applied sciences

MDPI

*Article*

# Usability of Certain Symbols Indicating Automobile Safety Status Based on Youth Assessment

**Uros Manojlovic [1], Aleksandar Zunjic [2], Aleksandar Trifunović [3], Tijana Ivanišević [4], Darina Duplakova [5,*], Jan Duplak [5] and Svetlana Čičević [3]**

1 Industrijska Oprema d.o.o., 11000 Belgrade, Serbia
2 Faculty of Mechanical Engineering, University of Belgrade, 11000 Belgrade, Serbia
3 Faculty of Transport and Traffic Engineering, University of Belgrade, 11000 Belgrade, Serbia
4 Department in Kragujevac, Academy of Professional Studies Sumadija, 34000 Kragujevac, Serbia
5 Faculty of Manufacturing Technologies with a Seat in Presov, Technical University of Kosice, 08001 Presov, Slovakia
* Correspondence: darina.duplakova@tuke.sk

**Abstract:** The research presented in this paper refers to the possibility to understand the information presented by symbols, which indicate safety status and possible troubles regarding automobiles and driving. The testing included sixteen symbols, six of which were ISO-verified and recommended symbols. The study included 204 youth respondents. The study used a multidisciplinary, ergonomic approach, based on research of the usability of symbols. The basic task of subjects was to recognize the symbols and to rate their confidence on the five-point scale that they gave exact answers. For each symbol, hypotheses about the proportion of correct answers at the population level were tested, applying the inferential statistics technique. The ISO criterion of 67% successful symbol recognition was adopted as the limit value for the justification of the use of symbols. The test results showed that eight out of sixteen symbols did not meet this criterion. The results of this research indicate that it is necessary to take certain measures in order to improve the understanding of the function of symbols on vehicle dashboards. One of the proposed measures consists in the improvement of training courses in driving schools, which from a theoretical but also a practical aspect should include education about symbols on car dashboards, primarily those responsible for informing about the safety status. In addition, a redesign of the symbols that had the lowest recognition rate can be recommended.

**Keywords:** automobile safety; symbols; vehicle dashboard; assessment



**Citation:** Manojlovic, U.; Zunjic, A.; Trifunović, A.; Ivanišević, T.; Duplakova, D.; Duplak, J.; Čičević, S. Usability of Certain Symbols Indicating Automobile Safety Status Based on Youth Assessment. *Appl. Sci.* **2023**, *13*, 9749. https://doi.org/10.3390/app13179749

Academic Editors: Dimitris Mourtzis and Mohamed Benbouzid

Received: 2 June 2023
Revised: 14 July 2023
Accepted: 25 August 2023
Published: 29 August 2023



## 1. Introduction

According to [1], symbols are visual elements that hold meaningful significance within a specific context and transmit the crucial information that needs to be shared. The most recent car screens possess the ability to display a wide variety of icons. Nowadays, the prevalence of compact screens for displaying information in vehicles is on the rise [2–4]. Despite their seemingly compact size, these displays are intentionally designed to reduce distractions and primarily use symbols to communicate crucial information to the passengers in the vehicle. As electric and self-driving vehicles become more and more popular, the display systems that are part of these vehicles will become increasingly important and complex, playing a major role in the overall driving experience. In connection with the previous, drivers' perception has been taken into account in the field of using instrument panels, driver behavior, safety assessment using driving simulators and field data, as well as surrogate safety measures (see for example [5–14]).

Important characteristics of symbols are concreteness, complexity, meaningfulness, familiarity, and semantic distance [15]. The driver's interaction with the symbol can be considered as a two-step process. First, the driver should recognize what the symbol stands for, i.e., what entity is depicted on the symbol. Next, the driver should understand

(comprehend) the information conveyed by the symbol in connection to the entity depicted. However, a lot of symbols are designed in such a way that differentiating between the mentioned processes with their separate applications becomes impractical. This leads to a simultaneous attempt to comprehend and recognize the meaning of these symbols [16].

Warning and trouble symbols are indicators used in automobiles to alert drivers of potential issues with their vehicles. These symbols are typically found on the dashboard of the car and can be illuminated in either red or yellow. The symbols used on automotive displays are rarely studied and not easy to find in the scientific literature. In our search for research of this kind, we discovered a technical paper [17] which had been written in 1988. This research involved only ISO-approved and designed symbols. These symbols were specified in SAE J1048 MAR80 and originally adopted from the ISO-2575 [18] symbol set. The names of the symbols presented in this research are horn, battery, turn signal, trunk, fuel, high beam, fan, oil, hood, low beam, temperature, w/s wipe, w/s wash, w/s wash/wipe, parking lights, rear defrost, cigarette lighter, headlamp cleaner, hazard warning, w/s defrost, master lighting, unleaded fuel only, front fog lights, choke, and rear fog lights. Authors in [17] did not classify the symbols according to their function. The only criterion for the selection of those symbols was that they were ISO-approved symbols. The research suggests a weak understanding of car display symbols, with a relatively higher level of recognition. According to this paper, the symbol with the highest percentage of correct recognition was the symbol for horn, with 97% of participants recognizing it correctly. The symbol with the lowest percentage of correct recognition was the symbol for rear fog lamps, with only 1.2% of participants recognizing it correctly (in the first part of the research). However, even in reference [17], which was published in cooperation with the well-known institution SAE (Society of Automotive Engineers), there is no reference to any previous paper on this topic that has been published in a journal or conference proceedings.

There was also research where not only ISO items were studied. The research in [14] conducted a comprehension test with 120 participants to assess the ability of different icons to communicate the message of tire underinflation. A total of 16 icons were presented to the participants, including two existing ISO symbols for tires, 13 proposed alternative symbols, and an existing dashboard icon representing an engine. The engine icon was included as a baseline to compare the comprehension of the tire pressure icons with a familiar and commonly used dashboard icon. The results of the test showed that all of the thirteen alternative icons had better comprehension than the ISO icons, with six of thirteen having 100% comprehension and two of thirteen having 87.5% comprehension.

One newer research work [6] included icons on dashboard panels that were designed by various car manufacturers. In this study, a variety of icons were tested (although the names of these icons were not mentioned) related to automation mode that were not standardized across different manufacturers of SAE level 2 vehicles and SAE level 3 vehicles. Seven participants were recruited for this research. The study aimed to determine whether these non-standard icons could be recognized and understood by the driving public and to identify any potential risks associated with the misinterpretation of these icons. The results of the study showed that while most participants were able to accurately interpret the meaning of the icons related to automation mode, there were some variations in interpretation based on the design of the icons and the participants' prior knowledge and experience with automation systems.

Another newer research work also considered symbols that were not part of any standard. The symbols used in this research [2] were designed by two different groups. The first set of three icons examined in the ITS laboratory was designed by the employees of the Motor Transport Institute or ITS. The other set of three different pictograms used in Solaris was designed by engineers from Solaris, and there were also an additional three symbols tested that were implemented in devices known as MobilEye Shield+. The results of this research showed varying levels of comprehension with respect to the studied icons. Firstly, the red car and red pedestrian icons were the most well-understood, receiving the highest recognition rates among the participants. These two symbols were clear in

indicating an imminent dangerous situation, thanks to their explicit depiction of the type of threat (vehicle or pedestrian) and the use of red to signal danger. On the other hand, the steering wheel on a yellow background and the lane departure icon were found to be less comprehensible, scoring the lowest ratings (3.2 of 5 in both cases). These icons were less clear in their representation of a warning signal, resulting in lower comprehension amongst the participants. Moreover, it was observed that participants often misinterpreted the "hands on wheel" icons, as they understood it to mean they needed to physically place their hands on the wheel when the icons appeared, which was not the intended message. So, the research indicated a need for further study concerning icon design to ensure the intended messages are accurately conveyed to their recipients.

