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# Assessing Driving Ability in the Elderly: Methodological issues

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# The Framework

- A **large driving simulator experiment** on driver distraction including drivers with cerebral diseases
- By an **interdisciplinary research team**, co-funded by the Greek Research Secretariat and the European Commission
- **Phases of the Experiment** (Fall 2012 – Fall 2015)

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

- **Sample size**

| Age | Impaired | Healthy | Total |
|---|---|---|---|
| > 55 | 125 | 75 | 200 |
| < 55 | 50 | 50 | 100 |
| Total | 175 | 125 | 300 |

# Objectives

- A comprehensive review of the methodological issues concerning the assessment of the driving ability in the elderly

  - Strengths and weaknesses of experiments on the road and on simulated environment

  - Analysis techniques of road accidents with the involvement of older drivers

# Basic Facts

- Elderly people (> 64 years old) are vulnerable road users
- In 2010, over 6.500 elderly people died in road traffic accidents in 24 European Union countries
- Elderly fatalities constitute 22% of fatalities of all ages in the EU
- Older drivers are especially at risk at certain types of collision (multi vehicle collisions at intersections or when merging)

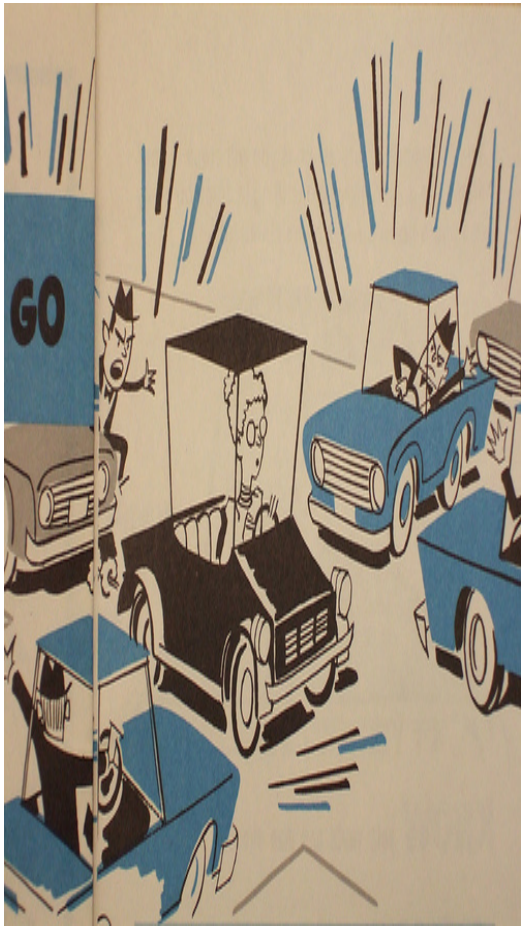
# Older Driver Behaviour characteristics

Older drivers have a relatively high fatality rate due to:

- functional limitations
- physical vulnerability
- low annual mileage

Particular Older Driver Behaviour characteristics

- driving habits
- social behaviour
- risk compensation
- changing behaviour over time

