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Traffic Risk Image in The Light of the Road Situation Assessment Questionnaire

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Abstract

Introduction: Drivers often lack reflection on their behaviour. For predictive purposes and educational interventions, it is useful to know the individual traffic risk picture of the driver under investigation.
Objective: This paper aimed to show the psychometric properties of the questionnaire and to establish a hierarchy of traffic situations in terms of perceptions of associated danger.
Material and Methods: A total of 548 people aged between 18 and 68 years participated in the study. A self-administered questionnaire method was used to measure situational (road) awareness and the ability to anticipate the consequences of engaging in unsafe road traffic actions. The tool's accuracy was verified with the 'Controversy' questionnaire, which is used to measure the severity of drivers' normative beliefs about breaking traffic laws.
Results: Satisfactory psychometric values of the questionnaire were obtained. After taking into account the correlation of measurement errors, an acceptable fit was obtained: χ^2 /df = 2.48; GFI = 0.95; AGFI = 0.92; CFI = 0.96; RMSEA = 0.06 (0.048-0.072). Mean values and standard deviations for 14 descriptions of unsafe traffic situations were shown.

Conclusions: The satisfactory reliability and accuracy of the measurement allow the method to be used in research and individual diagnosis in the areas of transport psychology and education. Overtaking at pedestrian crossings, on a bend, uphill, and continuing to drive despite fatigue are the most dangerous traffic situations associated with the risk of traffic accidents.

Keywords: driver, questionnaire, risk behaviour of drivers, road hazards, transport psychology

Introduction

Experiences from previous studies of drivers indicate that their psycho-physical properties (e.g., reaction time, perceptual properties, eye-hand coordination), although important for safe driving, do not exhaust the list of factors that significantly influence this safety. A psycho-physically fit driver, equipped with sufficient knowledge of traffic rules and driving skills, is not yet a safe driver. Driver reaction time and other psycho-physical variables are significant, but not sufficient, for driving safety [1].

Drivers often lack reflection on their behaviour, the situation they are in, and the risks to themselves and other road users; they lack situational awareness [2]. Situational awareness is defined as the perception and understanding of information that enables an individual to plan future courses of action necessary to respond to the dynamic demands of the environment [3].

Assuming that the vast majority of road users are equipped with the necessary skills and that the signposting of potentially dangerous places and situations is correct, we are looking for a variable to explain the increasing number of road accidents and crashes. The variable that seems to be responsible for this condition is hazardous and risky behaviour in traffic situations. We distinguish risky behaviour in this study from dangerous behaviour. This is because not all dangerous behaviour that exposes the driver and other road users to loss is risky. This is because we take risks when we are aware of the risks but at the same time expect a certain reward. Risky behaviour is therefore displayed by a driver who is aware of the danger of exceeding the speed limit, but who exceeds it because it gives him pleasure, or by a driver who is aware of the reduced grip of the wheels, but who accelerates because he is too late, etc. If, however, the driver considers that the speed he is travelling at is safe (even though prohibited by law) then he is behaving dangerously and riskily from the point of view of other road users, but subjectively he is not taking the risk because he simply does not perceive the danger or assesses it as unlikely, insignificant.

Perceiving danger (anticipating the risk of an accident) and experiencing fear, apprehension, or increased tension, as a result, has an adaptive function. Fear or apprehension in traffic situations can arise either through a conditioning process or based on acquired knowledge of danger. In both cases, there is a hyper-sensitivity of attention, an orientation reflex, and mobilisation for action. Thus, paradoxically, a driver who is risky, and therefore aware of the danger, is safer on the road than one who does not perceive the danger, even though it objectively exists. The manifestation of risky attitudes is gradable from minimum (never occurs in a given situation or at most sporadically, incidentally, very rarely) to maximum (always or almost always occurs in certain situations). Between these extreme poles extends a continuum on which, by observation or some measurement, specific attitudes of an individual in a specific situation(s) can be placed. Such a class of attitudes may be the risk behaviours in different traffic situations manifested by traffic participants with varying

frequency. Since, as we pointed out earlier, risk behaviour is related to the perception of danger, the starting point in the analysis of driver behaviour should be the subjective assessment of the degree of danger of different traffic situations.

