# Faculty Disclosure

| X | No, nothing to disclose |

| Yes, please specify: |

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Honoraria/Expenses</th>
<th>Consulting/Advisory Board</th>
<th>Funded Research</th>
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## Off-Label Product Use

**Will you be presenting or referencing off-label or investigational use of a therapeutic product?**

| X | No |

| Yes, please specify: |
Assessing Driving Ability in the Elderly: Methodological issues

George Yannis
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18 October 2013
Athens
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

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<th>Age</th>
<th>Impaired</th>
<th>Healthy</th>
<th>Total</th>
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<tr>
<td>&gt; 55</td>
<td>125</td>
<td>75</td>
<td>200</td>
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<tr>
<td>&lt; 55</td>
<td>50</td>
<td>50</td>
<td>100</td>
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<tr>
<td>Total</td>
<td>175</td>
<td>125</td>
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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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