The Spanish Journal of Psychology
2006, Vol. 9, No. 2, 193-200

ISSN 1138-7416

Psychophysiological Training of Operators in Adaptive Biofeedback Cardiorhythm Control

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A new individual computerized technique for psychophysiological training of operators before performing psychomotor activity on a computer model (psychomotor concentration and spatial orientation test) was developed. Qualitative criteria for the prediction of safe operator activity were formulated. Preliminary testing of operators' activity quality showed great dispersion of individual results: The amount of errors ranged from 0 to 56 and the rate of information processing varied from 1.01 up 3.56 bit/s. Subjects with initially identified respiratory sinus arrhythmia or synchronization caused by respiratory movements committed minimal recognition errors in initial stages at a high rate of information processing. The number of errors remained unchanged after the biofeedback cardio-training cycle, with the rate of information processing increasing noticeably. Subjects without inherent harmonics developed harmonics after sessions of cardiorhythm biofeedback control, and their operator activity quality improved significantly, making fewer mistakes and increasing the rate of information processing. Biofeedback control led not only to the restoration of respiratory sinus arrhythmia, a favorable diagnostic sign, as revealed by cardiorhythmograms, but also resulted in improvement of the quality of operator activity.
Keywords: adaptive cardio-biofeedback, harmonic target function, psychomotor test, operator psychophysiological training, cardio-respiratory synchronization

Se desarrolló una nueva técnica informática para el entrenamiento psicofísiológico de operadores antes de llevar a cabo una actividad psicomotora en un modelo informático (test de concentración psicomotora y orientación espacial). Se formularon los criterios cualitativos para la predicción de la actividad segura de los operadores. Las pruebas preliminares de la calidad de la actividad de los operadores reveló una gran dispersión de los resultados individuales: la cantidad de errores oscilaba entre 0 y 56 y el porcentaje de información procesado variaba entre 1.01 y 3.56 bits/s. Los sujetos inicialmente identificados con una arritmia respiratoria sinusal o sincronización causada por los movimientos respiratorios cometían mínimos errores de reconocimiento en las fases iniciales, con una alta velocidad de procesamiento de la información. El número de errores no cambió después del ciclo de entrenamiento biofeedback cardíaco y la velocidad de procesamiento de la información aumentó considerablemente. Los sujetos sin armónicos inherentes desarrollaron armónicos después de las sesiones de control biofeedback del ritmo cardíaco, y su calidad de actividad mejoró significativamente, cometiendo menos errores y aumentando su velocidad de procesamiento de la información. El control biofeedback no sólo llevó a la restauración de la arritmia respiratoria sinusal, una señal diagnóstica favorable, como se observa en los cardiorritmogramas, sino que también mejoró la calidad de la actividad de los operadores.
Palabras clave: retroalimentación cardiaca adaptativa, función armónica, test psicomotor, entrenamiento psicofisológico de operadores, sincronización cardiaca-respiratoria

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The widespread implementation of automatic systems, whose control is monotonous and requires operators' minimal physical—and sometimes minimal mental—exertion, leads to problems of decreased attention, fatigue, and drowsiness. In turn, a distracted, tired, or drowsy operator poses a threat of accidents with irreparable consequences. Prevention of such conditions and improvement of operators' reliability is possible and is continuing to be developed, using numerous psychophysiological methods and bioengineering systems. In order to prevent operators' undesirable distraction, emergency measures of "stimulation" are required, should attention begin to decline, or should the operator become drowsy. A review of current literature and patent sources has shown that there are as yet few sufficiently effective methods to prevent these potentially dangerous situations.

As it is known, the human factor has been and remains the reason for traffic accidents and deaths, as well as for financial loss. Therefore, the issues of personnel selection, prediction of operator activity and preparatory training, assessment and maintenance of vigilance and attention in conditions of monotonous activity, and rehabilitation after performance of particularly responsible functions are relevant.

The success of people's executive function in control systems depends not only on their health status, general and professional training, but also on their specific ability to work in a versatile environment for a lengthy period of time with minimal risk. In order to ensure such conditions, the development of a safe method to maintain the required functional level without adverse effects is needed. The field of computer systems with biofeedback in various modalities (bioengineering systems) for the correction of human biological conditions is constantly expanding.

