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Presentation title: Ability to handle unfamiliar systems in passenger cars according to driver skills

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Abstract. This paper addresses the ability of drivers to intuitively control special passenger car systems that they have as yet not encountered in the course of their driving practice and therefore have no experience of them. The study described in this paper was conducted on a sample group of drivers without any prior experience of the tested model or of any other model of the same brand, and the functions and systems selected for testing were unique for the brand and model in question. The reason for conduction of this study was the endeavour to recreate the common situation in which a driver is forced to drive a car with whose controls he/she has not yet had the opportunity to become acquainted. Based on statistical evaluation of the obtained data, it proved that the initial hypothesis claiming the existence of a correlation between driver parameters such as age, gender or length and quality of driver experience and his/her ability to adapt to completely unknown car control systems could be confirmed. The results in this paper may be applied in the cabin and car control system design process, thereby enhancing the user-friendliness of passenger car controls, thereby also indirectly increasing road traffic safety.

Key words: Ergonomics, Experience, Evaluating, Vehicle, Information systems, Safety.

INTRODUCTION

This paper addresses the relationship between a driver's ability to control a passenger car utilizing control systems he or she has hitherto not encountered in the course of his/her driving practice, and driver parameters such as age, gender, or driving experience. The control systems in modern passenger vehicles differ greatly from one another even regarding such fundamental procedures as shifting gears or operating vehicle driver assistance systems (Wang et al., 2007; Bhise, 2012). The impulse to conduct this research was, therefore, an attempt at describing the common situation where an uninformed driver is forced to operate a vehicle that utilizes systems the person has not encountered in course of his/driving practice. This situation directly effects the overall comfort of the driver and thus also impacts the operational safety of the vehicle (Matoušek, 1998; Reed, 1998). Another aspect of this problem is an ever-increasing burden of information drivers of modern automobiles must contend with. With vehicles becoming ever more digitalized and fitted with ever more intelligent information systems, drivers are being subjected to greater and greater challenges regarding the use of these systems. It is evident that drivers' abilities differ greatly from one another depending on a whole array of parameters which must be further defined. The basis of these differences are disparities in cognitive and social learning abilities, the grounds on which drivers are able to utilize their general knowledge when encountering an unknown situation (Wilson, 1999; Tilley, 2002).

If we define vehicle operation as a work activity, we can assess performance according to parameters that apply to the area of work ability. Work ability is a dynamic system; the personal resources and work environment of a person/driver change throughout his or her life as a result of, for instance, technological advancements or the process of aging. This discovery has resulted in the hypothesis below (Ilmarinen & Tuomi, 2004).

After relevant results were achieved, a hypothesis was determined stating that the ability of a driver to adapt to and operate a vehicle with an unfamiliar control system statistically diminished with increasing age. The ability to adapt is, in this instance, expressed by the time needed to discover and comprehend the principle of use regarding a specific control element (Goudswaard & de Nanteuil, 2000).

MATERIALS AND METHODS

The evaluated data described below was acquired using primary data collection methods in the form of a field experiment and survey. The research was conducted statically in a standing vehicle with primary and information systems activated and at factory settings to ensure identical starting conditions. The tested individuals were positioned in the driver's seat and completed a range of tasks intended to ascertain their ability to orient in an unfamiliar environment.

The Testing Environment

A 2015 Mercedes Benz C220 BlueTec station wagon fitted with maximum interior equipment and furnished with all available information systems was chosen as the test vehicle.

Figure 1. The driver's field of view in the Mercedes Benz C220 test vehicle.

This type and model was selected intentionally because the controls, tell-tales and information systems are very unconventional, and many do not occur in competitors' vehicles of the same category. Thus, a unique test environment was ensured and, subsequently, a greater group of test subjects could be used. Another reason for selecting this vehicle is the fact that components are arranged inside the cabin in an entirely new and revolutionary way, even in the context of the Mercedes brand as a whole. This shift in design is set to be the founding concept for the new cabins of several subsequent series. The location of the gearshift for the automatic transmission, operation of the Command information system, the location of controls on the multifunction steering wheel or the new sunroof controls are among a few of the main innovations.

The Test Group

In order to ensure relevant test results, it was necessary to select a group of subjects that had no prior experience with the test vehicle or any other Mercedes vehicle or model. In this way it was ensured that the tested individual would find him/herself in a truly unfamiliar environment. 150 men and 100 women from 18–70 years of age were selected, from which 121 men and 87 women were included in the study. The results of the other subjects either could not be considered relevant or their testing was impacted by outside influences.

