7th INTERNATIONAL CONFERENCE
"TOWARDS A HUMANE CITY"
Environmentally Friendly Mobility
Novi Sad 6th and 7th December 2019

Medić-Peričević Sonja, MSc[1,2]
E-mail: sonja.pericevic-medic@mf.uns.ac.rs
Španović Milorad, PhD[1,2]
E-mail: milorad.spanovic@mf.uns.ac.rs
Mikov Ivan, PhD[1,3]
E-mail: ivan.mikov@mf.uns.ac.rs
[1] University of Novi Sad, Faculty of Medicine
Novi Sad, Hajduk Veljkova 3
[2] Institute of Occupational Health of Novi Sad
Novi Sad, Futoška 121
[3] Clinical Centre of Vojvodina
Novi Sad, Hajduk Veljkova 1-9

THE IMPORTANCE OF AGING AND REACITON TIMES FOR TRAFFIC SAFETY

Key Words
Professional drivers;
Reaction time;
Age;
Traffic safety

Abstract

Reaction time is very important driver's trait, especially reaction time on visual stimuli. Adequate reaction on visual stimuli is inarguably a fundamental component of safe driving because driving relies heavily on vision for its successful execution. Professional drivers are considered to be very important part of the active working population, so there is a need for continuous improvement of operating efficiency and safety in driving. To assess the effects of natural process of aging on reaction times among professional drivers and their relationship with traffic safety. Study was carried out in the Institute of Occupational Health Novi Sad, Department of Occupational Medicine, Faculty of Medicine, University Novi Sad. Participants in this study were active professional drivers with a valid driver's license. Reaction times of 278 male professional drivers were tested using a hardware-software system for determining the speed of response to psychomotor simple and complex audio-visual stimuli. Our results showed a positive correlation between ageing and speed of response. Study suggested that the natural ageing process clearly slows down reaction times which can be an important factor for traffic safety. Traffic regulatory agencies should ensure that all professional drivers undergo basic visual reaction time tests. This could serve as a very strong tool in ascertaining the eligibility of an individual for professional driving.

1. INTRODUCTION

Safety is an important consideration in many human activities, but it has particular prominent role in traffic. The primary goal of transportation, the effective movement of people and goods, becomes better by increasing speed. A substantial proportion of technological innovation has focused on increasing traffic speeds, led to the traffic crashes. Every type of traffic transportation involves some risk of material harm and more important - loss of human lives. Road safety becomes a major social concern, due to its emotional and economic impact on society. In this concern, there is the need to accurately assess the cognitive functions associated with driving safety [1]. According to the WHO in 2016 low-income countries had the highest mortality rate due to road traffic injuries. Road traffic injuries were also among the leading 10 causes of death all over the world [2]. As driving is associated with independence, it is important to understand for traffic safety what skills are required to drive safely and how to assess them. Motor vehicle accidents are inherent in traffic and usually are the result of many different reasons that occur (including human error). Driving is a complex task, requiring the concurrent execution of various cognitive, physical, sensory and psychomotor skills. During comprehensive driving evaluations, some of the measurable components of driving ability include reaction time and the ability of motor answer. Reaction time is important when perceiving and reacting to risks or unexpected situations when driving [3]. Professional driving is a predominantly male occupation. The requirements for fitness to drive are not harmonized to the full extent in the European Union [4-7].

