A cost-effectiveness analysis of cognitive training programs for older drivers misestimating their cognitive abilities

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CONSEQUENCES OF AGEING

- ¼ population > 65 years old (OECD, 2012)

Difficulties in daily life activities

- Cognitive decline

- As the car-use is very important especially in rural areas, maintain **mobility, autonomy** and **quality of life** of older drivers in **safe conditions** is a public health issue

Anstey et al., 2005
### SELF-REGULATION

- Behavioral adaptation to maintain a safe driving despite the age-related decline *(Donorfio et al., 2008)*

- Compensatory and adaptive strategies

<table>
<thead>
<tr>
<th>Avoidance</th>
<th>Adaptation</th>
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*(Ball et al., 1998, Donorfio et al., 2009, Gabade et al., 2010, Holland & Rabbitt, 1992, Molnar & Eby, 2008)*

- Some drivers self-regulate their driving behavior **but not all**

- That’s why it is important to develop **educational interventions** to help them to use these strategies
EDUCATIONAL INTERVENTIONS

• Theoretical programs: some limits
  – No improvement of on-road driving performance (Bédard et al., 2004)
  – No crash risk reduction (Ker et al., 2005; Nasvadi & Vavrik, 2007)
  – Activation of the stereotype threat of the elderly which could decrease self-regulation abilities (Motak, 2011)

• Theoretical program + driving training: better effectiveness
  – Improvement of driving knowledge (road rules and safe driving practices) and some driving behavior (Marottoli, 2007; Bédard et al., 2008)
  – Specific driving skills improvement for trained situations (e.g. lane changes, indicator use, visual checking strategies, and visual scanning) (Roenker et al., 2003; Romoser & Fisher, 2009; Lavallière et al., 2012)

• Cognitive training
  – Durability of the training benefits but non-conclusive transfer (Cassavaugh & Kramer, 2009; Seidler, 2010; Gaspar et al., 2012)

→ Need to adapt content of these interventions to the drivers’ profile (awareness of their own abilities, Obriot-Claudel et al., 2006; Gabauade et al., 2010)
HYPOTHESIS (1/3)

Correct self-assessment
Correct self-regulation

Correct awareness

Age related cognitive decline

Incorrect awareness

Self-assessment bias
HYPOTHESIS (1/3)

OE = **over-estimators** ➔ people who think they have a higher cognitive level than the others whereas they aren’t

UE = **under-estimators** ➔ people who think they have a lower cognitive level than the others whereas they aren’t
**HYPOTHESIS (2/3)**

**Objective assessment**
- Trail Making Test
- Digit Symbol Substitution Test

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**From the SafeMove cohorte (n=1200)**

**Subjective assessment**
Self-declared cognitive performance (questionnaire)
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Subjective assessment
Self-declared cognitive performance (questionnaire)
HYPOTHESIS (3/3)

- Training Program
- Questionnaires & Feedbacks
- Awareness
- Driving simulator experience
- Better self-assessment
- Better self-regulation
- Driving performance
- Quality of life
OBJECTIVE

• Compare the effectiveness of two cognitive training programs associated or not with a driving simulator experience on older drivers presenting a cognitive self-assessment bias

• Effectiveness observed in terms of
  – Self-assessment of cognitive performances
  – Cognitive performance
  – Transfer benefits on the driving activity
EXPERIMENTAL PROTOCOL

T0 Pre-training

Questionnaires (Quality of life and well-being)
- French adaptation of General Self-efficacy Scale
- World Health Organization Quality Of Life – BREF questionnaire
- Psychological Autonomy questionnaire
  (Dumont, Schwarzer, & Jerusalem, 2000; WHOQOL-BREF, 1996; Dubé & Lamy, 1990)

Cognitive assessment
- Neuropsychological tests battery (TMT, DSST, Stroop test, dual-task walking test, phasic alertness task, UFOV®, & digit span test)
- Cognitive self-assessment questionnaire

Driving assessment
- On-road
- Driving simulator
**EXPERIMENTAL PROTOCOL**

**36h Computerized cognitive training**
- Attention – Memory – Visuo-spatial abilities – Executive functions

**35h Computerized cognitive training**
+ **1h Driving simulator experience**
  (3 sessions of 20 min each)

**Feedbacks**

**Durability of the training effects?**
COMPUTERIZED COGNITIVE TRAINING

- Twenty exercises based on a commercial cognitive training program, with 15 difficulty levels
  - Attention
  - Memory
  - Visuo-spatial abilities
  - Executive functions

