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Examination of naturalistic driving practices in drivers with Parkinson's disease compared to age and gender-matched controls

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ABSTRACT

A few studies suggest that drivers with Parkinson's disease (PD) may self-regulate or modify their driving behavior more than drivers without neurological disorders; however findings are limited to self-report. The purpose of this study was to objectively examine whether drivers with PD show more restrictive driving practices (exposure and patterns). Electronic devices were installed in the vehicles of 27 drivers with PD (71.6 ± 6.6; 78% men) and 20 matched controls (70.6 ± 7.9; 80% men) for two weeks and driving data were matched with aerial maps, weather and daylight archives and trip logs to examine driving context. Compared to controls, the PD group drove significantly less overall (number of trips, kilometres, duration), and proportionately less at night and on days with bad weather suggesting more restricted driving practices, congruent with lower ratings of driving comfort and abilities. However, they may not necessarily drive more cautiously or safely as they drove significantly faster (and over the speed limit) on highways and freeways and 19% reported driving problems over the two weeks. These preliminary findings need to be replicated and longitudinal studies using objective indicators are needed to examine changes in driving practices, as well as crash outcomes, as disease severity progresses.

1. Introduction

Safe driving requires a combination of motor, visual spatial and executive skills (information processing, attention, quick decision-making) that can be compromised in drivers with progressive neurological disorders, such as Parkinson's disease (PD). For example, compared to drivers without neurological disorders, those with PD have more difficulty with operational and tactical maneuvers such as maintaining lane position, turning, steering and speed control (e.g., Cordell et al., 2008; Heikkila et al., 1998; Stolwyk et al., 2006a, 2006b; Wood et al., 2005; Uc et al., 2009a,b). Although the symptoms associated with PD can affect driving ability even in the early stages of the disease, some studies have found that the majority of subjects with PD were still competent drivers, possibly because they had modified their driving practices (e.g., Devos et al., 2007; Heikkila et al., 1998).

The process of adapting or restricting one's driving behavior is generally referred to as self-regulation (e.g., Donorfio et al., 2009), which for some may be gradual and eventually lead to cessation (e.g., Dellinger et al., 2001; Rudman et al., 2006). While numerous studies have addressed self-regulation in healthy older drivers, only a few have examined such practices in drivers with PD. Compared to healthy older drivers, drivers with PD were found to drive less overall, at night, in peak traffic, long distances, and were less likely to drive alone (Adler et al., 2000; Wood et al., 2005). In contrast, Vaux et al. (2010) found drivers with PD drove more days and more miles per week, on average, while Cordell et al. (2008) found no significant difference in weekly driving exposure in PD patients versus controls. However, all these findings were based solely on self-report.

A recent review (Klimkeit et al., 2009) concluded that further research is needed to examine the amount of driving by individuals with PD overall and in various conditions (e.g., weather), as well as the capacity of drivers with PD to self-regulate. A few studies suggest that drivers with PD may be overly confident and overestimate their driving abilities (Cordell et al., 2008; Heikkila et al., 1998; Wood et al., 2005), although Adler et al. (2000) found that they felt more "uneasy" while driving.

While on-road performance with in-car observers is considered the 'gold standard' for assessing operational and tactical driving skills, naturalistic driving studies are required to examine how people drive in real-world situations. Higher-order, strategic level decisions about when and where to drive, including trip and route planning, can reduce demands and may reduce crash risk if drivers adjust their driving practices according to their capabilities (Eby and Molnar, 2009; Michon, 1985).

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While there are now studies on the naturalistic driving practices of healthy older drivers, no comparable studies have been conducted with PD populations. Such studies require the use of objective vehicle data based on evidence that self-estimates of driving distance are inaccurate (Huebner et al., 2006; Blanchard et al., 2010) and drivers may not regulate as much as they report on questionnaires (Blanchard et al., 2010; Blanchard and Myers, 2010; Myers et al., 2011). The primary purpose of the present study was to objectively examine naturalistic driving practices (exposure and patterns) in older drivers with PD compared to a matched control group to determine if the PD group showed more restricted driving practices. As driver perceptions (abilities and confidence) can influence self-regulatory practices (Blanchard and Myers, 2010; Myers et al., 2011; Rudman et al., 2006), we also examined these variables.

2. Methods

2.1. Participants

A sample of 27 drivers with PD (78% men), ranging in age from 57 to 82 (M = 71.6, S.D. = 6.6) and 20 matched controls (80% men), ranging in age from 57 to 84 (M = 70.6, S.D. = 7.9) were assessed in the same time frame between October, 2009 and August, 2010. Drivers with PD (average time since diagnosis 3.85 ± 2.77 years, range 1–11) were recruited from a movement disorders research and rehabilitation centre (MDRC) in Southwest Ontario (Crizzle et al., 2012) while the control group was recruited from rotary clubs and recreation centers in the same geographical region. To be eligible for the study, drivers with PD needed to have a confirmed diagnosis by a neurologist. All participants had to be aged 55+, have a valid license, drive a non-hybrid vehicle (as the CarChip device is not compatible with hybrid vehicles due to the alternating power source), be the primary driver of the vehicle and drive at least 3 times per week. Exclusion criteria were: stroke, dementia, glaucoma, age-related macular degeneration, schizophrenia, untreated sleep apnea, use of anti-anxiety medications, as well as any neurological disorder for the control group.

