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COMPARATIVE ANALYSIS OF STRUCTURAL TRANSFORMATIONS OF MOTOR DIMENSIONS OF SEVEN – YEAR OLD MALE AND FEMALE PUPILS

PRIMERJALNA ANALIZA STRUKTURNIH SPREMEMB MOTORIČNIH DIMENZIJ SEDEMLETNIH UČENCEV IN UČENK

Abstract

Structural i.e. qualitative changes of motor dimensions have been analyzed over a period of six months for 992 seven year old pupils divided into control groups of 325 boys and 310 girls who attended a regular school program of physical education (consist 2 hours sport activity per week) and another 185 boys and 172 girls forming two experimental groups which attended specially programmed classes of physical education guided by sport teacher. The structures of the isolated dimensions of 12 motor variables in two time points (two transitive conditions) changed in such a way that the cortical control and regulation of movement assumed the main role in the motor efficiency of the boys and girls in both control and experimental groups. Within the control groups a homogenization of motor abilities occurred in such a way that in the group of boys in the second time point the first dimension integrates abilities of coordination and strength, the second is a general factor of speed and the third flexibility with aerobic endurance. In the control group of girls the first dimension integrates abilities of coordination and speed, the second is a general factor of strength and the third integrates the abilities of flexibility and balance. Within the experimental groups as a homogenization occurs, there is also an evident differentiation of motor abilities.

Keywords: children, motor dimensions, structure and change

IZVLEČEK

Strukturne spremembe motoričnih dimenzij smo analizirali v obdobju šestih mesecev na skupini 992 sedemletnih učencev. Razdeljeni so bili v dve kontrolni skupini (325 dečkov in 310 deklic), ki so obiskovali redni šolski program športne vzgoje (2 uri na teden) in drugo 185 dečkov in 172 deklic, ki so sestavljali dve eksperimentalni skupini in so obiskovali razrede s specialnim programom športne vzgoje pod vodstvom športnega pedagoga. Strukture izoliranih dimenzij 12 motoričnih spremenljivk v obeh časovnih obdobjih (dve tranzitivni stanji) so se spremenile tako, da sta kortikalna kontrola in mehanizem za regulacijo gibanja prevzela glavno vlogo pri motorični učinkovitosti dečkov in deklic v obeh, kontrolni in eksperimentalni skupini. Znotraj kontrolnih skupin je nastopila homogenizacija motoričnih sposobnosti, tako, da je pri skupini dečkov pri drugem merjenju, prva dimenzija združila sposobnosti koordinacije in moči, druga predstavlja splošni faktor hitrosti in tretja gibljivost z aerobno vzdržljivostjo. V kontrolni skupini deklic združuje prva dimenzija sposobnosti koordinacije in hitrosti, druga splošni faktor moči in tretja sposobnosti gibljivosti in ravnotežja. Znotraj eksperimentalnih skupin obstaja po pojavu homogenizacije tudi očitna diferenciacija motoričnih sposobnosti.

Ključne besede: otroci, motorične dimenzije, struktura, spremembe

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INTRODUCTION

Change in the structure of any dimension, ability or characteristic requires a very demanding system of conclusions and an excellent knowledge of methodology. The reason for this is that it is not very often possible to separate the quantitative changes from the structural ones, and the targeted changes from those which are generated spontaneously and out of control and supervision.

Other investigations that have studied the influence of development and/or training on motor and functional skills e.g. CAHPER (6), Bouchard et al. (3), Malina (15), Sallis (28), Rutenfranz et al. (27), Bale et al. (1), Bunc and Heller (4), Shephard and Zavallee (29), Bonacin et al. (2), Burdikiewiez and Janusz (5), Katić (9), have mostly established quantitative changes and to a lesser extent qualitative ones.

To establish factors of physical fitness e.g. Marsh (17) and motor abilities e.g. Szopa (30) over gender and age, a factor analysis was applied. Although these are transversal studies they supply useful information about the development of functional and motor abilities, as Szopa (30) who has presented, on basis of the quantity of common variance of every isolated factor by age, curves of their development for both sexes.

