Driving Task: How Older Drivers' On-Road Driving Performance Relates to Abilities, Perceptions, and Restrictions*

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RÉSUMÉ

Cette étude a examiné une cohorte de 227 conducteurs âgés et a étudié la relation entre leur performance sur la grille d'observation e-DOS pour manœuvres de conduite et (1) les caractéristiques des conducteurs; (2) les capacités fonctionnelles; (3) les perceptions des capacités et le confort pendant la conduite, ainsi que (4) les restrictions auto-déclarées de la conduite. Les participants (hommes: 70%; âge: M = 81.53 ans, É-T = 3,37 ans) a achevé une série de mesures de la capacité fonctionnelle et d'écailles sur le confort, les capacités et les restrictions aperçut du Candrive / Ozcandrive protocole d'évaluation Année 2, avec une tâche de conduite e-DOS. Les observations des comportements de conduite des participants au cours de la tâche de conduite ont été enregistrées pour : la négociation au carrefour, le changement de voie, la fusion, les manœuvres à basse vitesse, et la conduite sans manoeuvres. Les scores de conduite e-DOS étaient élevés (M = 94,74; É-T = 5,70) et étaient liés d'une façon significative aux capacité de conduite perçu des participants, la fréquence rapporté de la conduite dans des situations difficiles, et le nombre de restrictions de la conduite. Les analyses futures exploreront les changements potentiels dans les scores de tâches de conduite au fil du temps.

ABSTRACT

This study examined a cohort of 227 older drivers and investigated the relationship between performance on the electronic Driver Observation Schedule (eDOS) driving task and: (1) driver characteristics; (2) functional abilities; (3) perceptions of driving comfort and abilities; and (4) self-reported driving restrictions. Participants (male: 70%; age: *M* = 81.53 years, *SD* = 3.37 years) completed a series of functional ability measures and scales on perceived driving comfort, abilities, and driving restrictions from the Year 2 Candrive/Ozcandrive assessment protocol, along with an eDOS driving task. Observations of participants' driving behaviours during the driving task were recorded for intersection negotiation, lane-changing, merging, low-speed maneuvers, and maneuver-free driving. eDOS driving task scores were high (*M* = 94.74; *SD* = 5.70) and significantly related to participants' perceived driving abilities, reported frequency of driving in challenging situations, and number of driving restrictions. Future analyses will explore potential changes in driving task scores over time.

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Older Drivers

Over the next five decades, there will be a substantial increase in both the number and proportion of older people in most industrialized countries (Organization for Economic Cooperation and Development [OECD], 2001). With the aging of the population, an increase is also anticipated in older drivers' licensing rates (Sivak & Schoettle, 2011). Further, the private motor vehicle is likely to remain the principal mode of transport for the emerging cohorts of older drivers who will be more mobile, and travel more frequently and at greater distances when compared with earlier cohorts (OECD, 2001). Demographic growth, increased licensing rates, and increased motor vehicle use will combine to produce a marked increase in the number of older drivers on the road.

Although there is strong support around the world for older people to maintain independent vehicular mobility for as long as possible, their safety is also a serious community concern necessitating development of innovative measures to reduce crash and injury risk (Langford & Koppel, 2006). While current figures show that older drivers are involved in few crashes in terms of absolute numbers, they represent one of the highest risk groups for crashes involving serious injury and death per number of drivers and per distance travelled (Koppel, Bohensky, Langford, & Taranto, 2011; Langford & Koppel, 2006).

Older Driver Risk Factors

Much of the older driver crash profile has been attributed to older drivers' greater frailty and reduced tolerance to injury (OECD, 2001). The energy required to cause injury reduces as a person ages (Augenstein, 2001): Older adults' biomechanical tolerances to injury are lower than those of younger persons (Mackay, 1998; Viano, Culver, Evans, Frick, & Scott, 1990), primarily due to reductions in bone and muscular strength and fracture tolerance (Dejeammes & Ramet, 1996; Padmanaban, 2001). For example, according to Evans (2004), in crashes of equal severity, consider these statistics: A 79-year-old man is 3.2 times more likely to die as a 32-year-old man; a 79-year-old woman is 2.7 times more likely to die as a 32-year-old woman; and one-half of the deaths to those aged 70 and older would not occur if the individuals were as robust as those aged 69 and younger. Li, Braver, and Chen (2003) used the U.S. Fatality Analysis Reporting System (FARS) and a national probability sample of all crashes (both non-casualty and casualty) to compute the role of frailty in older driver crashes. After due statistical correction, the authors reported that older drivers' (and especially older female drivers') overrepresentation in fatalities could be explained mainly by frailty, accounting for around 60 to 90 per cent of the fatalities.

In addition to the frailty factor, older drivers' crash risk has been attributed to their age-related sensory, cognitive, and physical impairments. Although there are many individual differences in the aging process, even relatively healthy older adults are likely to experience some level of functional decline in sensory, cognitive, and physical abilities. These include a decline in visual acuity and/or contrast sensitivity; visual field loss; reduced dark adaptation and glare recovery; loss of auditory capacity; reduced perceptual performance; reductions in motion perception; a decline in attentional and/or cognitive processing ability; reduced memory functions; neuromuscular and strength loss; postural control and gait changes, and slowed reaction time (Janke, 1994; Stelmach & Nahom, 1992). Of relevance to older drivers is how the declines in these abilities relate to skills required for safe driving and whether skill changes put them at an increased risk of crash-related injuries and/or death.

Current evidence for causal relationships between specific medical conditions and increased crash risk is limited (Charlton et al., 2010; Dobbs, 2001; Marshall, 2008). Clearly, not all medical conditions affect injury risk in the road system to the same extent, and not all individuals with the same condition will be affected in the same way (Charlton et al., 2010). The severity of the condition and other characteristics of the disorder are likely to be important determinants of crash risk. Notwithstanding the paucity of evidence linking health, medical conditions, and driving, there is mounting evidence that a number of age-related functional impairments may be of sizable concern to road safety. Importantly, it is not necessarily the medical condition and/or medical complications per se that affect driving, but rather the *functional impairments* that may be associated with these conditions. In discussing the merits of focussing on impairments in assessing risk, Marottoli (2001) noted that functional impairments are "the common pathway through which … medical conditions affect driving capability and … can be relatively easy to test" (p. 11). Moreover, the extent to which individuals may be able to adapt or compensate for their impairment while driving will undoubtedly have some bearing on their likelihood of crash involvement (Charlton et al., 2006).

