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TRANSFORMATION OF PSYCHO-PHYSIOLOGICAL PROPERTIES IN WAR SITUATIONS

TRANSFORMACJA WŁAŚCIWOŚCI PSYCHOFIZJOLOGICZNYCH W SYTUACJACH WOJENNYCH

Volodymyr Lyzohub[1(A,D,E,F)], **Mykola Makarchuk**[2(A,D,E,F)], **Liliya Yukhymenko**[1(A,D,E,F)],

Lidiya Iliukha[1(C,D,E,G)], **Oleksandr Bezkopylny**[1(B,D,F)]

[1]Department of Anatomy, Physiology and Physical Rehabilitation, Bohdan Khmelnitsky National University, Cherkassy, Ukraine
[2]Institute of Biology and Medicine, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

Authors' contribution
Wkład autorów:
A. Study design/planning
zaplanowanie badań
B. Data collection/entry
zebranie danych
C. Data analysis/statistics
dane – analiza i statystyki
D. Data interpretation
interpretacja danych
E. Preparation of manuscript
przygotowanie artykułu
F. Literature analysis/search
wyszukiwanie i analiza literatury
G. Funds collection
zebranie funduszy

Summary

Background. Neurodynamic and neurophysiological properties were studied in 53 men aged 21-35 years at the beginning and after 6 months of martial law.
Material and methods. The neurodynamic, individual-typological and sensorimotor properties of the subjects were studied while processing information using the "Diagnost 1M" system. The neurophysiological characteristics of long-latency visual evoked potentials (LVEPs) were determined using the "Neurokom" EEG-complex.
Results. At the beginning of the martial law, men were divided into two subgroups: conditionally resistant (the first subgroup) and not resistant (the second subgroup) to long-term psycho-emotional stress. It was found that neurodynamic, individual-typological properties of the first subgroup changed little and differed significantly from the second subgroup: balance (BNP), functional mobility (FMNP) and strength of nervous processes (SNP). Individual-typological properties of the nervous system (FMNP, SNP, BNP) and sensorimotor properties (SVMR, RC1-3, RC2-3) underwent significant changes in the representatives of the second subgroup in 6 months. Subjects of this subgroup had lower amplitude values between the peak intervals of N1-P2, P2-N2 and P3 peak, as well as significantly shorter latency of P1, P2 and longer P3 components, which indicates a violation of cortical-subcortical interaction.
Conclusions. It was found that the studied properties determine the formation of adaptive reactions in the conditions of martial law.
Keywords: evoked potentials, depression, war, brain

Streszczenie

Wprowadzenie. U 53 mężczyzn w wieku 21-35 lat badano cechy neurodynamiczne i neurofizjologiczne w chwili rozpoczęcia działań i po 6 miesiącach stanu wojennego.
Materiał i metody. Analizowano cechy neurodynamiczne, osobniczo-typologiczne i sensomotoryczne osób badanych podczas przetwarzania sygnałów informacji za pomocą systemu „Diagnost 1M". Charakterystyka neurofizjologiczna wzrokowych potencjałów wywołanych o długim czasie opóźnienia (ang. *long-latency visual evoked potential – LVEP*) została określona przy użyciu kompleksu EEG „Neurokom".
Wyniki. Na początku stanu wojennego podzielono badanych na dwie podgrupy: warunkowo odpornych (pierwsza podgrupa) i nieodpornych na długotrwały stres psycho-emocjonalny (druga podgrupa). Stwierdzono, że neurodynamiczne, indywidualno-typologiczne właściwości u pierwszej podgrupy zmieniły się w niewielkim stopniu i różniły się istotnie statystycznie od drugiej podgrupy w zakresie: równowagi (BNP), ruchomości funkcjonalnej (FMNP) i siły procesów nerwowych (SNP). Indywidualno-typologiczne właściwości układu nerwowego (FMNP, SNP, BNP) oraz właściwości sensomotoryczne (SVMR, RC1-3, RC2-3) uległy istotnym zmianom u przedstawicieli drugiej podgrupy w ciągu 6 miesięcy. Osoby z tej podgrupy miały niższe wartości amplitudy między szczytami N1-P2, P2-N2 i P3 oraz istotnie krótsze opóźnienia komponentów P1, P2 i dłuższe P3, co wskazuje na naruszenie interakcji korowo-podkorowej.
Wnioski. Stwierdzono, że badane właściwości są odpowiedzialne za kształtowanie adaptacyjnych reakcji w warunkach stanu wojennego.
Słowa kluczowe: potencjały wywołane, depresja, wojna, mózg

