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Level of selected movement coordination abilities in different trainings periods in athletes Polish National Team of Traditional Karate

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Summary

Introduction. Traditional karate belongs to the family of martial arts of the Far East. The popularity of this discipline of sport increases continuously. According to some sources the number of those practicing exceeds 10 million people. Karate requires movements of various complexity, that is, manifestation of all three levels of coordination. Achieving technical proficiency and sport success demands the manifestation of all basic coordination abilities at nearly the highest level. In spite of their leading importance in this discipline of sport, no research in this vital matter has been undertaken so far. Therefore, the aim of the research was to: 1. Define the level of coordination abilities among the leading karate competitors. 2. Establish its variability during the yearly training cycle. 3. Search the conditions of the level of these abilities. 4. Compare this level among athletes practicing various martial arts.

Material and methods. The researches were conducted three times, with 13 competitors of the Polish national team, out of which many athletes have achieved considerable success at international arenas (European and World champions). The average age of those tested was 28. The following methods were applied in the researches: the measurement of the ability level for the kinaesthetic differentiation of the movement amplitude (with a kineasthesiometer), as well as the size of the muscle tension (with a tensodynamometer); global coordination and jumping ability tests of W. Starosta a test of static balance maintenance ability (posturography), and a questionnaire.

Results and Conclusions. 1. Among the tested competitors practicing 7 different kinds of martial art sports, karate competitors demonstrated almost the highest level of movement global coordination (x = 848°). Only seniors of judo, many of whom belonged to the world's elite, demonstrated a slightly higher level of coordination (by 8°). 2. The average arithmetical value of the 3 successive researches conducted every few months, did not differ much. It confirms that there are insignificant alterations in the level of coordination in the 10 month training cycle. Simultaneously, considerable differences of results among athletes was observed.

Introduction

Traditional karate belongs to a vast branch of Far East martial arts. The popularity of this sports discipline is constantly increasing. In accordance to some sources the number of people going in for this discipline exceeds 10 million. A karate training, which takes many years, comprises three parts (Fig. 1). The first one of them includes teaching a technique of exercises constituting a base of martial art (Kihon). The second part is based on executing a precisely determined combination of defensive and offensive exercises applied in a fight with a simulated opponent (Kata). The third part (Kumite) – fighting with a real opponent was developed in the form of a sports karate only in the twentieth century. Hence, karate requires the application of movements of different complexity, i.e. the displaying of all three co-ordination levels [1,2,3,4].

The three-stage way to championship is original and complies with the modern theory of teaching movements. This theory assumes in the first stage a precise execution of an exercise according to a model (first level of coordination), then an ability of tying this precision with a quick execution of movements (second level), and finally demonstrating a precision and speed of movements in changeable conditions (third level), which may take place during a fight with an opponent. What is more important, **traditional karate is not based on hitting the opponent in a precise place with a fist or foot, but rather „stopping" this movement just before the tar-**

get, i.e. rendering physical contact with the opponent impossible. This is a particularly complicated movement activity, which requires a precise portioning of movements in time and space. Such a perfect mastering of own movement abilities requires an exceptionally well directed and long term training.

Achieving success in karate requires the demonstration (Fig. 2), on almost the highest level, of all basic abilities, such as: a speed and adequate reaction, maintaining balance, differentiation of movements, spatial differentiation, rhythmisation of movements, relaxation of muscles, movements combination, adaptation (transposition), movement connection and symmetrisation. Despite the leading importance of those abilities in karate, very little number of scientific studies of this important problem have been undertaken yet [5,6,7,8]. Hence, the aim of these studies was as follows: 1. Determination of the level of coordination abilities in leading karate athletes. 2. Determination of its changeability in a 16-month training cycle. 3. Searching for interdependencies between the studied coordination abilities. 4. Comparison of the level of those abilities in athletes of various martial art sports.

