SIMPLEX AND COMPLEX REACTION TIME OF MALE DRIVERS IN VARIOUS AGE – RESULTS OF RESEARCH WITH USE OF REFLEXOMETER

MAREK GUZEK[1]

Warsaw University of Technology

Summary

In the paper, results of some driver reaction time research are presented. In the research, typical device for psychological studies of drivers was used – so named reflexometer MCR. The reaction time of the driver, using controllers (keypads) of the panel, is assessed in response to stimuli in the form of sound and light signals. Results of measurement for above 100 drivers are presented. The surveyed group of respondents consisted of men aged from 19 up to 64. So called simple reaction as well as complex reaction is analyzed. A main criterion of analysis is driver age (age of respondents). This article presents a statistical analysis of the received results (reaction times). The results are presented in the form of histograms and statistical parameters of the distributions obtained (median, mean value, standard deviations, extreme values, and quantiles of order 0.1 and 0.9). They are presented for separate four age classes. In case of simple reaction examination, it has additionally been presented how a type of stimulus: light or sound stimuli affect the reaction time of respondents. The presented results are one of the effects of research project no N509 016 31/1251.

Keywords: driver research, driver reaction time, driver psychophysical properties

1. Introduction

Reaction time characterizes the driver in terms of taking defensive actions as early as possible in the pre-accident situation. Its value may therefore be a decisive importance in the course of a given accident situation, and thus directly affect traffic safety. Definition of that parameter is important as it is one of the decisive criteria for whether a person can become a professional driver. This parameter also plays an important role for an automotive appraiser during the reconstruction of road accidents. The age of the driver is among the many factors influencing its value. The paper focuses precisely on such dependency.

Various methods in testing practice are used to assess the reaction time. Generally, they can be divided into 4 groups:

[1] Warsaw University of Technology, Faculty of Transport, ul. Koszykowa 75, 00-662 Warsaw, Poland, e-mail: mgu@wt.pw.edu.pl, tel. +48 22 234 85 64

a. road tests on test tracks or on road sections,
b. testing (such as observation) in real traffic conditions,
c. tests in driving simulators,
d. tests using special stations for psycho-technical assess of drivers.

The first two seem to be the best, given the approximation to the natural conditions under which drivers operate. However, they are combined with big problems related to organizing this type of tests, repeatability of the measurement conditions, interpretation of results (in particular when using the observation method) and the costs of such undertakings. In this context, research testing by using car driving simulators may be much more convenient. They are accompanied, however, by other difficulties arising from the limitations of this type environments ("artificiality" of the environment), [2, 4].

Due to the availability of such devices as simulators, it is difficult to talk about the possibility of using them on a large scale, in particular during a standard assessment interview for people applying for getting a "professional" driver's license. The psychological laboratories issuing such qualifications have for many years worked out their methodology to assess the psychophysical properties of drivers or driver applicants. It consists of a set of evaluation tests assessing the person being tested in terms of a number of criteria,