Biofeedback control is a method of system research and system statistical analysis in which all the subject's consecutive actions are related to the state of his or her measured and controlled parameters, in a functional cause-and-effect association. Independently of the initial state and reactions, all consecutive actions inevitably cause the system to develop optimal behavior and achieve the desired psychophysiological result.

The technology of adaptive biological control with feedback is a comprehensive scientific research procedure. Information about the subjects' own state and the changes in their regulated physiological processes are presented to them via external feedback, in the form of an inverse afferentation signal, which is organized primarily by computer or micro-processor technique (Suvorov, 1998). Visual, auditory, or tactile stimulation are used and, with the subjects' active involvement, self-regulation and self-control skills can be acquired and used to correct of their state (Shtark & Schwartz, 2002a).

The analytic adaptive module of the bioengineering system that creates the feedback signal transforms and analyzes all the subjects' current variables that are characteristic of their behavior over time. Meanwhile, at any time t_1, t_2, … t_m, the subject can influence the informational structure of the external effects. Then, the entire system's behavior is described by the total of state vectors $X(t_1)$, $X(t_2)$, ... $X(t_m)$. Within space, these vectors are allotted by the region P that corresponds to the desired endpoint state of the bio-system. The analytical module registers the consecutive location of the vectors at each moment in time and, when the vector reaches state $X(t_i)$, region P creates a signal that controls the external stimuli that are, in turn, perceived by the subject (Suvorov, 2004).

The Department of ecological physiology of the Institute of Experimental Medicine of the Russian Academy of Medical Sciences has achieved important results, leading to the conviction that the use of biofeedback as a nonmedicinal means of psychophysiological support of standard treatment methods significantly improves their efficacy. In particular, improvement has been observed in hypertensive, hypotensive, and normotensive neurocirculatory dystonia with cardiac, asthenic-neurotic, and vaso-motor (cerebral) syndromes and in respiratory syndromes, including bronchial asthma. It has been suggested that these positive clinical results may be partly due to the restoration of a state of relaxed wakefulness with closed eyes, of respiratory sinus arrhythmia or respiratory arrhythmia in the form of the synchronization of the cardiac and respiratory rhythms (Eckberg, 1995; Hatch, Borchering, & German, 1992; Lehrer et al., 1997; Schäfer, Rosenblum, Kurths, & Abel, 1998; Schiek, Drepper, Engbert, Abel, & Suder, 1998; Zwiener, Schelenz, Bramer, & Hoyer, 2001, among others).

Psychomotor testing of the ability to analyze spatial orientation of visual images, attention, and visual information-processing speed permits assessment of the effectiveness of mobilization and rehabilitation procedures of adaptive cardio-training, and is one of the methods to control one's adaptive psychophysiological state.

The technology of functional adaptive bio-regulation of cardiac rhythm with oscillatory biofeedback has been previously studied in many patients and sportspersons, and in hundreds of industrial workers. It has been recommended as an auxiliary method of diagnostic treatment (in combination with standard treatment regimens) for the rehabilitation and correction of the organism's condition. A wealth of experience in the use of bio-regulation has been complied in scientific Russian literature (Shtark & Call, 1998; Shtark & Schwartz, 2002a; *Bulleten*, 2004). The benefits of adaptive biological regulation have been revealed in the psychophysiological training of emergency assistance doctors prior to and during 24-hour duty shifts.

Biofeedback of an oscillatory nature is informationally and rhythmically compatible with the organism's vital functions and facilitates training regulatory processes within their natural time range by increasing or depressing the existing links, or by reforming lost or functionally "depressed" links between the organism's separate subsystems.

The principal aim of this study was to assess the efficacy of previously developed computer technology of functional adaptive biofeedback control with an oscillatory feedback signal of cardiac rhythm—in other words, cardio-training (Suvorov, 1998, 2004; Suvorov, Frolova, & Chikhirzhin, 2004; Suvorov, Menitskiy, & Frolova, 1998)—for subsequent psychophysiological training (mobilization) of operators before performing psychomotor activity on computer models (attention and spatial orientation tests). Another aim was to establish criteria to predict the quality of operator activity.