Material and methods

The studies were conducted four times on 13 athletes of the Polish national team, of whom many have attained significant achievements on the international arena (multiple champions of Europe and world). The average age of the studied players was 28 years (it ranged from 21 to 36 years), and professional experience – 10.7 years (range of 3 to 18 years). In the studies use was made of the tests of global movement coordination and jumping ability of W. Starosta [4,9,10], measurement of the level of maintained static balance (posturography) [11,12,13], measurement of the level of ability in kinaesthetic differentiation of movement amplitude (by the means of a kinaesthesiometer), and of muscular strength (by a tensodynamometer), method of Schulte-Puni-Starosta [14,15], interviews.

Results

Level of coordination abilities

1. Ability of differentiation amplitude of movements

The test was based on executing by the tested athlete an assumed movement amplitude without sight control. It comprised two parts: in the first one the tested athlete was taught the assigned movement range, and in the second part the tested athlete was to repeat the learned and remembered task five times. The average summary error (results of the right and left hands) amounted to 77.6° (Table 1). Exceptionally small was the differentiation of results of the right hand and the left hand (r=1.4°). However, mean arithmetical values have hid a differentiation of individual results. In the majority of the tested athletes it exceeded 50%. The left hand was more precise in the majority of karate competitors. By multiplying this amount by the number of measurements taken (5 for each hand), we obtain a relatively small value of error (7.76°). However, in relation to results of tests of other competitors it was significant. Also significant was the differentiation of individual results (3.6° to 14.5°). The small precision of movements of the tested persons may be explained by an excessive training load, emphasised strength development, short breaks between successive lessons, inadequate regeneration by inappropriate proportions of exercises which are to develop form and co-ordination abilities.

2. Ability for differentiation strength input

For such measurements use was made of a tensodynamometer. The test comprised three parts. In the first one, the maximum strength was registered twice, and the best result

Table 1. Differentiation ability of level movement magnitude in start period by Polish national team competitors in traditional karate, n = 11

	Age	Measurement results of right hand (º)						Measurement results of left hand (º)						R+L SUM	x Errors
		I	II	III	IV	V	∑ errors	I	II	III	IV	V	∑ errors		
1	31	6	4	2	5	0	17	5	14	0	12	11	42	59	5,9
2	30	17	15	16	21	22	91	7	8	9	10	9	43	134	13,4
3	24	8	5	4	2	2	21	14	10	10	10	0	44	65	6,5
4	35	3	5	4	7	7	26	3	3	6	6	10	28	54	5,4
5	34	1	6	6	8	14	35	7	7	6	7	3	30	65	6,5
6	22	2	1	5	7	9	24	5	12	8	14	1	50	74	7,4
7	34	16	10	10	16	9	61	1	4	6	4	6	21	82	8,2
8	30	5	9	7	4	4	29	13	12	9	11	8	53	82	8,2
9	25	13	19	13	9	14	68	15	20	15	12	15	77	145	14,5
10	22	4	1	7	8	16	36	3	6	0	8	5	22	58	5,8
11	21	4	2	4	1	1	12	1	5	5	3	10	24	36	3,6
X	**28,0**	**7,18**	**7,00**	**7,09**	**8,00**	**8,91**	**38,18**	**6,73**	**9,18**	**6,73**	**8,82**	**8,00**	**39,45**	**77,64**	
S	**5,33**	**5,64**	**5,80**	**4,28**	**5,88**	**7,01**	**24,65**	**5,10**	**5,06**	**4,31**	**3,52**	**4,22**	**16,88**	**33,33**	

Table 2. Differentiation ability of level strength magnitude in start period by Polish national team competitors In traditional karate, n = 11