More recent research on this topic [16] related to symbols that indicate car failure has shown that subjects poorly recognize this type of symbol. This research involved symbols such as brake, engine coolant temperature, engine oil, and battery charging condition. No symbol in this research had a percentage of correct responses that was higher than 65%. Also, two recent studies [19,20] tested the usability of different groups of symbols indicating the lighting status of cars. The study in [19] involved symbols such as master lighting switch, exterior bulb failure, long-range lamp, and automatic headlight dimmer indicator, while the research in [20] included symbols tail light out, front fog light, headlamp leveling control, and daytime running lights. There was insufficient success in recognizing these symbols and their purpose in both of the previous studies mentioned. No symbol in [19] had a percentage of correct responses higher than 70.97%, while no symbol in [20] had a percentage of correct responses that was higher than 61.3%. Research in [16,19,20] included both ISO-verified symbols, as well as symbols that are used by certain car manufacturers. As it can be noticed, refs. [1–20] did not involve dashboard symbols indicating automobile trouble and safety status.

### 1.1. Goal of the Research

Modern cars are equipped with displays that show various symbols providing drivers with crucial information about their vehicle's condition, driving mode, and road state. Despite this, it was noted that certain drivers do not effectively utilize all the information that is accessible to them. A possible explanation for that is in part connected with the misinterpretation of the symbols on displays as a result of a failure to comprehend the meaning conveyed by them.

In order to test whether drivers understand the displayed vital information, 16 symbols that convey information about safety and possible troubles regarding driving were selected. After extensive literature research, we did not succeed in finding any research that previously involved these symbols indicating trouble and safety status. Studying the usability of these symbols is of particular importance, because failing to comprehend the information that they convey can cause serious damage to cars, traffic accidents, injuries, as well as possibly fatal outcomes. For the driver, it is very important not only to recognize which element is displayed by the icon, but what safety issue is presented by the symbol. However, even if the driver is not familiar with the symbols, a well-designed symbol ought to effectively communicate the information.

### 1.2. Safety Symbols Used in This Research

As previously mentioned, in order to verify the adequacy of the design solutions for the symbols used on car displays, 16 symbols indicating car safety and troubles connected with driving were selected. The chosen symbols represent very important information to the driver which influences the safety of occupants, other participants in traffic, and the vehicle itself. The names and descriptions of the basic functions of these symbols are as follows:

*1. Airbag (according to ISO 7000-2108 standard [21])*

An airbag warning symbol is a dashboard light that notifies drivers if there is something wrong with their car's airbag system. Normally, the light turns on for a few seconds each time the car is started to indicate that the system is working properly, after which it should turn off. However, if it remains lit, it may suggest a problem with one of the many airbags in the vehicle that needs to be fixed soon. This alert is important because if the indicator is on and the airbag system is compromised, the safety of the car's occupants is at risk in the event of a crash.

*2. Engine stop indicator*

The engine stop symbol indicates a serious engine issue that requires the engine to be shut down. This could be due to a variety of reasons such as low oil pressure, engine overheating, or, for example, a malfunctioning sensor. This light may be accompanied by an audible alarm or chime. This indicator is important because it alerts the driver to stop the vehicle and take necessary action to prevent further damage to the engine. It is crucial for the driver to respond to the engine stop indicator immediately to avoid potential accidents and costly repairs. The driver should seek professional assistance from a qualified mechanic.

*3. Check gauges indicator*

The check gauges symbol in automobiles is a warning light that appears on the dashboard. It is designed to alert the driver that one or more of their vehicle's essential systems are not functioning correctly. Typically, the indicator will illuminate when one of the gauges, such as the oil pressure or temperature, is indicating a problem. If the check gauges indicator appears, the driver should stop their vehicle as soon as possible and assess the issue to avoid further damage or potential accidents.

*4. Immobilizer system indicator*

The immobilizer system symbol is a security feature installed in automobiles to prevent theft. It is a warning light on the dashboard that indicates whether the vehicle's security system is active or not. When the key is inserted, the immobilizer system checks whether it matches the vehicle's code. If there is a match, the engine is allowed to start, indicating the system is inactive. However, if the code does not match, the engine will not start, indicating the system is active, and the dashboard will show an immobilizer system indicator.

*5. Auto door lock malfunction indicator*

The auto door lock failure symbol is an alert signal that appears on the instrument panel when there is a problem with the auto door locking system. This might result from a defective sensor, a compromised lock apparatus, or wiring complications. Addressing this alert is crucial due to the potential safety hazards it presents. Drivers should bring their vehicles to a reliable technician for prompt diagnosis and resolution of the issue.

*6. Transmission failure (according to ISO 7000-1396B standard [22])*

This is a powertrain trouble symbol. The transmission failure symbol is a warning signal that appears on the dashboard of an automobile indicating a problem with the transmission system. The transmission system is responsible for transmitting power from the engine to the wheels of the vehicle. Therefore, any issues with the transmission system can affect the performance of the vehicle and can also lead to accidents. Early detection of transmission problems can prevent further damage to the transmission system and other related components.

*7. Transmission oil temperature (according to ISO 7000-1168B standard [23])*

The transmission oil temperature symbol provides information on whether the transmission system is functioning correctly and alerts the driver when the transmission oil is overheating. Overheating can cause significant damage to the transmission system, which can be expensive to repair. The transmission oil temperature indicator helps to identify potential issues before they become major problems.

*8. Steering failure (according to ISO 7000-2441 standard [24])*

The dashboard of an automobile also contains a warning indicator in the form of a steering failure symbol, which serves to alert the driver to any potential problems with

the steering system. The symbol usually looks like a steering wheel with an exclamation point or some other type of cautionary sign. It is important to take immediate action when the symbol appears on the dashboard in order to avoid any further damage to the steering system. If the necessary steps are not taken, it can lead to a lack of steering control, which can be particularly hazardous when traveling at high speeds. This can cause serious safety risks and should be avoided at all costs.

*9. Loose wheel warning indicator*

This warning symbol is designed to alert the driver that one or more of the wheels are loose or not properly secured. Several factors can affect the activation of the loose wheel warning symbol indicator. Loose lug nuts or bolts due to improper installation or wear and tear can cause this warning symbol to appear. Checking for this warning symbol can help drivers maintain their vehicles and ensure their safety on the road.

*10. Electric park brake trouble indicator*

The electric parking brake system is in charge of automatically activating the parking brake when the vehicle comes to a halt, and it also prevents the vehicle from moving when parked. If the electric park brake warning symbol is turned on, it usually indicates a problem within the system that requires attention. This could be due to a malfunctioning switch, a faulty wiring connection, or a problem with the brake actuator. In some cases, the indicator may also be illuminated if the parking brake has not been fully released before the vehicle is driven. If the electric park brake trouble indicator is illuminated, the driver should take the vehicle to a qualified mechanic for diagnosis and repair.