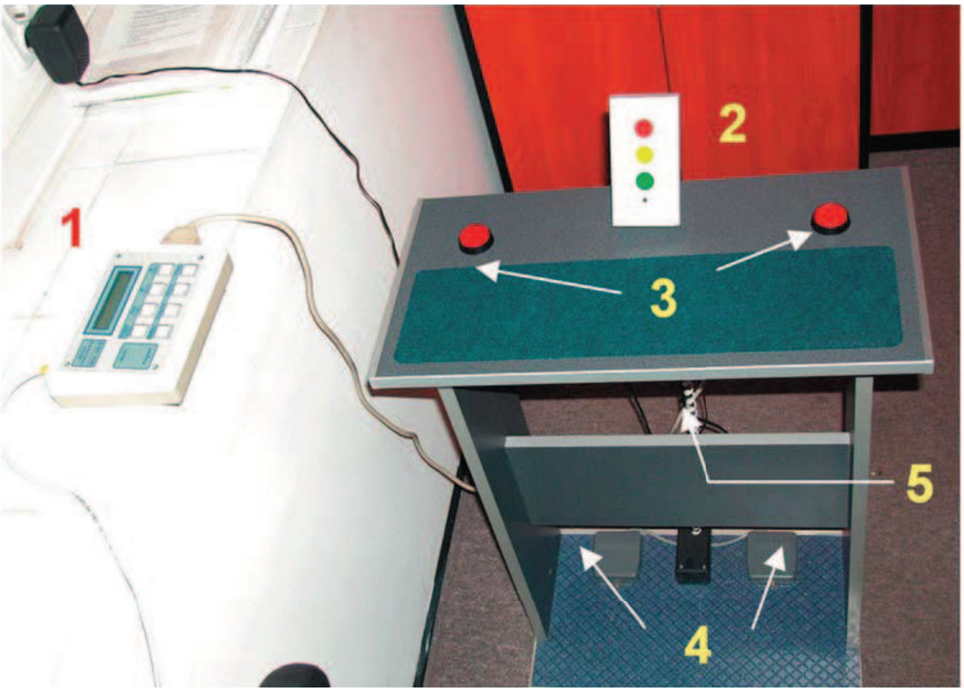

Fig. 1. Device for reaction time measurement MCR - 2001E, 1 – main unit of MCR – 2001 E – microchip meter of reaction time, 2 – semaphore (signaler - releaser of light and sound stimuli), 3 –„manual" manipulators, 4 –„leg" manipulators, 5 – connection system

using specialized equipment as well as measuring and testing stations. One of them is a test employing a so-called "reflexometer," that is, the meter to measure reaction time. The basic advantages of such reaction time assessment primarily include: the simplicity of both a measurement tool and a procedure for taking measurements (in effect of the measurement test duration) [3]. Important is a developed methodology to evaluate the results obtained. Not without significance is also the fact a longterm practice by using such devices.

2. Description of testing method & tool

Figure 1 illustrates the device that was used for testing. This system consists of a four contact-button panel (3 and 4), signaling semaphore (2), and the microchip meter (1), and the so-called connection system (5).

The task of the measurement system is to measure human reaction time to stimuli in the form of sound and light signals. The microchip time meter via the connection system enforces generation of an appropriate stimulus in the semaphore in the form of lighting up one of the three LEDs or as a beep. The semaphore consists of three LEDs in red, green, and yellow colors and a horn. The exposure time of each stimulus is 0.5 s.

The task of a person tested is to press the appropriate keypad (to switch on the right switch button) on the panel. The microchip system measures the time since the actual release of the stimulus until the switch is closed. The device can operate in the mode of measurement the so-called simple and complex reactions. In the simple reaction mode, time is measured from the occurrence of any stimulus until any reaction of the person being tested: pressing one of two manual switches or one of the two footswitches. The results further presented refer to a simple reaction in the manual mode. In the complex reaction mode, each stimulus is assigned with a relevant switch (for example, the red light –the left-hand switch, the yellow light – the right-hand switch, the green light – the right-leg switch, the beep – the left-leg switch).

Assignment of stimuli and switches is programmable. That given above is a standard scheme that has been used in the tests. In this mode, using by the person being tested a switch other than that assigned to a given stimulus is regarded as the so-called "invalid response." A number of stimuli that each of the drivers has undergone is 50, both referring to the measurement of simple and complex reactions' time.

3. A group of tested drivers

The research study involved 104 drivers aged between 20 and 64 years old. All the persons tested were male. A decision was made to divide all drivers in four age categories (class ranges, [1]). However, definitely most drivers were in the first age group. The number of drivers in individual classes and its graphical representation are given in Figure 2.

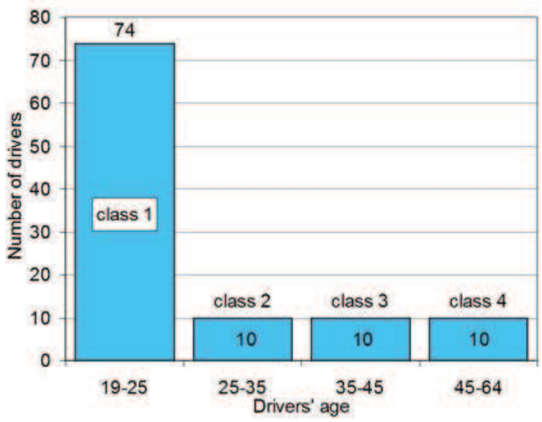

Fig. 2. Division of drivers into age classes

4. Simple reaction time

Figure 3 shows a histogram of simple reaction time obtained on the basis of all its registered values (when creating it a division was used into classes – reaction time intervals, so that it can also be used in the evaluation of a complex reaction). Table No. 1 provides basic parameters describing the results obtained. One may notice that 54% of the reaction times recorded ranges between 0.214-0.288s. The simple reaction time median is 0.245s, however, there have also been reactions more than three times longer. A positive asymmetry of results the vast majority of which is included in the first two classes is clearly visible. Asymmetrical distribution of reaction time and a considerable diversification of results (especially when it comes to the complex reaction – see section 5) suggests to use in data analysis rather positional measures, such as: quantiles or a dominant, and not the medium measurements, such as: mean, or standard deviation. Therefore, when analyzing the reaction time as a function of age, subject to analysis are the quantiles of rank: 0.1; 0.5 (median) and 0.9.

