



TOOLS FOR CONTROL AND RECOVERY OF THE PSYCHO-PHYSIOLOGICAL STATE OF MILITARY SERVANTS

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Relevance of the study

- In times of war, the largest risk group for the development of stress disorders and subsequent PTSD is military personnel who are directly involved in combat.
- The effect of stress factors on the body is manifested by tension of the autonomic nervous system (ANS), hypersympathicotonia, with its subsequent negative impact on the functioning of the cardiovascular, nervous, endocrine, immune and other body systems.
- Subsequently, if the stressful impact disappears, the ANS restores the disturbed balance and the body maintains the necessary homeostasis. But if the impact continues, and possibly increases, then the depletion of adaptation reserves develops and decompensation occurs, disruption of the functioning of organs and systems, somatic and psycho-emotional disorders appear and progress.
- The challenge faced by both the patient and the doctor is to detect at an early stage the autonomic imbalance that occurs in individuals after suffering distress.
- Assessment of the psycho-emotional state using only questionnaires is not specific to disorders that may occur in the future and does not reflect the level of depletion of the body's adaptive reserve. In addition, it may contain an error associated with impaired subjective self-assessment of their condition in people with organic damage to the central nervous system, for example, in case of mine-blast trauma.

Relevance of the study

- Therefore, for a comprehensive assessment of the condition, we used the method of mathematical analysis of heart rate variability (HRV), since it characterizes the functional state of the ANS and allows us to objectively assess the energy component of ensuring the functional state of both the whole organism and the human psyche.

Heart Rate Variability (HRV)



Recognition of the method by global specialized associations *

- *Allows to assess the state of regulatory systems (central and autonomous level) and the adaptation reserve*

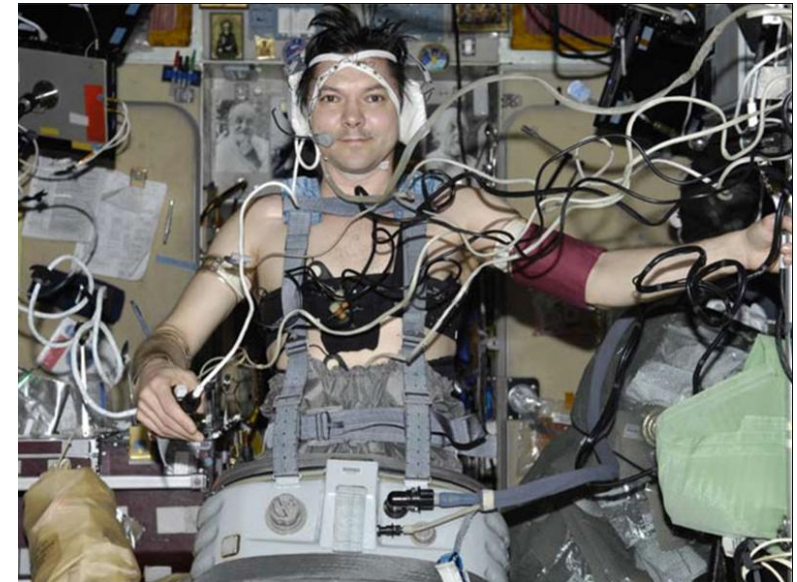
*Heart Rate Variability

Standards of Measurement, Physiological Interpretation, and Clinical Use

[Task Force of the European Society of Cardiology the North American Society of Pacing Electrophysiology](#)

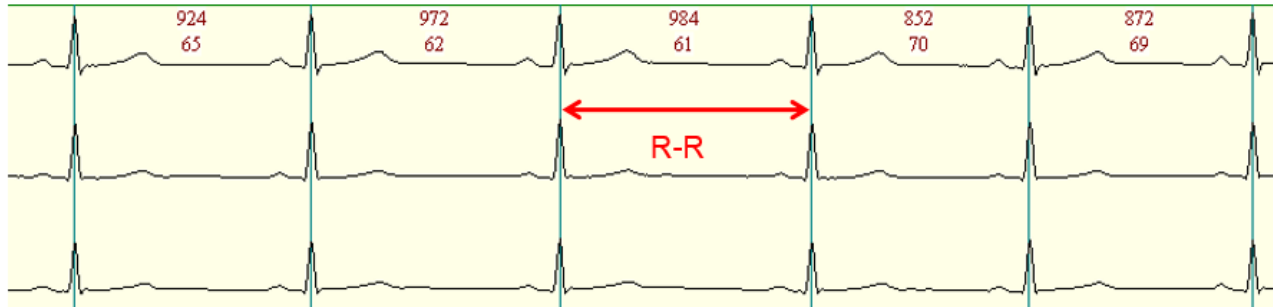
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Roman Bayevsky is the founder of Soviet space physiology and medicine. He was born in Ukraine (Dnipro region). He spent the last years of his life in exile in Canada.

