

Article



Statistical Evaluation of BIS-11 and DAQ Tools in the Field of Traffic Psychology

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Abstract: This paper focuses on the statistical evaluation of two independent research tools in the field of traffic psychology. Our research focuses on young drivers in the Slovak Republic and conducts an international comparison. At present, these young drivers make up only about 7% of the total number of drivers, but they cause about 20% of accidents. The paper analyzes the traffic accident rate of young as well as inexperienced drivers. All drivers in the survey had a short period of driving experience. The traffic-psychological survey obtained detailed data via two independent tools. We aimed to find relations between the factors and subfactors of the tools used, namely the BIS-11 (Barratt Impulsiveness Scale) and DAQ (Driver Attitude Questionnaire). The researchers also used these tools in other countries, so it was possible to compare the results obtained. The results from these tools should reveal the psychological causes of as many traffic accidents as possible. Our paper shows the possibilities for the evaluation of the tools used with correlation analysis. The results of our research are shown in symmetrical matrixes of correlation coefficients. Our study also compares its values with the results of foreign authors. Such research has revealed some facts about young drivers' violations connected with drunk driving, speeding, and other traffic offenses. Our aim was to find connections between the driver's history (skills, traffic accidents, age, etc.) and psychological characteristics, and we have answered several research questions. In conclusion, we have highlighted the most significant relationships between the factors of driver psychology.

Keywords: correlation; traffic psychology; driver; traffic accident; BIS-11; DAQ

1. Introduction

The increasing pace of human life and the constant pressure to use working time efficiently has also increased the demands on people's psychological resilience. As a result, humans' actions and thinking are changing, which can affect their driving. This is a big problem because there are up to 460 passenger cars per 1000 inhabitants in the European Union [1].

Three key factors affect road safety: humans, vehicles, and the environment [2,3]. The driver poses the highest risk to road safety. Researchers—for example, the authors in [4–7]—usually state that human errors cause more than 90% of road accidents. For this reason, research on the interaction between drivers, vehicles, and the environment is important, and therefore, researchers around the world must conduct work in the field of road safety and traffic psychology. With the gradual introduction of autonomous vehicles with different degrees of automation, the topic of human safety in the transport system is becoming even more relevant [8,9].

In our paper, we focus primarily on a group of young drivers. It is hard to specify the age at which someone is considered a young driver. Usually, these drivers are in the age range of 18 to 26. The upper limit varies in some studies. For example, in [10], the authors focused on the group of 18 to 20-year-old drivers, while a Romanian study [11] investigated a group of 18 to 24-year-old drivers. The lower limit can also be different: a



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Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). Belgian study [12] focused on 17- to 24-year-old drivers, while the authors in [13] focused on 16- to 24-year-old drivers, etc.

As can be seen from [10–13], many studies deal with young drivers. In Slovakia, only a few articles have focused on young drivers' psychology. In recent years, the police force has introduced several changes in the law. Now, young drivers in Slovakia have a probationary period; this means that if the driver violates traffic regulations twice within two years after obtaining a driving license, they must attend a refresher course at a driving school and meet with a traffic psychologist. Therefore, this topic is very important for the police force.

As we have already mentioned, young drivers are an exceptional group of drivers. These drivers fall within the age group of 18 to 26 years. They require special research because they have a higher tendency to cause accidents. The literature states that young drivers should drive at least 100,000 km over seven years to reach the level of an advanced driver [14–16]. There are many research methods that can be used, which are listed, for example, in [17] and used and described in [18,19]. For this kind of research, it is also possible to use driving simulators [20–23]. In [24], the authors use a research driving simulator for young drivers.

The British Road Safety Foundation, called "Brake", defines some personality characteristics of young drivers that cause accidents. These are the characteristics of young drivers:

- High self-confidence: In [14], it was shown that young drivers who show too much confidence in driving pose a higher risk.
- Risk unawareness: Research shows [25–27] that young drivers with less attention and worse perception are less able to choose the appropriate speed.
- Risk-taking: Young people are more prone to risky behavior, including the following [14,28]:
 - o Driving over the speed limit;
 - o Overtaking;
 - o Drunk driving and driving on drugs;
 - o Not using seat belts;
 - o Using mobile phones.

We mainly dealt with research on the behavior and reactions of young drivers when driving a car. Before this significant research, it was appropriate to process as much traffic accident data focused on young drivers in the Slovak Republic as possible. This section, therefore, provides basic statistics on the number of road accidents and related fatalities, as well as major and minor injuries caused by young drivers and drivers with a lack of driving experience. Figure 1 is a graphical representation of traffic accidents and their consequences caused by young drivers aged between 18 and 24. Although the numbers have a decreasing tendency, there are still efforts by police to reduce the number of traffic accidents as well as their consequences.

In some cases, the driver's age is not as relevant as their driving experience. In road traffic, increasing numbers of situations require driving experience. The natural development of the traffic environment is resulting in more junctions, more vehicles, new traffic signs, intelligent systems, etc. For this reason, it is suitable to introduce the statistics of traffic accidents in the Slovak Republic according to the duration of the driver's license.





Figure 1. Annual number of traffic accidents caused by young drivers). Processed with permission from ref. [29]. 2020 Presidium of the Police Force, Ministry of Interior of the Slovak republic.

