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SEEKING NEW METHODS OF MENTAL TRAINING IN SPORT

Key words: biofeedback, electroencephalography, tennis, mental training.

ABSTRACT

Seeking new methods of development of athlete's unique functional coordination of the psyche and the body is one of the most important tasks of the training process in contemporary sport. Composite control systems based on application of the latest information technology in order to gain the optimal feedback between the athlete's mental state and his/her efficiency of actions have been recently widely implemented. An example of such system is the electroencephalographic feedback (EEG) which enables information to reach the athlete's mind, based on feedback and representation of the body's biological activity. Regulative activities undertaken by athletes are submitted to mental processes and are understood as attempts to become aware of these processes regarded as naturally automatized, e.g. breath regulation, muscular tension, temperature or sensual orientation. Moreover, the athlete becomes aware of his or her state of mind in order to achieve the desired level of concentration, attention or relaxation (mental training). The NeuroHarmony system was applied in order to measure and analyze the above mentioned processes. This study shows how the system works and describes preliminary results of its implementation in tennis.

INTRODUCTION

The development of athlete's unique functional psyche-body coordination is one of the most important tasks in contemporary sport training [10]. Biofeedback appears to play an important role in this process. In professional training biofeedback is a new method based on modification-regulation of the athlete's own body functions to achieve the optimal level of activity – concentration, attention, relaxation, etc. Undertaking regulative activity is submitted to mental processes and is understood as an attempt to become aware of these processes regarded as naturally automatized, e.g. breath regulation, muscular tension, temperature, or sensual orientation. The development of this awareness is possible thanks to the information reaching the athlete's mind, based on feedback and illustration of the body's biological activity. The information is collected and processed using highly accurate measurement techniques. The essence of biofeedback is presented in the diagram below (Fig. 1).

Information processed by way of biofeedback most often includes:

- muscular feedback – concerning the athlete's bioelectrical muscular activity measured in micro volts;
- thermal feedback – concerning measurement of the athlete's body temperature;
- electrodermal feedback – concerning measurement of bioelectric conductance changes in different parts of the athlete's body;
- cardiovascular feedback – based on heart rate and blood flow measurement;
- electroencephalographic feedback – based on information on brainwaves (alpha, beta, gamma, delta, theta) or the brain's functional currents.

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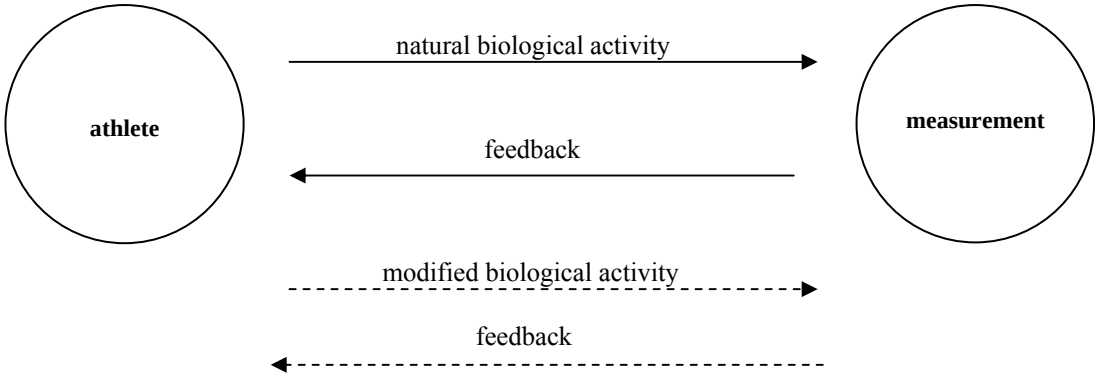


Figure 1. Schematic representation of biofeedback [1]

The last kind of regulation systems depends on figurative transmission of information about the athlete's brain activity. It is based on a well-known principle in electroencephalography which stipulates that unique patterns within brain activity (brainwaves) are strongly related to different psychical states, for example, relaxation, attention, concentration, self-control, etc [11]. In sport, each of such states may decide about the competitor's peculiar adaptation to the specific situational requirements connected with rivalry, training or post-exertion restitution [4, 1]. An ability of self-gaining the desirable effect at a given time based on appropriate exercises would be perfect for any athlete. As it appears, the biofeedback method can be applied in directional exercises.