Method

Participants

The study was carried out with volunteer subjects: 15 male students of a technological engineering university with computer trainer experience in modeling of operator activity. Participants were requested not to introduce any correctives in their daily routines, and on the day of investigation, they were to refrain from any drinks that affect the central nervous system (strong tea, coffee, alcohol). The use of any medication was also excluded. These limitations were required so as to define individual cardiorhythm regulation mechanisms, and to ensure isolated psychophysiological bio-regulation. All required conditions (according to participants' reports) were met.

Procedure

In the present study, a computer test of spatial thinking, attention, and visual information-processing speed was used. Essentially, the method uses participants' differential reactions to changes in spatial location and color of the presented stimulus to measure their reaction time and register the quantity of correct responses and the speed of information processing. On the first day following discussion of the objectives and aims of the study, the participants underwent this psychomotor testing. These pre-training test results were subsequently compared with the post-training results after a cycle of adaptive cardio-training procedures using biofeedback. The structural scheme of the biotechnological cardio-training system used is presented in Figure 1.

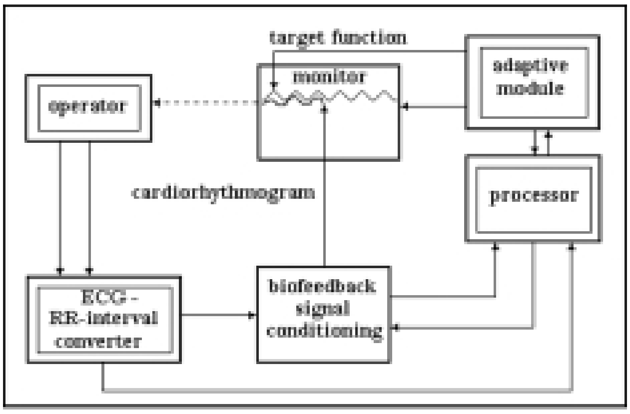

Figure 1. Structural scheme of the biotechnological "cardio-training" system.

After processing, in real-time mode, a feedback signal appeared on the computer screen in the form of the participant's own cardiorhythmogram (cardiointervalogram); simultaneously a sinus curve, representing the target function, appeared on the screen. The participant's task during training was to periodically increase/reduce the cardiac contraction rate with uninterrupted visual control (i.e., the participant was requested to attempt to superimpose his or her own cardiorhythmogram on the target function; see Figure 2). This can be achieved through a specific breathing rhythm dictated by the sinus curve. It has been repeatedly demonstrated that biofeedback is an adequate method to study the features of voluntary modulation of cardiorhythmic oscillations, and that it facilitates the normalization of autonomic balance and increases the functional reserves of the cardiovascular system (Suvorov, 2002; Suvorov et al., 1998, 2002; Lehrer et al., 1997; Lehrer, Vaschillo, & Vaschillo, 2002).

Tracking quality was assessed by the amplitude of the cardiorhythm harmonics corresponding to the period of the target function, and the cross-correlation coefficient between the cardiorhythmogram and the target function (see Figure 2). Thus, the components of the state vector were, on the one hand, the amplitude, period, and mean frequency of cardiac contractions and, on the other, the parameter of the target function as an exogenous variable.

The following cardio-training procedure was as used. First, there was a 2-minute cardiorhythm registration

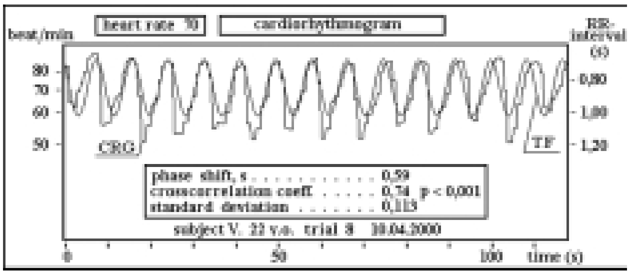

Figure 2. A cardiorhythmogram (CRG) during the 8th active test: Target function sinus wave (TF) tracking with a period of 8.41 seconds as a training element in the restoration of the respiratory component of cardiac rhythm.
Horizontal axis = current time (seconds); left vertical axis = instantaneous frequency of cardiac contractions (beats per minute); right vertical axis = cardio-interval duration (seconds). Top left in the frame = mean frequency of heartbeats for an epoch of 120 seconds. Bottom centre = phase shift between the cardiorhythmogram and the target function (seconds), cross-correlation coefficient, standard deviation (seconds).