Drivers with a lack of driving experience cause 27% to 36% of traffic accidents. Table 1 shows the complete data for only the group of drivers with less than five years of experience. The extreme value is the number of fatalities in 2016, where inexperienced drivers caused the deaths of up to 63 people (36% of the total number). The number of traffic accidents decreases each year, but the number of fatalities is stagnating.

Table 1. Traffic accidents of new drivers (with less than 5 years of experience). Reprinted with permission from ref. [29]. 2020 Presidium of the Police Force, Ministry of Interior of the Slovak republic.

Туре	Numbers of Traffic Accidents (-)									
	2014	2015	2016	2017	2018	2019				
Minor injuries	1437	1444	1563	1329	1405	1259				
Major injuries	284	242	250	261	291	242				
Fatalities	58	62	63	51	43	53				
Total	1779	1748	1876	1641	1739	1554				
Туре	Numbers of Traffic Accidents (%)									
	2014	2015	2016	2017	2018	2019				
Minor injuries	33	32	34	30	33	30				
Major injuries	34	29	31	30	30	30				
Fatalities	30	30	36	27	26	28				

Crashes caused by young drivers may result from connected factors. We assumed that a car accident might result not from a single driver mistake but from a combination of many factors. Some characteristics are typical of young drivers. In our research, we focused on the impulsive behavior and attitudes of young people. According to [30], impulsiveness influences one's control over thoughts and behaviors. It is a direct personality predictor of aggressive and risky driving, caused by a lack of self-control to refrain from this behavior.

The safe driving of a motor vehicle depends only on skills, abilities, knowledge, and the vehicle. The key factor is the driver and their perception, experience, and behavior. Their behavior affects the situation during driving.

The driver's behavior depends on the characteristics of their personality and the specific situation. There is still conceptual pluralism in personality psychology because scientists have not reached a consensus on the definition of this.

Factors that have a decisive influence on traffic behavior are the driver's personality structure, temperament, emotionality, motives, attitudes, and the ability to handle the load. The results of examinations [31] by traffic psychologists show that people who commit traffic accidents are "more peculiar, egocentric, more dynamic, more aggressive and emotional, with a disharmonious personality structure, weakened self-regulation, but adequate mental performance".

Several authors agree that there are characteristic differences between drivers with frequent traffic offenses and accidents and drivers without accidents. According to [31], people who fail in traffic situations have the typical characteristics of inadaptability, impulsivity, ignorance, hypersensitivity, rigidity, irresponsibility, carelessness, emotional lability, aggression, and others. On the other hand, successful drivers have the characteristics of adaptability, prudence, responsibility, reliability, balance, self-confidence, emotional stability, and conscientiousness.

In [32,33], the authors state that certain social, psychological, and behavioral factors distinguish young drivers, who are more likely to be involved in accidents. Although these drivers acquire the skills needed to drive relatively quickly, they need more time to develop higher-order perceptual and cognitive skills [34]. Young drivers often underestimate the risk of an accident in various dangerous situations. At the same time, they overestimate their driving skills. Young drivers are also more willing to take risks while driving than experienced drivers.

Research in this area points to the following driving errors of young drivers who have caused accidents:

- Errors of perception and assessment;
- Distraction;
- Falling asleep or blacking out.

In our research, we also used self-assessment from respondents. Self-assessment is a kind of center showing the core of a person's personality. According to [35], self-assessment offers many potential benefits to drivers. The greatest potential benefit is that self-assessment is conducted in an environment chosen by the individual, providing both a confidential and nonthreatening source of information about the individual's ability to drive. As such, those who may be resistant to having their abilities assessed by someone else may be more willing to engage in self-assessment.

2. Materials and Methods

In this article, we aimed to find research methods and especially to describe the behavior of young drivers with a comprehensive traffic–psychological survey on an adequate sample of young drivers. Appropriate statistical evaluation allowed for the comparison of results with relevant or similar studies from abroad. At present, there are no comprehensive studies into the traffic-psychological analysis of accidents caused by young drivers in the Slovak Republic or Slovak drivers in general, so this area can be considered a relatively "weak point" of current research.

As part of the research, we conducted an extensive survey among students at the University of Žilina. To ensure higher reliability of the questionnaire, we performed this survey only with face-to-face interactions. In total, it was possible to obtain 386 responses in a relatively short time. The evaluation of the data based on statistical principles was time-consuming.

The basic idea of the research task was to determine the causes of traffic accidents involving young drivers. It was necessary to examine their exact behavior. There are many methods of researching the driver-transport system interaction. The comprehensive comparative study presented in [17] describes all possible methods of this kind of research.

2.1. Psychological Tools

There are several ways to determine the behavior of young drivers through psychological tools. We used the following two tools:

• The BIS-11 (Barratt Impulsiveness Scale) is designed to assess three separable dispositions: (1) attentional impulsiveness, defined as the (in-)ability to concentrate or focus

attention; (2) motor impulsiveness, or the tendency to act without thinking; and (3) non-planning impulsiveness, or the lack of future planning and forethought [36]. The original wording of the whole BIS-11 questionnaire is in Appendix A.

• The DAQ, also known as the MDAQ (The Manchester Driver Attitude Questionnaire), detects whether a driver is prone to drunk driving, close-following, dangerous overtaking, and speeding [37]. The original wording of the whole BIS-11 questionnaire is in Appendix B.

