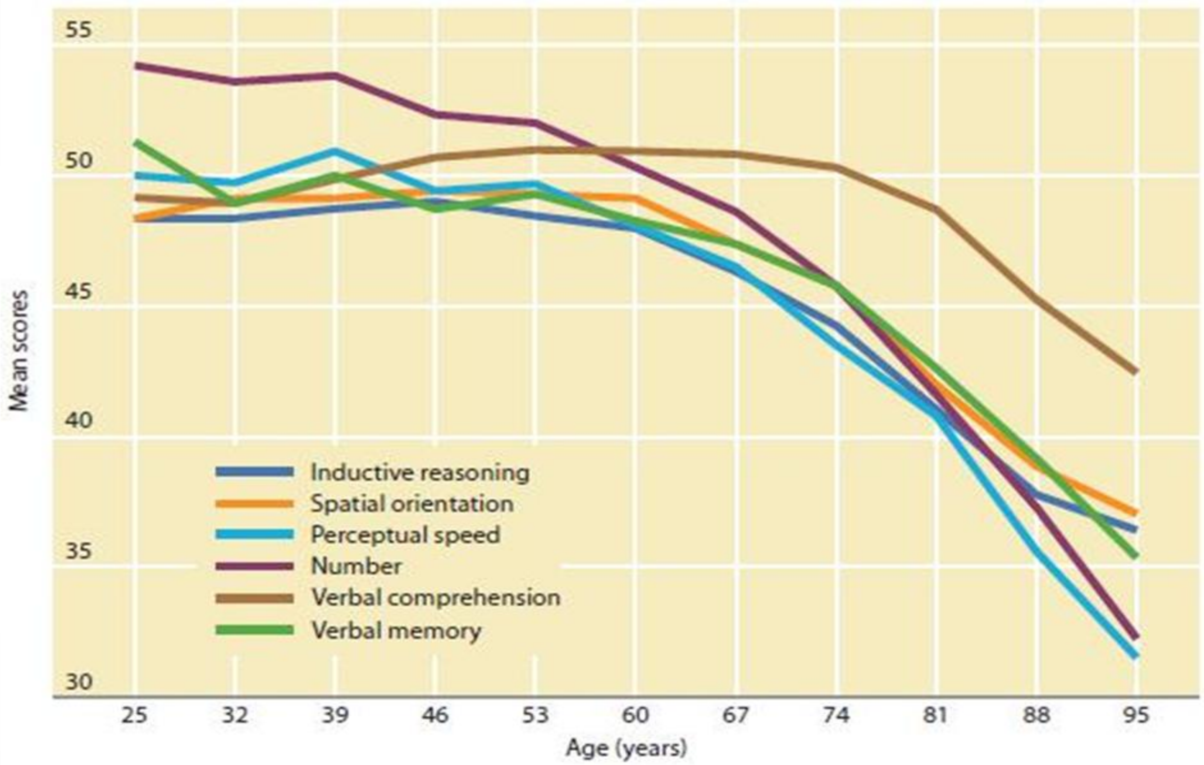


FIGURE **15.4**

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.

Mild Cognitive Impairment

- Mild Cognitive Impairment (MCI) is a transitional stage between normal aging and dementia (Winblad et al., 2004).

- MCI is a pathological condition with high prevalence in the general population as ~15% of people >65 years old are affected

- Involves the onset and evolution of cognitive impairments beyond those expected based on the age and education of the individual, but which are not significant enough to interfere with their daily activities.

MCI & Driving

- MCI population is at risk for driving difficulties, although their performance on on-road or on simulator testing is not consistently worse than that of controls (Fritteli et al., 2009; Kawano et al., 2012; Wadley et al., 2009)

- Measures of mental flexibility, inhibitory control and visual attention appear to be associated with driving performance in patients with MCI, but this issue needs further investigation (Kawano et al., 2012)

Objective of Study

- Scope of the present research was to investigate the association of neurological and neuropsychological measures with indexes of driving performance in individuals with MCI by applying a driving simulator experiment.

Participants

- A CDR score of 0.5 was required for the diagnosis of MCI.
- Additional inclusion criteria were the presence of a valid driver's license and regular car driving.
- Sixteen individuals with MCI attending our Memory Clinic participated in the study.

Procedure

- **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

General Cognitive Functioning : MMSE, MOCA

Working memory: Letter-Number Sequencing, Spatial Span, Spatial Addition (WMS), Neuropsychological Assessment Battery - Driving Scenes Test.

Memory: Hopkins Verbal Learning Test, Brief Visuospatial Memory Test.

Visual Perception: Benton's Judgment of Line Orientation, Witkin's Embedded Figure Test.

Executive function/processing speed: Frontal Assessment Battery, Trail Making Test, Comprehensive Trail Making Test, Symbol Digit Modalities Test.

Computerized tests: Useful Field of View, Psychomotor Vigilance Test.

Outcome Measures

- **Indexes of Driving Performance**

a) Average Speed
b) Number of crashes
c) Reaction time

Results (Average Speed)

Outcome: Driving Speed
Predictors:
(1st level) general cognitive functioning (MMSE)
(2nd level) balance and movement coordination (Tandem Walking, $\beta=-.63$, $p=.007$)

The model explained 55.9% of the variance in average driving speed

$R^2=.559$, $F(2,13)=8.25$, $p=.005$.

- In the cognitively intact group the same regression model did not contribute to the prediction of average driving speed

$R^2=.166$, $F(2,11)=1.10$, $p=.368$

Normal Group (*Mean*=43.62, *SD*=7.33) vs MCI Group(*Mean*=42.24, *SD*=7.46)
$t(28)=.51$, $p=.614$

Results (Number of Crashes)

Outcome: Number of Crashes
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

Results (Reaction Time)

Outcome: Reaction Time
Predictors:
(1st level) general cognitive functioning (MMSE)
(2nd level) information processing speed (SDMT, β=-.60, p=.014) and balance and movement coordination (Tandem Walking_RNC, β=.54, p=.007)

The model explained 73.2% of the variance in reaction time

R^2 =.732, F(3,12)=10.92, p=.001

- In the cognitively intact group the same regression model did not contribute to the prediction of reaction time

R^2=.119, F(3,10)=.45, p=.772

Normal Group (*Mean*=1.78, *SD*=.28) vs MCI Group (*Mean*=1.89, *SD*=.46)
t(28)=.80, p=.43

Conclusion

- Preliminary results show that neurological and neuropsychological measures are useful predictors of driving performance indexes of individuals with MCI
- In the cognitively intact group the same predictors were not contributing to the prediction of driving performance
- Measures assessing balance and movement coordination, visuospatial memory, speed of attention and information processing speed made the most important contribution on predicting various indexes of driving performance in the MCI group

Next steps

- Inclusion of additional participants for increasing the power of the analysis and assessing more clearly the unique contribution of each neurological/neuropsychological predictor
- Evaluation of additional driving indexes

- Exploration of the predictive role of neurological/ neuropsychological indexes during on road, ecologically valid, driving assessments
- Monitoring of drivers with MCI for estimating their actual risk of being engaged in traffic violations or crashes
- Estimation of cut-off scores that have adequate levels of sensitivity and specificity

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