Human Factors and Systems Interaction, Vol. 52, 2022, 249–255
https://doi.org/10.54941/ahfe1002162

An Exploration Into the Dependency of Speed and Distraction of Vehicle Drivers on a Handling Course at Bosch Boxberg Proving Ground

Sumona Sen[1], Sarah Kunz[2], Tobias Rusch[3], and Hans-Juergen Buxbaum[1]

[1]Niederrhein University of Applied Sciences, 47805 Krefeld, Germany
[2]Robert Bosch GmbH, Proving Ground Boxberg, 97944 Boxberg, Germany
[3]IFAA Institute for Applied Industrial Engineering and Ergonomics, 40474 Düsseldorf, Germany

ABSTRACT

The effects of driver distraction play a major role in road safety. In order to investigate this further, this paper aims to answer the question of the extent to which distraction at a run-off area of a Handling Course at the Bosch Boxberg Proving Ground has an effect on the speed of drivers and increases the risk of accidents. For this purpose, the behaviour of 30 probands is recorded and evaluated in a case-control study using the measurement methods eyetracking, velocimetry and questionnaire.

Keywords: Human behavior, Distraction, Accident risk

INTRODUCTION

Many drivers are aware of the dangers of excessive speed and numerous studies underline the increased risk of accidents caused by this (see Wong et al. 2005; Goodwin et al. 2006; Aarts & vanSchagen 2006; Aarts et al., 2011). Leaving aside characteristics like given speed limitations in normal road traffic e.g., a large number of other variables can be found in the literature that influence the choice of speed. For example, the attitude of the driver plays an important role (dePelsmacker & Janssens 2007), as do personality traits (Goldenbeld & vanSchagen 2007) or perceived task difficulty (Fuller 2000, 2005). In other studies, characteristics of the driving environment, such as vegetation or road width (Aarts et al. 2011) or even the height of buildings at the roadside (Elliot et al. 2003) or lane markings (Horberry et al. 2006) are leading factors. Integrating theoretical models attempt to bridge the incompatibility of parts of the listed influencing factors on the choice of speed by grouping the different influencing factors into categories (Brandenburg 2014). For the driver, driving a vehicle is a complex activity. In addition to physical abilities, cognitive and perceptive abilities also play a major role. External distractions, in particular, have a significant influence on the driver, and their individual effects on the individual driver are subjective and therefore difficult to determine (Kreußlein et al. 2020). Thus, the constant

Figure 1: Bosch Boxberg Proving Ground in Boxberg germanny.

control of their vehicle becomes an obligation for drivers to be constantly attentive, ready to react, careful and foresighted. This obligation is concretized in the exemplarily formulated subsequent sentences of the German Road Traffic Act, according to which the driving speed is to be adapted especially to the personal abilities. Drivers who are distracted from their driving tasks are subject to significantly reduced personal abilities during distraction phases and must therefore reduce their speed on a mandatory basis due to this regulation (Müller 2017). While distraction can generally be considered as the orientation of attention away from the driving task, it is still unclear whether distraction can be described as part of inattention (Hackenfort 2012), so this aspect is being further investigated in current studies.

This study, in cooperation with the Bosch company, focusses at how a distraction on a Handling Course track affects the speed of the drivers at a Proving Ground. The cornerstone for the founding of the proving ground was laid in the development of systems for active safety which aids the stabilizing of vehicles leading to the avoidance of accidents. The focus of this study is a handling course, for tests in dynamic situations.

Bosch Boxberg Proving Ground

The Bosch Proving Ground Boxberg is located 90 km north-east of Stuttgart, Germany and provides different test modules for vehicle and system testing on a total area of 94 hectare. The main purpose of the Proving Ground is to ensure safe testing conditions for applications that are not yet approved for public roads. Vehicles can be tested in many different situations, like for example low friction areas, off-road-tracks or dynamic areas. Besides internal utilization, the Proving Ground is open for other companies of the automotive industry. With over 20 different modules, the Proving Ground offers ideal conditions for all customers and all kinds of vehicles. To ensure safe testing, numerous measures were implemented. Besides personal and organizational measures, also technical measures like the installation of FIA and FIM homologated safety installations, like for example guard rails or energy absorber mats were taken. The whole area is pictured in Figure 1.