This subjective assessment depends on the driver's age, experience, and current psycho-physical state (e.g., a drowsy driver interprets a given situation differently from a sleepy and well-rested driver). In contrast, a general attitude to avoidance or risk-taking is considered by some researchers to be a personality trait [3-10] or a relatively permanent behavioural characteristic resulting from social learning, internalisation of social patterns of behaviour, and cultural influences [11]. In the case of traffic behaviour, cultural conditioning seems to play an important role [12-14].

For predictive purposes and educational interventions, it is useful to know the individual traffic risk picture of the driver under study. For this purpose, we have constructed the 'Road Situation Assessment Questionnaire'. It can also be used to measure the trend of perceived danger in different groups and populations, which will facilitate the organisation of the driving learning process and can provide guidelines for actions to increase road safety.

Purpose of the survey

This paper aimed to show the psychometric properties of the questionnaire and to establish a hierarchy of traffic situations in terms of perceptions of associated danger.

Material and methods

Study 1

Ninety-six men and 44 women aged between 19 and 68 years (M=35.3, SD=12.7) participated in the study. They were referrals for psychological counselling with work requiring high psychomotor performance.

The author's Road Situation Assessment method (OSD-14) was used. The design of the questionnaire includes an assessment of situational (road) awareness and the ability to anticipate the consequences of taking dangerous actions in traffic. The respondents, according to the procedure, were presented with 14 different traffic situations and asked to assess the associated degree of danger (accident risk) on a 5-point scale (0 - no danger, 1 - low danger, 2 - medium danger, 3 - high danger, 4 - very high danger).

The study used the SDP computerized psychophysiological diagnostic system. Figure 1 shows the presentation of the selected description on a response scale with numerical values and colour accents.

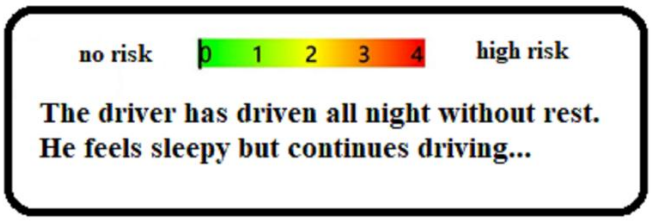

Figure 1. Chosen description of the traffic situation

Study 2

The participants in the study were people employed in a job requiring driving motor vehicles for work purposes. The sample analysed included 126 women and 282 men aged between 18 and 65 years (M = 35.2, SD = 12.4). In addition to the aforementioned OSD-14 scale, the

'Controversy' questionnaire, by Olejniczak-Serowiec and Rutkowska [15], was used. This is a tool to measure the severity of drivers' normative beliefs about breaking traffic laws.

Results

Study 1 - Measurement of reliability

The psychometric characteristics of the OSD-14 questionnaire items were verified using item retest correlation. From Table 1, we can conclude that the discriminatory power of the test items is satisfactory, ranging from 0.41 to 0.69.

The reliability assessment included internal consistency estimation procedures using Cronbach's α and McDonald's ω, as well as the split-half method according to Spearman-Brown.

The obtained values for the single-factor OSD-14 scale indicate satisfactory measurement accuracy: α = 0.877, ω = 0.880. The Spearman-Brown correlation coefficients take the value of 0.876, and the inter-half correlations are 0.781. The obtained values fully correspond to the psychometric requirements for similar questionnaires used in individual diagnosis.

