The detrimental effect of mobile phone use on the driving competence of patients with neurological diseases affecting cognitive functions

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Structure of the presentation

• Background

• Objective

• Experiment Design
  • Data
  • Analysis methods

• Results

• Discussion & Conclusions
Driving Behaviour and Road Safety

• **Driving in traffic** is more than just knowing how to operate the mechanisms which control the vehicle

• Road accidents constitute a major social problem in modern societies (**8th leading cause of fatalities globally**) and the leading cause of fatalities for young people aged 15-29 years), in 2015:
  • 1.2 million fatalities worldwide
  • 26,000 in the European Union
  • 805 in Greece
Cognitive functions critical for safe driving

- The task of driving requires the ability to **receive** sensory information, **process** the information, and to make **proper, timely judgments** and responses.

- Cognitive functions related to driving may be categorized into six neuropsychological domains:
  - Memory
  - Attention
  - Executive functions
  - Visuospatial skills
  - Cognitive functions critical for safe driving
  - Language and verbal functioning

D. Pavlou, Mobile phone use and drivers with neurological diseases affecting cognitive functions, DDI2017, Paris
Cerebral diseases and driver distraction

• Diseases affecting a person's brain functioning affect the ability to drive and lead to reduced driver fitness and increased accident risk

• Driver distraction is estimated to be an important cause of vehicle accidents, and when combined with a brain pathology it can lead to significant deterioration in driving performance

• The interaction of brain disorders and driver distraction, which has not been adequately investigated so far, makes the assessment of their driving competence a very challenging task
Objectives

• The analysis and quantification of the effect of mobile phone use on the driving competence of patients with Mild Cognitive Impairment (MCI), Alzheimer’s Disease (AD), and Parkinson’s Disease (PD).

• Basic research hypothesis is that the effect of the mobile phone use is detrimental on their driving performance and the question is to what extend their driving competence is compromised by this type of distraction.
Experiment Design

- **Distract** and **DriverBRAIN** research projects

- **Neurologists - Medical/neurological assessment:**
  - administration of a full clinical medical, ophthalmological and neurological evaluation

- **Neuropsychologists - Neuropsychological assessment:**
  - administration of a series of neuropsychological tests and psychological - behavioural questionnaires to the participants which cover a large spectrum of Cognitive Functions

- **Transportation Engineers - Driving at the simulator**
Driving simulator

- Concerns the **assessment of driving behaviour** by means of programming of a set of driving tasks for different driving scenarios

- **Quarter-cab driving simulator** manufactured by the FOERST Company

- **3 LCD wide screens** 42” (full HD: 1920x1080 pixels) - total F.O.V. 170 degrees

- **Validated** against a real world environment
“Driving at the simulator assessment”

• 1 practice drive (usually 15-20 minutes)
• 1 rural route (2.1km long, single carriageway, 3m lane width)
• 1 urban route (1.7km long, at its bigger part dual carriageway, 3.5m lane width)

• 2 traffic scenarios for each route:
  • Q_L: Moderate traffic conditions (Q=300 vehicles/hour)
  • Q_H: High traffic conditions (Q=600 vehicles/hour)

• 3 distraction conditions for each route:
  • Undistracted driving
  • Driving while conversing with a passenger
  • Driving while conversing on a hand-held mobile phone

• 2 unexpected incidents occur during each trial:
  • Sudden appearance of an animal on the roadway
  • Sudden appearance of a child chasing a ball or of a car suddenly getting out of a parking position.
125 participants (all more than 55 years of age and of similar demographic characteristics):

- **34 Healthy Controls** (aver. 64.1 y.o., 25 males)
- **91 Patients** (aver. 71.2 y.o., 59 males):
  - **43 MCI patients** (aver. 70.1 y.o.)
  - **28 AD patients** (aver. 75.4 y.o.)
  - **20 PD patients** (aver. 66.1 y.o.)

Table 1 Comparison of patients with neurological diseases affecting cognitive functions and of the Control group without neurological history on various demographics with the use of the Wilcoxon Rank Sum Test (age >55 y.o.)

