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THE ALGORITHM, THE SOFTWARE AND THE METHODOLOGY OF STRESS TOLERANCE ASSESSMENT

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Abstract. The paper deals with the research results of relation between stress resistance level and attention parameters influenced by visual factor of stress. Within the study there was used a modified Landolt ring correction test and the Cohen-Williamson self-assessment method of stress resistance. The relationship between stress level and quantitative (S_K) and qualitative (S_V) change in the errors percentage of probationers was established. The boundary values of the stress factor parameter were set based on the error rate change (S_V) to determine the stress tolerance level. Preliminary results of proposed methodology application for assessing the influence of stress factors on the attention parameters indicate the simplicity of its use and ease of data processing.

Keywords: *stress factor, stress tolerance, proofreading test "Landolt Rings", the self-assessment of stress resistance of Cowen- Williamson, attention parameters.*

1. Introduction

Stress tolerance is an important quality, which is necessary for workers in many occupations. The number of situations when person needs to perform his work effectively in conditions of heightened stress level is increasing. As a result the parameters of specialist's cognitive processes, particularly memory and attention processes, are changing. Therefore, there is a topical opportunity to determine the stress tolerance level of workers in various occupations qualitatively and timely.

A large number of methods for stress tolerance determining are developed. There are based on the results of tests and personality questionnaires techniques that assess the person's psychophysiological state [1]: Minnesota Multiphasic Personality Inventory (MMPI), as well as its modifications in the form of a standardized method of personality researching and derived from it methodology types of assessment of psychological instability "Forecast"; the Cattell's sixteen personality factor questionnaire; the Cowen-Williamson's self-assessment method of stress tolerance [2] and others. There are techniques which assess the physiological response to stress: assessment of hemodynamics with the help of psycho-emotional stress test "mathematical calculation" [3]; cardio-respiratory synchronization test [4]; methods for determining the functional state of operators [5] and

others. Numerous data that indicate the ambiguity of the estimates, which are obtained by methods that use questionnaires and tests, as they are often too subjective have been accumulated [6]. Methods for determining the person's psycho-emotional state according to hemodynamic or cardio-respiratory activity show good results, but they require expensive equipment. It complicates research of stress tolerance level in large quantities.

Thus, there is an urgent need to create an effective methodology for assessing stress resistance, which does not require any expensive specialized equipment both for analyzing the human's state and for generating of stress factors of various types [7, 8].

Since the attention characteristics are very sensitive to stressful situations [9–11], it was decided to test the possibility of using this effect to assess the influence of stress factors on probationers. Previous studies [10, 11] showed deterioration of the attention stability when a sound stress factor influences. It is proposed to investigate the degree of the generated impact in special software visual stress factor on the parameters of a person's attention. It is also required to prove the possibility of applying a modified research method using the Landolt ring correction test [11] to assess the stress tolerance level. To do this, it is necessary to compare the data, which is obtained with using this technique and results of questioning of probationers in order to determine their psychological stress tolerance level.

The purpose of the research is to develop an algorithm, a software and a methodology for assessing stress resistance.

2. Experimental technique

The visual stress factor is represented by change in the background color of the work table of the rings from white to red with a frequency of 2 Hz. It should be noted that the application of visual impact is difficult if the probationer has symptoms of photosensitive epilepsy. However, the applied frequency of changing of screen color lies outside the dangerous range of 5-30 Hz, at which there is risk of an epileptic attack [14]. Nevertheless, for security reasons, a warning message is presented before the visual impact. Also, the specialist, who is conducting the study must verify the absence of symptoms of photosensitive epilepsy during the research.

For each probatione with an interval of 30 seconds, the following parameters were recorded, calculated and stored: the number of viewed rings (N, pcs.);the number of required viewed rings (M, pcs.); the number of correctly marked rings (B, pcs.); the number of errors (O, pcs.); data processing rate (Q, bit / s); percentage of errors (K,%).

