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RESEARCH ARTICLE

STRESS ADVANCED RESEARCH .

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Abstract

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The research results of attention parameters are given under the influence of sound stress with the use of modified proofreading sample of the "Landolt Ring". Influence of the stress factor in the form of noise on the number of mistakes made by people under test, its nature and degree is evaluated.

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Introduction:-

Stress resistance is an important quality required for employees of many professions. The number of situations is increasing when a person is required to effectively carry out their work in conditions of increased emotional stress. Therefore the opportunity is relevant to qualitatively determine the level of stress resistance of representatives of different specialties in a timely manner. At the moment, a large number of methods to determine stress resistance is developed. There are methods that evaluate the psycho-physiological state of a person based on the results of tests and personal interviews (Kupriyanov and Kuzmina, 2012): Minnesota Multiphasic Personality Inventory (the MMPI), its modifications such as a Standardized Multifactorial Study of Personality (SMSP), and its derivatives methods for assessing the neuro-psychological instability "forecast"; Cattell's 16PF Questionnaire, etc. In addition, there are methods to evaluate the physiological response to stress: hemodynamic assessment using psycho-emotional stress test "mathematical counting" (Shabalin et al., 2003), the sample of cardiorespiratory synchronism (Pokrovskiy, 2010). Numerous data have been accumulated lately that point to the ambiguity of estimates obtained by the methods using questionnaires and tests, as they are often too subjective (Aleshin, 2000). Methods for determining the psycho-emotional state of a person to assess the hemodynamic or cardio- respiratory activities show good results, but require expensive equipment for work. This fact also makes it difficult to quickly assess the level of stress resistance of everyone. Therefore it is an urgent need for an effective method of stress resistance evaluation, which does not require the use of expensive specialized equipment. Since the characteristics of attention are very sensitive to stressful situations (El-Greid, 2012), it was decided to test the possibility of using this effect to assess the impact of stress factors on people under test. A variety of psychological and physiological stress factors (stressogenes) are used to simulate a stress situation (Aleksandrovskaya et al., 2004). Creation of physiological stress factors implies the necessity of either difficult controlled events during the evaluation (eg, the use of physical activity or jet lag) (Savchenko, 2012) or the use of specialized equipment (for example, to generate vibration, electrical discharges (Gerasimchik, 2005), or temperature changes). Therefore the use of psychological stressors is preferred in this case. Among the psychological stress factors with the use of computer equipment it is rational to use those which are easily reproducible and easy to manage. Such factors as an unexpected situation, the rate of the operation, the functional capacity and irritants correspond to these conditions. The need to re-use stress resistance

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valuation methods involves that we should consider the addiction to generated stress factors, so the use of unexpected situations is difficult. Irritating in the form of noise and flicker factors are forming much simpler and they are controlled more with the use of computer technology than functional load during the test. Thus, it is preferable to use irritating factors (light, noise, flickering, moves) to assess the changes in the parameters of attention in the subjects

Materials and Methods:-

The experiment is based on the use of proofreading sample "Landolt Ring" (Comstock and Arnegard, 1992) under condition of stress factors. 61 students of Technical University acted in the role of human subjects, 53 of which were male and 8 were female.

Special software has been developed for the experiment. Experimental stands were also equipped, including a personal computer with the installed software and headphones.

The software randomly generated a table with Landolt ring for each participant. There were 2000 rings, which they had to look through in 10 minutes. It was necessary to find the ring with a gap "on 12 hours". There were an average of 10% of those which a person had to find and mark among those rings. The number of rings and the time given to them for work was chosen empirically so that it was difficult to have time to mention the entire required ring for a person with normal characteristics of attention (Brunner, 2006).

Instruction for people under the test was conducted before the test. It was said: You have to cross out the rings with a gap "on 12 hours" browsing the table. To successfully complete the task as a whole you need to work as quickly as possible and accurately. There’s 10 minutes to complete the task. Each missing or incorrectly crossed out ring is considered to be a mistake. "

The main stress factor is the effect of sound (loud sound of the clock), which is complemented by a slight flicker (flashing colored indicator of spent time). At the same time, part of the participants was held immediately after the impact of a stressful situation - the exam at the university, i.e. in a psychological fatigue.