METHODS

On the basis of results of long-term studies of the conditional reactions theory and instrumental conditioning theory [5] the principles of neuro-technology were first defined. Until recently, because of technical limitations, e.g. lack of access to personal computers, the area of neurotechnology has remained practically unexplored. Nowadays, thanks to information technology self-regulation within the athlete's mental sphere has become more and more available. The cooperation of medicine and psychology in the field of engineering has enabled development of new systems of neuro-regulation. In our work we took advantage of NeuroHarmony which is a perfect example of such system. This particular method is based on examination of brainwaves and their relatively easy control in any time or place, forming unique conditions for mental training in sport. Different types of the system can also become very useful in other areas of science [2, 3].

NeuroHarmony has been specially designed for four areas: meditation, health, education and sport. In the last field it was applied in studying the ability of regulating and enhancing concentration. It is generally accepted that concentration is often highly connected with peak performance in sport, and among other features, it seems to be an important factor influencing the quality and efficiency of service in tennis [6, 8, 9]. The research apparatus (Fig. 2) consisted of a compact encephalograph with a special screen which allowed the possibility of conducting neurofeedback-based mental training.

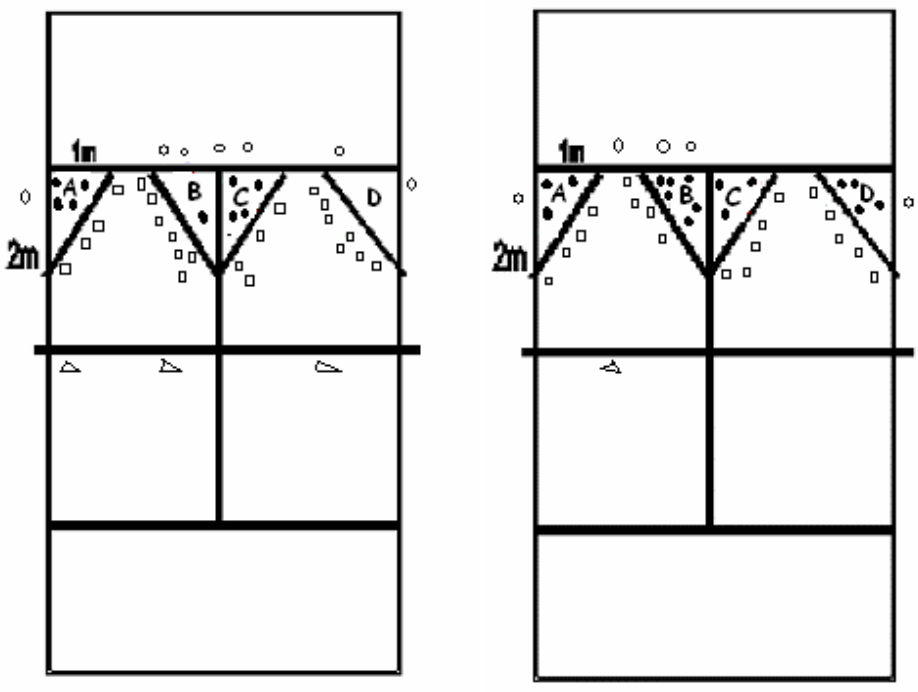
Figure 2. NeuroHarmony apparatus

Brainwaves are delivered using electrodes placed in a special band wrapped around the athlete's head. A special system transforms them into graphic or sound signals. In this way a tennis player under study receives information about his or her body's natural biological activity as well as about effects of the undertaken self-regulatory activity (neurofeedback) in enhancing concentration. During mental training the athlete's task was to control his thoughts (mental training) to maintain the state of concentration for as long as possible. The image on the screen as well as the sound signal emitted by the earphones determined the criterion of proper effects in training.

The NeuroHarmony apparatus for regulation of concentration in professional tennis players was used in the study. The study consisted of two different experiments. In the first experiment a 21-year-old male tennis player and 19-year-old female tennis player took part. The experiment had two stages. Stage I included a serve test [7] consisting of delivering successful hits against marked target areas (A, B, C, D) (Fig. 3). Each tennis player completed forty hits – ten at each area. The exercise was a regular component of tennis training. Stage II was based on execution of the identical task following participation in eight sessions of neurofeedback mental training. The scores achieved by the subjects in both stages of the experiment were then compared.

