

ABSTRACT

Objective: Goal of the present research was to explore in detail the driving profile of individuals with PD by applying a large driving simulation experiment. **Methods:** Forty one cognitively intact individuals (Age: 59.8±9.1 years) and 19 individuals with PD (Age: 62.7±11.1 years) participated in the study. The collection of the data included a comprehensive neurological/neuropsychological assessment and a driving simulation experiment. Drivers with PD were tested during the on-phase. **Results:** Significant differences were found in average speed ($p=.002$), speed variation ($p=.048$), reaction time ($p=.001$), average headway distance ($p<.001$), headway distance variation ($p=.004$), and wheel position variation ($p=.027$). The cognitively intact group had greater average speed, speed variation and variation of the wheel position as compared to the group of drivers with PD. On the contrary, the clinical group had increased reaction time as well average headway distance and headway distance variation. **Conclusions:** The results of the present study indicate that the driving patterns of individuals with PD differ significantly from those of healthy individuals in indexes that may play an important role in overall driving performance and behaviour.

INTRODUCTION

- The multimodal clinical picture of Parkinson's disease (PD) influences negatively various aspects of cognition, behavior and motor control that are closely linked to the capacity of an individual to maintain adequate driving skills.
- Epidemiological data indicate increased risk of car accidents in patients with PD (Dubinsky et al., 1991; Meindorfner et al, 2005)
- On-road driving evaluations and driving simulator assessments have observed increased driving difficulties in drivers with PD
- According to driving simulator assessments, drivers with PD need more time to initiate deceleration, have greater difficulty to stop at the proper position when approaching traffic signals, have lower speed during driving around curves and show greater variation in vehicle lateral position when driving around curves (Stolwyk et al., 2005; Stolwyk et al., 2006; . Ranchet et al., 2011)

OBJECTIVES

Goal of the present research was to explore in detail the driving profile of individuals with PD as well as to compare their driving behavior with that of cognitively intact individuals by applying a large driving simulation experiment.

PATIENTS & METHODS

Inclusion criteria were the presence of a valid driver's license, regular car driving, a Clinical Dementia Rating (CDR) score ≤ 0.5 and between 1 and 3 in the scale of Hoehn & Yahr.

Forty one cognitively intact individuals (Age: 59.8±9.1 years) and 19 individuals with PD (Age: 62.7±11.1 years) participated in the study.

Data collection included: a comprehensive neurological/ neuropsychological assessment and a driving simulation experiment.

Outcome measures were average driving speed (km/h), speed variation (variation of average speed), wheel position variation (variation of wheel steering angle in degrees), number of crashes, reaction time in unexpected incidents (in milliseconds), lateral position (average vehicle distance from the central road axis in meters), lateral position variation (the standard deviation of lateral position), average headway distance (average distance from other vehicles in meters), and headway distance variation (the standard deviation of headway).

Driving was assessed with a Foerst FPF driving simulator. Patients with PD were all in the ON state.

Phase 1: Practice session (5-10 min.)

Phase 2: Driving session: driving on a two-lane rural road for 20 min. The sudden appearance of animals on the rural road played the role of unexpected incidents during the driving assessment.

