MANUAL KINETOGRAPHY AS AN INNOVATIVE RESEARCH METHOD OF ATHLETES' MOTOR ACTIVITY (CASE STUDY OF BOXERS, TOURISTS AND BADMINTON PLAYERS)

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Among all types of motor activity hand movements are the most important in human life. They offer a greater number of degrees of freedom compared with the movements of other body parts. In the system of movement regulations the hand movement regulation is the most difficult one. At the same time physiology of manual movements is less studied than physiology of more simple forms of motor activity. Perhaps, the explanation of this fact lies in the lack of methodical and methodological support of experimental studies in this area. The concept of levels of movement formation by A.N. Bernstein [1] is rarely used in applied studies and developments.

A new approach to the study of manual movements is suggested. It is usually assumed that the highest level of movements formation manifested in graphic movements is level E. In our project, the starting point is the provision stating that all levels of movement formation are reflected in graphic movements in varying degrees. By registering signs of the activity of different levels it is possible to get a complex picture of the organization of hand movements in different people and identify their typological features. One can study the functional asymmetries features at different levels of movement formation via the research of the right and left hands movements. At the same time conducting psychological tests and comparing physiological data with psychological tests one can obtain the characteristics of man's psychophysiological type and his psychophysiological state.

While searching, selecting and testing express methods of the human psychophysiological state diagnosis suitable for using in the field the manual kinetographic test "Spirals" has been developed. During its implementation, the testee, on four test forms, arbitrarily, without having an example, makes drawings of concentric spirals around the reference points and draws straight lines on top of them with his right and left hand consistently, with his eyes open and closed. Moreover with his eyes

open the spiral is drawn from outside to the center (reference point), and with closed eyes - from the center. The test runs for about 30 seconds.

There are three parameters defined on each of the forms during the chart analysis:

1. The direction of movement while drawing the spiral - clockwise or counterclockwise direction (to the right or to the left).
2. Direction in which a straight line is drawn - towards right or left.
3. The direction of the general shift (deviation) of the spiral turns relative to the reference point - towards right or left, which is determined by the location of the largest radius of the outer spiral turn to the right or left from the reference point.

The directivity of each parameter is estimated in points. The highest score for a subtest is three points. In two subtests for the right hand each direction to the right is estimated at one point, and in two subtests for the left hand each direction to the left is estimated at one point. For the four subtests the maximum possible total numerical score is twelve points.

This score is used as an integral parameter and is called the index of psychomotor externalism (IPE). The value of this indicator is used in the estimation of the tendency of movement directions of both right and left hands outwardly. The index of psychomotor internalism (IPI) is alternatively important, its value in points is determined by deducting the 12th value from the IPE. IPI reflects the tendency of hand movement direction inwardly.

On the purely physiological level externalism and internalism are primary provided by the activity of the hand extensor and flexor muscles. The provision that motor acts represent mental processes, and the graphic movements can characterize mental activity at various levels of its organization underlies the elaboration of this technique.

When considering the twelve parameters as a primary data of the four subtests it turned out that the patterns of the three direction parameters are similar in the subtests with open and closed eyes for each hand, but psychomotor "portraits" of the right and left hands are not to be considered inverted invariants. The testee's movements with open eyes belong to visual-motor activities and are heavily corticolized. Similar movements with eyes closed largely reflect the activity of subcortical levels of the movement organization and are more automated and involuntary.

The data obtained enables to classify the testees, dividing them into groups with strong externalism or internalism of either right or left hands or both hands, as well as groups with less pronounced externalism and internalism and an amorphous group.

According to the test results, thanks to the express nature of the method there can be seen relatively independent behavior of two psychomotor subindividuals - the right and the left ones in their interaction and dynamics. This opens up new possibilities in the field of kinesiology and psychophysiology researches.

The E. Mira-Lopez's method should be noted among the analogues of the project. Common to the both tests is the cyclicity in the nature of graphic movements of the right and left hands and that the deviation in the movements is used to evaluate the test results. The principal difference is that during the Mira-Lopez's test the movements are set by a standard and a testee must repeat them, while during the kinetographic test the movements are free and the situation of choosing the direction of movement arises twice in each subtest.

In the analysis of motor activity during the test from the standpoint of the N.A. Bernstein's concept of levels of movement formation the deviation of cyclic movements to the right or left can be seen as a manifestation of lateralization at level B or at the synergies level. The directivity of the hand movements in a straight line to the right or left can be seen as a manifestation of lateralization at the level C or at the spatial field level. The directivity of the hand movement to the right or left at the beginning of a complicated spiral pattern can be regarded as a manifestation of lateralization at level A or at the level of tonic regulation when a spontaneous choice of the hand movement direction is determined by the ratio of muscle tone (hand flexors and extensors). At the same time, in the subtests performed with eyes open there is a manifestation of the substantive action level D. The use of manual kinetography gives the opportunity to study the functional asymmetry of the right and left hand movements on three levels of movement formation.

