



ASSESSMENT OF THE WAY HOLDING STEERING WHEEL IN DIFFERENT TRAFFIC SITUATIONS

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Abstract

This paper deals with assessing the differences in steering wheel holding positions for left-sided and right-sided steering vehicle in three specific driving situations. The collected data is compared to the generally accepted optimal steering wheel position in terms of both active and passive safety. The research described in this work was based on a sample of randomly selected drivers from the Czech Republic, Great Britain and Australia. Data collection was done by means of electronic questionnaires with precisely-described and visualized situations for better understanding and presentation of the examined state. The data was then subjected to statistical evaluation, where the difference between the drivers driving in the right-sided steering countries and the drivers driving in the left-side steering countries. Basis of the statistical evaluation of the data obtained, it was found that there is a difference in the way the steering wheel is held in the assessed traffic situations between drivers driving in left-sided traffic and between the drivers in right-sided traffic. The results of this work can be used in the process of designing passenger car cabins. Especially in the field of adaptation of control or multimedia elements to the needs of drivers in individual countries.

Key words: driver; safety; hands; traffic; steering wheel.

INTRODUCTION

Observation techniques are most commonly used today as a tool for assessing the safety of passenger car crews, where the observer usually deals with driver behaviour while driving. The most frequently observed parameters include seat belt use, mobile phone use, seat positioning, etc. Holding the steering wheel correctly is an important aspect of traffic safety (Thomas, J. A. & Walton, D., 2007; Viano, D. C., Patel, M. & Ciccone, M. A., 2018). Multifunctional steering wheels represents a direct link between driver and machine, and the optimal design of these elements, coupled with the design of the various armrests, directly affects the overall driver comfort and thus the safety of the vehicle operation (Chang, Y. & Chen, Ch.W., 2016).

Multifunctional steering wheels used in passenger cars today are equipped with a number of controls that make it easier for the driver to operate things such as a mobile phone or the car's multimedia system. These controls are located on the steering wheel so that the driver can control them tactfully, with the thumbs of both hands, only with the use of positional memory. This aims to keep the driver's attention, focusing the field of driver's view on the traffic situation in front of and around the vehicle and provides the ability to respond more quickly to possible changes in traffic conditions while driving.

Although car manufactures try to model the use of the multifunction steering wheel by assuming the steering wheel to hold in a generally recognized optimal position (Walton, D. & Thomas, J. A., 2005) but in practice, we know that a statistically significant percentage of drivers hold the steering wheel quite differently.

In traffic safety history, a number of researches (Hruška, 2018; Schmidt, S., Seiberl, W. & Schwirtz, A., 2015; Walton, D. & Thomas, J. A., 2005) have drawn attention to how the steering wheel is held, on the findings of which designers base their work. They are usually focused on the effect of grip on passive safety and the subsequent type and extent of injury in the accident. The most frequently quoted optimal value is according to the analogue clock face, i.e. the left hand position on the nine and the right hand on the three, with the driver holding the steering wheel with both hands (Schiro, J., Gabrielli, F., Pudlo, P. & Barbier, F., 2013; Hault-Debrulle, A., Robache, F., Paxaux, M., P. & Morvan, H., 2010). This value is specified as the optimum value regardless of the side that the steering wheel is on.



The aim of this work is to assess the hypothesis that there is a statistically significant difference in the way hold of steering wheel by drivers who are driving in right-sided traffic and drivers who are driving in left-sided traffic.

MATERIALS AND METHODS

For the needs of the measurements, a total of 160 participants (82 women and 78 men) from the Czech Republic, Great Britain and Australia were selected, and they were divided into two groups of 80 respondents. Each of the respondent groups comes from countries with different road traffic.

Respondents from the Czech Republic were included in the group of drivers driving on the right-sided traffic (Tab. 1) and respondents from Great Britain and Australia were assigned to a group of drivers driving on the left-sided traffic (Tab. 2).

Tab. 1 Data on tested persons from the group of drivers driving in the left-sided traffic (CZ)

	Number	Age		
		Average	Minimum	Maximum
Men	40	29.7	20	52
Women	40	32.2	19	64
Total	80	30.9	19	64

Tab. 2 Data on tested persons from the group of drivers driving in the right-sided traffic (UK, AUS)

	Number	Age		
		Average	Minimum	Maximum
Men	38	38.4	21	65
Women	42	34.7	20	56
Total	80	36.5	20	65

Three basic traffic situations were defined for the purpose of the research. These were traffic situations in which the interviewed driver could find him or herself and answer how he or she held the steering wheel in the given situation. These consist of three common situations in which drivers repeatedly find themselves when driving. Each of these situations has been thoroughly verbally described and supplemented with an illustrative photo for better understanding. **Situation A** was described as driving on highways or high-speed roads at low intensity traffic with no psychological pressure on the driver. **Situation B** was described as driving outside of a city on a secondary road with a lot of bends, in medium traffic, with moderate intensity psychological pressure on the driver. **Situation C** was described as driving outside of a city under reduced visibility and very dense traffic, where very high demands are placed on the driver and the driver is subjected to considerable psychological pressure.