Table 1. Simple reaction – reaction time basic statistics

number of drivers	104
number of samples	5190
median	0,245s
mean value	0,260s
standard deviation	0,069s
minimum	0,142s
maximum	0,745s
quantile 0.1	0.195s
quantile 0.9	0.344s

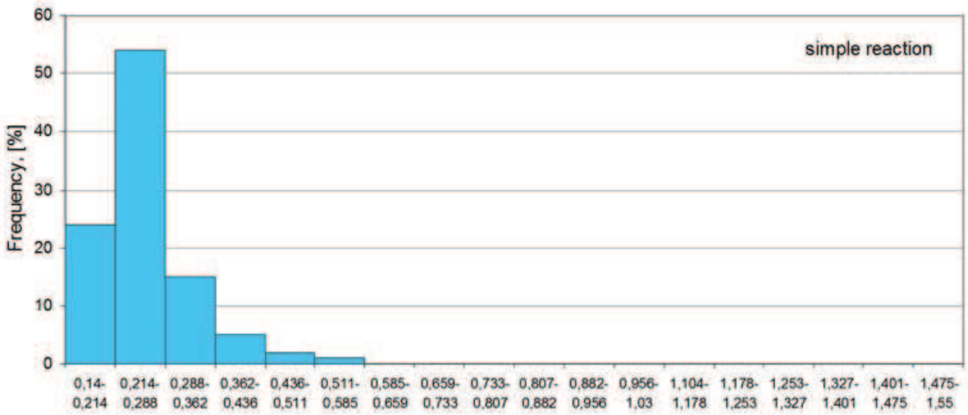

Fig. 3. Simple reaction time distribution

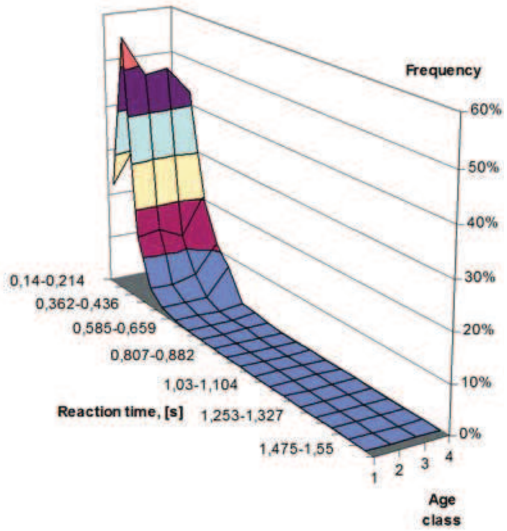

Fig. 4. Simple reaction time distributions for different class of age

Histograms obtained for individual age groups (classes 1 to 4, a description as in Tab. 1) are illustrated in one chart – Figure 4. As in the case of the simple reaction time distribution for all drivers (Fig. 3), the distributions in all individual classes – age groups, have an asymmetrical shape.

Therefore, when analyzing the reaction time as a function of age, subject to analysis are the quantiles of rank: 0.1; 0.5 (median) and 0.9. Analyzing the reaction time distribution in different age groups, we can conclude that the time interval of 0.214 - 0.288s dominates in each of them. For the youngest group of drivers (class 1), the percentage share of times included in that interval reaches almost 57% (Fig. 4). Moving to successive classes (older age groups 2 - 4), this share gradually decreases reaching the value of approximately 43% for the last fourth group.

Figure 5 shows the rank quantiles of 0.1 and 0.9, and the median of the simple reaction time for different age groups of drivers. For the first three age groups, the reaction time value is almost identical and reaches the level of about 0.24s. For the oldest group of drivers, the reaction time median value is higher than for the first three by about 11% and is at 0.272s. The difference between the median and upper quantile keeps growing along with age.

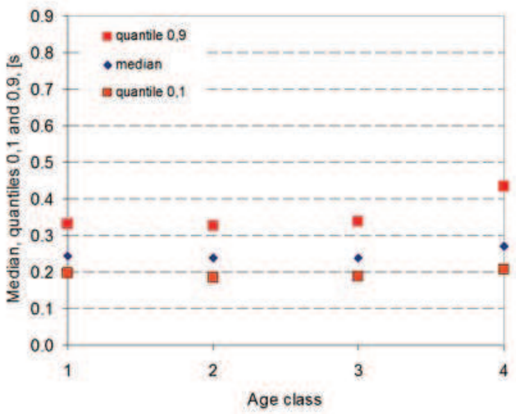

Fig. 5. Median and quantiles 0,1 and 0,9 of simple reaction time distributions for different class of age

5. Complex reaction time

Figure 6 and Table 3 presents the histogram and basic descriptive statistics related to the complex reaction. A smaller number of results as shown in Table 2 is due to the occurrence of invalid reactions which are not taken into account when analyzing the reaction time.