The mentioned questionnaires have never previously been translated into the Slovak language. For this reason, the priority was to obtain all questions in the questionnaires. Subsequently, we translated them from English to Slovak as precisely as possible. It was necessary to modify some parts of the questionnaire to be clear and understandable. Some questions (in BIS-11) do not collect information related to driving but rather to the everyday life of the respondent. This tool is usable also in other fields of research. Back translation to English was not necessary, as all questions were the same. Small differences were only present in questions about alcohol (drunk driving) because there is zero alcohol tolerance in Slovakia. Of course, few deviations from the original English wording were possible, but we trialed the questionnaires to a small group of respondents. All aspects were found to be accurate and easy to read.

However, the preparation of the questionnaires was less important than the evaluation of the data. Each answer in the questionnaire has a different impact on the factors of the tool; some questionnaire answers have a direct and indirect influence on the overall score of a specific factor.

2.2. Sample Size

We used the numbers of valid driving licenses in Slovakia in 2019 to determine the minimum sample size. These statistical data showed different groups than the data of traffic accidents, so we chose the second and the third groups. The second group included drivers aged 17–20, and the third group included drivers aged 20–24. In total, there were 253,859 drivers. We used the Sample Size Calculator [38] to calculate the sample size with the following parameters:

- Confidence level: Usually 95%, and therefore we used this typical value.
- Confidence interval: In statistics, this is a type of interval estimation for an unknown parameter. We chose a value of 5.
- Population: The total number of statistical units of the basic set. In this case, this was the number of drivers in the selected age category (253,859).

The result was the calculation of the minimum sample size in Figure 2. Its value was 384, so it was necessary to obtain at least this number of questionnaires.

Determine Sample Size								
Confidence Level:	●95% ○99%							
Confidence Interval:	5							
Population:	253859							
Calculate	Clear							
Sample size needed:	384							

Figure 2. Determination of sample size using the Sample Size Calculator [38].

Our questionnaire survey included 224 men and 160 women. Thus, 48% of the total respondents were men and 42% women. The average age of the respondents was 22 years.



The average driving experience expressed as the number of kilometers was at the level of 63,388 km. The composition of the respondents is shown in Figure 3.

Figure 3. The composition of the respondents.

2.3. Correlation Analysis

It was important to compare the obtained data with selected foreign studies [39]. As we aimed to collect comparative data, we needed to statistically analyze the obtained data using correlation analysis. Using regression analysis would also have been possible, but our experiments did not bring excellent results. The findings presented below are from the literature in the fields of statistics [40], economics [41–44], and informatics [45]. The regression analysis estimates the relationships between a dependent variable. On the contrary, the result of the correlation analysis is a single number—the correlation coefficient—which evaluates a statistical relationship between two variables.

Covariance (*cov xy*) classifies the existence of a linear relationship between two variables. It is a measure of the relationship between two random variables: x and y. The relation for calculating covariance is (1):

$$cov \ xy = \frac{1}{n} \sum_{i=1}^{n} (x_i - \overline{x})(y_i - \overline{y}) = \overline{xy} - \overline{x} \cdot \overline{y}$$
(1)

Covariance values are taken from the interval $(-\infty; +\infty)$. The covariance gives us only information about the existence of dependence between the variables. However, we aimed to determine the intensity of this dependence, which the correlation analysis provides. Correlation characteristics must meet the following conditions:

- Its values are from a fixed interval, most often $\langle -1; 1 \rangle$ or $\langle 0; 1 \rangle$;
- As the degree of dependence increases, their absolute values must also increase;
- They must be independent of the variable units.

These requirements were ensured by dividing the covariance by the standard deviations of variables. This means that we were able to obtain the correlation coefficient. The following relation defines the correlation coefficient (2):

$$r_{xy} = \frac{\cos xy}{s_x s_y} = \frac{n \sum xy - \sum x \sum y}{\sqrt{\left[n \sum x^2 - (\sum x)^2\right] \cdot \left[n \sum y^2 - (\sum y)^2\right]}}$$
(2)

The correlation coefficient measures the two-tailed linear dependence of two variables and takes values from the interval $\langle -1;1\rangle$. The following implications apply for the correlation coefficient:

- $r_{xy} = 0 \Leftrightarrow$ variables X and Y are not linearly dependent;
- $r_{xy} > 0 \Leftrightarrow$ there is a direct linear relationship between the variables X and Y;

 $r_{xy} < 0 \Leftrightarrow$ there is an indirect linear relationship between the variables X and Y.

The sign of the correlation coefficient determines the direction of the dependence. The absolute value of the correlation coefficient reveals the strength of the linear association between the two variables. The closer the absolute value is to 1, the stronger the dependence. From the value of the correlation coefficient, it is possible to determine the monotonicity of the regression line. If the correlation coefficient between two variables is zero, then the relationship between the two variables is not linear; they are either independent or they are related by some non-linear relationship. With a negative value for the correlation coefficient, there is an indirect linear relationship between the variables X and Y. This means that the regression line is decreasing. If the correlation coefficient is positive, there is a direct linear relationship between the variables X and Y. This means that the regression line is decreasing. Coefficient and the correlation coefficient show that the relationship of the same two variables, X and Y, are identical.

