UDC 612.084 *The authors declare no conflict of interest*
DOI: 10.22328/2413-5747-2017-3-3-63-69

DEPENDENCE OF CHANGES IN PHYSIOLOGICAL, PSYCHOPHYSIOLOGICAL PARAMETERS AND PHYSICAL PERFORMANCE ON THE LEVEL OF TRAIT ANXIETY IN THE CONDITIONS OF HYPOBARIC HYPOXIA

*Vladimir E. Isaenkov[1], Alexandr A. Chichikov[2], *Ruslan A. Dzankisov[2]*
[1]Russian Medical service of ASF of MD, Moscow, Russia
[2]300 Russian Aeromedical Laboratory of ASF of MD, Moscow, Russia

The features of tolerance to acute hypoxia by individuals with different levels of trait anxiety are presented. It was established that changes in such physiological parameters as heart rate in individuals with a high level of personal anxiety are more pronounced in hypoxic conditions. In particular, in this group, by the 25th minute of lifting in the altitude training chamber to a height of 5000 m, the heart rate increased by an average of 38.1% ($p < 0.01$) of background values. In persons with a low level of trait anxiety, an increase in heart rate does not exceed an average 32% ($p < 0.01$). However, in subjects with a high level of trait anxiety, compared with people with a low level of trait anxiety, a more pronounced increase in the Rufie index at an average of 18.2% ($p < 0.01$). In addition, in individuals with a high level of trait anxiety, a more pronounced slowing-down time of a complex sensorimotor reaction by 33.0 ms ($p < 0.05$) from the background value was observed, while in people with a low level of trait anxiety, on average, only by 20. 2 ms ($p < 0.05$).
Thus, changes in individual physiological parameters in individuals with a high level of trait anxiety are more pronounced, their functional state is less tolerant to the hypoxia effect, and the level of physical performance is lower on average in this group.
Keywords: marine medicine, hypoxia, trait anxiety, functional state, physical performance.

For quotation: *Isaenkov V.E., Chichikov A.A., Dzankisov R.A.* Dependence of changes in physiological, psychophysiological parameters and physical performance on the level of trait anxiety in the conditions of hypobaric hypoxia // *Marine medicine*. 2018, No. 4, P. 00–00, DOI:

Introduction. At the present time, the issue of effect of different types of hypoxia on the human body taking into account individual psychological features is understudied. Otherwise, it is known that individual psychological features are the key factors of effectiveness of professional activities [1, p. 5]. They are essential to the selection of candidates for some military occupational specialties, such as: pilots of SU-25 and other aircrafts without the pressurized cabin with a ceiling height over 4-5 km, and special operations troops for performing military operations at high altitudes [2, p. 168]. Revealing the relationships between individual psychological features and hypoxia tolerance will allow us to predict tolerance to unfavorable environmental factors in persons with different individual psychological features, particularly, with different level of trait anxiety. That, in turn, will allow to correct aptitude screening techniques, thus, increasing reliability of professional activities [3, p. 425].
Study objective: to reveal the dependence of change in physiological, psychophysiological parameters and physical performance on the level of trait anxiety under hypobaric hypoxia.
Materials and methods: 70 men-volunteers aged from 18 to 40 years were examined on the base of 300 Aeromedical Laboratory of the Russian Aerospace Forces in Pushkin. The patients attended a medical examination of medical officers (physical therapist, otolaryngologist, surgeon, neurologist), laboratory notes (general blood analysis and urine analysis, HIV antibody assay, RW blood test, hepatitis viral B and C markers), X-ray examinations (chest and pneumatic space X-ray examinations) and function tests (Ruffier test, electrocardiography) were made. Subjects were cleared to lifting in hypobaric chamber unless contraindicated [4, p. 56].
Evaluation of the level of trait anxiety was made according to Spielberg-Hanin test [5, p. 78]. Assessment of change in physiological, psychophysiological parameters and physical performance was carried out in three stages – before hypoxia impact (background), under hypoxia and immediately after it. Hypoxia exposure was during lifting in a hypobaric chamber at the altitude of 5000 meters for 60 minutes. The lifting was conducted in the hypobaric chamber ”SBK-48” at a speed of 15-20 km a second for 5 minutes (Figure). Then, at the altitude of 5000 meters, physiological (heart rate – HR, arterial tension – AT), saturation – SpO_2) and

