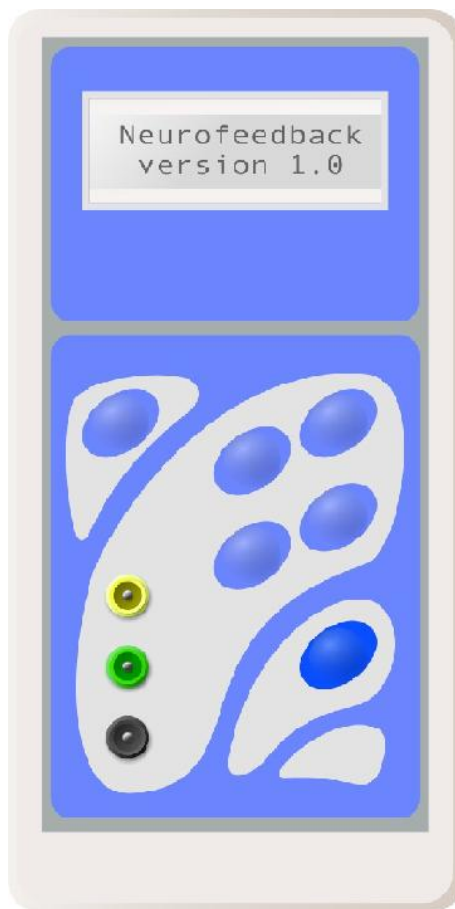


# Hardware/software for neurotherapy and neuroregulation

## Brain Tuner

### User Manual

### How to Use At Home



St.-Petersburg 2003

**Note:**

**Brain Tuner** is based on modern technology. It is designed as a result of latest neurophysiological research of several laboratories of the US, Great Britain, Germany and Russia.

Everything new needs learning. To use this set, some specific knowledge - briefed below - will be necessary. So please, find some patience to read this manual thoroughly.

**Attention:**

Use Brain Tuner at home only under supervision of a **professional** who should be responsible for correct usage of the device for correction of any brain dysfunction or for improvement of mental abilities.

**Attention!**

If you feel any discomfort or headache when using the set, please stop using it and consult a physician. The vendor is not responsible for any health disorder caused by incorrect, unsupervised use of the set.

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## What the Brain Tuner is for?

The Brain Tuner device is designed **to train your brain**. In the XX century the mankind has invented numerous trainers to strengthen muscles. Such a trainer, if used regularly, can help anyone to get a slender and handsome figure. In the XXI century, trainers for brain will be spread widely. A device like Brain Tuner can help anyone to improve her or his attention, memory, to learn how to control emotions... In some cases, such a tuner can help to correct mental or psychic disorders.

The brain controls almost all activities of a human. Our intellect, memory, attention, emotions, senses, love and hate are defined by complicated networks in our brain. These networks consist of a vast number of "little grey cells" - neurons that are arranged into complex brain systems. Number of those cells in a brain exceeds population of the Earth several times.

A cell transfers signals to another cell by means of electric impulses. Such an impulse, entering a neuron, changes its electrical properties and generates a small voltage. To perform a specific task, brain cells function **synchronously** as musicians in an orchestra. Their synchronous activity creates a specific "melody" that can be "heard" on the head surface, being reflected as oscillations of brain bioelectric potential.

When a brain dysfunction comes, it begins to mess up this "orchestra", and it needs, then, tuning!!! It is Brain Tuner that can tune brain melodies properly. Scientific research has proved high efficiency of Brain Tuner in treatment of the following brain dysfunctions: **stress-caused headaches, attention deficit/hyperactivity disorder (ADHD), obsession/compulsion syndrome, alcohol/drug addiction, dyslexia (reading disorder), depressions, sleep disorders, epilepsy, consequences of cerebral insults and injuries...**

Also, the set could be used to increase efficiency of brain activity and to achieve best results - for **sportsmen, musicians, artists, and many other creative professionals**.

It is also useful for training relaxation skills. A few minutes of relaxing training with the help of the Brain Tuner can be equal to a few hours of usual rest. Devices similar to the Brain Tuner are being more and more frequently used in fitness-centers or at **top managers'** workplaces.

## Principles of the Brain Tuner operation.

The Tuner functions are based on two principles: **brain self-regulation** and **biological feedback**.

Our experience shows that brain is very flexible. It is changing constantly, adapting itself to requirements of environment. Its abilities are practically unlimited. But the majority of us uses only a little part of the brain capacity. Moreover, the complicated "orchestra" of the brain can sometimes mess up due to such reasons as stress, psychic traumas, nonfavourable external conditions, brain injuries... so that a human becomes unable to resist external conditions..

Numerous scientific investigations have shown that the brain orchestra can be tuned deliberately - under the control of the will. In other words, one can change electrical activity of one's own brain actively, by oneself!!!

