Neuropsychological parameters associated with driver distraction in a driving simulator experiment: presentation of methodology and preliminary findings

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Background & Aims

Driver distraction constitutes a basic factor for increased risk of road accidents in Greece and internationally. It contributes to road accidents in a proportion ranging from 10% to 30% (MacEvoy et al., 2007; Wang et al., 1996), and driver inattention may, together with other factors, affect up to 70% of road accidents (Dingus et al., 2006).

Herein, we present the methodology and preliminary data from a recently funded research programme, National Strategic Reference Framework (NSRF 2007-13, O.P. Thales), aiming at integrating endogenous factors (subject variables, such as demographic factors, presence of neurological disorder, etc.), with exogenous factors, such as driving area type, traffic parameters, and presence and type of distraction (mobile phone, conversation) in a driving simulator experiment. The originality of the study lies in the integration of the two sources of variance in an experiment that manipulates type of distraction and driving conditions.

Variables / Research

Subject variables

- **Demographic**
- Age, gender
- **Driving history**
- Driving frequency, duration, conditions
- Accident history
- **Participant type**
- Healthy drivers
- Parkinson's disease
- MCI-mild AD
- **Medical**
- Medication
- Signs & symptoms
- **Neuropsychol.**
- Working memory
- Memory
- Visual perception
- Executive function
- Processing speed
- **Personality**
- Driving anger

Independent variables

- **Driving area type**
- Urban vs. rural environment
- **Traffic parameters**
- Traffic volume
- **Use of distraction**
- No distraction
- Mobile phone
- Conversation with passenger

Dependent variables

- **Driver behavior**
- Driver speed
- Vehicle lateral position in lane (distance of the vehicle from the right road border in meters)
- **Safety parameters**
- Accident probability
- Reaction time in unexpected incidents

Materials & Methods

Participants

At least 200 participants will be recruited over the course of two years: 50 young participants (ages 18-26), 60 middle aged/ older participants and 90 participants with neurological disorders: Mild Cognitive Impairment (MCI), mild Alzheimer's disease (mild AD), Parkinson's disease (PD).

Measures

A neuropsychological battery is employed that includes, by category: 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: Comprehensive Trail Making Test, Symbol Digit Modalities Test. Computerized tests: Useful Field of View, Psychomotor Vigilance Test.

Personality and driving behavior questionnaires.

Procedure

Neurological assessment

Participants underwent a neurological assessment and clinical history evaluation

Ophthalmological assessment

Participants' visual acuity and other possible visual problems were assessed

Neuropsychological assessment

Participants underwent a two-stage neuropsychological assessment and personality testing

Driving experiment

Driving was assessed with a Foerst FPF driving simulator, in different conditions

Data collection

- **Phase 1**: Practice session (5-10 min.)
- **Phase 2**: Two driving sessions (about 20 min. each) on urban streets with multiple lanes, and on a two-lane rural road. An unexpected incident occurs in each of the two sessions (sudden appearance of pedestrian or child on the road, sudden appearance of an animal on the rural road).
- **Phase 3**: Three test drives of about 2 min. each, with gradually increasing driving demands. Three memory tasks are presented before each condition (signs with safety information), with cued recall at the end of each drive.

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Experimental design

A mixed factorial design, with **within-subjects factors**: area type, traffic flow, and presence/type of distractor, and **between-subjects factor**: participant type. Traffic and distractor are fully counterbalanced for each area type.
Additional analyses examine the contribution of the other subject variables to driving performance.

SESSION	AREA TYPE	TRIAL	TRAFFIC	DISTRACTOR	LENGTH (Km)	DURATION (min)
1	URBAN	1	MODERATE	NONE	1,7	3:30
		2	HIGH	NONE	1,7	3:30
		3	MODERATE	CELL PHONE	1,7	3:30
		4	HIGH	CELL PHONE	1,7	3:30
		5	MODERATE	CONVERSATION	1,7	3:30
		6	HIGH	CONVERSATION	1,7	3:30
2	RURAL	7	MODERATE	NONE	2,1	3:30
		8	HIGH	NONE	2,1	3:30
		9	MODERATE	CELL PHONE	2,1	3:30
		10	HIGH	CELL PHONE	2,1	3:30
		11	MODERATE	CONVERSATION	2,1	3:30
		12	HIGH	CONVERSATION	2,1	3:30
				TOTAL	22,8	42:00

Preliminary results

Pilot results from 13 MCI-mild AD patients, 5 PD patients, and 7 healthy controls in the **rural area-moderate traffic condition with no distraction**, showed that healthy drivers drove the initial road section at higher speed than patients, especially PD patients (Figure 1). Lateral position differences among the 3 groups were less pronounced (Figure 2). All groups were able to reduce speed at unexpected incidents (marked by *).

Figure 1

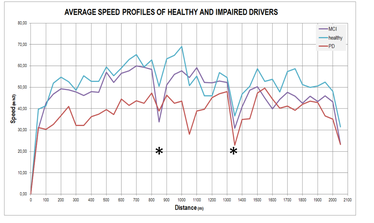
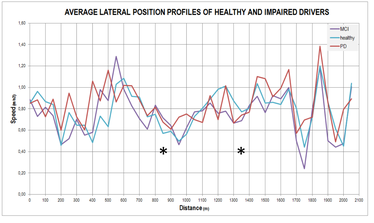


Figure 2



Discussion

- From preliminary analyses, the reduced speed of driving of the patients, especially the PD patients, may indicate a compensatory strategy for motor control and planning deficits. This enables them to maintain lateral position within lane and to reduce speed at unexpected incidents.
- The integration of endogenous (subject) variables and exogenous (independent) variables permits the examination of driving simulation performance for specific types of participants, under specific conditions. The incorporation of neuropsychological, personality and medical variables will further qualify driving behavior and safety parameters.
- The results of the study will be exploited for making specific safety recommendations.

References

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