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THE VISUALIZATION CONTRIBUTION TO THE BRAIN ACTIVITY OF ATHLETES ENGAGED WITH CLAY PIGEON SHOOTING

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Keywords: *clay pigeon shooting, skeet shooting, target, visualization, ideomotor training, visual-mental rehearsal of the shot, trigger, brain's activation area, functional magnetic resonance brain imaging (fMRI), cerebral cortex.*

Abstract. It is shown that visualization or ideomotor training activates a certain shooters' brain area, located in a visual system of cerebral cortex.

ВКЛАД ВИЗУАЛИЗАЦИИ В МОЗГОВУЮ АКТИВНОСТЬ СПОРТСМЕНОВ, ЗАНИМАЮЩИХСЯ СТЕНДОВОЙ СТРЕЛЬБОЙ

Ключевые слова: *стендовая стрельба, стрельба на круглом стенде, мишень, визуализация, идеомоторная тренировка, зрительно-мысленная репетиция выстрела, спусковой крючок, зона активации головного мозга, функциональная магнитно-резонансная томография мозга (фМРТ), кора головного мозга.*

Аннотация. Показано, что визуализация или идеомоторная тренировка активизирует у стрелков-стендовиков определенную зону, относящуюся к зрительной системе коры головного мозга.

Topicality. A modern professional sport is based on deep scientific investigations of all its components: sport techniques, methodics, sportsman's psychology, equipment, buildings etc. Clay pigeon shooting – is a high-tech and multivariate kind of sport, which requires from an athlete a good combination of physical, psychological, mental and technical skills. Improvement of effectiveness in clay pigeon shooting strongly depends on psychophysiological dominant, which makes it necessary to study shooter's motor control mechanism.

The aim. To estimate a possibility of determination of the active brain areas involved in athletes' firing by using a functional Magnetic Resonance brain Imaging (MRI scan).

Introduction. The human mind is capable to influence on subconscious regulation of vital processes and muscular activity via the central nervous system. A creation of neuronal connections in the brain and strengthening the existing neural connections is a physiological basis of visualization. The same mechanism takes place in the actual implementation of any movement or exercise. Visualization making it possible to set these neural connections without direct performance of movements and finally let the athlete get necessary skills (Porter).

Sport psychologists tried to understand the exact mechanisms of visualization affecting the performance of exercises. There are many hypotheses in sport psychology, but there is no a single unified theory, which fully explains the efficiency of constructing mental images.

The very first theory called psychoneuromuscular theory was suggested in 1894 by the British psychologist (Carpenter). According to this theory, the creation of mental images by means of nervous fibers causes muscular responses like in performing real movements. I.e. the mechanism of influence of ideomotor training is expressed by the fact that: nervous fibers are stimulated in the training process by means of a muscular potential whose impulse structure is corresponded by sensed or imagined movements.

Another well-known theory – is the theory of symbolic learning. It says that the effectiveness of training depends on the quality and brightness of mental images created by the central nervous system. Thus, learning takes place due to creation of the coding system that makes the athlete possible to strengthen neuronal connections and in future to make his movements and actions automatic.

A bioinformatics theory was developed by Peter Lang. According to this theory, visualization involves the activation of encoded stimuli and reactions (responses) which are stored in a long-term memory. In more recent studies (Taylor, 1995) the main attention was focused on the effectiveness of creating mental images as an important self-regulation skills (ex, the ability to set the goals, to plan and solve the problems, to regulate excitation and anxiety, to manage emotions effectively). Achieving success requires imagining the movements realistically. When bright and realistic images are made the central nervous system of athlete is ready to compete and becomes programmed for a success [6].

The clearest theoretical explanation of physiological mechanisms of ideomotor responses was given by IP Pavlov. He wrote: «It has long been noticed and scientifically proven that if you think about certain movement (i.e., you have a kinesthetic imagination), you perform it without noticing.»

Kinesthetic cells of cerebral hemispheres, excited by the movement from a periphery, can be stimulated centrally and send through a corresponding cell the impulse to the peripheral organs. When a weak electric current stimulation of certain points on the surface of a motor area of the cerebral cortex, strictly defined skeletal movements

appear. Consequently, a kinesthetic cell stimulated by certain passive movements, transmits a signal on performing the movement when it is stimulated not from the periphery, but centrally.