According to [41], the interpretation of the correlation coefficient depends on the context. If we are considering a physical law, then the value of the correlation coefficient of 0.8 is very low; on the contrary, in the social sciences, it is a very high value. In 1988, Cohen [45] established the exact tool for the interpretation of correlation coefficients in psychological research:

- A correlation in the absolute value below 0.1 is trivial;
- A correlation in the range of 0.1 to 0.3 is small;
- In the interval of 0.3 to 0.5, the correlation is medium;
- At values above 0.5, the correlation is high;
- A correlation of 0.7 to 0.9 is very high;
- A correlation in the range of 0.9 to 1.0 is almost perfect.

2.4. Research Hypotheses and Questions

In the following pages, this paper will answer some scientific questions. We will test two hypotheses:

Hypothesis 1 (H1): There are interrelationships between the driver's characteristics that can be revealed by some psychological tools. Research questions associated with this hypothesis are as follows:

- What characteristics does each tool reveal?
- Which pairs or groups of characteristics have the closest relations?
- How should research in this area continue?

Hypothesis 2 (H2): A psychological survey can identify a group of drivers who have a higher tendency to commit traffic offenses than the other drivers do. This hypothesis includes the following research questions:

- Which tool is most appropriate to test the hypothesis?
- Are the results similar to other studies?

This introductory part highlighted the need for research into young drivers. In the questionnaire, we focused not only on traffic accidents but also on offenses. We chose this because we assumed that few people would be involved in accidents. Indeed, only 30% of respondents had a car accident (11% were responsible, 19% were only participants). From the point of view of analysis, we tried to get the most diverse data. Therefore, we decided to investigate traffic offenses.

3. Results

It was necessary to obtain a comparable data set. In the introductory part of the questionnaire, we obtained the following data: the age of the respondent (in the interval of 18–26 years), driving experience expressed in a number of driven kilometers, driving

experience expressed by the length of holding a driving license and self-assessment of drivers on a scale of 1 to 10. Here, we focused on two tools that traffic psychologists use. However, it was important to process a basic factor analysis of each tool; this was an analysis of the composition of these tools, presented on an evaluation scale. The last but not least important requirement was to ensure the highest possible quality of translation.

3.1. BIS-11 Results

The tool BIS-11 or the Barratt Impulsiveness Scale has first and second-order factors. First-order factors are attention, motor, self-control, and cognitive complexity, while second-order factors are attentional, motor, and non-planning skills [46–51]. According to [47], the three basic factors of BIS-11 are as follows:

- Motor impulsiveness, which positively predicts the intention of a driver to commit a traffic violation;
- Non-planning impulsiveness, which positively predicts the intention of a driver to commit a traffic violation;
- Cognitive impulsiveness, which positively predicts the intention of a driver to commit a traffic violation.

The primary task after digitizing the data from the paper questionnaires was to ensure that the reverse-rated questions gave an inverted value to the total number of points. It is possible to evaluate this tool with absolute point values or percentage values. In BIS-11, one question belongs to only one first-order factor. On the other hand, many other psychological tools have items that affect more than one factor (factors overlap). The first simple evaluation is in Figure 4. Female respondents had better self-control, perseverance, and cognitive instability on average. Average differences were small for attention and motor impulsiveness.



Figure 4. Average rating of Barratt Impulsive Scale (BIS-11) factors according to gender. Source: processed by authors.

For the correlation analysis, we used the SPSS Software, which allows an advanced statistical analysis to be performed. The matrix of Pearson coefficients in Table 2 represents the results of the correlation analysis in the SPSS software. It also includes the p-value: the level at which the correlation is statistically significant.

Factor		1	2	3	4	5	6	7	8	9	10
BIS-11	а										
(Attentional)	b	1									
BIS-11 (Motor)	а	0.508 **	_								
	b	0.262 **	1								
BIS-11	а	0.359 **	0.513 **	4							
(Non-Planning)	b	0.078	0.326 **	1							
Attention	а	0.861 **	0.370 **	0.341 **							
	b	0.797 **	0.249 **	0.089	1						
Cognitive	а	0.763 **	0.473 **	0.233 **	0.328 **	1					
instability	b	0.728 **	0.173 *	0.062	0.198 *	1					
Motor	а	0.441 **	0.897 **	0.446 **	0.303 **	0.434 **	4				
impulsiveness	b	0.201 *	0.899 *	0.261 **	0.190 *	0.131	1				
D	а	0.343 **	0.624 **	0.345 **	0.282 **	0.279 **	0.215 **	1			
Perseverance	b	0.274 **	0.607 **	0.193 *	0.218 *	0.215 *	0.229 **	1			
	а	0.414 **	0.498 **	0.871 **	0.411 **	0.247 **	0.436 **	0.330 **	1		
Self-control	b	0.040	0.291 **	0.917 **	0.018	0.046 *	0.268 **	0.147	1		
Cognitive	а	0.136 **	0.320 **	0.757 **	0.107 *	0.117 *	0.275 **	0.222 **	0.338 **	1	
complexity	b	0.041	0.169 *	0.449 **	0.076	0.018	0.095	0.176*	0.920	1	
BIS-11 (Total)	а	0.738 **	0.847 **	0.810 **	0.621 **	0.581 **	0.748 **	0.549 **	0.764 **	0.536 **	1
DIS-11 (10tal)	b	0.569 **	0.812 **	0.654 **	0.482 **	0.410 **	0.723 **	0.523 **	0.580 **	?	1

Table 2. BIS-11 symmetric correlation matrix and comparison with a foreign study. Abbreviations: a = own study; b = comparative study. Source: [51], processed by authors.