The number and structure of the formed factors and/or dimensions of motor spaces depends on the age, sex, physical activities, but also on the application of technique of factor or taxonomic analysis.

So far investigations have shown that the motor space is multidimensional and that primary, secondary and tertiary factors exist in adults (7). They also show that various numbers and structure of primary motor factors have been isolated depending on the number and choice of motor tests as well as on the choice of the subjects (7, 18, 31) or taxonomic dimensions (21, 23). On the basis of Kurelić's and his assistant's investigations (14), in the young there are two latent dimensions of a broad range of regulation (the mechanism of the regulation of motion and the mechanism for regulation of energy.

In accordance with the studies of motor abilities (conducted in Croatia) one may conclude that basically in human motor behavior two latent dimensions of wide specter of regulation exist. The first latent dimension, responsible for processes of structuring, control and regulation of movement is called the mechanism for the regulation of movement and is best defined by the primary factor of coordination, followed by speed, flexibility, balance and precision. The second latent dimension is represented in those activities in which the main role is played by energy components and is called the mechanism for regulation of energy. This dimension consists of: 1) the factor of the regulation of duration of excitation, which is evaluated by tests of repetitive and static strength and which may be reduced to the so-called basic body strength and 2) the factor of the regulation of the intensity of excitation, which is most frequently evaluated by tests of explosive power.

The results of the investigation of the motor abilities' structure in children aged 6 to 10 indicate that the motor space of children can be defined generally by general motor dimensions (19). However, Malina (16) emphasized that the basic motor abilities in children are more or less already developed at the age of 7, which presents a prerequisite for the development of motor abilities and skills, which makes possible a differentiation of latent motor dimensions. The defining of the multidimensional motor space in children enables a more complete explanation of their motor functioning (11, 12, 24).

The level of human motor abilities is the result of both quantity and quality changes and interaction of maturation and conditioning processes during one's life. The intention of this research was to determine the structural changes over a period of 6 months in the frame of teaching physical education in the first class of elementary school. It considers the influence of the treatment on the transformation of motor dimensions of the seven years old boys and girls. It is well known that a child enters a school institution with a lot of bio-psycho-social needs. A major need is the need for movement. It is a biotic motive and moving is not, as we often say, an instrument. It is more than that. Because motorics is integrated in global maturation, it is a chance to develop all capacities, all abilities, and it is a chance to generate a complete human being.

MATERIAL AND METHODS

The total effective sample of 992 children consisted of 510 male and 482 female seven-year old pupils from Split. The sample of boys was divided into a control group of 325 pupils and 185 in the experimental group, while the sample of girls was divided into a control group of 310 and an experimental group of 172 girls. The subjects in the control groups regularly attended supervised physical and health education classes according to the conventional program while the subjects in the experimental groups had a programmed teaching of physical education with predominantly athletic and sport gymnastic contents.

A good and reliable assessment of the motor status of children is particularly important for the planning and programming of transformation processes equally in the field of physical education and health education and/or in various sports activities of children and youth. Thus, in the planning of such a program, different initial conditions in individual dimensions of the psychosomatic status tend to dictate the achievement of various levels of transformation. It is therefore important for the kinesiological practice to be able to optimally estimate the motor status of a individual with the least variables possible, without diminishing the amount of relevant information. That is why it is necessary to make a choice of those variables that are most relevant for the assessment of basic motor abilities and that at the same time estimate a coexistent model of motor status.

The choice of variables for the assessment of the motor status was made in such a way that they were representative for latent motor dimensions of the motor functioning described in the study by Gredelj et al. (7) and/or the model by Kurelić, Momirović et al. (13). Therefore the tests for the observation and evaluation of motor characteristics of pupils of elementary school in the Republic of Croatia suggested by Mraković et al. (25) were aligmented by another five motor tests. Therefore a sample of 12 motor tests has been applied twice, six months apart. The following variables have been used: sidesteps and polygon backwards for assessing the factor that is based on the mechanism for movement structuring, hand tapping, foot tapping, bench standing, forward bow, standing broad jump, ball throw and 20 m run, situps, bent arm hang, 3 min run.

