

Effects of Biofeedback Trainings on Hypoxia Resistance



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Abstract

As you know, the stress reaction is largely realized through the autonomic nervous system (ANS). However, excessive or insufficient reactivity can cause dysfunctional disorders. Violations of reactivity and balance of ANS are manifested when physiological changes implemented in the process of fighting or fleeing behavior occur in the absence of real physical danger.

Keywords: Biological Feedback; Heart Rate; Hypoxic Stress Test; Arterial Blood Pressure; Autonomic Nervous System

Introduction

To restore the balance of ANS reactivity by reducing the activity of the sympathetic nervous system (SNS) or enhancing the activity of parasympathetic (PSNS), biofeedback technologies (BFB) are actively used. BFB is used in the treatment of various conditions, such as tension headache, migraine, neurogenic bladder dysfunction, irritable bowel syndrome sleep disorders, chronic fatigue syndrome, hyperventilation syndrome and other disorders, etc [1- 3]. A number of studies have found that BFB forms the ability to suppress vegetative physiological responses to negative emotional stimuli [4-7]. Despite the fact that biofeedback heart rate control has been studied quite well, researchers often describe and evaluate the direct effect of adaptive biofeedback on the trained function. Since the biofeedback technology carries a wide range of opportunities, and the mechanism of management of cardiac activity has a complex, multi-level organization, the question arises about the impact of biofeedback training on other elements of vegetative control.

In other words, training of some components of vegetative control may lead to the formation of other conditional relationships of elements of vegetative control (indirect effect of training). However, the mechanism of formation and individual characteristics of the reactions are not fully disclosed, which makes this issue very relevant. Thus, effects of biological feedback trainings well covered in scientific literature, however the mechanism of their formation and specific features of the arising reactions haven't been revealed yet. An objective of

this research was studying the indirect influence of BFB cycle on hypoxia resistance and the arterial blood pressure (ABP) in healthy people.

Materials and methods

28 women and 26 men from 19 to 23 years, which performed a 15-day course of BFB, participated in the research. The study was conducted in 3 stages. At the first stage, within 3 days at rest, a 5-minute recording of heart rate and RR intervals was carried out using the device «biofeedback “with the software BFB-test. Then a hypoxic stress test (breathing a gas mixture of $10\pm 0.2\%$ O₂ for 10 minutes) was carried out using a hypoxia. They were recorded in the initial state and then every 30 seconds systolic (SBP), diastolic blood pressure (DBP), heart rate and RR intervals, oxygen content in the inhaled mixture (O₂, %), oxygen saturation in the blood (SpO₂, %). At the second stage, the subjects underwent a course of functional control using biofeedback, which includes 15 daily training sessions.

Each training session consisted of registration of the initial state (5-minute record of heart rate and RR-intervals) and 4 games of 5 minutes each, with a total duration of 25-30 minutes. Subjects were trained on the computerized complex «BFB» in the game «Vira». It was necessary to win the opponent, consciously reducing the heart rate, achieving greater relaxation, including with the help of slow calm breathing (diver player must dive faster opponent, the dive speed depends on the heart rate of the player – the heart rate is lower, the faster the diver moves). At the

third stage, a repeated hypoxic stress test was carried out, and during the next 3 days a background 5-minute recording of heart rate and RR intervals at rest during normoxia was carried out. The following statistical methods were used: for nonparametric comparison – U-test Mann-Whitney. Frequencies of occurrence were compared by one-sided Chi-square criterion. To compare two normally distributed samples we used student's t-test for dependent and independent variables.

Results

According to indicators of success of BFB - trainings volunteers were retrospectively subdivided into groups of «the reducing HR» (R) and «not reducing» (N). Almost double decrease in number of low hypoxia-resistant individuals, with transition to the level of average and high resistant was revealed in all women and N- men groups. In N-women group the quantity of highly resistant subjects grew stronger than in R ($p = 0.06$). Comparison of hypoxia-resistance between men groups showed also significant gain of high-resistant N-men in comparison with R ($p = 0.01$). BFB - training in general group led to steady decrease in ABP, both systolic ($p < 0.001$), and diastolic ($p < 0.03$).

Conclusion

The given results demonstrate adaptive decrease in sympathetic activation at rest and in response to a physiological (hypoxic) stress. At the same time the effect size of training depends on the specific features of the initial condition of the autonomic nervous system. It is known that the vasoconstrictive effect of sympathetic excitation in hypoxia resists the vasodilating

effect of local hypoxemia in a large circle of blood circulation (including adaptive hyperemia in the brain), contributing to systemic hypertension and increased vascular resistance. The results indicate the adaptive processes of ANS: after hypoxic stress, sympathetic activation is less pronounced in comparison with the state before biofeedback trainings.

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