The number of errors (O) is the total number of incorrectly marked and missing rings. The data processing rate Q (bit / s) was calculated by the formula [12]:

$$Q = \frac{0.5936 \cdot N - 2.807 \cdot O}{t}. \quad (1)$$

The percentage of errors K (%) was calculated by the formula:

$$K = \frac{O}{N} \cdot 100. \quad (2)$$

For the segments "before" and "after" the beginning of impact of the stress factor, the following factors were calculated:

– the average percentage of errors (K_{av},%);

– the rate of change of the percentage of errors (V_K,%/min.).

The average percentage of errors K_{av} (%) was counted for the time ranges "before" and "after" the beginning of the impact of the stress factor using the formula:

$$K_{av} = \sum_{i=0}^{n} \frac{K_i}{n}, \quad (3)$$

where n is the number of segments of 30 s in the period "before" or "after" the beginning of impact of the stress factor.

The rate of percentage change of errors V_K (%/min.) characterizes the change in the number of made errors to the total number of viewed rings during the test. The least squares method [14] was used to find formulas for approximation lines in the following form: $K = a \cdot t + b$, where a is the line tilt, b is the offset. V_K parameter is equal to (Figure 1):

$$V_K = a, \quad (4)$$

where a is the slope ration of the approximation line.

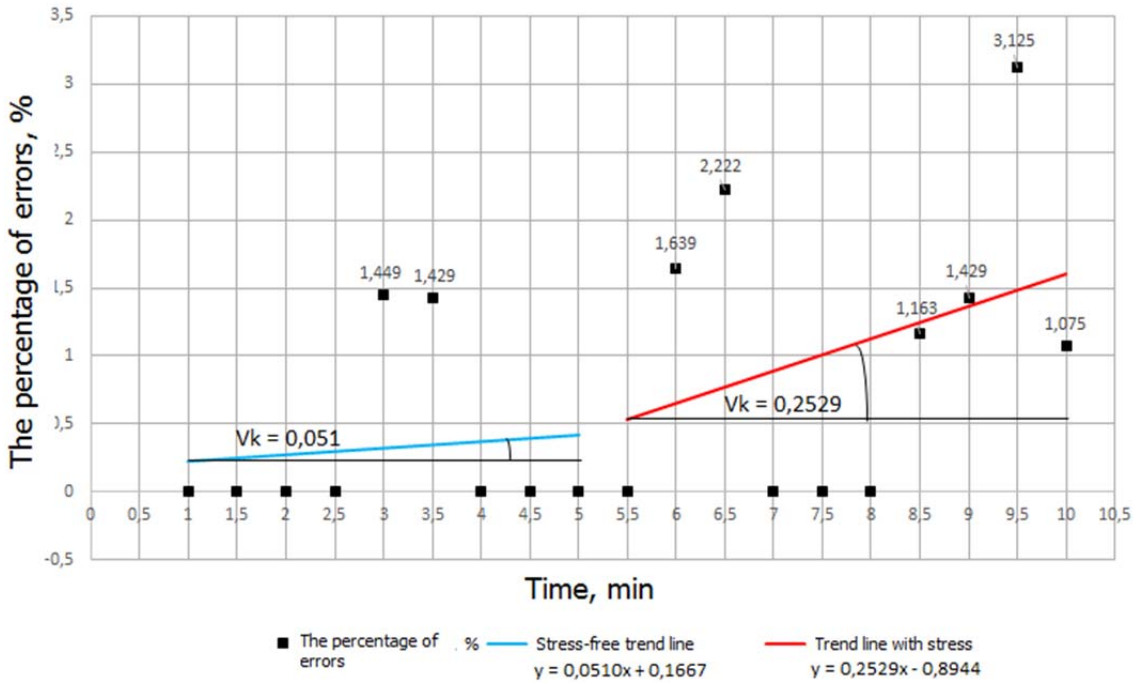

Figure 1. Illustration of the S and P parameters calculation according to the approximation formulas.

Further, the total scores for the probationer were calculated:

– the level of impact of the stress factor according to the average percentage of errors (S_K);

– the level of impact of the stress factor according to the rate of change of the percentage of errors (S_V).

The level of the stress factor S_K (%) impact reflects the deterioration of the attention parameters under the influence of stress factor and is defined as:

$$S_K = K_{av2} - K_{av1}, \quad (5)$$

where K_{av1} is the average percentage of errors “before” the beginning of impact of the stress factor,%;

K_{av2} is the average percentage of errors “after” the beginning of impact of the stress factor,%.

