

COMPARISON OF TESTING RESULTS OF DRIVERS ON THE ROAD TRAFFIC SIMULATOR AND ON THE SET OF PSYCHOLOGICAL TESTS

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Abstract – In the article, the convolution of the test results of drivers of motor vehicles on the auto-simulator and on the complex of psychological tests "effecton" is considered.

Keywords – professionally important qualities (PIQ), drivers of vehicles, reduction of recorded indicators.

I. INTRODUCTION

The study and diagnosis of significant psychophysiological qualities of drivers of motor vehicles make it possible to solve problems related to the human factor more effectively [1].

The authors of the work carried out research of the peculiarities of the professional activity of drivers of motor vehicles and developed a methodology for identifying professionally important qualities (PIQ) using expert assessments [2,3].

II. GOAL

As a result of the analysis of existing tests for assessing the degree of development of sensorimotor reactions, the authors developed test tasks for the evaluation of sensorimotor reactions in conditions close to the work of drivers of vehicles operating in the conditions of a large city. The proposed test tasks are focused on the use of stationary or laptop computers with the use of the game console driver (steering wheel, pedals, gear lever).

III. MATERIALS AND METHODS

Test tasks are imitation models of dangerous road and

transport situations with an evaluation characteristic of the degree of development of sensorimotor qualities [4,5].

Figure 1 shows a schematic representation of one of the developed simulation test tasks for the hardware-software complex for diagnosing psychophysiological qualities of drivers of motor vehicles.

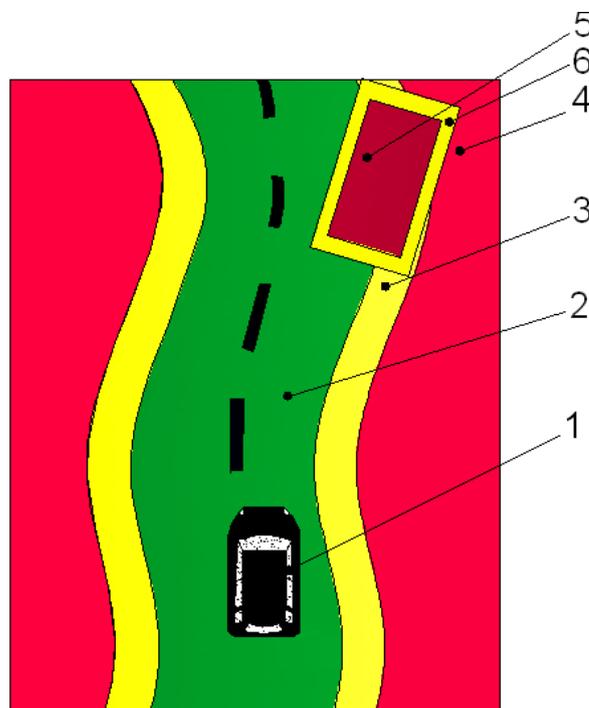


Fig. 1 Test "Driving on the road with fixed obstacles" 1 - "car" of the testing subject; 2- "road" contour (safety zone); 3 - the contour of the "roadside" (dangerous zone); 4 - contour of "near-road space" (critical zone); 5 - "parked

car" contour (critical area); 6 - a contour of dangerous distance along the perimeter of a "parked car" (danger zone).

IV. RESULTS AND DISCUSSION

When conducting research, especially in areas where precise single-valued deterministic estimation is difficult or impossible (for example, due to a large number of parameters, some of which are unknown or not explicitly taken into account), there arises the problem of convolution of results into a single, generalized criterion or several criteria for groups with reduction to the desired range.

The criteria obtained are then either used to perform computer analysis and information processing, or are provided to the person making the decision (DM) to justify the choice.

In developing the methodology for integrated support for the work of drivers of passenger vehicles and other operators of occupations, it was necessary to first obtain an assessment of the subject's passing through the test on a road simulator (in tests of different levels of complexity) and, second, to obtain a general criterion for passing standard and other known psycho-physiological tests.

To solve the first problem, the following convolution is proposed:

$$R_{OD} = \frac{(\sum \frac{V_i}{V_{max}}) + d_{y0}}{d_0} \quad (1)$$

where is the R_{OD} - criterion of maneuvering, concerning dangerous zones of fixed obstacles;

V_i - the speed at which the dangerous zone of the fixed obstacle intersects;

V_{max} - maximum speed in the test task;

d_{y0} - number of successfully passed obstacles;

d_0 - total number of dangerous obstacle zones.