("baseline"); the "session" consisted of consecutive of 30- to 40-minute tests. A series of 8-12 sessions ("cycle") was carried out daily or every other day. While watching both curves on the screen, participants should attempt to move their own cardiorhythmogram towards the target sinus curve, taking into account its period, amplitude, and deflection by the magnitude of the mean frequency of cardiac contractions. This manipulation is possible by means of rhythmic breathing, which modulates cardiac rhythm. The presence of waves in the cardiorhythm caused by respiratory movements is a favorable diagnostic sign and, therefore, the period of the target function was limited by frames of 4-13 seconds.

The principal distinction between this and other systems is the presence of an adaptive module within the system (Suvorov, 2004). The aim of each consecutive test is based on the analysis of the preceding test. The amplitude and period of the respiratory waves of the cardiac rhythm mean pulse rate and the defining level of the constant component of the target function are measured, and the values of the amplitude, period, and permanent component of the target sinus curve $y = C + A\sin x$ are automatically presented. If the subject is successful with the previous task, the adaptive module automatically increases its complexity (by 5%) and, accordingly, changes the amplitude, period, and value of the permanent component of the target function. However, if the subject is unable to cope, the task is simplified. The expert element of the adaptive program module does not permit changes in the parameters of the target function beyond the subject's physiological limits.

The first introductory session was to allow the participants to become familiar with the equipment. During the interviews, participants were informed of the goals and main training method, were told that they would see oscillations (variability) of their own heart rhythms. The dependence of these oscillations on respiratory movement was demonstrated: inhaling causes the cardiorhythm curve to move upwards (the pulse increases), exhaling leads to a depression of the curve (the pulse decreases). At the beginning of the session, the initial (baseline) cardiorhythmogram was recorded in a state of wakeful relaxation with closed eyes. Subsequently, five active self-regulation tests (i.e., cardiorhythm regulation), were carried out. At the end of the session, a final cardiorhythmogram was recorded, also in a state of wakeful relaxation with closed eyes. The between-test interval was 2-3 minutes. Each cardio-training session lasted approximately 30 minutes. The time of commencement remained constant throughout the entire cardio-training cycle of 5 daily sessions.

Data Analysis

The principal data processing method was the analysis of the oscillations of the components of cardiac rhythm with the aid of Fourier's method of rapid transformation (cardiorhythm count frequency—4 per second) with consequent graphic presentation: on the Y axis, the amplitude of the harmonics in measurement units of the cardiorhythmogram; on the X axis, the number of harmonics converted from frequency to period. A separate option was the indication of the value of the amplitude and period of any chosen harmonic. This nonstandard presentation form was determined by the study specifics, where the periods and amplitudes of the principal harmonics were the basic values for the establishment of amplitude-frequency parameters of the target function in the adaptive module.

Training results were considered satisfactory if there was a significantly high coefficient of cross-correlation between the cardiorhythmogram and the target function (count frequency—4 per second) with phase shift taken into account (see Figure 2). In the present study, particular attention was paid to the presence or absence of the phenomenon of respiratory arrhythmia or cardio-respiratory synchronization during the initial state of wakeful relaxation. Accordingly, the aim of the training was to strengthen, restore, or create harmonics associated with respiratory movements and the named inherent harmonics.

Statistical analysis was carried out with the aid of SPSS 11.5 statistical software.

Results

Cardio-respiratory synchronization is expressed by the formation of inherent harmonics associated with respiratory movements and is a favorable diagnostic sign. Therefore, the results of the study were analyzed taking this factor as well as the quality of operator activity into consideration.

