



Motorway driving performance in healthy controls, MCI, and AD patients: Preliminary results from a driving simulation experiment

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Background & Aims

Driver performance in different road conditions and especially while driving on the motorway offers valuable information concerning driving safety, but is difficult to investigate during on-road driving. The study presents preliminary findings on driving measures of middle aged/ older healthy controls and neurology patients from two driving scenarios associated with different demand levels (funded by the NSRF 2007-2013).

Materials & Methods

Participants

Fifty four drivers: 24 controls >50 years of age (age: 59.50 ±7.84, MMSE: 29.00 ±0.95), 21 mild cognitive impairment (MCI) patients (age: 66.14 ±8.22, MMSE: 27.95 ±2.28), and 10 mild AD patients (age: 74.45 ±4.85, MMSE: 23.27 ±4.17).

Measures

Average speed (in km) in each condition.

Lateral position of the vehicle (in m) from the left road border.

Lateral position variability (in m) the standard deviation of the lateral position

Procedure

Measures were taken during a motorway simulation drive along straight sections and gentle curves on a limited access, divided roadway. Two separate simulation drives were used in this study: **Medium and High Demand**.

Medium demand: Drivers made a forced double lane change that involved driving through a road works section containing large block barriers on either side of the road, causing the road to progressively narrow.

High demand: Drivers were additionally required to execute a lane change **if** a discriminating stimulus was presented (activation of brake lights on the lead vehicle). The decision rule was included in the pre-drive instructions and was employed as a working memory task, designed to impose the highest level of demand for this condition.

Each driving condition included 3 driving segments, presented in a fixed order, after presentation of a speed limit sign with the vehicle in a stationary position: the start of the drive (Start); a road works segment (Road works); and a final section before the end of the drive (Finish).

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 2-stage neuropsychological assessment and personality testing

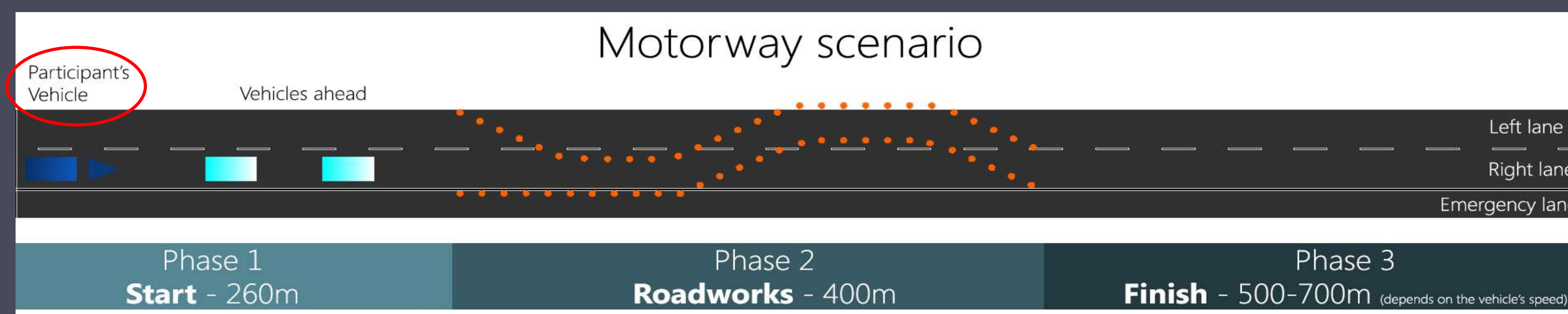
Driving experiment



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

Experimental design

A mixed factorial design, with **within-subjects factor:** demand (Medium, High), and road segment (Start, Road works, Finish), and **between-subjects factor:** participant type. Demand was counterbalanced between participants but road segment order was fixed.