*11. Brake fluid level (application of ISO 7000-1401 standard [25])*

The brake fluid level symbol is an indicator on the dashboard of automobiles that is used to indicate the amount of brake fluid in the vehicle's brake system. This symbol is typically a circle with a wavy line running through it. The line is usually red and indicates that the brake fluid level is low. A low level of brake fluid can cause the brakes to fail.

*12. Antilock braking system trouble*

A safety feature commonly found in contemporary vehicles, the antilock braking system (ABS) aids drivers in maintaining control during emergency braking circumstances. By utilizing sensors to identify when a wheel is on the verge of locking during forceful braking, the ABS system automatically adjusts brake pressure to avert wheel lock-up. When the ABS system is malfunctioning, a warning symbol will appear on the dashboard of the vehicle. If this warning light appears, it is important to have the ABS system checked by a qualified mechanic as soon as possible.

*13. Lambda sensor warning indicator*

A lambda sensor warning symbol on a car's dashboard serves as an alert for the driver regarding a potential issue in the vehicle's exhaust system. Also referred to as an oxygen sensor, the lambda sensor is an apparatus that measures the oxygen levels present in the exhaust system. As part of the vehicle's emissions control system, it ensures that the vehicle runs efficiently while producing minimal emissions. If the lambda sensor identifies an issue, it transmits a message to the car's computer, causing the lambda sensor alert symbol to appear on the dashboard. If the issue is left unattended, it may result in additional harm to the automobile's exhaust system and could potentially lead to failing emissions examinations.

*14. Message indicator*

A message symbol on the dashboard of an automobile is an indicator that usually warns that something is wrong with the vehicle. This symbol usually appears in yellow color and can be accompanied by a message that explains what the problem is. When this symbol appears, it is important to take the vehicle to a qualified mechanic as soon as possible to have the issue addressed. Ignoring the message symbol can lead to more serious problems, such as engine damage or a breakdown.

*15. Engine coolant level (according to ISO 7000-2429 standard [26])*

The low engine coolant level warning symbol is an indicator on the dashboard of automobiles that alerts the driver when the engine coolant level is low. The engine coolant

is a liquid that helps to keep the engine cool and prevent it from overheating. When the engine coolant level is too low, the engine can overheat, which can cause serious damage to it and to other components of the vehicle.

*16. Electronic throttle control indicator*

The car's dashboard usually features an electronic throttle control warning symbol meant to alert drivers to issues with the electronic throttle control system. Unintended acceleration can result from software or electronic problems within this system. If the warning light comes on, it indicates that the electronic throttle control system is not functioning properly, and the vehicle should be taken to a professional mechanic for further examination and repairs.

## 2. Materials and Methods

Three basic criteria were applied during the selection of symbols that will be tested. First, it was important to involve standardized symbols. On that basis were selected ISO-verified symbols. The second criterion was to include symbols that are nonstandardized, but that are often applied in practice. On that basis, symbols that are used by reputable car manufacturers were selected. These symbols have been applied in many models of automobiles that they produce. The selected manufacturers have had a considerable car market share. The third criterion for selecting those symbols was the possible lack of clarity of the information that these symbols convey at first glance and their possible ability to convey unforeseen information during recognition. For that purpose, an informal pilot study with a set of safety symbols has been conducted with a smaller group of participants that were not included later in the main study, in order to select which symbols satisfy these criteria. On that basis, 16 symbols were selected for testing: 6 ISO-verified symbols and 10 symbols designed by reputable automobile manufacturers.

In order to test the previously described symbols that are shown in Table A1 in Appendix A, usability research was designed. Usability, a widely known concept, finds extensive application in the ergonomic design and evaluation of various products and systems [27]. Usability is mainly concerned with the ease of use, learnability, satisfaction, efficiency, and error prevention during the use of a product, system, or selected element of interface. Usability has become an important factor in the design and assessment of the elements with which humans interact. Usability testing has evolved from strict experimental psychology methods to less controlled and more qualitative methods [28]. Usability testing rests upon the basis of research techniques like classical experiments. There are different variations of testing methods that vary from extensive classical experiments to less formal qualitative studies, which may involve just one participant [29]. Below, we will describe a usability experiment that was used to determine the usability of 16 described symbols which are used on car displays. Usability assessment was carried out through an assessment of the errors during the recognition of the selected symbols (i.e., by the number of errors that users made in the recognition of symbols and their functions). Previous studies [16,17,19,20] that included various symbols also used this criterion as a basis for the assessment of the successfulness of the design of symbols.

The study included 204 respondents, with an average age of 24.48 years (SD = 5.95). In the analyzed sample, the share of male respondents is 29.9%, while the share of female respondents is 70.1%. The sample was selected using a random sampling method, so the disproportion between males and females is most probably due to chance (response to the invitation to participate in this voluntary survey was greater by women than men). The largest percentage of respondents in terms of occupation were students at 71.1%, 27.5% were employed persons, while 1.5% of the analyzed sample consisted of unemployed persons. A total of 62% of respondents had a driver's license, while 37.3% did not. The largest percentage of respondents had a driver's license for 2 to 5 years (59.46%). A total of 85.9% of respondents reported participating in driving 1 to 3 times a week. From the respondents, certain other demographic data were also gathered.

The respondents were youths. A youth person can be defined in various ways. We adopted the attitude of United Nations Habitat (Youth Fund), which considers persons aged 15–32 as youths [30]. Although the youth drivers were selected, the sample was random within that category. Due to the youth group of drivers having undergone modern driving courses, their training instructions and content were believed to be up-to-date and relevant, resulting in their selection for testing. Every respondent took part voluntarily.

At the beginning of the survey, participants were made aware of its objective. They then proceeded to complete the survey independently via an online form. The primary responsibility of the respondents was to identify the symbol and its associated information. For each symbol, three possible answers were provided, with only one being correct. Table A1's third column (Appendix A) lists the answers, while the fourth column indicates the right response. Participants were asked to select the correct answer from the available choices (a, b, or c). They were also asked to rate their certainty in their chosen responses on a scale of 1 (least confident) to 5 (most confident). This applies to all responses they submitted, regardless of their accuracy. Participants were instructed to denote their confidence in their selected answer by marking the corresponding number on a 1-to-5 scale.

There was an additional objective in mind when choosing the options for the responses that were offered. The selection process was carried out with a specific intention, beyond just providing choices for the respondents. Unlike other symbol-based research that often provides irrelevant names along with the symbol's meaning, this research focuses primarily on names that have a more or less some kind of connection to the symbol's possible meaning. In addition to offering the exact meaning of the symbol, this study aims to provide more relevant and effective names that could resonate to a certain extent with the symbol's intended message (but which, in essence, are not representing the exact meaning of the symbol). The aim was to assess the efficacy of a specific symbol in conveying exact information and the possibility of misinterpretation of the symbol's function by the respondent. Besides this concise description of the procedure, for additional information, if necessary, the reader may consult [16,19,20], where a similar procedure was applied.

Respondents' answers were collected through an online questionnaire using Google Forms, and then imported into MS Excel. After the import, the data were analyzed and validated. Then a statistical analysis of the obtained data was performed in IBM SPSS Statistics v.22.

