CHANGE OF DRIVER'S REACTION TIME DEPENDING ON THE AMOUNT OF ALCOHOL CONSUMED BY THE DRIVER – THE CASE STUDY

JAN VRABEL[1], BRANISLAV SARKAN[2], AMIT VASHISTH[3]

Abstract

Each driver should drive according to the actual road traffic rules of the country in which he is currently located. The law systems of various states of Europe allow an increased maximal blood alcohol level of driver. As the fact that no small number of road accidents is caused because of the influence of alcohol on the driver, it is necessary to focus the attention of the society on this issue. The paper deals with the influence of alcohol on the reaction time of the driver. The effect of alcohol on driver behaviour has been studied. The reaction time of several drivers from a selected group of people was measured. At first (before alcohol drinking) the physical and mental condition of the drivers was assessed, using a series of question. Subsequently, the measurements were carried out with a sober driver. After this initial measurement the driver began to drink alcohol and after 20 minutes the level of alcohol in driver´s breath was determined by certificated equipment. It followed by starting the vehicle at a speed of approximately 50 km/h and stopping the vehicle in front of the simulated barrier. During the tests of the stopping distance, the mean fully developed deceleration was explored as the supporting variables. As the most important variable was the driver´s reaction time. It was researched by using of the video-analysing from two synchronized cameras. One camera was placed on the windscreen to monitor the situation in front of the vehicle, the other one monitored the movement of the driver´s feet. The aim of this paper is to focus on the fact that there is a dependence between the amount of consumed alcohol and the driver´s reaction time, which significantly affects the road safety. The reaction time of the driver directly influences to the stopping distance thus it is resolute for stopping the vehicle before a barrier.

Keywords: Alcohol consumption; Driver´s reaction time; Stopping distance; Driver´s attention

1. Introduction

There is a growing trend in the number of registered motor vehicles on the territory of the Slovak Republic. Despite of this fact there is the constant effort to reduce the number

[1] University of Zilina, Faculty of Operation and Economics of Transport and Communications, Department of Road and Urban Transport, Univerzitna 1 010 26 Zilina, Slovakia. e-mail: jan.vrabel@fpedas.uniza.sk

[2] University of Zilina, Faculty of Operation and Economics of Transport and Communications, Department of Road and Urban Transport, Univerzitna 1 010 26 Zilina, Slovakia. e-mail: branislav.sarkan@fpedas.uniza.sk

[3] Project Engineer, South Delhi Municipal Corporation, Civic Centre, Minto Road, New Delhi – 100 002, India, e-mail: amitrajsharma22@gmail.com

of accidents, especially accidents resulting in death or serious injury. Many of these road accidents are caused by the fact that the driver consumed alcohol before driving. These accidents occur even though there is no tolerance in the territory of the Slovak Republic, so it is only possible to drive with zero alcohol in the driver's breath. Many scientists are concerned with reaction time. For example, in publication [21] deals with an analysis of drivers´ stress reaction time. Results from this study show that the best fitting relationship between driver's reaction perception time and vehicle speed meets exponential distribution. From the perspective of traffic engineering, other scientists have focused on the driver's reaction time [13]. They elaborated "study on drivers´ perception-reaction times against different types of traffic signals". This publication delivers the differences in drivers' response times reflected by different types of signals and their causes. Similarly, the research of reaction time in the publication [4] is described, where the characterization of the driver perception reaction time is shown on the yellow indication. This publication describes the impact of driver gender, driver age, roadway grade, mean approach speed, platooning scenarios (leading, following, or alone), and time-to-intersection on the driver perception-reaction time. The very problem of "test methods and reaction time of drivers" is dealt with by the authors in [10]. This publication includes the results of the reaction time measurement set in the three test environments: on a test track, in a driving simulator and on the psychological aptitude test stand. The authors obtained reaction time values, they compared it and at the end of research they determined the correlation between the data. When analyzing the available sources, the reaction time issue is addressed by quite many of scientists from different parts of the world [15, 12, 16]. Nevertheless, the availability of scientific publications on the impact of alcohol on driver reaction time is largely limited [24, 14]. However, since many drivers who cause a traffic accident are found to have alcohol in their breath and/or blood, we consider it necessary to conduct a scientific study of this type. The research carried out on the closed section of the road, excluding other road users, was carried with a passenger car at a speed of approximately 50 km/h. Upon reaching this speed and seeing the reason for stopping the vehicle (simulated road traffic obstruction), the monitored driver should stop the vehicle as soon as possible [1, 5]. The reason for stopping the vehicle was to turn on the high beams of another car standing opposite the examined vehicle.