- The choice of these exercises was made regarding the trained functions ➔ those related with the driving activity
- Training performed at home, on a computer
- Duration: 36h during 3 months (± 25min/day)
DRIVING SIMULATOR IMMERSION

• Five driving situations
  – Overtaking on a highway
  – Left-turn
  – Car following
  – Pedestrian crossing
  – Traffic light (amber)

• Three difficulty levels for each situation

• Duration: 1h (3*20 minutes)
FIRST RESULTS

Analyses
120 older drivers > 70+
Data available for 50 participants
– 35 from the cognitive training group (CT)
– 15 from the cognitive training + driving simulator immersion group (CT + DS)

Characteristics

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<tr>
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<th>CT</th>
<th>CT + DS</th>
<th>Total</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>75 ± 3,5</td>
<td>75 ± 3,7</td>
<td>75 ± 3,5</td>
</tr>
<tr>
<td>Gender</td>
<td>14 ♂, 21 ♂♀</td>
<td>5 ♂, 10 ♂♀</td>
<td>19 ♂, 31 ♂♀</td>
</tr>
<tr>
<td>Training Duration</td>
<td>31 ± 9</td>
<td>32,5 ± 8</td>
<td>31 ± 8</td>
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<tr>
<td>Self-assessment profile</td>
<td>16 UE, 19 OE</td>
<td>11 UE, 4 OE</td>
<td>27 UE, 23 OE</td>
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COGNITIVE SELF-ASSESSMENT

Pre training:
- 16 (OE)
- 19 (UE)

Post training:
- 18 (Correct estimators)
- 14 (OE)
- 3 (UE)

Pre training:
- 4 (OE)
- 11 (UE)

Post training:
- 5
- 3
- 7

Legend:
- UE
- Correct estimators
- OE
COGNITIVE PERFORMANCE
UFOV® test

* $p<0.05$
** $p<0.01$
*** $p<0.001$

Graph showing performance improvements in different cognitive tasks after training:
- Speed of processing
- Divided attention
- Selective attention

Legend:
- Pre-training
- Post-training
CRASH RISK
(from UFOV® categorization)

Pre training

Post training

Very low risk  Low risk  Low to moderate risk  Moderate to high risk  High risk
DRIVING PERFORMANCE

• TRIP grid: Test Ride for Investigating Practical fitness to drive*
  – Tactical compensation score
    • Distance from the car ahead
    • Choice of speed
    • Anticipation behavior

(*Withaar, 2000; De Raedt & Ponjaert-Kristoffersen, 2000)
DRIVING PERFORMANCE

- TRIP grid: Test Ride for Investigating Practical fitness to drive
  - Operational score
    - Mechanical operation
    - Lateral position on the road

![Operational score graph]

* p<0.05
DISCUSSION

• Improvement of the **cognitive self-assessment** for 23/50 OD
  (18/35 from the CT group and 5/15 from the CT + DS group)
  ➔ The training is effective in reducing self-assessment bias

  ➔ The training seems more effective for UE than for OE (16/27 correct estimators post training vs 7/23, respectively)

• Improvement of the cognitive performance (visual divided and selective attention and speed of processing) for the **CT group**
  ➔ The training seems effective in reducing the crash risk (UFOV®)
**DISCUSSION**

- **Improvement of the *driving performance* (TRIP)**
  - Tactical compensation score improvement for the **CT + DS** group
    - Better anticipation and adaptation regarding the other vehicles ➔ improvement of the executive functions
  - Possible transfer effect of simulated driving experience on the road

- **Operational score improvement for the **CT** group**
  - Better car handling and lane positioning ➔ improvement of « low-level » functions, involving mechanical actions
## COST EFFECTIVENESS ANALYSIS

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<td>• Coming 3 times at the laboratory (±3*90min = 4h30)</td>
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<td>• 1h of simulated driving</td>
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<td>• Driving simulator charges (± 300€ comprising material and personnel costs)</td>
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Time + 5h
Money *11
CONCLUSION - PERSPECTIVES

• Idea: propose the DS immersion to OD presenting a low tactical compensatory score at the TRIP, in order to specifically improve their anticipation and behavioral adaptation in complex driving situations

• Experiment still in progress
  – Complete data for the CT + DS group to better investigate the benefits from the driving simulator use
  – Add a control group (« active » participants)
  – Analyze the long-term questionnaires (durability? changes?)

• Driving activity: analyse the penalty grid to better describe the adaptive strategies adopted by OD
Thank you for your attention

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Safe Move for older drivers

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European and interdisciplinary conference

AGEING

AND

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