No	Measurement results of right hand (kG)							Measurement results of left hand (kG)							R+L SUM	x errors
	Max.	I	II	III	IV	V	∑	Max.	I	II	III	IV	V	∑		
1	21	-0,6	-0,4	0,5	1,3	0,1	2,9	22	0	0,2	0	0,4	-1	1,6	4,5	0,45
2	25	-0,1	-12	-0,7	-0,5	-0,7	32	26	-0,7	-0,7	-2,8	-2,4	-2,5	9,1	12,3	1,23
3	25	-0,9	-22	-1,3	-1,4	-3,3	9,1	25	-2,4	-0,7	-4,2	-3,2	-5,3	15,8	24,9	2,49
4	21	-0,3	-1,3	-2,1	-2,7	-3,5	9,9	21	0,1	0,2	-0,3	0,3	0	0,9	10,8	1,08
5	26	-0,8	-1,4	-0,6	-0,4	-1,5	4,7	255	0	0,1	0	0	-0,3	0,4	5,1	0,51
6	24	0	0,9	-0,2	0	-1	2,1	20	0,7	-1	0	-2,8	-0,8	5,3	7,4	0,74
7	35	0,5	0,3	-0,1	-12	-1,4	3,5	33	0,1	-2,5	-2,7	-2	-3,5	10,8	14,3	1,43
8	25	-2,5	-0,1	-0,9	-0,4	-0,1	4	19	1,9	2,1	0,9	0,2	-0,3	5,4	9,4	0,94
9	19	0,1	-0,9	-2,4	-1	-1,8	62	20	-0,2	-1,4	-2,3	-1,4	-0,3	5,6	11,8	1,18
10	24	-2,9	-3	-3,7	-3,5	-5,3	18,4	18	-0,4	-0,5	-0,3	-2	-0,6	3,8	22,2	2,22
11	17	-1,4	-1	-0,3	0,6	1,5	4,8	16	0,2	0,2	-0,1	1	12	2,7	7,5	0,75
X	**23,8**	**-0,8**	**-0,9**	**-1,1**	**-0,8**	**-1,5**	**6,3**	**22,3**	**-0,1**	**-0,1**	**-1,0**	**-1,1**	**-12**	**5,6**	**11,8**	
S	**4,7**	**1,1**	**1,1**	**1,2**	**1,4**	**1,9**	**4,7**	**4,7**	**1,0**	**1,0**	**1,7**	**1,5**	**1,8**	**4,7**	**6,6**	

