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REFLECTION OF INDIVIDUAL TYPOLOGICAL PROPERTIES IN THE TREMOROGRAM
(Predicting the indicators of Rusalov's test according to the indicators of the tremorogram)

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Abstract

Rationale for choosing**.** An increase in physiological tremor (Tr) in emotionally saturated situations is reflected not only in fiction, but also in scientific literature. In other words, tremors and emotional responses are interconnected. **Purpose.** To investigate the reflection of individual-typological properties in a tremorogram using V. M. Rusalov's mathematical modeling. **Material and methods.** Tr was recorded using a linear transducer. Tr was recorded under postural load (arms extended forward). The sensor was alternately placed on the outstretched right and left arms in front of oneself, under conditions of "eyes open" (operative rest). The analysis of the tremorogram (TrG) files was carried out after the end of the study using the "Analist - 2" software according to the half - period analysis

algorithm. To study the individual psychological characteristics of the personality, we used the method of determining the properties of the temperament by V.M. Rusalov. Each of the many indicators of Rusalov's test selected in the analysis was considered as a target feature (Y-s), and the amplitudes and frequencies of TrG were considered as influencing variables (sets of X - s) and multiple linear regression equations of the form were built: The parameters of the amplitude and frequency of EEG rhythms were used as Xs. **Own research**. In multiple regression analysis of the influence of TrG indices of the right hand on the indices of Rusalov's test, 12 statistically significant regression coefficients were determined, and 11 statistically significant regression coefficients for the left hand. After obtaining the diagnostic equations of multiple linear regression, describing the influence of TrG indicators on the indicators of Rusalov's test, an attempt was made, using these equations, to obtain the indicators of Rusalov's test, using the tremor indicators. On average, the% discrepancy between the determined and predicted indicators was 97.42% for the right hand, and 101.98 for the left. **Conclusions**. 1. With the use of diagnostic equation, it was possible to predict the indicators of psychological testing according to Rusalov's test by the indicators of tremor of the right and left hands.

2. Influence of Rusalov's test indicators on TrG indicators were less in modulus than the influence of TrG indicators on the indicators of Rusalov's test, i.e. did not participate in the control of the mechanisms of TrG generation.

3. The results obtained indicate that tremor indicators contain information about the subject-activity and communicative aspects of temperament according to V. M. Rusalov.

Key words: individual typological properties; tremorogram; test of V.M. Rusalov; individual psychological portrait; essential tremor

Rationale for choosing. The possibility of calculating the parameters of the electroencephalogram of the psychological portrait of a person according to the MMPI test has been shown [2, 3]. According to A. N. Lebedev [4] "our inner world, encoded in memory by packets of coordinated waves of neural activity, the features of our personality, as in a mirror, are objectively reflected in the electrical potentials of the brain".

We have developed a method for registration and analysis of tremor [5], which is implemented within approximately 10 minutes and allows for the study of large populations of subjects.

Tremors (Tr) are rapid, rhythmic movements of limbs or trunk caused by involuntary muscle contractions. The most common type of tremor that occurs in healthy people is

physiological tremor, most often it appears in the hands or other part of the body (lips, head, etc.). The reason for the intensification of this type of tremor is strong emotions, excitement, anxiety, fatigue, hypothermia, increased body temperature [1]. According to studies [10], the frequency of physiological (simple and increased) hand tremor depends, among other things, on the biomechanical properties of the muscles and joints of limb. An increased physiological tremor has large amplitude, but the same frequency as a simple physiological one. It is an action tremor and occurs in conditions leading to the excitation of peripheral β-adrenergic receptors, most often stressful situations [10]. It is difficult to distinguish it from mild essential tremor (ETr) [9]. Physiological tremor, as you know, depends not only on the mechanical properties of the limb; an important role in its occurrence, in addition to peripheral factors, is played by the 8-12-hertz central component [11]. There is a point of view that in different conditions the central or peripheral mechanism of tremor may dominate [12].