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Address for correspondence / Adres korespondencyjny: Volodymyr Lyzohub, Department of Anatomy, Physiology and Physical Rehabilitation, Bohdan Khmelnitsky National University, 81 Shevchenko Boulevard, 18031 Cherkassy, Ukraine, e-mail: v_lizogub@ukr.net, phone: +380 (0472) 372142
ORCID: Volodymyr Lyzohub https://orcid.org/0000-0002-3001-138X, Mykola Makarchuk https://orcid.org/0000-0002-0982-3463, Liliya Yukhymenko https://orcid.org/0000-0002-4455-6233, Lidiya Iliukha https://orcid.org/0000-0001-9650-805X, Oleksandr Bezkopylny https://orcid.org/0000-0001-7207-7590

Introduction

The growing problem of depression and life complications became of primary importance for the population of Ukraine in connection with the start of the war [1]. According to the World Health Organization, the basis of mental disorders is cognitive dissonance caused by the effect of a long-term informational psychophysiological load on an individual [2]. Depressive states are associated with the events of the COVID-19 coronavirus pandemic and the destructive events of war, as well as the occurrence of extreme situations, the development of crisis psychological processes that negatively affect the state of health and cause a rapid decrease in work capacity, increased fatigue, decreased resistance to stress [3-5].

The relevance of solving this research problem and assessing the influence of war on the psychophysiological state of people stems from the intensive combat taking place in Ukraine over the last 8 years that has taken both a medical and psychophysiological toll [5]. Today, philosophers, sociologists, biologists, and psychologists deal with issues of human adaptation to war. It is possible that considering the results of psychophysiological research will contribute to the disclosure of cause-and-effect relationships between political and mental factors influencing the body and those physiological processes unfolding in the body in extreme situations.

Military psychophysiological stress is believed to cause a wide range of health complications, as well as other disorders in the human body [5]. Psychophysiological changes that occur in the body of people involved in hostilities are determined by the intensity of stress exposure, the duration of stay in combat conditions and the personal qualities of the combatants [6]. Factors that affect the psyche of people include air raid sirens, explosions, destroyed buildings, life-threatening events, persecution, being in the vicinity of the wounded and killed, upheaval of routine, visual contact with mutilated people and animals, etc. Under such conditions, the human psyche can react with insomnia or obsessive states, various vegetative symptoms or disorders, increased conflict or self-isolation, aggravation of already existing or emergence of new diseases. In this regard, psychophysiological studies related to the declaration of war are of particular importance.

It is noted that life during war is accompanied by high informational pressure, an increase in psycho-emotional stress, objective life complications, which are perceived and evaluated by a person as stressful or dangerous [7]. Therefore, it is believed that each individual psychophysiological state is not something constant, but on the contrary, it often changes depending on environmental circumstances, the level of tension experienced in situations at work or in the family, functional reserves, and the body's stress resistance [8,9]. It is known from the literature that in the process of influence of environment factors, there is a synchronous transformation of the level of several psychophysiological properties of the human body [7].

It has been shown that living in conditions of war and participating in armed confrontations is accompanied by negative consequences that increase the risk of injury and long-term disability, the development of physical and mental problems [8]. Moreover, people who are in extreme circumstances of war often do not pay due attention to their health and do not seek the necessary medical help. The fact is that when early signs of health impairment appear in the human body, compensatory processes must take place. Such processes are most often associated with a change in behavioral reactions caused by a transformation of the major psychophysiological properties. Probably, such properties can be sensitive indicators that reveal health disorders at an initial stage. That is why the issue of finding integral non-specific psychophysiological properties that can reflect information processes in the human body is relevant. In this direction, studies have been performed to evaluate the effectiveness of human activity in extreme conditions [9]. Currently, there are no prognostic psychophysiological criteria for the presence of early negative changes in the state of health of a population during war. It is emphasized that the psychophysiological properties of a person are responsible for the speed and accuracy of reaction, the ability to perform professional tasks with the involvement of personal qualities [7].