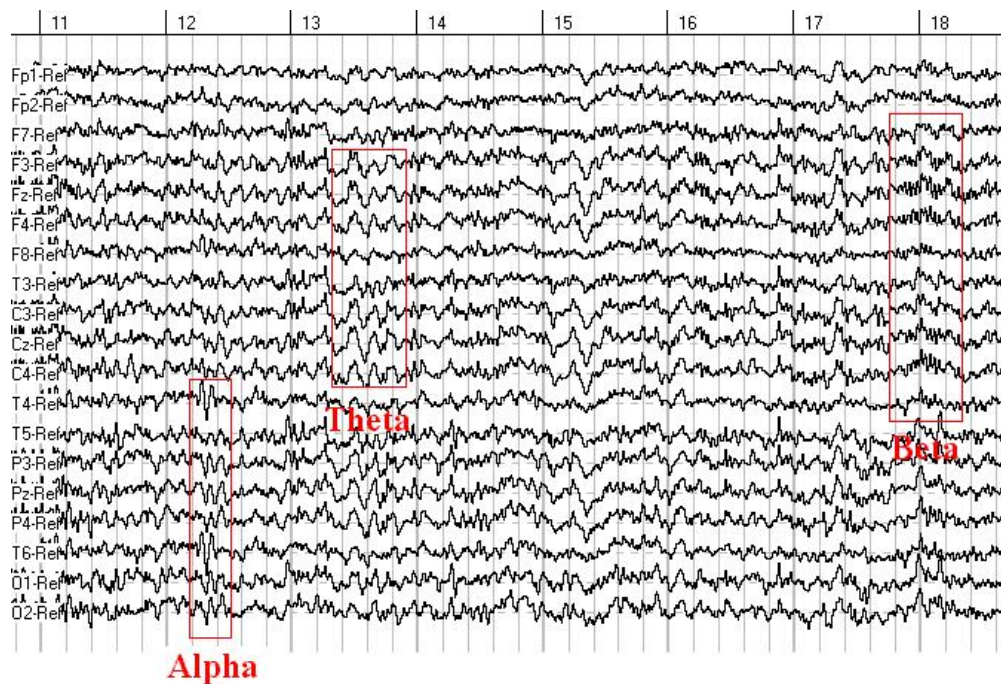
But how to learn to use this ability? A man knows how difficult it is to have a shave without looking in a mirror, and a woman without a mirror hardly dares to make up. Here, the mirror is that very feedback that controls out actions (a bit lower... slightly to the right...)

The Brain Tuner serves like a mirror - for the brain. Looking at it, we see how specific EEG characteristics are changed, so we can deliberately increase or decrease activity of specific systems in the brain, or - one can tune and correct performance of her or his own brain.

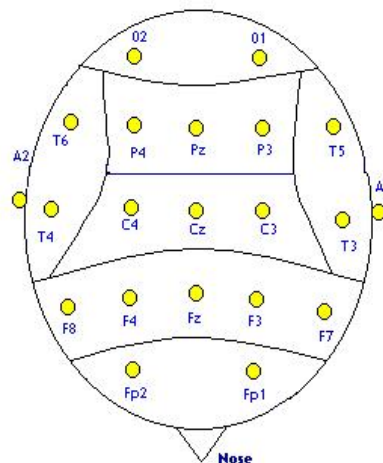
Of course, it takes time to learn neuroregulation skills - just like to learn to drive a car. For the first time, a task seems incredibly hard, but then, step by step, from simple to complex, you begin to be able to drive, and then you already can talk with your passenger while you are driving. Scientists have proved that it takes more 40 sessions, 30-50 min for a session, to train neuroregulation skills; not more than one session per day is recommended

## How do brain potentials reflect brain activity?

Coordinated activity of a symphonic orchestra becomes obvious due to oscillations of air affecting a human ear-drum. And brain activity can be observed from oscillations of brain potential. These oscillations form an electroencephalogram, or an EEG.



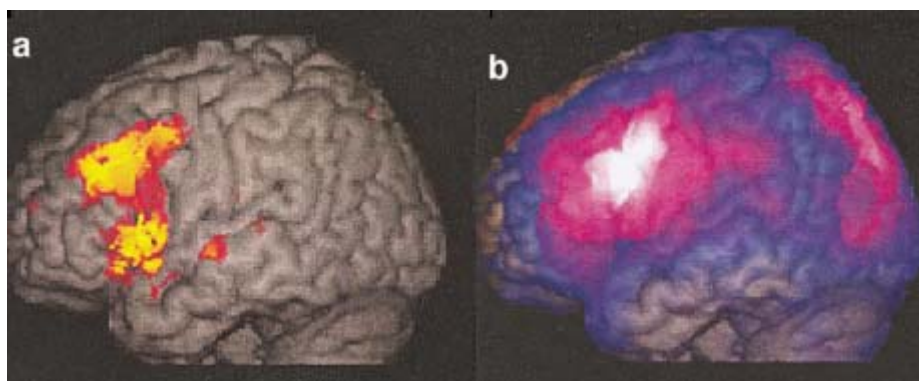
This figure presents a record of human brain EEG from 19 electrodes placed in different points of the scalp. Scheme of their placement is depicted below.



