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Cognitive and psychomotor performance of Polish and Ukrainian drivers

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Abstract

Introduction. Recent years have seen a dynamic increase in people from eastern countries employed in Polish road transport.
The aim of the study was to compare the cognitive and psychomotor performance of Polish and Ukrainian drivers.

Material and Methods. The results of 336 male truck drivers aged between 22 and 64 years were analysed. There were 174 respondents in the Polish sample (M = 38.6 years; SD = 10.3) and 162 respondents in the Ukrainian sample (M = 36.8 years; SD = 8.3). The level of intellectual performance was assessed using the Raven's Matrix Test (TMS) and the Precision of Movement and Quick Thinking (PIM) Index. Psychomotor performance was verified using computer tests belonging to the SDP System.

Results. Ukrainian drivers, compared to Polish drivers, were characterised by analogous results in terms of cognitive processes and psychomotor performance. The mean scores of the Raven's test, PIM index and also coordination tests were comparable in both groups. A strong positive correlation was found between TMS and PIM.

Conclusions. 1. Drivers from Ukraine and Poland have similar intellectual and psychomotor abilities. 2. The PIM index correlates strongly positively with TMS and can be a reliable tool in intelligence screening. 3. The presented methods of the SDP System are not culturally loaded. Standardised scales addressed to the Polish driver population should be used to assess these areas in Ukrainian subjects.

Keywords: driver, transport psychology, cognitive functions, psychomotor performance, cultural differences

Introduction

In recent years, we observe a dynamic increase in the number of foreigners who works as a truck driver in Poland. According to media reports [1], Polish drivers accuse "colleagues" from the eastern border of lack skills, driving wildly and even forging documents. Other sources claim [2] that Polish drivers "sow" the greatest fear on Ukraine's roads. In 2016, it was reported that the number of Ukrainian and Belarusian drivers in Poland was 100% higher in comparison to the previous year [3]. In the period analysed, almost 30,000 certificates of qualification were issued [4], i.e., at least the same number of psychological and medical examinations were performed.

Among psychologists, we can encounter different opinions about the methods used and the diagnostic difficulties with regard to citizens from eastern countries. The biggest problems revolve around the choice of research tools for the Ukrainian population and the communication difficulties related to the language barrier. Questions arise whether the methods used, especially in cognitive and psychomotor assessment, can be treated as culture-free test tasks [5]? Moreover, whether it is legitimate to compare the results obtained with standard tables addressed to Polish drivers? The assessment of cognitive and psychomotor functioning with the assessment of drivers' socio-emotional maturity belongs to the competence of a transport psychologist.

In the Polish legal system [6]-[8], psychological tests for drivers are compulsory, mainly for applicant professional drivers and others performing commercial road transport of persons or goods. In addition, they include people at risk, for example those who had been driving under the influence of alcohol. The Methodology for psychological testing of drivers [8] points out that used diagnostic tools should meet the conditions of psychometric goodness. It also indicates the need to follow the procedures and recommendations for the testing tools used as described in the manual. It should be noted that it is the psychologist who is responsible for the selection of individual methods, and therefore there is no set of tests that is uniform and obligatory for all [9]. While the personality and intellectual performance tests and apparatus tests used in the Polish driver sample are presented in the manuals with tables of norms, it is difficult to find a separate such description for Ukrainian drivers. In some cases, such as in the assessment of cognitive or psychomotor performance, this may not be necessary. Indeed, visual tasks are considered to be less culturally loaded than verbal tasks, as they do not usually depend on language [10].

Cognitive and psychomotor performance

Tarnowski at al. [11] expressed the view that the delineation of intellectual, psychomotor and personality traits is rather academic and arbitrary. This means that an accurate understanding of the driving situation, determined mainly by the level of crystallised intelligence, is also dependent on personality. The ability to predict the development of a traffic situation, will often be linked not only with assess of speed and distance, but also to the ability to estimate risk, take the perspective of another driver and a number of other variables.