2. Alcohol and its effect on the accident rate in the Slovak Republic

In 2019, there were 13 715 traffic accidents. Altogether 245 people were killed in traffic accidents. The number of road traffic accidents caused by alcohol was 1 564. The overview of road accidents and their consequences for the last 10 years as well as more detailed information for Slovak Republic is given in Table 1.

Tab. 1. Number of accidents in the Slovak Republic for the last 10 years [15]

Year	Number of accidents	Number of easily injured	Number of seriously injured	Number of killed people	Number of traffic accidents caused by drunken driving
2010	21 611	6 943	1 207	345	2 126
2011	15 001	5 889	1 168	324	1 903
2012	13 945	5 322	1 100	296	1 743
2013	13 586	5 225	1 086	223	1 696
2014	13 307	5 519	1 098	259	1 629
2015	13 547	5 628	1 121	274	1 518
2016	13 522	5 884	1 057	242	1 501
2017	14 013	5 750	1 108	250	1 585
2018	13 902	5 643	1 272	229	1 656
2019	13 715	5 507	1 034	245	1 564

The number of all traffic accidents and accidents caused by drunken driving is shown in Figure 1. As can be seen in this figure, with decreasing numbers of accidents in the last 10 years, there is also a reduced number of road accidents caused by drivers with alcohol in their breath [3].

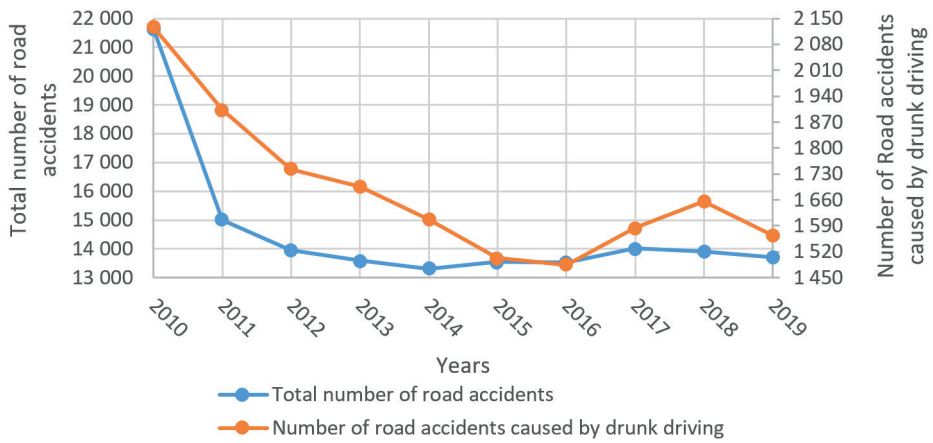

Fig. 1. Graphical representation of the number of accidents and road accidents to alcohol [authors]

3. Influence of alcohol on visual sense of drivers

When the driver drinks, alcohol causes different changes in human body. Loss of driver´s body control and vision are dangerous. These defects are called "tunnel effect", which you can see on Figure 2 [7, 8].

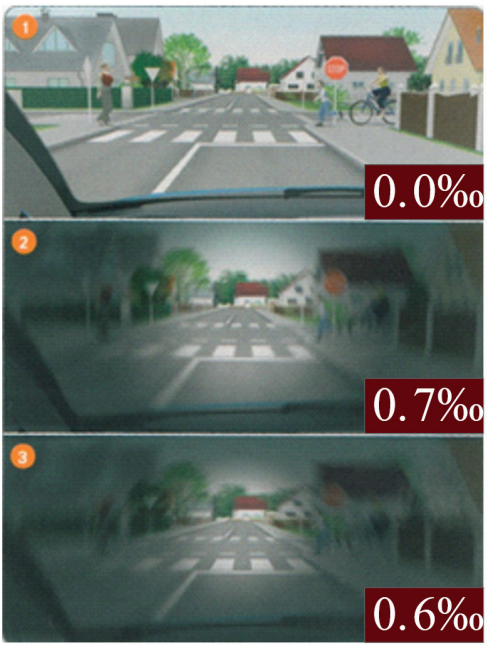

Fig. 2. Tunnel vision, depending on the measured quantity of alcohol in the driver's body

Worse driver´s vision from the car has these effects:

- reducing the ability to recognize or fully see a barrier near the vehicle,
- reducing vision of the red color (etc. brake lights, red light on traffic lights) the driver is seen orange or yellow and not red color [11, 6],
- decrease of peripheral vision and orientation,
- increase self-confidence,
- willingness to take risks (increased aggression),
- decrease of the flexibility of driver´s eyes for changes in light intensity [20, 22, 23],
- disruption of motor functions of the body (problems while driving vehicle, problems with changing gears, mistakes in the controlling pedals, etc.),
- decrease of auditory perception.