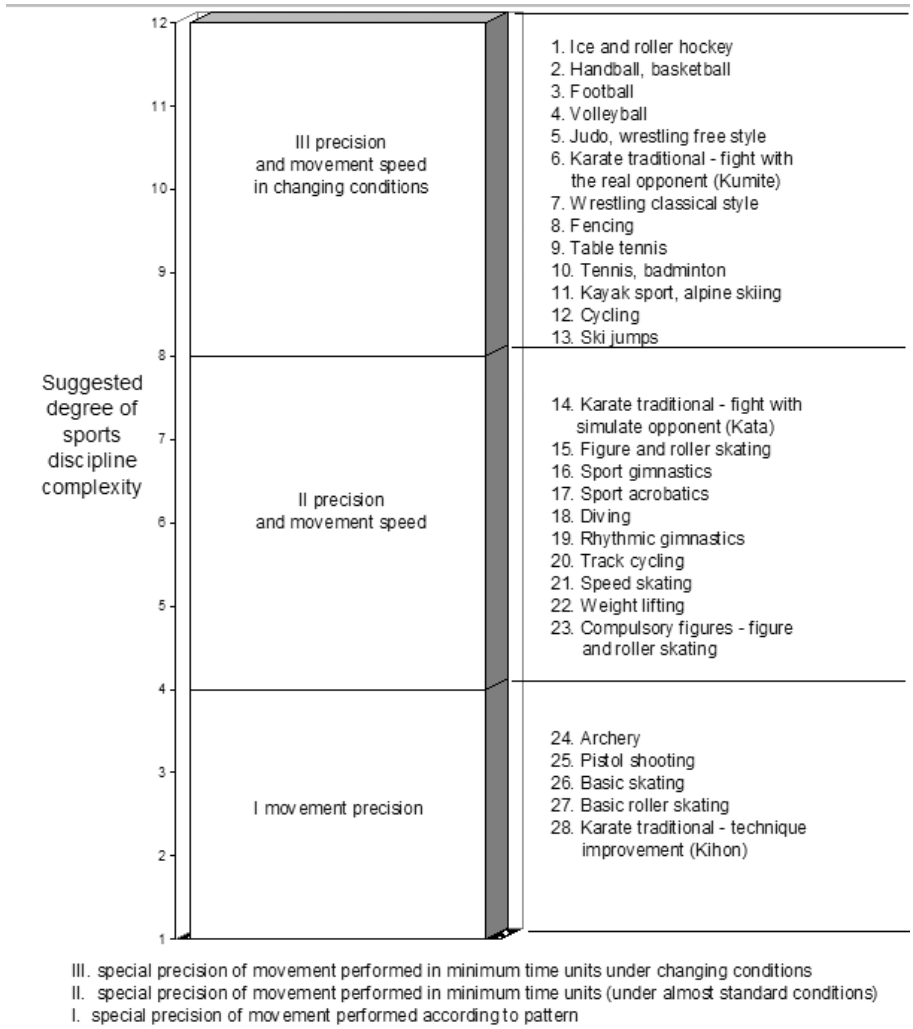


Fig. 1. Suggsted classification of selected sports disciplines according to their degree of complexity - coordination levels by W.Farfel [2] – interpretation of the concept W. Starosta

Table 3. Individual results of three kind measurements of static balance maintenance abilities in start period by Polish national team competitors in traditional karate (mm^2 and mm), n = 11

No.	Statokineziogramm – field areas developed			Statokineziogram – total length		
	Open eyes	Open eyes	Feedback	Open eyes	Closed eyes	Feedback
1.	954	1151	681	325	462	540
2.	309	331	418	198	207	320
3.	565	2216	518	408	620	467
4.	685	1474	481	315	537	381
5.	474	410	391	264	306	303
6.	378	844	685	223	352	408
7.	433	765	323	257	296	316
8.	397	2546	723	219	579	526
9.	405	1364	594	357	586	444
10.	1834	1634	590	347	502	491
11.	1184	1033	664	327	430	437
12.	524	1620	465	279	467	394
13.	639	682	365	321	442	339
x	**675,46**	**1236,15**	**530,62**	**295,38**	**445,08**	**412,77**
STD	**426,99**	**663,80**	**134,92**	**61,47**	**125,17**	**79,83**

was selected. In the second part, the tested athlete was taught three times to repeat a strength equal to 50% of the maximum strength of a particular opponent. In the third part, the tested athlete had to repeat five times the remembered 50% of his maximum strength. Summary results for the left and the right hands for 10 measurements indicated an error equal to 11.8 kg (Table 2). Slightly more accurate was the left hand (0.7 kg). An analysis of individual results has confirmed a better precision of movements of this arm in the case of 7 karate competitors. Mean arithmetical values have once again hidden significant lateral differentiation of limbs (which frequently exceed 50%).

3. Global movement coordination level – of the whole body

A global (synthetic) test of own concept evaluated simultaneously several coordination abilities: speed reaction, spatial orientation, maintaining of balance, movement differentiation and its rhythmisation, movement symmetrisation [16]. The measurements were carried out with the help of a coordinationmeter. The tested karate athletes have achieved an average result of 807o, with a rather significant differentiation of individual results (663o -976o), expressed by a standard deviation constituting almost 1/7 of it. Mean values have indicated the domination of the left turns (36o), which was not confirmed by an analysis of individual results (the majority of tested athletes has obtained better results in turns to the right) [4, 5].