IP Pavlov noted that kinesthetic cells can communicate with any other cells (aural, gustatory, etc.) and the process between them can «move back and forth.» By virtue of the link between kinesthetic cells of the motor and other analyzers, visual perception of objects and perception of speech cause revival traces of the whole system of temporary connections in the motor analyzer, corresponding to the system of the previously performed movements. As a result, a mechanism of central stimulation of the kinesthetic cortex cells gives imagination of these movements. The excitation of kinesthetic cells spreads to the cells of the motor, speechmotor and other analyzers from which the impulses are transmitted to motor neurons, and further – to muscles causing the corresponding external reactions.

Thus, ideomotor act is based on motor imaginations [4]. In doing so, not only unconsciously arisen, but also deliberately induced imaginations turns to micromovements. This re-conscious kinesthetic excitation of certain cells for both real performance and its imagination amplifies neuronal communications that, promotes a more rapid creation of motor stereotype.

According to IP Pavlov on the first and second signaling systems, the mechanisms and features of trace events in the form of the ideomotor act in the motor analyzer were detected.

Based on AA Ukhtomskii about a dominant, stimulation of kinesthetic cells in the cortex, which associated with motor imaginations, can be characterized as a dominant center, which is amplified and reinforced by additional muscle impulses because of micromovements, which occur in the ideomotor act. Symbolically-reflected nature of ideomotor reactions is confirmed by the results of a number of electroencephalographic (EEG) investigations. In doing so, the ideomotor can be represented as a closed ring of the chain of isorhythmic reactions. A central excitation of the motor area of cerebral cortex causes muscular micromovements and proprioceptors excitation arised becomes a source of peripheral impulses into the cerebral cortex. Thus, there are four main elements of the ideomotor act mechanism:

1) Preliminary motion perception and stimulation of kinesthetic cells associated with it;