In the literature, problematic issues of neurophysiological mechanisms of transformation of the psychophysiological state of military personnel who participated in combat operations are not sufficiently covered. It has been shown that in the case of sportsmen military servicemen under the influence of extreme neuropsychological loads, the body's functional reserves are activated based on physiological and psychophysiological mechanisms [10]. In addition, the risk of developing chronic fatigue syndrome and depression increases significantly with extremely intense neuropsychological informational psychophysiological stress [7,11].

Much less attention has been paid to the study of the dynamics of psychophysiological properties and health of those who do not directly participate in military operations, but are forced to live in conditions of war-related stress. The events taking place in Ukraine demonstrate the need to solve this problem in order to accurately assess psychophysiological state and the further development of how individuals and groups adapt to crisis situations. Therefore, in order to understand the mechanisms of war and its consequences on psychophysiological properties and health, it was important to study changes in the functional state of the nervous system and brain under these conditions. This article presents the results of the transformation of psychophysiological properties and their neurophysiological mechanisms in circumstances of war.

Material and methods

Fifty-three men aged 21-35 who were not in the active combat zone and performed their professional duties behind the front line (teachers of Cherkassy National University) participated in the study. Therefore, we conditionally defined the process of changing their psychophysiological functions as "spontaneous". The ethics commission reviewed the materials of this study and did not find an increased risk for the subjects of the study, which was performed considering the existing ethical norms and standards for conducting research (protocol dated 08/08/2022, No.123).

The psychophysiological properties of men (a longitudinal study) were studied at the beginning and 6 months after the declaration of war using the neurodynamic research method with Diagnost 1M hardware and software, and neurophysiological research using the LVEPs method with a Neurocom computer device by XAI-Medica. The subjects examined on "Diagnost-1M" performed neurodynamic and sensorimotor tasks on processing information in different modes of signal presentation [12]. The following indicators were determined: the strength of nervous processes (SNP), the functional mobility of nervous processes (FMNP), and the balance of nervous processes (BNP), speed characteristics of a simple visual-motor reaction (SVMR), reaction in choosing one of the three signals (RC_{1-3}) and reaction in differentiating two of the three signals (RC_{2-3}) [13]. For this, it was necessary to differentiate image signals quickly and qualitatively (shapes: triangle, circle and square) and, according to the instructions, press the button with the left or right hand [14]. For all the subjects, the same scheme was applied when solving tasks, which differed both in terms of presentation pace and content. This made it possible to consider the reaction of the subjects to be both independent of the conditions of the experiment and dependent on the perception and processing of information.

To study the features of the induced brain activity, we analyzed the component composition of LVEP. Research was carried out in a state of rest, in conditions of active wakefulness. LVEP was recorded in a shielded sound- and light-insulated chamber in a sitting position during photostimulation of the right and left eye with eyes closed. The duration of generating stimuli was 5-7 s with an alternating period of 1 s ±15%. The analysis epoch was 500 ms. A time interval of 300 ms before the appearance of the LED flash was considered. Artifact-free implementations were considered. Latency periods of peaks of P_1, N_1, P_2, N_2, P_3 waves and amplitudes of interpeak intervals P_1-N_1, N_1-P_2, P_2-N_2, N_2-P_3, P_3-N_3 of biopotentials in areas O_1 and O_2 and P_3 and P_4 were analyzed, since components had maximum amplitudes precisely in these leads. Aural lead (A1-A2) was used as a reference" [15,16].

The statistical analysis of the results was carried out using the methods of parametric and non-parametric statistics, cluster analysis, factorial, correlation analysis using STATISTICA 13.3 software [17].

Results

The indicators of established neurodynamic and sensorimotor properties are presented in Table 1.

Table 1. Psychophysiological characteristics of men at the beginning of the war (n=53)

Statistical indicators	Psychophysiological properties under study					
	SVMR, ms	RC_{1-3}, ms	RC_{2-3}, ms	FMNP, s	SNP, sign.	BNP, ms
M±m	225.4±2.2	335.5±4.8	396.9±5.5	62.7±0.66	643.7±10.6	23.1±0.69
As±m_{As}	3.32±0.20***	1.47±0.27***	1.33±0.31***	1.02±0.28**	0.87±0.29**	1.00±0.29**
Ex±T_{Ex}	9.39±0.63***	7.34±0.48***	4.27±0.43***	1.63±0.45*	1.72±0.49**	1.88±0.63**

Notes: M±m, As±m_{As}, Ex±T_{Ex}, respectively, the arithmetic mean and its error, the asymmetry coefficient and its error, the kurtosis coefficient and its error; *, **, *** statistical probability of the presence of asymmetry and kurtosis in the samples at the level of p<0.05, <0.01, <0.001.