Table 1
Mean values (±SD) of motor indices measured twice in boys and girls - the control groups

Variable \ Measurement	Boys (n=325)		Girls (n=310)	
	1	2	1	2
Sidesteps (s)	16.28 ± 2.09	14.20 ± 1.65	16.71 ± 1.99**	14.64 ± 1.55**
Polygon backward (s)	22.95 ± 6.22	16.89 ± 4.01	26.62 ± 7.62***	19.62 ± 4.70***
Bench standing (s)	1.76 ± 0.75	2.13 ± 0.76	1.67 ± 0.79	2.02 ± 0.76
Forward bow (cm)	36.86 ± 8.49	40.22 ± 8.22	41.27 ± 7.89***	45.49 ± 8.64***
Hand tapping (taps/min)	19.18 ± 2.78	21.31 ± 2.56	18.73 ± 2.45*	21.38 ± 2.75
Foot tapping (taps/min)	15.67 ± 1.94	17.37 ± 1.88	15.92 ± 1.75	17.95 ± 1.88***
Standing jump (cm)	113.09 ± 17.36	129.38 ± 17.08	103.84 ± 17.31***	118.88 ± 16.57***
Ball throw (m)	10.56 ± 3.07	12.35 ± 3.35	7.10 ± 1.87***	8.35 ± 2.34***
20 m run (s)	4.94 ± 0.44	4.58 ± 0.37	5.11 ± 0.46***	4.73 ± 0.41***
Sit-ups (per minute)	21.66 ± 6.35	26.88 ± 6.14	20.38 ± 6.48*	25.44 ± 6.17**
Bent arm hang (s)	10.91 ± 9.51	18.81 ± 12.50	9.83 ± 7.99	16.73 ± 10.85*
3 min run (m)	440.94 ± 59.95	506.85 ± 67.66	418.78 ± 63.36***	477.77 ± 64.64***

*Significant differences between boys and girls: *P<0.05; **P<0.01; ***P<0.001*

Table 2
Mean values (±SD) of motor indices measured twice in boys and girls – the experimental groups

Variable \ Measurement	Boys (n=185)		Girls (n=172)	
	1	2	1	2
Sidesteps (s)	16.41 ± 2.14	14.15 ± 1.58	17.10 ± 1.94**	14.66 ± 1.51**
Polygon backward (s)	22.74 ± 5.46	16.46 ± 3.66	26.09 ± 7.31***	18.81 ± 4.46***
Bench standing (s)	1.69 ± 0.69	2.22 ± 0.74	1.53 ± 0.61*	2.10 ± 0.80
Forward bow (cm)	37.22 ± 8.76	42.40 ± 8.42	42.12 ± 7.92***	48.32 ± 8.54***
Hand tapping (taps/min)	18.71 ± 2.50	21.68 ± 2.66	18.47 ± 2.33	21.90 ± 2.83
Foot tapping (taps/min)	15.47 ± 1.97	17.59 ± 1.92	15.80 ± 1.61	18.28 ± 1.81***
Standing jump (cm)	114.30 ± 16.24	130.71 ± 15.53	104.38 ± 18.18***	120.87 ± 17.07***
Ball throw (m)	10.40 ± 2.95	12.65 ± 3.15	6.96 ± 1.97***	8.97 ± 2.29***
20 m run (s)	4.91 ± 0.43	4.48 ± 0.34	5.13 ± 0.48***	4.61 ± 0.39***
Sit-ups (per minute)	21.44 ± 5.83	28.22 ± 5.44	19.73 ± 5.81**	26.65 ± 5.55**
Bent arm hang (s)	9.57 ± 7.19	22.45 ± 12.99	9.25 ± 7.44	20.42 ± 11.03
3 min run (m)	434.59 ± 65.46	531.11 ± 61.82	407.30 ± 67.87***	497.53 ± 64.94***

*Significant differences between boys and girls: *P<0.05; **P<0.01; ***P<0.001*

An exact description of the tests was published by Katić (9). All motor tests were performed three times except the following: sit-ups, bent arm hang and 3 min run that were measured once, all by the same observers with the same instruments. The results of these multi-item tests were brought to one by a projection onto the first principal component of the common subject of measurement (22).

