

Senior Drivers and Involuntary Processes

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ABSTRACT

The aim of this paper is to present issues related to operating a vehicle by elderly people. The article concerns activity problems encountered by elderly people. It discusses involuntary processes in humans and the influence of ontogenetic changes on the driving abilities of senior drivers. The author shows how age-related dysfunctions can be overcome. In many cases, it is advisable to carry out simple car adjustments allowing for further safe use of the vehicles by elderly persons.

SOCIAL ASPECTS OF SENIOR DRIVERS' INDEPENDENCE

The use of motor vehicles by seniors allows them to lead active lifestyles and supports their long-term physiological independence [1]. The use of vehicles can make life more attractive and increase the effectiveness of social rehabilitation. However, the issue of road traffic safety, especially with respect to the ageing process, can have a significant impact on the perception of this problem.

The behaviour of senior drivers is discussed in many scientific papers. The topics covered are: traffic safety, accident prevention methods (e.g. courses, training and rehabilitation) and aspects of self-regulation, i.e. drivers decide themselves whether or not they are able to drive [2]. The studies also explore the technical aspects of vehicle technology and the possibility of adapting cars to the specific needs of seniors through the use of assistive technology and rehabilitation engineering [3]. Interest in this subject is due to the ever-increasing number of older people in society. The study of relationships between an older driver, a car and the surroundings provides much new data on possible directions for automotive development. Global strategies to alleviate the effects of ageing developed by the World Health Organization (WHO), the United Nations Economic Commission for Europe (UNECE) and the Organisation for Economic Co-operation and Development (OECD) support the paradigm of 'active ageing', defined as 'the process of optimising opportunities for health, participation and security in order to enhance quality of life as people age'. Active ageing can be supported by enabling seniors to drive safely in traffic.

The growing knowledge of gerontechnology, which studies relationships between rehabilitation, technology and ageing, is aimed at improving the lives and rehabilitation of seniors. Gerontechnology implies: preventing problems; increasing the ability to

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tackle problems without changing one's own skills and the environment; compensating for lost opportunities; providing only the care needed; as well as testing and modifying existing technical solutions [4].

SENIOR DRIVERS

The automobile industry has developed over more than 100 years, during which time the motor vehicle has become the basic mass medium for covering short and medium distances for most people. In 2015, there were only 1.66 inhabitants per car in Poland which is one of the most motorised countries in Europe. Nearly every adult has, or tries to obtain, permission to drive a car. Due to a rapidly ageing society, older people are now the fastest growing group of drivers, both in terms of the number of drivers and kilometres covered [5]. In Europe, between 71% and 93% of male drivers and between 7% and 46% of female drivers are aged between 65 and 74 years. It is estimated that by 2030, 25% of all drivers will be aged 65 and over [6]. More and more people support the idea of imposing driving restrictions on older people due to their health status. The decline in the psychophysical abilities of older people often the limits their ability to take part in different activities. According to the WHO, the so-called 'presenile age' begins at the age of 45. However, the onset of old age is, on average, 60 years for both men and women. People of the same age, however, may differ in principle, so there is no one model of ageing [7].

Ageing can be considered in biological, psychological, social and medical terms. It can be determined by: measuring body performance parameters; testing the viability of tissues; a sense of long-term youth or premature ageing; social affiliation with changing generations (e.g. becoming a grandmother or a grandfather); economic allocation to the group of people with retirement benefits; and limited self-reliance resulting from emerging ailments. From an older driver's point of view, not all of these factors must clearly point to the need to stop driving, or to limit the use of a car. Table 1 contains age-related changes affecting driving abilities [8].

Table 1. Ageing changes in humans.

Changes	Age	
	From 65 to 75 years old	Over 75 years old
brain	reduced intellectual ability to adapt to changes associated with neuronal death	further reduction in intellectual ability, cerebral cortical deficits from 30% to 50%, problems with concentration, memory and remembering
muscles	physical capacity reduced by 60%, decrease in the number and size of cells	account for only about 27% of body weight
skin	thermoregulation disturbances, risk of thermal shock	-
sight	hyperopia, difficulties with light-dark adaptation, risk of cataract development	-
hearing	reduced audibility of high frequency sounds, frequent hearing loss	-
posture	walking disorders in 8-19% of seniors, lower limb movement coordination, body tilting, hand tremor	tilted or hunched posture, walking pace ranging from 0.8 to 1.2 m/s, small step length – 20 cm, foot scuffing
psyche	-	major changes, mood swings, irritability, aggression, eccentricities, senile dementia after 80 years of age taking the form of Alzheimer's disease, loss of self-reliance

These involutory changes (involution—a progressive decline or degeneration of normal physiological functioning occurring as a result of the aging process) can have a significant impact on the ability of seniors to drive safely in traffic.