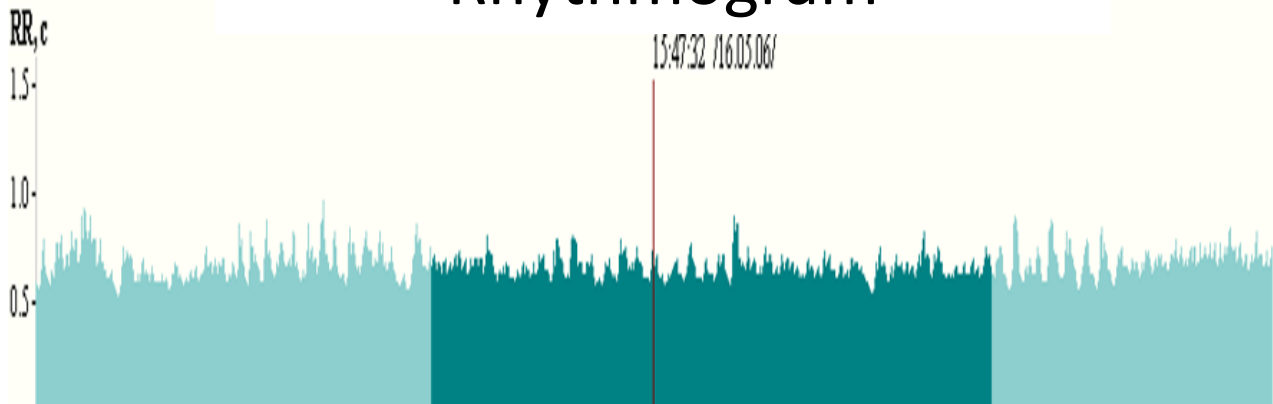


Definition of the term "Heart Rate Variability" (HRV).

ECG

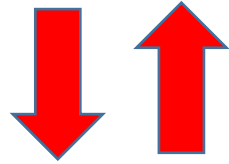


Rhythmogram



- HRV is a **sequence of time values of the intervals between the R-waves of ECG complexes** of sinus origin.
- HRV reflects the **complex effect of neuro-endocrine regulation** on the sinus node, and therefore indirectly characterizes its functional state.

Health



**Reversible
premorbid
changes**



Disease

IARS, the indicator of the activity of regulatory systems
(by Roman Bayevsky)



1

2

3

Norma

4

5

6

7

Moderate
stress

Expressed
stress

8

9

10

Failure of
adaptation

Purpose of the study:

1. To investigate the functional state of servicemen's ANS;
2. To evaluate it from the standpoint of the age norm and to identify the relationship between HRV and psychoemotional state;
3. To evaluate the corrective effect of Transcendental Meditation (TM)

Material and methods of the study:

- 45 military personnel who participated in hostilities and 36 civilians were examined
- To detect depression, stress, anxiety, we used the DASS21 questionnaire, a questionnaire for screening PTSD, autonomic dysfunction (according to A.M. Wayne), daytime sleepiness (according to Epworth).
- The ECG was recorded in 6 standard and augmented limb leads (I, II, III, aVR, aVL, aVF) for 5 minutes lying down and 3 minutes sitting using a miniature portable device DiaCard 06000.1 (Solvaig, Ukraine).
- The ECG and HRV were analyzed using the Finnish-Ukrainian cloud service CardioLyse and the program for recording and analyzing ECG signals Oracul (AC No. 95334, AC No. 47857, Glushkov Institute of Cybernetics of the National Academy of Sciences of Ukraine).



3 minutes sitting

5 minutes of lying down



Results of the study

Group 20 – 39 years old

Index HRV	Servicemen age 31,4±1,2 years, n=15, M±m	Norma (healthy control), n=36, M±m
mRR, ms	733 ± 29	754 ± 35
SDNN, ms	33,2 ± 3,3 *	59,8 ± 3,7
RMSSD, ms	19,3 ± 2,4 *	32,2 ± 2,9
Stress index	339 ± 71 *	103 ± 11
VLF, ms ²	350 ± 75 *	1767 ± 136
LF, ms ²	557 ± 140 *	810 ± 92
HF, ms ²	138 ± 34 *	540 ± 98
LF norm, %	73,3 ± 3,5 *	59,8 ± 2,2