4. Ability of maintaining balance

In the tests use was made of measuring devices comprising a tensometric platform connected to a computer, which was to register transferring the centre of gravity of the body. The test comprised three parts. In the first part, the ability of stabilising the point of gravity with the help of visual control was measured. In the second part, the stabilisation of this centre of gravity with closed eyes was evaluated. In the third part, use was made of feed-back, on the basis of which the tested athlete endeavoured to maintain the cursor in a square shown on the monitor through appropriate regulation of the tensometric platform. As it was expected (Table 3), a significant (50%) differentiation of results was observed in executing of the task with open eyes and with closed eyes (676 and 1236 sq. mm). An analysis of individual results indicated an insignificant differentiation of results of the execution of those two tasks in the case of some of the athletes (22 sq. mm), and in the case of a part of them – a significant differentiation (three- or even fourfold). **Those results seem to indicate that the ability of maintaining balance in karate competitors is closely connected with visual control. Without it, they most probably lose a lot of their technical and tactical values.** The high level of spatial orientation is demonstrated thanks to an ability of differentiating movements on the basis of kinaesthetic impressions, which function without visual control. Their development is favourable to the creation of „opponent feeling" [17,18] i.e. the distance to the opponent, ability of foreseeing his movements etc. Characteristic was the fact that the best results were obtained in feedback.

2. Changeability in level of coordination abilities

Repeated measurements of the level of global co-ordination during 16 months of training have indicated slight varia-

tions (Fig. 3) in various time intervals. This was significant from the statistical viewpoint between extreme results (10.44 – critical value 2.37 at 0.05), as well as between test results II and IV – 9.41, and between III and IV – 14.40. Characteristic was the individual differentiation of results in all tests, and particularly in test II and IV. It constituted almost 1/6 of the value of the mean result. **Those results seem to indicate that the selection of athletes for the national team is based on results obtained by the athletes during competitions.** And those results are a resultant of numerous conditions among which the tested type of coordination constitutes one of the more significant requirements, but not the exclusive one.

3. Interdependence of coordination abilities

When evaluating the level of balance applied were three tasks. The highest correlation has taken place between the execution of the task with closed eyes and with feedback, however, it was statistically insignificant. Moreover, a dependence was sought between the area of developed surface and the total length statokinaeziogram in all the three tasks. In the majori-

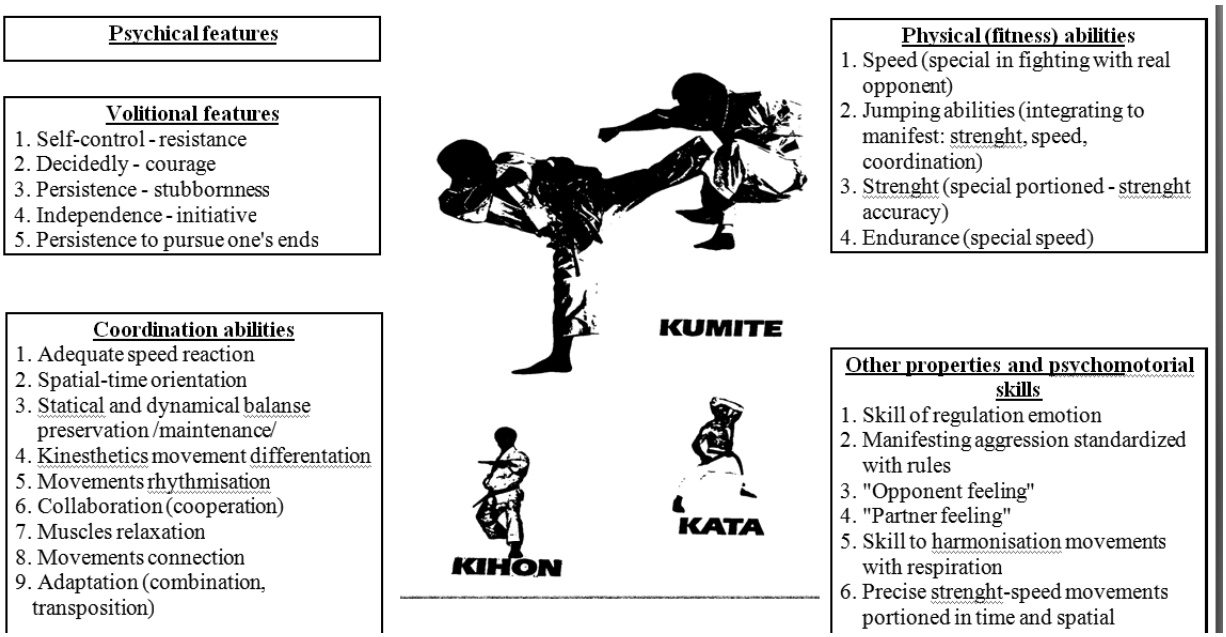


Fig. 2. Psychical features and motor abilities required to sports achieves a success in traditional karate