It can be seen from the table that the investigated indicators of psychophysiological properties according to the coefficient of asymmetry (As) and kurtosis (Ex) did not fall under the law of normal distribution. The results proved the heterogeneity of psychophysiological properties in the studied men. Therefore, to obtain clearer statistical information, we used cluster analysis to divide the subjects into two subgroups. Men presenting less variability of psychophysiological properties were assigned to the first subgroup. Men with more variable indicators made up the second subgroup (Table 2). The analysis of the results of Table 2 showed the peculiarities of sensorimotor and neurodynamic properties in the examinees, who were assigned to the first and second subgroups.

Table 2. Psychophysiological characteristics of the men of subgroups 1 (n=29) and 2 (n=24) before and 6 months after the war

Subgroups of the subjects	Conditions of the study	Studies psychophysiological properties					
		SVMR, ms	RC_{1-3}, ms	RC_{2-3}, ms	FMNP, s	SNP, sign.	BNP, ms
Subgroup 1	before the beginning of the war	228.4±3.1	326.5±4.8	363.7±6.5	61.2±0.35	663.7±9.4	19.1±0.79
	in 6 months	218.3±4.6	331.6±5.2	343.3±6.5*	62.2±0.64	659.1±10.8	20.4±0.66
Subgroup 2	before the beginning of the war	215.2±2.6	334.3±3.7	359.9±6.3	64.3±0.46##	632.7±11.4#	24.2±0.67##
	in 6 months	205.2±2.6**	314.3±4.8*	367.5±7.8	66.6±0.33**	612.4±12.4*	26.5±0.56**

Notes: #, ## the statistical probability of a difference between the groups of subjects at the beginning of the war; *, **, *** in 6 months after the war beginning at the level of p<0.05, <0.01, <0.001.

It is found that there are several indicators that are statistically significantly and functionally higher in the first subgroup compared to the second. They include BNP (p=0.032), FMNP (p=0.037) and SNP (p=0.044). Sensorimotor indicators of SVMR, RC1-3 and RC2-3 had a tendency towards higher reactivity. However, statistically significant differences between these indicators at the beginning of the study were not established, respectively (p=0.062, 0.053, 0.065). It is possible that in each of the subgroups objectively there are indicators with higher and slightly lower values of the studied psychophysiological characteristics. Therefore, we assumed that even in 6 months after a long period of living in conditions of war, the subjects might observe some

deterioration of psychophysiological characteristics. This fact may indicate the presence of different adaptation mechanisms determined by innate neurodynamic properties of the nervous system (FRNP, SNP and BNP).

The validity of our assumption can be partially confirmed by the results of a comparison of the studied indicators in the same subjects at the beginning (25-29th February 2022) and after 6 months (20-25th September 2022) of the war (Table 2). A comparative analysis of the average values of sensorimotor and neurodynamic characteristics between subgroups emphasize the following aspects. The studied indicators both at the beginning and after 6 months of the war differ in subgroups. Moreover, the investigated indicators had functionally higher values in the representatives of the first subgroup, which indicates their more favorable psychophysiological state.

Based on the results of comparing the data in the subgroups with the state at the beginning of the war, we can distinguish some features. First, statistically significantly higher values of FMNP, SNP and BNP indicators were found in the first subgroup than in the second. Secondly, 6 months after the declaration of war, the investigated indicators of neurodynamic properties (FMNP, SNP and BNP) changed statistically significantly in the subjects of the second subgroup. In this case, we can talk about the negative impact of war on the central nervous system of the examined men of the second subgroup. In other words, the subjects of the second subgroup developed an unfavorable psychophysiological state. Thirdly, during the 6 months of war, no statistically significant changes in the investigated psychophysiological properties were found in the persons of the first subgroup (p>0.05). Therefore, the men in the second subgroup were more sensitive to the negative effects of factors related to war. This is confirmed by significantly lower functional indicators of FMNP, SNP, BNP, and speed characteristics of sensorimotor properties of SVMR, RC_{1-3} and RC_{2-3} for the second subgroup than in the first.

