

Special article

Neuropsychology and Driving Behaviour: Analysis of a complex correlation

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Abstract

Driving is a multimodal task that requires the integrity of executive functions in order to process simultaneously multiple environmental cues, to predict the development of traffic situations, as well as to take rapid, accurate and safe decisions. Memory plays an important role, among others, on route planning and traffic signs recognition. In addition, visuospatial skills are crucial for vehicle's road positioning along with the estimation of distances between vehicles, while attention is necessary for the accurate perception of on-road changes. The role of Neuropsychology is of critical importance for evaluating driving ability in the elderly, especially in the case of drivers with cognitive disorders, such as Mild Cognitive Impairment and Alzheimer's Dementia. Regarding the driving competence of drivers with Mild Cognitive Impairment, in the majority of cases they are considered capable of driving. Although Alzheimer's Dementia has a well-recognized and – described negative effect on driving performance, there is a subgroup of mild Alzheimer's Dementia patients who retain satisfactory driving skills. Neuropsychological assessment needs to be harmonized across different teams and countries, in order to provide a common and reliable tool in the holistic approach of cognitive impaired drivers.

Introduction

Driving is a very important function for the elderly, as it is closely related to their autonomy, their self-esteem and the overall quality of life, while loss of driving privileges may have a detrimental effect on their psychological health. Nowadays, more and more elderly are active drivers and tend to retain their driving privileges for longer periods of time, as compared to the past (Eurostat, 2014) [1].

The effect of normal aging on driving ability has been thoroughly investigated. General health problems, vision difficulties and cognitive impairment are all age-related parameters associated with a decline in driving ability. However, the percentage of older drivers at high risk for an accident remains unclear. This arises from a lack of a systematic and unanimously accepted methodology to evaluate these people's both cognitive and physical deficits.

As far as cognitive status is concerned, driving is a multimodal task that requires the integrity of executive functions in order to process simultaneously multiple environmental cues, to predict the development of traffic situations, as well as to take rapid, accurate and safe decisions. Memory plays an important role, among others, on route planning and traffic signs recognition. In addition, visuospatial skills are crucial for vehicle's road positioning along with the estimation of distances between vehicles, while attention is necessary for the accurate perception of on-road changes [2]. Under this perspective, neurodegenerative diseases which cause cognitive impairment may have a detrimental effect on driving ability [3].

Aim

The objective of this article is to present and discuss the current knowledge about the driving behaviour of patients with Alzheimer's Dementia (AD) and Mild Cognitive Impairment (MCI) and consequently their ability to drive. In addition, we present a personalized approach when taking decisions about the driving fitness of patients belonging in the above mentioned clinical

groups, emphasizing on the neuropsychological aspects of this evaluation. This personalized approach is, by definition, interdisciplinary, as it requires the collaboration of neurologists, neuropsychologists and transportation engineers.

Methods

AD: Patients with Alzheimer's dementia are 2.5 to 4.7 times more likely to get involved in a car accident than other non-demented elderly drivers of similar age. However, around 50% of AD patients continue to drive for at least three years after their initial diagnosis [4], while a cross-sectional study of a memory clinic conducted in northern Italy reported that 87% of patients with dementia were still active drivers [5]. The fact that patients with AD are more vulnerable to driving errors is well-established in the literature and has been confirmed by our findings, too.

More specifically, as on-road driving tests have shown, they make significantly more incorrect turns, get lost more often and commit at-fault safety errors.

Findings from our driving simulator experiment indicate that patients with mild AD adopt a different driving pattern (lower average speed, longer average headway), have a longer reaction time and, most importantly, have a (statistically significant) higher probability of an accident, in comparison to healthy individuals of the same aging group [6]. We have also shown that distraction while driving (in terms of mobile phone use) has a clear detrimental effect on both reaction time and accident probability among individuals with AD [7].

Nonetheless, not all patients with AD are incapable of driving, especially in the milder stages of the disease. Indicative is the study of Brown et al. (2005) [8], which observed that 76% of a group of mild AD patients were able to pass an on-road driving test.

Concerning the correlation of neuropsychological tests with the ability to drive, data are rather ambiguous. Previous research indicates that performance on tests measuring visuospatial and attentional abilities, executive functioning and possibly memory is associated with the ability to drive safely

in patients with dementia. However, other studies have failed to reproduce these results, highlighting though the importance of self-assessment along with evaluation of driving fitness by patients' informants.