Human factor is the sole or partial cause of about 82-95% of road accidents [9] (65% - only human factor, 24% - human factor + road, 4.5% human factor + vehicle, 1.25% - human factor + vehicle + road) (op. cit. [10]). For example, the response time to the changing environment during driving depends on a variety of factors, including age. The response time is clearly longer in people aged over 40 and can be extended even twice in those aged over 75. The risk of car accidents caused by the increase in reaction time is clearly growing in individuals of over 60 years of age (Figure 1).

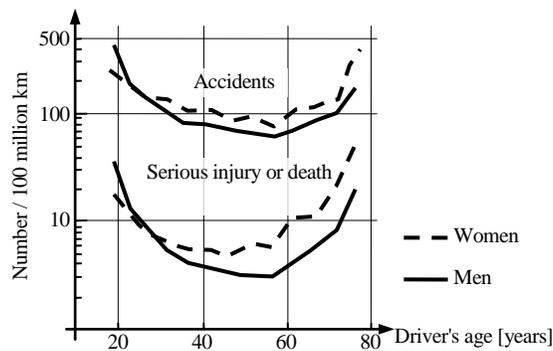


Figure 1. The number of car accidents by age in the UK in 1986 [11].

The consequences of car accidents in which older people are involved can be very serious. This is because their bodies are more susceptible to external influences and the convalescent process is longer and more difficult.

Vision is, of course, a sense vital to safe driving. Accommodation, static visual acuity and contrast sensitivity decrease in elderly people due to changes in the visual receptor system. Visual acuity decreases at dusk. At an age between 40 and 50 years, dynamic visual acuity in pursuing moving objects decreases more than static visual acuity and a sense of glare increases at the same time.

Good hearing is also required for safe driving. Seniors often find it difficult to recognise sounds, such as speech or warning signals coming from outside a moving vehicle whose interior is filled with increased noise.

Musculoskeletal diseases, reduced mobility, reduced brain response, decreased mental acuity, frequent psychological changes with a tendency to depression and impaired senses (vision, hearing and touch) significantly limit seniors' ability to perform tasks, and to operate a motor vehicle in particular. The frequent need to take medication can also affect a senior driver's behaviour.

Symptoms indicating that an elderly individual should stop driving can be grouped into three categories:

- psychophysical constraints (spatial disorientation, loss of confidence in driving, trouble turning back, difficulty in getting into and out of the car, kinematic and manual problems, distraction during driving, agitation or nervousness during driving, delayed responses)
- symptoms related to the driving process (trying to drive with brake applied, incorrect signalling, parking problems, failure to see road signs or roadside events, trouble navigating turns, failure to observe speed limits, difficulty in predicting

dangerous driving situations, difficulty in keeping driving direction, mistaking accelerator pedal for brake)

– symptoms related to the consequences of driving (hearing other drivers honk, hitting curbs, scrapes and dents on a car, getting lost on the road, driving through a red light, accidents).

The occurrence of these symptoms should initiate a self-regulatory process in drivers and can also be verified by a team of specialists (physicians, therapists, driving instructors).

THE INVOLUTIONARY PROCESS IN HUMANS

Changes in morphological, physiological and biomechanical properties are observed in humans throughout their lifetime. Muscle loss in people over 50 years of age is approximately 1-2% per year and is due to loss of both muscle fibres and muscle protein. The biggest muscle mass is found at the age of 25, amounting to about 45% of body weight. Over the age of 75, it decreases to about 27% of body weight. The muscle cross-sectional area in individuals of 70 years of age is 25-30% smaller than in young persons and is accompanied by a decrease in muscle strength of 30-40% [12]. The maximum isometric contraction of muscles is about 20% lower at the age of 60 and 50% lower over 70 years of age compared with young people. At the age of 65, muscle strength in men is about 80-90% of muscle strength of men aged 25, and 70-80% in women. On average, the muscle strength of young women is 65% of the muscle strength of men at the same age [13]. As a result of ageing, the peak performance of the respiratory system is reduced by 40%. The number of tactile receptors (known as Meissner's corpuscles) on the palm surface is reduced and accompanied by reduced sensitivity to vibration.

Due to age hyperopia, elderly individuals find it more difficult to focus on close objects. Over about 40 years of age, visual acuity, binocular vision and ocular functions begin to slowly deteriorate [14]. These changes become significantly faster over the age of 60. Colour perception deteriorates (e.g. difficulty with identifying purple and distinguishing blue from black). Typical eye diseases in seniors are cataract, glaucoma and age-related macular degeneration. Due to reduction of pupil size, the retina of a 60-year old person receives only about 40% of the same amount of available light received by a person of 20 years of age. The effect of glare lasts longer, dark adaptation is slower and the yellowing of the eye lens can lead to impaired colour vision. With age, the field of vision is reduced and there are problems with depth perception and the assessment of the position of moving objects. Accommodation significantly declines with age from 14 dioptres at the age of 10 to one dioptre at the age of 70 resulting from reduced muscle performance. There is a significant increase in lighting requirements.