psychophysiological (complex sensorimotor reaction time – CSRT, critical flicker fusion frequency – CFFF) parameters were registered in subjects. The measurements were made by tonometer OmromM3 Expert, pulseoxymetry device ARMEDYX300 and computing psychophysiological test battery "NS Psihotest". Well-being, activity and mood were assessed by WAM test [6, p. 154]. The Ruffier test was used to measure total physical performance by assessing Ruffier index [7, p. 10].

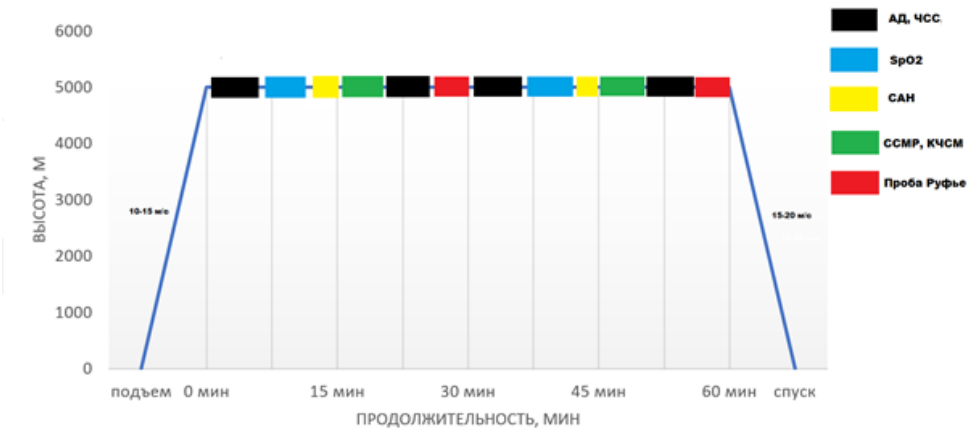

Figure. Cyclogram during lifting in a hyperbaric chamber

Высота, м	Altitude, m
Подъем, мин	Lifting, min
Спуск, мин	Descend, min
Продолжительность, мин	Duration, min
м/с	m/s
АД, ЧСС	AT, HR
SpO_2	SpO_2
ССМР, КЧСМ	CSRT, CFFF
Проба Руфье	Ruffier test

To improve the fidelity of transmitted information, psychophysiological methods and the Ruffier test were used twice in the course of lifting: from 10^{th} to 30^{th} minute and from 40^{th} to 60^{th} minute. AT and HR measurements were taken 4 times: at the 5^{th}, 25^{th}, 35^{th} and 55^{th} minutes. Saturation was additionally assessed after physical activities of 30 squats at the 9^{th} and 39^{th} minutes of lifting.

The study was carried out in three stages. At the first stage, the parameters of AT, HR and SpO_2 were assessed in persons with absolutely different levels of trait anxiety under hypobaric hypoxia. The subjects were divided into two groups by the level of trait anxiety: the first group (n=20) with the level of trait anxiety under 30 scores, the second (n=22) with the level of trait anxiety over 45 scores. The same parameters were intercompared in both groups as well as change of parameters was assessed in each group before, during and after the lifting in a hypobaric chamber. At the second stage, the issue of revealing the dependence of change in physiological, psychophysiological parameters and physical performance on the level of trait anxiety in hypoxic conditions. At the third stage of the study, the dependence of total physical performance on the level of trait anxiety was assessed in the same conditions.

All studies were carried out with adherence to ethic and legal rules. Each participant comprehended the aspects of the study held, gave an informed consent to participate.

