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THE COMPUTERIZED AQUA-TOW THROUGH THE NEUROMUSCULAR MECHANISM

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Abstract: *In the practice of sports training the use of traditional and non-traditional technical means has proven to be effective. The application of non-traditional means, such as the aqua-tow in swimming, allows to create regimes for performing exercises or basic elements, inaccessible in natural conditions. This fact creates the possibility of preventing errors and increases the probability of obtaining higher indices of the most important characteristics: rhythmic structure, the force-speed movements' component, the programmed result etc. At the same time, the planning of the work program under such conditions requires an argument and the obtained results an analysis of the neuromuscular mechanism of the motor skills.*

Key words: *sports training, technical means, swimmer, neuromuscular mechanism, motor skills.*

1. Introduction

It is known that the development of a muscle force depends primarily on two factors: the size of exceeded resistance and the number of repetitions. However, the type of resistance defeated by the muscle, either body weight or frictional force does not matter, etc.

Carrying out the exercises for the special physical training of a swimmer, when the paddling movements are performed by muscle groups, it is important that the work of each muscle is carried out according to inter-muscular structural coordination, which takes place during maximum-speed swimming. Formation and training legalities of the motor activity are "convincing", and the practice "confirms" that they cannot be swimming performances if the muscle force development takes place without the recording of their correlation during the fulfillment of a competitive exercise.

This position should largely result in the selection of the most effective means of special physical training of a swimmer. Using the instrumental methodologies in the study of paddling movements of the arms, in each type of training exercises carried out on land and in water, a particular model of kinematic and dynamic specificities and intramuscular co-ordination links are emerging. Moreover,

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with increasing resistance to "hand" during the paddling movement, the biodynamic specificities of several swimmers tend to change despite their individual differences in the sport mastery [3].

In turn, studying the specificities of support reactions during swimming and in imitational land exercises, it is certified that the specificities of exceeded resistance require a certain imprint on the biodynamic structure of the action performed. Therefore, the movements of a human, however complicated, could still be broken down into groups or motion schemes that are memorized in the sensitive-sensory area in the form of sensitive-sensory engrams (imprints) of motor movements. The sensory engram shall be formed and drafted particularly by a repeated proprioceptive multicultural feed-back that performs the servo-mechanism. Due to engrams, desired movements are performed and at the same time, the synapses that do not need to enter the desired movement schedule are inhibited [10]. Karel Bobath said: "Every motor engram is a way of excitement surrounded by a wall of inhibition" [1].

It should be also noted that during maximum-speed swimming, the electrical activity of muscles is more concentrated than in the exercises performed on land, developing the same impulse of force [4], [10].

There is also a divergence in the training exercises between the engrams of muscles' "connection" and the order of their "disconnection" from work, when the change in the resistance indices during the paddling movement does not correspond to the conditions of the sportsman's hand interaction with the aquatic environment, as well as the beginning, and the asynchronous end of their excitement [2].

Thus, paddling movements made on land, with the bent body position, often are accompanied by relative stiffening of the muscles of the trunk compared to real swimming conditions. In this case, the increased neural impulse and effort is taken over by other muscles. The confirmation of the fairness of the facts found are studies in which the lowest changes in the initial position have been shown to lead to visible changes in the manifestation of muscles' force [3], [10]. These changes also entail changes in the execution of motor actions. A positive effect in preventing and eliminating serious distortions in the motor actions technique shall be obtained by means of traditional and non-traditional special technical means facilitating the execution of movements, and shall allow for a more accurate and faster separation of the sensations necessary for the kinesthetic relapse [7], [12].

The measure of the muscle's electrical activity in different efforts confirms the reasonability, on the one hand, of achieving more active muscle excitement compared to its degree of contraction in the competitive exercise, and on the other hand — that such excitement should be as short as possible in duration, i.e. each muscle or muscle group shall develop a greater pulse of force, but shall however run in a shorter impulse regimen. This provision links well with a series of researches dedicated to the problem of improving sports movements [8], [11].

Thus, taking into account the neuromuscular mechanism and the principles of biomechanics of home movements set out above, it appears to be an integral part of the application of non-traditional technical means of training, such as hydro-tugboat, which allows creating competitive exercises or specific basics that are unaffordable in natural conditions. Its constructive peculiarities, i.e. the towage of a swimmer with a scheduled speed, help to form the rational technique for carrying out the planned motor action. This makes it possible to prevent mistakes and increases the likelihood of obtaining higher indicators of the most important features: rhythmic structure, force-speed component of movements, scheduled outcome, etc.

This opens up the prospect allowing the development of muscles force potential and the enhancement of their impulsive connection in accordance with the principles of conjugation and urgent information in the special physical training of athletes under variability conditions.

About this the Professor. Macarenco L.P. notifies that individual deviations and changes are accepted in the swimming technique, but at the same time the permissible limits of such deviations are also set, which narrow once the phases and leading elements of such variant of the technique are concerned [9].

2. Objective

Therefore, the determination of the neuromuscular mechanism of paddling movements with arms, as an "effect" and an "aftereffect" of the high-speed towage of the crawl swimmer, has become the current objective of our research.