Thus, an increase in physiological tremor in emotionally saturated situations was reflected not only in fiction, but also in scientific literature.

The questionnaire of formal dynamic properties of individuality (OFDSI) by V. M. Rusalov [6] is used to diagnose four basal properties of the nervous system - ergicity, plasticity, tempo rhythm (speed), emotionality, which are manifested in the psychomotor, mental, and communicative spheres of the psyche.

Among the individual characteristics of a person, which clearly characterize his behavior, a prominent place belongs to temperament. This is the most stable formation, which has a biological basis, since individual typological properties are genetically and inherently determined.

The technique allows you to determine the levels of ergicity, plasticity, tempo rhythm and emotionality as properties of temperament.

Ergic (energetic) - the degree of activity shown by a person in communicating with people and in practical work.

Plasticity - the ease of switching from performing one type of activity to performing another, or changing behavior in communicating with people

Temporhythm - the speed of performing individual actions, operations, movements.

Emotionality - a person's tendency to emotionally react to various events related to his practical activities and communication with people [6]. The use of multiple regression analysis methods will make it possible to obtain diagnostic equations for calculating

psychological indicators (Rusalov's test) based on a set of predictors - tremorogram indicators.

Considering tremor as an information system reflecting the functional state of the brain, it is advisable to identify the relationship of this information system and information systems representing mental acts and states and the functional state of the central nervous system.

Purpose. To investigate the reflection of individual-typological properties in TrG using V. M. Rusalov's mathematical modeling.

Research methodology. Tremor was recorded using a linear displacement transducer developed by us [5], which consisted of a carbon-resistive transducer (a soft resistor — a rubber tube filled with carbon powder) included in a bridge circuit. The linear displacement transducer was supplied with a voltage of 4.5 V, and the TrG was recorded during the calibration of the 500 MkV amplifier path. Tremor was recorded under postural loading (arms extended forward). The sensor was alternately placed on the outstretched right and left arms in front of oneself, under conditions of "eyes open" (operative rest).

The analysis of the TrG files was carried out after the end of the experiments using the "Analist 2" program according to the half-period analysis algorithm. Five physiological tremor rhythms were identified: beta-2 - 21-32 Hz, beta -1 - 14.22-18.3 Hz, alpha - 8.0-12.8 Hz, theta - 4-7.53 Hz and delta - 0.5-3.87 Hz. For each of the ranges, the following parameters were determined:

1) amplitude in microvolts,

2) frequency in hertz,

3) index - time as a percentage of the severity of waves of gamma, beta-1-, beta-2-, alpha-, theta and delta-ranges .

In statistical analysis, mean values, standard (root-mean-square) deviation, and mean error were calculated.

Each of the many indicators of Rusalov's test selected in the analysis was considered as a target feature (Y-s), and the amplitudes and frequencies of the tremorogram were considered as influencing variables (sets of X-s) and multiple linear regression equations of the form were built:

$Y1 = a0 + b1X1 + b2X2\ldots + bnXn,$

where a0 – free term, coefficients b1,b2…., bn – regression indicators, reflecting the measure of influence on the analyzed indicator of the remaining elements of the set, x_1, x_2…, x_n indicators. The likelihood of manifestation of influence, i.e., the adequacy of the regression

coefficients, was estimated using the sigma deviations of the regression coefficients, and the effectiveness of the regression in general was estimated by calculating the multiple correlation coefficient.

The indicators of Rusalov's test were used as Ys: motor ergic, intellectual ergic, communicative ergic, psychomotor plasticity, intellectual plasticity, communicative plasticity, psychomotor speed, intellectual speed, communicative speed, psychomotor emotionality, intellectual emotionality, communicative emotionality. The parameters of the amplitude and frequency of EEG rhythms were used as Xs.

The likelihood of manifestation of influence the adequacy of the regression coefficients was assessed using the sigma deviations of the regression coefficients, and the effectiveness of the regression in general was assessed by calculating the multiple correlation coefficient.