Indeed, Meyer (2004) has proposed that drivers can be highly adaptive and can compensate for deficiencies in certain areas by adapting their behaviour (i.e., changing the conditions in which they drive, using different driving techniques, or using in-vehicle technologies to assist with some of their deficiencies) to minimise their crash risk. Older drivers' capacity to moderate their risk is a crucial element in determining their safety. Many older drivers become aware of their declines in functional capacities and adapt their driving patterns to match these changes by self-regulating when, where, and how they drive (Baldock, Mathias, McLean, & Berndt, 2006; Blanchard, Myers, & Porter, 2010; Charlton et al., 2006; Molnar & Eby, 2008). For example, older adults may reduce their exposure by driving fewer annual kilometres, making shorter trips, and making fewer trips by destination chaining (i.e., linking multiple trips together) (Benekohal, Michaels, Shim, & Resende, 1994). Older drivers have also been found to do the following: avoid complex traffic maneuvers that are cognitively demanding (Ball et al., 1998; Hakamies-Blomqvist & Wahlstrom, 1998); limit their peak hour and night driving; restrict long-distance travel; take more frequent breaks; and drive only on familiar and well-lit roads (Ernst & O'Connor, 1988; Smiley, 1999).

Several studies have also shown that most older drivers recognize that good vision is one of the most important elements for safe driving and often cite poor vision as a major determinant for reducing their driving at night or in poor weather (Kostyniuk & Shope, 1998; Marottoli et al., 1993; Persson, 1993). This evidence suggests that at least some older adults are able to compensate well for limitations in their abilities in such a way that is likely to minimise exposure to difficult driving situations to reduce their crash risk.

In addition, recent research has demonstrated a link between psychosocial factors (e.g., attitudes, beliefs, and perceptions) and older driver self-regulation (Tuokko et al., 2013). For example, measures of these constructs specific to the context of driving have been linked to self-reported restrictions in older drivers (Blanchard & Myers, 2010; MacDonald, Myers, & Blanchard, 2008; Myers, Paradis, & Blanchard, 2008; Webber, Porter, & Menec, 2010), as well as objectively measured restrictions in driving exposure (i.e., distance, duration) and patterns (i.e., radius from home, driving at night and in bad weather) (Blanchard & Myers, 2010; Myers, Trang, & Crizzle, 2011; Myers et al., 2008).

On-road Assessments

On-road assessments have been described by driving rehabilitation specialists as the "gold standard" for determining a driver's true driving ability and for identifying potential remediable elements (Justiss, 2005; Marcotte & Grant, 2009; McCarthy, 2005). Despite the potential importance of on-road assessments for determining older drivers' fitness to drive, there is a paucity of research in this area.

Within the limited number of studies that have been conducted in this area, most researchers acknowledge the value of standardizing on-road assessments to allow objective measurement of driving performance (e.g., Di Stefano & Macdonald, 2010; Korner-Bitensky, Bitensky, Sofer, Man-Son-Hing, & Gelinas, 2005; Withaar, Brouwer, & Van Zomeren, 2000). On-road assessments are standardized by developing geographically replicable pre-determined maneuvers rated on explicit criteria on fixed routes (Kowalski & Tuokko, 2007). Moreover, it has been argued that when a representative range of traffic conditions at an appropriate level of difficulty are performed by the driver, driving competence is more accurately evaluated, as the assessor is able to observe critical aspects of driver performance (Di Stefano & Macdonald, 2003). Consequently, researchers have developed a wide range of psychometrically sound standardised on-road assessments that can be applied to specific populations with specialised conditions and broader populations of older drivers (Kowalski & Tuokko, 2007).

Although standardised on-road assessments serve a vital purpose in distinguishing safe from unsafe older drivers (MacDonald, Pellerito, & Di Stefano, 2006), there are circumstances where a less-structured assessment route and protocol may be justified. The appropriateness and value of assessments conducted over routes familiar to and chosen by the older driver have been asserted by driving rehabilitation specialists and researchers (Justiss, 2005; Withaar et al., 2000). These on-road assessments, commonly referred to as personalised assessments, are inherently non-standardised (MacDonald et al., 2006). Although, in theory, all drivers are expected to deal with any environmental demands, in practice the intensity and quantity of environmental demand experienced are unique to each driver (Nasvadi, 2007). The core assumption behind the utilisation of non-standardised tests is that customised assessments provide more ecological validity in terms of matching assessment requirements to the specific real-world driving needs of the driver (Nasvadi, 2007).

It has been noted that personalised non-standardised tests could be appropriate where geographic licensing restrictions are available (Justiss, 2005). Indeed, some research suggests that driving restrictions may be an effective measure for reducing crash risk for some older drivers, thus prolonging their continued independence and mobility (Nasvadi & Vavrik, 2007). Furthermore, it has been argued that personalised, non-standardised assessments more closely resemble drivers' everyday driving and provide greater ecological validity (Withaar et al., 2000).

A major consideration for on-road assessments is whether to use the driver's own vehicle, or an instrumented, dual-control test vehicle. Using the same instrumented vehicle with dual-control brakes for each assessment enhances the standardization of the evaluation by ensuring that the mechanical conditions of the vehicle are the same for each driver. This also has the simultaneous benefit of improving passenger (assessor) safety (Fox, 1989; Kowalski & Tuokko, 2007). However, research has shown that the processes involved in adapting to an unfamiliar vehicle may be problematic for driving performance in older drivers, and thus compromise the validity of the overall assessment (Lundberg & Hakamies-Blomqvist, 2003). Indeed, research has demonstrated that for older drivers, simple motor components of the driving task, such as manual gear shifting, are not easily automated and can impair driving performance, until familiarised (Lundberg & Hakamies-Blomqvist, 2003). Moreover, Lundberg and Hakamies-Blomqvist (2003) suggested that various features of compensatory behaviour will not emerge unless the driver can make strategic decisions regarding the choice of the vehicle.

Candrive/Ozcandrive Study

The Candrive/Ozcandrive study is a longitudinal, multi-centre international research program with the core objective of identifying solutions to promote older drivers' safe mobility (Marshall et al., 2013). The Candrive/Ozcandrive study involves 928 drivers aged 70 and over in Canada and 302 drivers aged 75 and older in Australia and New Zealand (Australia: $n = 257$; New Zealand: $n = 45$). Using a longitudinal study design, the project is tracking this cohort of older drivers for up to six years, assessing changes in their functional abilities, driving practices (e.g., exposure and patterns), as well as crashes and citations. The primary purpose is to determine and validate a screening test (Decision Rule) to identify potentially at-risk drivers (Marshall et al., 2013). Participants' usual (or naturalistic) driving practices (e.g., trip distance, duration, type of road, speed) are recorded through an in-car recording device installed in the participant's own vehicle, and measures of participants' functional ability, medical conditions, and self-reported driving-related abilities and practices are documented annually. In addition, participants' driving behaviour is evaluated annually through an on-road driving task.

electronic Driver Observation Schedule (eDOS)

The eDOS is an on-road driving task, designed initially for use in the Ozcandrive study to evaluate older drivers' driving behaviour in order to monitor changes in individual driving behaviours over time (Koppel et al., 2013; Vlahodimitrakou et al., 2013). Additionally, it was expected that such a tool could supplement the (relatively rare) primary outcome measures of crashes and police-recorded infringements/violations of traffic safety rules and regulations for validation of the screening test.