This EEG was recorded from a healthy person in usual condition with opened eyes. Numbers above mean seconds, letters on the left mean points on the scalp EEG was recorded from. One can see that EEG oscillations are very dynamic and can vary in frequency within an interval less than a second. For instance, a flash of alpha activity (frequency of 10 oscillations per second) can be noted on the figure at the 12<sup>th</sup> second in parietal zones of the head, while at the 13<sup>th</sup> second theta-waves (4-6 oscillations per second) appear in the frontal zones, at the edge of the 17<sup>th</sup> and the 18<sup>th</sup> seconds come electrodes record waves with frequency of 15-20 oscillations per second - these are beta waves.

The last decade of the XX century was proclaimed as the decade of brain research. During this period, new methods of brain activity imaging such as positron emission tomography (PET) and magnetic resonance imaging (MRI) have begun to be used widely. The

figure shows maps of brain blood flux obtained by means of PET (right) and a map of EEG theta rhythm distribution within EEG activity (left). Having combined different investigation methods scientists have shown that different **EEG rhythms** do reflect different processes in the brain.



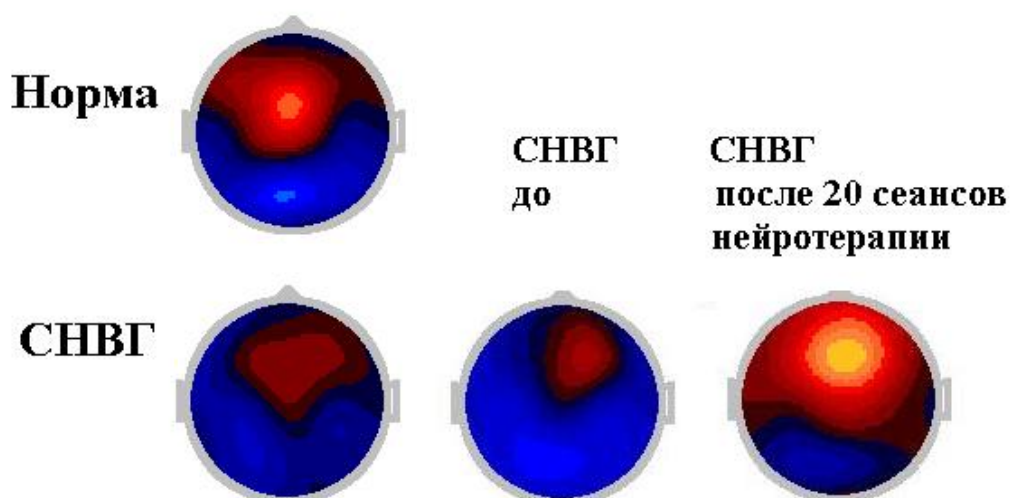
For instance, alpha rhythm reflects inhibition in the brain area that generates it, beta rhythm (15-20 oscillations per second) reflects activation of this area, and theta rhythm is related to information extraction from episodic memory.

Since many of these processes last for fractions of a second, it is difficult to monitor them by eye. Specific computer technologies are used for monitoring. These EEG processing algorithms require large computing capacities provided by modern computers. That is why brain tuners have found wide application only during last years.

### How a neurotherapy protocol is defined?

To start brain training, a **neurotherapy protocol** should be defined. The protocol determines what brain areas to place electrodes on and what correction algorithm to use. Only a specialist in neurotherapy can perform this procedure.

A protocol is defined from results of multi-channel EEG analysis. Such an analysis reflects brain performance when the subject relaxes (with eyes shut or open) and when he/she is performing special tests. A neurotherapist analyses brain activity maps. These maps allow the specialist to understand how different brain systems perform. Comparing brain maps with normative database (by means of computer), a specialist can define what brain system has dysfunction and how is it reflected in brain rhythms mentioned above.