Example: Total number of obstacles in test 15, crossing hazardous areas 2, at speeds of 70 and 80 km / h, maximum test speed 90 km / h, then

$$R_{OD} = \frac{(\frac{70}{90} + \frac{80}{90}) + 13}{15} \quad (2)$$

where is the R_{OK} - criterion of maneuvering, concerning critical areas of fixed obstacles;

V_i - the speed at which the critical area of the fixed obstacle intersects;

V_{max} - maximum speed in the test task;

d_{yk} - number of successfully passed obstacles;

d_k - the total number of critical obstacle zones.

Example: The total number of obstacles in test 15, the intersection of critical zones 2, at speeds of 70 and 80 km / h, the maximum test speed is 90 km / h, then

$$R_{OK} = \frac{(\frac{70}{90} + \frac{80}{90}) + 13}{15}$$

$$R_{RD} = 1 - \sum \left[\frac{\Delta t}{t} \left(1 - \frac{V_i}{V_{max}} \right) \right] \quad (3)$$

where is the R_{RD} - criterion of maneuvering, concerning dangerous road zones;

Δt - crossing time of the dangerous road zone at speed V_i , sec.;

t - the time of the test task, sec.;

V_i - the speed at which the dangerous road zone intersects;

V_{max} - maximum speed in the test task.

Example: The total test time is 300 seconds, the number of intersections of dangerous road zones 2, at speeds of 70 and 80 km / h, the duration of intersections is 2 and 5 seconds. accordingly, the maximum speed of the test is 90 km / h, then

$$R_{RD} = 1 - \left[\frac{2}{300} \left(1 - \frac{70}{90} \right) \right] + \left[\frac{5}{300} \left(1 - \frac{80}{90} \right) \right]$$

$$R_{RK} = 1 - \sum \left[\frac{\Delta t}{t} \left(1 - \frac{V_i}{V_{max}} \right) \right] \quad (4)$$

where is the R_{RK} - criterion of maneuvering, relative to critical road zones;

Δt - crossing time of the critical road zone at speed V_i , sec;

t - the time of the test task, sec.;

V_i - the speed at which the critical road zone intersects;

V_{max} - maximum speed in the test task.

Example: Total test time 300 seconds, the number of intersections of critical road zones 2, at speeds of 70 and 85 km / h, the duration of intersections 3 and 5 seconds. accordingly, the maximum speed of the test is 90 km / h, then

$$R_{RK} = 1 - \left[\frac{3}{300} \left(1 - \frac{70}{90} \right) \right] + \left[\frac{5}{300} \left(1 - \frac{85}{90} \right) \right]$$

$$R = \frac{a_1 R_{OD} + a_2 R_{OK} + a_3 R_{RD} + a_4 R_{RK}}{a_1 + a_2 + a_3 + a_4} \quad (5)$$

where the R - criterion of reliability of maneuvering, which is a generalized estimate of passing the test on the road simulator;

a_1, a_2, a_3, a_4 - additional coefficients of significance criteria for the resulting value ($a_1=0.2; a_2=0.8; a_3=0.2; a_4=0.8$);

Drivers of vehicles participating in the studies also performed test tasks of the software complex "Effecton" [6]. In the work the modules of the program were applied: "Attention" and "Jaguar". These software applications are developed by the company for diagnostics of sensorimotor reactions and attention of specialists of various professions, for the effective labor activity of which the data of the PIQ group are needed.

The results of the test tasks of this psychological complex are interpreted on a 4-point system (5 - excellent, 4 - good, 3 - satisfactory, 2 - unsatisfactory).

When solving the second task, it is necessary to perform convolution in such a way that even a single "failure",

inadmissible low parameter, greatly reduces the generalized criterion.