3. Results and Discussions. Material and Methods

To resolve the proposed task, an experimental research has been conducted by applying the computerized hydro-tugboat. Two homogeneous groups of subjects - experimental and witness, 10 athletes (category I-candidate) each, 15-17 years of age, were formed. In the pre-competitive phase, a towage process for athletes was used after a scheduled programme and was more than 10 per cent higher than the maximum possible for them. A mobile installation has also been constructed to record the swimming technique sequences on which the ThiEYE i60e "action" camera is attached, with the frequency of 60/120 cadres per second and the visual angle 115 ° with the underwater registration option, coupled with the mobile phone via the "live" Wi-Fi network to determine the video camera fixation angles, the video over water being recorded in parallel with another camera, with a frequency of 30 cadres per second.

According to the analysis of literature data and expert opinions, while exceeding high resistances, the electrical activity of ordinary muscles increases, but with it increases the excitation duration of each [author] muscle. From the development position of force qualities, this increase in muscle electrical activity during training exercises can be assessed positively, but the increase in activity time of each muscle during the motion cycle is reflected negatively on the development of swimmer speed skills. Therefore, the aim of our research was to optimize intra - and inter-muscle co-ordination, and to increase the degree of muscle tightening with the reduction of their time of excitation.

The initial and final results during a training exercise on rapid adjustment in the paddling phases with the arms in the 25 m segment are given in Table 1.

Table 1

The paddling phases with arms for crawl swimming technique in the experimental group over a distance of 25 m (rapid adaptation)

[s]	Paddling phase						Total paddling cycle [s]	Tempo [n/min]	Step length [m]
	Water entry, draining	Water grab	Traction	Push	Exit from water	Passing over water			
1. Originally (2 x 25 m)	0.19	0.24	0.13	0.25	0.05	0.33	1.20	50.42	2.01
2. Towage (2 x 25 m)	0.16	0.22	0.13	0.23	0.05	0.32	1.11	54	2.19
3. Final (2 x 25 m)	0.17	0.23	0.13	0.23	0.05	0.32	1.13	53.09	2.05

The data obtained (Table 1) confirm that urgent adaptive processes have been formed in the coordinating structure of paddling movements. Thus, the 25 m test shows that the time needed to carry out the basic phases of paddling is reduced. This confirms the theses set out above in terms of better muscle coordination, as during such a brief period muscle strength cannot advance so clearly from the account of fibers thickening.

Therefore, based on this argument, a basic pre-competitive phase experiment was conducted (3 weeks). As mentioned above, a programme for the application of the computerized hydro-tugboat has been developed and integrated in the preparation of swimmers.

By pedagogical remarks, using video sequences and the timer method, the speed parameters in the 25 m and force segment have been analyzed using the hydro-dynamometer [9] (Table 2).

Table 2

Comparative analysis of the level of initial and final motor training of performance swimmers (experimental group: n = 10; control group: n = 10)

Tests [s, kg]	**Lot**	**Initial testing**	**Final testing**	**t**	**P**
		$\overline{X_i} \pm m$	$\overline{X_f} \pm m$		
Crawl speed 25 m, s	**E**	12.36 ± 0.20	12.04 ± 0.15	2.282	P<0.05
	M	12.39 ± 0.29	12.19 ± 0.25	1.007	P>0.05
Traction force, kg	**E**	14.01 ± 0.42	14.78 ± 0.30	2.582	P<0.05
	M	13.30 ± 0.89	13.69 ± 0.95	0.552	P>0.05

Unconjugated samples:
n = 20; f = 18; for P - 0.05 0.01 0.001
t = 2.101 2.878 3.922

Conjugated samples:
n = 10; f = 9; for P - 0.05 0.01 0.001
t = 2.262 3.250 4.781

In initial speed testing, swimmers in the control group managed a result of 12.39 s, while swimmers in the experimental group achieved an average of 12.36 s being with 0.03 s behind those from the experimental group, but the difference between the two results was insignificant (P>0.05), an established fact by mathematical-statistical calculations.

It is notable that in the final testing the experimental group achieves a result of 12.04 s, with 0.13s above that of the control group, which obtained an average of 12.19 s. Compared to initial testing the difference between the final group test indices is significant (P<0.05).

By comparing the two final results with the initial ones, we see that both groups registered a significant growth in this test. The progress in final tests vs. initial tests can be explained by the fact that both groups of swimmers were in the pre-competitive stage at which swimming time usually improves, but the group following the force-speed development methodology achieved significantly higher growth than the traditional training programme group, which was significant (P<0.05) and insignificant in the control group (P>0.05).

Completely other results were recorded at the end of the pedagogical experiment, where the difference between the final results of the experimental and control groups was significant to this parameter. The experimental group achieved 14.78 kg and control results – 13.69, with a difference of 1.01 kg (P<0.05).

At the same time this "aftereffect", resulting from the maximum speed of movement combined with the maximum speed, i.e. the practice of variable training providing for an optimal combination of increased or reduced interaction with the external environment, is the full use of "fresh imprint" reactions in the nervous system [8]. These reactions have caused positive changes not only at the maximum swimming speed level but also specific, essential changes at the level of certain important stages of paddling with the arms (Table3).