At the same time, the participants were exposed to such stressogen as repetitive work, causing fatigue while doing the test. However, to determine the degree of influence of the main stress factor on the participants when calculating the relevant parameters, as described below, account of fatigue was taken under consideration in the results obtained.

During the test sound effects began after the first 5 minutes which were given for this work. The Adjustment of the sound coming through the headphones was used which were used by a participant – it was the average value of the volume scale in Windows settings.

The participants were arbitrarily divided into two groups (Table. 1). The test was given for the first group (28 testees) only once in a relaxed atmosphere. In the second group (33 testees) the test was given twice: the first time was in a relaxed atmosphere, the second - after the exam at the university.

The following parameters were calculated and stored in every 30 seconds for each participant of the test:
- Number of viewed rings (*N*),
- Number of rings which were required to view (*M*),
- The number of errors (*O*),
- Information processing speed (*Q*),
- The percentage of errors (*K*).

The number of errors (*G*) is the total number of incorrectly marked and missed rings.
Speed of processing data *Q* (bit / s) was calculated by the formula [7]:

$$Q = \frac{0,5936 \cdot N - 2,807 \cdot O}{t} \quad (1)$$

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

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

These parameters were saved as XML-files. Excel pivot table was then formed for each group of participants.
The following indicators were calculated for each group:

- The average percentage of errors (K_{av});
- The degree of influence of fatigue (P);
- The degree of exposure to stress factors (S);
- The degree of exposure to the test conditions (R).

Average percentage error K_{av} (%) was calculated for periods of time before and after the impact of stressogene by the formula:

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

where n - number of segments 30 to the period "before" or "after" the beginning of the impact of stressogene.

The degree of fatigue effect P (%) takes into account the increase in the number of errors of the participant as monotonous work goes on. To eliminate the effect of the accumulation of fatigue while completing the tasks, you need to estimate the growth percentage of errors in the length of time before the exposure stressogene and take it into consideration. We used linear approximation error rate (trend line) for the periods of time before the exposure stressogene affected in the form of the sound. Least squares trend line formula was found as follows: where a - slope of the line, b - offset. Thus, the calculation of the parameter P by the formula (Fig. 1):

$$P = a \cdot t + b, \quad (4)$$

where a - the slope of the approximation line;
t - Time of the mid-length of time after the start of exposure stressogen in minutes, equal to 7,75 minutes;
b - Offset approximation line.

The impact stress factor setting S (%) characterizes the deterioration of attention under the influence of stressogene, taking into account the effect of fatigue. We used linear approximation error rate (trend line) for the periods before and after the exposure stressogene in the form of the sound. Least squares trend line formula was found as follows: where a - slope of the line, b - offset. At the same time, it gets straight "before" used directly to account for the effect of fatigue. Thus, the calculation of the S parameter according to the formula (Fig. 1):

$$S = (a_2 - a_1) \cdot t + b_2 - b_1, \quad (5)$$

where 1 and 2 - indexes approximation formula parameters for periods of time before and after the exposure stressogen respectively;
t - Time of the mid-length of time after the start of exposure stressogene in minutes, equal to 7,75 minutes.

The impact of test conditions R (%) describes deterioration of attention for the test before and after the exam. The calculation was performed using the formula:

$$R = S'' - S' \quad (6)$$

where S '- the impact of stress factors in a calm environment in percent
S "- the impact stress factor after the exam as a percentage.
MS Excel program and STATISTICA were used for charting changes and distributions parameters K and S.

Table 1:- Test results of the 1st test group

Parameter	Without stressogen			With stressogen		
	min.	average	max.	min.	average	max.
Information processing speed *Q*, bit/s	0,94	1,69	2,33	1,08	1,63	2,0
The percentage of errors *K*, %	0	0,895	7,05	0	1,765	9,78
The degree of influence of fatigue *P*, %	0,54					
The degree of exposure to stress factors *S*, %	0,33					

Table 2:- Test results of the 2nd test group.