Studies of the efficiency of operator activity in monotonous conditions carried out on the same group of subjects in 2001 revealed that they could all be classified as adaptive in nature, according to the classification developed by the Department of ecological physiology of the Institute of Experimental Medicine of the Russian Academy (Vassilevsky, Suvorov, & Bekshaev, 1988). Nevertheless, they showed individual features of adaptive self-regulation of cardiac rhythm, which were revealed by the variability of the effectiveness of training cycles with biofeedback of cardiorhythm (5 sessions and 35 tests). The cycle was not sufficient for all subjects to attain stable and well-defined effects of cardiorespiratory synchronization. As a result of training, 14 participants showed strengthening or formation of inherent harmonics conditioned by respiratory movements. The inherent harmonic period varied over a wide range of fast and slow waves from 5 to 13 seconds (see Table1). In two participants (F and D), inherent harmonics were well defined in the initial state on the first day of investigation (July 1, 2002) and the period remained unaltered by adaptive training, with a significant increase in amplitude (see Figures 3a, 3b, 4a, and 4b). The quantity of erroneous decisions in the entire group during the initial testing varied extensively from 0 to 56; after cardio-training, it dropped to between 0 and 13 (Table 1).

Table 1
Principal Pre- and Post-Indices of the Quality of Operator Activity (July 2002)

Subject	Accuracy (amount of errors)		Inherent harmonics amplitude (in seconds)		Inherent harmonics period (in seconds)	Information processing rate (IPS) (bit/s)		$\frac{IPS_{5.07}}{IPS_{1.07}}$
	Pre	Post	Pre	Post		Pre	Post	
	July 1	July 5	July 1	July 5		July 1	July 5	
A	21*	5	0.002	0.051	7.85	1.43	2.78	1.94
B	10	9	0.008	0.010	11.78	1.01	1.30	1.29
V	11	2	0.041	0.075	8.41	2.08	3.37	1.62
G	7	1	0.008	0.015	6.93	2.13	2.98	1.40
D	1	0	0.021	0.086	9.81	2.60	3.03	1.17
K	7	13	0.002	0.113	13.08	3.56	3.39	0.95
M	5	4	0.016	0.050	9.06	1.31	2.03	1.55
Mo	3	1	0.034	0.076	7.36	2.08	3.23	1.55
O	5	4	0.004	0.055	7.85	2.06	3.18	1.54
Pa	11	0	0.001	0.047	6.93	1.64	2.28	1.39
Pe	56*	3	0.003	0.043	5.12	1.34	1.22	0.91
Pu	3	0	0.006	0.092	9.81	1.78	2.76	1.55
S	8	5	0.010	0.016	5.35	1.78	2.96	1.66
T	4	1	0.003	0.011	8.41	1.53	2.59	1.69
F	0	0	0.055	0.084	11.78	2.04	3.30	1.62
M	5.77	3.20				1.89	2.69	
± *SEM*	± 0.64	± 0.66				± 0.11	± 0.12	

Note. * = assessed as spikes.