<table>
<thead>
<tr>
<th></th>
<th>“MCI, AD, PD Patients” group</th>
<th>“Control” group</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y, mean±SD</td>
<td>71.2±7.2</td>
<td>64.1±6.6</td>
<td>0.122</td>
</tr>
<tr>
<td>N, M/F (Gender)</td>
<td>91, 59/32</td>
<td>34, 25/9</td>
<td>0.141</td>
</tr>
<tr>
<td>Driving experience, y, mean±SD</td>
<td>41.3±5.8</td>
<td>38.7±2.8</td>
<td>0.271</td>
</tr>
<tr>
<td>Days/week, median (range)</td>
<td>4 (2-7)</td>
<td>5 (2-7)</td>
<td>0.359</td>
</tr>
<tr>
<td>Kilometers driven/week, median (range)</td>
<td>3 (2-5)</td>
<td>3 (2-5)</td>
<td>0.416</td>
</tr>
<tr>
<td>Accidents (2 years) - reported, median (range)</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>1.000</td>
</tr>
<tr>
<td>Education, y, mean±SD</td>
<td>12.1±3.5</td>
<td>13.5±2.2</td>
<td>0.812</td>
</tr>
<tr>
<td>Simulator sickness &lt;sup&gt;b&lt;/sup&gt; - reported, median (range)</td>
<td>0.23 (0-3)</td>
<td>0.18 (0-3)</td>
<td>0.726</td>
</tr>
</tbody>
</table>

<sup>a</sup>1=1-20km; 2=21-50km; 3=50-100km; 4=100-150 and 5>150

<sup>b</sup>Question: Did you feel dizzy at the simulator? 0~Not at all, 1~Just a little, 2~To some extent, 3~A lot
Analysis Overview

- 4 group of participants
  - Controls vs. MCI vs. AD vs. PD
- 2 driving environments
  - Rural and Urban
- 3 distraction conditions
  - No distraction condition
  - Conversation with passenger
  - Conversation through handheld mobile phone
- 3 critical driving performance measures
  - Mean speed
  - Reaction time
  - Accident probability
- Regression analysis method:
  - generalized linear modeling (GLM) techniques
Results - Controls

In general terms, the distraction conditions (even the mobile phone use while driving) **don’t have a significant impact** on mean speed, reaction time and accident probability in the group of controls overall, compared to their undistracted driving performance.
## Results - MCI

In rural area mobile phone use leads to:
- 8% lower speeds,
- 0.34 sec worse reaction time
- 20% higher accident risk for the MCI group compared to their undistracted driving

In urban area mobile phone use leads to:
- 23% higher accident probability

The effect of conversation with passenger isn’t that detrimental
Results - AD

Mobile phone use **worsen the reaction times of AD patients by 1.2 sec** and more importantly **catapults their accident probability to more than 40%**.

In urban area no significant differences were detected regarding the effect of distraction to the driving competence of the AD group.
Results - PD

PD patients in rural area, when using the mobile phone, have **0.8 sec larger reaction time** and **40% higher accident probability** compared to the undistracted driving.

In **urban area**, they have significantly larger reaction time and higher accident probability compared to the undistracted driving, but not when using their mobile phone.
Conclusions 1/2

Drivers with MCI, AD or PD tried to compensate their driving behaviour by reducing, at an important extent, their speed when using a mobile phone, but this self-regulated strategy was unsuccessful.

Conversation with a passenger, had a detrimental effect, but only for the MCI and the PD groups in urban area.

The execution of two tasks simultaneously, namely of driving and using a hand-held mobile phone, placed the group of drivers with neurological diseases affecting cognition in a vulnerable position due to the need to effectively divide their attention under this demanding driving condition, confirming our initial research hypothesis.
Conclusions 2/2

The presence of an in-vehicle distractor while driving such as conversing through a handheld mobile phone, has a significantly deleterious effect on accident probability of drivers with cognitive impairments (AD, PD and in a lesser extend MCI).

Observations of considerable practical importance as they provide quite useful information for the development of policies that aim at reducing the risk for car accidents and at improving aspects of driving performance (restrictive measures, training and licensing, information campaigns, medical and neuropsychological monitoring), especially in a sensitive group of car drivers, such that of drivers with MCI, AD or PD.
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