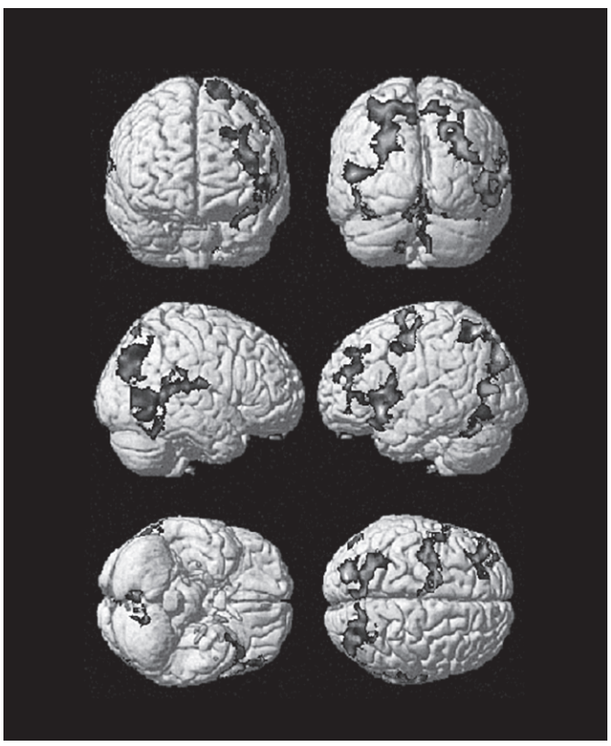

Fig. 1. Activation areas of athletes

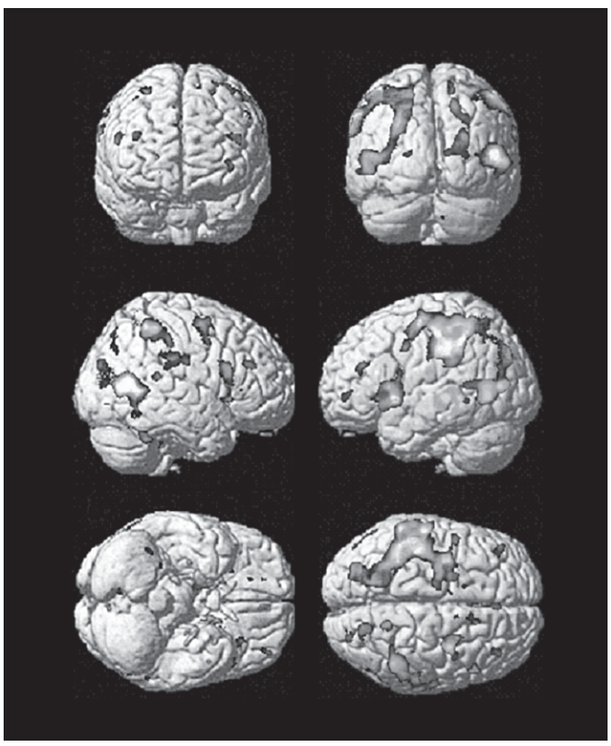

Fig. 2. Activation areas of untrained people

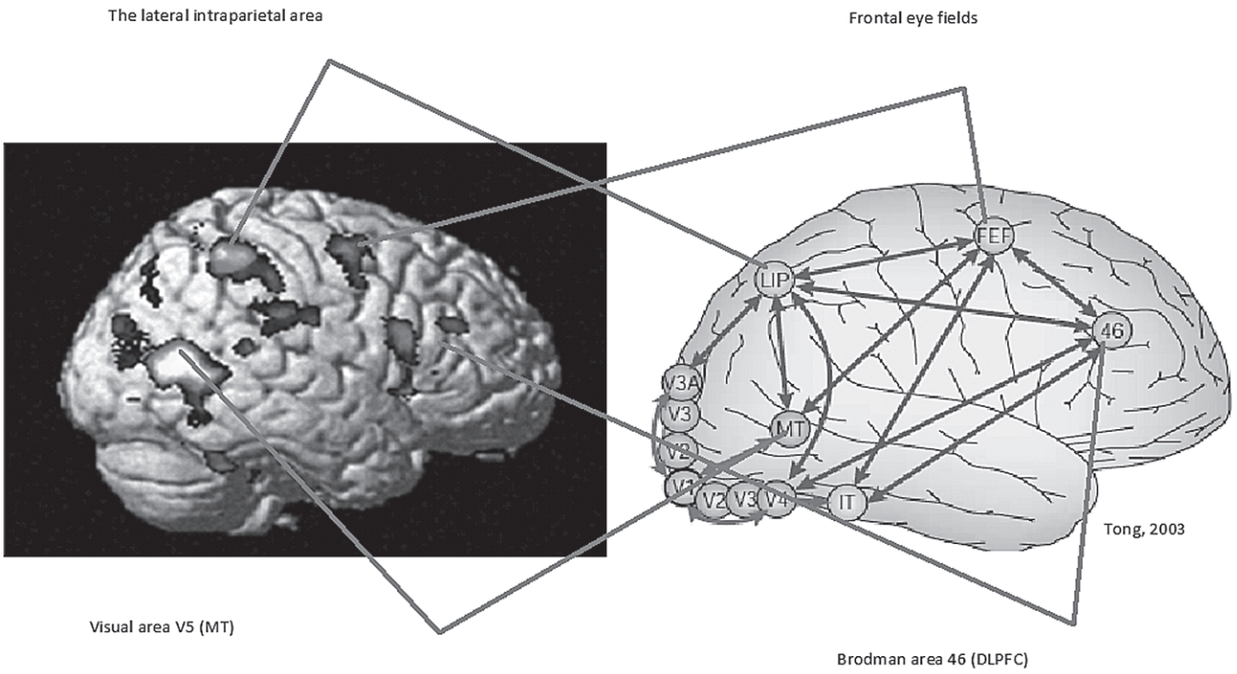

Fig. 3. The scheme of visual areas of athlete's cerebral cortex according to the fMRI data

2) The appearance of the image of motor imagination and excitation, which is similar to the one, that took place in the perception;

3) The excitation in motor cells arising based on their temporal relationships with kinesthetic cells;

4) The excitation transmission to muscle and response reaction.

According to neurophysiology, a training effect of imaging is a consequence of strengthening of the certain bonds in the functional dynamic system with multiple mental implementation of the certain actions like it happens while multiple practice. Consequently, the training effect of imaginations related to a reinforcement of the motor dominant in the nerve centers as well as with the additional influence of the afferent feedback, arising in the real movement.