For an in-depth analysis of the presented results of the neurodynamic and sensorimotor properties and clarifying the neurophysiological mechanisms of adaptation to the conditions of war, we looked at the characteristics of LVEP. The analysis of the time indicators of LVEP inducing the functional state of the cortical part of the visual analyzer revealed the following: the subjects of the second subgroup had statistically significantly shorter latencies of peaks P_1, N_1, P_2 (p<0.05, r=0.37-0.39) and longer N_2 and P_3 at the beginning of the war (Table 3).

Table 3. Latent components of evoked potentials in men of the first (n=29) and second (n=24) subgroups under conditions of photo stimulation before and 6 months after the declaration of war (median, upper and lower quartile)

Studied subgroups	Conditions of the study	Latent components of LVEP				
		P_1	N_1	P_2	N_2	P_3
Subgroup 1	abduction P_3, P_4					
	before the war	64.8 (98.1;60.3)	124.7 (138.2;109.4)	178.4 (216.3;154.1)	210.2 (264.8;172.9)	325.7 (369.3;321.4)
	6 months later	61.7 (88.1;57.5)	117.5 (131.7;99.1)	159.3 (221.5;151.0)	198.4 (254.2;194.6)	312.2 (349.7;310.1)
	abduction O_1, O_2					
	before the war	74.8 (102.5;66.8)	135.6 (164.6;122.7)	183.4 (216.3;133.7)	215.6 (268.3;211.6)	329.7 (352.4;317.3)
	6 months later	68.5 (98.3;58.5)	123,5 (152.1;107.1)	197.6 (229.1;129.1)	208.7 (260.5;198.2)	320.0 (349.1;309.3)

Subgroup 2	**abduction P_3, P_4**					
	before the war	53.5* (96.3;51.1)	114.3* (136.1;101.2)	161.8* (222.7;161.6)	228.9* (272.4;181.6)	342.9* (372.8;319.1)
	6 months later	42.2** (92.5;33.4)	87.3** (137.6;71.1)	109.7** (159.1;98.2)	249.4** (293.4;229.1)	363.4** (369.3;347.6)
	abduction O_1, O_2					
	before the war	60.2* (100.1;57.4)	120.4* (152.5;114.3)	169.3 (210.1;130.4)	249.6* (355.2;257.4)	355.9* (358.4;344.6)
	6 months later	42.5* (90.2;32.1)	89.8* (139.3;79.7)	115.1* (162.4;104.1)	262.6** (283.2;256.1)	377.3** (383.1;365.2)

Notes: *, ** – statistical significance of the difference in subgroups before and 6 months after the declaration of war in samples at the level of $p<0.05$, <0.01.

After 6 months of living in conditions of war, a decrease in the time of the early components was established in the subjects of both subgroups. At the same time, multidirectional changes were found for the N_2 and P_3 peaks, which were characterized by a significant decrease in brain response time in the subjects of the first subgroup and, conversely, an increase in the latencies of these evoked potentials in the representatives of the second subgroup ($p<0.05$-0.01, r=0.41-0.45).

According to the indicators of the LVEP amplitude at the beginning of war in the subjects of the second subgroup, slightly lower values of the interpeak intervals N_1-P_2 and P_2N_2 were found compared to the representatives of the first subgroup (Table 4).

Table 4. Amplitude components of evoked potentials in men of the first (n=29) and second (n=24) subgroups under conditions of photo stimulation before and 6 months after the declaration of war (median, upper and lower quartiles)