Basic data collection was carried out with the help of electronic questionnaires in two language versions. Their translations and semantically-identical content were verified by a professional translation agency. As part of the basic information provided in the questionnaire, respondents were advised to devote sufficient time to filling out individual questions and had schemes available to help them better imagine the situation (Fig. 1). Although the questionnaire method may not be as accurate as real-environment testing, given the set objectives and the number of subjects surveyed, testing in a real environment would be virtually impossible in organizational terms.

The questionnaire consisted of nine questions divided into two groups. The first group were questions about age (in years), gender (female, male), and side preference (right-handed, left-handed) of the subject. In addition, the test subject was interviewed about how long he or she had a driver's licence (in years), how often he or she drove a passenger car (every day, at least once a week, occasionally, exceptionally), with the final data being about the position in which the subject most often sits behind

the steering wheel (a choice of three basic positions divided according to the subject's chest distance from the centre of the steering wheel).

In the second group of questions, the test subject was asked to gradually imagine each of the three traffic situations described above and responsibly state for each of them whether he or she held the steering wheel with one or both hands, and in which position. This was always based on the pre-selected scheme attached to each question (Fig. 1), where, according to the watch face, the range of R12-R6 was defined for the right hand, and for the left hand the analogous range of L6-L12. The overlap at 12 and 6 o'clock is selected because the test groups from left-sided and right-sided traffic were evaluated. The subject was also told to indicate the most prevalent value of the grip on the steering wheel. We dismissed in the first phase extreme values where the test subject crosses the hand and held the steering wheel with, for example, the left-hand on the right, as highly unlikely in view of the objectively high degree of discomfort the driver would experience in such a position. For this reason, we completely discarded these alternatives.

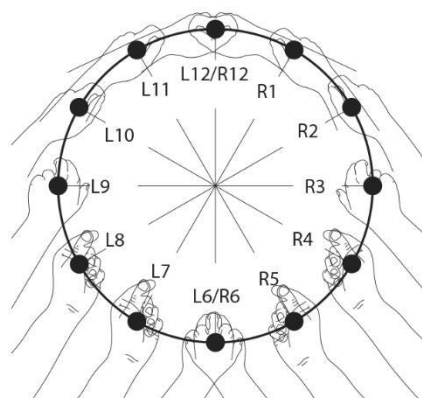


Fig. 1 Scheme of positions of individual grips according to an analogue watch face

RESULTS AND DISCUSSION

The results obtained during the measurements were statistically processed and evaluated using contingency tables, Pearson's chi-squared test and adjusted residuals methods. The percentage of individual hand positions on the steering wheel, regardless of whether the steering wheel is held by one hand or both, obtained from the measured data, is shown in Tab. 3 for right-sided traffic respondents (CZ) and in Tab. 4 for left-sided traffic respondents (UK, AUS).

Tab. 3 Percentage of grips for drivers in right-sided traffic (CZ).

	Position							
Left hand	L6	L7	L8	L9	L10	L11	L12	ΣL
Situation A	0,00 %	8,30 %	9,70 %	31,90 %	40,30 %	5,60 %	4,20 %	100,00 %
Situation B	0,00 %	2,70 %	5,30 %	22,70 %	58,70 %	5,30 %	5,30 %	100,00 %
Situation C	0,00 %	0,00 %	1,30 %	25,00 %	68,60 %	3,80 %	1,30 %	100,00 %
	Position							
Right hand	R12	R1	R2	R3	R4	R5	R6	ΣR
Situation A	0,00 %	0,00 %	36,20 %	25,50 %	21,30 %	10,60 %	6,40 %	100,00 %
Situation B	0,00 %	0,00 %	55,80 %	30,90 %	11,80 %	1,50 %	0,00 %	100,00 %
Situation C	0,00 %	1,30 %	64,00 %	30,70 %	2,70 %	1,30 %	0,00 %	100,00 %

It is clear from Tab. 3 and 4 that there are differences in steering wheel hand positions for drivers who are driving in right-sided traffic and drivers who are in left-sided traffic. The highest percentage of positions, regardless of the combination of both hands for all interviewed drivers, are L10 and R2. From this, it can be concluded that a significant percentage of drivers still use an older hand's position in L10 R2 (Brown, 2002). This is confirmed by the average age of interviewed drivers, which can be deduced



from having attended a driving school while this position was part of the curriculum (*Brown, 2002*). It is also evident that drivers do not use L6 and R12 positions in the right-sided traffic at all. This is also true for drivers in left-sided traffic, but these positions are marked L12 and R6 (Fig 1). The second highest percentages, regardless of the combination of both hands, are positions L9 and R3.

