Intraindividual variability within and across conditions in driving simulator measures of neurology patients and healthy drivers

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BACKGROUND & AIMS

Intraindividual variability in cognitive measures and reaction time is associated with cognitive impairment or dementia (e.g., Christensen et al., 2005; Thaler et al., 2015). The continuous nature of driving simulator measures lends itself to the study of intraindividual variability but has been investigated to a very limited extent.

The present study examines intraindividual variability in healthy drivers and drivers with neurological disorders in different driving environments and conditions.

METHODS

Participants

Rural environment:

- 43 healthy drivers over 38 years (age of youngest patient) (*M*=54.63, *SD*=10.95)
- 37 mild cognitive impairment (MCI) drivers (*M*=68.43, *SD*=9.15)
- 16 mild Alzheimer's disease (AD) drivers (*M*=75.38, *SD*=4.86)
- 15 Parkinson's disease (PD) drivers (*M*=62.13, *SD*=10.24)

Urban environment:

- 33healthy drivers over the age of 38 (*M*=56.06, *SD*=10.51)
- 28 MCI drivers (*M*=69.68, *SD*=9.84)
- 8 mild AD drivers (*M*=76.38, *SD*=3.89)
- 10 PD drivers (*M*=62.60, *SD*=9.18)

Driving simulator experiment

- Data from **Distract and DriverBrain** research projects
- All participants underwent neurological, neuropsychological and ophthalmological assessment
- **Driving simulator assessment**: all drivers drove a quarter-cab FOERST driving simulator (3 LCD wide screens 42'', full HD: 1920x1080pixels - total field of view 170 degrees, validated against a real world environment) in **4 rural (R) conditions**, and **4 urban (U) conditions** counterbalanced across participants. Rural conditions occurred before urban conditions.
- A practice drive (10-15 minutes) preceded the driving assessment

moderate traffic (R1, R3)
without & with distraction

high traffic (R2, R4)
without & with distraction

moderate traffic (U1, U3)
without & with distraction

high traffic (U2, U4)
without & with distraction (shown)

Measures

- **Average speed** (in km)
- **Headway average** (distance from the vehicle ahead in m)
- **Lateral position** (distance from the right road border in m)
- **Average speed variability** (*SD* of average speed)
- **Headway variability** (*SD* of headway average)
- **Lateral position variability** (*SD* of lateral position)
- **Coefficient of Variation** (**CV**) = Intraindividual *SD* / Intraindividual *M* for Speed, Headway distance, Lateral position

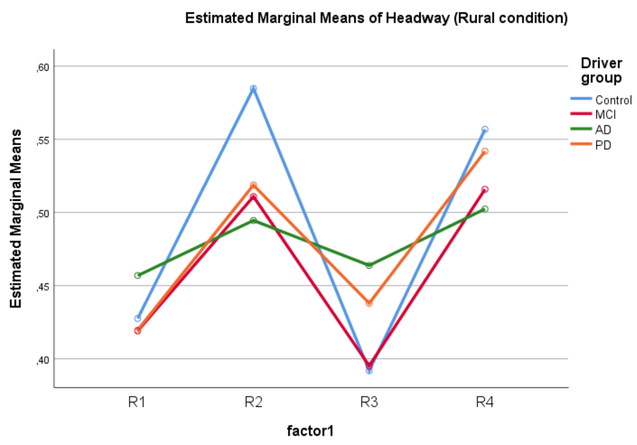
Distraction: conversation with passenger (R3, R4, U3, U4)