The methodology for drivers testing indicates that "In terms of intellectual performance and cognitive processes, the licensed psychologist selects diagnostic tools and techniques to determine perceptual, attentional, situational understanding and anticipatory performance" [8]. For psychomotor performance, "the authorised psychologist selects tests and testing devices to determine speed and adequacy of reaction and eye-hand coordination" [8].

The objective of the study

The aim of the study was to compare the cognitive and psychomotor performance of Polish and Ukrainian drivers.

Due to the exploratory nature of the study, no hypotheses were set.

Answers were sought to the following research questions:

1. Do Polish and Ukrainian drivers differ significantly in their performance on the Raven Matrix Test (TMS)?
2. Do Ukrainian drivers differ significantly from drivers in the Polish group in terms of psychomotor performance in terms of speed and reaction adequacy?
3. Are there positive correlations between the number of good responses in the Raven's Matrices Test and the PIM index, assessing precision of movements and quick thinking?

MATERIAL AND METHODS

Description of the study

The study included a selected group of drivers. The main criterion for selection was possession of a category C, C+E driving licence, a minimum of 3 years of work experience related to driving heavy goods vehicles and no history of traffic accidents. The subjects were informed of the purpose of the study and agreed to participate without financial gratification. The study took place at the Training Centre for Drivers and Freight Forwarders in Poznań.

In the Ukrainian sample, results were obtained from 162 men. In the Polish sample, the number of women was very small, so their data were excluded from further analyses. A total of 336 lorry drivers between the ages of 22 and 64 participated in the study. The mean age in the entire sample was M = 37.7 years (SD = 9.4), was similar in the Polish sample M = 38.6 years (SD = 10.3) and the Ukrainian sample M = 36.8 years (SD = 8.3).

Methods

The level of intellectual performance and cognitive processes was checked using the Raven's Matrices Test in the Standard version of the classic form [12], designed to test general intelligence in a population of people with varying levels of education. The Cronbach's α coefficient ranges from 0.89 to 0.97, depending on the age group. This test consists of 60 tasks arranged in 5 series (A, B, C, D, E), with 12 tasks each. They are in the form of incomplete patterns (matrices), and the respondent's task is to select the missing passage from the six or eight given. Each series requires the respondent to learn and use a different method of thinking. The respondents performed the test without time constraints. The test was conducted in small groups of 3-5 people.

Cognitive performance was also verified using the PIM index as a measure of precision of movements and quick thinking [13], [14]. This index represents the number of good responses in simple arithmetic operations in complex coordination and the number of correct responses in the simple coordination test. The reliability of the test is high, rtt = 0.945 [14].

Psychomotor performance was assessed using 2 tests: simple and complex coordination implemented into the SDP computerised Psychophysiological Diagnostic System [14], [15]. The simple coordination test is a method for testing eye-hand coordination and precision of movements. Numbers appear sequentially on the monitor screen, to which one must respond by pressing the keypad button with the exposed digit. The test uses one-minute sequences, in which the next exposure takes place only after the subject has previously reacted correctly [13]-[15]. The measurement accuracy for the mean reaction time is rtt = 0.834 and for the number of good reactions rtt = 0.957 [14].

The compound coordination test is a method of measuring psychomotor performance extended to include a thinking component. Simple mathematical tasks based on addition or subtraction of single numbers were displayed on a monitor screen for 1 minute. The subject's task was to enter the result of the presented operation using the keyboard. The method illustrates the thinking time component of psychomotor responses [13]-[15]. The reliability of the measurement for the mean reaction time is rtt = 0.912 and for the number of good reactions rtt = 0.909 [14]. Both tests have satisfactory measurement accuracy and were included in the variables assessing psychomotor performance in terms of reaction speed and adequacy and eye-hand coordination. The psychomotor proficiencies presented in our study are an 'artificial' division, as both the cognitive and executive spheres condition each other, and it is difficult to distinguish between them in tasks requiring motor responses [13].

Statistical calculations

Statistical analysis of the assessment of the significance of differences between groups was performed using the Student's *t* test and Mann-Whitney *U* test, and the normality of the distribution was tested using the Shapiro-Wilk test. The strength of the association of measurable parameters was determined using Pearson's r correlation coefficient. The statistical package SPSS IBM Statistics 26 was used for the analysis [16]. The classic threshold of $\alpha = 0.05$ was considered as the level of significance.