Table 1

Item Reliability Statistics (N = 140)

		if item dropped	
	item-rest correlation	Cronbach's α	McDonald's ω
O1	0.420	0.879	0.882
O2	0.506	0.876	0.879
O3	0.419	0.879	0.882
O4	0.656	0.868	0.872
O5	0.704	0.865	0.869
O6	0.550	0.876	0.877
O7	0.507	0.875	0.879
O8	0.679	0.866	0.870
O9	0.452	0.878	0.881
O10	0.522	0.875	0.878
O11	0.658	0.868	0.872
O12	0.415	0.880	0.882
O13	0.684	0.867	0.871
O14	0.582	0.872	0.875

Factor analysis of EFA

A factor analysis was carried out, using the Oblimin method, which resulted in two factors explaining 49.8% of the variance (KMO = 0.877, Barlett's test of sphericity $\chi^2 = 737.519$, df = 91, $p < 0.001$). The first factor explained 40.3% of the variance and the second explained the remaining percentage. The distribution of items proved to be uninterpretable in the light of the assumptions made (it was expected to measure beliefs about one category of behaviour related to the perception of the danger of traffic accident risk in a specific traffic situation). Therefore, an analysis with a forced single factor was performed. The extracted component of

5.641 explained 40.3% of the variance. All content items of the questionnaire met the criterion of load size, which allowed their inclusion in the final version of the tool.

Study 2 - Measuring relevance

The theoretical relevance of the scale was verified using Confirmatory Factor Analysis. The software used was AMOS 27. The analysis used the ML (Maximum Likelihood) method, which is the most commonly used estimation method [16]. The following measures of discrepancy were obtained: χ^2 /df = 6.59; GFI = 0.85; AGFI = 0.79; CFI = 0.79; RMSEA = 0.117. The values obtained provide unfavourable evidence of the adequacy of the model tested. It should be emphasised, however, that the results shown approach the confirmation of a model in which no additional modifications were made. After taking into account the correlation of measurement errors, an acceptable fit was obtained: χ^2 /df = 2.48; GFI = 0.95; AGFI = 0.92; CFI = 0.96; RMSEA = 0.06 (0.048-0.072). The factor loadings of the individual items ranged between 0.37 and 0.79 (cf. Figure 2).

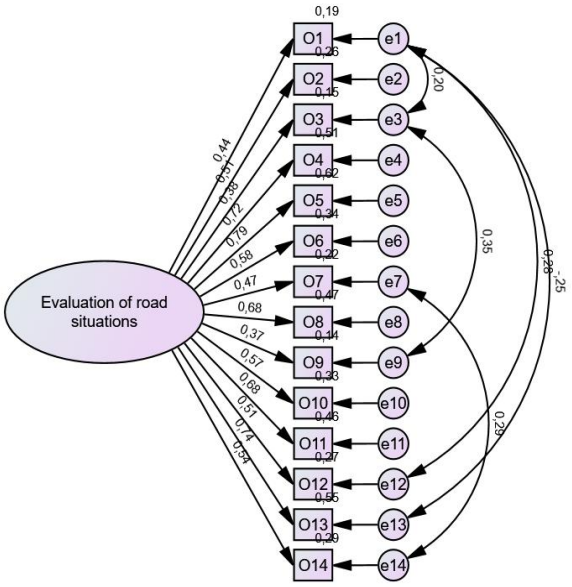

Figure 2. Path analysis (N = 408)

The results of the correlation between the OSD-14 scale and the 'Controversy' questionnaire [15], were used to assess the external validity of our tool. It was assumed that its relevance would be determined by a negative correlation between the scores of the two overall scales. This is because a higher awareness of the risk of a road accident promotes a lower tolerance of drivers to disobey the rules in the road environment. Correlation analysis showed a negative and statistically significant relationship: rho = -0.61; $p < 0.001$. As expected, the direction of this relationship was negative and strong. This positively demonstrates the relevance of the new tool.

An attempt was made to standardise expressed on a centile scale (cf. Table 2). A person's score can be assigned to one of four categories: low (below the 25th centile), medium (between the 25th and 75th centile), high (between the 75th and 95th centile) or very high (above the 95th centile; cf. Table 2). The tool is currently pre-standardised on a sample of 408 drivers from one region of Poland, so it should be treated with caution.