Tab. 4 Percentage of grips for drivers in left-sided traffic (UK, AUS).

		Position							
Left hand	L6	L7	L8	L9	L10	L11	L12	ΣL	
Situation A	1,60 %	4,80 %	35,60 %	17,70 %	38,70 %	1,60 %	0,00 %	100,00 %	
Situation B	0,00 %	0,00 %	26,00 %	26,00 %	45,30 %	2,70 %	0,00 %	100,00 %	
Situation C	0,00 %	0,00 %	12,80 %	29,50 %	56,40 %	1,30 %	0,00 %	100,00 %	

		Position							
Right hand	R12	R1	R2	R3	R4	R5	R6	ΣR	
Situation A	1,60 %	1,60 %	35,50 %	30,60 %	19,40 %	11,30 %	0,00 %	100,00 %	
Situation B	0,00 %	6,50 %	49,30 %	22,10 %	18,20 %	3,90 %	0,00 %	100,00 %	
Situation C	0,00 %	2,50 %	52,40 %	26,30 %	13,80 %	5,00 %	0,00 %	100,00 %	

Tab. 5 and 6 show how the driver holds the steering wheel in each situation. Whether the driver holds the steering wheel with one hand, both or at the optimal position L9 and R3 (*Schiro, J., Gabrielli, F., Pudlo, P. & Barbier, F., 2013; Hault-Debrulle, A., Robache, F., Paxaux, M., P. & Morvan, H., 2010*). It is clear in the PivotTables (Tab. 5 and 6) that if the traffic situation becomes more complex and the driver is perceived as potentially more dangerous, most of the interviewed drivers use both hands to drive. A total of 41 drivers from the Czech Republic hold the steering wheel by one hand, 31 drivers with both and 8 drivers holding the steering wheel in this position in the optimal position. The data from drivers in left-sided traffic is not fundamentally different in any situation. Pivot tables were subsequently supplemented by the method of adjusted residuals. In general, when comparing Tab. 5 and 6, it can be argued that drivers in the UK and Australia driving more carefully than drivers in the Czech Republic.

Tab. 5 Combination of tracked grips for drivers in right-sided traffic (CZ).

CZ	One hand	Both hands	Optimal	Σ
Situation A	41 (++++)	31 (---)	8	80
Situation B	17	50	13	80
Situation C	4 (---)	58 (++)	18	80
Σ	62	139	39	240

Tab. 6 Combination of tracked grips for drivers in left-sided traffic (UK, AUS).

UK, AUS	One hand	Both hands	Optimal	Σ
Situation A	36 (++++)	35 (---)	9	80
Situation B	10 (-)	58 (+)	12	80
Situation C	2 (---)	60 (+)	18	80
Σ	48	153	39	240

To determine whether there is a significant difference in the way in which the steering wheel is being held between drivers in left-sided and right-sided traffic was used Pearson's chi-squared test where the measured data were compared for each situation separately. The data for Pearson's chi-squared test were used data from Tab. 5 and 6, each table being 2x3 for each situation. The number of degrees of freedom for each situation was 2 and the critical value at the selected significance level (0,05) was 5,991465. The result test value was compared to the critical value (5,991465). Cramer's V value was also calculated



from the resulting data. The claim that there is a statistically significant difference in the way in which the steering wheel is held by the drivers in right-sided traffic and the drivers in the left-sided traffic cannot be statistically confirmed in any situation, as shown in Tab. 7.

CONCLUSIONS

The results published in this work are thematically linked to previous researches (Hruška, 2018; Kůrka, 2019) and complement the complex view of steering wheel holding issues in various types of traffic and in different traffic situations. In this work, a large amount of data was obtained from a large group of respondents from three different countries with two different traffic types, which may be statistically interesting in terms of possible comparisons with other statistics that could be obtained from respondents with other parameters such as for example, different education, age, etc.

Based on the above results, it can be stated that the primary hypothesis stated in the introduction to the work was not confirmed. There are no statistically significant differences in how drivers are holding the steering wheel in left-sided traffic and right-sided traffic. What can be said with certainty is that drivers, with a deteriorating situation, tend to hold the steering wheel with both hands, regardless of the type of road traffic. From a safety point of view, it was found that a statistically significant number of interviewed drivers held the steering wheel in the wrong way, either with one hand or in the wrong combination of both hands.

The results of this work can be used in the process of designing passenger car cabs, especially in the process of ergonomically shaping the steering wheel and controls elements in such a way that the driver has both hands on the steering wheel voluntarily and comfortably.

The benefit of this work is to provide valid data for further research in this field, where it would be possible to refine the above results or supplement data obtained from field research in other countries.

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