

Henryk Noga

## The use of biofeedback technical devices in pedagogical practice and therapy

Feedback - a self-control technique in the use of biofeedback system

### Biofeedback in the historical aspect

The first experiments which influenced the development of the EEG Biofeedback were conducted by a German, Hans Berger, in the 1930s. They focused on the exploration of the Alpha rhythm (8–12 Hz) [1].

Right after the Second World War the issue was tackled again. In 1958, at the University of San Francisco Dr Joe Kamiya (a Japanese immigrant) and Kliternan initiated their work on the EEG and the feedback system. Their main concern was the Alpha waves. What they declared was that a human being is able to control the Alpha waves using his will power, which had been considered impossible before. The Alpha-feedback of the time, which is now said to be a state of deep relaxation, became a significant impulse for further experiments.

The research on the relation of the EEG waves activeness, that is Alpha waves relation with the emotional states and the state of consciousness, started at the beginning of the 1960s. Their major aim was the states of a complete relax [3].

The most vigorous progress of the EEG Biofeedback is connected with the work of Professor B. Sterman, a NASA worker. At the end of 1960s he claimed that the activeness of the waves rhythm approx. 14 Hz is present both during sleep and while staying awake. It was that kind of activeness that he started training on animals.

Dr Joel Lubar, one of Sterman's co-workers, dealt with the problem of hyperactivity. In his work, he pointed out that the EEG Biofeedback method was useful not only in the therapy of children suffering from ADHD, but also in the therapy of people with concentration disturbances with no psychomotor hyperactivity or the disturbances of the learning processes (ADD) [4].

The information revolution of the 1990s made it possible to measure the physiological indications more precisely, which meant greater possibilities of the use of Biofeedback. As feedback information, visual elements were added (instead of the originally used sound). The computers were equipped with such computational tools that allow noticing even the slightest change within a given physiological modality.

### **Biological feedback**

Biofeedback is a method of supplying information about the course and parameters of a monitored physiological activity. The information gained allows controlling and optimization of a monitored parameter, therefore of a given physiological activity. The process of returning the information is called feedback, and as it refers to the functioning of living organisms, it is called Biofeedback. The process of monitoring a given physiological parameter is, in most cases, conditioned by certain paradigm (a concept of feedback modelling), and the attempt to fulfil the conditions of a paradigm is called the Biofeedback training [3].

Biological feedback is a technique of treatment in which people train the improvement of their health by using the signals from their own bodies. Physiotherapists use biological feedback in order to help patients with muscles paralysis regain their motor abilities. Psychologists use the method to remove their patients' tensions and anxieties, while the patients learn to relax. Many other specialists use biological feedback to cope with pains.

The biofeedback training is based on the states of consciousness. It has been proved that what is most important for a human being is a state called "alpha" (connected with deep relaxation, positive thinking and visualization) and a state called "theta", which displays interesting connections with the immunological system.

### **The use of biological feedback**

A practical use of the biofeedback system is wide and it is applicable to various spheres of life. The method is used to eliminate many medical problems: to treat the illnesses of the cardiovascular system, the digestive tract and the respiratory system, as well as the illnesses accompanying functional disorders. Biofeedback has been found particularly useful in neurology and psychiatry. It is mainly used for diagnosing schizophrenia and depression [5].

There is another research whose aim is to check the usefulness of Biofeedback for healthy people. Biofeedback training is recommended for people with psychological problems (both children and adults), e.g. a lowered ability to present one's own potential and achievements, suffering from stage fright or anxiety, having problems with learning processes (dyslexia, dysgraphia), behavioural and sleep disorders, problems with concentration, distorted self-evaluation and problems connected with planning one's doings. EEG Biofeedback training helps to learn better, soothes psychomotor hyperactivity, anxieties and fears, reduces aggression, and improves one's relations with others. The biofeedback system is also successfully used in pedagogy and criminology.