Test	Parametr	Without stressogen			With stressogen		
		min.	average	max.	min.	average	max.
Relaxed atmosphere	Information processing speed *Q*, bit/s	0,83	1,76	2,75	1,03	1,74	2,45
	The percentage of errors *K*, %	0	1	7,89	0	1,51	8,8
	The degree of influence of fatigue *P*, %	0,12					
	The degree of exposure to stress factors *S*, %	0,39					
After exam	Information processing speed *Q*, bit/s	1,34	1,84	2,48	1,35	1,80	2,69
	The percentage of errors *K*, %	0	1,14	8,91	0,12	1,85	10,03
	The degree of influence of fatigue *P*, %	0,23					
	The degree of exposure to stress factors *S*, %	0,48					
Total	The degree of exposure to the test conditions *R*, %	0,09					

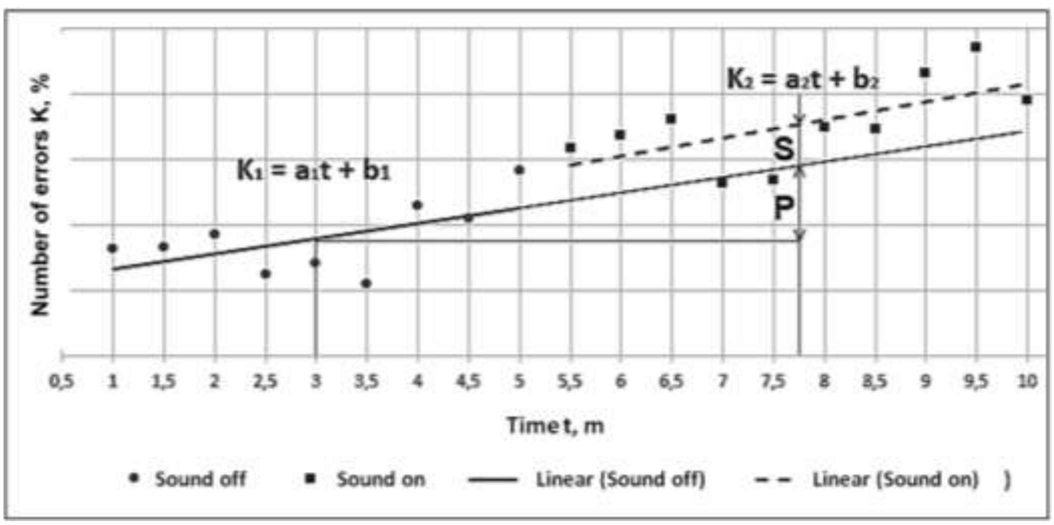

Fig. 1:- Illustration of calculation the the degree of exposure to stress factors *S* and the degree of influence of fatigue *P* parameters by approximation formulas