The focus of this study is the Handling Course, where the vehicle's handling can be tested in extreme dynamic situations in higher-speed driving. The module is used by all kind of vehicles. Due to the high utilization of motorbikes, Bosch decided to upgrade the existing energy absorber in front of the guardrails and tyre stacks to FIM-certified energy absorber mats. These energy absorber mats are also being used for racetracks and for example Moto GP events. As the companys' brand color is red, the energy absorber mats were chosen in the colors red and grey, which is also considered as an often-used color in terms of safety installations.

OBJECTIVES

In the regular course scenario at the Handling Course described above, energy absorber mats have been installed for safety reasons. During an exchanging phase, the energy absorber mats where temporarily deinstalled, but the track was still open for passenger cars. Within that timeframe, three similar accidents happened in the same area. Except of the missing energy absorber mats there were no differences on the module or any other reason that could explain a higher accident rate. It is assumed, that the energy absorber mats' absence may have had an influence on the speed and the behavior of the drivers.

The proof, that the color of the energy absorbers mats or their absence has got an influence on the driving behavior, especially in terms of speed and distraction, could play an important role when deciding over further preventional measures focusing on design of the Course and safety installations. The following research questions are raised on the basis of these aspects.

1. Do the energy absorber mats have an influence on the occurrence of accidents?
2. Do the absence of the energy absorber mats distract the driver while driving?
3. Do the absence of the energy absorber mats has an influence on the speed driven in this area?

In order to answer these research questions, the following hypotheses need to be investigated:

H1: The energy absorber mats help to focus the driver's attention.

H2: The driver is consciously aware of the energy absorber mats.

H3: The speed in this area is higher in the absence of the energy absorber mats.

H4: There is a difference in the driving speed between drivers who fixate the energy absorber mats and those who do not register them.

METHODS

Sample

The experiment is carried out with 30 probands, 27 men and 3 women. The probands are aged between 25 and 50. Most of them are application engineers. They are divided into two experimental groups, both groups with a

balanced number of 15 each. For the first group the energy absorber mats are not present, for the second experimental group the energy absorber mats are present. A case-control study is developed as study design so the effects can be revealed by comparison. In order to avoid bias, such as selection effects or similar, the group allocation of the drivers is randomised. Furthermore, it was not mentioned what the exact goal of the study is. It was briefly explained to each proband that this was an investigation regarding safety on the track. They should drive quickly, not in the sense of the best lap time, but as far as the feeling of safety allows the driven speed.

Experimental Design

The experiment thus consists of two different groups (15 probands per group) who each drive the route individually; group 1 with absence of the energy absorber mats; group 2 with the energy absorber mats. The car is equipped with a velocity tracking, so that the speed is recorded at any time. During the drive, each proband in both groups wears eyetracking glasses with a recorder. The tracked data is synchronized with GPS and time stamp. Each proband drives two rounds. Before completing the rounds, each proband receives a safety briefing for the course. As already been mentioned, it was very important not to create a racing character. At the end of each run, a questionnaire is given to each proband. Subjective opinions are asked there.

Measures

Eyetracking

The nowadays most used capturing and recording of eye movements is called eyetracking. Physiology connects the eye with attention, as it serves to absorb information. According to Just and Carpenter (1980), the viewing duration of objects is closely related to their cognitive processing (eye-mind hypothesis). Furthermore, it is stated that the processing of visual stimuli in the brain takes place immediately after the reception of the visual stimulus and is not delayed. This describes the theoretical background of the connection between attention and eye movements (Strohmaier 2014). The possibility of a time stamp allows the eyetracking data to be synchronized with the residual measurements.

Questionnaire

A specially designed questionnaire was developed for the study. It covers the most important aspects related to the remarkability of the energy absorber mats, the speed, self-perceived exertion and distraction and the own driving experience.

Velocimetry

For accurate measurement of speed in the experiment, a V-Box is installed in the car used. The V-Box makes it possible to determine the speed at any point along the route with a precise time stamp and GPS data.

Table 1 illustrates the different types of measurements and how they relate to the hypotheses stated.

Table 1. Types of measurement and relation to the hypotheses.