In developing the eDOS driving task, key criteria were that it should reflect drivers' everyday driving and be feasible (in light of both time and resources) to sustain within the multi-site longitudinal study. More specifically, the five eDOS driving task requirements were as follows:

- observation of "natural" driving with no intervention/instruction by the observer;
- conducted in driver's own vehicle (following positive effects reported by Lundberg & Hakamies-Blomquist (2003) as noted above);
- conducted over routes familiar to and chosen by the older driver;
- took approximately 20–25 minutes to complete;
- rated behaviours specifically associated with older driver safety.

The Person-Environment (P-E) Fit theory of driving competence (Willis, 2000) and Michon's Model of Driver Behaviour (Michon, 1989) were influential in determining the nature of the eDOS driving task. Consequently, the eDOS driving task was designed to be undertaken on driver-selected routes to observe drivers' competency in environments encountered in their everyday driving. In addition, item selection and operationalization of the eDOS driving task was based on three factors: (a) older-driver crash epidemiology (e.g., Catchpole, Styles, Pyta, & Imberger, 2005; Fildes et al., 1994; Langford & Koppel, 2006), (b) older driver self-regulatory behaviour (e.g., Baldock et al., 2006; Charlton et al., 2006), and (c) published driving measures (Di Stefano & Macdonald, 2003; Dobbs, Heller, & Schopflocher, 1998; Galski, Bruno, & Ehle, 1993; Hunt et al., 1997; Justiss, 2005; Kowalski & Tuokko, 2007; Ott, Papandonatos, Davis, & Barco, 2012). Based on these findings, we identified six categories of driving behaviours for inclusion in the final eDOS driving task: (a) observation of road environment; (b) signalling; (c) speed regulation; (d) gap acceptance; (e) road-rule compliance; and (f) vehicle/lateral lane positioning (see Table 1 for the definitions for inappropriate driving behaviours). We scored the behaviours during driving maneuvers, as appropriate or inappropriate: intersection negotiation, lane-changing, merging, low-speed maneuvers, and maneuver-free driving (i.e., straight travel path).

The eDOS was initially developed with a paper-based evaluation form. Vlahodimitrakou et al. (2013) evaluated the inter-rater reliability, feasibility, and acceptability of the eDOS driving task on a sub-sample of 33 Ozcandrive participants (20 male [61%], 13 female [39%], mean age = 80.12 years, *SD* = 3.39, range: 75–88 years). The authors reported that the eDOS driving task was possible to implement in participants' own vehicles, could be scored reliably (r [18] = .83, $p < 0.05$), was practical in terms of duration, and was acceptable to participants. Koppel et al. (2012) revised the eDOS driving task, including (a) an electronic score sheet to record and score driving behaviour, and (b) installation of video recording equipment in participants' vehicles to capture images of the driver and the forward driving environment throughout the drive. Based on a sub-sample of 96 Ozcandrive participants, the authors reported that it was possible to observe and score detailed driving behaviour during intersection negotiation, lane-changing, merging, and maneuver-free driving, and that the revised (eDOS) driving task demonstrated practicality and high user acceptance. Koppel et al. (2013) then investigated the relationship between participants' driving performance during the eDOS driving task and their cognitive performance for a subset of 144 Ozcandrive participants (104 male [72%], 40 female [28%], mean age = 81.49 years, *SD* = 3.58 years, range: 76–96 years).

Preliminary analyses of the eDOS driving task revealed a high level of appropriate driving behaviour among Ozcandrive older drivers. The authors reported that there was no significant relationship observed between participants' overall eDOS driving task scores and age, and participants' performance on various cognitive assessments. However, the authors suggested that it would be important to explore the potential relationship between performance on the eDOS driving task and cognitive performance with the full sample (n = 227), as well as to explore the potential relationship between participants' performance on the eDOS driving task

Table 1: Definitions for inappropriate driving behaviour

Driving Behaviour	Specific Error	Explanation
Observation of Road Environment:	No Mirror Use	Non-use of rear-/side-view mirrors
Maintaining awareness of surroundings and road environment	No looking	Failure to look ahead/left/right before proceeding through intersection
Signaling:	Inappropriate	Failure to use signal/leaving signal on after negotiating intersection/Use of incorrect signal
Ability to signal intention to negotiate an intersection		
Speed Regulation:	Too fast	Driving over speed limit or at dangerous speed for maneuver
Adhering to posted speed limits, and regulating speed consistent with road/traffic conditions	Too slow	Driving too slowly (consistently; a sign of overcautiousness)
Gap acceptance:	Missed opportunity	Being overcautious/missing opportunities when selecting gap
Making safe judgments about presence of other vehicles and selecting a suitably risk-free point to pull into line of traffic, or cross one or more lanes of traffic	Unsafe gap	Selecting unsafe gap
	Failure to yield	Failing to yield (give right of way)
	Hitting curb	Hitting side curb
Road-Rules Compliance:	Non-compliance light/sign	Failing to comply with road sign/traffic light
Ability to follow and appropriately respond to road signs, and not cross pavement markings	Crossing pavement	Crossing a pavement marking to the extent of disturbing other road users
Vehicle/Lane Positioning:	Out of lane	Drifting out of lane (with or without marked lanes)
Position of vehicle while moving or stopped, in accordance with side lane markings on a motorway	Hitting curb	Hitting side curb
	Inappropriate following distance	Driving too close to vehicle in-front

and other functional performance measures, as well as participants' perceptions of driving comfort and abilities.

Aims

The aim of this study was to examine a cohort of older drivers using the eDOS driving task and investigate the relationship between performance on the task and (1) driver characteristics (e.g., age, gender, frequency of driving, etc.); (2) functional abilities; (3) perceptions of driving comfort and abilities; and (4) self-reported driving restrictions using a number of measures from the Candrive/Ozcandrive assessment protocol (Marshall et al., 2013).

Method

Participants

In all, 227 Ozcandrive participants completed the eDOS driving task in Melbourne, Australia.[1] All participants were required to meet the following inclusion criteria: (a) aged 75 or older; (b) held a valid driver's license; (c) drove at least four times per week, and (d) did not have an absolute contraindication to driving, as defined by the Austroads Fitness to Drive Guidelines (Austroads, 2012).

Materials

All participants underwent their Year 2 annual Candrive/Ozcandrive assessment that incorporated a range of demographic and driving history questions, as well as a range of functional ability measures, medical conditions, and self-reported abilities and practices related to driving (Marshall et al., 2013).

Functional Ability Measures

Five measures of functional ability were analysed.