RESULTS

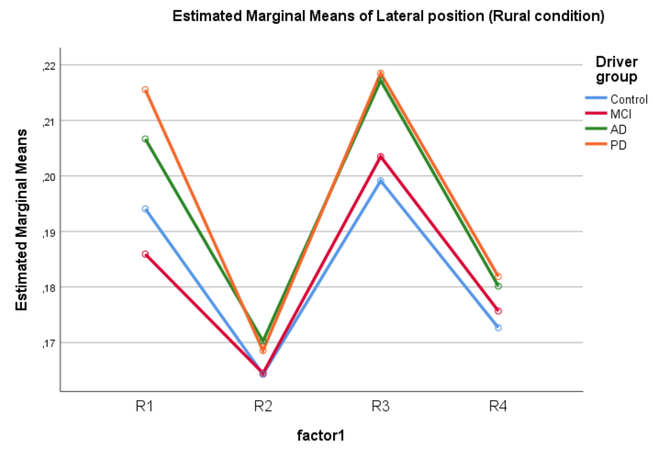
Repeated measure analyses were conducted with condition as within-subject variable and driver group as between-subject variable.

Rural environment

No effect of driver group for any of the measures
Effect of condition: Greater CV for Headway in R2, R4
Smaller CV for Lateral position in R2, R4 (*p*s <0.001)



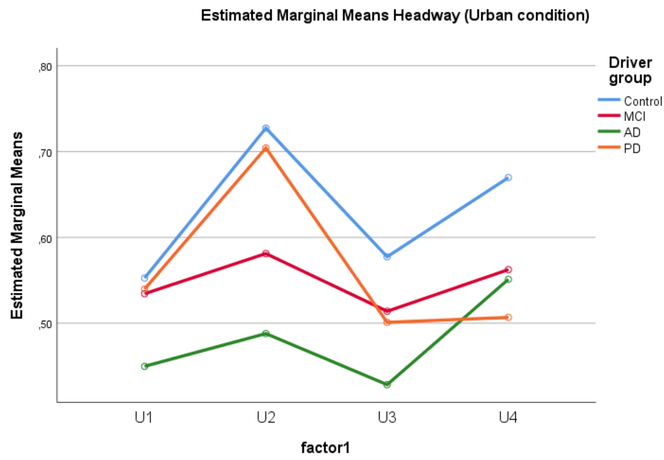
Interaction (*p* <0.05)

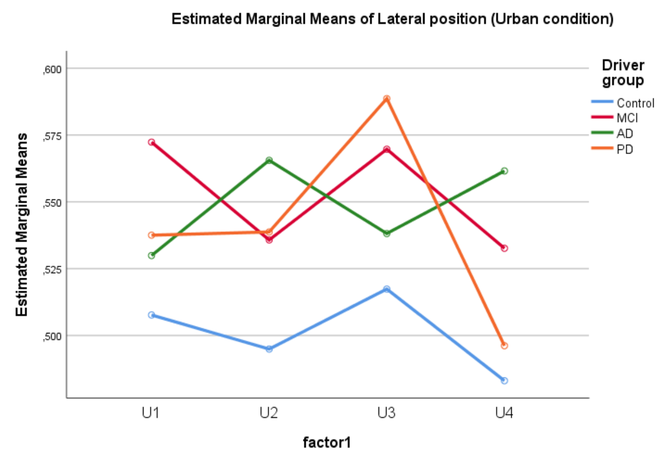


Urban environment

Effect of driver group for Headway (MCI, AD < controls), and Lateral position (MCI > controls), (*p*s <0.01)

Effect of condition: Greater CV for Headway in U2, U4 (*p*s <0.001)





CONCLUSION

- Intraindividual variability is stable across patient groups in Rural but not in Urban environments once corrected for performance level.
- High traffic conditions result in higher intraindividual variability in Headway (Rural, Urban) and lower intraindividual variability in Lateral position (Rural).
- MCI and mild AD drivers are more variable in Lateral position and less variable in Headway than controls in Urban environments.
- The Urban environment affects variability measures in MCI, mild AD drivers more than the Rural environment.

References

Christensen, H., Dear, K.B.G., Anstey, K.J., Parslow, R.A., Sachdev, P., & Jorm, A.F. (2005). Within-occasion intraindividual variability and preclinical diagnostic status: Is intraindividual variability an indicator of mild cognitive impairment? *Neuropsychology*, *19*, 309-317.
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