Participants in both the PD and control groups tended to be college educated (70% versus 75%), married and living with their spouse (74% versus 80%); two PD participants lived with other family members. Ten people (21% of the sample, five in each group) were still working.

Most of the drivers in both the PD and control groups rated their health as good or excellent (82% versus 100%). Apart from PD, diagnosed health conditions most often reported by the PD and control groups, respectively, were: high blood pressure (56% versus 50%), arthritis, rheumatism and/or osteoporosis (44% versus 35%), back problems (26% versus 10%), hearing problems (19% versus 35%), sleep disorders (11% versus 15%), cataracts (7% versus 20%) and diabetes (7% versus 5%). The majority of the sample (95%) rated their eyesight as the same or better than most their age; only two PD subjects rated their eyesight as worse.

With respect to mobility, seven subjects used a cane (six were in the PD group) and one of the PD participants used a walker. A significantly greater proportion of the PD group reported that they could not walk a quarter of a mile ($\chi^2 = 4.15$, $p = .04$) and had fallen in the past year ($\chi^2 = 7.72$, $p = .005$). Sixteen PD subjects (59%) and nine controls (45%) were enrolled in regular exercise classes or activities; nine of the PD group in a specialized exercise program at the center.

All participants had at least 37 years of driving experience and had their own vehicle equipped for the study, although 70% of the PD group and 63% of the controls lived with another driver. A greater proportion of the PD group preferred to drive with a passenger (48% versus 15%), while proportionately more of the controls preferred to drive alone (40% versus 11%), $\chi^2 = 7.85$, $p = .02$. The remainder had no preference. Similar proportions of the PD and control groups (41% versus 45%) said that others relied on them to drive.

Compared to 10 years ago, 67% of the PD group and 45% of the controls said they now drove less; about a third of both groups drove about the same amount, while 4% of the PD drivers and 20% of the controls said they drove more. Continuing to drive was rated as significantly more important by the control group ($t = -2.06$, $p = .045$), although reasons for continuing to drive were similar in both groups. Maintaining their present lifestyle was seen as the most important reason, followed by getting to shops and services and being able to meet commitments such as volunteer work or helping others. While none of the controls had seriously thought about driving reduction or cessation, seven in the PD group (4 men, 3 women) said they had thought about reducing their driving, four of whom (3 men, 1 woman) had thought about quitting in the next few years. Three drivers (all with PD) reported having a collision over the past year and one PD driver reported a traffic violation. Three people (one PD and two controls) reported getting lost, while 15% of both groups reported backing into things.

2.2. Measures

2.2.1. Driving data

The CarChip Pro® (Model 8226; Davis Instruments, Hayward, CA) and the Otto Driving Companion® (Model PM2626; Persen Technologies Inc., Winnipeg, MB) were installed in each subject's vehicle for two weeks. The CarChip was installed in the vehicle's diagnostic (OBDII) port, while the Otto (a small GPS device) was mounted on the dashboard. Electronic recording automatically begins when the vehicle is turned on and stops when the ignition is turned off. Although both devices record similar date- and time-stamped information (i.e., distance traveled, duration, speed), delayed connection to satellite signals can result in lost GPS data, especially for short trips (Blanchard et al., 2010; Grengs et al., 2008). The CarChip has been shown to be more accurate in recording distance (Huebner et al., 2006), thus was used for most of the indicators. The GPS data were primarily used to examine driving on various roadways and radius or distance from home. Participants were asked to complete trip logs (checklists) over the monitoring period to identify presence of other drivers and passengers, and describe general weather conditions, trip purposes, corresponding destinations, and approximate time of arrival.

2.2.2. Driver comfort and perceived abilities

Driving comfort was assessed using the 13-item day Driving Comfort Scale (DCS-D) and the 16-item night Driving Comfort Scale (DCS-N), which were developed with older drivers and have undergone extensive psychometric examination (Myers et al., 2008). When completing the DCSs, respondents are instructed to consider confidence in their own abilities and driving skills, as well as the situation itself (including other drivers) and to assume normal traffic flow. Scores can range from 0% to 100% with higher scores indicating greater comfort. Both scales are unidimensional and hierarchical, demonstrating goodness of fit, interval properties and reliability over 7–16 days: $ICC_{2,1}$ were .91 and .86 for the DCS-D and DCS-N scales, respectively (Myers et al., 2008). Test–retest reliability of the DCSs has been further supported with another sample of older drivers (Blanchard and Myers, 2010).

The 15-item Perceived Driving Abilities (PDA) scales were used to assess perceptions of current abilities and changes in abilities (MacDonald et al., 2008). Respondents rate their current abilities on a four-point scale (from "poor" to "very good"), and on the PDA Change Scale from "a lot worse" to "better", compared to 10 years ago. Higher scores (range 0–45) indicate more positive perceptions and fewer declines, respectively. Both the current and change