The figure shows results of an investigation carried out in the Institute of Human Brain in 1995-2000 (see: «Влияние электроэнцефалографической биологической обратной связи по сенсомоторному ритму и бета-1 ритму на параметры внимания» авторов Гринь-Яценко В.А., Кропотов Ю.Д., Пономарев В.А., Чутко Л.С., Яковенко Е.А в журнале Российской Академии Наук «Физиология человека», 2001, Том27, № 3, стр. 5-13). On the left there are brain potential maps reflecting brain performance when the subject pressed a button in response to specific stimuli and did not perform any action in response to other stimuli. Stimuli were presented in random way. A red area in the map reflects how is the brain able to focus on the task. For children with attention deficit/ hyperactivity disorder (ADSD), it could be seen clearly on the maps that frontal cortex is not active enough. A course of 20 sessions of so-called beta therapy for those children led to significant increase of frontal cortical activity as well as to obvious improvement of attention and lessening of impulsiveness.

Up to now, several different methods for EEG analysis and brain dysfunction diagnostics are developed. Some of them are based on spectral analysis of background EEG, other use event-related brain potentials or desynchronization for different specific frequency ranges. In the last case, EEG is registered while the subject is performing tests for memory, attention, reading, etc.

This manual cannot acquaint the readers with all modern methods of EEG analysis - that is a task for experienced neurotherapists. Here, we will tell only that this analysis serves as a basis when defining: location of brain disorders, points for electrodes to be placed onto, and neurotherapy protocol (i.e. what EEG rhythms are to be facilitated and what ones are to be inhibited to treat a specific brain dysfunction). Desirable changes of local EEG rhythms are reflected in so-called **neuroregulation parameter**, which usually is a ratio of powers of two specific rhythms, where a rhythm to be facilitated is the numerator, and a rhythm to be inhibited is the denominator. A person can deliberately increase this parameter, therefore controlling his(her) electroencephalogram and correcting dysfunction in a brain system that causes symptoms of a disease.

## How a Brain Tuner is built?

A Brain Tuner includes three components: electrodes (in a cap), an autonomous device Mitsar-BFB (Brane Tune) and a jammer.

1. The **electrode cap** is put on subject's head. Use "stickers" to adjust the cap size. To enable good contact with head skin, electrodes are wetted by slightly salted water. Three electrodes are connected to the cap. One serves as so-called *common point* and can be placed in any point of the scalp. The rest two ones are "active" electrodes. They are placed onto the target scalp area. Then, electrodes are connected to nests of the device front panel.

A neuroregulation protocol determines where to place electrodes. In any individual case, the protocol is defined by a specialist, based on 19-channel EEG analysis. To register 19 channel EEG and to analyze it, special expensive equipment is needed. As a rule, such equipment, operated by qualified specialists, is at the disposal of neurotherapy centers.

2. The **autonomous device Mitsar-BFB** (BrainTune) includes a brain potential amplifier and a microprocessor. The latter computes neuroregulation parameter value that is displayed as a horizontal bar.

As the parameter value in individual for each subject, the displayed bar size scale (in other words, "volume") can be adjusted by means of "+" and "-" keys on the device front panel. Use the "+" key to increase and the "-" key to lessen the bar. Adjust the bar size so that neuroregulation parameter would oscillate near the middle of the device screen. The middle of the screen (marked by two triangles on the frontal panel) defines so-called **neuroregulation threshold**. The subject task is to hold the neuroregulation parameter above the threshold by volitional effort.

We should note that a subject is human, not a computer, and therefore state of his or her brain, as well as value of neuroregulation parameter, is constantly changing. For many persons, this parameter is very unstable. Please, don't get upset because of the bar jumping non-stop! It is

quite normal. What you should aim at is to make the bar stay above threshold (i.e. in the right half of the screen) for as long time as possible.

It should be noted that sound signal may also serve as a biofeedback parameter, instead of or together with visual one. In that case, for this device, a metronome starts to sound when the neuroregulation parameter exceeds the threshold.

To tune brain, appropriate **neuroregulation protocol** must be chosen. Such a protocol defines 1) electrode location, i.e. where to place active electrodes, and 2) algorithm for computing neuroregulation parameter.

Remember that neuroregulation parameter is usually computed as the ratio of two EEG signal power values for two selected frequency ranges. The range for power to be increased is in the ratio numerator, and the one for power to be decreased is in the denominator. The algorithm for computation of neuroregulation parameter is strictly individual for each specific subject. It is defined by a specialist and then loaded into the microprocessor memory by means of a special procedure carried out only by a specialist.

This protocol appears in the protocol list as the first one, under the name **Personal**.

But together with it, the processor stores also several standard protocols that are used widely by different neurotherapy centers. These are:

- 1) **Alpha** protocol – modifying EEG power for 8-12 Hz frequency range,
- 2) **Alpha-Theta** protocol – modifying EEG power for 4-12 Hz frequency range,
- 3) **Beta** protocol – modifying EEG power for 14-20 Hz frequency range,
- 4) **Sensomotoric (SMR)** protocol – modifying EEG power for 12-15 Hz frequency range.

Protocols differ also by direction of EEG spectrum modifications. Protocols of the "+" type are aimed to increase and those of the "-" type - to decrease EEG power for the given range.