- Montreal Cognitive Assessment (MoCA), a brief cognitive assessment, where scores range from 0 to 30 and with scores less than 26 suggestive of mild cognitive impairment (Nasreddine et al., 2005);
- Mini-Mental State Examination (MMSE), a brief cognitive assessment, where scores range from 0 to 30 and with scores less than 24 suggestive of cognitive impairment (Folstein, Folstein, & McHugh, 1975);
- Trail Making Test B (Moses, 2004), a timed executive functioning task, where scores greater than 180 seconds have been associated with increased crash risk (Staplin, Gish, & Wagner, 2003);
- Rapid Pace Walk, a measure of motor speed, balance, and coordination (Carr, Schwartzberg, Manning, & Sempek, 2010), where scores greater than 10 seconds may indicate an increased crash risk (Staplin et al., 2003);
- Snellen eye chart, a measure of visual acuity,[2] where 6/6 (LogMAR = 0) is considered normal vision, 6/12 (LogMAR = +0.3) is considered "reduced vision" and is the Australian legal driving limit (Austroads, 2012).

Self-reported Driving-Related Abilities and Practices

Four measures of self-reported abilities and practices were analysed.

- Driving Comfort Scales (DCS): The 13-item daytime (DCS-D) and 16-item nighttime (DCS-N) Driving Comfort Scales ask participants to rate their level of comfort while driving in a range of driving situations. Possible scores range from 0 to 100 per cent, with higher scores indicating greater driving comfort (Blanchard et al., 2010; MacDonald et al., 2008). Both scales have demonstrated good test–test reliability over a two-week period (intraclass correlation coefficients [ICCs] = 0.70 and 0.88) and excellent structural properties (unidimensionality, hierarchiality, goodness of fit, interval properties) (MacDonald et al., 2008; Myers et al., 2008).
- Perceived Driving Abilities (PDA) scale: The 15-item Perceived Driving Abilities (PDA) scale asks participants to rate various aspects of their current abilities (e.g., see road signs at night, make quick driving decisions) on a four-point scale (where 0 = poor, 3 = very good). The PDA scale has strong, internal consistency ($\alpha = 0.92$) and moderate test–retest reliability over one week (ICC = 0.65). Total scores can range from 0 to 45, with higher scores indicating more-positive perceptions of driving abilities (Blanchard et al., 2010; MacDonald et al., 2008).
- Situational Driving Frequency (SDF) and Situational Driving Avoidance (SDA) scales: Driving practices were assessed using the Situational Driving Frequency (SDF) and Avoidance (SDA) scales. On the SDF scale, participants are asked how often they drive, on average, in 14 different driving scenarios (e.g., at night, on highways, in rural areas, in heavy traffic or rush hour in town, on trips lasting 2 hours each way, etc.) on a 5-point scale: never (0), rarely (1 = less than once a month), occasionally (2 = more than once a month but less than weekly), often (3 = one to three days per week), or very often (4 = four to seven days a week). Total scores can range from 0 to 56 with higher scores indicating driving more often in challenging situations. On the SDA scale, participants are asked "If possible, do you try and avoid any of these driving situations? Check all that apply" on a list of 19[3] situations (e.g., night, dawn or dusk, bad weather conditions in general, heavy rain, making left-hand turns, etc.). The last item, "No, I don't try to avoid any of these situations", is used to ensure that people have considered all the situations. Scores can range from 0 to 19, with higher scores indicating greater avoidance. Both scales were developed inductively with older drivers and have shown good internal consistency and test–retest reliability (MacDonald et al., 2008; Myers et al., 2008).
- Driving Habits and Intentions Questionnaire (DHI): The Driving Habits and Intentions Questionnaire (Kowalski et al., 2011) was adapted from an existing short questionnaire (Webber et al., 2010) designed to assess driving-related

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thoughts, beliefs, and action. The questionnaire contains items related to current driving restrictions (i.e., situations under which they prefer *not* to drive such as turning right[4] at intersections, driving in unfamiliar locations). These were recoded into a global continuous driving restriction variable ranging from 0 to 17 indicating current driving restrictions, with higher scores representing more restrictions.

eDOS

In the current study, participants' driving behaviour was observed by a single trained observer who scored the driving behaviour using an electronic score sheet (for a more detailed description of the eDOS driving task, see Koppel et al., 2012; Koppel et al., 2013; Vlahodimitrakou et al., 2013).

Although the driving route itself was selected by each participant to represent their everyday driving environment and was therefore not standardized, driving behaviours were observed and documented using standardized procedures for intersection negotiation, lane-changing, merging, maneuver-free driving, and low-speed maneuvering. Six categories of driving behaviours, each scored as appropriate or inappropriate, were recorded for each intersection negotiation, lane change, and merge (see Table 1). Route complexity was recorded in terms of traffic density, speed zone, and number of road lanes.

The observer also documented the occurrence of "critical errors", defined as errors which result in (1) the vehicle being involved in a crash or near-crash, and/or (2) the observer using verbal prompts either to prevent an error escalating in severity or to correct the error.

The eDOS driving task score (maximum 100 points) was calculated as the total number of driving maneuvers completed appropriately, minus 1 point for each error performed during maneuver-free driving and minus 2 points for each critical error, divided by the total number of maneuvers observed, multiplied by 100. The computation of the eDOS driving task score was adapted from an approach commonly employed in driving assessment research (Di Stefano & Macdonald, 2003).

A post-drive survey comprising four items was developed to assess drivers' perceptions of the eDOS driving task experience. Participants were asked to rate (1) the overall quality of their driving during the eDOS driving task, (2) the difficulty of the eDOS driving task compared with their everyday driving, (3) their familiarity with the selected route during the eDOS driving task, and (4) their level of comfort with being observed during the eDOS driving task.

Procedure

Ethics approval was obtained from the Monash University Human Research Ethics Committee (MUHREC), and all participants provided written informed consent.

All participants underwent an annual assessment as part of the Candrive/Ozcandrive protocol that incorporated a range of psychometric measures of functional ability (e.g., cognitive, vision, and physical assessments), medical conditions, and self-reported abilities related to driving (e.g., perceived driving comfort, abilities, and self-reported driving restrictions) (Marshall et al., 2013). The annual assessment was conducted up to eight months before participants completed the eDOS driving task.

The eDOS driving task was implemented by a single trained observer who underwent 6 hours of training with an Occupational Therapist Driving Expert in both classroom and on-road environments. Training included familiarization with the eDOS observation and recording procedures, general principles of driving assessment and the video recording equipment setup and installation.

The eDOS driving task commenced from each participant's home and was conducted on routes familiar to and chosen by the participant. Prior to the start of the driving task, participants were asked to nominate up to four nearby locations to which they regularly drive, and to devise a driving route commencing and ending at home and linking the nominated destinations within a 20–25 minute round-trip.

The observations were conducted in the participant's vehicle with the observer seated in the rear left seat (i.e., behind the front passenger seat) to ensure that critical aspects of driving behaviour were observable (Fox, 1989).

Throughout the eDOS driving task, the observer documented and scored the maneuvers specified in the eDOS driving task as they occurred on the agreed route, using the eDOS driving task criteria.

The eDOS driving task was designed to study driving behaviours that reflect everyday driving, so drivers were encouraged to behave as they normally would, including listening to the radio or a CD. They were also permitted to have their regular passenger travel with them and assist with navigation. However, none of these participants required assistance with navigation from their passengers. In addition, several eDOS driving task appointments were rescheduled due to bad weather when participants reported that they never drove in bad weather (e.g., rain, hail, etc.).