MCI: The fact that MCI affects not only memory (amnestic MCI- aMCI), but also other cognitive domains (including executive functions, attention, visuospatial skills and multiple domains- mdMCI) is well-established in the literature. However, the effect of MCI on driving fitness still lacks a consensus, as evidence is relatively sparse and equivocal. Although MCI patients are at risk for presenting increased driving difficulties and tend to modify their driving habits (reducing their driving frequency and avoiding driving under difficult weather conditions), overall their performance on on-road or on simulator driving tests is not consistently worse than that of healthy individuals of the same age [9]. Our findings are consistent with the above described evidence; furthermore we have described the detrimental impact of distraction (mobile phone use) on both reaction time and accident probability among MCI patients [10]. Very recently, Hird et al. (2017) [11] have clearly shown that patients with md MCI seem to perform worse in many important driving parameters, compared to healthy controls, highlighting the significance of differentiating between different subtypes of MCI when evaluating driving competence.

Regarding neuropsychological tests that can predict driving ability in the clinical group of MCI, current research is sparse. Measures of mental flexibility, inhibitory control and visual attention, appear to be associated with driving performance in patients with MCI, but these issues need further investigation [12]. It is worth to note that depressive symptoms -even in the absence of clinical depression- have a clear negative effect on driving skills, among individuals with MCI [13]. Interestingly enough, measures of insomnia and sleepiness (as expressed through Athens Insomnia Scale and Epworth Sleeping Scale, respectively) seem to have a negative impact on various parameters of driving behaviour [14].

Conclusions

Aim of this article was to present the current knowledge about driving behaviour of patients with MCI and AD and to discuss the correlation of neuropsychological evaluation with driving performance.

Although AD has a well-recognized and -described negative effect on driving performance, there is a subgroup of mild AD patients who retain satisfactory driving skills. Hence, a diagnosis of AD should not be considered by itself as an adequate criterion for loss of driving privileges. Instead, what appears to be the best option is the adoption of a personalized and holistic approach based on the analytical evaluation of each driver with AD. In this direction, neurological and neuropsychological indexes could and should be combined with driving performance indexes (evaluated during actual or simulated road tests), in order to make well documented recommendations regarding these patients' fitness to drive.

Regarding the driving competence of drivers with MCI, in the majority of cases they are considered capable of driving. However, when a thorough and inter-disciplinary evaluation is performed, even small changes are detected: More specifically, MCI patients have the tendency of making more driving errors than their healthy counterparts, are vulnerable to on-road distraction and it seems that a portion of them (especially those with md MCI) has considerably increased driving difficulties, which may influence their ability to drive. Therefore, analytical and periodical re-evaluation of driving ability on this clinical group is suggested to be formally implemented, in order to detect small changes in driving behavior and make proper regulations on time. We should take into consideration that neuropsychiatric symptoms such as irritability, aggressiveness or depressive symptomatology and sleep abnormalities as well, may be present in up to 50% of the MCI patients and those features may have a detrimental effect on driving ability. Thus, their early recognition and treatment is of great significance, as it can elongate the continuation of driving privileges.

When evaluating driving competence of patients with neu-

rodenerative diseases (namely MCI and AD), it is very important for the patients and their relatives to participate in the decision process and the overall planning about the cessation of driving. The utility of this policy is double: not only keeps a balance between personal/public safety and self-determination, but also adds the extra aspect of self-evaluation on the holistic approach of driving competence.

To conclude with, the role of Neuropsychology is of critical importance for evaluating driving ability in the elderly, especially in the case of drivers with cognitive disorders, such as MCI and AD. However, despite necessary, neuropsychological evaluation is not sufficient alone to dictate decisions related to the critical question “continue to drive or not?”. According to our view, restriction or total loss of driving privileges can be decided only by an inter-disciplinary team that integrates the specialties of neurology, neuropsychology and transportation engineering. Such a team is able to perform analytical evaluation and assess the whole spectrum of the information provided. Towards this direction, neuropsychological assessment needs to be harmonized across different teams and countries, in order to provide a common and reliable tool in the holistic approach of cognitive impaired drivers [15]. We must not forget that periodic re-evaluations of patients’ fitness to drive are necessary, in terms of a follow-up of the temporal progression of the underlying disease.

The schematic representation of the proposed approach is illustrated in Figure 1. (Adapted from Papageorgiou et. al, 2016) [2]



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