Figure. 1 Driving under the rural Condition

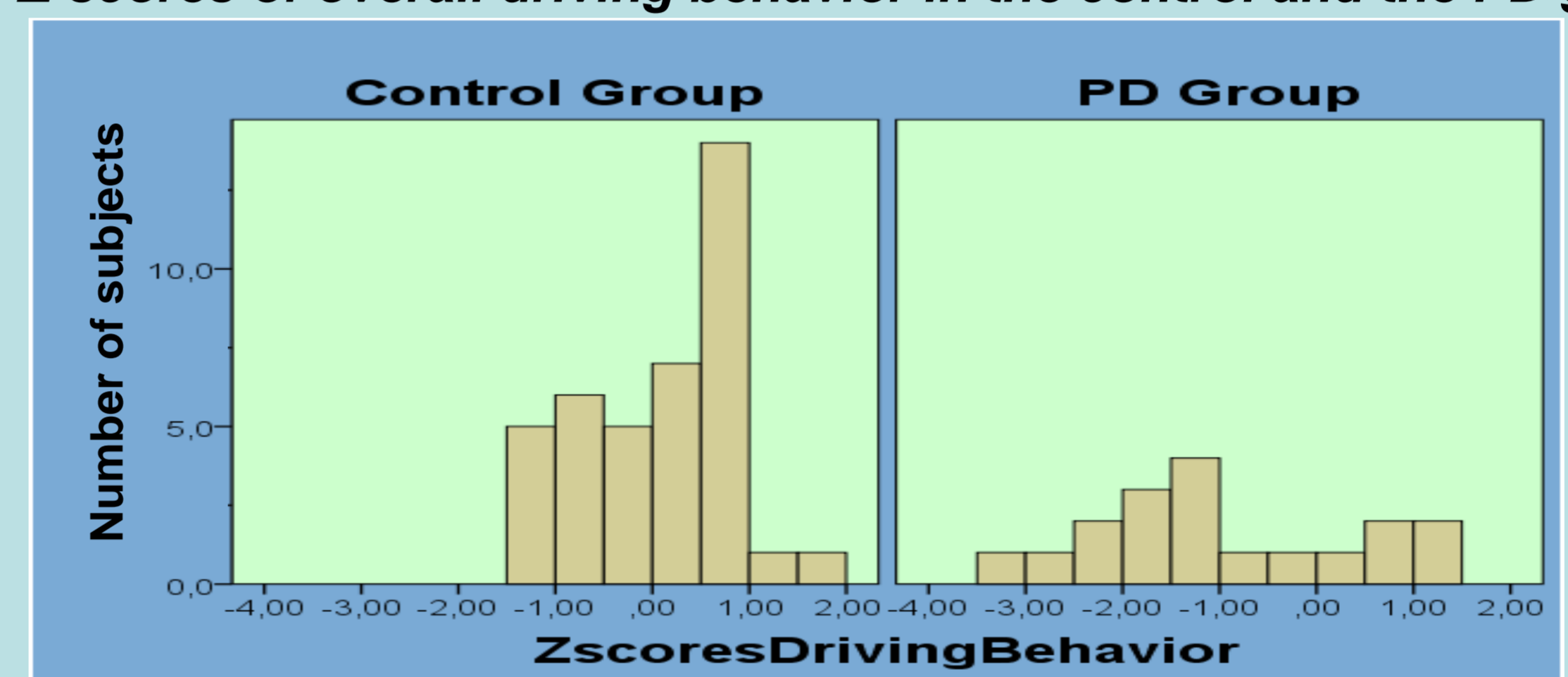


RESULTS

Table.1 Control vs. PD Group on Cognitive & Driving Indexes

| | Control Group | | PD Group | | t-test | |
|----------------------------|---------------|--------|----------|---------|--------|-------|
| | Mean | SD | Mean | SD | t | p |
| MMSE | 29.28 | .99 | 28.21 | 1.71 | 2.51 | .019 |
| Trails A | 41.68 | 13.33 | 66.42 | 36.06 | 2.90 | .009 |
| Trails B | 86.40 | 42.13 | 165.05 | 91.21 | 3.58 | .002 |
| HopkinsTotal | 23.78 | 4.80 | 18.72 | 4.52 | 3.84 | <.001 |
| HopkinsDelayed | 7.58 | 2.84 | 4.95 | 3.03 | 3.25 | .002 |
| Average Speed | 43.73 | 7.89 | 35.53 | 11.55 | 3.20 | .002 |
| Speed Variation | 12.37 | 3.56 | 10.24 | 4.30 | 2.00 | .050 |
| Average Headway Distance | 449.07 | 124.41 | 611.73 | 161.74 | 4.25 | <.001 |
| Headway Variation | 194.61 | 63.29 | 274.99 | 102.79 | 3.14 | .004 |
| Lateral Position | .84 | .13 | .90 | .14 | 1.74 | .087 |
| Lateral Position Variation | .28 | .07 | .30 | .08 | 1.11 | .270 |
| Wheel Position Variation | 17.16 | 1.85 | 15.60 | 3.42 | 2.29 | .026 |
| Number of Crashes | .05 | .22 | .05 | .23 | 0.02 | .983 |
| Reaction time | 1672.80 | 536.76 | 2424.67 | 1129.37 | 2.69 | .014 |

Z-scores of overall driving behavior in the control and the PD group



DISCUSSION / CONCLUSION

- In line with previous research, significant differences were observed between the control and the PD group on various indexes of driving behavior
- The PD group had lower: average speed, speed variation and variation of the wheel position as compared to the control group. Also they had increased: reaction time, average headway distance and headway distance variation as compared to the control group.
- Seven out of the 19 PD patients had an overall driving behavior that was below -1.5 SD from the corresponding average driving behavior of the control group
- An individualized approach appears to be the best option for the assessment of driving fitness of individuals with PD
- Future research should focus on the detection of measures that have the capacity to predict the driving performance of drivers of PD as well as on the extraction of cut-off scores with the use of the proper neuropsychological tests

SUMMARY

- According to previous research, drivers with PD differ from cognitively intact individuals on various indexes of driving behavior
- The current findings support the existence of significant differences on various driving indexes between the two groups
- Seven out of the 19 PD drivers had a clearly altered overall driving behavior

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