* Reliability of differences in mean values at the level of $p < 0,05$,
by Student's t-test

Group 40 – 59 years old

Index HRV	Servicemen age 46,5±1,1 years, n=19, M±m	Norma (healthy control), n=36, M±m
mRR, ms	767 ± 29 *	832 ± 19
SDNN, ms	25,3 ± 2,6 *	51,6 ± 1,7
RMSSD, ms	17,5 ± 3,4 *	27,7 ± 1,2
Stress index	513 ± 99 *	102 ± 6
VLF, ms ²	224 ± 41 *	1542 ± 145
LF, ms ²	281 ± 73 *	710 ± 63
HF, ms ²	182 ± 86 *	386 ± 25
LF norm, %	68,6 ± 4,1	64,8 ± 1,8

* Reliability of differences in mean values at the level of $p < 0,05$,
by Student's t-test

- When analyzing HRV indices in both age groups of servicemen (20-39 and 40-60 years), deviations from the Ukrainian population age norm were found (Pysaruk A.V. et al., 2000).
- Characteristic for both age groups of servicemen is a decrease in total HRV, according to the SDNN index, a decrease in the activity of parasympathetic modulation (RMSSD, HF), the activity of the baroreflex center of the medulla oblongata (LF) and subcortical sympathetic ergotropic nerve centers (VLF).
- In servicemen, R.M. Bayevsky's stress index exceeded the norm by 3.3 times in the younger age group (under 40 years old) and by 5 times in the older age group of the Armed Forces (40-60 years old).

Results of the study

Spearman's linear correlation coefficient (R) in the group of people with very high anxiety levels that exceeds the third quartile (Q3) of the total sample

	PTSD	DASS-21	Anxiety	Stress	Wayne	Epworth
age			0,667*			0,780*
SDNN					-0,704*	-0,712*
RMSSD				-0,805*		
pNN50	0,733*	-0,638*				-0,716*
TP				-0,647*	-0,694*	
LF					-0,863**	-0,725*
HF				-0,710*		
VLFn					0,739*	
LFn					-0,709*	-0,847**
HFn				-0,615*		

* - reliability of Spearman's linear correlation coefficient (R) at the level of significance $p < 0.05$;

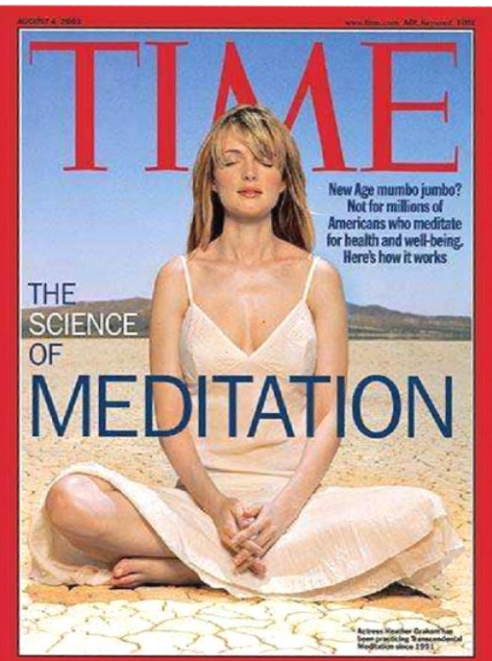
** - reliability of Spearman's linear correlation coefficient (R) at the level of significance $p < 0,01$

•The correlation analysis revealed a significant number of reliable ($p < 0.05$) medium strength and strong relationships between HRV indicators and the results of questionnaire assessments of psychoemotional state.

•It has been established that the strength and number of these connections increase as the level of anxiety increases.

Transcendental Meditation (TM)

- It is a simple, **non-traumatizing (!)**, natural mental technique
- It does not require effort, concentration, or suggestion
- 20 minutes twice a day, sitting comfortably with eyes closed
- TM is not a religion or philosophy and does not require lifestyle changes