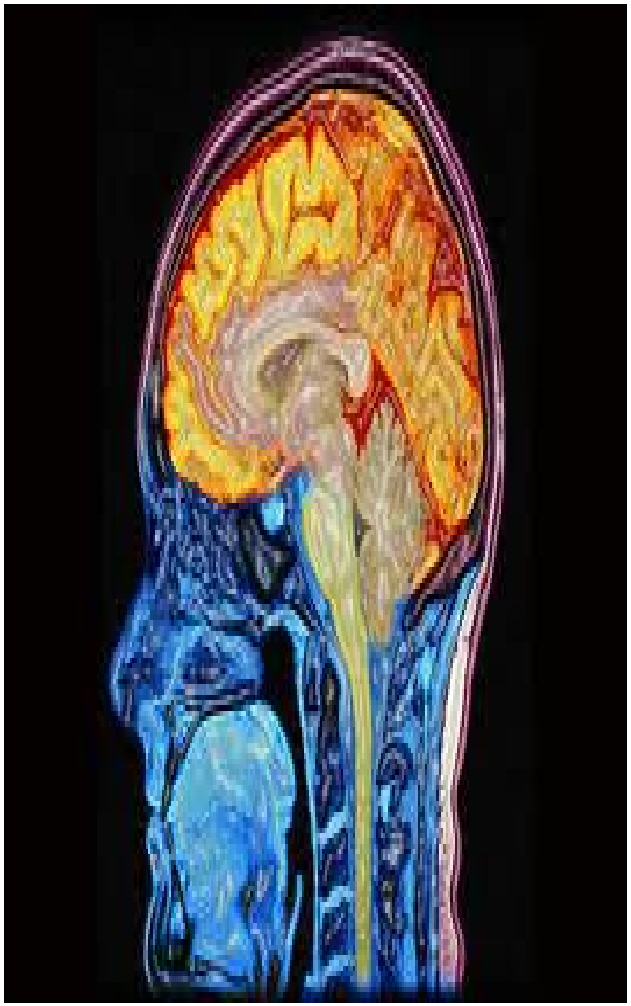


# Cognitive functions related to driving

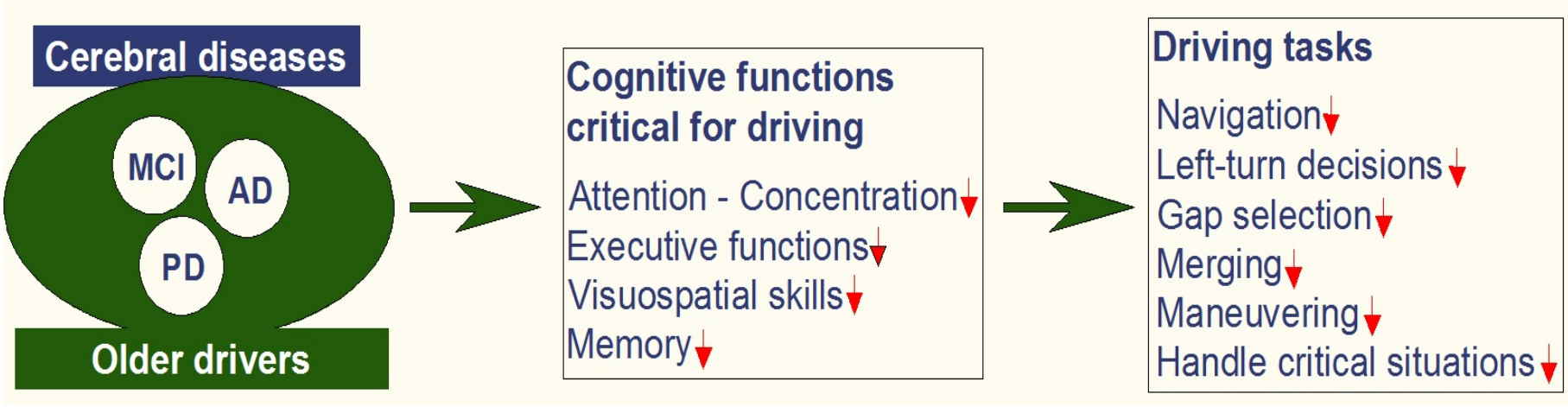
- Driving – sufficient cognitive, visual and motor skills
- Cognitive functions related to driving may be categorized into the following six neuropsychological domains (Reger et al. 2004):
  - mental status-general cognition
  - attention–concentration
  - executive functions
  - language–verbal functioning
  - visuospatial skills
  - memory

# 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
- Visuospatial 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