All investigational medicinal products should have necessary code certificates and marketing authorisations. Mathematical and statistical analysis included calculation of numeric distribution measures, comparative analysis of populations by calculating the Student's t-test for related and unrelated samples checked for a normality of distribution using F-test [8, p. 112]. $P<0.05$ was taken as statistically significant difference. Calculations were performed using "Statistica 10.0" software and spreadsheet tables of Microsoft Excel 2010 software.

The results of research and their discussion. During the containment in a hypobaric chamber for 25 minutes, at the altitude of 5000 meters, the subjects with high level of trait anxiety showed HR values increased by an

average of 38.1% ($p<0.01$), while the subjects in the first group with low level of trait anxiety - increased by an average of 32.1% ($p<0.01$) (Table 1). So, at the 25th and 35th minutes, HR values were marked up by an average of 10% in the group with high level of trait anxiety, at the 55th minute - by an average of 9%. It is interesting that parameters of HR in the group with high level of trait anxiety remained up by an average of 13.5% than in the group with low level of trait anxiety that may evidence of preserving excitement even after the completion of lifting in a hypobaric chamber.

Table 1

Dynamics of heart rate during lifting in hypobaric chamber in persons with various levels of trait anxiety, beats per minute (M±m)

Level of trait anxiety, group	Background values	Duration of containment in chamber				After lifting in chamber
		3rd-4th minute	25th minute	35th minute	55th minute	
Low level of trait anxiety (n=20)	69.4±1.96	88.2±2.54*	91.7±3.04*	89.0±3.08*	91.6±3.20*	77.7±3.27**
High level of trait anxiety (n=22)	73.2±1.68	95.4±2.02*^	101.1±2.16*^	97.8±1.83*^	99.9±2.46*^	88.2±3.00*^

Note: differences in comparison with background values: * $p<0.01$; ** $p<0.05$; differences in comparison with groups: ^ $p<0.05$.

At the 25th minute, SpO_2 was up by an average of 5.2% ($p<0.05$) in persons with high level of trait anxiety in comparison with persons with low level of trait anxiety, and at the 35th minute – by 5.8% ($p<0.05$). After physical exercises, by the 39th minute, difference of mean values of SpO_2 was 4.9% ($p<0.05$) (Table 2).

Table 2

Dynamics of SpO_2 in persons with various levels of trait anxiety during lifting in hypobaric chamber, % (M±m)

Level of trait anxiety, group	3rd minute	5th minute	9th minute	25th minute	35th minute	39th minute	55th minute
Low level of trait anxiety (n=20)	74.7±1.33	67.6±1.16	67.1±1.46	68.6±1.34	70.9±1.23	66.3±1.46	68.7±1.42
High level of trait anxiety (n=22)	74.8±1.07	69.3±1.64	70.0±1.29	72.2±1.04*	75.0±1.05*	70.0±1.13*	72.1±0.97*

Notes: differences in comparison with groups: * $p<0.05$; at the 9th and 39th minute the participants performed physical activities of 30 squats.

The obtained results are similar to results of works of D.V. Davydov and Ya.A. Khananashvili [9, p. 43] who noted significant psychophysiological changes in groups randomized by Spielberg-Hanin test with different levels of trait anxiety in normobaric hypoxic conditions.

Revealing the dependence of the level of trait anxiety on dynamics of psychophysiological parameters in hypobaric hypoxic conditions was the next study objective. The following data were obtained when comparing values of CFFF and CSRT in the groups (Table 3).

