

The Demands of Road Environments as Perceived by Vulnerable Road Users

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Abstract

This exploratory study explored the factors underlying the perceived driving difficulties of older drivers with mild cognitive impairment (MCI) in comparison with controls of similar age, using an extensive questionnaire to assess their relative importance. Each group reported distinct patterns of perceived difficulties, indicating driving situations which may warrant special attention on the part of road designers and road safety engineers. Consideration of challenging driving situations might also have a role to play in the design of fitness-to-drive assessment tools, training programs, and/or vehicle technologies for older drivers.

Keywords: older drivers; road safety; self-perceptions; cognitive impairment, driver behavior, vehicle technology.

1. Introduction

Aging normally results in a deterioration in the attributes required for safe driving, at widely differing rates between individuals, with functional deficiencies being observed most notably in drivers' vision, perception, motor skills, and cognition. For example, older drivers, in particular those over the age of seventy, face difficulties when changing lanes, merging, positioning at multi-lane intersections, and in demanding traffic situations in general. Most notably, older people are at greater risk of being involved in a collision than other drivers, owing to the functional decline arising from impaired cognition, especially when they suffer from neurological diseases such as dementia. Studies on older drivers with MCI indicate that they are more likely than cognitively normal individuals to experience difficulties with driving and avoid unfamiliar areas and busy roads. MCI individuals exhibit lower ratings on driving performance in demanding tasks such as intersection approach, time-to-collision and left turns. In terms of safety, it is imperative that drivers are able to correctly assess driving difficulty and their own capabilities. Studies suggest that cognitively impaired older drivers who do not have dementia may have considerable insight into their deficiencies, despite a non-statistically significant trend for drivers with mild cognitive impairment (MCI) to overestimate their driving abilities. As research has shown, complex driving situations must be factored into the design of interventions to promote safety and mobility for older drivers. Furthermore, road infrastructure, training and/or driving evaluation programs, and vehicle

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technologies must all be designed in such a way that they assist older drivers in situations which are (or are perceived to be) difficult.

The purpose of this study was to examine the factors underlying the perceived driving difficulties of thirty older drivers with MCI and thirty controls of similar age with no cognitive impairment.

2. Methodology

This study originated in a large-scale assessment of the driving performance of drivers with cerebral diseases using a driving simulator and an extensive questionnaire. A convenience sample of 30 drivers diagnosed with MCI was selected from the sample of the simulator experiment, along with 30 non-cognitively affected controls of similar age. To discern the perceived driving difficulties of each group, data was analyzed from a part of the questionnaire asking the respondents to report how often they encountered problems relating to functional deficits. Significant differences were revealed between the control group and the MCI group in terms of general cognitive functioning (MMSE), specific executive cognitive function impairments (FAB), verbal episodic memory (Hopkins Verbal Learning Test), information processing speed (SDMT), psychomotor speed (TMTA), mental flexibility (TMTB), working memory (LNS) and selective attention (UFV3). The difficulties perceived by the drivers are determined by such functional abilities as visuo-perceptual abilities, useful field of view, reaction time, selective attention, divided attention, sustained attention, psychomotor performance (moving head, neck and feet), knowledge (of new traffic rules and new traffic signs) and mental flexibility.

3. Analysis and Results

The MCI Group. Following principal component analysis (PCA) on nine items with oblique rotation, two factors were retained in the final analysis. The first relates to difficulties when drivers are late to detect and slow to respond to stimuli/targets in their field of peripheral vision, for example at intersections with a high volume of traffic and cluttered surroundings. The second factor represents the challenge of attention-dividing situations involving a switch between automatic and conscious tasks, especially over an extended period, for example when driving on a busy highway and having to combine maneuvering with way-finding.

The control group. Following principal component analysis (PCA) on nine items with oblique rotation, three factors were retained in the final analysis, suggesting that the driving difficulties perceived by the cognitively healthy group comprise three constructs. The first concerns difficulties in estimating the speed and distance of oncoming vehicles in complex situations where the attention is divided, for example at uncontrolled intersections where the information load from competing information sources (e.g. traffic signs and traffic control devices) is high. The other two factors relate to lesser concerns chiefly regarding slowed movements and the challenge of alternating between tasks requiring automatic and conscious processing which correlate with less frequent occurrence of delayed reactions.

4. Conclusions and Discussion

The findings revealed the demands of road environments as perceived by vulnerable road users, either cognitively normal older drivers or drivers with MCI, who may experience subtle changes in driving skills. The MCI group and the control group of similarly-aged non-cognitively impaired subjects reported distinct patterns of perceived difficulties, indicating driving situations which may warrant special attention on the part of road designers and road safety engineers. These differences have implications for the evaluation of fitness-to-drive and the training of older drivers. They might also have a role to play in the design of vehicle technologies for older drivers.

Road safety auditors may find the results of this study useful when auditing intersections, ramp terminals involving exiting and entering maneuvers, work zones and transitions between rural/high speed and urban/low speed roads. They might also prove helpful in the application of human factor principles and task analysis.

While both groups in the study experience difficulties when alternating between automatic and conscious processing, analysis of the results reveals that the specific difficulties of each group differ. For the MCI group, the challenge lies in switching between tasks when the attention is divided, while for the control group,

switching is difficult in new or unexpected situations. For the control group, performance is only affected during unfamiliar tasks with a high cognitive load, while those with MCI experience cognitive “overload” during easier tasks. The cognitively healthy controls also report that they experience difficulty when moving their hands, feet and neck. Most senior drivers understand that with age, their physical abilities change significantly, and may even compensate for this decline by using advanced vehicle technologies. These findings should be factored into the design of in-vehicle technologies specifically intended to ameliorate the perceived difficulties of older drivers, and in training in the use of these technologies.

This study is limited by the exploratory nature of the factor analysis, which may or may not be replicable. Furthermore, it is not possible to attribute the specific driving problems described in the questions to isolated/distinct functions. The results of the study do not cover self-awareness, since we have not yet analyzed to what extent perception of driving difficulties may be associated with actual functional impairments. Our future research will focus on the relationship of perceptions and performance in visual, perceptual, cognitive and motor functions.

Key Reference

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