### **The way biofeedback system works**

The biofeedback system work consists in the control of human behaviour. It is conditioned by the rotation of information between the disposition centres located in the central nervous system and the performing organs. In the biofeedback system, va-

rious electrodes are used. They act as sensors connected with an electronic apparatus compatible with a computer [6].

The whole therapy can be divided into three subsequent phases, in which a patient is taught how to influence and modify the reactions of his body. In the first phase, a given physiological state is discovered, for example electro-dermal reactions. In the second phase, the electric signal is intensified so that it becomes perceptible for the patient. The way it is done consists mainly in the change of an electric signal into a sound. In the third phase, the visual or sound signal reflecting a state of altered physiological activeness of a given organ becomes available to the sensual perception of the patient.

The EEG Biofeedback training stimulates the regulatory mechanisms which participate in the activation of the cortex. Depending on the kind of the clinical problem, various ranges of brain wave-lengths are trained [7].

Brain waves are the electric waves generated by every brain. All their elements are always produced but one can develop a predominance of certain desired brain waves using one's will power and a suitable training. A production of certain brain waves and a reduction of others make the essence of the EEG Biofeedback training [10].

The brain waves can be divided into:

- Delta band, with a dominating range of wave-lengths below 3 Hz;
- Theta band, with a dominating range of wave-lengths between 4 Hz – 7 Hz;
- Alpha band, with a dominating range of wave-lengths between 8 Hz – 13 Hz;
- Beta band, with a dominating range of wave-lengths above 13 Hz, with the upper limit depending on the method of measurement;
- Gamma band, with a dominating range of wave-lengths 36 – 44 Hz.

The EEG Biofeedback training focuses on the promotion of the desired waves: Alpha, SMR, Beta 1 (15 – 19 Hz), and the suppression of the free waves – usually Delta, Theta, Beta 2. Sometimes, Alpha waves are also reduced when there is a surfeit of them (the frontal lobe for ADD and ADHD). The basic training records are:

- Beta/ Theta; Beta/ Delta training;
- SMR/ Theta; SMR/ Delta training;
- Alpha/ Theta training.

The number of sessions is approximate and has a growth tendency. The sleep disorders are easiest to be regulated, sometimes after 5–7 sessions. The neurofeedback specialists claim that the positive changes of symptoms can be observed after each series of 20 trainings.

## **The biofeedback system in pedagogy and therapy**

### **Diagnostic tests**

The registration and evaluation of EEG Biofeedback makes one of the standard methods of neurological diagnosis, e.g. EEG is one of the most important methods of diagnosing epilepsy. There are also some well established areas of the use of potentials correlated with stimulation [11].

Psychology and psychophysiology is mainly interested in so-called functional brain disorders. The term refers to such disorders for which no organic basis can be found. Psychosomatic illnesses are the typical example of functional disorders. An examination of a spontaneous EEG and the potentials triggered can provide plenty of very useful, though sometimes equally controversial, results.

### **Revalidation tests**

EEG Biofeedback is a non-invasive method used both for diagnosis and revalidation, and it consists in stimulation or suppression of some ranges of brain bioelectrical waves. The method makes use of learning through instrumental conditioning, and requires the use of a specialist EEG apparatus and appropriate computer software.

A person who is put through the revalidation EEG Biofeedback training learns, while playing a computer game, how to control the activeness of his or her brain by means of feedback [13].

The basic advantage of the method is the lack of side effects, as well as the possibility to use it for young children, aged 3 – 4, who are able to get interested in a simple computer game. Biofeedback as a therapeutic method of learning to self-control one's unconsciously occurring biological functioning has been known for a long time. The EEG Biofeedback is a method of autonomous regulation of brain waves.

### **Educational use of the Biofeedback system**

Training the left hemisphere, that is logical, mathematical thinking, is typical for our culture and the educational system. However, people who use both hemispheres are most successful in their lives.