The level of the stress factor S_V (%/min.) impact reflects the behavior of attention parameters under the influence of a stressor:

$$S_V = V_{K1} - V_{K2}, \quad (6)$$

Where V_{K1} is the rate of change in the percentage of errors "before" the beginning of impact of the stress factor,%/min;

V_{K2} is the rate of change in the percentage of errors "after" the beginning of impact of the stress factor,%/min.

This is followed by the second stage, where probationers were divided into 3 groups according to the results of passing the questionnaire using the Cowan-Williamson method [2]. The questionnaire consists of 10 questions with formatted answers. Each answer is estimated from 0 to 4 points. After the summation of points probationers' stress tolerance level is defined to be high (0-13 points), medium (14-26 points) or low (27-40 points).

According to the results of the two stages, indicators of the average percentage of errors and the sum of the rate of change in the percentage of errors are determined for the "before" and "after" the beginning of impact of the stress factor periods. These indicators are characteristic of each stress tolerance level group of probationers.

3. Results and its discussion

Research was conducted in two stages. 1) Testing of probationers according to the method of assessing changes in the attention parameters under the influence of a stress factor and using the Landolt ring correction test [12]. 2) Questioning of probationers according to the Cowan-Williamson method [3] to determine the stress tolerance level.

The probationer is presented with a randomly generated table with Landolt rings; 3000 rings must be viewed in 10 minutes. The probationer finds and marks the rings with the given break position; the number of such rings is about 10% of the total. The total number of rings is chosen in such way that the probationer, even with a very high data processing rate, doesn't have enough time to look through the entire table [13]. The tests are divided into 2 time intervals of 5 minutes each: the first is working in a calm atmosphere, the second one - under the influence of a visual stress factor. The algorithm for testing under stress factor conditions is developed (Table 1).

Probationers were divided into 3 groups according to the stress tolerance level according to Cohan-Williamson method: group 1 – high level, 7 people; group 2 – medium level, 9 people; group 3 – low level, 4 people. Averaged parameters for probationers (table 2) and selected groups of probationers (table 3) are calculated. Figure 2 shows the dynamics of changes in the parameters K (average percentage of errors) and V_K (rate of change in the percentage of errors) in the selected groups of probationers/

Table 1

The algorithmic diagram of testing under the stress factor

Work in a calm atmosphere	1) Presentation of tables with Landolt rings to the probationer
	2) Determination of rings with a given break position
	3) Calculation and saving of results
	4) Determination of data processing rate
	5) Determination of the percentage of errors
Work under the influence of a visual stress factor	6) Presentation of tables with Landolt rings to the probationer
	7) Determination of rings with a given break position
	8) Calculation and saving of results
	9) Determination of data processing rate

Continuation Table 1

	10) Determination of the percentage of errors
Calculation and comparison of results	11) The calculation of the level of impact of the stress factor on the average percentage of errors
	12) The calculation of the level of impact of the stress factor on the rate of change in the percentage of errors
	13) Comparison of results

Table 2

The evaluation results of probationers attention parameters

Parameter	Stressor is absent			Stressor is present		
	Min.	Medium	Max.	Min.	Medium	Max.
Q, bit/s	1.34	1.72	2.48	1.35	1.8	2.69
K, %	0	1.06	2.45	0.28	2.04	4.52
V_K, %/min.	0	0.47	1.17	-0.54	0.1	1.11
S_K, %	0.98					
S_V, %/min.	0.57					

Table 3

The evaluation results of attention parameters in selected groups of probationers

Parameter	Stress tolerance level					
	Low		Medium		High	
	Quiet	Stress	Quiet	Stress	Quiet	Stress
Q, bit/s	1.59	1.99	1.82	1.78	1.64	1.72
K, %	0.469	4.48	1.25	1.75	0.46	0.91
V_K, %/min.	1.04	0.64	0.44	0.15	0.15	-0.32
S_K, %	3.01		0.5		0.45	
S_V, %/min.	1.68		0.59		-0.17	

Research has shown a slight increase in the data processing rate Q after the beginning of impact of the stress factor. This fact may indicate an increase in the concentration of probationers attention to compensate a distraction factor. The average percentage of errors K increased by S_K = 0.98%, which reflects a general deterioration in the stability of the probationers' attention under the influence of visual stress factor.