Reaction time

How quickly a person responds to a stimulus depends on his reaction time (RT) thus it determines the alertness of a person, which is a prerequisite in certain occupations like driving. Driving requires executive functions for attention, multi-tasking, and quick reactions. A comprehensive driving ability assessment is a clinical evaluation that can performed specialist of occupational medicine, in order to assess a professional driving ability. Assessments involve assessing several dimensions of driving ability. RT is one of these dimensions and is a key component of driving ability [8] and one of the most commonly used assessments in driving evaluations [9]. The common use of RT as a component of driving assessments clearly positions RT as a widely accepted and key element of driving ability. RT is an index of the processing ability of central nervous system and is a simple mean of determining sensory-motor associations and performance of an individual. It is the measurement of a behavioural response, in time units, from the presentation of a given task to its completion. Simple reaction time (SRT) and complex reaction time (CRT) are two types of reaction times. SRT are those where subjects must respond to simple stimuli such as light or sound while CRT are those where subjects have to select a response from a set of possible responses [10]. SRT are the most common kind in driving because the stimulus is reasonably expected and the driver has already decided (and practiced) what he will do when the stimulus appears. Simple reaction time is often a matter of habit. Such reaction times normally take about 250ms to initiate action. The changing of a green traffic light to yellow in a driver's visual field and the typical driver's reaction to it would be an example of a simple reaction. A complex stimulus is a situation that requires a decision for response to multiple stimuli, such as needing to react to a specific stimulus when other visual or auditory input is being given. CRT generally calls for a choice among several possible responses. Here, the decision related to the most appropriate response has not been made in advance. Even situations involving little ultimate choice can fall into this category. Complex reactions are slower than simple reactions. How long a complex reaction takes depends on how complex the stimulus is, how many choices there are for reaction, and how often the individual has been in a similar situation. Normally, such reactions can take from 500 – 1500ms or more. SRT gives an indication of the individual's physical ability to react, while CRT is a measure of ability that is more applicable to real-life driving situations. Bilban and al found a positive correlation between age and SRT, with response time increasing significantly after 65. Drivers' reactions may differ when reacting to more complex stimuli – such as reaction on three different stimuli (red, green and yellow light). Differences in reaction times across ages were due to a decrease in processing ability attributable to age [11]. Other researchers tested SRT as measured by the amount of time it took participants to press a button in response to a visual stimulus. Findings showed a median reaction time of 236 ± 32 ms for drivers under 30 years of age, and a median RT of 262 ± 81 ms for drivers between the ages of 30 and 55. These findings indicate a difference between reaction times of young and old drivers, too [12]. Researcher in domain of driving skills (Marc Green) performed a systematic review of studies involving reaction time. Green's paper examined studies following one of three paradigms: simulator studies, controlled road studies, or naturalistic observation, that also focused on reaction times. Green's review found that older drivers tend to respond about 100 to 300 ms more slowly than younger ones. He also found that response times are the shortest when the reaction is expected and certain, with average timing across all ages being 600 to 750 ms [13]. One study found CRT to be significantly related with accident involvement for all drivers [14]. Together, these findings indicate that older drivers' longer CRT may be related to an increased risk for accident involvement.

The study described in this paper will contribute to our knowledge about driving by measuring driving reactions that involve peripheral input and measure of the physical answer in order to mirror the actions used in real-life driving situations. This study will also contribute information about the relationship between SRT and CRT as well as the effects of age on these relationships. The outcomes of this study explored the relationship between SRT and CRT of professional drivers. Results also provide information about how varies in a simple or complex situation, and with age.

2. MATERIALS AND METHODS

Participants in this study were active professional drivers with a valid driver's license. Professional drivers in Serbia have to meet health requirements. There is an obligation for professional drivers to conduct a health re-examination every third year to obtain a medical certificate for the approval and extension of a professional driver's license [15]. Health examinations were performed in Institute of Occupational Health Novi Sad, Department of Occupational Medicine, Faculty of Medicine, University of Novi Sad, Serbia. Testing was carried out in the period February 1st up to September

30th 2018. Exclusion criteria were: subjects younger than 22, older than 65 years and driving experience as professional driver less than one year. Participants included in the study gave written informed consent after comprehensive information detailing the study. Participants' information and data were collected with the use of self-structured questionnaire. The questionnaires included questions related to age and professional driver experience (in years), workplace (truck, bus, delivery van and taxi drivers) as well as the use of alcohol, medicines, the presence of head injuries and other health disorders that may affect the value of RT.