**. Correlation is significant at the 0.01 level (two-tailed). *. Correlation is significant at the 0.05 level (two-tailed).

After the statistical evaluation, it was possible to compare our results with other studies. For example, Serbian researchers [51] focused on 305 drivers, of which 202 were professional truck or bus drivers. About 88% of the respondents were men. The average age (46.2) and the age interval (36–46 years) of the respondents were different in their study. The total driven distance and the length of holding the driving license were also different for these more experienced drivers. On the contrary, the research methodology was the same. They also used the same software (SPSS). We are sure that the Serbian study [51] is not ideal for comparison, but it was chosen because it was not a problem to perform the same survey among young drivers in Slovakia.

In the first three lines of the table are the first-order factors. Below them, there are six second-order factors. The last line is the overall evaluation of the respondent's answers. The letter "a" indicates lines with our correlation coefficients. The lines marked with "b" include coefficients from the foreign study [51].

As can be seen from Table 2, the correlation dependence, which can be described as large, was achieved between the factors "attentional" and "motor" (r = 0.508, p < 0.01) as well as between "non-planning" and "motor" (r = 0.513, p < 0.05).

From the second-order factors, we calculated the first-order factors, so these factors were related, and the correlation coefficients between them were very high. These dependencies had different correlation coefficients because each first-order factor had a different number of questions and, therefore, different weights of importance regarding the overall second-order factor.

In most cases, our values from the first psychological tool are higher than in the comparative study. Considering the values in detail, we found that a medium correlation existed between motor impulsiveness and self-control ($r_a = 0.436$, p < 0.01 and in the comparative study only $r_b = 0.268$, p < 0.01). Medium correlation was also found between motor impulsiveness and cognitive instability ($r_a = 0.434$, p < 0.01 and in the comparative study only $r_b = 0.131$) as well as between self-control and attention ($r_a = 0.418$, p < 0.01

and in the comparative study only $r_b = 0.018$). There were other correlations, but not above 0.4. Our results seemed to be more relevant than the comparative study because this study showed suspiciously low values of the dependence of self-control on attention and

After the first part of the evaluation, we were able to confirm hypothesis H1, the exact wording of which was "there are interrelationships between the driver's characteristics that can be revealed by the psychological tools". It was possible to reveal and evaluate these relations between characteristics with well-prepared and understandable psychological questionnaires. If we compare the results from our research with outputs from abroad, we find relatively accurate internal relationships.

3.2. DAQ Results

cognitive instability.

In our research, we also tried to use Driver Attitude Questionnaire (abbreviation DAQ). Even in this case, we did not have a more relevant study, so we used the work presented in [37]. We used the DAQ tool to identify driver's attitudes [52]. The final evaluation of this questionnaire was easy because each question influenced only one of the factors, which meant that the factors did not overlap. Each of the four factors depended on five items, so this tool had 20 questions [53–55].

Again, we did not show only our own results, but we also compared our outputs with a study from Queensland, Australia [37], in which there were 443 respondent-drivers involved. This means that the sample was approximately similar, although with different age compositions. It would be more appropriate to compare the results with similar research, but this research tool has not previously been used in the Slovak Republic and on young drivers. Therefore, we were satisfied with the use of this data bank for comparison.

The DAQ tool examines drivers' attitudes in four areas. These areas are drunk driving, close-following, dangerous overtaking, and speeding. Each respondent filled out the introductory part of the questionnaire, meaning that we had data about their offenses and traffic accidents. We were able to identify a group of drivers who had an above-average tendency to commit certain traffic offenses. The process of extracting the necessary data was not complicated as we had text answers converted to numbers. Thus, we were able to sort the data according to the committed sanctioned offenses. Similarly, we were able to evaluate the differences in results between drivers without any fines for road traffic offenses and other drivers (already sanctioned). The graph in Figure 5 shows these differences.



Average driver's rating by DAQ

Figure 5. Average rating of Driver Attitude Questionnaire (DAQ) factors according to fines. Source: processed by authors.

We were able to compare our obtained results with foreign results, in this case, with the Australian study [37]. We needed to be very careful when making an assessment. The percentage rating in our evaluation was always the opposite of that of the point evaluation. If the driver reached 90% for any factor, this showed a very positive characteristic or

attitude from the view of road safety, while in the case of point evaluation, a lower rating was better. The results of the comparative study and our research are shown in Table 3.

Table 3. DAQ results and comparison with a foreign study. Abbreviations: M = arithmetic mean; SD = standard deviation. Source: [37], processed by authors.

Factor	Compara	ble Study	Own Research			
	Μ	SD	Μ	SD		
Drunk driving (DD)	3.71	0.41	4.01	0.76		
Close-following (CF)	3.36	0.40	3.71	0.67		
Dangerous overtaking (DO)	3.27	0.48	3.04	0.71		
Speeding (R)	2.76	0.49	2.70	0.69		

As can be seen from the table, it did not matter whether we considered drivers in Slovakia or Australia because their results were very similar. In addition, the order of their tolerance to four types of offenses was the same. Slovak drivers had a higher tolerance for violating rules connected with overtaking (3.27 > 3.04) and speeding (2.76 > 2.70). On the other hand, they had a lower tolerance to drunk driving (3.71 > 4.01) and close-following (3.36 < 3.71). These differences may be due to different customs and demographic conditions and, significantly, the different infrastructure. The standard deviations (SD) were slightly different, reaching higher values in this work.