The structural, or qualitative differences in the time function, were obtained for both groups by obliquely rotated factor solutions, LSDIFF analysis (tests the differences between the correlation matrices of two time points), QDIFF1 analysis (establishes measures of local changes based upon the relative norm of the matrix of the expected covariances after treatment) and CRAMER (determines structural changes based upon the coefficient of alienation, derived from the vector coefficient of correlations of variables, before and after the treatment). The algorithms and programmes were prepared by Momirović (20).

RESULTS

By comparing the arithmetic means of the variables applied in the first and second measurement of boys and girls (Table 1 and 2) it is evident that significant (quantitative) changes have occurred in all motor variables. This points to an intensive development of motor abilities of both boys and girls in their seventh year.

Within the control groups of boys and girls in the space of motor tests, especially evident changes have occurred in the tests for the estimation of static strength of arms and tests for coordination as a solving of complex motor tasks, then in the test for estimating the repetitive strength of the body and the test of balance (Table 1). Within the experimental groups of boys and girls in relation to the control groups, a relative growth of results is even more evident, especially in the test for the static strength of the arms, then in the test of balance, test for repetitive strength of the body, for aerobic endurance and in the test for the explosive strength (throwing). Girls as compared to boys, have slightly more expressed relative changes in the test of the explosive strength of the throwing type, the test of balance and the tests for frequency of movements (Table 2).

Gender differences in the control and experimental groups in motor abilities can also be seen in Table 1 and 2. Boys compared to girls have significantly better results in all tests of explosive strength, especially in the explosive strength of the throwing type (ball throw), further in the test for the estimation of coordination (polygon backward) and finally in the test for the estimation of aerobic endurance (3 min run). Inversely, girls compared to boys have shown significantly better results in the flexibility test (forward bow), and in the second measurement also in the frequency of movement test (foot tapping).

It can be presumed that a developed skeleton and a larger quantity of muscular tissue positively influences the intensity of the mobilization of energy in boys, while more expressed fatty tissue in girls reduces their efficiency, especially in those motor tasks where strength dominate (10). Tests of coordination of these samples are highly saturated with explosive strength (polygon backwards) and speed (sidesteps).

Table 3
Promax factors (P) and correlations of promax factors (CF) in the first and second measurements – males (control group)

Variable		First measurement			Second measurement	
	P1	P2	P3	P1	P2	P3
Sidesteps (s)	0.51	-0.26	0.04	-0.62	-0.20	0.20
Polygon beckward (s)	0.53	-0.11	-0.14	-0.63	-0.19	0.06
Bench standing (s)	-0.33	0.11	0.04	0.13	0.49	-0.13
Forward bow (cm)	0.05	-0.21	0.59	-0.11	0.11	0.84
Hand tapping(taps/min)	-0.14	0.75	-0.14	-0.11	0.82	0.16
Foot tapping (taps/min)	-0.11	0.83	-0.21	0.01	0.82	0.05
Standing jump (cm)	-0.78	-0.01	0.03	0.73	0.15	-0.12
Ball throw (m)	-0.38	0.12	0.33	0.72	-0.09	-0.01
20 m run (s)	0.79	0.05	0.10	-0.60	-0.05	-0.22
Sit-ups (per minute)	-0.39	-0.05	0.44	0.57	0.08	0.11
Bent arm hang (s)	-0.21	-0.19	0.57	0.75	-0.27	0.15
3 min run (m)	0.27	0.49	0.58	0.31	-0.06	0.58
CF P1		-0.31	-0.26		0.47	0.24
P2			0.33			0.10

Table 4
Promax factors (P) and correlations of promax factors (CF) in the first and second measurements – females (control group)