Health examination consisted of the following: health-history, work-history, access to the available medical reports: previous health examination reports and copy of the general practitioner patient's medical record, clinical examination, resting electrocardiogram, spirometry, Romberg test, audiometry, as well as laboratory analysis: sedimentation rate, complete blood count, blood glucose and urinalysis. Consultative examinations of psychologist, psychiatrist, and ophthalmologist were conducted. Determination of a simple reaction time was based on the driver's reaction to a single simple stimulus - light. Driver's reaction was to press a key at the time of the appearance of a stimulus. The research of a complex reaction consisted in a specific type of stimulus - the light colour, has been assigned with a specific manipulator on which the driver should press with a hand.

Reaction time testing was carried out using a MERREX analysis system, a hardware-software system for determining the speed of response to psychomotor simple and complex audio-visual stimuli. MERREX uses LCD colour display for performance stimuli, connected with two ergonomic handles with pressing buttons. Complex visual stimuli are representative of stimulus - the distribution of light forms on dark display in the sense of testing the colours - red, green and yellow and measuring the response time to stimuli. The occurrence of stimulus is not predictable. Response to the stimulus is manual in nature, such as pressing or releasing a button according to the changing of lights. Designed system accuracy of measuring the response time is extremely high and amounts to +/- 2ms; maximum response time is 1500 ms respondents. This delay is representative of driving situations where quick decisions are required, most being taken within 1500 ms [13,16]. The study protocol included two types of tasks. Both tasks contained 20 attempts of the response and after adequate practice of a few attempts, the tests were carried out.

<u>Task I:</u> Measuring of simple reaction time (SRT) by the occurrence of the red circle in a random sequence of appearance. SRT was represented the elapsed time of the moment of occurrence red circle to moment registered pressure-button. During the test were registered total speeds of all responses to occurrence red circle (20 independent measurements and their average value)

<u>Task II:</u> Measuring of complex reaction time (CRT) in the occurrence of three different colours (red, green or yellow circle) in random sequence and random spacing appearance. CRT was represented the elapsed time of the moment of appearance of the red, green or yellow circle to the moment registries pressure the appropriate handle-button. During the test were registered total speeds all responses to the occurrence of all colours in a random arrangement (20 independent measurements and their average value)

Under this mode of stimuli presentation, the mean value of total speed SRT, the mean value of total speed CRT was used as performance measurements. Statistical analysis was performed using statistical software STATISTICA.

3. RESULTS

A sample consisted of 278 male professional drivers. Age mean (42.36 ± 10.44), range 22 to 65 years, driving experience (12.44 ± 9.57), range 1–43 years. Workplace structure: truck 149 (53.59%), bus 26 (9.35%), delivery van 41(14.75%) and taxi drivers 62 (22.30%). Statistical data for dependent variables related to reaction time are shown in Table 1.

Table 1. Mean values and standard deviations (M±SD) for dependent variables related to reaction time

Variable	M	SD	Confidence -95.0%	Confidence 95.0%	Minimum	Maximum
Total SRT	304.28	58.49	297.38	311.19	202.65	649.40
Total CRT	656.07	131.40	640.56	671.58	404.45	1053.70

Note: Total SRT= total simple reaction time, Total CRT=total complex reaction time

In order to examine whether there exists an effect of age on dependent variables, we chose 10-year interval and categorise professional drivers into four age groups: 22-32 years with 58 (20.86%), 33-42 years with 88 (31.65%), 43-52 years with 78 (28.06%) and 53-64 years with 54 (19.42%) drivers.

Table 2 shows mean values and standard deviations for dependent variables in age group.