Table 1. The number of tested individuals and relevant parameters

	Number	Average age	Average number of km driven	Average number of vehicles
Men	121*	34	303,885	8.3
Women	87*	33	132,481	6.1
Total	**208***	**33.6**	**232,192**	**7.4**

*Only valid results were included from the original number of 150 men and 100 women.

The Survey and Questions

The research was conducted by asking a number of questions, or, more precisely, by assigning a total of 10 tasks and then timing the test subject in order to ascertain the length of time it takes him/her to complete them. With regard to their importance, tasks were divided into two sets, a primary set of 8 tasks and a control set of 2. Before commencement of each test sequence, the subject was asked about some basic information including whether or not he/she understands the fundamental principles of operating a motor vehicle.

The primary set of tasks, which had been selected to address control and tell-tale elements unique to the test vehicle consisted of the following questions:

1. Activate the wind shield wipers.
2. Turn on the rear window wipers.
3. Open the sunroof.
4. Put the gear lever in the D (drive) position.
5. Turn the central information panel off.
6. Turn of the Head Up Display.
7. Deactivate ESP.
8. Set the navigation system to navigate to a specific address (always the same one).

The control tasks were selected in order to be simple for the tested individual to carry out, thus producing unambiguously different results than the primary tasks. For that reason, tasks were selected to address elements of conventional design that occur both in the test vehicle itself and in practically all other common models of passenger vehicles. The following questions were chosen:

9. Close any air vent.
10. From your current position, open the vehicle's hood.

A time limit of 300 seconds was set for each task. If the test subject was not able to complete a task within the allotted amount of time, the maximum value was recorded along with a note that the task had not been completed. This information was used for further evaluation which is beyond the scope of this paper. The 300 second time limit had been chosen for organizational reasons, but also in light of incidents that occurred during test runs where it was observed that a subject's motivation gradually diminished if he/she was not able to complete a task within a 5 minute interval.

Control tasks were intentionally designed so as not to confirm the above hypotheses and consisted only of activities relating to control elements, the placement of which are generally well known and should be known to the test subjects, regardless of age and experience, or in the case of task 9, are so obvious their completion could be considered trivial. These tasks were expected to produce a **'cannot be confirmed'** result regarding the hypothesis.

RESULTS AND DISCUSSION

Primary task results are listed in Tables 2 and 3. Control task results are listed in Table 4. The regression line, $Y = b1 + b2.ln(X)$, was used as the dependence model. Coefficients b1 and b2 were acquired through linear least squares regression. Logarithmic dependence was selected because it captured the trend better than ordinary linear regression. Logarithmic dependence also reflects the perception of time and other variables.

Each task was assessed against a null hypothesis (b2 = 0) which had been evaluated by an F-test. In this case, the F-test examined whether the model with a b2 coefficient greater than zero expresses the obtained data better than an arithmetic average – in other words, if the dependence model is statistically significant.

For values obtained for both genders, the value of an F statistic was calculated and subsequently compared to the critical value of F distribution of (1, n-2) degrees of freedom at a significance level of 95%. If the value of the F statistic were greater than the critical value, the null hypothesis could be rejected and the model expressing the correlation between age and reaction time in individual tasks could be confirmed. Thus, in addition to the F value in Tables 2 and 3, there is also the 'confirmed' parameter which takes the value of 'yes' or 'no', whereby the value of 'yes' means the hypothesis listed at the start of the paper has been confirmed.

Table 2. Primary Tasks Results for Tasks 1–4

		Task 1		Task 2		Task 3		Task 4	
		F	Confirmed	F	Confirmed	F	Confirmed	F	Confirmed
Sex	**Male** $f_{crit} = 4.01$	50.67	yes	4.25	yes	15.81	yes	25.01	yes
	Female $f_{crit} = 4.24$	22.50	yes	0.48	no	6.81	yes	11.74	yes

Table 3. Primary Tasks Results for Tasks 4–8

		Task 5		Task 6		Task 7		Task 8	
		F	Confirmed	F	Confirmed	F	Confirmed	F	Confirmed
Sex	**Male** $f_{crit} = 4.01$	15.82	yes	14.18	yes	24.37	yes	18.63	yes
	Female $f_{crit} = 4.24$	1.89	no	5.02	yes	5.68	yes	4.56	yes

Table 4. Control Tasks Results

		Task 9		Task 10	
		f_{crit}	Confirmed	f_{stat}	Confirmed
Sex	**Male** F = 4.01	13.3	yes	0.74	no
	Female F = 4.24	0.53	no	0.99	no

Because of the scale of this paper, it is not possible to include all 20 graphs and curves with their individual factors. Therefore, figures below illustrate data for male and female test group in one figure for each task.