Overall, all these facts show how strong motor imaginings influence on changing the functional state of multiple human body systems. The results obtained after imaginings are similar to the ones obtained after real perception of the objects, things, events, feelings, actions and movements [5].

The experiment. At the first stage, we conducted a computer research of the brain activity [2] while firing visualization (when observing a movement trajectory of a yellow circle on the target field, mentally making a shot at the moment of it's passing through the center of the target field). A studied group consisted of 26 people: 17 athletes, who professionally engaged with clay pigeon shooting (9 masters of sport and 8 one and two rated athletes) and 9 untrained people.

At the second stage of research, the cerebral cortex was scanned by firing imitation with the use of shotgun layouts. The target was displayed on the screen like in the first stage. In doing so, a yellow circle moved with different directions and speeds. At the moment of it's passage through the center of the target, it was necessary to make a shot (to pull the trigger).

Our research was conducted in the Russian State University of Physical Education, Sport, Youth and Tourism (GTSOLIFK). For Magnetic Resonance brain Imaging (MRI scan) it was applied Siemens Magnetom Avanto, 1.5T. The subsequent processing of obtained data, individual and group analysis, as well as comparisons between groups were performed by SPM8 based on MatLab [3].

Discussion of research results. Results of the experiment showed that the functionally important brain areas involved in the act of firing for both untrained people and athletes are:

- The left fusiform gyrus
- The right axillary gyrus (BA 33)
- The left upper parietal gyrus
- Left precuneus
- The left middle occipital gyrus

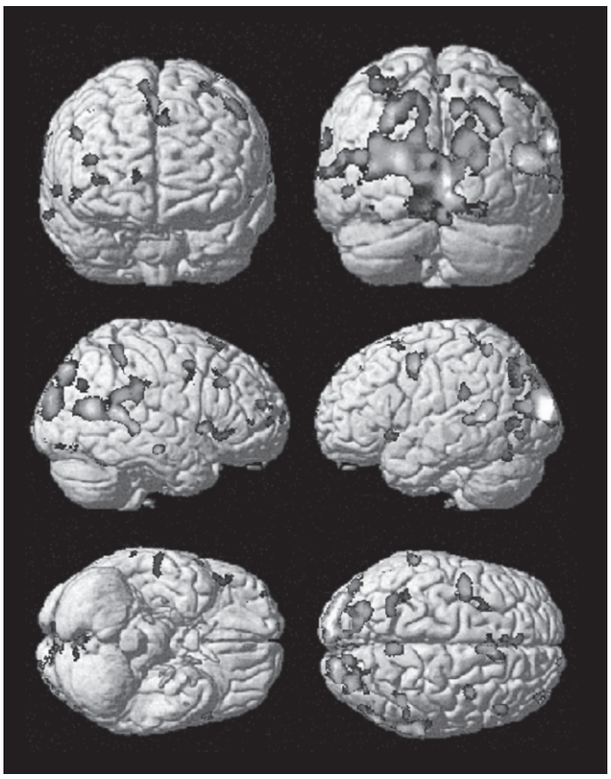

Fig. 4. The activation areas of athletes (when firing visualization) who include visual-mental rehearsal of the shot into the training process

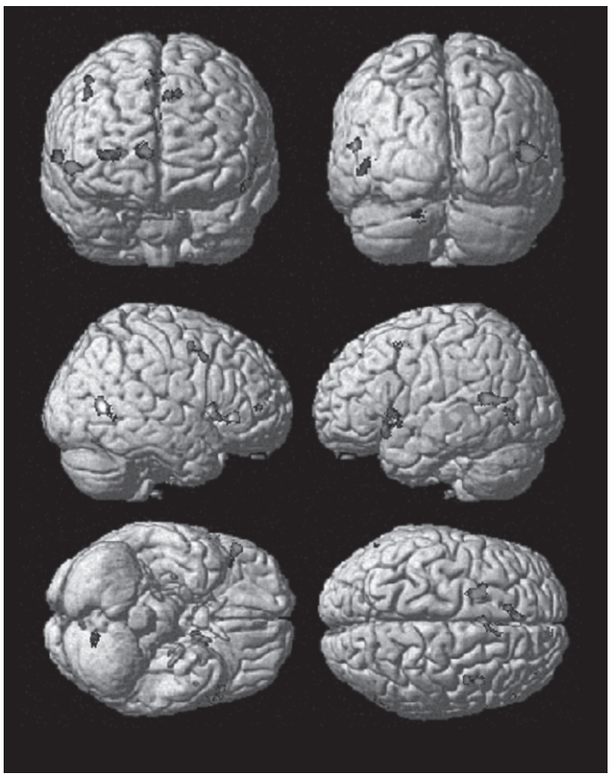

Fig. 5. The activation areas of athletes (when firing imitation with the use of shotgun layouts) who include visual-mental rehearsal of the shot into the training process