## 3. Results and Analysis of Results

Table A2 in Appendix A shows the percentage of correct answers for each symbol tested. The table's "average" column reflects respondents' average rating on a 1–5 scale, accounting for those who provided correct answers and believe in their accuracy. The standard deviation column in the table indicates the standard deviation in relation to the respondents' self-reporting that they provided the right answer, taking into account only those who provided correct answers.

Table 1 shows the percentage of incorrect answers for each symbol tested. The table's "average" column reflects respondents' average rating on a 1–5 scale, accounting for those who provided incorrect answers and believe in their accuracy. The standard deviation column in the table indicates the standard deviation in relation to the respondents' self-reporting that they provided the right answer, taking into account only those who provided incorrect answers. This means that they believe that they have given the correct answer, but the answer is actually wrong.

The results show that respondents who have a driver's license have a slightly higher percentage of correct answers (73.43%) to the questions asked about the meaning of the symbol, compared to drivers who do not have a driver's license (73.25%). The results of symbol recognition also indicate that respondents with a higher percentage of success recognize symbols that are defined according to the ISO standard (73.34%), compared to symbols that are not defined according to the ISO standard (61.49%). Symbols that are not ISO-verified symbols are in essence symbols that various car manufacturers are

using when designing the instrument panel in the cabin. The respondents answered the question about the ISO 7000-2441 [24] "Power steering trouble indicator" symbol with the highest percentage of correct answers, while the respondents answered the question about the ISO 7000-1401 [25] "Low brake fluid indicator" symbol with the lowest percentage of correct answers.

**Table 1.** Percentage of incorrectly recognized symbols, and the average and standard deviation of respondents' belief that the symbol has the meaning given in their answer, for the respondents who gave incorrect answers.

| Symbols | Percent of Incorrect Answers [%] | Awerage (Taking Into Account Only the Incorrectly Chosen Options) | Standard Deviation (Taking Into Account Only the Incorrectly Chosen Options) |
|---|---|---|---|
| 1. Airbag | 13.73 | 4.89 | 0.31 |
| 2. Engine stop indicator | 20.59 | 4.21 | 0.84 |
| 3. Check gauges indicator | 17.65 | 4.27 | 0.94 |
| 4. Immobilizer system indicator | 38.24 | 3.11 | 1.47 |
| 5. Auto door lock malfunction indicator | 87.75 | 3.20 | 1.20 |
| 6. Transmission failure | 40.2 | 4.10 | 1.24 |
| 7. Transmission oil temperature | 29.91 | 2.73 | 1.40 |
| 8. Steering failure | 6.87 | 5.0 | 0 |
| 9. Loose wheel warning indicator | 8.83 | 4.77 | 0.42 |
| 10. Electric park brake trouble indicator | 51.96 | 3.54 | 1.31 |
| 11. Brake fluid level | 53.88 | 3.43 | 1.03 |
| 12. Antilock braking system trouble | 79.41 | 3.09 | 1.35 |
| 13. Lambda sensor warning indicator | 24.51 | 3.1 | 1.18 |
| 14. Message indicator | 27.45 | 1.87 | 0.78 |
| 15. Engine coolant level | 15.69 | 4.12 | 0.33 |
| 16. Electronic throttle control indicator | 34.31 | 2.74 | 1.01 |

Table A2 in Appendix A shows the results based on the sample selected. However, if we are interested in the situation on this issue at the population level, it is necessary to test certain statistical hypotheses, using the inferential statistics technique (in addition to the use of the appropriate basic statistical test). We will now test the "Airbag" symbol. We will set the null hypothesis as follows: The population proportion of people who correctly identify the "Airbag" symbol is $\leq$0.82. We will formulate the alternative hypothesis as follows: The population proportion of people who correctly identify the "Airbag" symbol is >0.82. The Z-test for one population proportion will be employed in order to analyze the data. This parametric test assumes that the data follow a normal distribution. The Z-test for one population proportion is a statistical method that allows making assumptions about the population using sample data. In the case of a right-tailed test, the significance level is fixed at 0.05, which means the probability of obtaining a test statistic higher than the critical value of 1.645 is 0.05. The null hypothesis is rejected if the z-score surpasses 1.645, indicating a region to the right of it. The z-score has been determined to be 1.59. As the z-score, z = 1.59, does not exceed the critical z-value, $z_c$ = 1.645, the null hypothesis cannot be dismissed. This implies that there is not enough evidence from the observed data to reject the null hypothesis. In addition, using the *p*-value method, a *p*-value of 0.0562 is computed. As the value is equal to or exceeds 0.05, it can be deduced that the null hypothesis cannot be dismissed. From the information given, we are unable to determine with 95% certainty that the population proportion *p* surpasses 0.82. In essence, there is inadequate evidence to propose that the population proportion *p* exceeds 0.82 at a significance level of $\alpha$ = 0.05.

The Z-test for one population proportion with the parallel application of the inferential statistics technique for the determination of the proportion $p_0$ will be employed in order to analyze the data for all other symbols. The analysis will be given in compact form in Table 2. This analysis is performed in the same manner as shown above for the Airbag symbol.

**Table 2.** Application of the Z-test for one population proportion in order to determine the proportion of people who will recognize the safety symbol on a car instrument panel, taking into account the youth population.

| Symbols | Null Hypothesis about the Population Proportion | z-Score | Critical z-Value | Decision Based on the z-Score | *p*-Value | Decision Based on the *p*-Value |
|---|---|---|---|---|---|---|
| 1. Airbag | The proportion of people who correctly identify the symbol is $\leq$0.82 | 1.59 | 1.645 | Null hypothesis is not rejected | 0.0562 | Null hypothesis is not rejected |
| 2. Engine stop indicator | The proportion of people who correctly identify the symbol is $\leq$0.75 | 1.45 | 1.645 | Null hypothesis is not rejected | 0.0729 | Null hypothesis is not rejected |
| 3. Check gauges indicator | The proportion of people who correctly identify the symbol is $\leq$0.78 | 1.50 | 1.645 | Null hypothesis is not rejected | 0.0668 | Null hypothesis is not rejected |
| 4. Immobilizer system indicator | The proportion of people who correctly identify the symbol is $\leq$0.57 | 1.37 | 1.645 | Null hypothesis is not rejected | 0.0848 | Null hypothesis is not rejected |
| 5. Auto door lock malfunction indicator | The proportion of people who correctly identify the symbol is $\leq$0.09 | 1.62 | 1.645 | Null hypothesis is not rejected | 0.0524 | Null hypothesis is not rejected |
| 6. Transmission failure | The proportion of people who correctly identify the symbol is $\leq$0.55 | 1.38 | 1.645 | Null hypothesis is not rejected | 0.0841 | Null hypothesis is not rejected |
| 7. Transmission oil temperature | The proportion of people who correctly identify the symbol is $\leq$0.65 | 1.52 | 1.645 | Null hypothesis is not rejected | 0.0637 | Null hypothesis is not rejected |
| 8. Steering failure | The proportion of people who correctly identify the symbol is $\leq$0.9 | 1.49 | 1.645 | Null hypothesis is not rejected | 0.0681 | Null hypothesis is not rejected |
| 9. Loose wheel warning indicator | The proportion of people who correctly identify the symbol is $\leq$0.88 | 1.39 | 1.645 | Null hypothesis is not rejected | 0.0818 | Null hypothesis is not rejected |
| 10. Electric park brake trouble indicator | The proportion of people who correctly identify the symbol is $\leq$0.43 | 1.45 | 1.645 | Null hypothesis is not rejected | 0.0734 | Null hypothesis is not rejected |
| 11. Brake fluid level | The proportion of people who correctly identify the symbol is $\leq$0.49 | 1.39 | 1.645 | Null hypothesis is not rejected | 0.0816 | Null hypothesis is not rejected |
| 12. Antilock braking system trouble | The proportion of people who correctly identify the symbol is $\leq$0.17 | 1.37 | 1.645 | Null hypothesis is not rejected | 0.0861 | Null hypothesis is not rejected |
| 13. Lambda sensor warning indicator | The proportion of people who correctly identify the symbol is $\leq$0.71 | 1.41 | 1.645 | Null hypothesis is not rejected | 0.0788 | Null hypothesis is not rejected |
| 14. Message indicator | The proportion of people who correctly identify the symbol is $\leq$0.68 | 1.39 | 1.645 | Null hypothesis is not rejected | 0.0818 | Null hypothesis is not rejected |
| 15. Engine coolant level | The proportion of people who correctly identify the symbol is $\leq$0.8 | 1.54 | 1.645 | Null hypothesis is not rejected | 0.0619 | Null hypothesis is not rejected |
| 16. Electronic throttle control indicator | The proportion of people who correctly identify the symbol is $\leq$0.61 | 1.37 | 1.645 | Null hypothesis is not rejected | 0.0848 | Null hypothesis is not rejected |