The sum of the averaged rates of change in the percentage of errors S_V = 0.57%/min. It reflects the fact that the average percentage of probationers errors is increasing during the test. In the group with low stress tolerance level there is an increase in the averaged data processing rate. This change is significantly higher than change in the other two groups. The fact suggests that the stress factor translates the body into a state of excitement, in which concentration of attention and productivity should increase.

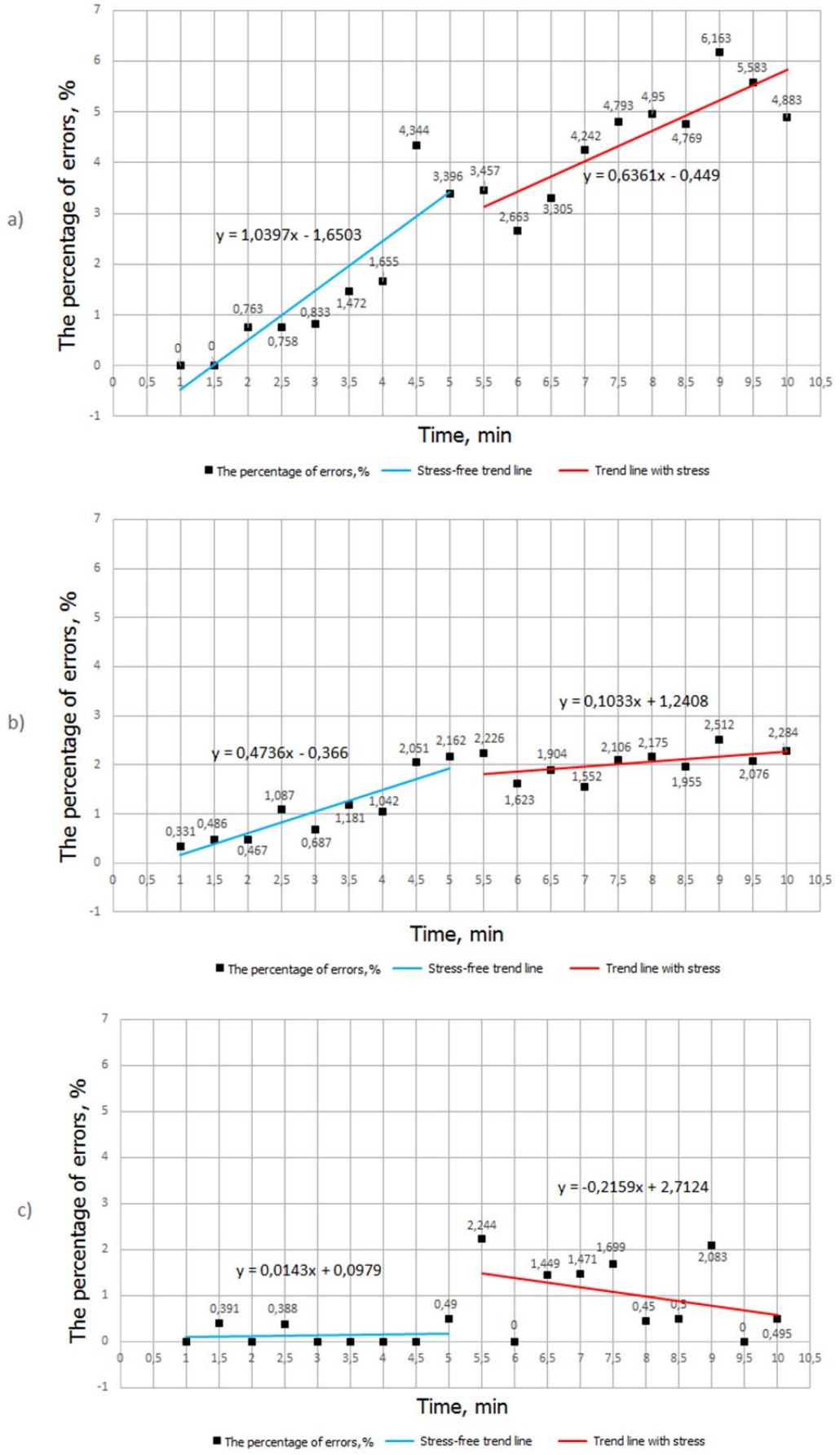

Figure 2. Change of averaged parameters K and V_K in the test groups with low (a), medium (b) and high (c) stress tolerance level.