Alpha+ and Alpha-Theta+ protocols are general relaxing ones. Electrodes are placed to Fz and Pz points. These protocols are used to train relaxation methods for treating alcohol and drug addictions, strain headaches, insomnia, etc.

Beta+ is an activating protocol. Active electrodes are placed to Fz and Cz points. The protocol is used to activate frontal brain areas, for instance, when treating ADHD.

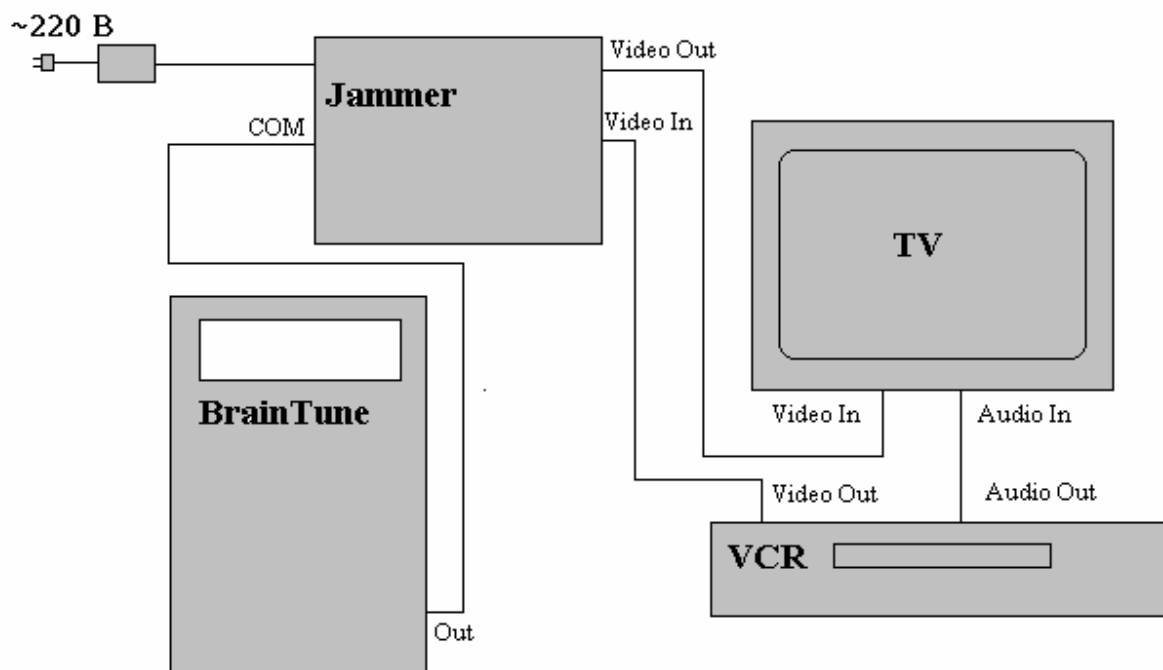
SMR+ is a motor relaxation protocol. Electrodes are placed in the points C3 and Cz, which are above the brain cortical zone responsible for motorics.

A neuroregulation protocol can be chosen by means of the "**α**" key on the device frontal panel.

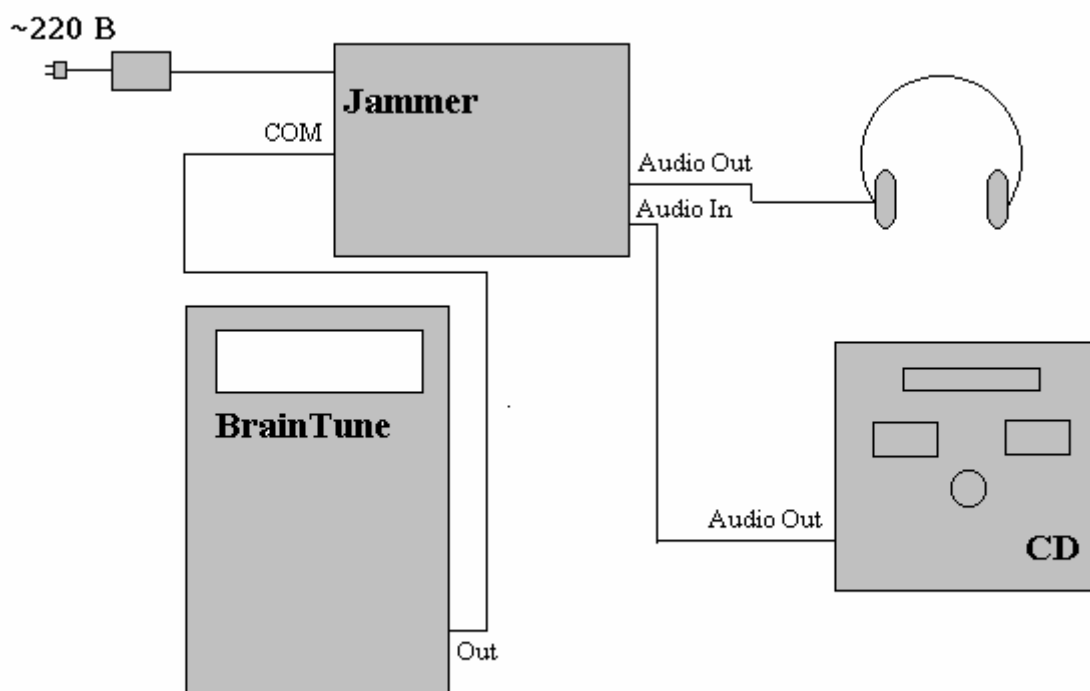
3. The **jammer** is used to carry out neuroregulation by means of video player and TV set or of CD player.