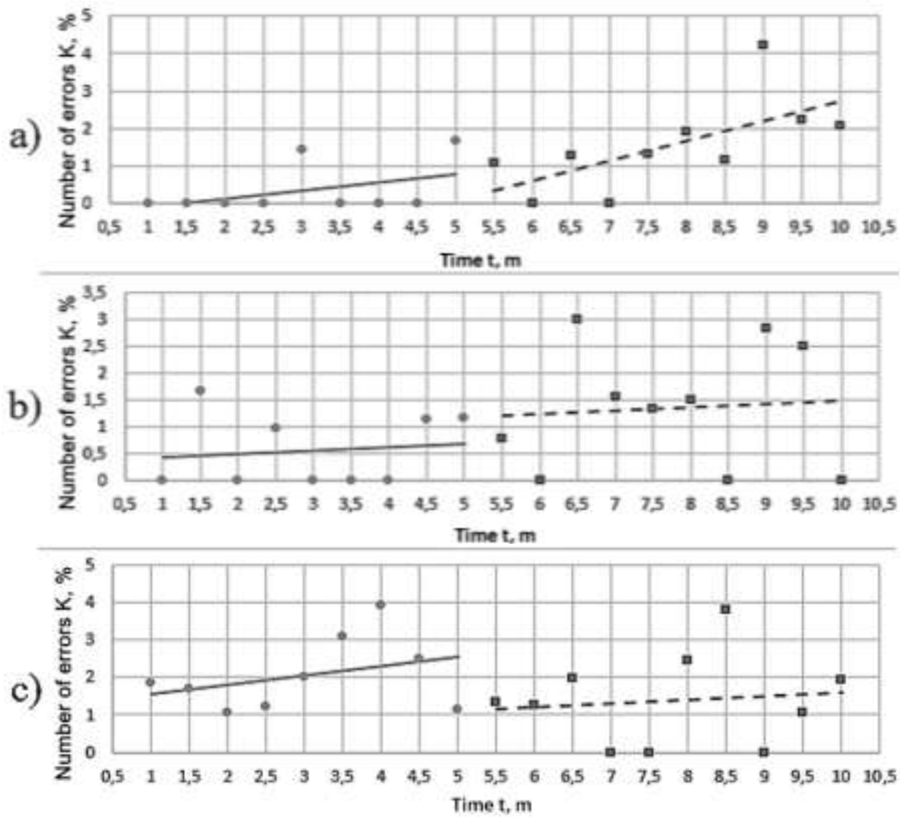

Fig. 2:- The most typical changes of testees' the percentage of errors *K*.

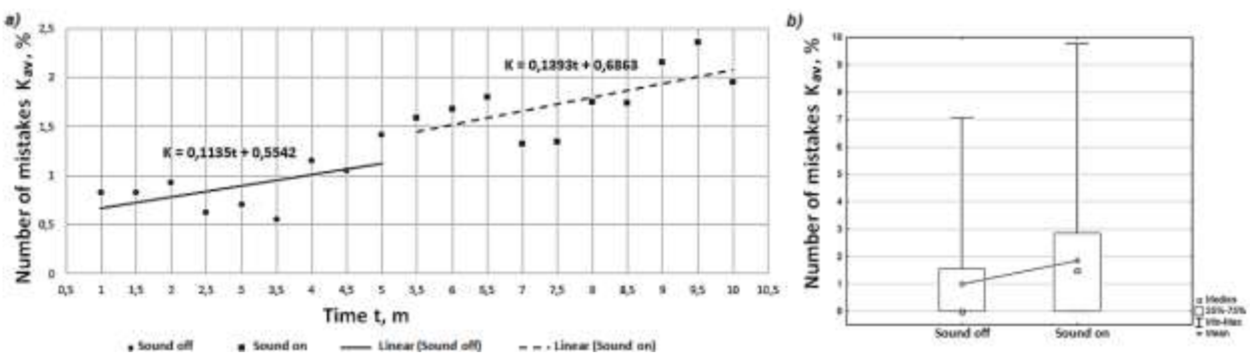

Fig. 3:- Results of measurement attention parameters of the 1st test group before and after stressogen influence: a) parameter K dependence of time; b) change in average number of mistakes before and after stressogen influence