Table 4 shows a matrix of Pearson correlation coefficients. The shown values are in a two-line structure. The coefficients obtained in our research are in lines marked "a", and output coefficients from the comparative study are in lines marked "b". The matrix is symmetric—this means that coefficients below the diagonal were the same.

Factor		1	2	3	4	5	6	7	8	9	10
DAQ (DO) dangerous overtaking	a b	1									
DAQ (R) speeding	a b	0.459 ** 0.100 *	1								
DAQ (CF) close-following	a b	0.329 ** 0.370 **	0.196 ** 0.270 **	1							
DAQ (DD) drunk driving	a b	0.184 ** 0.210 **	0.024 0.210 **	0.441 ** 0.260 **	1						
Age	a b	0.039 0.111 *	$0.040 \\ -0.050$	0.149 ** 0.200 **	$0.040 \\ 0.040$	1					
Practice (years)	a b	0.050 0.600	$0.082 \\ -0.090$	0.092 0.140 **	0.007 0.030	0.769 ** 0.830 **	1				
Driving hours per week	a b	0.103 * -0.050	$0.050 \\ 0.010$	$0.020 \\ -0.020$	$-0.062 \\ -0.040$	0.041 0.100 *	0.166 ** 0.110 *	1			
Driving dist. per week	a b	$0.075 \\ -0.020$	0.111 * 0.050	0.019 0.010	-0.022 -0.100 *	0.021 0.070	0.146 ** 0.100 *	0.496 ** 0.560 **	1		
Number of traff. accidents	a b	$0.081 \\ -0.080$	0.134 ** 0.000	$0.060 \\ -0.030$	$-0.026 \\ 0.010$	0.135 ** -0.060	0.188 ** -0.070	0.147 ** 0.080	0.160 ** 0.060	1	
Fines	a b	0.092 -0.020	0.176 ** 0.100 *	$0.046 \\ -0.040$	$0.040 \\ -0.010$	0.257 ** 0.000	0.311 ** -0.040	0.184 * 0.610	0.204 ** 0.140 *	0.264 ** 0.210 **	1

Table 4. DAQ correlation matrix and comparison with a foreign study. Abbreviations: a = own study; b = comparative study. Source: [32], processed by authors.

**. Correlation is significant at the 0.01 level (two-tailed). *. Correlation is significant at the 0.05 level (two-tailed).

Most important is the mutual relation between factors and the relations of factors to other characteristics of respondents. There is a close relationship between speeding and dangerous overtaking ($r_a = 0.459$, p < 0.01), but in the comparable study, this was a lower value for an unknown reason ($r_b = 0.100$). A close relationship was also found between drunk driving and close-following ($r_a = 0.441$, p < 0.01). The foreign study did not confirm the connection between individual factors and the number of traffic accidents or fines. On the other hand, our research shows that the correlation between speeding and the number of fines was 0.176 (p < 0.01).

Table 4 shows that we obtained relatively similar relationships, especially regarding the factors. Our research also revealed a dependence between the number of traffic accidents and the factor of "speeding" ($r_a = 0.134$, p < 0.01), as well as between the distance traveled per week and the factor of "speeding" ($r_a = 0.111$, p < 0.05). We interpret this as drivers with a higher mileage having greater tolerance for violating speed limits; at the same time, people with such tolerance are more prone to accidents. An even higher dependence was shown between the number of respondents' fines and their tolerance to speed (0.176, p < 0.01).

However, the foreign study only contained information on the number of fines and traffic accidents for 12 months. We assume that this was not an appropriate input because it is difficult to find the correlation relationship when the output presents low values. The results of this paper should therefore be more accurate.

4. Discussion

Despite significant technical progress in the fields of electronics, electrical engineering, and the automotive industry, the driver is still a central factor in road safety. In [56], presented as early as 1929, it is stated that "the fight against traffic accidents will be very psychological in the future". Almost a hundred years after the writing of this sentence, we can say that it still applies. Another theory [57] states that the probability of a driver being involved in a traffic accident depends on the number of accidents they have caused in the past. In this research, we tried to estimate the development of the number of accidents by regression analysis, but we did not achieve significant results.

Our research focuses on young Slovak drivers. They are not very different from drivers in other countries. On the other hand, the environment can change their behavior. For example, there is zero-tolerance for alcohol while driving in Slovakia. We assume that this caused the higher drunk driving aversion that our research revealed. However, when discussing speeding, opinions are diverse; the border between good and bad behavior is not as clear. Fines are also graduated, with many young people willing to take the risk and possibly pay a fine. We used two tools in our article. The first was used to determine the impulsiveness of the respondents. Based on the statistical evaluation, we can say that women achieved better results in the following subfactors: self-control, perseverance, and cognitive instability. The rating of other factors was similar. It follows that the characteristics of the respondents were very similar. More impressive results were found from the second DAQ tool, which examined the driver's attitudes. We can assume that with a certain probability, we were able to identify drivers who were prone to committing traffic offenses with this method.

Before starting our research, we set two hypotheses. Based on the first evaluation of the BIS-11 tool, we could confirm hypothesis H1: "There are interrelationships between the driver's characteristics that can be revealed by some of the psychological tools". It is possible to reveal and evaluate the relations between characteristics with psychological tools such as BIS-11, DAQ, or others, such as the ADBQ (Aggressive Driving Behavior Questionnaire) described in [58–60], DBQ (Driver Behavior Questionnaire), or SCQ (Safety Climate Questionnaire) described in [60]. The traffic psychology of young drivers also affects the economy of driving and, therefore, the environment [61]. If we compare the results from our research with outputs from abroad, we find relatively accurate internal relationships. Research questions connected to this hypothesis were as follows:

What characteristics does each tool reveal?