Table 3

Dynamics of psychophysiological parameters in persons with various levels of trait anxiety during lifting in hypobaric chamber, ms, Hz (M±m)

Parameter	Low level of trait anxiety	High level of trait anxiety

	background values	duration of containment in chamber, minute		after lifting in chamber	background values	duration of containment in chamber, minute		after lifting in chamber
		20th	45th			20th	45th	
CSRT, ms	395 ±13.2	396 ±17.0	405 ±11.2	415 ±14.0**	346 ±8.6^	356 ±7.2^	367 ±8.8**^	379 ±5.3*^
Errors, un.	4.1±0.7	5.3±0.6	4.9±0.9	3.5±0.6	5.0±0.7	4.8±0.7	4.2±0.7	2.5±0.4
CFFF, Hz	42.2±0.8	40.5±0.7	40.0±0.8	42.5±0.9	39.8±0.6	39.6±0.8	39.4±0.8	40.9±1.0

Notes: differences in comparison with background values: * $p<0.01$; ** $p<0.05$; differences in comparison with the group with low level of trait anxiety: ^ $p<0.05$.

The comparison of psychophysiological parameters in groups with different levels of trait anxiety shows that CSRT was less at an average by 48.9 ms, 40.2 ms, 38.4 ms, 38.4 ms, 36.1 ms ($p<0.05$) in the group with high level of trait anxiety than in the group with low level of trait anxiety at all stages of the study. However, when assessing the dynamics of changes of CSRT, it was revealed that the value of CSRT increased at an average by 6.1% ($p<0.05$) in the group with high level of trait anxiety by the 45th minute and after the hypobaric chamber study – by 9.5% ($p<0.01$) while in the group with high level of trait anxiety, negative trend was less pronounced and was evident in increasing the CSRT by 2.7% by the 45th minute of the study and by 5.1% ($p<0.05$) after the study. Statistically significant differences between values of CSRT in these groups were not obtained, however, mean values of CSRT in the group with high level of trait anxiety may testify more pronounced tension when performing this study and tendency to push desk button in advance, therefore the values of CSRT were less at an average by 40 Hz.

While analyzing the parameters of well-being self-assessment in the group with high level of trait anxiety, it was found that by the 40th minute of containment in the chamber, parameters of well-being reduced on average by 20.3% ($p<0.01$), activity – by 12.5% ($p<0.05$), mood – by 11.6% ($p<0.01$) (Table 4). What stands out is that in the group with low level of trait anxiety, parameters of well-being, activity and mood were almost back to original values registered before the study as opposed to the other group which showed reduction in parameters of well-being on average by 14% ($p<0.01$), activity – by 11.3% ($p<0.05$), mood – by 8.9% ($p<0.01$).

Table 4

Self-assessment of psychoemotional state (WAM parameters) in persons with various levels of trait anxiety during lifting in hyperbaric chamber, point (M±m)

Parameter	Low level of trait anxiety				High level of trait anxiety			
	background values	duration of containment in chamber, minute		after lifting in chamber	background values	duration of containment in chamber, minute		after lifting in chamber
		15th	40th			15th	40th	
Well-being	6.1 ±0.18	5.5 ±0.19**	5.5 ±0.27*	5.8 ±0.20**	5.9 ±0.11	4.9 ±0.16*	4.7 ±0.23*	5.0 ±0.19*
Activity	5.6 ±0.20	5.2 ±0.22	4.9 ±0.31**	5.4 ±0.17	5.3 ±0.11	4.6 ±0.16*	4.3 ±0.25*	4.5 ±0.18*
Mood	6.0 ±0.19	5.6 ±0.20**	5.3 ±0.20*	5.9 ±0.19	5.8 ±0.13	5.2 ±0.16*	5.0 ±0.16*	5.1 ±0.17*

Notes: differences in comparison with background values: * $p<0.01$; ** $p<0.05$.

Thus, functional state of the subjects with high level of trait anxiety is more impacted by an adverse effect of hypobaric hypoxia that is confirmed by significant changes in psychophysiological parameters and self-assessment of the state.

The next objective was to assess the relationship between physical capability and level of trait anxiety in the conditions of hypobaric hypoxia.