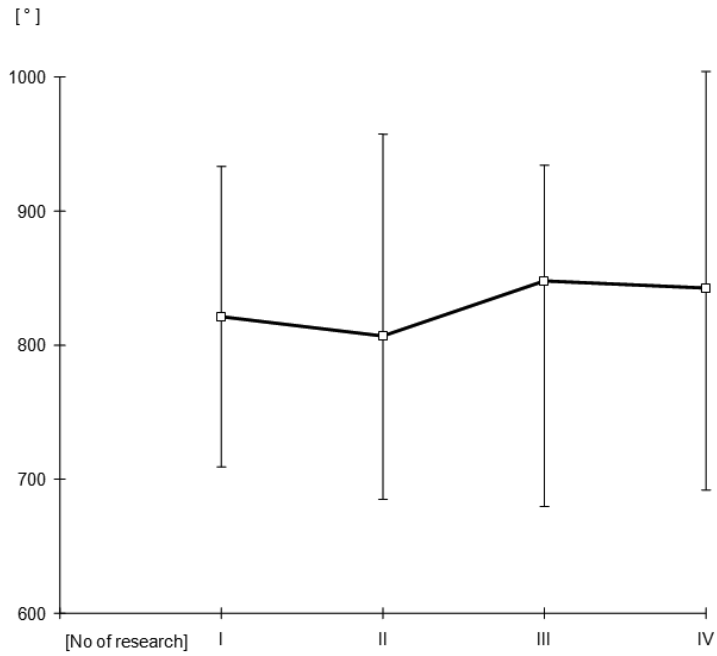
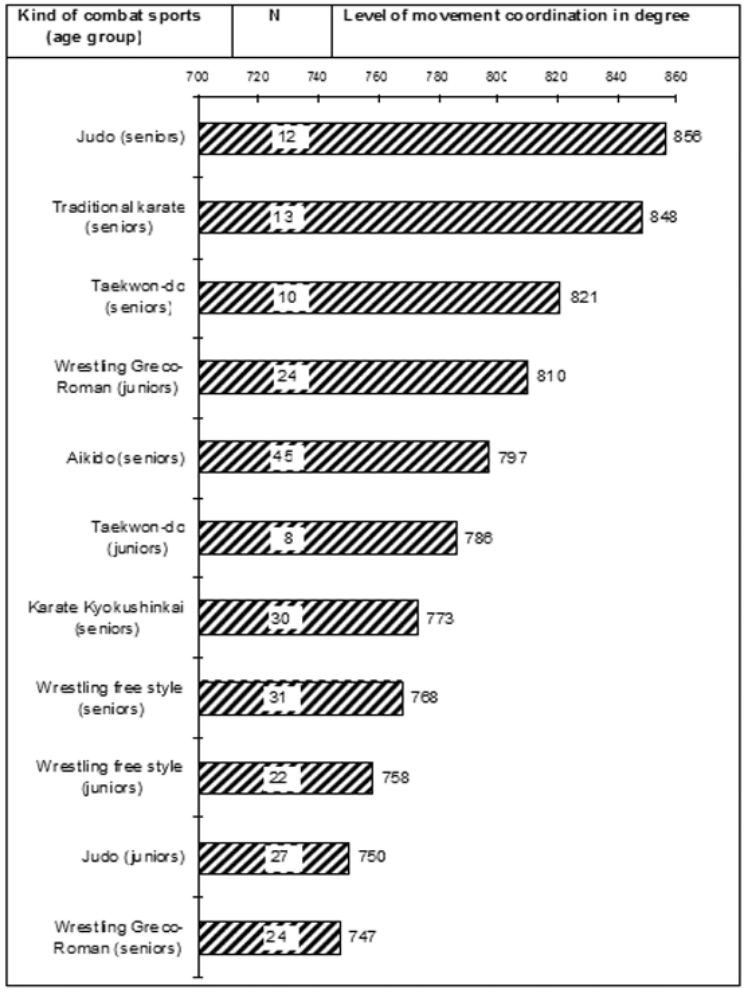