Preliminary results

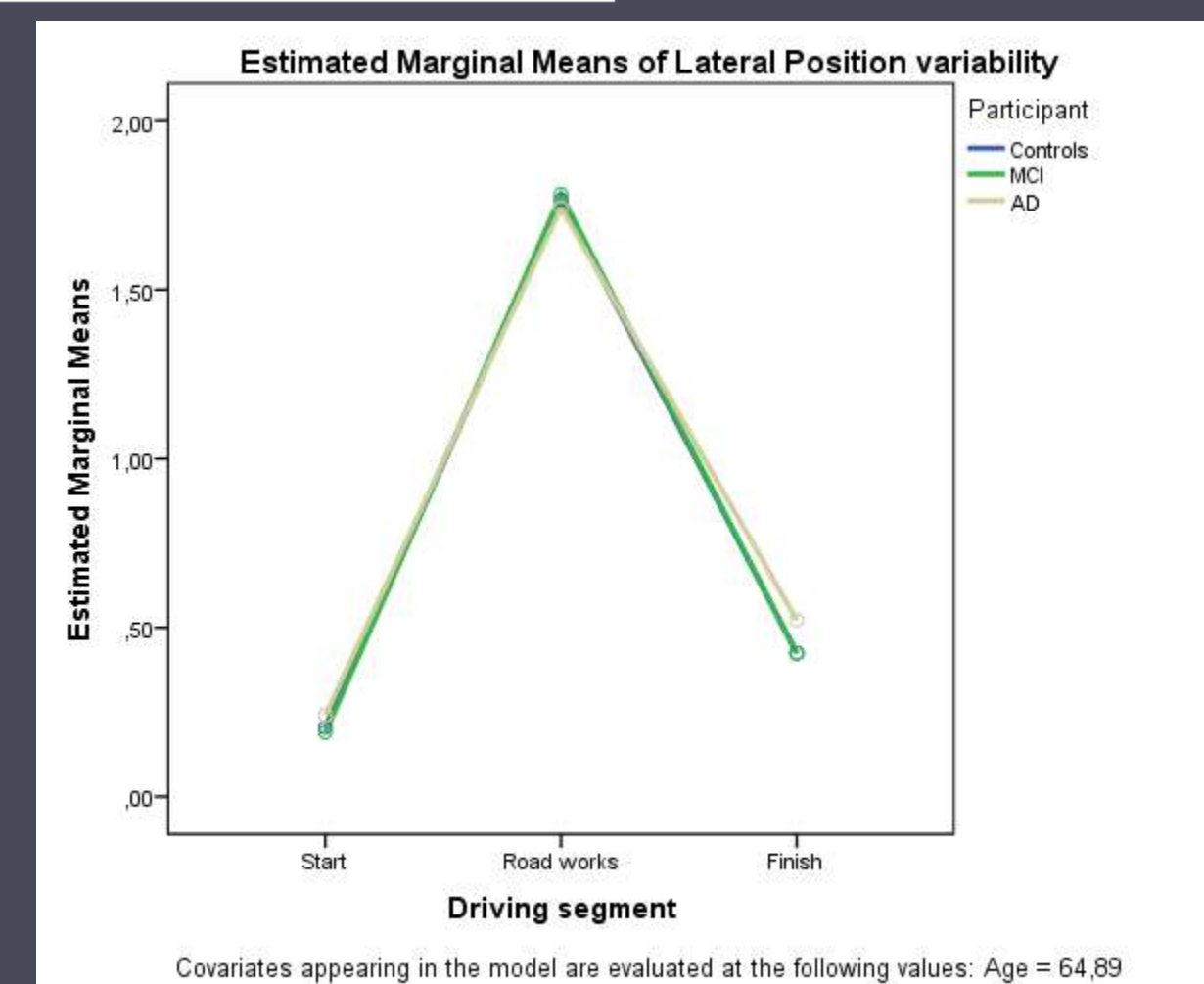
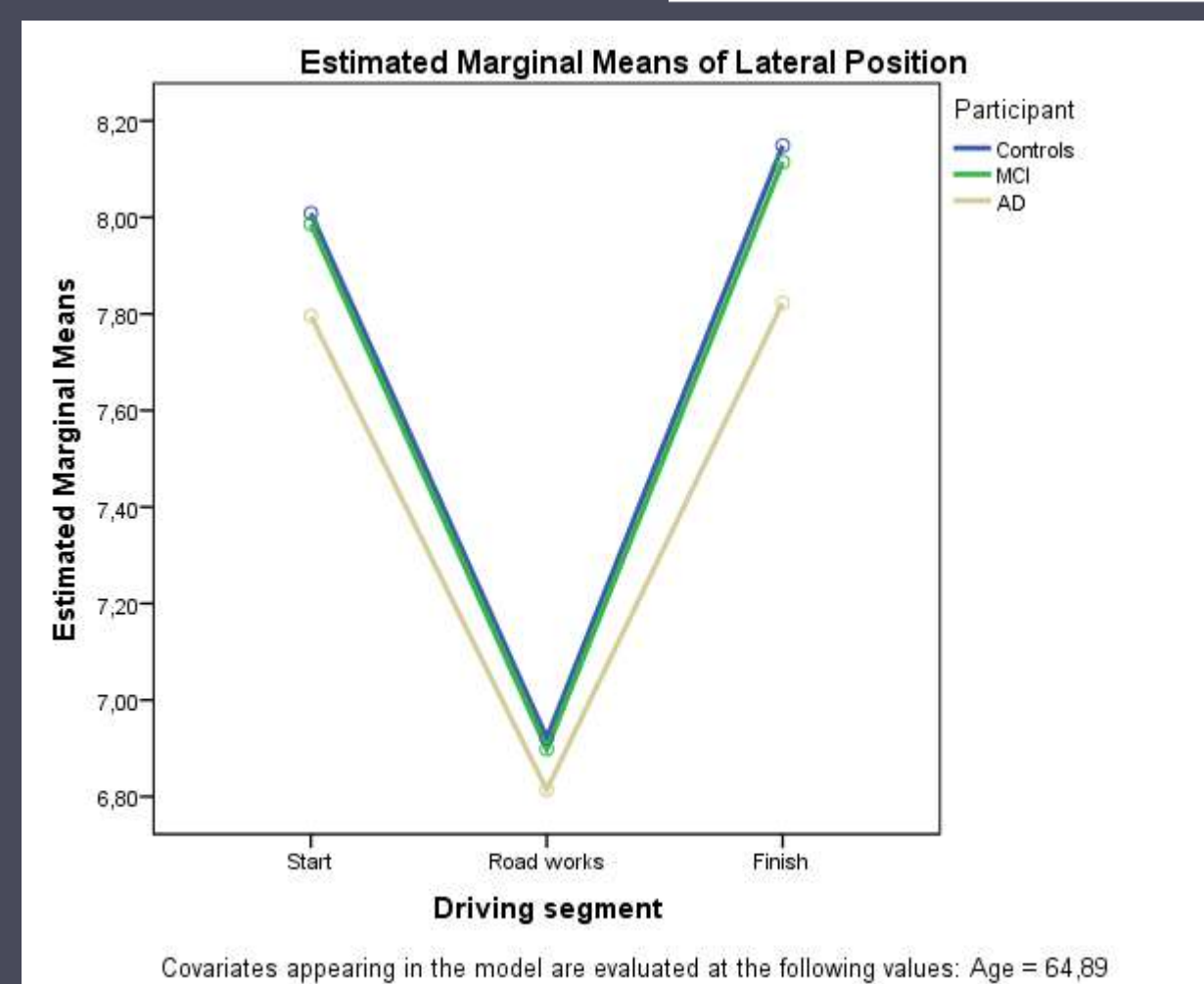
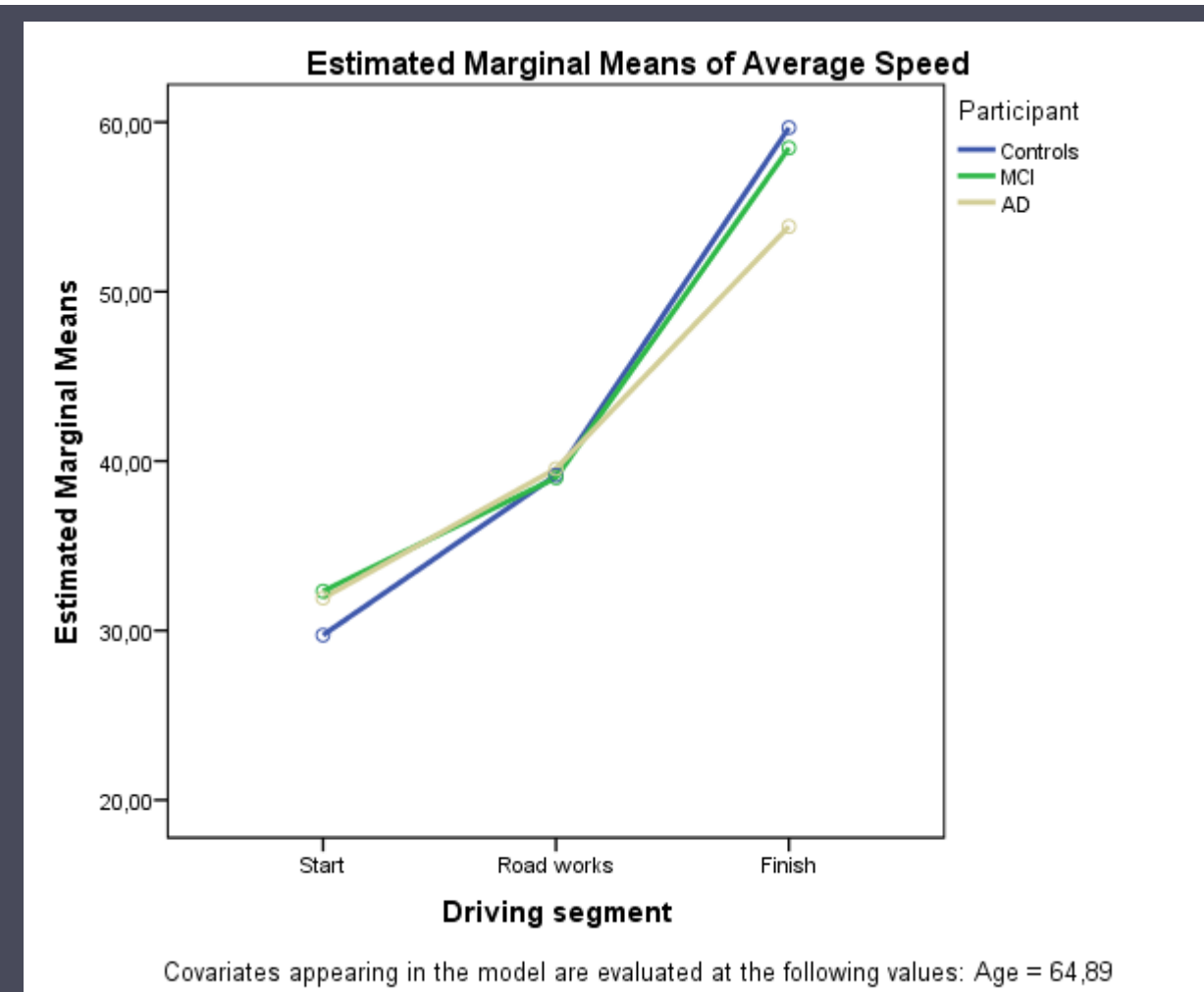
Repeated measures analyses with road segment (3 levels) as within-subjects variable, participant type as between-subject variable and age as covariate, were performed separately for each driving condition (Medium, High Demand), comparing each segment to the previous one and each patient group to the control group.