*Analysis of Certain Factors of Potential Influence on the Recognition of the Safety Symbols*

It is important to consider whether certain factors, such as the possession of a driver's license, frequency of participation in driving (1–3 times a week; 4–7 times a week; 1–3 times a month; once every few months; not driving a car at all), and the number of explained symbols on the dashboard of the car (1–5; 6–10; 11–15; 16–20; over 20) during training at the driving school could have an influence on the distribution of the results. In connection with that, the following null hypotheses will be set:

- There are statistically significant differences in the recognition of symbols that indicate the state of safety of the vehicle depending on the subject's possession of a driver's license.
- There are statistically significant differences in the recognition of symbols that indicate the state of safety of the vehicle depending on the frequency of participation in driving.
- There are statistically significant differences in the recognition of symbols that indicate the state of safety of the vehicle depending on the number of explained symbols during training at the driving school.

Considering all the above-stated hypotheses, the normality of distribution was tested by inspection of histograms and the Kolmogorov–Smirnov test. Bearing in mind that the results were normally distributed, we used parametric methods. The following tests were used to assess statistical significance: Independent Samples T-Test and One-way ANOVA.

Regarding the first hypothesis concerning the possible influence of the possession of a driver's license, although there were certain differences in the success of recognition of symbols between these two groups of participants in percent, the results of the Independent Samples T-Test show that there exists a statistically significant difference between respondents who have and do not have a driver's license in the case of recognizing the Electric park brake trouble indicator symbol, which is not defined according to the ISO standard (F = 0.030; $p$ = 0.014).

Regarding the second hypothesis concerning the potential influence of driving frequency on success in symbol recognition, the effect was analyzed using a one-way ANOVA test. The results show a significant statistical difference between drivers with different driving frequencies in relation to the success in recognizing one symbol according to the ISO standard—Transmission oil temperature warning (F = 2.765; $p$ = 0.043), as well as concerning one symbol that is not defined by the ISO 2575 standard [18]—Auto door lock malfunction indicator (F = 5.620; $p$ = 0.001). The Eta squared for the symbol Transmission oil temperature warning is 0.04, while for the symbol Auto door lock malfunction indicator, it is 0.08. The size of the effect is indicated as medium.

Regarding the third hypothesis, concerning the potential influence of the number of explained symbols during training at the driving school on the number of recognized symbols, was also used one-way ANOVA for testing. The results show a statistically significant difference related to the influence of the number of explained symbols in driving schools on symbol recognition in relation to one symbol that is not defined by the ISO 2575 standard [18]—Electric park brake trouble indicator (F = 4.027; $p$ = 0.004). The Eta squared is 0.1, and the effect size is small.

## 4. Discussion

It is important to underscore the selection process of $p_0$ values during the examination of statistical hypotheses through Z-tests for one population proportion. As mentioned earlier, for this purpose, the inferential statistics technique was used. Inferential statistics is a type of statistical analysis that is used to make predictions or inferences about a population based on a sample. It involves using data from a sample to draw conclusions about the population as a whole. This technique is used to make decisions and predictions about a population based on a smaller sample size. This means that the stated values for the proportion $p_0$ (0.82, 0.75, 0.78, 0.57, 0.09, 0.55, 0.65, 0.9, 0.88, 0.43, 0.49, 0.17, 0.71, 0.68, 0.8, and 0.61) were obtained for each symbol individually based on the calculation. To achieve this, the Z-test for one population proportion was applied iteratively until a $p_0$ limit

value was reached for each symbol, where the set null hypothesis could not be rejected. In other words, it means that in the population, the percentage of correct understanding for the symbol "Airbag" cannot be expected to be higher than 82%, as well as that the percentage of correct understanding in the population for the symbol "Engine stop" cannot be expected to be greater than 75%, etc. It should be mentioned that in all computations pertaining to the Z-test application for a single population proportion, the conditions for sample size have been met, with $np > 5$ and $n(1 - p) \geq 5$ ($n \geq 30$). This indicates that the population-level predictions can be deemed statistically valid.

In connection with the foregoing, based on the conducted analysis of all tested symbols, it can be deduced that there is not enough evidence to conclude that the percent of the youth population $p$ who can, at a significance level of 5%, correctly recognize the following symbols is greater than:

- 82% for the Airbag symbol;
- 75% for the Engine stop symbol;
- 78% for the Check gauges symbol;
- 57% for the Immobilizer system symbol;
- 9% for the Auto door lock malfunction symbol;
- 55% for the Transmission failure symbol;
- 65% for the Transmission oil temperature symbol;
- 90% for the Steering failure symbol;
- 88% for the Loose wheel warning symbol;
- 43% for the Electric park brake trouble symbol;
- 49% for the Brake fluid level symbol;
- 17% for the Antilock braking system trouble symbol;
- 71% for the Lambda sensor warning symbol;
- 68% for the Message symbol;
- 80% for the Engine coolant level symbol;
- 61% for the Electronic throttle control symbol.

This kind of analysis can be found in recent analyses of car dashboard symbols [16,19,20], but it was not previously performed in other research on symbols. However, much research on car dashboard symbols does not include the application of statistical tests for making conclusions. For example, Ref. [2] does not explicitly mention any hypothesis testing that was conducted by using statistical tests. The results were analyzed by the application of descriptive statistics. Similarly, Ref. [6] also does not mention any statistical tests being used to check hypotheses about symbols used in cars. Instead, the study used a qualitative approach to investigate the effectiveness of using icons to convey information about automation systems to users. The research in [14] also does not mention the use of any specific statistical tests to analyze the results regarding the testing of car display panel symbols. A primary focus of the study was to assess comprehension via direct interpretation of the responses given by the participants. Correct responses were quantified and percentages were associated with each icon to determine the level of comprehension.