Variable		First measurement				Second measurement		
		P1	P2	P3	P4	P1	P2	P3
Sidesteps (s)		-0.18	-0.23	0.49	0.02	-0.77	-0.04	0.24
Polygon backward (s)		-0.53	-0.22	-0.02	-0.01	-0.58	-0.25	-0.04
Bench standing (s)		0.16	0.13	-0.08	0.84	0.26	-0.27	0.66
Forward bow (cm)		0.18	0.33	0.70	0.09	-0.23	0.23	0.79
Hand tapping (taps/min)		-0.23	0.87	-0.03	0.01	0.77	-0.18	0.16
Foot tapping (taps/min)		0.02	0.73	-0.01	0.15	0.79	-0.03	0.07
Standing jump (cm)		0.75	0.05	0.11	0.04	0.51	0.40	-0.06
Ball throw (m)		0.27	0.43	-0.03	-0.43	0.18	0.47	0.22
20 m run (s)		-0.75	0.08	-0.14	-0.11	-0.01	-0.73	-0.13
Sit-ups (per minute)		0.45	0.02	-0.25	-0.21	0.02	0.73	-0.12
Bent arm hang (s)		0.82	-0.36	-0.12	0.11	-0.04	0.76	-0.09
3 min run (m)		-0.04	0.25	-0.66	0.26	0.40	0.17	0.03
CF	P1		0.44	-0.21	-0.04		0.50	0.24
	P2			-0.18	-0.01			0.28
	P3				0.06			

Therefore a greater explosive strength in boys than in girls has mostly contributed to their better results in the test polygon backwards and less in the results of the test sidesteps, which is more saturated by speed and where the girls are even more superior. Girls are superior to boys in flexibility, which can be explained by their more movable joints and a greater elasticity of muscles.

Within the sample of boys in the control group the factor analysis, in the first as well as in the second measurement, isolated three latent motor dimensions which were obtained by a promax rotation of the main components of the intercorrelation matrix (Table 3).

In the first measurement the first factor is defined by high projections of the variables for the estimation of explosive strength and coordination, the second is dominantly defined by high projections of the variables for the estimation of frequency of movements. The third factor is defined by a group of motor abilities: endurance, flexibility, static strength and repetitive strength.

In the second measurement (after six months) the isolated factors were defined to some extent more clearly and differently. Thus, the first factor is defined dominantly and equally by variables for the estimation of all factors of strength and by variables for the estimation of coordination, the second by variables of frequency of movements. The basis of the third factor is probably flexibility, that is followed by aerobic endurance.

Within the sample of girls in the control group the factor analysis of motor variables in the first measurement isolated four factors: the first defines general motor efficiency, based dominantly on strength by Katić et all. (11), the second the ability for frequency of movements, explosive and repetitive strength, the third confronts abilities of aerobic endurance and coordination/agility with flexibility and the fourth defines balance.

In the second measurement three motor factors were isolated: the first integrates coordination and frequency of movements into a united basis of motor functioning, the second clearly defines a general factor of strength, and the third integrates flexibility and balance.

The factor analysis of the experimental group of boys isolated three latent motor dimensions in the first, and four in the second measurement (Table 5).

In the first measurement the first factor is defined by variables of explosive strength and coordination. The second factor is defined by variables of frequency of movement while the basis of the third is a motor complex of strength and endurance.

The second measurement reveals a differentiation of motor abilities. The first factor is dominantly defined by variables of coordination and variables of all factors of strength. The basis of the second factor is frequency of movement, the basis of the third is explosive strength and endurance, and the basis of the fourth is flexibility followed by balance.

Within the experimental group of girls the factor analysis of motor variables in the first measurement has isolated three, and in the second measurement

Table 5
Promax factors (P) and correlations of promax factors (CF) in the first and second measurements – males (experimental group)