The research results point out that the Alpha state of mind is the one in which a human being has access to both hemispheres, which means thinking takes place both in the right and left hemisphere. It creates a well-balanced way of thinking, which makes our capability of understanding, creating and solving problems significantly greater [2].

Professor Roger Sperry, the Nobel prize winner, and others pointed out that the more both hemispheres work simultaneously, the more each of them makes use of this cooperation.

The Biofeedback method tends to synchronize the waves in both hemispheres. Therefore it is recommended to people preparing for exams – it makes the assimi-

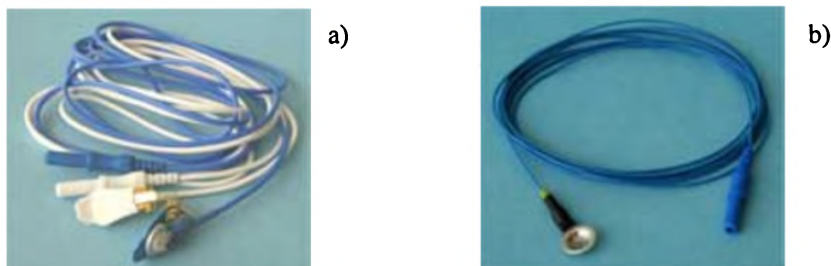
lation of knowledge easier and quicker, the training helps to discover and improve positive and creative thinking, calms and relaxes while activating the process of thinking itself.

In Poland, one of the best known devices to use the biological feedback technique is called SITA system, which allows to learn intensively in a state of deep relax. Another very useful device is the so called Watcher set, which also makes use of the Biofeedback method, and can stimulate the process of learning particularly large portions of material.

### The Biofeedback system for relax

Next to its medical and educational uses, the feedback system is becoming more and more valued among computer games authors. Dominic Greco, a psychologist, the founder of Cyber Learning Technology, by using special computer games, treats children and adults with concentration disorders and problems with information processing [9, s. 91].

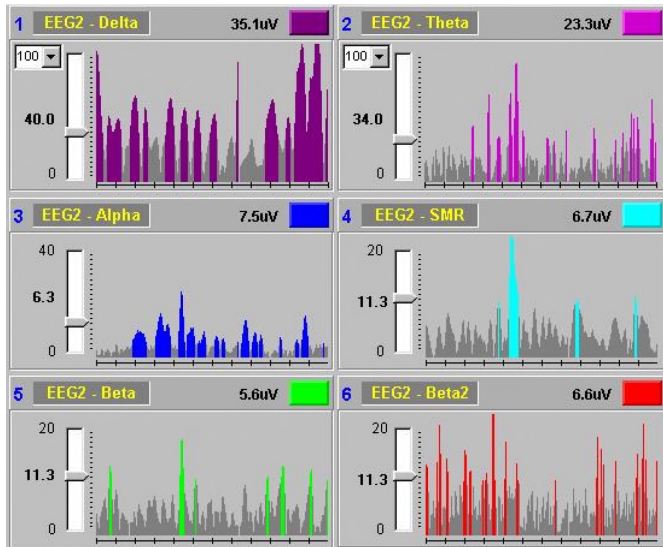
The computer game 'Journey to Wild Divine', already present on the Polish market, is a good example of the above-mentioned therapeutic use of computer games. The electrodes used in the game measure the cuticle resistance. Seemingly, it is a typical computer game having very realistic and colourful graphics, riddles and jigsaws which require both logical thinking and a particular state of mind, the second characteristic being not typical at all for other well-known games. Going through the consecutive levels of the game requires a suitable state of relaxation, which is systematically controlled by means of the electrodes placed on the player's fingers. During the game, the player-patient meets characters who teach him or her the relaxation techniques and how to control emotions.