In the first case, the neuroregulation parameter is controlling **video noise in the video player**. The less is the parameter (the closer is the bar to the left edge of the display), the greater is the noise. In contrary, if the neuroregulation parameter exceeds specifically chosen threshold value, the image on the TV screen becomes sharp. In other words, a subject can watch a video film without disturbing noises only when her or his brain is performing "properly" and therefore the neuroregulation parameter exceeds the threshold.

Fig. shows the scheme for connecting BrainTune to a video player (or a VCR) and to a TV set via a jammer.



In the second case neuroregulation parameter is controlling **sound volume** in CD player. The less is the parameter, i.e. the "worse" is the subject's EEG, the lower is the music sound. Fig. shows the scheme for connecting BrainTune to an audio CD player via a jammer.



One can see that connection is easy enough: video or audio signal comes to a corresponding (video or audio) input of the jammer. The jammer is generating noise controlled by neuroregulation parameter coming to the **COM** input of the jammer. The "noised" signal from the video or audio output of the jammer is transferred to the appropriate input of the TV set or of the speaker (or ear-phones).

For those who likes computers and prefers to work with them, the amplified EEG signal from **BrainTune** can be send to a computer via a **COM** port. In this case, special software

computes the neuroregulation parameter and displays it on the monitor (see Brain Tuner User Manual).

Fig. shows the scheme for connecting Brain Tune via jammer to a computer, a video player and a TV set. The only difference from the scheme without a PC is that the BrainTune output is connected to the COM1 port of the PC, and the COM2 port of the PC - to the COM input of the jammer.