RESULTS

Table 1 shows the primary statistics for the entire study sample for the methods used. Response times are presented in seconds (s). We can observe that only the distribution of results in terms of the number of good responses in the complex coordination test (TKZ_R) follows a Gaussian curve. It was decided to analyse the value of the skewness. If it falls within the conventional interval from -2 to +2, it can then be assumed that the distribution is close to a symmetrical distribution [16]. This was the case for most of the variables studied. Its significant excess was recorded for the mean reaction times in the tests of simple (TKP_M) and complex (TMZ_M) coordination. Therefore, non-parametric tests will have to be used for analyses with these variables, and parametric analyses will be used for the others.

Table 1. Basic statistics for the different methods (N = 336)

	TKP_M	**TKZ_M**	**TKP_R**	**TKZ_R**	**PIM**	**TMS**
Mean	0.93	1.78	64.7	35.1	99.8	44.7
Median	0.89	1.62	66.0	36.0	100	45.0
Standard deviation	0.13	0.57	7.67	8.63	14.3	6.73
Minimum	0.73	0.97	31.0	9.00	40.0	22.0
Maximum	1.88	6.00	81.0	61.0	142	58.0
Skewness	2.39	2.65	-0.77	-0.09	-0.37	-0.53
Kurtosis	11.3	12.2	1.14	0.19	1.12	0.07
Shapiro-Wilk W	0.83	0.79	0.96	0.99	0.99	0.98
Shapiro-Wilk p	< .001	< .001	< .001	0.209	0.004	< .001

TKP_M - average reaction time in simple coordination test; *TKZ_M* - average reaction time in complex coordination test; *TKP_R* - number of good responses in simple coordination test (pts); *TKZ_R* - number of good responses in complex coordination test (pts); *PIM* - precision index of movements and quick thinking (pts); *TMS* - number of correct answers in the Raven Matrix Test (pts).

Student's t test for independent samples was applied to consult or results of the Raven's Matrix Test (TMS) differed significantly between the groups of Polish and Ukrainian truck drivers. The results of the analyses shown in Table 2. There were no statistically significant differences between the study groups.

Table 2. Results of the Raven Matrix Test (TMS) in the Polish and Ukrainian groups of drivers (N = 336)

	Group I Polish sample (n =174)		Group II Ukrainian sample (n = 162)				95% *CI*		
	M	*SD*	*M*	*SD*	*t*	*p*	*LL*	*UL*	*Cohen's d*
TMS score (pts)	45.00	6.9	44.4	6.5	0.90	0.367	-0.12	0.31	0.10

M - mean; *SD* - standard deviation; *t* - Student's t-test result; *p* - statistical significance; *CI* - confidence interval; *LL* - lower limit; *UL* - upper limit

Subsequent analyses were undertaken to seek an answer to the question of whether professional drivers from Ukraine differ significantly in their level of psychomotor performance in terms of reaction speed and adequacy from drivers in the Polish group?
The results of the Mann-Whitney *U* test revealed no statistically significant differences in relation to mean reaction times in both tests - simple and complex coordination (Table 3).

Table 3. Level scores for mean reaction times in simple and complex coordination tests (N = 336)

	Group I Polish sample (n =174)		Group II Ukrainian sample (n = 162)					
	M	*SD*	*M*	*SD*	*U*	*Z*	*p*	*r*
TKP_M - average reaction time in simple coordination test	0.92	0.13	0.93	0.13	13483.0	-0.69	0.493	0.04
TKZ_M - average reaction time in the complex coordination test	1.77	0.61	1.79	0.53	13849.0	-0.28	0.783	0.02

M - mean; *SD* - standard deviation; *U* - Mann-Whitney U test result; *Z* - standardized value; *p* - statistical significance; *r* - strength of effect

As can be seen in Table 4, there were also no statistically significant differences between the groups in terms of reaction speed and adequacy and the Precision of Movement and Quick Thinking (PIM) index. The number of good responses in the Polish driver group was comparable in the Ukrainian group (Table 4).