Table 2. Mean values and standard deviations (M±SD) for dependent variables related to reaction times in age groups

Variable	Age				
	22-32 n=58 (20.9%)	33-42 n=88 (31.6%)	43-52 n=78 (28.1%)	53-64 n=54 (19.4%)	Total N=278 (100%)
Total SRT	278.9±32.5	298.3±49.9	308.8±56.1	334.7±79.7	304.3±58.5
Total CRT	610.5±117.7	616.4±107.0	699.6±137.0	706.8±137.8	656.1±131.4

Note: Total SRT = total simple reaction time, Total CRT = total complex reaction time

Statistically significant differences between age groups for dependent variables were found and showed in figures: Total SRT, ($F(3, 274)=9.8326$, $p<0.001$), (Figure 1), Total CRT, ($F(3, 274)=11.768$, $p<0.001$), (Figure 2).

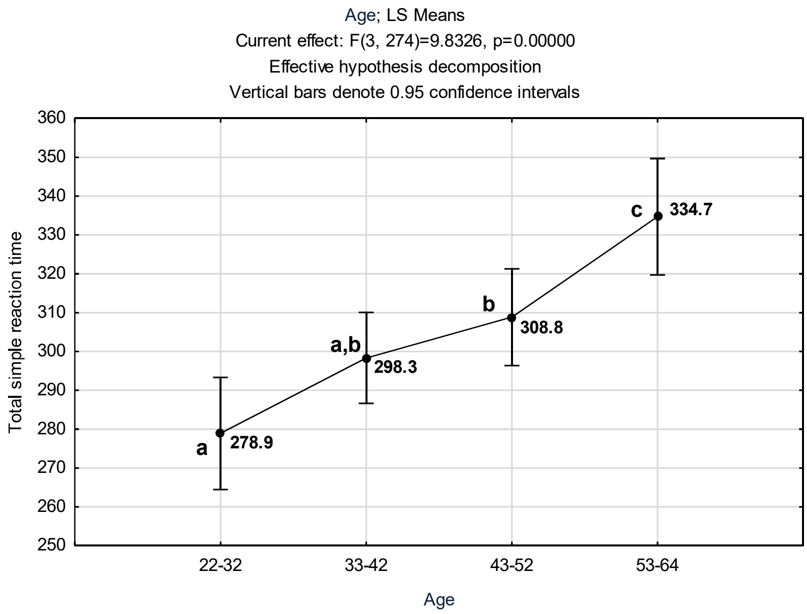

Figure1. Total simple reaction time (SRT) in age groups

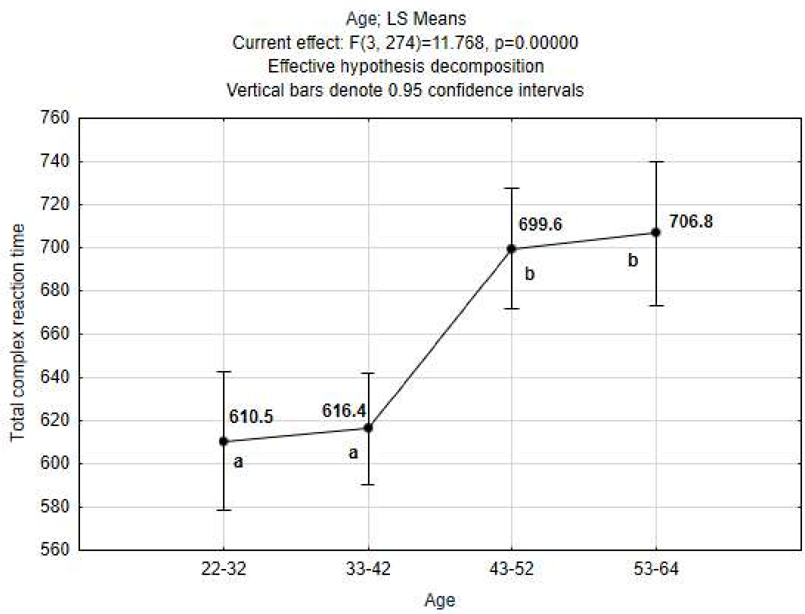

Figure 2. Total complex reaction time (CRT) in age groups

4. DISCUSSION

There are various cognitive skills that relate to the ability to drive; these include processing speed, attention and perception.