Psychological methods were carried out in electronic form and had a standard form. To study the individual psychological characteristics of the personality, we used the method of determining the properties of temperament by V. M. Rusalov (OFDSI) [6].

Own research. The multiple correlation coefficients of the obtained multiple regression equations ranged from R=0,67428635 R^2=0,45466209 to R=0,84527638 R^2=0,71449216, those. The effectiveness of the regression was sufficient.

In multiple regression analysis of the influence of TrG indices (Table 1) of the right hand on the indices of Rusalov's test, 12 statistically significant regression coefficients were determined.

The indicator "motor ergicity" was statistically significantly positively influenced by the rates of beta-1 and delta rhythms. The indicator "intellectual ergicity" was statistically significantly positively influenced by the indicator of the amplitude of the alpha rhythm. The index of "intellectual plasticity" was statistically significantly positively influenced by the index of the amplitude of the alpha rhythm, and the index of the frequency of the alpha rhythm was statistically significantly negative. The "psychomotor speed" indicator was statistically significantly negatively influenced by the beta-2 rhythm amplitude indicator, and the "intellectual speed" indicator was influenced by the delta rhythm frequency indicator. The "communicative speed" indicator was statistically significantly positively influenced by the beta-2 rhythm frequency indicator. The indicator "intellectual emotionality" was statistically significantly positively influenced by the rate of beta-2 rhythm and statistically significantly negatively by indicators of the frequency of beta-1 and amplitude of delta rhythms. The

indicator "communicative emotionality" was statistically significantly negatively influenced by the indicator of the amplitude of the delta rhythm.

Table 1

Statistically significant regression coefficients determined from the indicators of the right hand tremor to the indicators of Rusalov's test

Indicators of Rusalov's test	Tremorogram rhythms									
	Beta -2		Beta -1		Alpha		Theta		Delta	
	A	F	A	F	A	F	F	F	A	F
ergic motor				0,68						0,67
ergic intellectual					2,08					
ergic communicative										
psychomotor plasticity										
intellectual plasticity					1,93	-0,88				
plasticity is communicative										
psychomotor speed	-2,14									
intellectual speed										-0,96
communicative speed		0,82								
psychomotor emotionality										
intellectual emotionality		1,02		-0,61					-1,24	
communicative emotionality									-1,20	

Note: A - amplitude, F- frequency

In multiple regression analysis of the influence of the left hand TrG indicators (Table 2) on the indicators of Rusalov's test, 11 statistically significant regression coefficients were determined.

The indicator "communicative plasticity" was statistically significantly positively influenced by the indicator of the amplitude of the beta-1 rhythm. The indicator "communicative speed" was statistically significantly positively influenced by the indicators of the amplitude of beta-1, the frequencies of alpha and delta rhythms, and statistically significantly negatively influenced by the indicator of the amplitude of the theta rhythm. The indicator "psychomotor emotionality" was statistically significantly positively influenced by

the indicator of the theta rhythm frequency. The “intellectual emotionality” indicator was statistically significantly positively influenced by the amplitude indicators of theta and delta rhythms and the frequency of the alpha rhythm. The indicator "communicative emotionality" was statistically significantly positively influenced by the rate of beta-1 and statistically significantly negatively influenced by the rate of beta-2 rhythms.

Table 2

Statistically significant regression coefficients determined from indicators of left hand tremor to indicators of Rusalov’s test

Indicators of Rusalov’s test	Tremorogram rhythms									
	A		F		A		F		A	
	A	F	A	F	A	F	A	F	A	F
plasticity is communicative			1,32							
psychomotor speed										
intellectual speed										
communicative speed			-1,15			0,74	-1,33			1,41
psychomotor emotionality								0,67		
intellectual emotionality						0,61	1,93		0,76	
communicative emotionality		-0,67		0,66			-			

After obtaining the diagnostic equations of multiple linear regression, describing the influence of the TrG indicators on the indicators of Rusalov’s test, an attempt was made, using these equations, to obtain the indicators of Rusalov’s test, using the tremor indicators. Table 3 shows the indicators of psychological testing according to Rusalov’s test, determined and predicted according to the indicators of the right hand tremor, and in Table 4, the determined and predicted indicators of psychological testing according to Rusalov’s test according to the indicators of the left hand tremor in one subject.