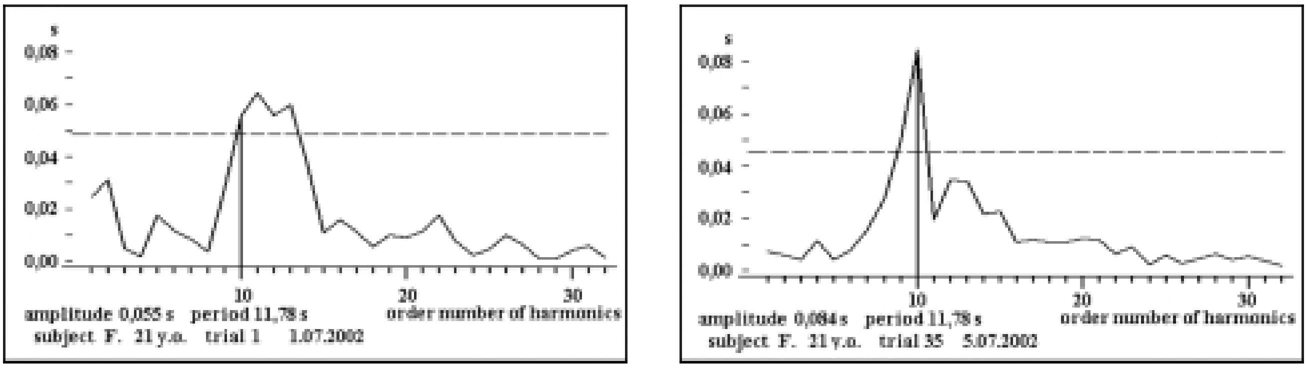

Figure 3. Rhythmic components of the cardiorhythmogram of subject F initially on July 1, 2002 (*3a*) and after completion of the cardio-training cycle on July 5, 2002 (*3b*).
Y-axis = harmonics amplitude (seconds); X-axis = harmonics order number. The magnitude of the period and amplitude of the harmonics are indicated with a vertical cursor. The horizontal dotted line shows the assessment of the amplitudes of the harmonics of random processes with confidence intervals at $p < .95$.

Participants who took part in the study had experience working in a familiar psychophysiological laboratory and were therefore sufficiently familiar with procedure conditions. Preliminary testing of the quality of operator activity revealed a wide individual range of information processing rate, from 1.01 to 3.56 bit/s (see Table 1). The quality of activity (amount of errors and information processing rate) of most of the participants prior to bio-regulation was unsatisfactory.

Over 5 sessions of cardio-training, inherent harmonics remained unformed in operator B's cardiac rhythm (see Figure 5). Our experience in the use of oscillatory regulation treatments has revealed that inherent harmonics caused by respiratory movements may be restored in practically all patients irrespective of age, and may require up to 15-20 sessions.

According to various researchers (Shtark & Schwartz, 2002b), the results obtained during training procedures

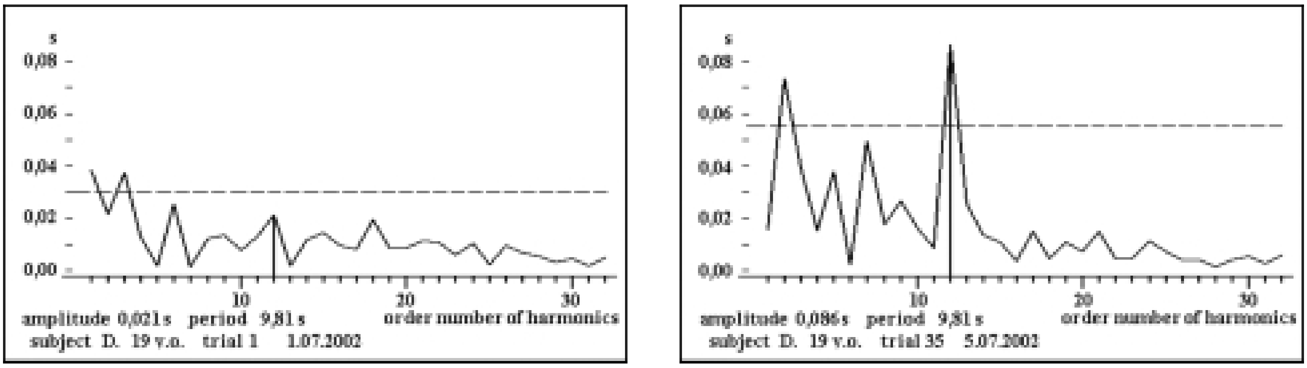

Figure 4. Rhythmic components of the cardiorhythmogram of subject D initially on July 1, 2002 (*4a*) and after completion of the cardio-training cycle on July 5, 2002 (*4b*).
Y-axis = harmonics amplitude (seconds); X-axis = harmonics order number. The magnitude of the period and amplitude of the harmonics are indicated with a vertical cursor. The horizontal dotted line shows the assessment of the amplitudes of the harmonics of random processes with confidence intervals (.95).

remain stable for a lengthy period of time. This has been confirmed in a single follow-up study of cardiac rhythm after $1^{1}/_{2}$ years. The same subjects took part in this study. All subjects, in a state of wakeful relaxation with closed eyes, showed retained inherent harmonics (see Table 2). In operator B, the amplitude increased (see Figure 6). Changes in the period of inherent harmonics may be explained by various factors. Possibly, a shortened cardio-training cycle was insufficient for conclusive definition and consolidation of inherent harmonics. One cannot exclude the influence of the subjects' psychophysiological state: The first investigations were carried out a week after summer examinations and the follow-up investigation during the winter exam period. However, the fact that the participants retained the inherent harmonics even $1^{1}/_{2}$ years after the cardio-training sessions serves as confirmation of its lasting positive influence on the cardiovascular system.