The following additive convolutions were considered:
the additive criterion in the form of the arithmetic mean

$$Q = \frac{1}{3n} (\sum_{i=1}^n (q_i - 2)) \quad (6)$$

The additive criterion in the form of a functional average

$$Q = \frac{\sum_{i=1}^n \lg(3q_i - 5)}{n} \quad (7)$$

The multiplicative criterion in the form

$$Q = \prod_{i=1}^n \left(\frac{1}{3} q_i - \frac{2}{3} \right) \quad (8)$$

The multiplicative functional criterion in the form

$$Q = \prod_{i=1}^n \lg(3q_i - 5) \quad (9)$$

The multiplicative functional criterion with extended interval of positive estimates

$$Q = \frac{\prod_{i=1}^n \lg(33q_i - 65)}{2^n} \quad (10)$$

where is the n - number of tests passed;
q_i - score in the test task.

The most sensitive is the criterion obtained by multiplicative convolution. In order to preserve sensitivity, but to avoid a large fall in the generalized criterion due to a small decrease in the quotients, the logarithm is taken from them. The obtained value is brought to the necessary interval by normalization using the best possible (ideal) values of the partial criteria.

Consider convolutions on the following sets of partial criteria based on the results of testing six subjects:

TABLE I. ADDITIVE CRITERION
IN THE FORM OF THE ARITHMETIC MEAN (6)

q1	q2	q3	q4	q5	q6	q7	q8	q9	$\frac{Q}{(0,1)}$	$\frac{Q^1}{(2,5)}$
2	2	2	2	2	2	2	2	2	0	2
2	2	2	2	3	3	3	3	4	0,222	2,666
2	4	4	4	4	5	5	5	5	0,741	4,222
3	3	3	4	4	4	5	5	5	0,667	4
4	4	4	4	5	5	5	5	5	0,852	4,556
5	5	5	5	5	5	5	5	5	1	5

TABLE II. ADDITIVE CRITERION
IN THE FORM OF THE FUNCTIONAL AVERAGE (7)

q1	q2	q3	q4	q5	q6	q7	q8	q9	Q	Q ¹
2	2	2	2	2	2	2	2	2	0	2
2	2	2	2	3	3	3	3	4	0,361	3,084
2	4	4	4	4	5	5	5	5	0,820	4,460
3	3	3	4	4	4	5	5	5	0,816	4,447
4	4	4	4	5	5	5	5	5	0,931	4,793
5	5	5	5	5	5	5	5	5	1	5

TABLE III. THE MULTIPLICATIVE CRITERION (8)

q1	q2	q3	q4	q5	q6	q7	q8	q9	Q	Q ¹
2	2	2	2	2	2	2	2	2	0	2
2	2	2	2	3	3	3	3	4	0	2
2	4	4	4	4	5	5	5	5	0	2
3	3	3	4	4	4	5	5	5	0,011	2,033
4	4	4	4	5	5	5	5	5	0,198	2,593
5	5	5	5	5	5	5	5	5	1	5

TABLE IV. THE MULTIPLICATIVE FUNCTIONAL CRITERION (9)

q1	q2	q3	q4	q5	q6	q7	q8	q9	Q	Q ¹
2	2	2	2	2	2	2	2	2	0	2
2	2	2	2	3	3	3	3	4	0	2
2	4	4	4	4	5	5	5	5	0	2
3	3	3	4	4	4	5	5	5	0,132	2,395
4	4	4	4	5	5	5	5	5	0,510	3,530
5	5	5	5	5	5	5	5	5	1	5

TABLE V. MULTIPLICATIVE FUNCTIONAL CRITERION WITH EXTENDED
INTERNAL OF POSITIVE ESTIMATES (10)

q1	q2	q3	q4	q5	q6	q7	q8	q9	Q	Q ¹
2	2	2	2	2	2	2	2	2	0	2
2	2	2	2	3	3	3	3	4	0	2
2	4	4	4	4	5	5	5	5	0	2
3	3	3	4	4	4	5	5	5	0,342	3,025
4	4	4	4	5	5	5	5	5	0,695	4,085
5	5	5	5	5	5	5	5	5	1	5

where is the q_i - evaluation in the test task;
Q – is a multiplicative criterion for evaluating the results of performing psychological tests «Effecton» within the range from 0 to 1;
Q¹ - is a multiplicative criterion for evaluating the results of performing psychological tests "Effecton" within the values from 2 to 5.

V. CONCLUSIONS

As can be seen from the comparison of the results, the most successful and obvious is convolution (10).

Comparing the general criterion and the maneuvering factor R, we establish the full or group (selective) equivalence of the results obtained on the simulator and the results of the psychological tests.

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