As can be seen from the table, the predicted indicators fell into the ± 5% confidence interval.

Table 3

Indicators of psychological testing determined and predicted

by the indicators of the tremor of the right hand according to Rusalov's test

Indicators of Rusalov's test	Specific value	Predicted value	Confidence interval		% Forecasted from a certain value
			-95,0% CL	+95,0% CL	
Ergicity motor	30	35,31	28,88	41,74	117,70
Ergic intellectual	43	38,61	30,91	46,32	89,79
Ergic communicative	47	38,84	30,17	47,51	82,64
Psychomotor plasticity	34,00	35,42	25,57	45,28	104,18
Intellectual plasticity	35,00	33,39	28,42	38,36	95,40
Plasticity is communicative	31,00	27,34	18,98	35,69	88,19
Psychomotor speed	32,00	35,43	29,07	41,78	110,72
Intellectual speed	21,00	30,73	19,89	41,56	146,33
Communication speed	45,00	40,48	29,49	51,47	89,96
Psychomotor emotionality	30,00	32,63	24,15	41,11	108,77
Intellectual emotionality	38,00	30,53	22,31	38,75	80,34
Emotionality communicative	28,00	30,73	22,62	38,84	109,75

Table 4

Indicators of psychological testing determined and predicted by indicators of left hand tremor

according to Rusalov's test

Indicators of Rusalov's test	Specific value	Predicted value	Confidence interval		% Forecasted from a certain value
			-95,0%	+95,0%	
Ergicity motor	30,00	29,06	17,49	40,63	96,87
Ergic intellectual	43,00	36,01	22,50	49,53	83,74
Ergic communicative	47,00	45,71	35,66	55,76	97,26
Psychomotor plasticity	34,00	33,15	22,03	44,28	97,50
Intellectual plasticity	35,00	30,08	19,73	40,44	85,94
Plasticity is communicative	31,00	32,46	23,10	41,81	104,71
Psychomotor speed	32,00	30,23	21,73	38,74	94,47
Intellectual speed	21,00	22,89	9,41	36,36	109,00
Communication speed	45,00	43,43	26,48	60,37	96,51
Psychomotor emotionality	30,00	30,08	20,01	40,16	100,27
Intellectual emotionality	38,00	36,90	23,15	50,66	97,11
Emotionality	28,00	29,59			105,68

communicative			16,69	42,50	

On average, the% discrepancy between the determined and predicted indicators was 97.42% for the right hand, and 101.98 for the left.

Discussion. From the indices of the right hand TrG to the indices of Rusalov's test. 12, and the left hand - 11 statistically significant regression coefficients were determined. Reverse influences from indicators of Rusalov's test to the indicators of TrG were less in modulus, i. e. did not participate in the control of the mechanisms of TrG generation.

To the indicator "intellectual emotionality" of Rusalov's test. Three statistically significant regression coefficients were determined from the indicators of the TrG of the right hand, and only 1-2 statistically significant regression coefficients were determined for the rest of the test indicators.

To the indicators "communicative emotionality", "intellectual emotionality", "communicative speed" of Rusalov's test. from the indices of the left hand TrG, respectively, two, three and four statistically significant regression coefficients were determined. It can be assumed that the above three indicators of Rusalov's test are controlled by the mechanisms of TrG generation.

Conclusions:

1. With the use of diagnostic equation, it was possible to predict the indicators of psychological testing according to Rusalov's test by the indicators of tremor of the right and left hands.

2. Influence of Rusalov's test indicators on the indicators of TrG were less in modulus than the influence of the indicators of TrG on the indicators of Rusalov's test, i. e. did not participate in the control of the mechanisms of tremorogram generation.

3. The results obtained indicate that tremor indicators contain information about the subject-activity and communicative aspects of temperament according to V. M. Rusalov.

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