Data Analysis

Descriptive statistics were used to document the driver characteristics, functional abilities, self-reported driving-related abilities and practices, and eDOS driving task scores of the sample. Univariate analyses (student *t*-tests and χ^2) were conducted, where appropriate, to explore the relationship group differences in eDOS driving task scores and driver characteristics, functional abilities, self-reported driving-related abilities, and practices. Where the assumption of sphericity was not met, degrees of freedom were adjusted using Welch's correction. A Bonferroni correction ($p < 0.01$) was applied to adjust for the number of comparisons being performed and to protect against an inflated probability of Type 1 errors.

Results

A total of 227 Ozcandrive participants (159 male [70%], 68 female [30%], mean age = 81.53 years, *SD* = 3.37 years, range: 76–96 years) completed the eDOS driving task. Participants' demographic and driving characteristics are shown in Table 2. As the table shows, most participants were between ages 80 and 84 (51%), male (70%), married (60%), had achieved a diploma as their highest level of education (29%), reported driving daily (50%), and estimated that they had driven 5,001–10,000km in the past year (45%).

Table 2: Demographic and driving characteristics for participants who completed the eDOS driving task

Demographic and Driving Characteristics		Percentage (*n*)
Age group	75–79 years	31% (70)
	80–84 years	51% (115)
	85–89 years	17% (39)
	90–94 years	1% (3)
Gender	Male	70% (159)
	Female	30% (68)
Marital status	Single (never married)	7% (15)
	Married / de facto	60% (137)
	Divorced / separated	6% (14)
	Widowed	27% (61)
Highest level of education	Primary school	25% (56)
	High school	9% (20)
	Trade/Technical certificate	14% (32)
	Diploma	29% (66)
	Degree	17% (39)
	Postgraduate	6% (14)
Frequency of driving	Daily	50% (113)
	4–6 times per week	45% (103)
	2–3 times per week	5% (11)
Estimated kilometres driven in past year	≤ 1,000 km	0% (0)
	1,001–3,000 km	2% (5)
	3,001–5,000 km	12% (28)
	5,001–10,000 km	45% (101)
	10,001–15,000 km	26% (59)
	15,001–20,000 km	9% (21)
	20,001–25,000 km	3% (7)
	> 25,000 km	3% (6)

Functional Ability Measures

Participants' performance on a range of functional ability measures from the Candrive/Ozcandrive annual assessment is described in Table 3. Overall, participant performance was quite high according to conventional benchmarks for impairment.

Self-reported Driving-Related Abilities and Practices

Participants' self-reported driving-related abilities and practices are described in Table 4. Participants reported high driving comfort scores for both daytime and night-time driving, positive perceptions regarding their own driving abilities, high frequency of driving in challenging situations, and low levels of driving avoidance or restrictions.

eDOS Driving Task Descriptives

The average duration for the eDOS driving task was 24 min, 26 s (*SD* = 7 min 25 s, range 11 min, 50 s – 1 h, 5 min, 57 s), with the majority of participants completing the eDOS driving task within 5 minutes of the target range of 20–25 minutes (82%). The average distance driven was 12.75 km (*SD* = 5.06, range = 5 km – 29 km). Due to technical difficulties with the electronic recording device, driving distance was only available for 170 participants.

Most participants drove to one (54%) or two (34%) nominated destinations near their home; a small proportion drove to three (11%) or four (1%) destinations. Most commonly, participants chose a local shopping centre as one of their destinations (45%), followed by places for sports or hobbies (25%), family or friends' houses (13%), medical centres (5%), and churches (3%).

eDOS Driving Task Scores

The average eDOS driving task score (maximum = 100) was high (*M* = 94.74; *SD* = 5.70; range = 65.63–100.00). A summary of the frequency of driving maneuvers observed during the eDOS driving task, including intersection negotiation, lane changing, merging, and low-speed maneuvering, is presented in Table 5. The average number of intersections negotiated by participants per eDOS driving task was 30.90 (*SD* = 9.14). The majority of turns were conducted at uncontrolled intersections (turning left: *M* = 3.91, *SD* = 2.26; turning right: *M* = 3.46, *SD* = 2.04) and at roundabouts (*M* = 3.12, *SD* = 3.29). On average, 7.90 (*SD* = 4.72) lane changes were observed per eDOS driving task, with relatively few merges observed per driving task (*M* = 1.26, *SD* = 1.13). Detailed analysis of participants' driving behaviour during intersection negotiation, lane changing, merging, and low-speed maneuvering revealed a high level of appropriate driving behaviour (96%, *n* = 6,969

Table 3: Performance on functional ability measures[a]

Functional ability measure	Mean (*SD*)	Range	Benchmark for impairment	Percentage (*n*) below impairment criteria
MOCA	26.70 (2.19)	19–30	< 26	27% (61)
MMSE	29.09 (1.04)	26–30	< 24	0% (0)
Trails B	109.72 sec (42.76)	43–301 sec	> 180 sec	7% (16)
Rapid Pace Walk	7.30 sec (1.41)	4–16 sec	> 10 sec	3% (7)
Visual Acuity LogMAR[1]	+0.07 (0.13)	–0.20 ± 0.40	> + 0.30	1% (2)

[a] **Visual acuity scores were converted to the logarithm of the minimum angle of resolution (logMAR) as recommended in the literature (McGwin & Brown, 1999).**

maneuvers), with few errors (4%, *n* = 273 maneuvers) (see Table 6). The most common type of error observed was inappropriate signaling (intersection negotiation: *n* = 121; merges: *n* = 114; lane changing: *n* = 30).

Both appropriate and inappropriate behaviours observed during different intersection types are shown in Table 7. Due to technical difficulties with electronic scoring, intersection type was available only for 98 per cent of the intersections observed (*n* = 6,850). As shown in Table 7, participants were most likely to make errors while negotiating a roundabout (11%), turning left at a traffic light with an arrow (11%), and making a U-turn (9%). Note, in Australia, right turns are made across traffic.

Post-drive Survey

When asked about their driving behaviour during the eDOS driving task compared with their everyday driving (where 1 = much better, 3 = about the same, 5 = much worse), most participants rated their eDOS driving task behaviour as "about the same" as their everyday driving (97%). The remaining participants indicated that their driving behaviour was "better" (2%, *n* = 4) or "worse" (1%, *n* = 2) during the eDOS driving task.

Participants were then asked to rate the difficulty of the eDOS driving task compared with the difficulty of their everyday driving (where 1 = much less difficult, 3 = about the same, 5 = much more difficult). Most participants rated the difficulty of the eDOS driving task as "about the same" as their everyday driving (68%). Interestingly, 27 per cent of participants rated the eDOS driving task as "a little less difficult", 1 per cent rated the eDOS driving task as "much less difficult", and 4 percent rated the eDOS driving task as "a little more difficult" compared with their everyday driving.