**Fig. 1.** Electrodes used for EEG Biofeedback examination: a) ear electrodes, b) bowl electrodes



**Pic. 2.** The arrangement of the Alien electrodes on the left part of the patient's head: an electrode placed on the head and an ear electrode;



**Pic. 3.** A dialog box showing the range of EEG frequencies

## Bibliography

- [1] Berger H., *Über das Elektrenkephalogramm des Menschen*, [in:] *Archiv für Psychiatrie und Nervenkrankheiten*, Berlin 1929
- [2] Croal N., Frender M., *Wideoterapia*, „Newsweek” 42/2004
- [3] Pecyna M.B., *System Biofeedback w praktyce pedagogicznej*, Warszawa 1998
- [4] Geras G., *Psychologiczno-medyczna diagnostyka elektroskórna*, Gdańsk 1996
- [5] Ciarkowska W., *Psychofizjologiczna analiza aktywności poznawczej*, Wrocław–Warszawa–Kraków 1992
- [6] Cade N., *Coxhead, The awakened mind*, Wildwood House 1979
- [7] Majkowski J., *Elektroencefalografia kliniczna*, Warszawa 1989
- [8] Mastalerz E., Bożek A., *Kształtowanie postawy ucznia priorytetowym zadaniem edukacji ogólnotechnicznej*, [in:] *Research In Didactics of Chemistry*, ed. C. Plewka, Dyduchem, Kraków 2006
- [9] Noga H., *Bohaterowie gier komputerowych – implikacje pedagogiczne*, Kraków 2005
- [10] Pecyna M.B., *Rodzinne uwarunkowania zachowania dziecka*, Warszawa 1998
- [11] Proctor T., *Zarządzanie Twórcze*, Warszawa 1998
- [12] Pytel K., *Kontrola postępów w nauce jako uwarunkowanie procesów kształcenia na przykładzie studentów ETI oraz WT Akademii Pedagogicznej w Krakowie*, VI Konferencja Naukowa Edukacja Techniczna i Informatyczna. Przygotowanie zawodowe – kwalifikacje – rynek pracy, Ciechocinek 17–19 IV 2007 r., UKW, Bydgoszcz 2007
- [13] Ornstein R., *The Psychology of Consciousness*, New York 1977
- [14] Šimonová I., *Activities towards effective listening*, [in:] *Sborník příspěvků z mezinárodní konference Modernizace vysokoškolské výuky technických předmětů I*, Hradec Králové 2006, pp. 154–157
- [15] Vargová M., Tomková V., *Pracovné vyučovanie v súvislosti s prácou s počítačom*, [in:] *Zborník Vplyv technickej výchovy na rozvoj osobnosti žiaka*, Nitra 2002, pp. 167–170
- [16] Vargová M., Depešová J., *Poznámky k niektorým pojmom technickej terminológie*, [in:] *Vplyv technickej výchovy na rozvoj osobnosti žiaka. Zborník*, Nitra 2000, pp. 107–110

## Streszczenie

*System Biofeedback* rozumiany jest jako technika korzystania z informacyjnej roli pomiaru elektronicznego, w skład którego wchodzi aparatura elektroniczna służąca do wzmacniania, monitorowania i oceny reakcji fizjologicznych zachodzących w organizmie ludzkim bez udziału jego świadomości. Istotą tego pomiaru jest modyfikacja przy pomocy samokontroli zaburzonego zachowania warunkowanego autonomicznym układem nerwowym.

Psychologowie definiują samokontrolę jako inicjowany przez człowieka proces, za pośrednictwem którego chce on osiągnąć zbieżność między własnym funkcjonowaniem a standardami wewnętrznymi (osobistymi) bądź zewnętrznymi (nieosobistymi). Jej celem jest bezpośrednia zmiana autonomicznych procesów fizjologicznych, w efekcie, ograniczenie znaczenia intensywności reakcji fizjologicznych towarzyszących im emocji może powodować ograniczenie ich istotności dla człowieka. Ważne jest również to, że każdej emocji towarzyszy zachwianie równowagi fizjologicznej.