This study assesses part of driving efficiency of professional drivers by measuring SRT (one stimulus) and CRT (three stimuli) in the domain (cognitive, perceptual and motor skills) that are relevant to driving safety. The results clearly demonstrate that a correlation between age and the reaction time exists. Increased age is often related to slowed cognitive abilities, which can impair driving.

Processing speed is the cognitive ability that is most closely associated with involvement in a motor vehicle collision [17]; speed of processing slows significantly with age [18]. It has been shown to be a relevant factor impacting other cognitive abilities such as memory, reasoning and psychomotor ability; so as processing speeds slow, so do a variety of other cognitive functions. Processing speed can slow everyday functioning, and is particularly necessary for skills like driving [18]. Increased age was also found to correlate with whether drivers passed or failed; indicating that age and perception may be the best predictors of unsafe driving [19]. One study found that for drivers aged 55 and older, poor cognitive ability was predictive of future at-fault motor vehicle collisions, indicating that cognitive abilities are directly related to driving abilities [20].

Processing speed and visual attention have been shown to deteriorate with age [17,18]. Age-related cognitive deficits may be linked with deteriorating driving ability [18-22]. Few studies found that aging can be associated with delayed RTs, particularly in complex situations [8, 11,12,13, 23]. Thus, it would be reasonable to expect that older drivers would have slower RTs than younger drivers in all situations, and that older drivers' RTs will increase disproportionately (as compared with younger drivers) with increased complexity of the task.

These findings support the concept that age related changes might influence the ability to process and react to all stimuli. Depending on the value of a driver reaction time accident may depend on the extent of any fault of a driver.

5. CONCLUSION

- Our results support the concept that age related changes might influence the ability to process and react to all stimuli.
- All participants, had reaction times that increased with aging. Older drivers' increased times SRTs and CRTs than the younger, suggesting an effect of aging on processing speed of information.
- Viewed functionally, the importance of SRT is limited, as drivers rarely react with certainty to a single stimulus; however, CRT, with a reaction to multiple stimuli, is more frequently applied in daily life, and particularly, in driving.
- The findings described throughout this paper contribute to our foundational knowledge about driving skills. However, driving safety is about many psychophysical functions, not just age, and assessment of driving safety with this in mind.

- There is a need for studies that examine RT in situations that are more representative of driving. Driving simulators may be important tools in the future for both driving evaluation and intervention, it is critical to increase the use of simulation in driving research.
- For all of us as professionals in own domain, it is imperative that we recognize driving as the risky and important occupation and address it accordingly.
- And finally, the findings of this study provide information as may relate to driving assessment and further interventions.

REFERENCES

[1] P. Raina, N. Sohel, M. Oremus, H. Shannon, P. Mony, R. Kumar, et al. Assessing global risk factors for non-fatal injuries from road traffic accidents and falls in adults aged 35-70 years in 17 countries: a cross-sectional analysis of the prospective urban rural epidemiological study. *Inj Prev.,* vol. 22, pp. 92-8, 2016.

[2] World Health Organisation. Global Health Estimates 2016: Deaths by cause, age, sex, by Country and by region, 2000-2016. Geneva, Switzerland: World Health Organisation, 2018.

[3] Young K., Regan M. *Driver distraction: A review of the literature. In: Faulks M, Regan M, Stevenson J, Brown, A. Porter and Irwin J (Eds.). Distracted driving.* Sydney, NSW: Australasian College of Road Safety, 379-405. 2007.

[4] Official Journal of the European Union, Commission directive 2009/113/EC.L 223/31

[5] Council Regulation (EEC) No 3820/85 of 20 December 1985 on the harmonization of certain social legislation relating to road transport (OJ L 370, 31.12.1985, p. 1).

[6] Council Directive 76/914/EEC of 16 December 1976 on the minimum level of training for some road transport drivers (OJ L 357, 29.12.1976, p. 36).