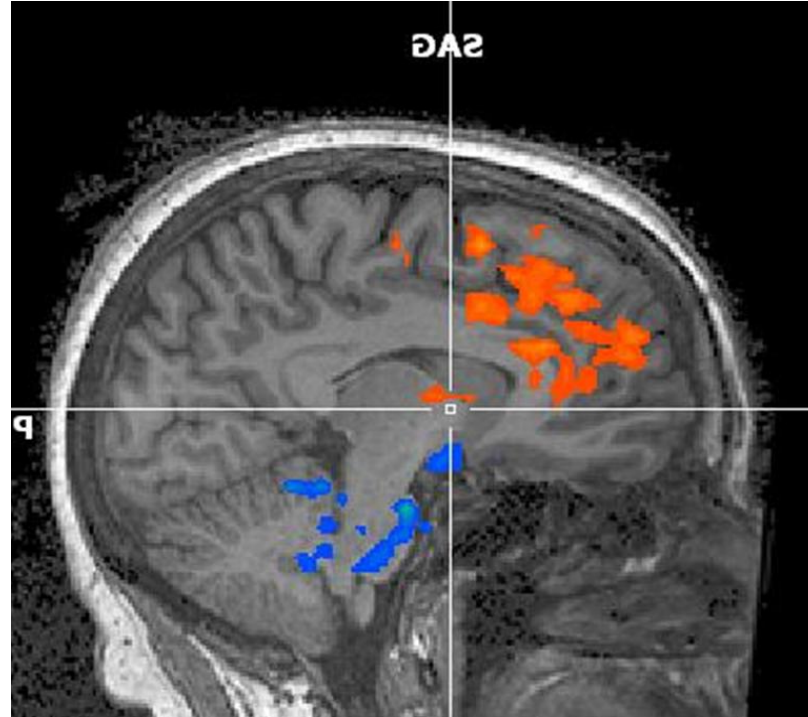


During the practice, the usual mental process becomes less active and a special psychophysiological state is achieved - "awakened calm"



Resting state fMRI study: Cerebral blood flow pattern during TM

Decreased activity in the brain stem: slowed breathing, heartbeat, etc.

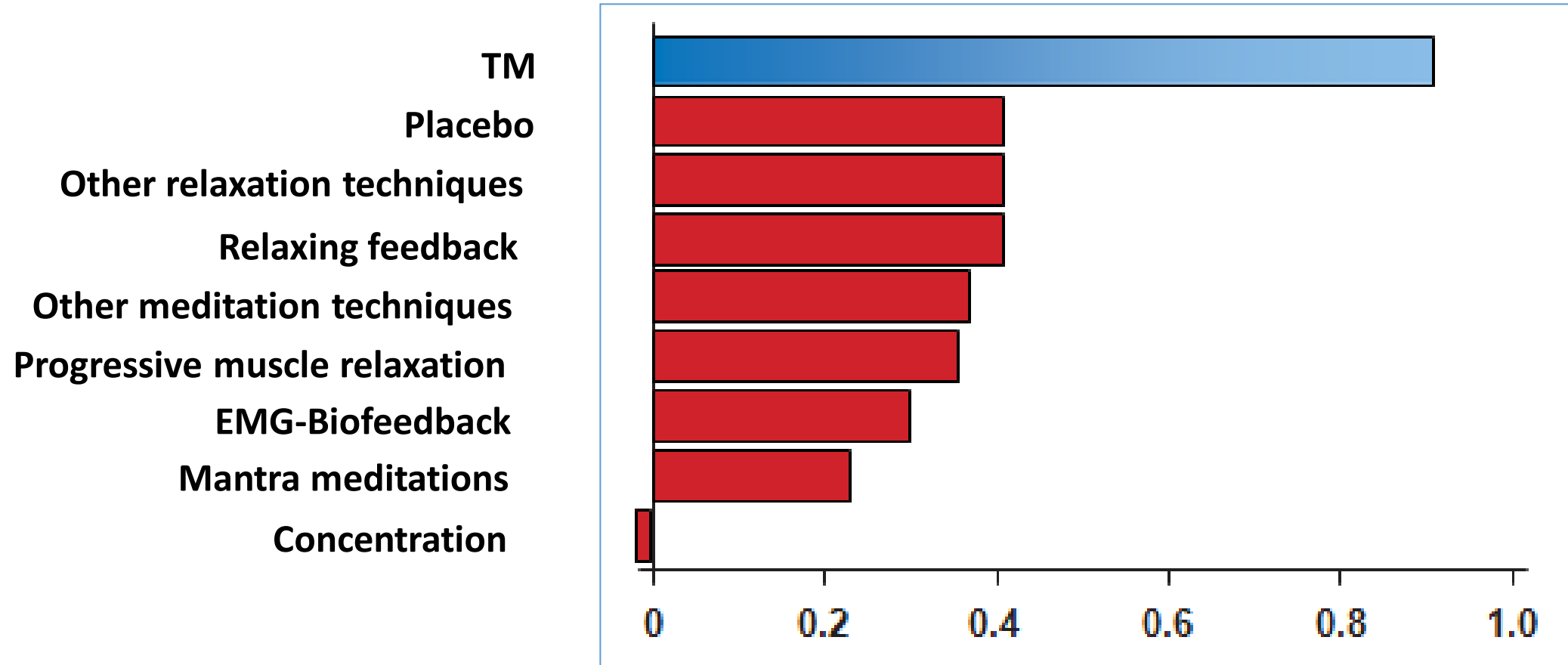


Increased activity in the prefrontal gyrus of the cerebral cortex: vigilance, inner awareness