There is also research on car dashboard symbols that use certain statistical tests in order to analyze the data. A statistical test was used in [17], in order to analyze the influence of demographic variables on the understandability and recognizability of each symbol. In that research, of the five symbols that achieved the highest recognition rates, the horn, trunk, and fan symbols were not significantly affected by any demographic variable. The rate for the battery symbol was significantly impacted by age, while the rate for the hood symbol was affected by both age and education. Of the six symbols that achieved the lowest recognition rates, the rate for the rear fog light symbol was not significantly impacted by any demographic variable. The front fog light symbol was significantly affected by sex, while the cigarette lighter symbol was significantly influenced by age, with younger persons performing better than mid-age persons, who in turn performed better than older persons. The hazard, choke, and master lighting symbols were all impacted by both age and education, though the age effect for the master lighting symbol differed from the others

in that younger persons performed better than mid-age persons, who performed better than older persons.

Research presented in [16,19,20] used statistical tests like in this research. However, in those papers, it is not mentioned whether any statistical tests were used to check hypotheses about the potential influence of the demographic variables on the obtained results. However, in this research, statistical analysis has been performed regarding the influence of demographic variables on success in recognizing symbols and their functions. After checking the normality of distribution by inspection of histograms and the Kolmogorov–Smirnov test, it was determined that the results were normally distributed. Due to that, we used parametric methods, Independent Samples T-Test and One-way ANOVA. There were no significant statistical differences in symbol recognition depending on the sex of the subjects, for all tested symbols. Also, the results show that there are no significant statistical differences in symbol recognition depending on the subject's occupation for all tested symbols. In addition, the driving experience did not have a statistically significant effect on the obtained results.

Taking the above into account, the analysis of the result conducted in this paper has certain comparative advantages, because it was made based on the use of descriptive statistics, testing the statistical hypotheses on the level of the whole population, testing of the statistical hypotheses that involve demographic variables, including also additional variables that could influence the recognition of the symbols.

However, there is no universally agreed-upon percentage for what constitutes satisfactory recognition in symbol recognition tests, as it can vary depending on the specificity of the test and the context. Due to that, a satisfactory level can be determined by the organization or researcher conducting the test based on the specific goals and requirements. In connection with that, in many papers dealing with the recognition of various symbols (for example [31]), certain established criteria were not used for the classification of the success of symbol recognition. Instead of this, such papers usually mention terms like high or low symbol recognition percentages. In addition, there are papers that use some criteria to classify success in the recognition of symbols. For example, Ferreira et al. used the standard ISO 9186:2001 [32] benchmark of 66% for successful icon recognition, while Gatsou et al. adopted the more stringent standard ISO 3864:1984 [33], which has a slightly higher benchmark, in which a success rate above 66.7% was considered as "good" and below that as "low", and according to the scale by Howell and Fuchs, icons achieving 60% or above are classed as "identifiable", whereas icons scoring less than that are "unsuccessful" in conveying their meaning [34]. Similarly, Robielos et al. [35] cite a comprehension rate of 67% set by the ISO 3864-1:2011 standard [36], while Duarte et al. [37] also quote a rate of 67% as the acceptable level of comprehension according to criteria defined by the ISO/TC 145 standard [38]. Some authors also tried to establish their own classification rate for recognizing symbols. For example, Radzak et al. [39] quoted a scale concerning the accuracy level of detection: 0–20% (no detection), 20–40% (poor detection), 40–60% (average detection), 60–80% (good detection), and 80–100% (excellent detection).

If we use the ISO criterion of 67% as a criterion for acceptance of a symbol as recognizable, then we can see that symbols that do not satisfy the mentioned norm in this research on the level of the population are immobilizer system, auto door lock malfunction, transmission failure, transmission oil temperature, electric park brake trouble, brake fluid level, antilock braking system trouble, and electronic throttle control. This means that 50% of the symbols that were the subject of this research do not satisfy the set criterion and cannot be accepted in terms of usability. This also means that three ISO symbols—transmission failure, transmission oil temperature, and brake fluid level—do not fulfill ISO criterion.

However, the situation is even more unfavorable if the subjective conviction of the respondents that they gave the correct answer is taken into account. From Table A2 (Appendix A), which refers only to correctly given answers, it can be seen that for no symbol was the level of conviction of the respondents (on average) in the correctly given answer the maximum score on the scale, i.e., 5. This means that although they gave the

correct answer, a part of the respondents is not sure that it is really the correct answer. One of the reasons for the appearance of this uncertainty may be the design of the offered answers, because the incorrectly offered answers could in a certain way represent an alternative to the meaning of the symbol.

Additional analysis that provides the level of conviction regarding the given answers gives this paper an additional comparative advantage. This kind of analysis provides insight and clarity that would be difficult to achieve without it. Furthermore, as previously mentioned, this paper used a numerical ISO criterion for the assessment of the usability of each tested symbol (which was not used in the previous papers concerning symbols used on the drivers' displays).

## 5. Conclusions

The knowledge of the safety and warning symbols used in automobiles and that were tested in this survey on the youth population cannot be assessed as satisfactory. If drivers are unable to comprehend the meaning of the safety symbols on their displays, or if they cannot differentiate between them, they will miss out on vital warning messages. The increased probability of car damage and the appearance of unsafe traffic situations could arise from this, potentially leading to undesirable consequences, including injuries and possibly fatal outcomes. In order to ensure that users are able to comprehend and identify symbols displayed on car dashboards, it is essential to take the necessary steps to enhance their understanding and recognition. This is especially important in order to ensure that drivers are able to interpret the information provided by their vehicles in a timely and accurate manner. Taking the appropriate actions to improve the understanding and recognition of symbols shown on car displays is therefore necessary.

There are two potential solutions to this issue: improvement of education in driving schools and making changes to the design of dashboard symbols. Older courses in driving schools did not involve more detailed theory regarding dashboard symbols. This issue was typically part of the overall curriculum of the driving schools, first of all from the practical aspect, and was designed to help students understand the various gauges and basic indicators on the dashboard of a vehicle. Unfortunately, it is a similar case with new courses in driving. This research confirmed the global hypothesis that youth drivers are not well-educated about the warning and safety symbols, which are very important for the safety of traffic participants and vehicle status. Driving educators suppose that it is on the student when buying a car to read the manual for using a specific car. However, it is a very rare situation that a driver uses a car manual to educate himself about symbols used on the dashboard.

When training future drivers, driving schools should place extra emphasis on the importance of this type of education. By giving additional attention to the education about meanings and functions of symbols on dashboards, driving schools can ensure that their students are well-prepared to use their cars on a safe basis. In addition, new design solutions for symbols that indicate the safety status of automobiles that do not meet the usability criteria could further improve the ability to recognize this type of symbol, which is of great importance in order to prevent accidents.

## 6. Limitations

As quoted in the title of this paper, this study investigates the population of youths. However, the older population could have different answers regarding the recognition of symbols used on automobile displays. This circumstance could be conditionally considered a limitation of this study.

Testing of the statistical hypothesis revealed that there was no effect of sex on the results, although our sample involved more females than males. This circumstance also could be considered as a conditional limitation.

## 7. Future Research

Having in mind the conditional limitation of the study regarding the involvement of only the younger part of the population, future research could involve responses from the older part of the population.