- The left middle frontal gyrus
- The triangular part of the inferior left frontal gyrus (BA 10)
- The right middle occipital gyrus
- The left precentral gyrus (M1)
- The left supplementary motor area

Activation areas of athletes and untrained people in resting state (when observing a movement trajectory of a yellow circle on the target field without firing imitation) are represented in the figure 1 and 2.

When fMRI research, firing imitation made it possible to discover increasing of activities in the four brain areas (figure 3). Moreover, the 'X' area activation differs athletes from untrained ones. This area is located in a visual system of cerebral cortex.

The main areas involved in a visual perception of shooters when firing:

- The lateral intraparietal area – is responsible for visual-spatial attention and eye movement planning;
- Frontal eye fields – has close links with the previous area and plays an important role in visual attention and eye movements. Stimulation of this area causes saccades;
- Visual area V5 (MT) – is the secondary area of visual cortex responsible for motion perception;
- Brodman area 46 (DLPFC).

The scheme of visual areas of athlete's cerebral cortex according to the fMRI data is represented in the figure 3.

It was previously shown [1], that to improve effectiveness in clay pigeon shooting, the visualization or visual-mental rehearsal of the shot must be included into the athlete's training process. Therefore, the athletes, who include visual-mental rehearsal of the shot into the training process, were investigated in more details. The greater athletes' activity we identified in the 'X' area, which differs professionals from untrained ones. The activation areas of athletes (when firing visualization and when firing imitation with the use of shotgun layouts) who include visual-mental rehearsal of the

shot into the training process are mentioned below (figures 4 and 5).

- Front areas of the right middle frontal gyrus
- Rear areas of middle frontal gyrus, passing into the precentral gyrus
- The supplementary motor area
- Occipital gyrus
- Upper and middle temporal gyrus on both sides
- Upper parietal gyrus
- The precuneus
- Front areas of the right middle frontal gyrus
- Rear areas of right middle frontal gyrus, passing into the precentral gyrus
- The supplementary motor area
- The left upper frontal gyrus (prefrontal cortex)
- Right and left middle temporal gyrus
- Triangles of inferior frontal gyrus on both sides

Conclusion

1. Shooting visualization in the training process of athletes activates the certain areas of brain.

2. The activation brain area, which differs shooters from untrained ones, was determined.

3. We need to conduct extra researches making it possible to establish a clear correlation between brain activity and the effectiveness of shooting exercises.

4. Stimulation methodics, leading to much more rapid development of the abilities in the clay pigeon shooting are being designed.

References

1. Ambartsumov N. A. Psihologicheskie aspekty povisheniya resul'tativnosti v stendovoy strel'be (s uchetom vizualizacii) / N. A. Ambartsumov, A. N. Bleer, M. G. Pokotilo. – Moscow: Extereme activity of human, 2013. – №3(28). – p. 39-42.

2. Donaldson D. I., Buckner R.L. Effective paradigm design. In: Jezzard, P., Matthews, P. M., Smith, S. M. (Eds.), Functional MRI, an Introduction to Methods. Oxford, Oxford University Press; 2003.

3. Statistical parametric mapping (Welcome Trust Centre of Neuroimaging, London, UK).

4. Belkin A. A. Ideomotornaya trenirovka v sporte / A. A. Belkin. – Moscow: Physiacal culture and Sports. 1983. – 256 p.

5. Kandiba V. M. Psihicheskaya samoregulyatsiya / V. M. Kandiba. – St. Petersburg: Lan, 2001. – 448 p.

6. Surkov E. N. Psichomotorika sportsmen / E. N. Surkov. – Moscow: Physical Culture and Sports, 1984. – 126 p.