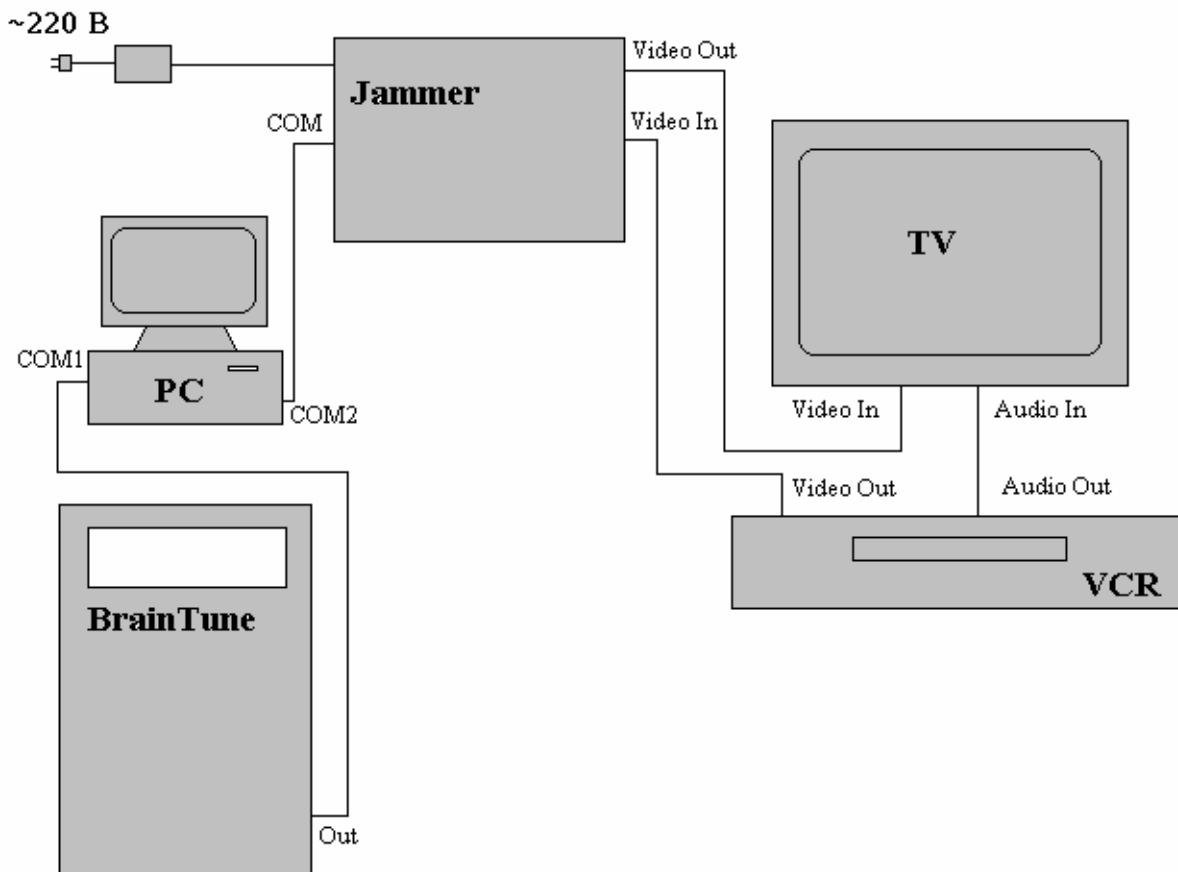
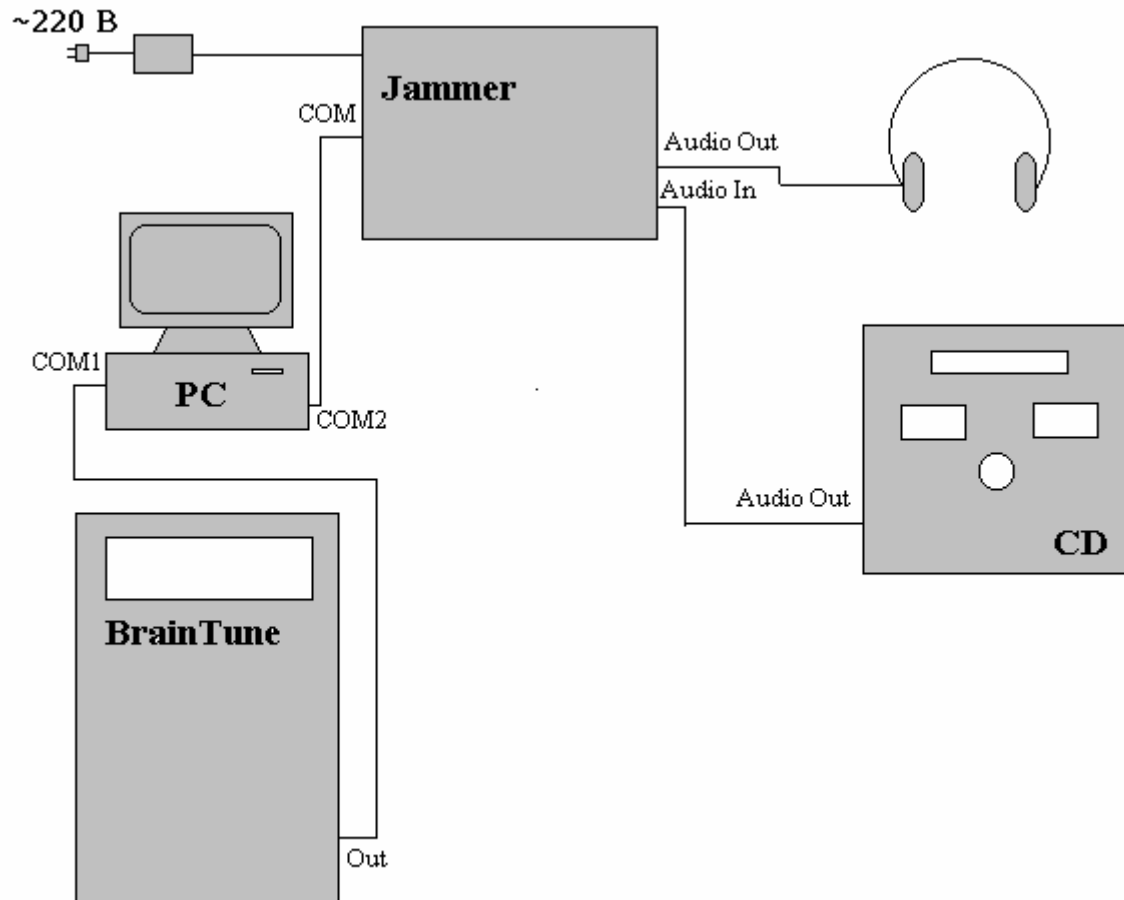


Fig. shows scheme for connecting a computer and a CD player to BrainTune via jammer. The only difference from the scheme without a PC is that the BrainTune output is connected to the COM1 port of the PC, and the COM2 port of the PC - to the COM input of the jammer.