Participants were asked to rate their level of familiarity with the route undertaken during the eDOS driving task (where 5 = completely familiar, 3 = neither familiar nor unfamiliar, 1 = completely unfamiliar). Most participants reported that they were "highly familiar" (93%) or "familiar" (7%) with the eDOS route.

Finally, participants were asked to rate their level of comfort with being observed during the eDOS driving task (where 5 = completely at ease, 1 = completely uneasy). Approximately two thirds reported they were "completely at ease" (68%), 31 per cent reported that they were "at ease"; only 1 per cent felt "uneasy".

Relationship between eDOS Driving Task Scores, Functional Scores, and Self-reported Driving-Related Abilities and Practices

Participants' eDOS driving task scores were not normally distributed; therefore, participants were allocated to one of three equally sized groups based on their eDOS driving task score (low eDOS driving task score: 65.63–93.65, *n* = 74; moderate eDOS driving task score: 93.66–97.87, *n* = 78; high eDOS driving task score: 97.88–100, *n* = 75). The following analyses are restricted to comparing participants with low and high eDOS driving task scores. No further analyses were conducted for the moderate eDOS driving task score group.

Table 4: Self-reported driving-related abilities and practices

Self-reported Driving-Related Abilities and Practices	Mean (*SD*)	Range
Driving Comfort Scale (DCS) – Day (Max = 100)	76.80 (14.80)	23–100
Driving Comfort Scale (DCS) – Night (Max = 100)	70.17 (18.26)	2–100
Perceived Driving Abilities (Max = 45)	33.57 (6.39)	15–45
Situational Driving Frequency (Max = 56)	33.15 (6.80)	10–50
Situational Driving Avoidance (Max = 20)	4.07 (3.70)	0–19
No. of driving conditions currently restricting (Max = 17)	0.68 (1.78)	0–11

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Table 5: Frequency of driving maneuvers observed during the eDOS driving task[a]

Driving Maneuver		Mean Number (*SD*) Observed	Range Observed
Intersections (all)		30.70 (9.14)	9–70
Traffic lights (with arrow)			
	Turning left	0.23 (0.53)	0–4
	Turning right	1.28 (1.14)	0–5
Traffic lights (no arrow)			
	Turning left	1.06 (1.06)	0–4
	Turning right	0.96 (0.94)	0–4
	Straight through	12.29 (8.49)	0–47
Controlled[a] Intersection (No traffic light)			
	Turning left	2.33 (1.53)	0–8
	Turning right	0.97 (0.94)	0–5
	Straight through	0.20 (0.50)	0–2
Uncontrolled Intersection			
	Turning left	3.91 (2.26)	0–13
	Turning right	3.46 (2.04)	0–10
	Straight through	0.07 (0.32)	0–3
Roundabout (any maneuver)		3.12 (3.29)	0–18
U-turn, any intersection		0.19 (0.41)	0–2
Lane changes		7.90 (4.72)	1–31
Merges		1.26 (1.13)	0–4
Low-speed maneuvers (all)		3.32 (1.31)	1–8
Reversing		1.45 (0.79)	0–4
Pulling into a curb		0.26 (0.49)	0–2
Parking		1.61 (0.77)	0–4

[a] **Note that Controlled Intersection refers to stop and giveway signs.**

Relationship between eDOS Driving Task Scores, Driver Characteristics, and Functional Ability Scores

Although participants with low eDOS scores were older (M = 82.41 years, SD = 3.96) than those with high eDOS driving task scores (M = 80.93 years, SD = 2.98), this difference failed to reach statistical significance, $t(135.71) = 2.56$, $p = 0.01$). In addition, there was no significant relationship between eDOS driving task score groups and gender, reported frequency of driving, or estimated kilometres driven in the past 12 months (gender: $\chi^2(1) = 2.41$, $p > 0.1$; frequency of driving: $\chi^2(2) = 2.16$, $p > 0.1$; estimated kilometres driven in past year: $\chi^2(2) = 3.09$, $p > 0.1$).

Participants' scores on selected functional ability measures are shown in Table 8. There was no significant relationship between eDOS driving task scores and functional abilities (MoCA: $t(147) = –0.08$, $p = 0.94$; MMSE: $t(147) = 1.00$, $p = 0.32$; Trails B: $t(146) = 0.09$, $p = 0.93$; Rapid Pace Walk: $t(147) = 1.35$, $p = 0.18$; Visual Acuity LogMar: $t(146) = 0.06$, $p = 0.95$).

Relationship between eDOS Driving Task Scores and Self-reported Driving-Related Abilities and Practices

Participants' scores on selected measures are shown in Table 8. Those with lower eDOS driving task scores had lower driving comfort scores for both day and night driving and reported higher levels of situational driving avoidance compared to those with higher eDOS driving task scores; however, these differences failed to reach statistical significance (DCS – Day: $t(146) = –1.65$, $p = 0.10$; DSC – Night: $t(138.80) = –1.66$, $p = 0.10$; SDA: $t(146) = 1.67$, $p = 0.10$). However, those with lower eDOS driving task scores had significantly lower scores on the Situational Driving Frequency (SDF) Scale, the measure of Perceived Driving Abilities (PDA) Scale, and the number of driving restrictions reported compared to participants with higher eDOS driving task scores (SDF: $t(146) = –2.32$, $p < 0.01$; PDA: $t(146) = –2.02$, $p < 0.01$; driving conditions restricted: $t(126.92) = –2.66$, $p < 0.01$).

Discussion

The eDOS driving task was developed for use in the Candrive/Ozcandrive five-year prospective study of older drivers to observe the driving behaviour of older drivers and monitor changes in driving behaviours over time. This study examined a cohort of older drivers using the eDOS driving task and investigated the relationship between performance on the eDOS driving task and (1) driver characteristics; (2) functional abilities; (3) perceptions of driving comfort and abilities; and (4) self-reported driving restrictions using a number of measures from the Candrive/Ozcandrive assessment protocols.