Symbols presented on the dashboard panels of automobiles are a part of the information system surrounding a driver. Considering that, future research could involve these symbols in broader consideration and the concept of in-vehicle driver information systems.

**Author Contributions:** Conceptualization, A.Z. and U.M.; methodology, U.M. and A.Z.; software, T.I., A.T. and S.Č.; validation, T.I. and U.M.; formal analysis, A.Z., U.M. and T.I.; investigation, U.M., T.I., A.T. and A.Z.; resources, U.M., D.D. and J.D.; data curation, U.M., A.Z. and T.I.; writing—original draft preparation, A.Z., U.M. and T.I.; writing—review and editing, D.D. and J.D.; visualization, U.M., A.Z., T.I., D.D. and J.D.; supervision, A.Z., D.D., J.D. and S.Č.; funding acquisition, D.D. and J.D. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was supported by Cultural and Educational Grant Agency Ministry of Education, Science, Research and Sport of the Slovak Republic, grant no. KEGA 028TUKE-4/2021 "Transfer of new knowledge from the field of production technologies into teaching of technology-oriented subjects for the current needs of Slovak industry" and by Scientific Grant Agency Ministry of Education, Science, Research and Sport of the Slovak Republic and Slovak Academy of Sciences, grant no. VEGA 1/0431/21 "Research of light-technical parameters in production hall using digital ergonomics tools".

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

**Table A1.** Symbols used in the research, offered answers related to their meaning (function), and correct answers.

| Ordinal Number of Symbols | Symbol | Answers Offered | Correct Answer |
|---|---|---|---|
| 1 |  | (a) The side airbag does not work<br>(b) Airbag activated by mistake<br>(c) Airbag does not work (any) | Airbag does not work (any) |
| 2 |  | (a) The engine requires a regular annual service<br>(b) It is necessary to turn off the engine due to a malfunction<br>(c) The engine will soon become overheated | It is necessary to turn off the engine due to a malfunction |
| 3 |  | (a) Check the oil level and operating temperature<br>(b) Mileage indicator<br>(c) Speed indicator | Check the oil level and operating temperature |
| 4 |  | (a) The car is out of service because the system does not recognize the key<br>(b) The car must be locked<br>(c) The car cannot be started using the remote vehicle start system | The car is out of service because the system does not recognize the key |

**Table A1.** *Cont.*

| Ordinal Number of Symbols | Symbol | Answers Offered | Correct Answer |
|---|---|---|---|
| 5 |  | (a) The doors cannot be locked automatically while driving<br>(b) Mechanical damage to the door<br>(c) The door is open | The doors cannot be locked automatically while driving |
| 6 |  | (a) Transmission failure<br>(b) Cardan joint failure<br>(c) Timing belt failure | Transmission failure |
| 7 |  | (a) Mechanical failure of the transmission<br>(b) Low transmission system temperature<br>(c) Increased transmission oil temperature | Increased transmission oil temperature |
| 8 |  | (a) Failure of the steering gear lath<br>(b) Steering failure<br>(c) Steering siren failure | Steering failure |
| 9 |  | (a) Wheel failure (loose wheel)<br>(b) Tire pressure too high<br>(c) Damaged rims | Wheel failure (loose wheel) |
| 10 |  | (a) The handbrake is not fully pulled<br>(b) Electric park brake malfunctioning<br>(c) Handbrake applied | Electric park brake malfunctioning |
| 11 |  | (a) Low brake fluid level<br>(b) High brake oil temperature<br>(c) Excess oil in the brake | Low brake fluid level |
| 12 |  | (a) Antilock braking system is in failure<br>(b) An electronic system that completely takes over the braking of the vehicle<br>(c) Electronic system that activates braking hydraulics | Antilock braking system is in failure |
| 13 |  | (a) The symbol indicates danger on the road<br>(b) The symbol indicates the appearance of a curve on the road<br>(c) Problem with the Lambda sensor | Problem with the Lambda sensor |
| 14 |  | (a) Messages of different content<br>(b) Fast driving message<br>(c) Message about the change in outside temperature | Messages of different content |
| 15 |  | (a) Low fuel level<br>(b) Low level of glass fluid<br>(c) Low coolant level | Low coolant level |
| 16 |  | (a) Problem in the electronic throttle control system<br>(b) Problem in vehicle mechanics<br>(c) Ice on the road | Problem in the electronic throttle control system |

**Table A2.** Percentage of correctly recognized symbols and the average and standard deviation of respondents' belief that the symbol has the meaning given in their answer, for the respondents who gave correct answers.

| Symbols | Percent of Correct Answers [%] | Awerage | Standard Deviation |
|---|---|---|---|
| 1. Airbag | 86.27 | 3.29 | 1.52 |
| 2. Engine stop indicator | 79.41 | 3.65 | 1.38 |
| 3. Check gauges indicator | 82.35 | 3.73 | 1.29 |
| 4. Immobilizer system indicator | 61.76 | 2.98 | 1.20 |
| 5. Auto door lock malfunction indicator | 12.25 | 4.44 | 0.50 |
| 6. Transmission failure | 59.80 | 2.73 | 1.49 |
| 7. Transmission oil temperature | 70.09 | 3.75 | 1.34 |
| 8. Steering failure | 93.13 | 3.43 | 1.28 |
| 9. Loose wheel warning indicator | 91.17 | 3.39 | 1.36 |
| 10. Electric park brake trouble indicator | 48.03 | 3.90 | 0.87 |
| 11. Brake fluid level | 46.11 | 2.15 | 1.17 |
| 12. Antilock braking system trouble | 20.59 | 3.45 | 1.79 |
| 13. Lambda sensor warning indicator | 75.49 | 3.46 | 1.18 |
| 14. Message indicator | 72.55 | 2.51 | 1.3 |
| 15. Engine coolant level | 84.31 | 2.64 | 1.53 |
| 16. Electronic throttle control indicator | 65.69 | 2.12 | 1.32 |