Table 2
Descriptive statistics of the standardisation group (N = 408)

	OSD-14
N – number of people	408
Mean	46,95
Median	48,00
SD – standard deviation	6,99
Minimum	23,00
Maximum	56,00
Skewness	-0,97
Cronbach's alpha	0,88
Shapiro-Wilk W	0,92
Shapiro-Wilk p	< 0,001
Low scores (1st-24th percentile)	< 42
Average results (25-75th percentile)	43 - 51
High scores (76-95 percentile)	52 - 55
Very high scores (96-100 percentile)	56

Source: own elaboration

How the test is conducted
The one-factor scale design takes into account the assessment of situational (road) awareness and the ability to anticipate traffic accidents on the road traffic. The OSD-14 questionnaire consists of a description of 14 traffic situations and the respondent's task is to assess the degree of danger (accident risk) on a 5-point scale (0 - no danger, 1 - low danger, 2 - medium danger, 3 - high danger, 4 - very high danger). Scores range from 0 to 56.

Extremely high scores may be the result of social approval, so-called social desirability [17,18], related to creating one's personality or responding according to 'social' expectations. Extremely low or low scores are indicative of the subject's low awareness of the risk of a traffic accident in certain traffic situations. These may be due, among other things, to a lack of possession of adequate social and emotional maturity resulting in the acceptability to ignore various types of traffic rules. Low awareness of the risk of an accident or ignoring such a danger may foster an attitude on the part of the person surveyed of being the 'best driver' who can handle any situation better than others. This may indicate a lack of adequate insight, proper criticism, or the ability to rationally assess the traffic situation. Low scores on this scale may be accompanied by excessive 'self-confidence', a tendency to overestimate one's psycho-physical skills and abilities, and, most often, younger age and little experience in driving a motor vehicle.

Table 3 presents statistics related to the assessment of the danger of traffic accidents in the described traffic situations according to the respondent drivers' own experiences.
We can see that the most dangerous (mean score above 3.5 points) included:

- O3 - overtaking at a pedestrian crossing;
- O9 - overtaking on a bend;
- O12 - continuing to drive despite being tired;
- O1 - overtaking uphill.

The least dangerous (average value below 3.0 points) included:

- O6 - failing to stop the car before a 'stop' sign at an unguarded level crossing;

– O2 - accelerating despite the onset of rain.

It should be noted the low awareness of the danger at level crossings and ignoring the 'stop' sign, which leads to tragic incidents in road-rail traffic. Those surveyed are not aware of the reduced grip of the tyres at the first moments of rain. They downplay the danger of increased speed, both in built-up areas (O5) and outside (O8), which is one of the main causes of road accidents.

Table 3
Description of traffic situations and an average rating of the related danger (N = 408)

Ref.	Description of traffic situations	M	SD
O1	On a road leading uphill with a continuous line, two cars are driving in the same direction. The driver of the second car, impatient with the slow driving of the first, starts an overtaking maneuver.	3.70	0.66
O2	It is a nice spring day. It starts to rain. The driver looks at his watch and starts to speed up because he is late.	2.80	0.88
O3	A car stops in front of a pedestrian crossing. The driver of the other vehicle arriving at the crossing starts an overtaking maneuver.	3.82	0.60
O4	While driving, the driver is talking on his mobile phone without a hands-free set.	3.16	0.83
O5	A wide road with a good surface in a built-up area. There are no police controls or radars in sight. The driver does not slow down, continuing to drive at a speed higher than the speed limit...	3.13	0.89
O6	Unguarded level crossing in open country with good visibility. The driver in front of the crossing slows down slightly but drives through the crossing without stopping.	2.85	1.13
O7	It is nighttime. A small town with little traffic. A driver taking the main road in transit does not slow down before the crossing.	3.28	0.82
O8	On a two-way road with one lane in each direction, the driver is traveling at a speed of 130 km/h.	3.15	0.89
O9	A turn begins; the driver of the second car, impatient with the slow driving of the first, starts an overtaking maneuver...	3.82	0.50
O10	The driver at the party drinks a glass of vodka (50g). After an hour, he decides to drive home. He lives on a rarely used road.	3.55	0.77
O11	A 4-year-old child needs to be transported but does not have a car seat. The driver decides to take the child nonetheless…	3.44	0.85
O12	The driver has driven all night without rest. He feels sleepy but continues driving.	3.71	0.61
O13	Driving through a busy city center, the driver reaches the traffic lights when they change to orange. He accelerates to make it through the intersection without stopping the car at the red lights.	3.24	0.77
O14	The driver sees a group of children playing on the pavement with a ball. He passes them at the speed limit without slowing down.	3.31	0.88