Thanks to the presence of a writing tool in the testee's hand the method of manual kinetography can be considered a new instrumental method in kinesiology with a view to its implementation on the graphic tablet. The study of the efficacy of externalism-internalism indicators has been following the path of comparing them with other psychological and physiological techniques during integrated studies. There is an experimental material composed of several thousands of graphic images of hundreds of testees.

The purpose of the study was to make an express analysis of the relative level of manifestation of arm motor activity at the levels A, B and C in athletes specializing in boxing, tourism and badminton.

Results and discussion. In our work we presented only the results of comparative kinetographic studies involving athletes from three sports - boxing, badminton and tourism. In these sports an important role is played by hands movements of different nature. In boxing the movements of both hands are similar, but clearly one of the hands is leading. In badminton, one hand performs instrumental movements, and another one - supporting, the role of which is not entirely clear. Often these are the associated movements. The activities of tourist-athletes are associated with the ability to use their hands when working with ropes, climbing equipment, packing a backpack, rowing, setting camp, picking up firewood and maintaining fire at the encampment and so on. The nature of these movements is close to everyday ones, but a common set of manual skills greatly exceeds the skills of non-tourists.

Kinetograms (drawings of spirals) of a hundred first-year students engaged in boxing classes was subject to processing, examination and comparison, including 50 students of the tourism instructor school and active hikers as well as another 25 first-year students engaged in badminton classes. Externalism indicators in points: or - right hand with eyes open; ol - left hand with eyes open; cr - right hand with eyes closed; el - left hand with eyes closed; A, B and C - levels of movement formation. The points percentage in groups was calculated to compare three groups of athletes in each of 12 indicators. That is, the average values of points were turned into percentages. Thus, group profiles of the external motor activity have been obtained.

The data is presented in Tables 1, 2, 3.

Table 1. *Profile of boxers' external motor activity (values in %).*

Values												Average
orA	orB	orC	olA	olB	olC	crA	crB	crC	clA	clB	clC	
34	49	**77**	58	55	66	58	62	64	**75**	59	70	61

Table 2. *Profile of tourists' external motor activity (values in %)*

Values												Average
orA	orB	orC	olA	olB	olC	crA	crB	crC	clA	clB	clC	
46	54	**90**	46	64	54	60	60	**82**	52	52	**70**	61

Table 3. *Profile of badminton players' external motor activity (values in %)*

Values												Average
orA	orB	orC	olA	olB	olC	crA	crB	crC	clA	clB	clC	
52	44	**84**	68	68	**80**	60	60	**80**	**72**	48	**76**	66

When considering the data obtained first of all there is a primarily evident trend of the increasing external lateralization of movements from the A level of movement formation to the level C. In case this turns out to be a general law, we would be able to find an important fact in the physiology of movements. When considering the average values it seems surprising that boxers and tourists (61) have the same level of them and badminton players (66) have an increased one. This may indicate the special nature of badminton players' general motor activity.

The high value level for the right hand with eyes open on the third level C is logically clear for all sports. (77, 90, 84).

Boxers are distinguished by the high level of external tonic (Level A) activity of the left hand (75). You can add to this that rated athletes have this value at 90%. It might be the indication of the special role of the left hand in boxing. Badminton players also have a sharply increased level of values of this

parameter, however the externalism at the C level of both left and right hands is dramatically increased (80, 84). In tourists we observe a pronounced functional asymmetry at the C level between the right and left hands with the natural dominance of the right hand (90-54). At the same time the externalism values of the left hand at the C level with eyes closed are higher than those with eyes open (70 and 54).

Conclusion. The findings show the capacities of the new method of research of athletes' motor activity and reveal the perspectives for using manual kinetography in the tasks of qualification, estimation of competitive fitness and assessment of athletes' individual style. The individual profile of man's externalism in 12 indicators, along with other physiological indices, is volatile and has a relatively stable configuration.

It is for the first time when both a physiologist and a trainer can easily observe the fine internal organization of motor activity of athlete's arms using the method of manual kinetography.

References

1. Bernstein, N.A. Physiology of movements and activity / N.A. Bernstein. – Moscow: Nauka, 1990 P. 373-392. (In Russian)

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Here is the description of the new instrumental method of the study of athletes' hand movements according to the features of the graphic movements. The resulting data is interpreted in view of the levels of movement formation by A.N. Bernstein. There has been shown a possibility of the express analysis of the relative degree of manifestation of manual motor activity at the levels A, B and C in athletes specializing in boxing, badminton and tourism.