By the end of training, participant K greatly increased the amplitude of his inherent harmonics in the slow wave diapason. However, the quantity of errors committed and the information-processing speed turned out to be worse than at his initial level. This occurred on July 5, 2002, coinciding with a significant drop in his blood pressure to 90/60 mm Hg.

Among the remaining participants, Pe stood out, showing major progress in the quality of test performance (errors dropped from 56 to 3 with an insignificant decrease in information processing rate). Furthermore, there was a 14-fold increase in inherent harmonics amplitude. A similar result was noted in Participant A, with almost a two-fold increase in information-processing speed. Participant Pa restored inherent harmonics and showed an improvement in all parameters of operator activity quality (errors dropped from 11 to 0, information processing rate increased from 1.64 to 2.28). On the whole, the results of the remaining subjects are characterized by an increase in information processing rate, a limited amount of errors or lack thereof both in pre- and post-training testing (see Table 1).

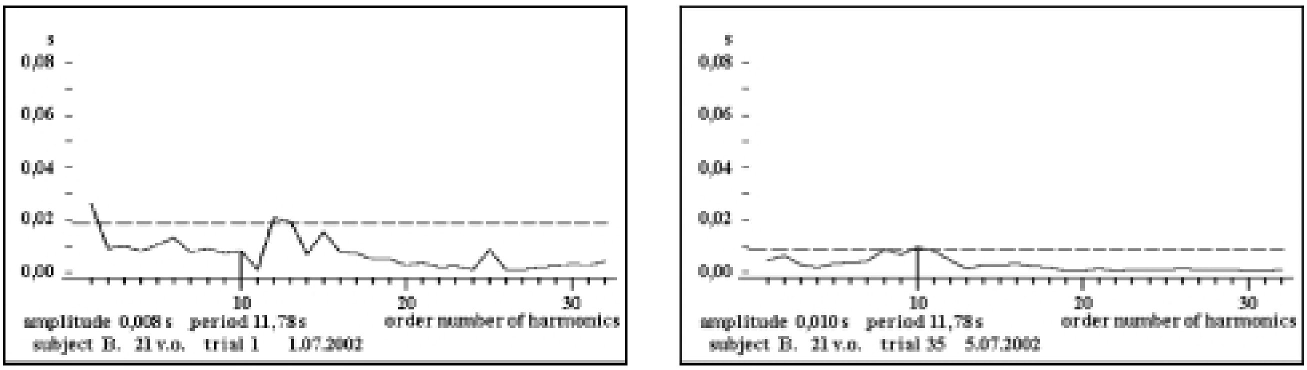

Figure 5. Rhythmic components of the cardiorhythmogram of subject B initially on July 1, 2002 (*5a*) and after completion of the cardio-training cycle on July 5, 2002 (*5b*).
Y-axis = harmonics amplitude (seconds); X-axis = harmonics order number. The magnitude of the period and amplitude of the harmonics are indicated with a vertical cursor. The horizontal dotted line shows the assessment of the amplitudes of the harmonics of random processes with confidence intervals (.95).

Table 2
Inherent Harmonics of Cardiac Rhythm at $1^1/_2$ Year Follow-Up

Subject	December 25, 2003 Inherent harmonics period (in seconds)	Inherent harmonics amplitude (in seconds)
A	7.36	0.043
B	11.78	0.025
V	8.41	0.056
G	6.93	0.016
D	7.85	0.057
K	5.35	0.029
M	11.78	0.023
Mo	6.93	0.062
O	9.06	0.029
Pa	7.36	0.037
Pe	4.91	0.034
Pu	9.06	0.029
S	5.61	0.019
T	7.85	0.011
F	10.71	0.082