## References


1. Rusiñol, M.; Lladós, J. *Symbol Spotting in Digital Libraries: Focused Retrieval Over Graphic-Rich Document Collections*; Springer: London, UK, 2010.
2. Rodak, A.; Kruszewski, M.; Sztandera, B. Does the Driver Understand the Warning? Comprehension of the Request to Intervene. *Appl. Sci.* **2022**, *12*, 9451. [CrossRef]
3. Čičević, S.; Trifunović, A.; Mitrović, S.; Nešić, M. The usability analysis of a different presentation media design for vehicle speed assessment. In *Ergonomic Design and Assessment of Products and Systems*; Zunjic, A., Ed.; Nova Science: New York, NY, USA, 2017; pp. 195–220.
4. Liu, X.; Sun, H.; Gao, Y.; Zhang, W.; Ge, Y.; Qu, W. Exploring the performance of click and slide gestures on large in-vehicle touch screens. *Appl. Ergon.* **2022**, *99*, 103613. [CrossRef]
5. Tice, P.C.; Mouloua, M.; Abou-Senna, H. Aging drivers and post delineated express lanes: Threading the needle at 70 miles per hour. *Transp. Res. Part F Traffic Psychol. Behaviour.* **2020**, *74*, 396–407. [CrossRef]
6. Richardson, J.; Revell, K.M.A.; Kim, J.; Stanton, N.A. The iconography of vehicle automation—A focus group study. *Hum.-Intell. Syst. Integr.* **2021**, *3*, 251–261. [CrossRef]
7. Radwan, E.; Darius, B.; Wu, J.; Abou-Senna, H. Simulation of pedestrian safety surrogate measures. In Proceedings of the 27th ARRB Conference, Melbourne, Australia, 16–18 November 2016.
8. Kim, J.; Revell, K.; Langdon, P.; Bradley, M.; Politis, I.; Thompson, S.; Skrypchuk, L.; O-Donoghue, J.; Richardson, J.; Clark, J.; et al. Drivers' interaction with, and perception toward semi-autonomous vehicles in naturalistic settings. In *Intelligent Human Systems Integration 2020, Proceedings of the 3rd International Conference on Intelligent Human Systems Integration (IHSI 2020): Integrating People and Intelligent Systems, Modena, Italy, 19–21 February 2020*; Springer: Cham, Switzerland, 2020; pp. 20–26.
9. Abou-Senna, H.; El-Agroudy, M.; Mouloua, M.; Radwan, E. Effect of changing a traffic control device color on driver behavior and perception across different age groups. *Transp. Res. Record.* **2021**, *2675*, 228–240. [CrossRef]
10. Cauffman, S.J.; Lau, M.; Deng, Y.; Cunningham, C.; Kaber, D.B.; Feng, J. Research and Design Considerations for Presentation of Non-Safety Related Information via In-Vehicle Displays during Automated Driving. *Appl. Sci.* **2022**, *12*, 10538. [CrossRef]
11. Abou-Senna, H.; Tice, P.; El-Agroudy, M.; Holley, G.M.; Mouloua, M.; Radwan, E. Conspicuity of Various Colored Express Lane Delineators: Matching or Contrast? *Transp. Res. Record.* **2023**, *2677*, 474–487. [CrossRef]
12. Collins, B.L. *The Development and Evaluation of Effective Symbol Signs*; National Bureau of Standards: Washington, DC, USA, 1982.
13. Abou-Senna, H.; Radwan, E.; Mouloua, M.; Wu, J.; Michaelis, J.; Nager, S. *Human Factors Study on the Use of Colors for Express Lane Delineators*; Department of Transportation: Tallahassee, FL, USA, 2019.
14. Mazzae, E.N.; Ranney, T.A. Development of an Automotive Icon for Indication of Significant Tire Underinflation. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*; SAGE Publications: Los Angeles, CA, USA, 2001; Volume 45, pp. 1641–1645.
15. McDougall, S.J.P.; Curry, M.B.; de Bruijn, O. Measuring symbol and icon characteristics: Norms for concreteness, complexity, meaningfulness, familiarity, and semantic distance for 239 symbols. *Behav. Res. Methods.* **1999**, *31*, 487–519. [CrossRef]
16. Zunjic, A.; Manojlovic, U. Evaluation of the usability of symbols indicating a malfunction of automobiles. *Acta Tech. Napoc.* **2022**, *65*, 959–965.

17. Saunby, C.S.; Farber, E.I.; DeMello, J. *Driver Understanding and Recognition of Automotive ISO Symbols*; Society of Automotive Engineers: Warrendale, PA, USA, 1988.
18. *ISO 2575 Standard*; Road Vehicles—Symbols for Controls, Indicators and Tell-Tales (Eighth Edition). ISO: Geneva, Switzerland, 1982.
19. Zunjic, A.; Manojlovic, U.; Čicević, S.; Trifunović, A. Evaluation of the usability of symbols indicating the state of automobile lighting. In Proceedings of the 8th International Conference on Industrial Engineering SIE, Belgrade, Serbia, 29–30 September 2022; pp. 287–290.
20. Zunjic, A.; Manojlovic, U.; Čicević, S.; Trifunović, A. Evaluation of the usability of certain symbols indicating automobile lighting status. *J. Traffic Transp. Eng.* **2022**, *68*, 19–22.
21. *ISO 7000-2108 Standard*; Airbag. ISO: Geneva, Switzerland, 2004.
22. *ISO 7000-1396B Standard*; Transmission Failure/Malfunction. ISO: Geneva, Switzerland, 2004.
23. *ISO 7000-1168B Standard*; Transmission Oil-Temperature. ISO: Geneva, Switzerland, 2004.
24. *ISO 7000-2441 Standard*; Steering Failure (Front View). ISO: Geneva, Switzerland, 2004.
25. *ISO 7000-1401 Standard*; Brake Fluid Level. ISO: Geneva, Switzerland, 2004.
26. *ISO 7000-2429 Standard*; Road Vehicle, Engine Coolant Level. ISO: Geneva, Switzerland, 2004.
27. Zunjic, A.; Leduc, S. Readability as a component of the usability of a Web presentation—A case study from the banking sector. *Adv. Intell. Syst. Comput.* **2018**, *822*, 441–456.
28. Fox, J.E. The science of usability testing. In Proceedings of the Federal Committee on Statistical Methodology (FCSM) Research Conference, Washington Convention Center, Washington, DC, USA, 1–3 December 2015.
29. Rubin, J.; Chisnell, D. *Handbook of Usability Testing*, 2nd ed.; Wiley Publishing, Inc.: Indianapolis, IN, USA, 2008.
30. UN Department of Economic and Social Affairs, 2023, Definition of Youth. Available online: https://www.un.org/esa/socdev/documents/youth/fact-sheets/youth-definition.pdf (accessed on 20 March 2023).
31. Adams, A.; Bochner, S.; Bilik, L. The effectiveness of warning signs in hazardous work places: Cognitive and social determinants. *Appl. Ergon.* **1998**, *29*, 247–254. [CrossRef] [PubMed]
32. *ISO 9186:2001 Standard*; Graphical Symbols—Test Methods for Judged Comprehensibility and for Comprehension. ISO: Geneva, Switzerland, 2001.
33. *ISO 3864:1984 Standard*; Safety Colours and Safety Signs. ISO: Geneva, Switzerland, 1984.
34. Ashe, D.; Eardley, A.; Fletcher, B. An Empirical Study of Icon Recognition in a Virtual Gallery Interface. *Adv. Sci. Technol. Eng. Syst. J.* **2018**, *3*, 289–313. [CrossRef]
35. Robielos, R.A.C.; Lin, C.J. Traffic Sign Comprehension among Filipino Drivers and Nondrivers in Metro Manila. *Appl. Sci.* **2022**, *12*, 8337. [CrossRef]
36. *ISO 3864-1:2011 Standard*; Graphical Symbols—Safety Colours and Safety Signs—Part 1: Design Principles for Safety Signs and Safety Markings. ISO: Geneva, Switzerland, 2011.
37. Duarte, E.; Rebelo, F.; Teles, J.; Wogalter, M.S. Safety sign comprehension by students, adult workers and disabled persons with cerebral palsy. *Saf. Sci.* **2014**, *62*, 75–186. [CrossRef]
38. *ISO/TC 145 Standard*; Graphical Symbols. ISO: Geneva, Switzerland, 1970.
39. Radzak, M.Y.; Alias, M.F.; Arof, S.; Ahmad, M.R.; Muniandy, I. Study on Traffic Sign Recognition. *Int. J. Comput. Sci. Eng.* **2015**, *2*, 33–39.