Reaction time to incidents as a function of age and neurological disease: preliminary findings from a large driving simulation experiment

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Background & Aims

Reaction time (RT) of the driver in unexpected incidents is an important component of accident probability, yet it is difficult to investigate during on-road driving. Herein, we present initial findings from RT performance and other measures of neurology patients and healthy control drivers of different ages in two driving simulation environments: Rural and Urban, in order to examining the factors that influence RT.

The research is part of an ongoing project aiming at integrating subject variables with driving environments/conditions in a driving simulator experiment.

Materials & Methods

Participants

In these analyses, 87 drivers participated: 49 controls (22-30 years N= 23; 33-53 years N= 14; 56-78 years N= 12), 14 Mild Cognitive Impairment (MCI) patients, 13 mild Dementia patients (AD= 6), and 11 Parkinson's disease (PD) patients.

Measures

RT; average speed (in km); average lateral position (distance of the vehicle from the right road border in m)

Measures were recorded during the unexpected incidents.

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 an urban road, of an animal on a rural road).

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.

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

Univariate analyses of variance, with group as fixed variable and age as covariate, showed that RT was affected by age but not by group in both environments.

Contrasts of the RT of each patient group with the control group showed that mild Dementia patients were slower than control participants in the Rural environment (p =.053), only.

Small samples precluded analyses by gender.

Figure 1. Reaction time of participants in the rural condition

Table 1. Performance of the participant groups in the two driving conditions

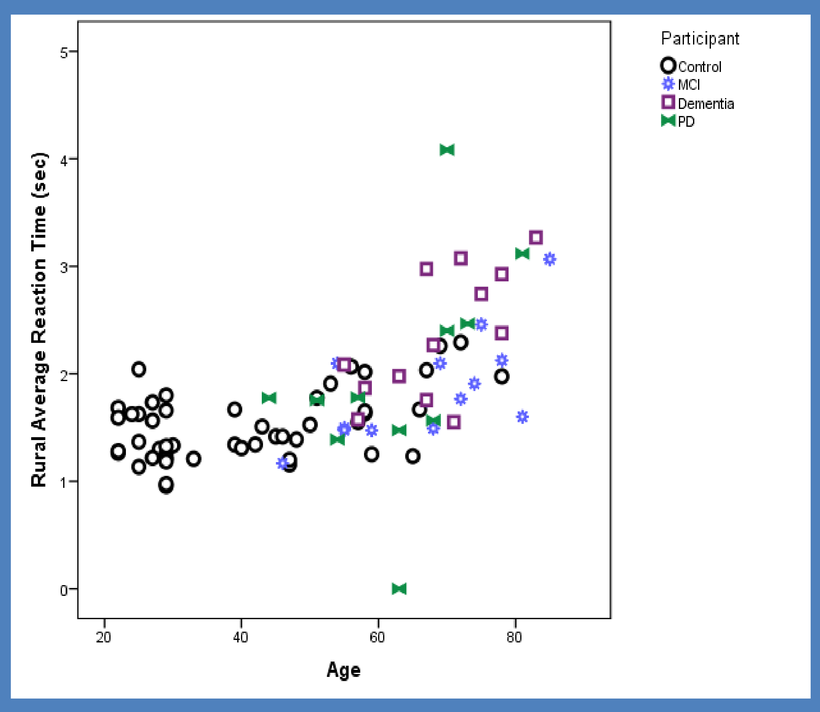
Condition	Variable	Controls (49) ± SD	MCI (14) ± SD	Dementia (13) ± SD	PD (11) ± SD
Rural	Avg speed (km)	48.36 ± 6.09	42.56 ± 7.94	36.03 ± 8.84	36.91 ± 11.37
	Avg lateral position (m)	0.79 ± 0.14	0.72 ± 0.10	0.79 ± 0.18	0.82 ± 0.11
	Reaction time (sec)	1.51 ± 0.32	1.86 ± 0.49	2.34 ± 0.60	1.98 ± 1.05
		Controls (n=45) ± SD	MCI (n=12) ± SD	Dementia (n=9) ± SD	PD (n=5) ± SD
Urban	Avg speed (km)	33.25 ± 4.15	26.32 ± 3.63	26.19 ± 8.14	27.27 ± 7.93
	Avg lateral position (m)	2.42 ± 0.53	1.95 ± 0.53	2.22 ± 0.69	2.02 ± 0.49
	Reaction time (sec)	1.32 ± 0.38	1.57 ± 0.40	1.69 ± 0.50	1.58 ± 0.35

Table 2. Univariate analyses of variance of performance in the two driving conditions

Condition	Variable	Age	Participant type
Rural	Avg speed (km)	$F(1, 82) = 25.13$, $p < .0001$, $\eta_p^2 = .24$	$F(3, 82) = 3.40$, $p < .05$, $\eta_p^2 = .11$
	Avg lateral position (m)	$F(1, 82) = 7.47$, $p < .01$, $\eta_p^2 = .08$	$F(3, 82) = 1.82$, ns
	Reaction time (sec)	$F(1, 82) = 19.72$, $p < .0001$, $\eta_p^2 = .19$	$F(3, 82) = 2.24$, ns
Urban	Avg speed (km)	$F(1, 66) = 17.84$, $p < .0001$, $\eta_p^2 = .21$	$F(3, 66) = 0.81$, ns
	Avg lateral position (m)	$F(1, 66) = 7.53$, $p < .01$, $\eta_p^2 = .10$	$F(3, 66) = 0.74$, ns
	Reaction time (sec)	$F(1, 66) = 8.51$, $p < .01$, $\eta_p^2 = .11$	$F(3, 66) = 0.19$, ns

Procedure

Neurological assessment	Ophthalmological assessment	Neuropsychological assessment	Driving experiment
			
Participants underwent a neurological assessment and clinical history evaluation	Participants' visual acuity and other possible visual problems were assessed	Participants underwent a two-stage neuropsychological assessment and personality testing	Driving was assessed with a Foerst FPF driving simulator, in different conditions



Discussion

Initial findings show that younger participants reacted faster than older participants of all groups. Age was also the determining factor of overall differences in speed and lateral position of the vehicle in both Rural and Urban driving environments.

Dementia patients were slower to react in unexpected incidents in the Rural environment, possibly because of higher driving speed than in the Urban environment.

A driver's diagnosis does not suffice for predicting RT performance or speed of driving. The contribution of other subject variables (e.g., gender, driving experience), as well as neuropsychological measures, to driving performance will be explored in future analyses with larger samples.

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