[7] B. Fildes, J. Oxley, A. Morris, S. Helman, J. Weekly. Review of medical fitness to drive in Europe. In: N. Van Nes, C. Voegele. (eds.). *Proceedings of the 6th Humanist Conference* 2018, June 13-14, The Hague, The Netherlands. Lyon: Humanist publications, 2018: pp.1-5.

[8] A. Dickerson, T. Reistetter, M. Parnell, S. Robinson, K. Stone, et al. Standardizing the RT-2S brake reaction time tester. *Physical and Occupational Therapy in Geriatrics*., vol. 27(2), pp. 96-106, 2008.

[9] A. Dickerson., T. Reistetter., L. Trujillo. Using an IADL assessment to identify older adults who need a behind-the-wheel driving evaluation. *Journal of Applied Gerontology*., vol. 29(4), pp. 494-506, 2010.

[10] H. Baayen., P. Milin. Analyzing reaction times. *Int J Psychol.,* vol. 3, pp.1-27, 2010.

[11] M. Bilban, A. Vojvoda, J. Jerman. Age affects drivers' response times. *Coll Antropol.,* vo.33 (2), pp. 467-71, 2009.

[12] P. Philip., J. Taillard., M. Quera-Salva., B. Bioulac., T. Åkerstedt. Simple reaction time, duration of driving and sleep deprivation in young versus old automobile drivers. *J Sleep Res.,* vol. 8, pp. 9-14, 1999.
[13] M. Green. "How long does it take to stop?" Methodological analysis of driver perception-brake times. *Transportation Human Factors.,* vol, 2(3), pp. 195-216, 2000.
[14] L. Mihal., G. Barrett. Individual differences in perceptual information processing and their relation to automobile accident involvement. *J Appl Physiol.,* vol. 61(2), pp. 229-33, 1976.
[15] Pravilnik o bližim zdravstvenim uslovima koje moraju da ispunjavaju vozači određenih kategorija motornih vozila. Sl. glasnik RS, 83/2011.
[16] Lerner N.D. Brake perception-reaction times of older and younger drivers. Proceedings of the Human Factors and Ergonomics Society Annual Meeting. vol. 37, pp.206-10, 1993.
[17] K. Ball., J.D. Edwards., L.A. Ross., G. McGwin. Cognitive training decreases motor vehicle collision involvement of older drivers. *J Am Geriatr Soc.,* vol. 58(11), pp. 2107-13, 2010.
[18] D.E. Vance. Speed of processing in older adults: a cognitive overview for nursing. *J Neurosci Nurs.,* vol. 41(6), pp. 29, 2009.
[19] J.L. Mathias., L.K. Lucas.Cognitive predictors of unsafe driving in older drivers: a meta-analysis. *Int Psychogeriatr.*, vol. 21 (4), pp. 637-53, 2009.
[20] K. Ball, K. Roenker, D. Wadley, V. Edwards, J. Roth, D. McGwin, et al. Can high-risk older drivers be identified through performance-based measures in a Department of Motor Vehicles setting? *J Am Geriatr Soc.,* Vol. 54(1), pp. 77-84, 2006.
[21] B. Freund., L.A. Colgrove., D. Petrakos., R. McLeod. In my car the brake is on the right: Pedal errors among older drivers. *Accid Anal Prev.*, vol. 40 (1), pp. 403-9, 2008.
[22] M. Bedard., E. Leonard., J. McAuliffe., B. Weaver., C. Bibbons., S. Bubois. Visual attention and older drivers: The contribution of inhibition of return to safe driving. *Exp Aging Res.*, vol. 32, pp. 119-35, 2006.
[23] P.L. Martin., T. Audet., H. Corriveau., M. Hamel., M. D'Amours., C. Smeesters. Comparison between younger and older drivers of the effect of obstacle direction on the minimum obstacle distance to brake and avoid a motor vehicle accident. *Accid Anal Prev.*, vol. 42(4), pp. 1144-50, 2010.