When comparing Ruffier index in the groups, it was revealed that in persons with low level of trait anxiety with originally lower Ruffier index (at average by 28% ($p<0.05$) in comparison with persons with high level of trait anxiety, throughout lifting in chamber, this parameter increased in 2.16 times ($p<0.01$) by the 30th minute and in 2.25 times ($p<0.01$) by the 60th minute comparing with initial values. However, Ruffier index remained lower by 18.2% ($p<0.05$) in comparison with persons with high level of trait anxiety throughout lifting in chamber (Table 5). It may testify of the relationship between physical performance and level of trait anxiety in the conditions of hypobaric hypoxia. However, we haven't got significant differences in Ruffier index after a lifting in a chamber, through the difference remained as an average.

Table 5

Dynamics of Ruffier index in persons with various levels of trait anxiety during lifting in hyperbaric chamber, c. u. (M±m)

Level of trait anxiety, group	Background	Duration of containment in chamber, minute		After lifting in chamber
		30th minute	60th minute	
Low level of trait anxiety (n=20)	5.4±0.72	11.7±0.88*	12.1±0.87*	7.6±0.80
High level of trait anxiety (n=22)	7.5±0.73^	14.4±0.75*^	14.8±0.67*^	8.8±0.62

Notes: differences in comparison with background values: * $p<0.01$; differences in comparison with groups: ^ $p<0.05$.

Thus, persons with high level of trait anxiety have lower level of total physical performance in the conditions of hypobaric hypoxia as well as in other conditions.

The data received are consistent with the results of work by A.A.Bulagin and co-authors who studied the dynamics of the functional state in persons with different levels of neuroticism when under different adverse effects [10, p. 16; 11, p. 17], as well as with the studies that show the aspects of adverse impact of professional factors on the functional state of the body taking into account the level of trait anxiety [12, p. 64].

Conclusion. Changes in some physiological parameters in persons with high level of trait anxiety are more pronounced. Thus, tachycardia is more evident in them comparing with persons with low level of trait anxiety (38.1% against 32%).

The functional state of the body in subjects with high level of trait anxiety is less resistant to hypoxia than in persons with low level of trait anxiety. It is confirmed with significant changes in functional state parameters such as: feeling unwell after stress at average by 14% ($p<0.01$), decrease of activity – by 11.3% ($p<0.05$), mood – by 8.9 ($p<0.01$) and increase of CSRT time after a lifting in a hypobaric chamber by 9.5% ($p<0.01$) comparing with the background values in the group of individuals with high level of trait anxiety.

Besides, persons with high level of trait anxiety are less efficient in conditions of hypobaric hypoxia than persons with low level of trait anxiety. It is testified by lower level of their physical performance (by 18.2%; $p<0.05$) throughout the lifting in a hypobaric chamber.

Hence, there is the relationship between individual psychological traits, particularly, the level of trait anxiety and tolerance to hypoxia that should be taken into account when selecting the persons who are imposed to hypoxia.

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Received by the Editor: *September 25, 2018*
Contact: *Dzankisov Ruslan Arturovich, akm-vma@mail.ru*

Author credentials:
Isaenkov Vladimir Egorovich — Medical Service Colonel, Chief of the Medical Service of the Chief Command of the Aerospace Forces of the Ministry of Defense of the Russian Federation; Moscow, Znamenka street 19, room 2051,; e-mail: samgkvks@mail.ru; tel.: +7 (916) 033-03-03;
Chichikov Alexander Alekseevich —Lieutenant Colonel of the Medical Service, the Chief of 300 Aeromedical Laboratory of the Aerospace Forces of the Ministry of Defense of the Russian Federation; Moscow Region, Balashikha, Gagarina microdistrict 20, room 501; e-mail: laboram@yandex.ru; tel.: +7 (977) 292-42-88;

Dzankisov Ruslan Arturovich — the Commander of the Medical Service, the Chief of the Group of the Office of Special Investigations and Rehabilitation of Flying Personnel of 300 Aeromedical Laboratory of the Aerospace Forces of the Ministry of Defense of the Russian Federation; Moscow Region, Balashikha, Gagarina microdistrict 20, room 514; e-mail: akm-vma@mail.ru, tel.: +7 (911) 829-96-69.