Table 6: Appropriate and inappropriate driving behaviour observed during intersection negotiation, lane changes, merges, low-speed maneuvering

Driving Behaviour		Percentage (*n*)
Intersection Negotiation Behaviour (Total)		*n* = 6,969
Appropriate Behaviour		96% (6,694)
Inappropriate Behaviour		4% (273)
Frequency of Inappropriate Behaviour observed:		
Inappropriate Signaling		121
Speed regulation	Too fast	72
	Too slow	0
Vehicle positioning	Out of lane	8
	Hitting curb	33
Observation of road environment	No mirror use	1
	No looking	4
Gap acceptance	Missed opportunity	8
	Unsafe gap	17
	Failure yielding	0
Road rule compliance	Non-compliance lights/signs	24
	Crossing pavement	0
Lane Changing Behaviour (Total)		*n* = 1,794
Appropriate Behaviour		92% (1,653)
Inappropriate Behaviour		8% (140)
Frequency of Inappropriate Behaviour observed:		
Inappropriate Signaling		114
Speed regulation	Too fast	6
	Too slow	0
Vehicle positioning	Out of lane	1
	Hitting curb	0
	Inappropriate following distance	2
Observation of road environment	No mirror use	2
	No looking	9
Gap acceptance	Missed opportunity	0
	Unsafe gap	10
	Failure yielding	0
Merging Behaviour (Total)		*n* = 286
Appropriate behaviour		88% (251)
Inappropriate behaviour		12% (35)
Frequency of inappropriate merging behaviour observed:		
Inappropriate signaling		30
Speed regulation	Too fast	0
	Too slow	0
Vehicle positioning	Out of lane	0
	Hitting curb	0
	Inappropriate following distance	0
Observation of road environment	No mirror use	0
	No looking	2
Gap acceptance	Missed opportunity	0
	Unsafe gap	2
	Failure yielding	0
Low-speed Maneuvering Behaviour (Total)		*n* = 754
Appropriate behaviour		94% (711)
Inappropriate behaviour		6% (43)
Frequency of inappropriate behaviour observed:		
Inappropriate signaling		20
Inappropriate positioning attempts		18
No observation		5

Table 7: Appropriate and inappropriate driving behaviour observed during different intersection types

Intersection Type		Percentage Appropriate (*n*)	Percentage Inappropriate (*n*)
Traffic lights (with arrow)			
	Turning left	89 (47)	11 (6)
	Turning right	97 (282)	3 (9)
Traffic lights (no arrow)			
	Turning left	99 (239)	1 (2)
	Turning right	96 (211)	4 (8)
	Straight through	99 (2,781)	1 (24)
Controlled Intersection (No traffic light)			
	Turning left	94 (498)	6 (30)
	Turning right	95 (208)	5 (12)
	Straight through	98 (45)	2 (1)
Uncontrolled Intersection			
	Turning left	94 (838)	6 (51)
	Turning right	95 (753)	5 (37)
	Straight through	100 (16)	0 (0)
Roundabout (any maneuver)		89 (634)	11 (75)
U-turn, any intersection		91 (39)	9 (4)
Total		**96 (6,591)**	**4 (259)**

Driving Behaviour

Consistent with the findings of the pilot study described by Vlahodimitrakou et al. (2013), overall eDOS driving task scores (maximum = 100) were very high (M = 94.74; SD = 5.70). Detailed analyses of participants' driving behaviour revealed high levels of appropriate driving behaviour during intersection negotiation (96%), lane changing (92%), and merging (88%). Compared with other studies (e.g., Di Stefano & Macdonald, 2003), drivers' error rates were very low. This difference may reflect the better health and functional abilities of the present sample compared with that of Di Stefano and Macdonald (2003), in which drivers had been referred to the licensing authority for review because their driving competence was in question. Interestingly, the majority of inappropriate behaviours observed in the current study across all driving maneuvers were signaling errors. Arguably, while signaling errors potentially have serious consequences, other behaviours may impact more on safety, including poor gap choices at intersections and inappropriate speed choices (too fast) for all three maneuvers categories.

In terms of intersection negotiation, the most common errors observed were inappropriate signaling, driving too fast, or hitting curbs. These types of errors are consistent with those observed in other recent intersection error studies with younger, middle-aged, and older drivers (Gstalter & Fastenmeier, 2010; Young, Salmon & Lenne, 2012). Although errors were compared across intersection types, participants in the

Table 8: Functional abilities and self-reported driving-related abilities and practices across eDOS driving task score groups

Functional abilities	Low eDOS driving task score	High eDOS driving task score
	(***n*** **= 74**)	(***n*** **= 75**)
	Mean (*SD*)	**Mean (SD)**
MoCA	26.70 (2.38)	26.73 (2.18)
MMSE	29.20 (1.03)	29.04 (0.95)
Trails B	112.67 sec (36.47)	112.03 sec (48.89)
Rapid Pace Walk	7.45 sec (1.61)	7.13 sec (1.19)
Visual Acuity LogMAR	0.08 (0.14)	0.08 (0.12)
Self-reported driving-related abilities and practices		
Driving Comfort Scale (DCS) - Day	75.08 (14.42)	79.03 (14.27)
Driving Comfort Scale (DCS) - Night	67.88 (20.37)	72.89 (16.16)
Perceived Driving Abilities (PDA)	32.41 (5.85)	34.47 (6.57)
Situational Driving Frequency (SDF)	31.78 (6.30)	34.34 (7.09)
Situational Driving Avoidance (SDA)	4.34 (3.59)	3.38 (3.38)
No. of driving conditions currently restricting	1.07 (2.05)	0.31 (1.37)

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current study were most likely to make errors while turning left at a traffic light with an arrow (11%) or negotiating a roundabout (11%). This finding is consistent with Gstalter and Fastenmeier (2010) who reported that the highest errors occurred for non-signalized intersections and roundabouts for all drivers. In particular, the authors noted that older drivers were most likely to commit inappropriate signaling errors (false or missing) at roundabouts, especially at the exit.

Undergoing a driving "evaluation" in which driving behaviour is scrutinized can often be very stressful for older individuals. Therefore, ensuring that drivers are at ease with being observed and comfortable with demands of the route is a key requirement for eDOS driving task acceptability (Vlahodimitrakou et al., 2013). Although the researchers were careful to emphasize to participants that the eDOS driving task was not a test, we were conscious that the task was somewhat contrived in its destination-chaining requirements (i.e., linking together two or more purpose-specific trips prior to their returning home which was primarily to ensure that the driving task duration was not excessive), and that presence of an observer may cause discomfort and/or alter behaviour. Results of the post-drive survey showed that most participants rated their overall driving during the eDOS driving task as "about the same when compared with their normal driving" (97%), and that, even though they knew they were being observed, they were "completely at ease" (68%). These findings are consistent with previous research which has suggested that personalised, non-standardised assessments more closely resemble drivers' everyday driving and provide greater ecological validity (Withaar et al., 2000).

It seems likely that the use of drivers' own vehicles contributed to their feelings of ease with the eDOS driving task procedure, although there is no direct evidence of this. Research by Lundberg and Hakamies-Blomqvist (2003) reported higher fail rates for medically referred drivers using a test vehicle compared with drivers using their own vehicles. The authors attributed the result to drivers' need to adapt to an unfamiliar vehicle which imposed an additional cognitive load that compromised their driving ability. Overall, the current findings suggest that the participants believed that their behaviour on the eDOS driving task was representative of their everyday driving. This suggests that the eDOS driving task has a high level of face validity in reflecting drivers' everyday driving. Given the increasing international interest and use of modified (local area) licenses (Langford & Koppel, 2011), the eDOS driving task also offers a promising approach for the purpose of local-area license testing.