Studied subgroups	Conditions of the study	Amplitude components of LVEP				
		P_1-N_1	N_1-P_2	P_2-N_2	N_2-P_3	P_3-N_3
Subgroup 1	**abductions P_3, P_4**					
	before the war	6.4 (8.1;6.7)	12.6 (18.5;7.9)	8.8 (17.5;7.1)	15.3 (21.1;9.9)	5.9 (8.7;5.6)
	6 months later	6.1 (8.5;4.4)	10.6 (16.2;7.3)	7.0 (12.1;6.4)	11.3 (18.3;8.7)	5.6 (8.4;4.2)
	abduction O_1, O_2					
	before the war	5.9 (8.6;5.3)	14.6 (19.2;9.9)	8.4 (16.7;6.9)	13.9 (18.7;9.3)	6.8 (9.2;5.7)
	6 months later	5.5 (7.8;4.9)	12.1 (18.4;9.7)	7.7 (15.4;6.2)	12.6 (19.3;9.9)	6.3 (8.4;5.2)
Subgroup 2	**abduction P_3, P_4**					
	before the war	5.7 (7.9;3.8)	11.0 (12.8;3.9)	6.5 (8.0;4.2)	10.1 (15.2;5.8)	5.1 (6.3;4.7)
	6 months later	5.2 (7.3;3.1)	5.0 (12.8;3.9)*	3.5 (6.0;2.2)**	5.1 (14.2;3.8)*	5.0 (6.8;4.2)
	abduction O_1, O_2					
	before the war	5.9 (8.3;4.1)	16.4 (9.7;5.5)	8.1 (9.7;6.6)	9.3 (10.7;7.4)	5.2 (6.6;4.8)
	6 months later	5.3 (8.1;3.2)	6.0 (8.6;5.2)*	3.1 (6.2;2.2)**	6.2 (8.8;5.1)*	5.0 (6.1;4.2)

Notes: *, ** – statistically significant differences in subgroups before and 6 months after the declaration of war in samples at the level of $p<0.05$, <0.01.

It is known that the processes of perception and recognition of the stimulus are reflected in the N_1, N_2, P_2 peaks, while the actual stage of information processing by the brain with the adoption of an appropriate decision, during which the properties of attention, memory, and thinking are involved, are revealed in the P_3 component. A comparison of the amplitude indicators of LVEP, recorded 6 months after the war, revealed their decrease in representatives of both groups. At the same time, the comparison of the quantitative values of the amplitude indicated statistically significantly lower values between the peak intervals N_1-P_2, P_2-N_2 and $N_{2\text{-}P3}$ in the subjects of the second group (p<0.05-0.01, r=0.35-0.46).

Therefore, LVEP indicators, as indicators of the brain's response to the presentation of high-frequency light stimulation, which were registered 6 months after the declaration of war in the subjects of the second subgroup, indicate shorter latency periods and inter-peak intervals at early and longer latencies and smaller amplitudes at the later stages of information processing than in the subjects who were assigned to the conditionally resistant subgroup. This indicates the existence of differences in the brain systems of the examined different subgroups, the danger of developing an imbalance in the cortical-subcortical structures of the brain in the representatives of the second subgroup, which can cause a possible dysfunction in the sensory system and a decrease in brain performance in the future.

Thus, the men of the second subgroup were characterized by both vulnerability to the psycho-emotional factors of war and the inconsistency of adaptive adjustments of psychophysiological functions to the existing realities of life. This was confirmed by the results of the study of neurodynamic, sensorimotor properties and evoked brain activity.

Discussion

It is known that during information processing, not only cortical processes responsible for psychomotor activity, but also many subcortical structures are involved in neural activity. The frontal, cingulate and insular cortices are the central link in the organization of switching functions [18-20]. On the other hand, these parts of the brain are not only important for switching, but are also considered to be important in the implementation of the brain's information system [18,20,21]. According to the psychophysiological understanding of the speed and quality of information processing, the results presented by us demonstrate the peculiarities of the transformation of the studied psychophysiological properties and the mechanisms of their regulation in different subgroups of the examined men. We should note the presence of differences in the studied sensorimotor, neurodynamic properties and neurophysiological characteristics, which are presented by the different subgroups. It is obvious that there are several psychophysiological indicators that are statistically significant, or with some tendency, have lower values in the second subgroup compared to the first. These include the speed characteristics of SVMR and $RC_{1\text{-}3}$, which were slightly higher in the second subgroup than in the first. Indeed, SVMR and $RC_{1\text{-}3}$ are associated with the performance of the fastest possible response to the unexpected appearance of signals and the reaction by choosing one of the given alternative three stimuli. In this case, it can be assumed that such a motor act usually reflects the level of activation of the nervous system and brain and does not require a significant strain of functional systems and concentration of attention when performing the specified task [13].