# Cerebral Diseases affecting Driving Behaviour

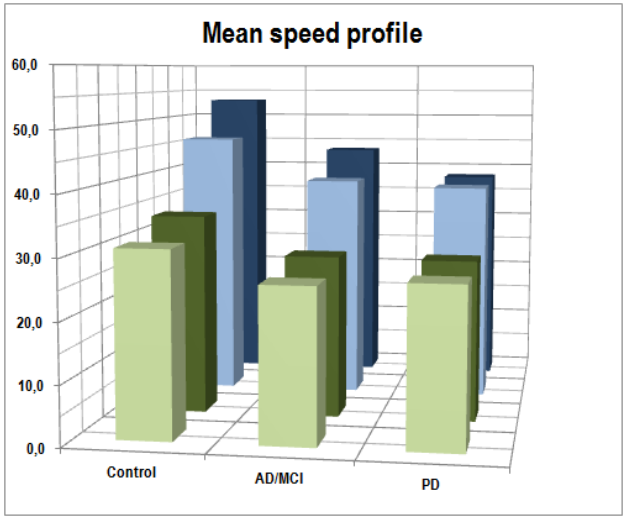


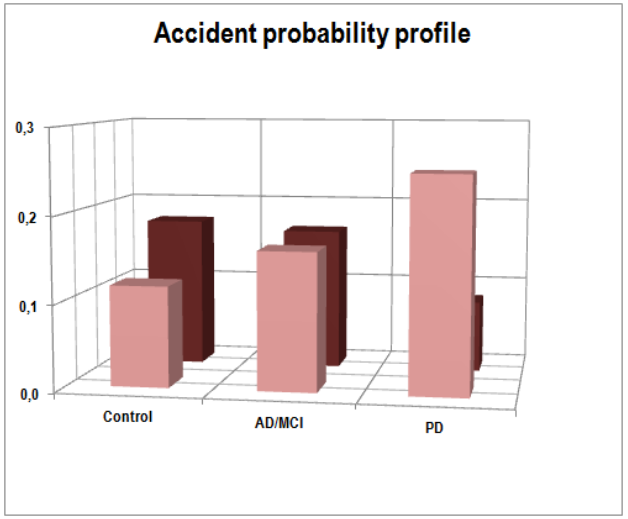

- Older Drivers
- Cerebral diseases (MCI, AD, PD)

Downgrade the main cognitive functions critical for safe driving and affect driving tasks

# Driving Performance Indicators

- Lateral Control Measures
  - Lateral position
  - Standard deviation of lateral position
  - Lane excursion
- Longitudinal Control Measures
  - Speed
  - Headway
- Reaction Time Measures
  - Reaction time
- Safety
  - The probability of getting involved in an accident in case of an unexpected incident



# Key Research Parameters

- Road environment
  (urban, interurban, motorway)
- Traffic conditions
  (heavy, moderate, low traffic)
- Lighting
  (daylight, night-time)
- Weather conditions
  (normal, rainy, windy)

# Naturalistic Driving Experiments

A research method for the observation of everyday driving behaviour of road users

## Advantages

- Large degree of control over the variables that affect driving behaviour
- Researchers study issues that cannot be investigated in a lab
- Help support the external validity of research

## Disadvantages

- Difficult to determine the exact cause of a behavior
- The experimenter cannot control outside factors
- Traffic incidents are very rare

# Driving Simulator Experiments

## 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

## Disadvantages

- Non totally realistic simulated road environment
- Possibility of adopting a different driving behaviour
- Feeling of safety
- Simulator sickness

# On-road Experiments

Studies using instrumented test vehicles to gain greater insights into the factors that contribute to road user accident risk and the associated crash factors at specific conditions.

## Advantages

- Large degree of control over the variables that affect driving behaviour
- Study of actual observed behaviour

## Disadvantages

- Data not collected over a longer time period and in response to selected interventions

# In Depth Accident Investigation

- **In-depth accident data** describe the causes of accidents and injuries and aim to reveal detailed and factual information from an independent perspective on **what happens in a crash**

## Advantages

- Describe the accident process and determine appropriate countermeasures
- Provide a major contribution to the development of new safety policies

## Disadvantages

- Insufficient reconstruction evidence

# Surveys on Opinion and Stated Behaviour

- In **stated behaviour surveys**, a reference questionnaire is built, based on a list of selected topics and a representative sample of population is interviewed

## Advantages

- Survey design may control for external factors
- Allow to investigate new situations, outside the current set of experiences

## Disadvantages

- Often hypothetical nature of questions
- Actual behaviour is not observed
- Over- or under-representation of actual behaviour

# Methodological Challenges

## Reliability

- Increased variability - Older people may perform very well on one occasion and much worse on another
- Aged related health conditions change from day to day

## Validity

- Differential exposure
- Difficulties in distinguishing the effects of normal age-related changes from those from age-related disorders
- Older adults may take one or more prescription drugs which may impair driving

# Experiment design and driving scenarios

## Experimental design principles

- Between- or within-subject design
- Full or fractional factorial design
- Counterbalanced design (order of trials, learning and fatigue effects etc.)
- Extensive pilot testing