The tools of traffic-psychological research used in this work revealed some psychological characteristics or tendencies. BIS-11 focuses on attention, cognitive instability, motor impulsiveness, perseverance, self-control, and cognitive complexity. The DAQ tool assesses drivers' tendencies to drunk driving, dangerous overtaking, speeding, and close-following.

Which pairs of respondents' characteristics have the closest relationships?

The tightness of relationships is expressed by correlation coefficients, and the two closest relationships that we have revealed in our research were BIS-11: self-control and motor impulsiveness (r = 0.436, p < 0.01); DAQ: Speeding and dangerous overtaking (r = 0.4594, p < 0.01).

What goal should the next research have?

Future research activities should aim to expand the existing database of results obtained by our experiment. The complete database of raw data is presented in an attachment to this paper. This core database makes it possible to compare results in the future. Based on this comparison, it is possible to make road safety recommendations. This study is only based on simple correlation analysis. We have tried to estimate some of the more significant dependencies by regression analysis. However, the results were not significant. Future research should also include indicators for non-linear communication measures.

Hypothesis H2 was as follows: "A psychological survey can identify a group of drivers who have a higher tendency to commit traffic offenses than the other drivers do". Based on the analysis of the research results, we could confirm this hypothesis. A group of sanctioned respondents had a higher tendency to commit offenses. They were also more tolerant to offenses connected with speeding and dangerous overtaking because their driving self-confidence was high.

Which tool is most appropriate to test the hypothesis?

The Driver Attitude Questionnaire (DAQ) was the best for this research, which, after appropriate modification, could also be used to examine the tendency towards other offenses.

Are the results similar to other studies?

The results from the two selected tools were very easily comparable. The research shows small differences, which may be due to different research conditions and demographics. Based on the correlation analysis performed in the SPSS software, we described the dependence of the respondents' traffic accidents and individual first-order factors by correlation coefficients using standardized questionnaires. These factors had the following impact on the overall results of BIS-11:

- Factor 1 "Attention" r = -0.003
- Factor 2 "Cognitive instability" r = 0.071
- Factor 3 "Motor impulsiveness" r = 0.025
- Factor 4 "Perseverance" r = 0.059
- Factor 5 "Self-control" r = 0.041
- Factor 6 "Cognitive complexity" r = -0.074

These factors had the following impact on the overall results of BIS-11:

- Factor 1 "Drunk driving" r = -0.029
- Factor 2 "Close-following" r = 0.042
- Factor 3 "Dangerous overtaking" r = 0.114; p < 0.05
- Factor 4 "Speeding" r = 0.181; *p* < 0.01

5. Conclusions

The issue of the behavior of young drivers is very pertinent. There is a great deal of government investment in various campaigns. These campaigns aim at reducing the accident rate of young drivers.

In our paper, the results of a traffic-sociological survey were presented. This survey used the BIS-11 and DAQ tools. Our research is exceptional in Slovakia because we have

used non-traditional research methods and tools. Abroad, these tools are relatively well known, but they have not been used to examine such a specific age category as drivers aged 18 to 26. We were not able to ensure the ideal sample of young people for the survey. Only university students provided information to our research. Therefore, all respondents had a similar or equal education. This limitation of our study could affect our results.

We hope that other researchers will continue in this field. They can use our database of results from our survey. Therefore, they will have our sample for comparison. It is also possible to examine drivers in other age categories. During our preparation, we have also translated the tools BIS-11 and DAQ into Slovak. The correct translation is essential for respondents' understanding and accurate results.

Our study had several limitations. During its processing, we only used a few consultations with traffic psychologists. For future research activities, it would be necessary to invite an expert or specialist in this area. We prepared this topic in an independent dissertation thesis. We consulted results and methods with a skilled traffic psychologist. Based on experience, we recommend not to use special terminology but rather simple texts without mistakes in questionnaires for ordinary users. There were also errors in our finished questionnaires. We highly recommend using only one direction of the response scales. Values such as "never", "absolutely disagree", or "false" should be on the one side; values such as "always", "absolutely agree", or "true" should be on the other side. If this condition is met, respondents can quickly answer questions. Respondents discovered this error during our survey, but it did not affect the results. We used face-to-face interactions during the process of obtaining data because we wanted to ensure reliable fulfillment. Our research took into account all completed questionnaires without exceptions.

Our study can be considered to be experimental. When attempting to make some conclusions from the research, we highly recommend obtaining more answers. On the other hand, we can see that our results revealed some implications for road safety. For example, from Table 4, it is obvious that there was a significant connection between the first and second factors for the DAQ tool. This means that young people who were used to driving fast were prone to dangerous overtaking. This quite significant correlation was not found in [32]. A similar coefficient was also found between DAQ factors 3 and 4. We can say that close-following and drunk driving are related. From this, we can deduce how road safety campaigns should look and what goals they should have. For example, the police force, road safety department of the Ministry of Transport and Construction of the Slovak Republic (BECEP), or other researchers can use the research results and calculated coefficients to compare their research results. In the future, we would like to focus our research on wider age groups of drivers. For future experiments, we should examine and use other tools. The advantages of these kinds of tools are their low costs and numerical outputs. It is also possible to compare results. We are sure that every reader of this article would be able to try to analyze the results again (for example, with SPSS) because the article has as Supplementary Material the full database of results. There is also an opportunity to select only specific respondents (with traffic accidents, for example) in a few seconds.