## Appendix 1. Using Brain Tuner in medicine.

After the neuroregulation was discovered by scientists, clinicians almost immediately began to use it as an alternative to traditional methods of therapy. But in the 1970-80s the method was developing slowly due to lack of computers powerful enough and not expensive. During the last years computers and amplifier became less expensive and more efficient, and a renaissance came for the method. In 1970s neuroregulation devices cost about a hundred thousand dollars, and now simple devices cost near one thousand dollars and are becoming available even for usage at home.

Of course the method is not a panacea, though there are people who try to use it in treating practically any brain disorder. The method has clearly defined possibilities and limitations. Below there is a table of brain disorders and neuroregulation protocols used successfully to correct the disorders. Positive results of using the protocols listed below are more than once confirmed and published widely in scientific periodical press. The protocols are now used widely in numerous neurotherapy centers in the US, Australia, UK, Germany and many other countries.

**Table 1. Brain disorders treated by neuroregulation and appropriate protocols used.**

<b>DISORDER</b>	<b>ELECTRODE POSITIONS</b>	<b>PROTOCOL</b>
Attention deficit disorder	Cz-Pz for children from 7 to 9 FCz – CPz for children from 10 to 15 Fz-Cz for those who are older than 16	Beta+ (often together with Theta- )
Hyperactivity	C1-C5 or C3-Fz	SMR+
Epilepsy with seizures in motor sphere	C1-C5 C2-C6	SMR+
Dyslexia	F3-P3 F7-P7	Beta+
Tourette syndrome	C1-C5 or C2-C6	SMR+
Alcohol or drug addictions	Oz-Fz	Alpha+ or Alpha/Theta+ (sometimes together with Beta-)
Closed brain injuries	Area of maximal EEG deviations	Beta+
Reactive depression	F4 F3	Alpha+ Alpha-
Obsessions	P4 or P6	Alpha+ (sometimes together with Beta-)
Autism	Fz-Cz	Beta+ and Theta-
Migraine	Fz-Cz	SMR+ protocol for middle line
Sleep disorders	C1-C5 C2-C6	SMR protocols
Brain insult and ischemia	Area of maximal EEG deviations	Beta+ (or SMR+) combined with Theta- protocols
Strain headaches	Fz-Pz	SMR+

## Appendix 2. Non-medical usage of Brain Tuner.

In English and American literature, non-medical usage of neuroregulation method is called Peak Performance. It is for those who wish to reach maximal success in their profession - mostly, students, musicians, artists, sportsmen, and businessmen.

During the last years many papers dedicated to Peak Performance has been published, describing investigations that used different methods. These methods often are very specialized, depending on what features and for what job are to be improved. More, different specialists use different protocols. But some common principles could be noted.

Protocols can be divided into two kinds: relaxing and activating. Relaxing protocols include those increasing alpha activity in the trained cortical areas. Activating protocols aim to increase beta activity.

Neuroregulation is usually used in addition to other mental training in a specific field: for instance, musicians use training of musical abilities, and golf players improve features needed in that game.

## Appendix 3. Mitsar- BFB (BrainTune): Technical Features.

Power supply	4 batteries 1.5 B (AA size)
Channel number	1 channel for bipolar montage
Isolation	Optical
Frequency range	1 – 30 Hz
Digitizing frequency	250 Hz
Analog-digital conversion	8 bit
Digital filter order	250
Number of internal fixed protocols	8
Number of neuroregulation parameter gradations	16
Liquid-crystal display	2 lines, 16 chars per line
Regulation of input signal sensitivity	256 grades
Automatic artifact detection	If signal amplitude exceeds 200 mcV
Connection to PC and to jammer	COM port
Feedback sound signal	Short-time tones with 1 sec interval

#### Appendix 4. Mitsar- BFB (BrainTune)kit.

<b>№</b>	<b>Name</b>	<b>Number</b>
1.	BrainTune autonomous device	1
2.	Jammer	1
3.	Electrode cap	1
4.	Electrodes	3
5.	Cable for connecting electrodes to autonomous device	3
6.	Cable for connecting autonomous device to computer or to jammer	1
7.	Cable for connecting jammer to TV set and to video player	1
8.	Cable for connecting jammer to audio player	1
9.	Cable for connecting computer to jammer	1
10.	Power supply unit for jammer	1
11.	Power supply batteries for autonomous device	4
12.	CD or Flash memory with software*	1
13.	Device User Manual	1
14.	BrainTuner Software UserManual	1
15.	USB to Serial Adapter (BF-810)	1
16.	Security dongle*	1

\* Can be included in Mitsar-EEG system kit.