The second group of indicators that demonstrate a better manifestation of psychophysiological properties in the first than in the second subgroup includes SNP, FMNP, BNP and $RC_{2\text{-}3}$. Some of these indicators did not change their level (BNP, SNP and FMNP and $RC_{2\text{-}3}$) during the 6 months of the study and therefore were also interesting for analysis and discussion. Another group of indicators has a slightly different nature. They form the fundamental basis of nervous processes: FMNP, SNP, BNP, and reflect the innate properties of the nervous system, as they determine the maximum capability to maintain a standardized information load [13]. A characteristic feature

of these indicators is the gradual refinement of measurement results with the help of feedback. This technique is implemented with the participation of a more complex analytical and synthetic activity of the brain involving the subject's willpower and constant switching of attention to different components of the activity [14].

We found that the predominance of the functional state of the central nervous system and brain was characteristic for the first subgroup in terms of sensorimotor (SVMR, RC_{1-3} RC_{2-3}), neurodynamic (FMNP, SNP, BNP) properties and neurophysiological indicators of SVMR both in the state at the beginning of declaring war and after 6 months of life in circumstances of war compared to the subjects of the second subgroup. Therefore, the subjects of this group were classified according to their psychophysiological status as conditionally resistant to the effects of factors accompanying war. The preservation of a steady and stable level of many psychophysiological functions of the body during the entire period of research was characteristic of individuals in this subgroup. Perhaps, this can be explained from the standpoint of systemogenesis [22], driven by the importance and priority of preserving those functions that are responsible for the higher psychophysiological processes associated with the implementation of cognitive activity in conditions of war.

The psychophysiological state of persons in the second subgroup was formed differently. We observed lower values of psychophysiological properties in these subjects, than in the first group. These subjects, who were assigned to the subgroup with conditionally unstable characteristics of the psychophysiological functions of the SNP, FMNP and BNP at the beginning of the war, had statistically significantly shorter latent periods of P_1, N_1, P_2 peaks (p<0.05), longer N_2 and P_3, and slightly lower values of the amplitude between the peak intervals N_1-P_2, P_2-N_2 that indicated lower functional capabilities of their brain processes. 6 months after the declaration of war, most of the studied properties of representatives of this subgroup deteriorated that indicates an incompletely completed phase of adaptive processes. The lower values of the amplitude between the peak intervals N_1-P_2, P_2-N_2 and the P_3 peak, which were found in the subjects of the second subgroup compared to the similar indicators of the individuals of the first subgroup, indicate insufficient involvement of cortical neurons in the deployment of memory processes, selection and analysis of information, the development of rapid fatigue of visual system and the occurrence of shifts in the neurophysiological adaptive mechanisms of the brain [23,24].

It is known that in the system of integrating the perception of stimuli through the sense organs and maintaining the tone of the cortex, the main role is played by the limbic structures of the brain [16]. The data that we obtained about the significantly shorter latency of P_1, P_2 components and longer P_3, as well as lower amplitude in all studied peaks and between peak intervals of individuals of the second subgroup may indicate the risk of violation of cortical-subcortical interaction. It has been proven that the waves of LVEP P_1 and P_2 are a consequence of the activity of subcortical centers and induce the possibility of involving non-specific systems in the processes of differentiating stimuli. The P_3 component signals the level of specific comprehension of material that occurs in the primary, secondary, and tertiary fields of the cerebral cortex [15], nonspecific nuclei of the thalamus, and the reticular formation [25]. It is likely that the multidirectional reaction of the brain responses and differences in the time characteristics of P_3 between the representatives of the examined subgroups that we obtained demonstrate the emergence of difficulties in the formation of new neural connections, the existence of excessive tension during nervous processes in neural networks, which arose in the individuals of the second subgroup as a result of the effects of psycho-emotional stress caused by war. On the other hand, we can claim that the subjects of the second subgroup have a higher reactivity of the cells of the cerebral cortex, detected by the P_2 component, which reflects the processes of non-specific processing of information [15]. This may indicate the possibility of the existence of a delayed deployment of adaptation processes in emotionally unstable people living in circumstances of war.