Supplementary Materials: The following are available online at https://www.mdpi.com/2227-739 0/9/4/433/s1, Table S1: Complete database of obtained data in traffic–psychological survey using the BIS-11 and DAQ tools.

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Appendix A

This appendix includes the whole questionnaire used by the BIS-11 tool. Its introductory text was as follows: "People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and put an X on the appropriate circle on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly". This appendix was obtained from [30].

1—Rarely	v/Never, 2—Occasionally, 3—Often, 4—Always/Always	1	2	3	4
1.	I plan tasks carefully.	0	0	0	0
2.	I do things without thinking.	0	0	0	0
3.	I make up my mind quickly.	0	0	0	0
4.	I am happy-go-lucky.	0	0	0	0
5.	I do not "pay attention".	\bigcirc	\bigcirc	\bigcirc	\bigcirc
6.	I have "racing" thoughts.	\bigcirc	\bigcirc	\bigcirc	\bigcirc
7.	I plan trips well ahead of time.	\circ	\bigcirc	\bigcirc	0
8.	I am self-controlled.	\bigcirc	\bigcirc	\bigcirc	0
9.	I concentrate easily.	\bigcirc	\bigcirc	\bigcirc	0
10.	I save regularly.	\bigcirc	\bigcirc	\bigcirc	0
11.	I "squirm" at plays or lectures.	\bigcirc	\bigcirc	\bigcirc	0
12.	I am a careful thinker.	\circ	\bigcirc	\bigcirc	0
13.	I plan for job security.	\circ	\bigcirc	\bigcirc	0
14.	I say things without thinking.	\circ	\bigcirc	\bigcirc	0
15.	I like to think about complex problems.	\bigcirc	\bigcirc	\bigcirc	0
16.	I change jobs.	\bigcirc	\bigcirc	\bigcirc	0
17.	I act "on impulse".	\bigcirc	\bigcirc	\bigcirc	\bigcirc
18.	I get easily bored when solving thought problems.	\bigcirc	\bigcirc	\bigcirc	0
19.	I act on the spur of the moment.	\bigcirc	\bigcirc	\bigcirc	0
20.	I am a steady thinker.	0	0	0	0
21.	I change residences.	0	0	0	0
22.	I buy things on impulse.	0	\circ	0	0
23.	I can only think about one thing at a time.	0	\circ	0	0
24.	I change hobbies.	0	\circ	0	0
25.	I spend or charge more than I earn.	0	0	0	0
26.	I often have extraneous thoughts when thinking.	0	0	0	0
27.	I am more interested in the present than the future.	0	0	0	0
28.	I am restless at the theater or lectures.	0	0	0	0
29.	l like puzzles.	0	0	\bigcirc	0
30.	I am future oriented.	0	0	0	0

Appendix **B**

This appendix includes the whole questionnaire used by the DAQ tool. Its introductory text was as follows: "Read each statement and put an X on the appropriate circle on the right side of this page. Answer quickly and honestly". This appendix was obtained from [62].

	1—Strongly disagree, 5—Strongly agree	1	2	3	4	5
1.	On the whole, people are not aware of the dangers involved in close following.	0	0	0	0	0
2.	It is hard to have a good time if everyone else is drinking but you have to limit yourself because you are driving	0	0	0	0	0
3.	I would be happier if speed limit regulations were more strictly applied	0	0	0	0	0
4.	The aim of the police should be to stop as many drink drivers as possible.	0	0	0	0	0
5.	I think it is OK to overtake in risky circumstances as long as you drive within your own capabilities.	0	0	0	0	0
6.	Even one drink makes you drive less safely.	0	\bigcirc	\bigcirc	\bigcirc	\bigcirc
7.	I would be happier if close following regulations were more strictly applied.	0	0	0	0	0
8.	People stopped by the police for speeding are unlucky because lots of people do it.	0	0	0	0	0
9.	I know exactly what risks I can take when I overtake.	0	0	0	0	0
10.	Some people can drive safe after drinking three pots of beer.	0	0	0	0	0
11.	Close following is not really a serious road safety problem.	0	0	0	0	0
12.	I think the police should start breath analyzing a lot more drivers around pub closing times.	0	0	0	0	0
13.	Speed limits are often set too low, with the result that many drivers ignore them.	0	0	0	0	0
14.	Some drivers can be perfectly safe overtaking in situations which would be risky for others.	0	0	0	0	0
15.	Harsher penalties should be introduced for drivers who drive too close to the car in front.	0	0	0	0	0
16.	The aim of the police should be to stop as many people as possible overtaking in risky circumstances	0	0	0	0	0
17.	Some people can drive safe with only a small gap.	0	0	0	0	0
18.	I know exactly how fast I can drive and still drive safely.	\bigcirc	\bigcirc	\bigcirc	0	0
19.	Dangerous overtaking is not really a serious road safety problem.	0	0	0	0	0
20.	Sometimes you have to drive in excess of the speed limit in order to keep up with the flow of traffic.	0	0	0	0	0

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