The resulting complex reaction time distribution, compared to the simple reaction time distribution, is more of symmetrical shape, but still there is a clear positive asymmetry. The results here are more dispersed and for the largest interval (0.436-0.511s) their count is simply over 20%. This value is nearly three times lower compared to the count of the simple reaction dominating time interval. There are non-zero intervals with time above 1 second, but their count is less than 0.1%.

Table 2. Complex reaction – reaction time basic statistics

number of drivers	104
number of samples	4669
Median	0,514s
mean value	0,540s

Table 2. Complex reaction – reaction time basic statistics, cont.

standard deviation	0,174s
Minimum	0,214s
Maximum	1,541s
quantile 0,1	0,343s
quantile 0,9	0,755s

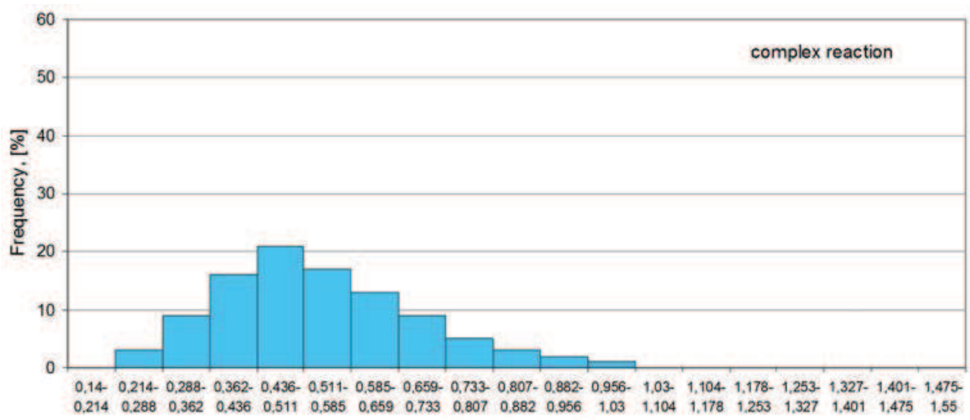

Fig. 6. Complex reaction time distribution

Analyzing the time distribution of the complex reaction in different age classes, one may say that distributions are quite similar to each other for the first three intervals.

For each of those three cases, the largest number of results that is 22% is included in the interval of 0.436-0.511 seconds. For the last class – the oldest age group, there is a "shift" of histograms towards longer times. Histograms for individual classes are shown in a single chart – Figure 7.

Similarly as in the case of simple reaction, the median value for the first three groups of drivers is constant at 0.5s (Fig. 8). This value is more than twice as long as compared to the simple reaction. For the last oldest age group, the reaction time value is at 0.637s, and therefore it is by ca. 27% higher than the reaction time values for 1-3 classes.

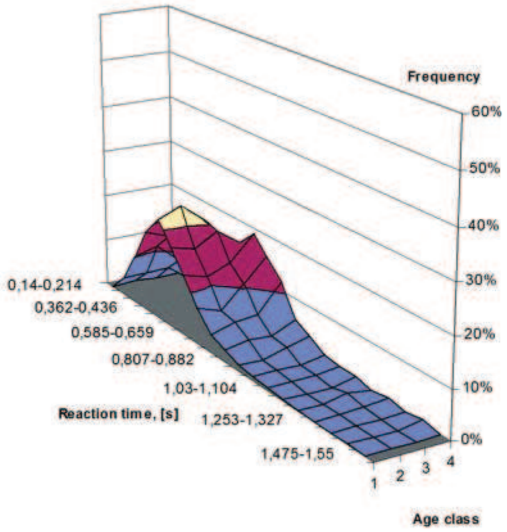

Fig. 7. Complex reaction time distributions for different class of age

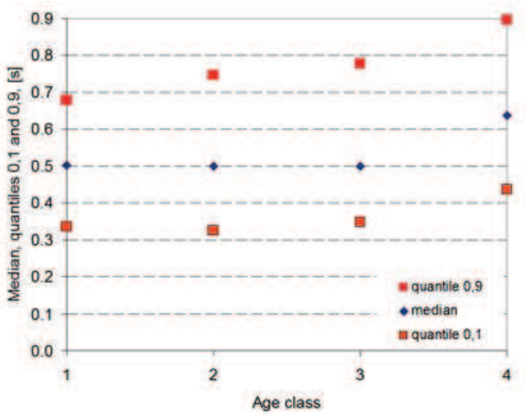

Fig. 8. Median and quantiles 0.1 and 0.9 of complex reaction time distributions for different class of age