Eyetracking	H1, H2, H4
Velocimetry	H3, H4
Questionnaire	H1, H2

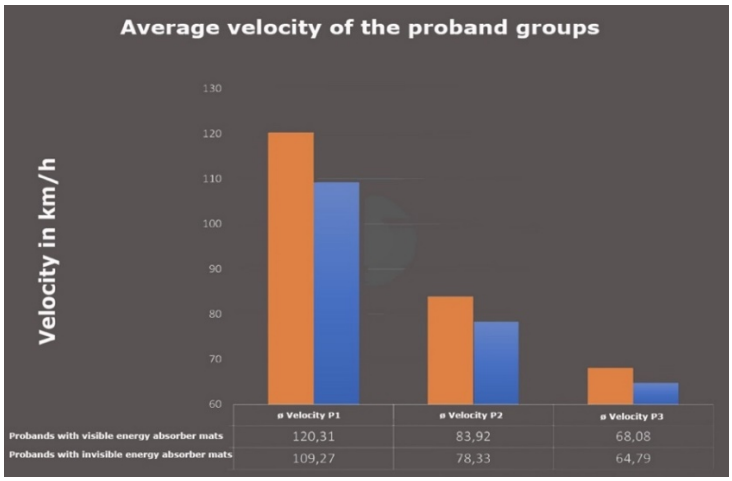

Figure 2: Average velocity of the proband groups at three points.

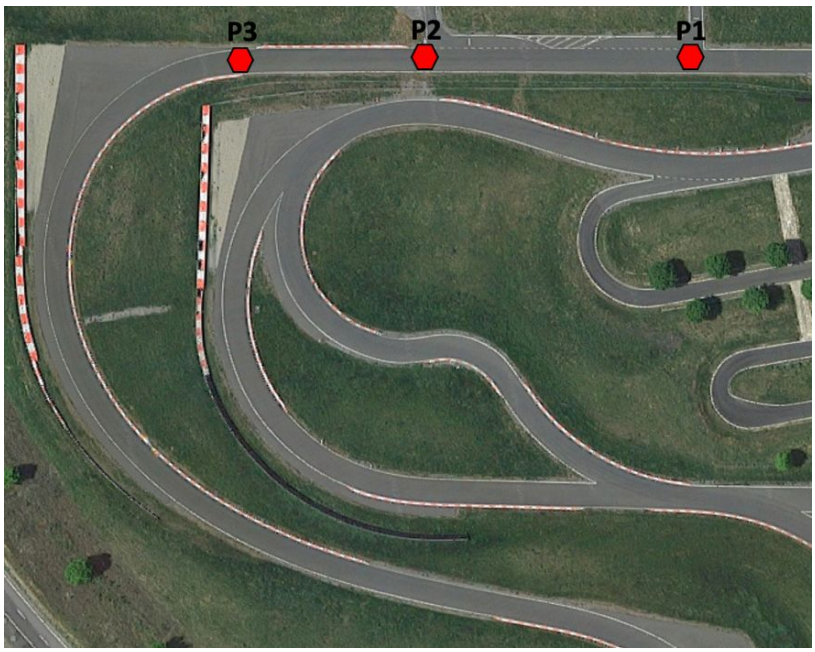

Figure 3: Points of speed and eyetracking measurement.

RESULTS AND CONCLUSION

The data, provided by the different measurements, showed some interesting findings. The results are divided into the different types of measurements.

Eyetracking: Heatmaps with Areas of Interests are created and demonstrated a different focus of the driver's attention. The fixations in group 1 are much more distributed in the complete area. Group 2, with present energy absorber mats focused intensely on the inside of the curve. The energy absorber mats were only perceived in the peripheral field of vision.

Velocimetry: Figure 2 shows the difference between both groups. The average velocity of group 2 (orange color) is significantly higher than the average velocity of group 1, especially at P1. The three points of measurement are illustrated in Figure 3.

Questionnaire: No probands without energy absorber mats consciously noticed their absence. So there was no difference in answering the questions.

In summary, there is a remarkable difference between the speed of the two groups. Above all, eyetracking and velocimetry show that present energy absorber mats have led to a better and safer driving experience. The average higher speed and the type of fixations support this statement. Hypothesis H1 and H4 can thus be verified. With regard to H2, it is striking that none of the drivers are aware of the presence of the energy absorber mats, so the hypothesis can be falsified. H3 is also not verified. The assumption that an absence of the energy absorber mats could lead to high speed is incorrect. It behaves exactly the other way around. In further investigations, attention should also be paid to other environmental factors.

ACKNOWLEDGMENT

A special thanks to the cooperation of the students of the Niederrhein University of Applied Sciences Felix Claßen, Zeynep Acar, Alain Arriens, Emily Bruns and Johannes Hinrichs.

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