Several effects mentioned above were demonstrated during performed tests [17].

4. Analysis and results of measurements of the driver's reaction time

Measurements were made with a vehicle owned by a driving school, which had an auxiliary pedal. For driver´s safety, the driving school instructor sat beside them, in case the driver doesn´t respond to the barrier and doesn´t stop the vehicle [19, 2].

Base information about measurements:

- 5 people took part in the measurements (3 adult men, 2 adult women),
- each had a driving license and practice in driving vehicle,
- nobody drunk alcohol before measuring,
- the measurement was made on the driving school vehicle with auxiliary pedals,
- the measurement was made by two cameras, which were installed inside the vehicle. The first camera recorded the situation in front of the vehicle. The second one recorded the reaction of the driver's feet on impulse to stop vehicle (it can be seen in Figure 3),
- the drivers drank 0.04 liter of alcohol (alcohol content 37.5%),
- measurement conditions: sunny weather all time with dry roads,
- the vehicle´s speed was approximately 50 km/h while the second vehicle stayed on opposite side. This vehicle lighted up distance light [9, 18].

Each driver had made 11 measurements on the vehicle when drivers drank alcoholic drink.

Fig. 3. Data from two cameras installed inside the vehicle [authors]

Evaluation of the obtained video from both synchronized cameras was performed by computer video analysis. Video analyzing start was performed by video playing from camera no. 1 (Figure 3 - left) as well as video playing from camera no. 2 (Figure 3 - right) at the same time. Although the left camera resolution from the Figure 3 is low, it is sufficient for the purposes of the research. It was necessary to reach an information about the exact time of opposite standing vehicle headlight illumination as the start of driver´s reaction time. The sampling rate of the cameras was set to 25 fps. After the lights came on, the driver's

reaction time began. The end of the driver´s reaction time was reached by pressing the brake pedal with the driver's foot (camera no. 2).

Dependence between the measured amount of alcohol in the breath of the driver and his reaction time is shown in Figures 4 to 8.