Discussion

This paper aimed to show the psychometric properties of the questionnaire and to establish a hierarchy of traffic situations in terms of perceptions of associated danger. Factor structure analysis, relevance, and reliability assessments were carried out on two samples with a total of 548 people.

An exploratory factor analysis with a forced single factor resulted in a model that was subjected to confirmatory analysis on a sample of 408 motor vehicle drivers. A commonly quoted indicator of the model's fit to the data is the value of the χ^2 statistic. We can consider a model to be fit if the p-value is greater than 0.05. This means that the standardised residuals of the theoretical and empirical matrices are similar [19]. However, the use of this test requires, among other things, the condition of a multivariate normal distribution and a large sample size.

Therefore, other measures of the goodness of fit of the model to the data are also used, such as χ^2 /df, GFI (goodness of fit index), adjusted goodness of fit index AGFI (adjusted goodness of fit index), root mean square error of approximation RMSEA (root mean square error of approximation). According to a conservative criterion, a value of the statistic for χ^2 /df less than 2 indicates the accuracy of the model. In the case of the other two measures, a numerical value greater than 0.9 indicates the accuracy of the model. The highest rank is held by the RMSEA index, whose values less than 0.08 indicate an acceptable (decent) fit and less than 0.05 indicate a good fit to the empirical data [19]. The introduction of the modification indices allowed the model fit values to improve significantly. The obtained values in terms of the χ^2/df statistic slightly exceed the restrictive criteria suggesting rejection of the models. It should be noted that more liberal criteria also accept values of this statistic not exceeding five [16,20]. Other measures of fit were acceptable even under the more conservative assumptions. The reliability assessment showed that the OSD-14 scale has satisfactory measurement accuracy required for research and individual diagnosis. Negative and strong correlations with the Controversy questionnaire [15] allowed positive verification of the assumptions made. As shown, the higher the scores on the OSD-14 questionnaire, the lower the tolerance of drivers to engage in behaviour contrary to traffic rules.

The work presented here has several limitations. The results of the validation study require further replication of the research. It is advisable to increase the sample size, to assess the level of situational awareness in the traffic environment in different groups of drivers, e.g., younger vs. older drivers, amateur vs. professional drivers, women vs. men, perpetrators of traffic accidents vs. persons with no history of traffic accidents, etc. Correlational analyses with other test measures are warranted, especially in the context of temperamental traits, personality, and psychomotor performance. Differential validity was not assessed in the sample analysed.

Improper overtaking was the most frequently indicated road hazard by the drivers surveyed. Police statistics [21], among the main causes of road accidents due to drivers' fault, list the following: failure to give priority to a crossing, failure to adjust speed to traffic conditions, failure to give priority to a pedestrian at a pedestrian crossing, failure to keep a safe distance between vehicles, and improper overtaking. The results obtained are similar to previous studies conducted by Horoszkiewicz [22].

Conclusions

1. The satisfactory reliability and accuracy of the measurement allow the method to be used in research and individual diagnosis in the areas of transport psychology and education.
2. Overtaking at pedestrian crossings, on a bend, uphill, and continuing to drive despite fatigue are the most dangerous traffic situations associated with the risk of traffic accidents. Drivers have a low awareness of the risks at level crossings.

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