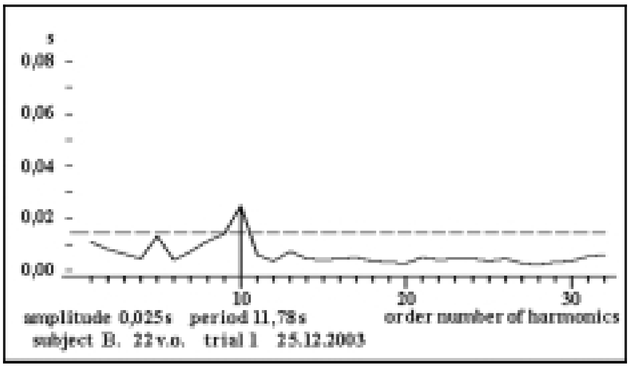

Figure 6. Rhythmic components of the cardiorhythmogram of subject B after $1^1/_2$ years.
Y-axis = harmonics amplitude (seconds); X-axis = harmonics order number. The magnitude of the period and amplitude of the harmonics are indicated with a vertical cursor. The horizontal dotted line shows the assessment of the amplitudes of the harmonics of random processes with confidence intervals (.95).

Furthermore, a formation or increase in the amplitude of their inherent harmonics was noted. Participants F and D had inherent harmonics that remained at the initial state level and, accordingly, the quantity of recognition errors (i.e., accuracy) was minimal and remained unaltered, and their information processing rate was sufficiently high although it increased after the conclusion of the cardio-training cycle. According to the results of the *t*-tests to compare the means, the amount of errors dropped 1.8-fold ($p < .01$), and information processing rate increased 1.43-fold ($p < .01$).

Discussion

The results obtained in this study show that the procedure of oscillatory adaptive bio-regulation facilitates not only the restoration of cardio-respiratory synchronization, which is retained for $1^1/_2$ years, but also leads to improvement of the quality of operator activity. This was observed in the majority of participants. The negative result of Participant K is most likely due to a significant drop in his blood pressure during the final testing. In Participant B, the absence of the formation of inherent harmonics was accompanied by the absence of positive results in the operator tests. Individuals with initially pronounced respiratory arrhythmia did not have any trouble in the initial test performance. After the cycle of adaptive bio-regulation, information processing rate increased and accuracy was either maintained or improved. Thus, we can confidently conclude that one of the important predicting subject criteria of operator “success” is the presence respiratory sinus arrhythmia (but not repetitive performance of the test) in a state of wakeful relaxation and closed eyes. Thus, we can confidently conclude that one of the important predicting subject criteria of operator “success” is the presence respiratory sinus arrhythmia in a state of wakeful relaxation and closed eyes, which, according to the specialists’ data (Eckberg, Kifle, & Roberts, 1980; Schäfer et al., 1998), can be observed mostly in young healthy subjects. The oscillatory regimen of adaptive cardiorhythm bio-regulation is based on psychophysiological mechanisms and carried out by means of individual adaptive algorithms. This method can restore lost respiratory sinus arrhythmia and thus improve the performance of operator activity.

When selecting operators, it is preferable to choose adaptive types who, according to on-site research in various extreme conditions (Vassilevsky, Suvorov, Sidorov, & Bovtushko, 1996), are more resistant not only to nervous breakdowns but also to somatic disorders. Only in some cases, adaptive individuals require mobilization or rehabilitation in bioengineering feedback systems. Low adapative examinees require an especially individual approach and regular sessions of self-regulation. The use of bioengineering systems for comprehensive pre-launching specialist training is justified in all cases.

It is important to note that inclusion within the field of voluntary cardiac rhythm regulation of factors such as individuality as conscious behavior control, motivation in combination with fervor, combined with graphic positive training results, helps to decrease anxiety and improve mood. Positive emotions (motivational feedback) in turn result in additional interest in the training process and a desire to improve and consolidate the results. An emotional uplift, caused by the positive results of training, its simplicity and obviousness was observed in all participants.

The results of the studies allow us to recommend the practical implementation of measures to mobilize operators’ reserves and improve their performance quality. These measures include individual pre-launching preparation in a bioengineering system and operative formation or restoration of respiratory arrhythmia. The presence of inherent harmonics in the cardiorhythm in a state of wakeful relaxation caused by respiratory movements is one of the qualitative criteria for the improvement of the efficiency of operator activity.

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Received June 23, 2005
Review received November 17, 2005
Accepted April 26, 2006