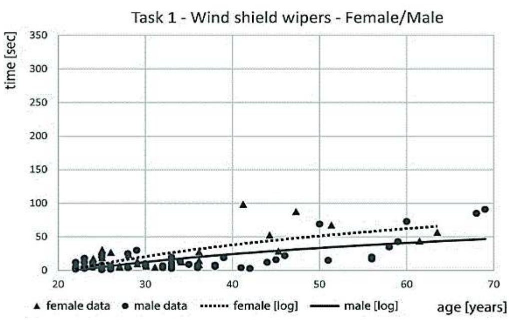


Figure 2. Task 1 – Evaluation of times necessary for test subjects to find the switch for the wind shield wipers. Results measured on a group of men.

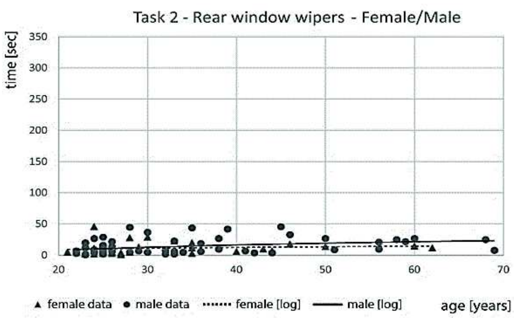


Figure 3. Task 2 – Evaluation of times necessary for test subjects to find the switch for the rear window wipers. Results measured on a group of men.

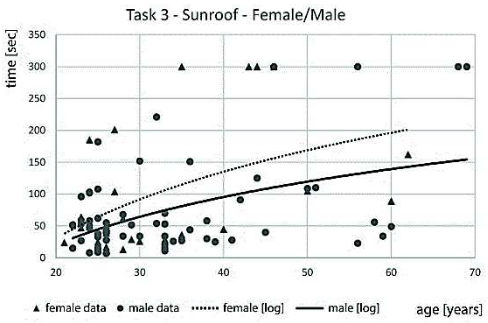


Figure 4. Task 3 – Evaluation of times necessary for test subjects to find the switch for opening the sunroof. Results measured on a group of men.

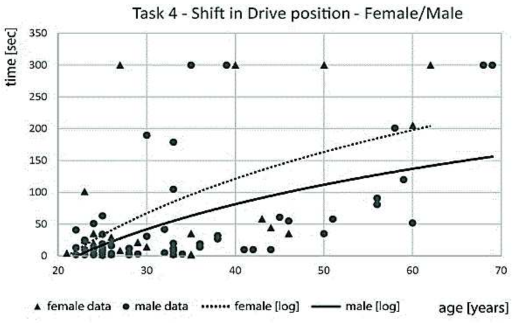


Figure 5. Task 4 – Evaluation of times necessary for test subjects to find the switch gear to be set in to Drive position. Results measured on a group of men.

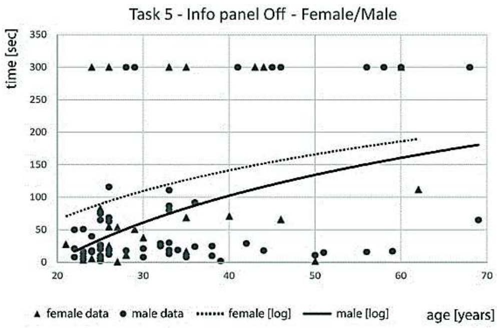


Figure 6. Task 5 – Evaluation of times necessary for test subjects to find the switch for turning off the main info panel. Results measured on a group of men.

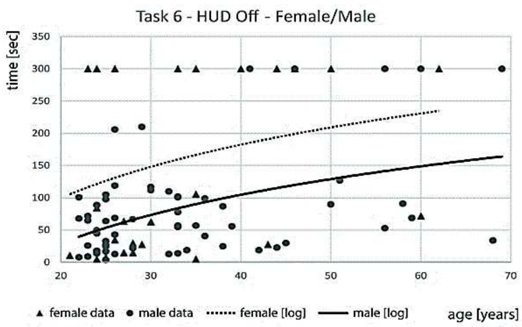


Figure 7. Task 6 – Evaluation of times necessary for test subjects to find how to switch off HUD display. Results measured on a group of woman.