Therefore, it is possible that subjects with different degrees of resistance to military stress have different mechanisms of brain activation, which is manifested in differences in information processing and plasticity of the neuro-cortex. We can indicate a lower level of brain functioning for the subjects of the second subgroup due

to the relatively faster, but short-term involvement of its non-specific structures for processing information, and, as a result, the threat of imbalance in cortical-subcortical structures. Individuals in the first subgroup, who were distinguished by lower variability of indicators of neurodynamic and sensorimotor properties in conditions of war, are characterized by a lower dependence of the functional activity of the brain on endogenous mechanisms of regulation and a better balance of cortical-subcortical processes.

Thus, in each subgroup, there is a multidirectional manifestation of the mechanisms of how war influences the studied psychophysiological properties. This leads us to consider the problem of transformation of psychophysiological properties as a key one, if criteria for psychophysiological selection are developed. More research is needed to determine the "best" of these mechanisms. However, it can already be stated that there is a group of psychophysiological properties that have higher and slightly lower values in the first conditionally resistant subgroup and the second non-resistant subgroup to the effects of war factors. Therefore, it can be stated that even 6 months after the declaration of war, there is a certain deterioration of the studied characteristics that indicate the incompleteness of the processes of adaptation of the functional state of the examined men, that is, the existence of negative manifestations of psycho-emotional stress caused by the war. On the other hand, this fact indicates the functioning of several mechanisms that underlie the transformation of psychophysiological properties in circumstances of war. The first of these mechanisms is determined by the individual typological properties of the nervous system of the subjects and is indicated by FMNP, SNP and BNP. It has been proven that these indicators are genetically determined [13,26] and they did not change during 6 months of war in the first group of subjects. The second of these mechanisms lies in the plane of analysis of the results obtained in the second subgroup. Lower values of neurodynamic (FMNP, SNP and BNP) indicators and higher values of SVMR and RC_{1-3} compared to the first subgroup are observed, both in the initial state and after 6 months of re-examination after the declaration of war. This can probably be explained by several mechanisms. First, by interference of nervous processes [14,21], which are the basis of mental activity. Secondly, by the presence of dominant states [26], and thirdly, by the processes underlying the development of depression of psychophysiological properties, the driving force of which is the imbalance of cortical-subcortical interactions in the brain structures and impossibility of high-quality processing of information [18]. The validity of this assumption is confirmed by the results of a neurophysiological study of latency and amplitude characteristics of LVEP in abductions P_3, P_4, O_1 and O_2. The presence of shorter latency periods and between peak intervals in the subjects of the second subgroup in the early and longer latencies and lower amplitude in the later stages of information processing than in the individuals of the first subgroup indicates the existence of an imbalance of cortical-subcortical processes in the brain systems and the development of dysfunction of the sensory system, as well as decrease in adaptive capacity and brain performance.

Conclusions

1. It was established that the contingent of examined men was heterogeneous, and they were categorized according to psychophysiological properties as conditionally resistant or non-resistant to long-term informational psycho-emotional stress caused by war.
2. Psychophysiological properties were revealed, namely, balance, functional mobility, and strength of nervous processes, which did not change in the representatives of the first group. These properties were genetically determined and were more responsible for the predicted behavioral responses than the speed characteristics of a simple visual-motor response and choosing one of the three signals.
3. The absence of statistically significant changes in the individual-typological properties of the nervous system (FMNP, SNP, BNP) and sensorimotor reactions (SVMR, RC_{1-3}, RC_{2-3}) was characteristic for the subjects of the first subgroup with a stable psychophysiological status for 6 months. It was characteristic to

maintain a steady and stable level of latency and amplitude of LVEP in abductions P_3, P_4, O_1 and O_2 according to the neurophysiological characteristics of the first subgroup, during the entire period of research. Evoked potentials of LVEP indicated the absence of risks of violation of cortical-subcortical interaction.

4. Individual and typological properties of the nervous system (FMNP, SNP, BNP) and simple and complex sensorimotor reactions (SVMR, RC_{1-3}, RC_{2-3}) underwent statistically significant changes in the representatives of the second subgroup with an unstable psychophysiological status, during the 6 months of the war. The evoked potentials in these subjects had lower amplitude values between the peak intervals N_1-P_2, P_2-N_2 and P_3 peak, as well as significantly shorter latency of the P_1, P_2 and longer P_3 components, which indicates risks of cortico-subcortical interaction violation.
5. The results can be used in the selection of more suitable candidates for the performance of official duties in conditions of increased danger and the development of recommendations for the prevention of disorders caused by war.

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