6. Kind of stimulus influence

With measurements taken at diversified (light, sound) stimuli, a comparison has been made of the values obtained in reaction times, depending on their types. In order to reduce the number of influencing factors, the presentation has been limited only to research results of the simple reaction. Figure 9 summarizes the medians of simple reaction times for sound and light stimuli (regardless of the color of light). The same qualitative result was obtained for the entire tested population, as well, for different age categories: the reaction time to the sound stimulus is higher than to the light stimulus (by ca. 24% on average compared to the light stimulus). A significant effect of age is not apparent here, but for the group of younger drivers (classes 1 and 2), the differences are somewhat smaller than for the groups of older drivers (classes 3 and 4).

Analogically, the reaction times for different light stimuli have been compared with each other. Figure 10 summarizes the medians of the simple reaction time to light stimuli of red, yellow, and green colors. This study indicates that the drivers tested reacted the fastest to igniting yellow color "light" (the average median is lower by ca. 4-6 %). The values achieved with the red and green signals are similar to each other. The factor affecting the presented values is the luminance of the light signals emitted. The results described refer to each of the driver populations discussed hereto.

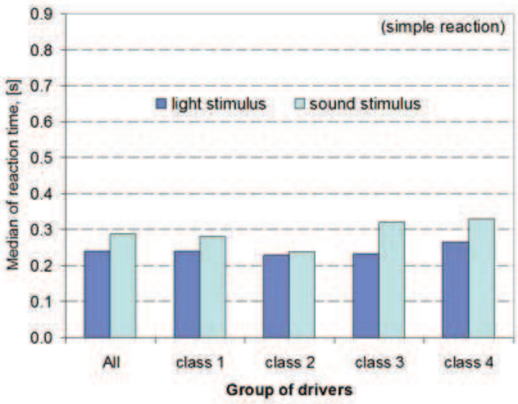

Fig. 9. Median of simple reaction time distributions for sound and light stimulus

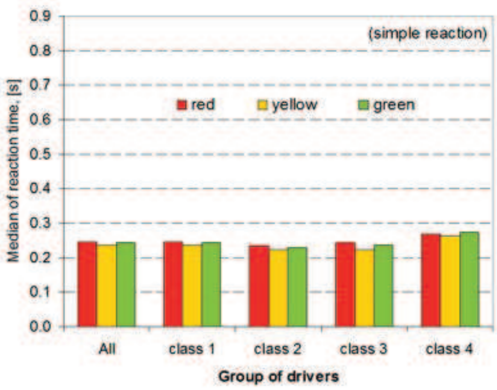

Fig. 10. Median of simple reaction time distributions for different light stimulus

7. Conclusion

This paper has shown that the distribution of both simple reaction time and that of the complex one is asymmetric (positive asymmetry). Therefore, quantiles have been used during data analysis. The simple reaction time is characterized by a clear dominance of the times in the interval of 0.214 - 0.288 seconds. Almost 60% of the results obtained is included in this interval. In the case of the complex reaction, the results are distributed more evenly. There is a clearly visible difference between the two research studies. Having introduced the need to analyze the occurring situation and make the right decisions caused not only an increase in reaction time, but also a greater diversity of results for the same group of drivers. The dominant interval of 0.436-0.511 seconds embraces slightly over 20% of the reported cases.

This paper shows that the values of reaction time for the groups between 20-45 years of age (groups 1-3) are very similar. This applies both to the simple reaction time and that of the complex one. Only for the last fourth – the oldest group of drivers (45-64 years) – there is an increase in reaction time compared to other age groups. In the case of the simple reaction time, this increase is about 11%. In the case of the complex reaction, this difference is more transparent and is at the level of about 27%.

Also, the differences occurring in the reaction time, depending on the nature of the stimulus, have been indicated. On average, drivers have reacted faster to light signals than to sounds. There have also been some differences recorded in the reaction time for the light signals of different colors, but here results could have been affected by a luminance value of individual stimuli, and not just by their color.

In conclusion, it should be noted that the hereto presented results provide valuable data on the psycho-physical properties of drivers (reaction time, age impact), however, the reaction time values as presented cannot be directly transferred to an analysis of the actual car accident situations in road traffic. They have been obtained in the lab conditions that are far away from the actual road traffic.

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