However, this leads to an increase in the nervousness and to a deterioration of concentration of attention of probationers. Groups with high and medium stress tolerance levels are adapted to stressful conditions better. Probationers continued to perform tasks evenly, which is expressed in a small change in the averaged index Q.

In the group with low stress tolerance level there is a significant increase in the average percentage of errors after the beginning of the stress factor impact (S_K = 3.01%). This is much higher than the averaged indexes in group with medium (S_K = 0.5%) and high (S_K = 0.45%) stress tolerance level. This fact confirms the hypothesis about the dependence between the stress tolerance level and the increase in the probationer's percentage of errors. Indicators of the average rate of change in the errors percentage at calm atmosphere and under the influence of stress also shows that in the group with high stress tolerance level both the initial and final rates (0.15 and -0.32%/min.) are lower than in the group with medium level (0.44 and 0.25%/min.), and in the medium level group rates are significantly lower than in the low stress tolerance group (1.04 and 0.64%/min.).

It is also expressed in the averaged index S_V, which is -0.17%/min. for high, 0.59%/min. for the medium and 1.68%/min. for low stress tolerance.

Thereby, a correlation between the parameter S_V and the stress tolerance level of the probationers, which had been obtained from the results of the Cowan-Williamson questionnaire, was established. The results of the experiment allowed us to estimate the maximum and minimum values of the parameters according to the result of the questionnaire. Indicators, which in the best way characterize the dependence of the attention parameters and the stress tolerance level of the probationers, are presented in table 4.

Table 4.

The evaluation results of the attention parameters of individual probationers in groups according to stress tolerance level

Parameter	Stress tolerance level					
	Low		Medium		High	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
V_K, %/min.	0.16	1.17	-0.18	1.04	-0.54	0.42
S_K, %	1.07	3.32	0.05	0.9	-0.45	1.23
S_V, %/min.	1.41	2.02	0.02	1.4	-0.27	-0.12

According to the level of the stress factor impact and to the rate of change in the percentage of errors (S_V), the following can be determined: high stress tolerance with S_V less than minus 0.05%/min.; medium stress tolerance with S_V from minus 0.05 to 1.4%/min.; low stress tolerance with S_V greater than 1.4%/min. Other parameters can be used in the aggregate with the distribution according to the parameter S_V - for more accurate determination of the stress tolerance level of probationers. Thus, the results are consistent with our hypothesis about the possibility of using a modified Landolt ring correction test to assess the level of psychological stress tolerance. The experience of applying the developed technique showed its ease of use. For testing users need a personal computer with installed software. In most cases, probationers did not need additional instruction before performing the work, and their actions corresponded to the specified test algorithm. Data collection,

the calculation of the required parameters and the construction of graphs were carried out automatically, which greatly simplified the processing of experimental results.

4. Conclusion and development prospects

1) It was established that the impact of the visual stress factor leads to an increase in the average percentage of errors by 0.98%.

2) The relationship between stress level and quantitative (S_K) and qualitative (S_V) change in the errors percentage of probationers was established.

3) The boundary values of the parameter of the impact of the stress factor according to the rate of change in the percentage of errors (S_V) to determine the stress tolerance level of probationers are established: less than minus 0.05%/min. for high, from minus 0.05 to 1.4%/min for medium and more than 1.4%/min for low level.

4) Preliminary results of the application of the proposed methodology for assessing the stress factors influence on the attention parameters indicate the simplicity of its use and ease of data processing.

5) The results of the research prove the possibility to use the developed methodology for attention parameters assessment using the Landolt ring correction test for diagnosing a person's psychological stress tolerance level.

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