Fig. 3. Level of selected element of movement coordination in different training periods of Polish national team in traditional karate, n = 13

Fig. 4. Level of selected element movement coordination in advanced competitors practising different combat sports, n = 246



ty of cases statistically significant differences have taken place between those results. This may be connected with a rather high correlation of results. For an evaluation of global movement co-ordination use was made of two test tasks – maximum rotation in a jump to the right and to the left. **Between results of executed rotations to the right and to the left a moderate correlation was determined (0.48), which was a significant interdependence.** A comparison of execution of the whole tests with its first part, i.e. maximum rotation to the left, indicated a higher correlation (0.62) than to the right (0.53). In order to evaluate the level of coordination abilities an own test of jumping ability was applied (some authors ascribe this ability to the coordination abilities range). The tested athletes have obtained in this test an average result of 59 cm (S=7.63). **No dependence between this ability and results obtained in the test of global coordination was observed.**

4. Comparison of level of global coordination in athletes of various sport martial arts (Fig. 4).

Let us limit them to results concerning the level of global movement coordination. **The tested karate competitors have obtained a mean value – 848°. From among the hitherto tested athletes of 7 kind of martial arts this was the highest level [3,4].** A slightly higher level (by 8°) was only obtained by senior judo athletes, from among whom many belonged to world leaders (among others **J. Pawłowski** – vice champion of Olympic Games in Seoul). This result, in accordance to the „T" scale, amounted to 63 points, which was equal to a very good evaluation [4,19]. What was more, some of the karate competitors have obtained results from the end of the scale. For example, **K. Neugebauer – 93** points for a result amounting to 1131 (outstanding result in the „T" scale commences already from 72.5 points). Thus it is not surprising at all that this athlete became the champion of Europe and of the world (in team). The outstanding valuation concerned also the co-ordination level: **R. Urban – 1063°** and **A. Melkanowska – 933°**, and excellent of **S. Garbacki – 904°** (champion of Europe in the junior category) and **M. Grubski – 893°** (world champion). Average results, as well as individual ones, constitute a proof of a high level of coordination in karate competitors. **Such a level enables them to master the technical elements on a champion level and to achieve success on an international arena.**

Conclusions

1. The three-stage character of the way leading to technical mastering in karate is compliant with the theory of W. Farfel concerning three levels of movement coordination. It also complies with the modern theory of teaching of movements.
2. Achievement of success in karate requires the demonstration of all the basic coordination abilities at almost the highest level.
3. A comparison of results obtained by karate athletes in the scope of abilities for differentiation a movement amplitude with those obtained by athletes of other sports disciplines indicates an insignificant level of precision (x=77.6).
4. Tests of ability of differentiating the muscular strength of the arm indicated a big lateral differentiation of individual results.
5. The execution of a test that evaluates the level of static balance showed in many karate athletes a significant differentiation in results obtained from executing the task with open and shut eyes.
6. From among competitors of 7 kind of martial arts, karate athletes were characterised by almost the highest level of global movement coordination. A slightly higher level was ascertained only in the case of senior judo athletes, from among which many belonged to the world elite.
7. Arithmetical mean values of global movement coordination in four successive tests conducted at intervals of several months have not shown major differences, although between results of certain tests a statistically significant differentiation has taken place. Simultaneously observed was a significant differentiation of results between individual athletes.

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