Table 4. Results of Student's t-test analyses for the number of correct responses in tests of simple and complex coordination and the PIM Index (N = 336)

	Group I Polish sample (n =174)		Group II Ukrainian sample (n = 162)				95% *CI*		
	M	*SD*	*M*	*SD*	*t*	*p*	*LL*	*UL*	*Cohen's d*
TKP_R - number of good responses in simple coordination test	65.10	7.87	64.20	7.44	1.03	0.306	-0.10	0.33	0.11
TKZ_R - number of good responses in the complex coordination test	35.50	8.76	34.80	8.51	0.75	0.45	-0.13	0.30	0.08
PIM - precision of movement and quick-thinking index (points);	100.60	14.99	99.00	13.52	1.01	0.32	-0.11	0.32	0.11

M - mean; *SD* - standard deviation; *t* - Student's t-test result; *p* - statistical significance; *CI* - confidence interval; *LL* - lower limit; *UL* - upper limit

Final analyses were undertaken to see if there were positive associations between the number of good responses in the Raven's matrices test and the index assessing precision of movement and rapid thinking performance (PIM). Pearson's r correlation analysis revealed a statistically significant strong positive relationship between the variables assessed: $r = 0.63$, $p < 0.001$. This means that higher scores on the Raven's test, were accompanied by higher scores on the PIM index.

DISCUSSION

The results in the Raven's Matrix Test (TMS) were comparable in the 'Polish' and 'Ukrainian' groups. In the scientific literature, arguments are presented that intelligence cannot be measured without the distorting influence of cultural factors, since the definition of the concept, as well as its expression, is cultural [17]. The same authors also remind us that Raven's tests are still considered to be measures of intelligence that show less influence of disruptive cultural factors on differences between nations than any other intelligence test. The results obtained in our study support this thesis. It should be noted that in assessing the performance

of individual areas: intellectual processes, psychomotor skills or personality traits, it is necessary to compare the so-called raw results obtained with standardised results expressed on a specific scale (e.g., the Sten scale or Centile chart). The analyses performed suggest that the creation of separate standards for TMS results for drivers of the Polish and Ukrainian populations is not justified.

An analogous conclusion should be made with regard to psychomotor performance tests. The statistical analyses conducted suggest that there is no significant differentiation of results in this area. Country of origin (Poland or Ukraine), as an independent variable, does not significantly affect the level of task performance in tests assessing speed and adequacy of reaction. In both tests of simple and complex coordination, as well as in the area of precision of movement and quick thinking, the results appeared to be similar in both groups. It is worth recalling that the adequacy of response to exposed stimuli in the test of simple coordination (i.e., single digits on the screen) is more related to the precision of movements (clicking the correct number button on the keyboard); in the task involving the assessment of complex coordination performance, an additional role should be noted concerning the dynamics of thinking (the speed of giving the correct response to the result of a mathematical operation exposed on the screen). The lack of statistically significant correlations in this area suggests that the test tasks presented are either culture-free or culture-reduced. This may mean that they are based on material that takes into account habits common to these cultures and attempts to minimise the influence of special, culturally conditioned proficiencies in the performance of different relations [5].

The results of the correlational analyses showed the existence of statistically significant correlations between Raven's test scores and the index of precision of movements and quick thinking. The correlation of the Raven's test and the PIM index explained almost 40% of the joint variance. This very favourably demonstrates the role of the PIM index, which can be recommended as a determinant of intelligence in research in transport psychology, occupational medicine or sport psychology. It is worth recalling that the value of this variable is counted after 2 test tasks with a total duration of 2 minutes. Our observations show that it takes drivers between 20 and 40 minutes on average to solve the TMS test.

Pajeska at al. [18], showed a positive correlation between the R-W test used by transport psychologists to assess speed and accuracy of thinking and the TMS. The explained 25% common variance confirmed the authors' belief that the method they used can be successfully recommended for intelligence screening. As they emphasise [18], "these tests are not conducted to determine the intellectual potential of the subject as accurately as possible, but are only intended to help decide whether the subject falls within the population intellectual norm". The results of our study leave no doubt that the PIM index is more precise and can be successfully used for the same purpose.

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