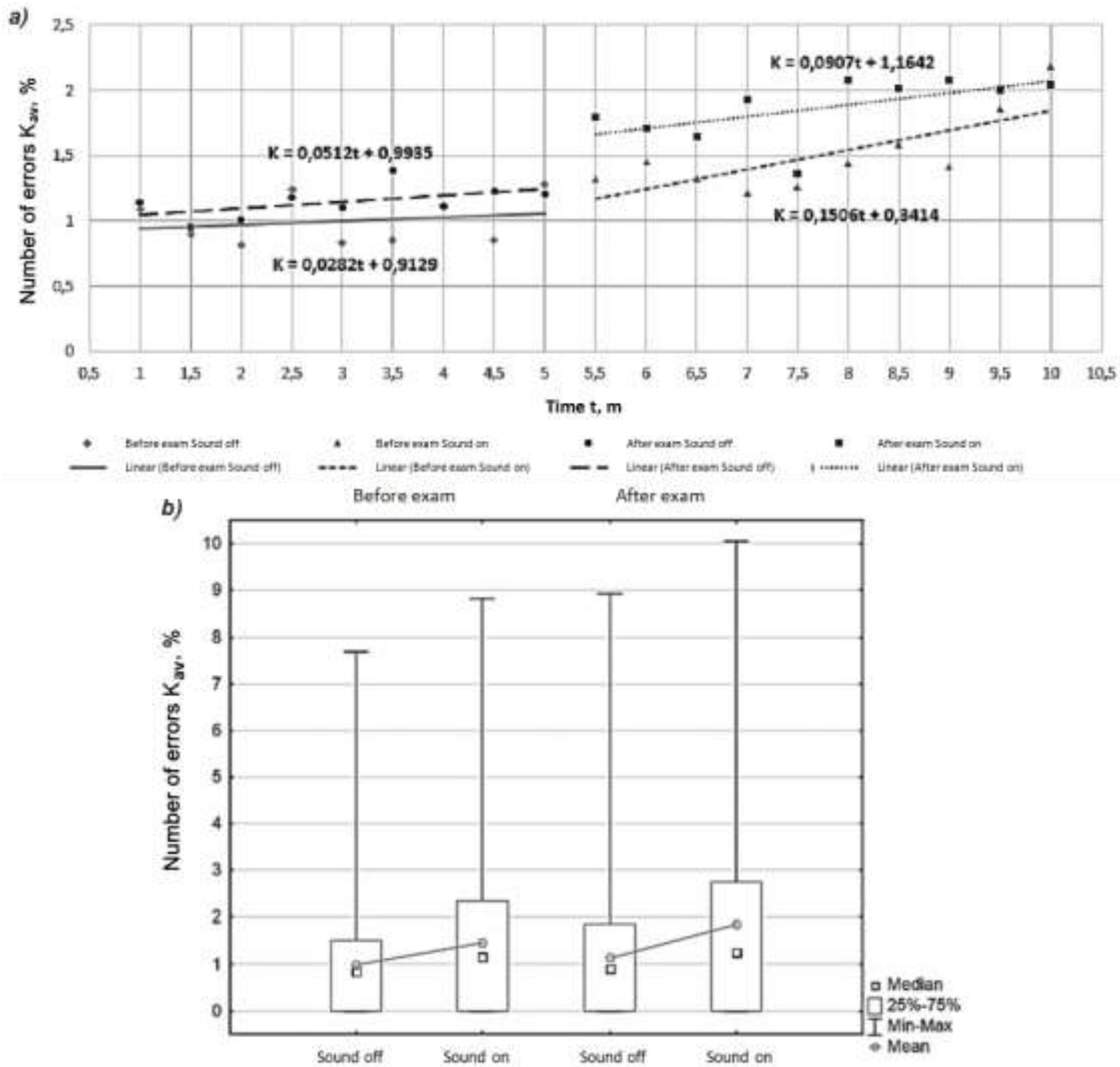

Fig. 4:- Results of measurement attention parameters of the 2nd test group before and after exam: a) average number of mistakes dependence of time; b) average number of mistakes change before and after stressogen unfluence in a quiet situation.

Results and Discussion:-

The results for both groups of the participants were obtained during the experiment. It was found that the percentage error (K) for the majority of the participant was growing up as the tasks proceeded. At the same time, there was a significant increase in the error rate after the beginning of the impact sound stressogene. The Fig. 2 shows the results of the three participants, reflecting the characteristic changes in the average percentage of errors from time to time among all participants. Diagrams are supplemented by trend lines.

Fig. 2a shows the situation when after the beginning of exposure of the sound stressogen a marked increase in error rate is observed, as shown by an increase in the angle of the trend line. In this case, the average number of errors after the start of exposure also increased. In this case, the deterioration is clearly seen together with the sound, which may indicate low stress test.

Fig. 2b shows the situation when the impact stressogen has little effect on the increase in the number of errors, and the average number of errors is slightly higher with the impact of stressogen. Such a change in the nature of the parameters K and K_{av} may indicate the average level of stress.

Fig. 2c is a situation in which the average number of errors (and increase in their number) at the time of exposure to the stress factor is approximately equal to or even lower than the average error rate before the beginning of the impact (as can be judged from the slope of the trend line). This result indicates a high level of stress resistance, since stressogen has no effect on the parameters of attention.

It should be noted that according to the obtained charts of percent of errors changing during the task, the degree and nature of changes in the parameters of attention, under the influence of stress factor in the form of sound, is individual.