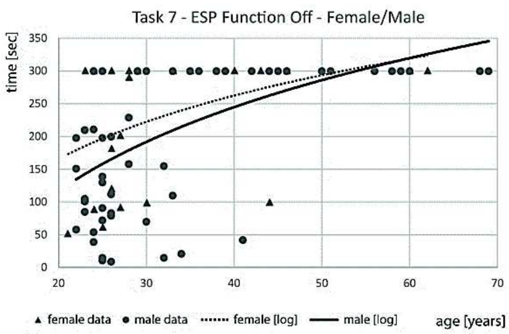


Figure 8. Task 7 – Evaluation of times necessary for test subjects to find how to turn off the ESP function. Results measured on a group of men.

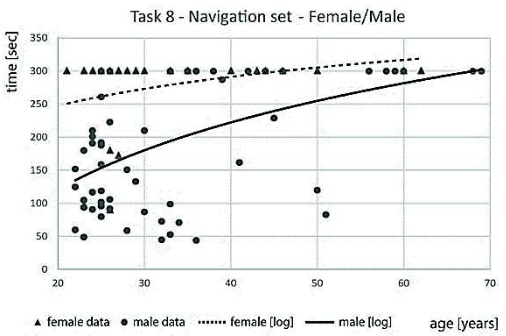
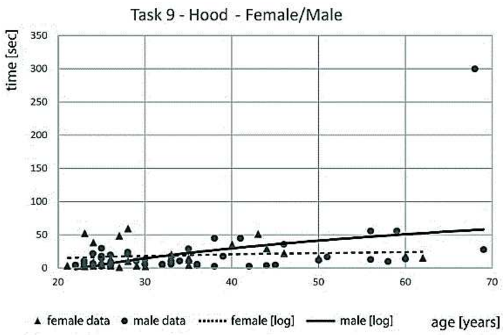


Figure 9. Task 8 – Evaluation of times necessary for test subjects to find how to turn off the ESP function. Results measured on a group of men.



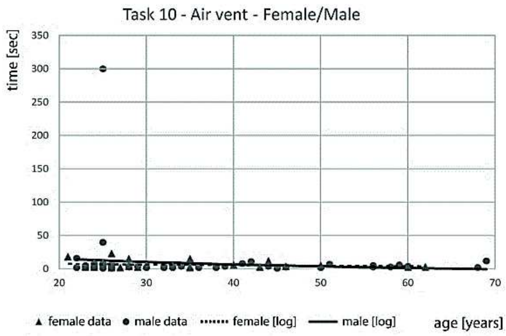


Figure 10. Task 9 – Evaluation of times necessary for test subjects to find the lever to the vehicle's hood. Results measured on a group of woman.

Figure 11. Task 10 – Evaluation of times necessary for test subjects to find how to manage the air ventilation switch. Results measured on a group of man.

In the case of task 2, the hypothesis was not confirmed by the sample group of women, and the sample group of men produced borderline results. This can be interpreted to mean that the controls for front and back wipers were located very near each other, and once the subject discovered how to operate the front windshield wipers, he or she intuitively assumed the controls for the rear wipers would be similar in function and could be found nearby. Many test subjects also accidentally discovered the rear wiper controls while solving task 1. This unfortunately influenced the results of the task. On the other hand, this situation could be construed as exemplifying the principle of learning through the similarity of functions. In the instance of task 5, a correlation was confirmed only among men, the reason being that practically the entire sample group of women was unable to complete the taske regardless of age.

Regarding the control tasks, an evaluation of task 10 involving the all-male group must be put forth. During the assignment where the factor of age was being examined, three men were unable to complete the task due to not being able to physically reach the control, although they new where it was located. If these extreme cases are set aside, the results are practically uniform, regardless of the subject's age.

CONCLUSIONS

On the basis of the foregoing results, it can be stated that the hypothesis voiced in the introduction has been, to a great extent, confirmed. Age has a direct influence on the ability of a driver to adapt to an unfamiliar cabin environment and to new and unknown vehicle control systems. It must be conceded, however, that the time limit given for task completion did bring about some distortion of data, primarily with regard to more complicated assignments. It may be assumed, though, that with regard to this data occurring in the extreme values of the evaluation parameters (advanced age and little experience), increasing the time limit would cause the curve to favour the established hypotheses even more.

The results set forth in this paper could serve as material for further research, helping to refine the above-mentioned findings. The data and hypotheses listed herein could serve as auxiliary factors in automobile design with respect to potential target groups and customers. For instance, manufacturers of high-class luxury vehicles fitted with extensive, intelligent information systems focus on middle-aged and elderly customers. Unfortunately, elderly drivers are not able to take full advantage of these systems, as was shown by the results herein. That begs the question whether such sophisticated and expensive equipment as these vehicles are furnished with is actually prudent, or whether it has, in extreme cases, a disruptive effect on drivers, lowering operational safety of the vehicle.

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