Variable		First measurement			Second measurement		
	P1	P2	P3	P1	P2	P3	P4
Sidesteps (s)	0.44	-0.30	-0.13	-0.74	-0.14	0.07	0.16
Polygon backward (s)	-0.40	0.02	-0.51	-0.67	-0.03	-0.09	-0.11
Bench standing (s)	-0.54	0.17	-0.14	0.08	0.39	-0.24	0.43
Forward bow (cm)	-0.39	-0.23	-0.06	-0.13	-0.15	0.10	0.96
Hand tapping (taps/min)	-0.03	0.80	0.07	-0.15	0.87	0.18	-0.08
Foot tapping (taps/min)	-0.02	0.88	-0.05	0.07	0.86	-0.03	-0.05
Standing jump (cm)	-0.61	0.12	0.17	0.59	0.11	0.30	0.07
Ball throw (m)	0.00	0.00	0.72	0.24	0.07	0.61	0.10
20 m run (s)	0.78	-0.10	0.18	-0.69	0.01	0.14	-0.24
Sit-ups (per minute)	-0.38	-0.17	0.47	0.77	0.00	-0.13	-0.18
Bent arm hang (s)	-0.44	-0.18	0.24	0.73	-0.30	0.11	-0.10
3 min run (m)	0.41	0.17	0.78	-0.13	0.06	0.89	-0.01
CF P1		-0.24	-0.35		0.42	0.29	0.29
P2			0.27			0.14	0.19
P3							0.01

four dimensions (Table 6), the same as for the boys experimental group.

In the first measurement the first dimension is defined mostly by variables of explosive strength of the jumping and running type, by static strength of the arms and the repetitive strength of the body, followed by projections of variables of coordination and balance. The second dimension is defined by variables of frequency of movement (psychomotor speed), and the third by the variable of flexibility on the positive pole, and slightly less by the variable of endurance on the negative pole.

In the second measurement the first dimension is defined by significantly high projections of the variables of frequency of movement and high projections of the variables of coordination. The second dimension is defined by high projections of variables for estimating static and repetitive strength and explosive strength of the running type. The third is defined by a quite high projection of the variable of flexibility that is positively followed by a moderate projection of the variable for explosive strength of the running type and negatively by a moderate projection of the variable for aerobic endurance, while the fourth is

Table 6
Promax factors (P) and corelations of promax factors (CF) in the first and second measurements – females (experimental group)

Variable		First measurement			Second measurement		
	P1	P2	P3	P1	P2	P3	P4
Sidesteps (s)	-0.34	-0.26	0.21	-0.71	-0.20	-0.02	0.09
Polygon backward (s)	-0.56	-0.25	0.05	-0.67	-0.24	-0.09	0.05
Bench standing (s)	0.44	0.03	-0.19	-0.15	-0.17	0.25	0.84
Forward bow (cm)	0.03	0.22	0.81	0.10	-0.10	0.84	0.32
Hand tapping (taps/min)	-0.16	0.83	-0.01	0.94	-0.33	-0.03	-0.08
Foot tapping (taps/min)	0.00	0.79	0.08	0.85	-0.08	0.04	-0.04
Standing jump (cm)	0.74	0.07	0.07	0.40	0.39	-0.02	0.22
Ball throw (m)	0.21	0.54	0.00	0.00	0.40	-0.09	0.53
20 m run (s)	-0.68	0.00	-0.26	-0.05	-0.69	-0.41	0.05
Sit-ups (per minute)	0.43	0.20	-0.06	-0.16	0.73	-0.03	0.16
Bent arm hang (s)	0.79	-0.37	-0.05	-0.06	0.83	-0.19	-0.28
3 min run (m)	0.04	0.24	-0.64	0.17	-0.02	-0.55	0.43
CF P1		0.38	-0.02		0.50	-0.09	0.41
P2			-0.10			0.06	0.30
P3							-0.18

defined by quite a high projection of the variable for balance that is positively followed by moderate projections of the variables of explosive strength of the throwing type, aerobic endurance and flexibility.

DISCUSSION

Even though quantitative differences in motor abilities between boys and girls are evident both at the beginning and the end of the first class of elementary school, relative changes of motor variables between these two time points are mostly equally expressed by both sexes, of both the control and the experimental groups.

Significant quantitative changes of motor variables (Table 1 and 2), which were obtained in the second measurement, related to the first brought-to changes of correlations between variables and thus to changes in the structures of dimensions (for boys in Table 3 and 5, for girls in Table 4 and 6).