The ability to filter information from the environment decreases with age. Response time is delayed in the elderly as the mean cellular conduction velocity decreases from 100% at the age of 40 to 85% at the age of over 80. Older people also find it difficult to divide attention between two tasks performed at the same time. Susceptibility to distracting stimuli increases adversely affecting the performance of various tasks. There are difficulties in retaining new information (from 1 to 2 seconds), whose registration is a prerequisite for correct response to a signal. If a task is more complex and there are more alternative responses to choose from, the response time and the time taken to make difficult decisions increase in older people compared to

younger ones. The response time is also significantly longer when an older person performs a task requiring deduction [10]. The effects of dementia-related diseases (Alzheimer's disease, Levy dementia or Parkinson's disease) are much worse. Memory deterioration and cognitive impairment lead to frustration in the elderly. Ageing causes a permanent decrease in learning abilities, especially when it comes to new tasks whose performance requires breaking old habits.

The ability to hear high tones gradually deteriorates over 40 years of age. Decreased hearing sensitivity occurs earlier in men. Speech intelligibility in older people is worse than audiometric results may suggest (phonemic regression). In older people, a gradual loss of sensitivity to high frequency sounds occurs. This phenomenon begins in individuals aged over 30 when they are unable to hear sounds above 15 kHz.

The dimensions of the human body also change. For example, women aged 19-60 years of age are on average 9 cm taller than women aged 60-96 years of age and the seating height (measured from the seat to the top of the head) of the latter decreases by more than 6 cm [15].

The ageing process and the appearance of pathological changes lead to primary involutionary disability. Ageing can also generate secondary involutionary disability, which is manifested by increased morbidity. Old age disability is primarily linked to physical and exercise constraints. Thus, musculoskeletal disorders directly translate into difficulties in maintaining balance, tactile precision and strength generated.

All of the above and other involutionary changes emerging in older people may adversely affect the behaviour of senior drivers.

COMPENSATING FOR DRIVERS' LIMITED ABILITIES WITH TECHNICAL SOLUTIONS

Contemporary technical development often does not take account of the needs of older people. Technical innovations usually ignore this target group through their complex functionality, inadequate user interface, design and marketing. Therefore, older people neglect new technologies, pointing out that they are too complex and unrelated to their basic life needs. Thus, reducing the number of available functions and increasing the usability of products is the right direction for the development of technical devices for seniors. At the same time, modern trends in the development of sophisticated technologies for seniors indicate that the elderly person's life will be easier thanks to a range of new solutions, such as: intelligent products, systems for navigating through cities, innovative hearing and visual implants and memory support products [16].

A good design solution for the elderly must take account of a certain conservatism, resulting from experience and a general understanding of new products. The lucrative car market for older consumers (the segment of expensive and luxury cars) is an example of how difficult it is to introduce changes [17].

New design solutions for safety and comfort available in many modern cars can help compensate for the age-related dysfunctions of their users. Advanced car interior solutions help reduce the annoyance caused by a loss of height, mobility problems, arthritis and other causes of pain. Significant variations in dimensions and quality classes, and a very wide range of vehicle retrofits from different manufacturers, make it easy to select a car according to the size of the human body and utility preferences.

SUMMARY

The priorities ensuring that elderly people can live a full life include:

- 1) security in the sense of meeting basic biological needs,
- 2) a lack of age discrimination,
- 3) autonomy in decision-making, privacy and living in the environment,
- 4) maintaining the meaning of life as a priority,
- 5) dignity of life.

All these expectations of seniors can be met, among other things, by enabling them to live an active life in society.

The elderly can live an active life thanks to technological solutions and in the automotive industry in particular. Naturally, among the most important issues for senior drivers are the questions of whether they can still drive a car and when to stop driving. However, there is no clear indication that people at a certain age should not drive any longer. At the same time, it can be said that modern vehicles, thanks to advanced construction solutions, largely facilitate, and even allow (autonomous cars), senior drivers to keep their old lifestyles. Every form of activity contributes to maintaining good physical and mental health over a long period of time, resulting in positive interpersonal relationships.

Regular health check-ups and developing individual skills help maintain driving abilities. The inevitable involutionary process in those who want to 'live a full life' despite old age, forces them to replace their cars with vehicles that are better suited to the needs of the elderly or to adapt the existing cars (by applying a number of retrofits to specific dysfunctions). This increases the possibility of using their vehicle. In many cases, it is enough to use simple vehicle adaptations that do not significantly increase the cost of the car.

The analysis of the safety of senior drivers does not clearly determine whether the risk of accidents increases with age. Consideration may be given to the need of introducing a national program of intervention aiming at better control of skills and aptitude to operate mechanical vehicles safely. Recent research conducted in Poland shows that the number of accidents in which drivers aged over 65 were involved is small compared to other age groups. This is because senior drivers often live conservative lifestyles, adapt driving parameters to their capabilities (choose familiar routes, take shortcuts, take more rest, rest at night and peak hours) and, above all, have more life experience and are more cautious.

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