In order to verify the influence of neurofeedback on effectiveness of sports actions in tennis a second experiment was carried out using ten NeuroHarmony mental training sessions during one training cycle. After the second experiment the classification changes concerning the subjects' place on the ranking of the Polish Tennis Association (PZT) were assessed.

Mental training was incorporated into the tennis training program in March 2006 at a sports camp. Two 16-year-old professional tennis players took part in the study.



Stage I before mental training

Stage II after mental training

Figure 3. Serve test results achieved by the male tennis player (first experiment). Ball marks: ● Serve into control area A, B, C and D; ▯ Serve into the supplementary area; ○ Serve out; △ Serve in the net.

RESULTS

In the first experiment, during Stage II, the male player scored nine hits into the control areas. During the II stage, following mental training, the player scored 16 hits. The difference was 7 hits. Figures 3 and 4 show detailed information on the player's scores in the two stages of the experiment.

The male tennis player improved not only his accuracy, but also concentration of tennis passes following mental training. Similar conclusions can be drawn about the female tennis player's performance (Figures 5 and 6).

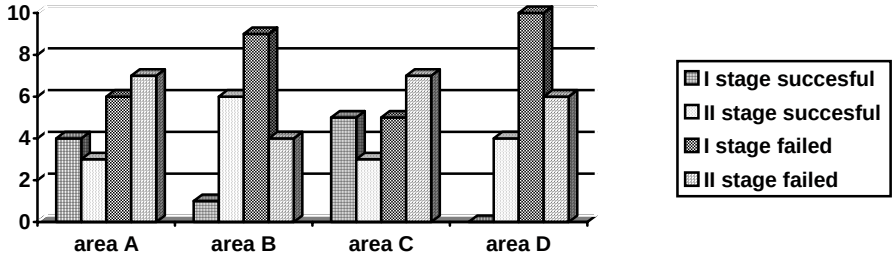
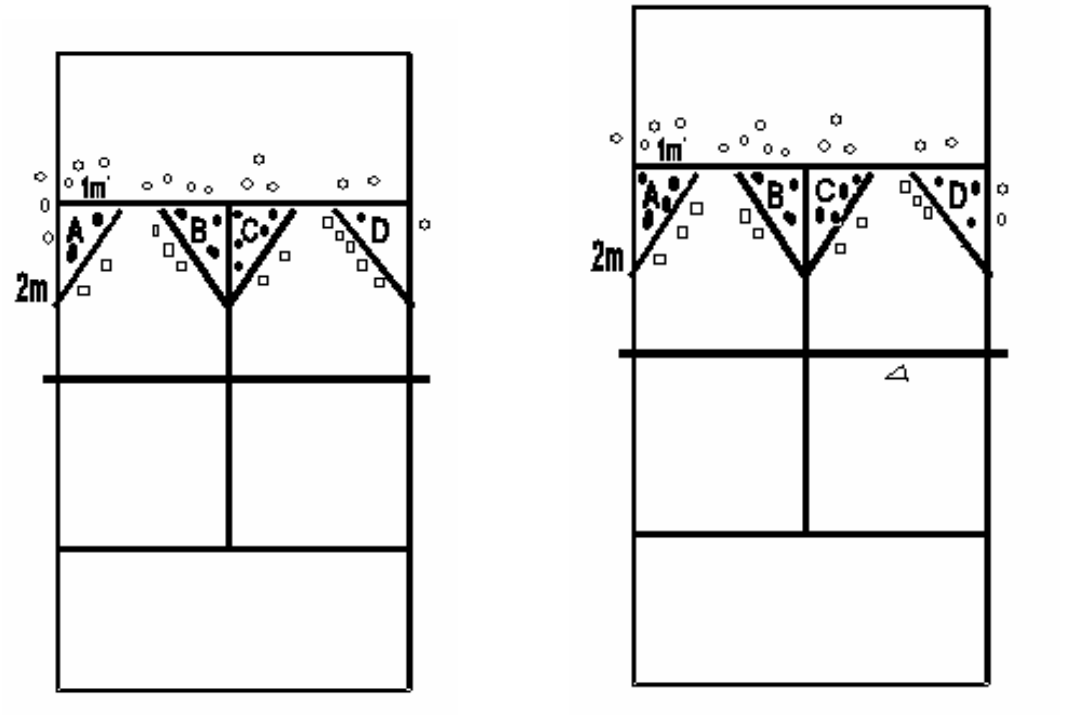