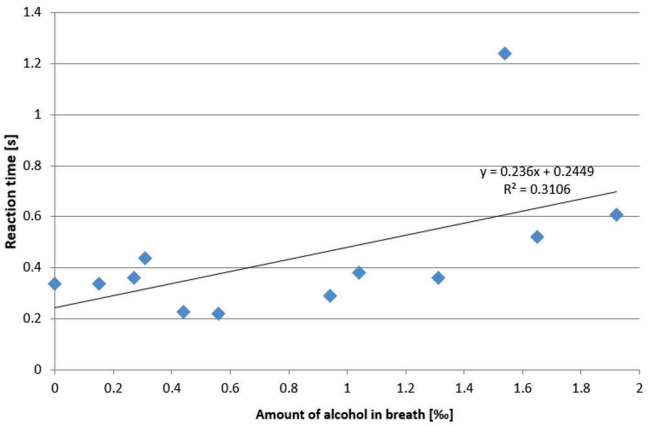

Fig. 4. Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the first driver

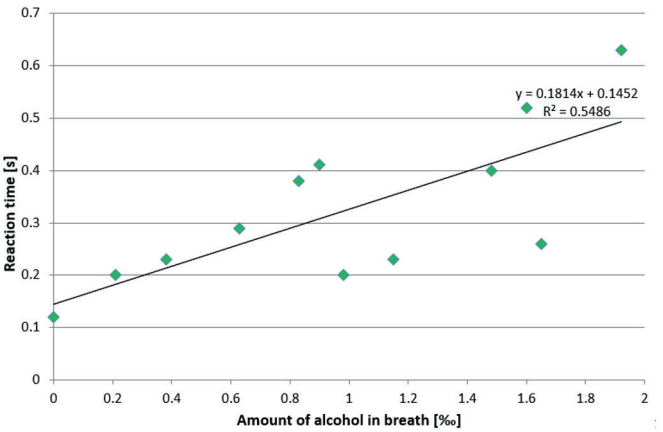

Fig. 5. Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the second driver

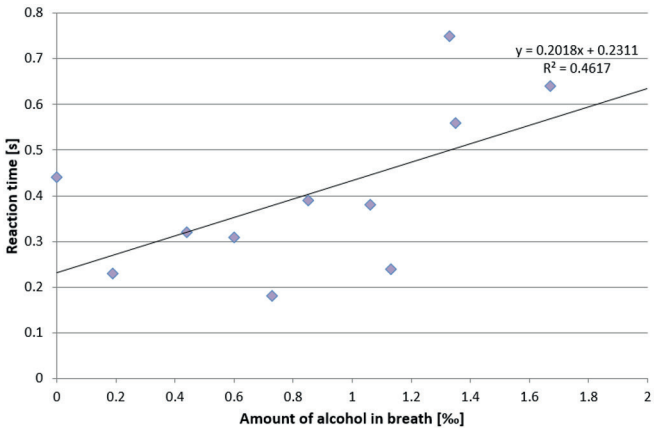

Fig. 6. Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the third driver

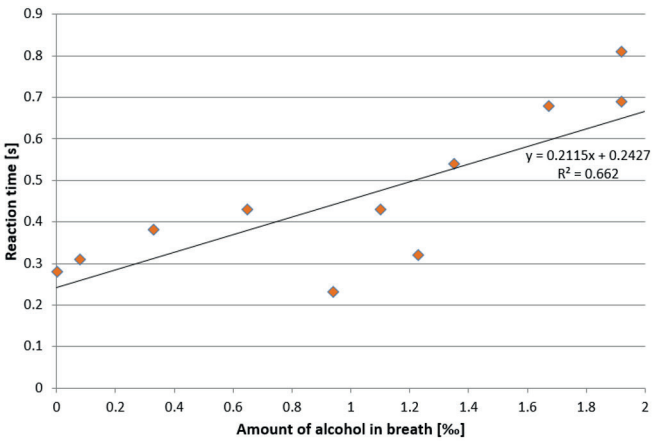

Fig. 7. Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the fourth driver

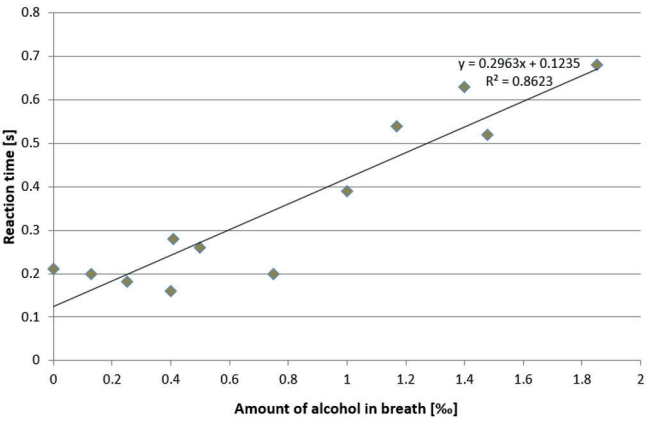

Fig. 8. Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the fifth driver

Tab. 2. Amount of consumed Alcohol by individual driver and statistical values

	Driver 1	Driver 2	Driver 3	Driver 4	Driver 5
Amount of consumed glasses of 40% alcohol [0,04 l]	11 x	11 x	10 x	10 x	11 x
Total number of Measurements (incl. measuring with sober driver)	12	12	11	11	12
Trend equation	y =0.236x +0.2449	y =0.1814x +0.1452	y =0.2018x +0.2311	y =0.2115x +0.2427	y =0.2963x +0.8623
R^2 coefficient	0.3106	0.5486	0.4617	0.662	0.8623

The Figures 4-8 and Table 2 shows the increase in reaction time of each driver due to the increasing amount of alcohol in the driver's breath. It is possible to read from the figures a common basis, which shows a double increase in reaction time already at the value of approximately 1.5‰ of alcohol in the driver's breath. It should be noted that all drivers were expecting an incentive to respond to. However, there is an increase in reaction times for all drivers.

5. Conclusions

As written in the theoretical part of the paper, a drunk driver has a reduced ability to spot an obstacle due to the so-called tunnel vision effect. Thus, they lose peripheral vision capability, which can lead to an inability to respond to a moving obstacle. However, when driving in the vehicle, all surrounding objects are moving relative to the vehicle.

The reaction time of each driver was monitored by measuring the time from two synchronized cameras. The driver should stop the vehicle (thus should react) to the stimulus (simulated barrier), which was lighting up the high beams of the opposite standing vehicle.

All drivers were to respond to a stimulus coming directly from the centre of their tunnel vision. Thus, the reaction time measurement results assume that even in a real-life operation of a vehicle in road traffic, an obstacle in road traffic would be directly in front of the vehicle. However, this assumption is not always true.

This implies that several other measurements need to be made based on a similar principle, but the incentive to stop the vehicle could also be out of central vision (i.e. vehicles simulating road traffic obstruction would consist of multiple vehicles and one of these would light up the high beam lights).

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