It has been established that structural changes of motor dimensions occur in different ways in connection with gender and the intensity of kinesiological activities. Greater structural changes of motor dimensions and their sooner forming occurs in girls, as related to boys.

Within both genders and both control and experimental groups, especially in the second measurement, the first two isolated promax factors are clearly defined, and they act as latent motor dimensions that carry the most information about the motor functioning of the subjects.

In the second measurement, in both the control and experimental group of boys, the mechanism for cortical regulation of movement and the mechanism for selective control of the speed of the transmission of impulses through motor neurons (in accordance with the model by Gredelj and ass.) is the basis of the first motor dimension.

In the control and experimental group of girls, the mechanism for selective control of the transmissional speed of impulses through motor neurons and the mechanism for the cortical regulation of movements is the basis of the first motor dimension, while the mechanism for the regulation of the energy output is the basis of the second mechanism. This is in accordance with the model by Gredelj and ass., as for the model of Kurelić and ass. the mechanism for the regulation of movement is responsable for the first dimension, and for the second – the mechanism for energy regulation.

The first promax factor in the second measurement carries, as a factor of general motor abilities, the most information of motor characteristics in the control groups of boys and girls. While the development of motor functioning of boys manifests through the integration of the abilities of coordination and strength, in girls that development is manifested in an integration of coordination and speed. The basis of motor efficiency are those abilities that are more

Table 7
Results of the analysis of structural changes - males (M) and females (F) in the control groups

LSDIFF-Analysis			M	F
Real matrix trace of the square of differences			1.38	2.26
HI-Square (of functions of trace)			224.19	349.96
Degrees of freedom			12.00	12.00
Probability			0.00	0.00
Differences under QDIFF1 (Q) and Cramer (C) model. Global measurement changes (G) and vector cofficient of correlation (VCC)y				
Variable	Q (M)	C (M)	Q (F)	C (F)
Sidesteps (s)	0.38	0.42	0.43	0.51
Polygon backward (s)	0.30	0.38	0.30	0.36
Bench standing (s)	0.54	0.61	0.60	0.66
Forward bow (cm)	0.15	0.14	0.18	0.19
Hand tapping (taps/min)	0.40	0.41	0.43	0.43
Foot tapping (taps/min)	0.36	0.37	0.38	0.44
Standing jump (cm)	0.27	0.29	0.24	0.24
Ball throw (m)	0.18	0.19	0.26	0.27
20 m run (s)	0.26	0.25	0.25	0.26
Sit-ups (per minute)	0.33	0.36	0.30	0.34
Bent arm hang (s)	0.41	0.46	0.34	0.34
3 min run (m)	0.32	0.29	0.30	0.26
	G=0.38	VCC=0.00	G=0.43	VCC=0.00

Table 8
Results of the analysis of structural changes - males (M) and females (F) in the experimental groups

LSDIFF-Analysis			M	F
Real matrix trace of the square of differences			0.91	1.75
HI-Square (of functions of trace)			84.46	150.20
Degrees of freedom			12.00	12.00
Probability			0.00	0.00
Differences under QDIFF1 (Q) and Cramer (C) model. Global measurement changes (G) and vector cofficient of correlation (VCC).				
Variable	Q (M)	C (M)	Q (F)	C (F)
Sidesteps (s)	0.31	0.36	0.37	0.49
Polygon backward (s)	0.30	0.33	0.22	0.25
Bench standing (s)	0.49	0.51	0.58	0.58
Forward bow (cm)	0.11	0.10	0.17	0.18
Hand tapping taps/min)	0.28	0.29	0.44	0.37
Foot tapping (taps/min)	0.25	0.29	0.33	0.35
Standing jump (cm)	0.28	0.27	0.16	0.16
Ball throw (m)	0.13	0.14	0.18	0.18
20 m run (s)	0.21	0.23	0.19	0.21
Sit-ups (per minute)	0.20	0.20	0.22	0.22
Bent arm hang (s)	0.24	0.24	0.17	0.18
3 min run (m)	0.14	0.14	0.14	0.16
	G=0.28	VCC=0.00	G=0.29	VCC=0.00