Relationship between Driving Behaviour on the eDOS Driving Task and Driver Characteristics and Functional Abilities

Participants' performance on the eDOS driving task was not significantly related to age, gender, reported frequency of driving, or estimated kilometres driven in the past 12 months. In addition, participants' eDOS driving task scores were not significantly related to any of the functional measures; this is not surprising as few people showed impairments according to conventional benchmarks (e.g., 27% scored < 26 on the MoCA [Nasreddine et al., 2005]; 0% scored < 24 on the MMSE [Folstein et al., 1975]; 7% scored > 180 sec on Trails Making Part B [Staplin et al., 2003]; 3% scored > 10 sec on Rapid Pace Walk [Staplin et al., 2003]; 1% scored > + 0.3 on Visual Acuity [Austroads, 2012]). The findings are consistent with the preliminary analyses previously reported by Koppel et al. (2013) with 144 Ozcandrive participants. It will be important to explore relationships over time as functional abilities may decline with the development of health conditions (Marshall, 2008).

Relationship between Driving Behaviour on the eDOS Driving Task and Self-reported Driving-Related Abilities and Practices

The current study revealed several interesting relationships between participants' eDOS driving task scores and their self-reported driving-related abilities and practices. For example, participants with lower eDOS driving task scores (1) were significantly less likely to report driving in challenging situations (e.g., at night, on highways, in rural areas, in heavy traffic or rush hour in town, on trips lasting 2 hours each way, etc.); (2) reported significantly lower levels of perceived driving abilities; and (3) reported restricting significantly more driving conditions compared to participants with higher eDOS driving task scores. In addition, participants with lower eDOS driving task scores were more likely to report lower driving comfort for both day and night driving and higher instances of situational driving avoidance compared to participants with higher eDOS driving task scores; however, these differences failed to reach statistical significance.

These findings are consistent with previous research which has shown that many older drivers become aware of their functional capacities and adapt their driving patterns to match these by self-regulating when, where, and how they drive (Baldock et al., 2006; Blanchard et al., 2010; Charlton et al., 2006; Molnar & Eby, 2008). For example, older adults may reduce their exposure by driving fewer annual kilometres, making shorter trips, and making fewer trips by destination chaining (i.e., linking multiple trips together) (Benekohal et al., 1994; 9).

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Older drivers have also been found to avoid complex traffic maneuvers that are cognitively demanding (Ball et al., 1998; Hakamies-Blomqvist & Wahlstrom, 1998), limit their peak hour and night driving, restrict long-distance travel, take more frequent breaks, and drive only on familiar and well-lit roads (Ernst & O'Connor, 1988; Smiley, 1999). Taken together, these findings suggest that at least some older adults are able to compensate well for limitations in their abilities in such a way that is likely to minimise exposure to difficult driving situations to reduce their crash risk.

Several limitations should be noted. The analyses are based on baseline driving data from the Ozcandrive cohort study. This is a convenience sample of independent, healthy older drivers who made a commitment to participate in a five-year study, and therefore the results may not be generalizable to all older drivers. Indeed, participants' performance on a range of functional ability measures from the Candrive/Ozcandrive assessment protocol was quite high according to conventional benchmarks for impairment.

Scores on the perception measures (comfort and driving abilities) were also high relative to prior samples of older drivers whereas SDF and SDA scores were lower (Blanchard & Myers, 2010). As already noted, functional abilities and driver perceptions, as well as driving performance (on the eDOS driving task or simulator tasks), may decline over time as the sample ages and develops age-related functional declines and/or health problems. It will be important to explore the potential relationship between age-related functional fitness to drive changes over the five-year period of the cohort study.

Participants completed their Candrive/Ozcandrive annual assessment up to eight months before they completed the eDOS driving task. It is possible that changes in functional abilities and/or driving-related attitudes and practices may have occurred in the interval. Participants in the current study reported that their eDOS driving task driving performance was representative of their everyday driving; however, these responses may have been influenced by social desirability (Coughlin, 2009). Future research will explore the representativeness of participants' eDOS driving task performance using participants' naturalistic driving practices recorded through the in-car recording device.

Several issues relating to the coding and computation of eDOS driving task scores need further investigation. First, coding of appropriate/inappropriate behaviour for the driving maneuvers within the eDOS driving task relied on subjective judgments of the trained observer. However, we provided a detailed data dictionary and instruction manual to guide the coding of observations and to improve objectivity of judgments.

Second, the computation of the total eDOS driving task score was adapted from an approach commonly employed in driving assessment research (see Di Stefano & Macdonald, 2003; Odenheimer et al., 1994). Weighting of errors is controversial due to the multitude of factors that contribute to the level of "severity" assigned to a given error and the possible range of safety implications resulting from the error (Dobbs et al, 1998; Di Stefano & Macdonald, 2006). For example, Justiss and Stav (2006) and others (e.g., Dobbs et al., 1998) used a more complex rating of errors and applied heavier penalty to critical errors. It should be noted that only 17 critical errors were observed, and therefore, regardless of the weighting assigned here, its contribution to overall eDOS driving task scores in the current study was minimal. Future research will examine error weighting and implications for safety, as we will discuss.

Third, a limitation of the total eDOS driving task score is that it can be interpreted only in relative terms over time or in comparison to other drivers. It is also possible to use observations from the eDOS driving task to describe driving behaviour in terms of patterns of maneuvers made and types of errors (e.g., gap acceptance, signaling). There is an opportunity for refinement of the current scoring approach to enable determination of how much a given difference in scores matters from a safety viewpoint. Recent work by Classen et al. (Classen, Shechtman, Awadzi, Joo, & Lanford, 2010) demonstrated a hierarchy of error importance in predicting crash-related injury with the highest probability for injury associated with lane maintenance, yielding, and gap acceptance errors; moderate probability for injury associated with speed regulation; and the lowest probability for injury associated with vehicle positioning and adjustment to stimuli. Based on their findings, it will be important that further analyses be conducted to explore the potential refinement of eDOS scoring.

Conclusion

Analyses of the eDOS driving task revealed a high level of appropriate driving behaviour among this presently healthy cohort of older drivers. Participants' eDOS driving task scores were significantly related to their frequency of driving in challenging situations, their perceived driving abilities, as well as the number of driving conditions that are currently restricted. Although scores on the eDOS driving task were not related to any of the functional measures, most of the sample was not impaired.

Future analyses are planned to explore potential changes in participants' eDOS driving task scores over time, as well as to explore the relationship between eDOS driving task scores and a wider range of functional measures.

Notes

1 The eDOS driving task was completed by Ozcandrive participants from the Melbourne site (n = 257). Of the 257 Ozcandrive participants recruited, only 227 participants completed the eDOS driving task. Reasons for non-completion included withdrawal from the study prior to the eDOS driving task appointment (e.g., death, ill health, moving interstate, n = 26); did not want to complete (n = 4).

2 Note that binocular visual acuity LogMAR scores are reported in this articlemanuscript.

3 Note that one of the SDA items "First snowstorm of the season" was not relevant for Ozcandrive participants and was therefore removed for this sample.

4 Note that right-hand turns are across traffic in Australia.

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