Figure 4. Accuracy of the male tennis player's service before and after mental training



Stage I before mental training

Stage II after mental training

Figure 5. Serve test results achieved by the female tennis player (first experiment). Ball marks: ● Serve into control area A, B, C and D; ▯ Serve into the supplementary area; ○ Serve out; △ Serve in the net

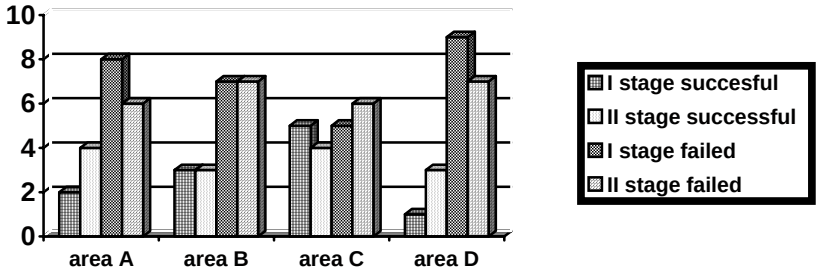


Figure 6. Accuracy of the female tennis player's serve test before and after mental training

In the first experiment, during Stage I, the female player scored 11 hits into the control areas. During Stage II, following mental training, she scored 14 hits. The difference was 3 hits.

The analysis of service accuracy of both tennis players during both stages of the experiment showed that after eight sessions of mental training focused on concentration enhancement their service accuracy improved. Therefore we can suppose that regular training using a neurofeedback-based method will positively influence the athlete' ability to concentrate and, in consequence, the efficiency of sport task performance.

Table 1 presents an analysis of general effectiveness of the tennis players who took part in the second experiment. The player's position on the PZT ranking list before and after mental training.

Table 1. Players' position on the PZT ranking list before and after training using the biofeedback method

Subjects	PZT ranking (place number)			
	Junior (below 18 years)		Senior	
	Before mental training	After mental training	Before mental training	After mental training
Player 1	61	14	223	170
Player 2	69	51	190	170

The ranking position of Player 1 following NeuroHarmony mental training moved up 47 places in the junior category, and 53 places in the senior category. Player 2 moved up 18 places in the junior category, and 30 places in the senior category. Considering the fact that the experiment was carried out on two 16-year-old tennis players, it can be concluded that the observed changes in positions on the PZT ranking list in the junior and senior categories were highly significant.

DISCUSSION

The analysis of the results shows that after mental training sessions the effectiveness of tennis service increased considerably. The supposition that neurofeedback-based mental training has a positive impact on the efficiency of the athlete's activity seems to be well-founded. We must not forget, however, that the above analysis concerns a single case study, although the results gathered during the research can be an incentive to continue the work on application of the biofeedback method in sport. It is also significant that the investigated player, independently of positive changes in his performance efficiency, also improved his self-control and ability to regulate his own psychomotor activity in a sport situation.

In the second experiment consisting of an analysis of changes of the players' positions in the PZT standings, a great improvement in the players' effectiveness was noted. In the junior category, Player 1 moved up from the 61st to 14th place on the list; whereas Player 2 from 69th to 51st place. In the senior category Player 1 moved up 53 places and Player 2 20 places.

The data presented above are one of the first results of a study carried out with the use of NeuroHarmony. Presently, on the basis of the attained experience, study proceedings will be modified in order to fully understand advantages of participation in mental training, conducted with the use of the latest methods based on neurofeedback.

Conclusions:

1. The results of the study showed that mental concentration training using the neurofeedback method enhanced tennis players' service.
2. Inclusion of mental training with the biofeedback method into the tennis players' training greatly improved their overall effectiveness. This was reflected in changes of their positions in the PZT standings in the junior and senior category.
3. The gathered data give strong reasons for inclusion of elements of NeuroHarmony mental training into sport instruction.
4. The research should be continued in more numerous groups and diversified sport situations in order to confirm the observed positive changes in the efficiency of sport activity.

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