The paddling phases with the arms in the 25 m crawl test - final testing Table 3

Tests [s]	Lot	Initial testing $\overline{X_i}$	Final testing $\overline{X_f}$	t	P
Grab	**E**	0.243 ± 0.0028	0.231 ± 0.0030	5.528	P<0.01
	C	0.245 ± 0.0030	0.242 ± 0.0025	1.263	P>0.05
Push	**E**	0.251 ± 0.0028	0.235 ± 0.0029	7.262	P<0.001
	C	0.253 ± 0.0029	0.249 ± 0.0025	1.894	P>0.05

Unconfirmed samples:
n = 20; f = 18; for P - 0.05 0.01 0.001
t = 2.101 2.878 3.922

Conjugate samples:
n = 10; f = 9; for P - 0.05 0.01 0.001
t = 2.262 3.250 4.781

Assessing these two forehead phases - grab and push, during the initial testing as well as in case of other tests, the achieved values were fairly close, indicating a very close initial level of preparedness (P>0.05).

In the final testing, there were better results in both groups, but in the experimental group, these were significant, with the growth rate being P<0.01 – water grab and P<0.001 – push.

The evident rise in the level of special physical training of swimmers detected at the end of the experiment should be seen, first of all, as a result of the formation of the rational structure of intramuscular coordination of arms movements in the process of special physical training of a swimmer.

4. Conclusions

At the same time, the materials of pedagogical observations allow us to conclude that the conditions created by application of the swimmer's body towage (up ahead) for his movement in water determines, to a large extent, the qualitative fulfilment of movements.

It can also be observed that the towage of the athlete, with a maximum speed, introduces some corrections and /optimizations in the process of forming the rhythm-speed basis of paddling movements with the arms.

Thus, the analysis of the materials obtained in the research process indicates that the efficiency of the special physical training of a swimmer may be further increased taking into account the rational improvement of the coordinating skills of the sportsman's neuromuscular system.

These positions better shape the cause of poor efficiency, sometimes even the damage of the use of technical means in the special physical preparation of a swimmer. This phenomenon occurs because the nature of the dynamic effort, predetermining the coordinating structure of the muscles' interaction, is very different from the interacting conditions of the sportsman's hand with the aquatic environment during high-speed swimming. So, the application of traditional and non-traditional technical means can be efficiently achieved, if it is largely in line with, or complements to, the legalities of neuromuscular mechanism.

References

1. Bobath, B.: *Adult Hemiplegia.* London. Heinemann Med. Books Ltd., 1970.
2. Gilev, G.A.: *Cercetarea experimentală a posibilităților de creștere privind eficiența pregătirii fizice speciale a înotătorului în baza folosirii instalațiilor de antrenament (Experimental study of the possibilities to increase the efficiency of special physical preparation of the swimmer through the use of training devices.)*. Teza de dis. dr. în șt. ped., - M.,1978. -173p.
3. Gilev, G.A.: *Metodologia pregătirii de forță-viteză a înotătorilor de mare performanță (Methodology of speed-strength training of highly qualified swimmers).* Dissertation thesis Phd hab. in pedagogical sciences, 1998, 268 p.
4. Golikov, N.V.: *Teorea reflectării și mecanismele activității nervoase (Theory of reflection and mechanisms of nervous activity)*. Ziarul de fiziologie URSS, 1970, T.56, № 4. p. 466 - 473.
5. Macarenco, L.P.: *Măiestria tehnică a înotătorului* (*Swimmer technical skill).* M.: FiS, 1975, 224p.
6. Melkov, Yu. V.: *Cercetarea structurii coordonării exercițiilor de forță din pregătirea specială a înotătorului și argumentarea aplicării lor* (*Study of the coordination structure of strength exercises in the special training of swimmers and the rationale for their use).* Autoref. dissertation thesis - PhD in pedagogical sciences. 1973. – 19p.
7. Rasch, P.J.: *Effect of position of ferearm on strength of elbow flexion.* The Research Quarterly, 1956, V. 27, p. 321-332.
8. Ratov, I.P.: *Problemele soluționării contradicțiilor în procesul de învățarea a mișcărilor și realizare a principiilor didactice (Problems of overcoming contradictions in the process of learning the movements and the realization of didactic principles).* Teoria și practica culturii fizice, 1983 Nr. 7, p. 40-44.
9. Sandu, Yu.B., Ivanyuk V.H.: *Măsurarea forței de tracțiune și a rezistenței hidrodinamice a înotătorilor* (*Measurement of traction and hydrodynamic drag of swimmers)*. Teoria și practica culturii fizice, 1986. №1. p. 12-14.
10. Sbenghe, T.: *Kinetologie profilactică, terapeutică și de recuperare (Prophylactic, therapeutic and recovery kinetology).* București. Editura medicală, 1987, p. 154-155.
11. Verhoșanski, Yu.V.: *Bazele pregătirii fizice speciale a sportivilor (Bases of special physical training of athletes).* -M.: FiS, 1988. 331p.
12. Wells, K.: *Kinesiology.* Philadelphia. W. Saunders Co., 1955. 516 p.