## Common older drivers scenarios

- Car following
- Way finding
- Left turns
- Late yellow light

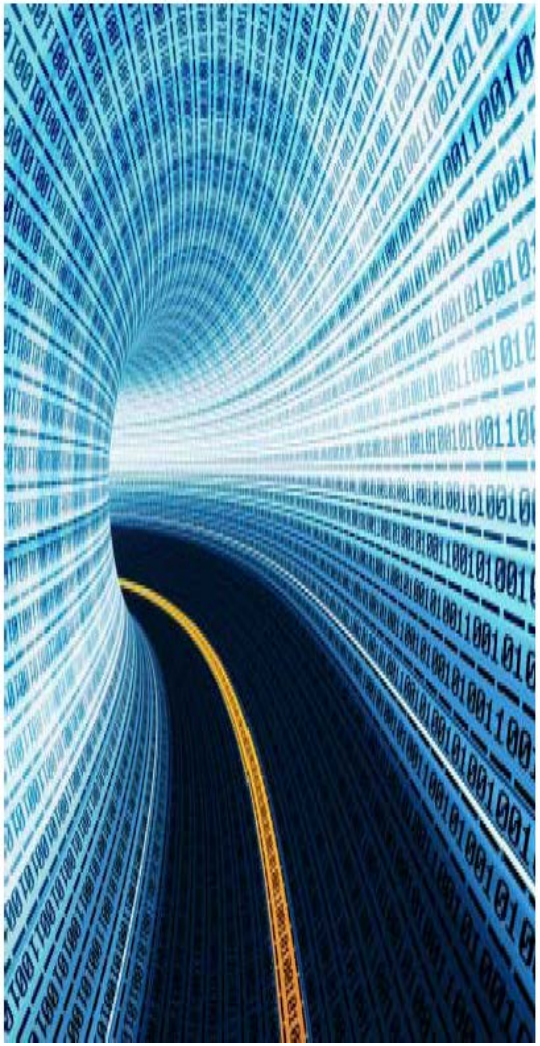
# Data analysis

## Data handling

- Data selection (e.g. outliers)
- Data reduction: what level of aggregation?
- Sample representativity and power

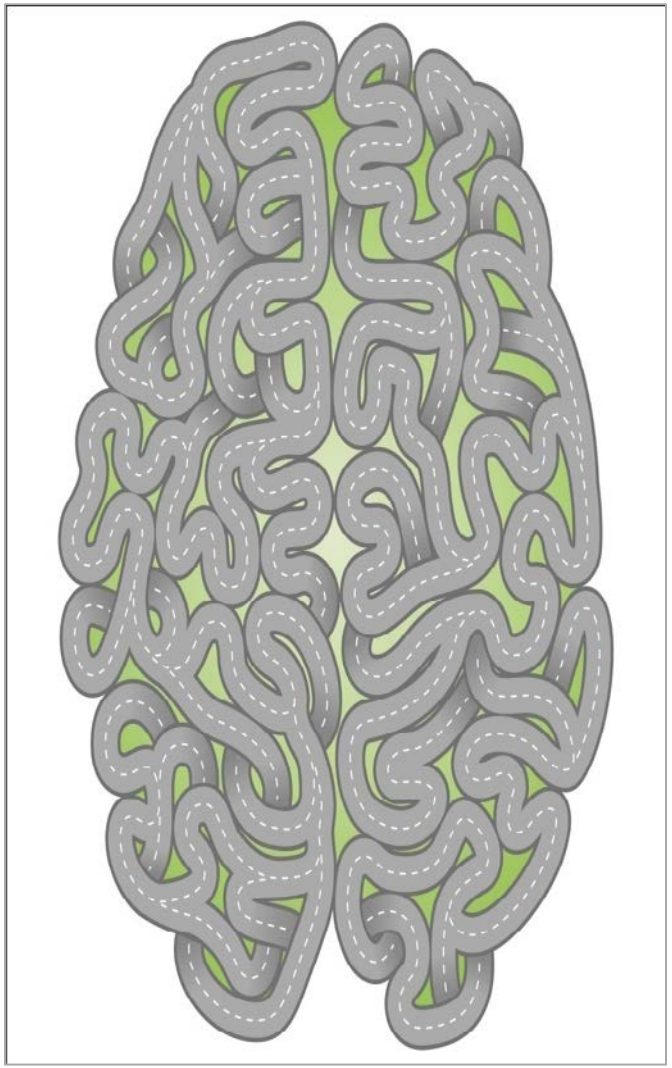
## Analysis methods

- Selection of the appropriate technique for each study design
- Dependent and independent variables properties (continuous or discrete)
- Analysis of Variance: Handling mixed designs (between- and within-subject) and / or repeated observations
- Multivariate regression models
- Multilevel models and time series models



# Conclusions

- Every experiment type has benefits and deficiencies. Combination and meta-analysis of experiments results may bring more reliable conclusions.
- Sample size should correspond to the number of variables to analyse.
- Internal structure of experiments has a direct impact to the results reliability.
- Valid data analysis requires multi-annual effort to address the high complexity.



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