Table 1 shows the test results of the first group of the participants.
The results showed that the appearance of stress factors in the first group have led to a deterioration of the parameters of attention, which is reflected in the decrease in the speed of information processing Q and the average percent growth of K_{av} errors.

The average value of information processing speed Q decreased by 0,06 bits / s, but remained within the normal range for an adult (Q = 1,6 ± 0,16) [7]. Deterioration insignificant and may be due to fatigue test. The average percentage of errors increased by 0,87%.

The value of the degree of fatigue effect of P for the first group was 0,54%. The measured value of the impact stress factor S is equal to 0,33%. This suggests that despite the accounting of fatigue in our calculations (formulas 4 and 5), there is a growth in the average number of errors for the test after the start of exposure to the sound stressogen.

Analysis of changes in the error rate K and the mean percentage of errors K_{av} (Fig. 3) showed:
In the segments before and after the impact there is continuous stressogen deterioration attention; drop in the parameters of attention is almost independent of the presence of stressogen that may be due to fatigue test as you complete the work;

deterioration is observed after exposure stressogen in parameters of attention, which is reflected in the difference of the average error rate before and after exposure stressogen.

To assess the influence of the conditions of test data of the second group were collected. The results are shown in Table 2.
As in the case with the first group of information processing speed is reduced after exposure to Q audio signal, and the average error rate increases K_{av}.

The speed of information processing Q has not changed after exposure stressogen (decreased by 0,02 bits / s for the first test and 0,04 bits / s for the second). The average error rates for the first and second test increased, the difference was 0,51% for the first test and 0,71% for the second.

Analysis of changes in the character error rate K and the average percentage of errors (Fig. 4) shows:

- The growing importance of fatigue for the second experiment, due to the increased general fatigue after the exam, which can be seen to increase the angle of the trend line in the second case;
- Higher level of the average error rate and more scatter percent error for all participants in the second experiment.

Exposure value of the degree of fatigue was 0,12% P and 0,48% inclusive for the first and second test. The impact of fatigue in the second experiment was significant. This indicates the summation of fatigue from the task and from being tired of the exam.

In this case, the value of degree of stress exposure factor S for the first test was 0,395% and 0,485% for the second.

The results of the second group showed that when the test is carried out immediately after the stressful situation caused by passing an examination, more pronounced signs of deterioration attention were observed. It results in the impact index parameter test conditions R, which in this case is 0,09%. Despite the fact that the value of this setting is negligible, Figure 4 shows that the average percentage error K after the exam is higher as the "before" and "after" the beginning of the impact sound stressogen. This may reflect the cumulative effects of stress of different origin on the human body.

Average values fatigue influence degree P_{av} = 0,3% and the degree of exposure to the stress factor S_{av} = 0,4% were empirically found by using both groups ,which can be used to assess the impact of individual stress factor in the form of sound on each subject.

Thus, the results of the study are consistent with the hypothesis put forward by us about the possibility of using modified proofreading sample "Landolt Ring" to assess the changes in the parameters of attention in stressful situations. It suggests the possibility of using the method developed by an experiment in evaluating stress test.

Experience in conducting research using the developed method showed the simplicity of its use. To perform user testing a PC with pre-installed software was required and headphones. In most cases, the test does not require additional instruction before proceeding, and their actions are consistent with a given testing algorithm. Data collection, calculation of the required parameters and plotting were performed in automatic mode, which greatly simplifies the processing of the experimental results.

Conclusion:-

1. It was found that exposure to sound stress factor causes a change in the parameters of human attention: the speed of processing of information is reduced for the majority of subjects (an average of 0,23 bits / s), the average percentage error increases (an average of 1,65 times), the general parameters attention (on average 1,38 times)are getting worse.
2. The degree and nature of changes in the parameters of attention is individual.
3. The influence of the degree of fatigue and impact stress factor as an audio signal that were obtained by empirical parameters can be further used in evaluating the stress test.
4. Preliminary results of the proposed methodology for assessing the impact of stress factors on attention parameters indicate the simplicity of its application and data processing.
5. Analysis of the types of stress factors showed the possibility of use of developed method with minimal changes to estimate the parameters of deterioration of attention when somebody is subjected to a different type of stress. For example, a flicker, a move and increased pace of work.

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