Medium Demand motorway environment

Average speed: No effect of speed across driving segments. No effect of participant.

Average lateral position: All participants showed a **decrease in lateral position from Start to Road works** ($p < .05$, $\eta^2 p = .08$).

Lateral position variability: Significant effect of **lateral position across driving segments** ($p < .0001$, $\eta^2 p = .58$). All participants showed an increase in lateral position variability from Start to Road works ($p < .0001$, $\eta^2 p = .58$), and a decrease from Road works to Finish ($p < .05$, $\eta^2 p = .09$).



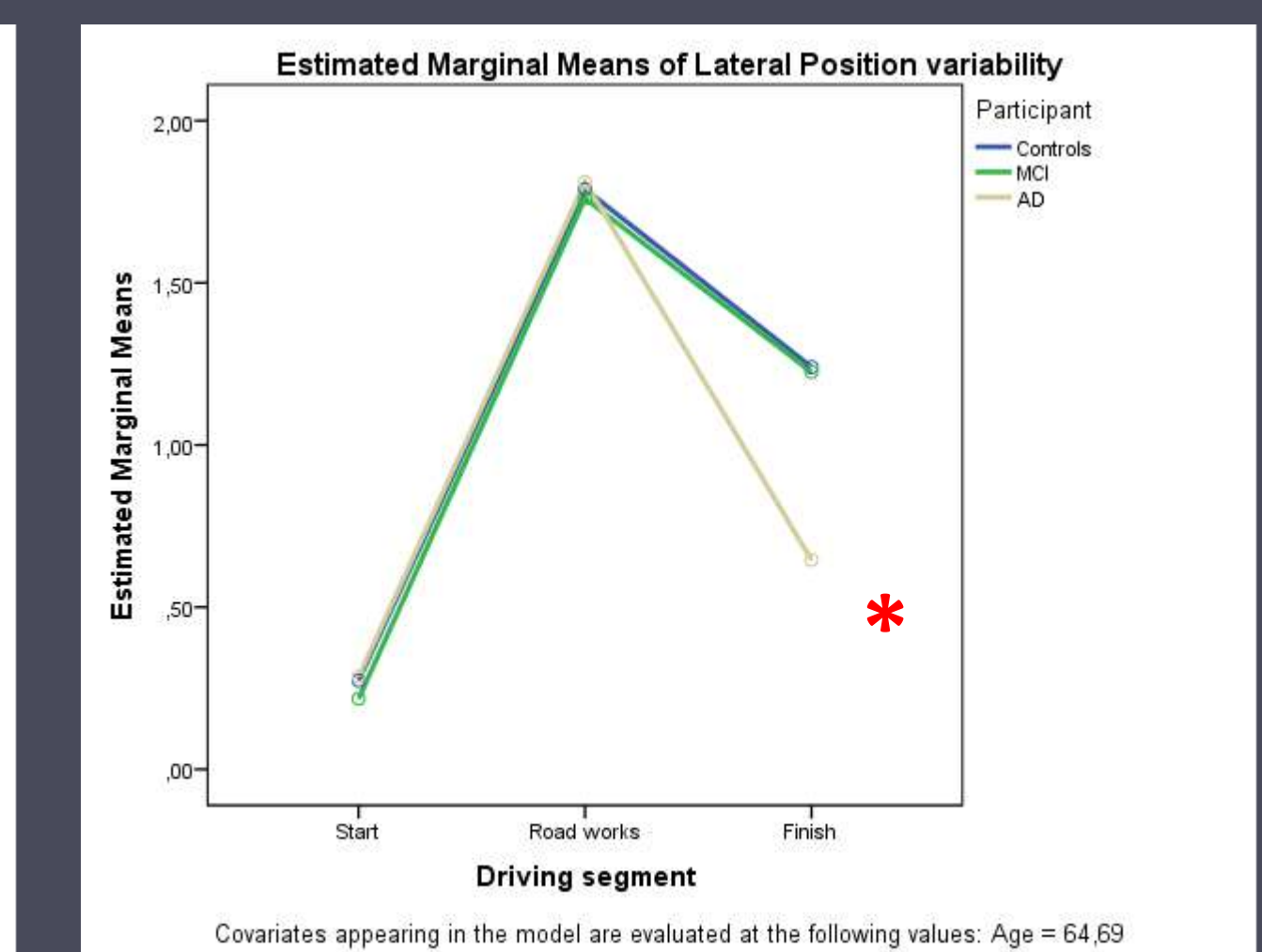
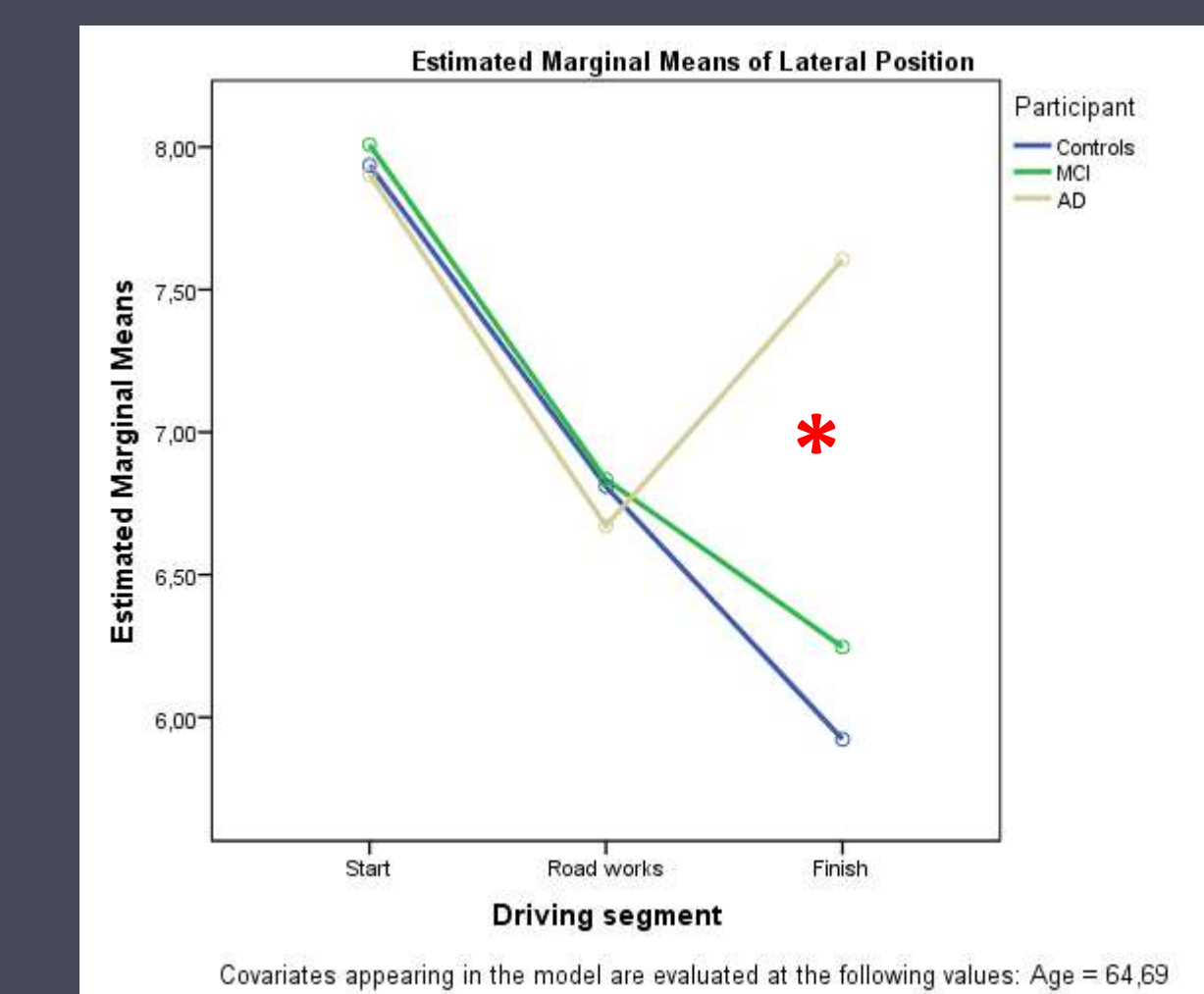
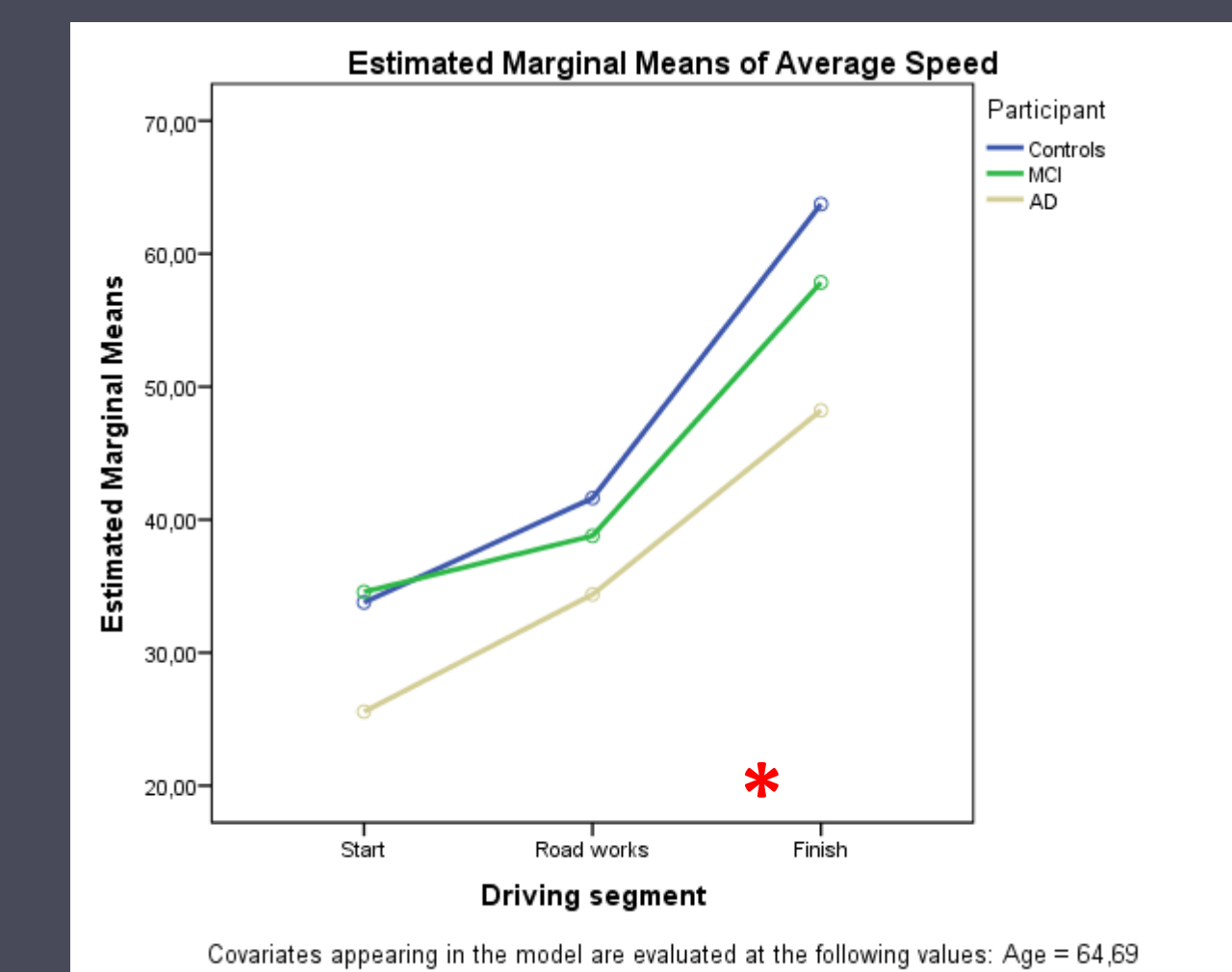
Preliminary results (cont'd)

High Demand motorway environment

Average speed: Significant effect of **participant** ($p < .01$, $\eta^2 p = .19$), and a **speed x participant interaction** ($p < .05$, $\eta^2 p = .11$). **AD patients were slower than controls** ($p = .001$) and **did not increase their speed from Road works to Finish** ($p < .05$).

Lateral position: Significant **lateral position x participant interaction** ($p < .01$, $\eta^2 p = .14$). **AD patients increased their lateral position more from Road works to Finish** relative to the other groups ($p < .05$).

Lateral position variability: Significant **lateral position variability x participant interaction:** AD patients **decreased their variability from Road works to Finish** relative to the other groups ($p < .05$).



Discussion & Conclusions

The High Demand environment was more taxing for AD patients, who reduced their speed more than controls as compensatory behavior; however, they did not differ from controls in the Medium Demand motorway environment.

AD patients increased their lateral position and decreased their lateral position variability in the High Demand environment from Road works to Finish relative to controls. During the latter section they had to maintain in working memory and execute a tactical driving task, to perform a conditional lane change. Their performance shows that **they did not change lanes**, because they did not maintain the task in working memory, or store it in long-term memory. Poor prospective memory (working memory) **affects mild AD patients' ability to follow pre-drive instructions.**