Reference. Mahone, Michelle C., Travis, Fred , Gevirtz, Richard, & Hubbard, David (2018). fMRI during Transcendental Meditation practice. *Brain and Cognition*, Epub 2018 Mar 2.

TM: an effective treatment for anxiety disorders.

Meta-analysis of 146 studies



κ. Eppley, Abrams A. I., Shear J. "Differential effects of relaxation techniques on trait anxiety: A meta-analysis." *Journal of Clinical Psychology* 45, no. 6 (1989): 957–974. K. Eppley, Abrams A. I., Shear J. "Differential effects of relaxation techniques on trait anxiety: A meta-analysis." *Journal of Clinical Psychology* 45, no. 6 (1989): 957–974.

The effect of TM on HRV.

- We examined 36 people who did not participate in hostilities, 21 women and 15 men, whose average age was 42.3 ± 2.2 years.

HRV indices	Before TM, M±m	After TM, M±m	Average individual shift after TM, M±m	Reliability of the average individual shift (by one-sample Student's T-test), p
HR, bpm	82,4±4,8	74,5±3,4	-7,91±2,02	0,004**
mRR, mc	761±56	826±45	65,6±17,8	0,004**
SDNN, mc ²	29,8±3,5	37,7±4,0	7,91±1,50	0,0004***
RMSSD, mc	18,3±4,2	23,6±3,3	5,36±1,80	0,014*
SI, y.o.	437,0±100,8	260,7±50,1	-176±65	0,022*
TP, mc ²	831±170	1395±263	564±161	0,006**
VLF, mc ²	338±98	643±161	305±103	0,014*
LF, mc ²	275±39	505±108	230±93	0,033*
HF, mc ²	218±82	247±64	29±43	0,510
VLF/HF	3,62±1,13	4,50±1,60	0,88±0,96	0,382
LF/HF	3,92±1,04	3,85±0,90	-0,07±1,15	0,955
IC	7,54±1,85	8,34±2,36	0,81±2,04	0,700
VLFn, %	37,20±5,37	41,31±5,31	4,11±3,72	0,296
LFn, %	41,85±5,63	40,62±5,19	-1,23±2,96	0,686
HFn, %	20,95±4,96	18,07±3,72	-2,88±5,08	0,584
IARS	3,82±0,52	2,91±0,37	-0,91±0,37	0,033*

The effect of TM on HRV.

HR	↓
mRR	↑
SDNN	↑
RMSSD	↑
Stress - index	↓
TP	↑
VLF	↑
LF	↑
IARS	↓

- TM increases the total HRV, which is expressed in an increase in SDNN, and also increases the HRV power in the spectral domains VLF, LF, which indicates an increase in the activity of subcortical sympathetic nerve centers, humoral regulation and the baroreflex center of the medulla oblongata.
- The fact that the activity of the parasympathetic link of heart rate regulation, assessed by the time series index RMSSD, increases, while the activity of the spectral index HF does not change significantly, may reflect a change in the respiratory pattern during TM.
- The increase in VLF and LF during TM, in our opinion, is a reflection of the state of "awakened calm" where, against the background of deep physical relaxation, fully awakened mental activity and concentration remain, that is, this state is not similar to falling asleep, trance or hypnosis.
- TM reduces Baevsky's stress index and IARS, which means it reduces nervous and emotional tension and the degree of tension in regulatory systems.
- After practicing TM, an increase in Total power (TP) is noted, which indicates an increase in the power of the body's adaptive reserves.

Conclusions:

- The presence of signs of nervous and emotional stress and depletion of neurohumoral regulation reserves in military personnel participating in combat operations was objectively proved both by questionnaire methods and by HRV analysis.
- The high level of correlation between HRV and psychoemotional state revealed in the study gives grounds for the widespread introduction of the method of mathematical analysis of HRV, both for assessing the psychophysiological functional state of servicemen and for monitoring the effectiveness of its correction.
- It is advisable to continue researching the impact of transcendental meditation, breathing practices, and other non-drug methods of correction.



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for your
attention!**