distinctive and that extensively differentiate the subjects. Therefore in the solving and realization of motor tasks boys will use mainly strength and girls speed, thus those abilities that they potentially mostly possess. This can partly be concluded on a basis of gender differences in motor abilities (Table 1 and 2), where boys are superior to girls in factors of strength, and girls to boys, although to a lesser extent, in frequency of movement. However it needs to be emphasized that this is a symmetrical relation i.e. a mutual conditioning of abilities of coordination and strength in boys and of coordination and speed in girls. If we presume on the basis of the model by Gredelj et al. (7) that the mechanism for cortical regulation of movement (tests of coordination) in boys is superior to the mechanism for the regulation of energy output (tests of strength), and in girls to the mechanism for selective control of transmission speed of impulses through motoneurons (tests of speed), then this isolated factor can be called a dimension of cortical regulation of movement with a controlled application of strength in boys, and a dimension of cortical regulation of movement with a controlled application of speed in girls.

In the second measurement the structure of the second promax factor changed slightly for boys and completely for girls. The projections of the frequency of movement variables increased in boys and the projection of the aerobic endurance variable significantly diminished. Namely, while aerobic endurance influenced the realization of the frequency of movement tasks in the first measurement, the realization of those tasks in the second measurement is mildly connected to balance and coordination abilities. Thus, the realization of frequency of movements changes from a higher to a lower level of a controlled process. On the contrary in girls, a general factor of strength was isolated in the second measurement as a separate motor dimension – basically a mechanism responsible for the regulation of the energy output (7).

The structure of the third promax factor in the second measurement relative to the first measurement, has considerably changed, again more in girls than in boys. Thus for boys, the third promax factor in the second measurement is defined more by flexibility and less by aerobic endurance, so it can be supposed that a differentiation of flexibility, as a separate motor dimension, is taking place. Whereas for girls an integration of flexibility and balance into a unique motor dimension occurred for which the mechanism of synergistic automatism and of tonus regulation is responsible, according to Kurelić, Momirović et al. (13).

The results presented here show that the development of motor abilities takes place as a homogenisation, thus bringing motor functioning to a higher level, for both boys and girls in the control groups in this period. Thus in both boys and girls the mechanism for cortical control and movement regulation undertakes the main influence on general motor efficiency.

Increased physical activity within the experimental groups brought to a differentiation of motor abilities. Thus in the group of boys on basis of the third promax factor, a forming of aerobic endurance is most likely occurring, and on the basis of the fourth promax factor a forming of flexibility.

As for girls, most likely a forming of flexibility occurs as seen in the third promax factor, and a forming of balance from the fourth.

But, even though the third and fourth isolated factors probably exist as separate motor factors in these subjects, their exsistence in this research has not been adequate confirmed. One of reasons is that the tests applied to estimate these factors are saturated with other motor abilities in these subjects and the second reason is that motor abilities of endurance, flexibility and balance are estimated by only one variable each. Because of this second reason, it is necessary for research of this kind to make a choice of motor variables, based not only upon some coexistent model of motor functioning i.e. by estimating secondary factors and/or dimensions, but also that the primary factors of first order be well defined, and that means by at least 3 motor tests each, tests which have good metric characteristics (especially reliability and validity).

The LSDIFF analysis applied to both control groups of boys and girls indicates that the changes that occurred within the structure of dimensions are on a significant level (Table 7). It is also evident that the progress is more significant within the group of girls. Therefore the correlations of variables in the two transitive conditions (two time points) have changed. The generator of these changes within both groups is most likely equally physical activity at school (2,3,9,27,29,) as well as the biological continuity of the development of functions (1,5,6,15,28). The local measurements of changes confirm that these changes are mostly conditioned by the development of motor abilities of balance, psychomotor speed, static and repetitive strength, coordination and aerobic endurance in boys, and by balance, psychomotor speed, coordination, all factors of strength and aerobic endurance in girls.

The LSDIFF analysis within the experimental groups of boys and girls also shows that changes in the structure of dimensions have occurred on a significant level (Table 8). Within both experimental groups an enhanced physical activity has produced positive effects, manifesting itself as a differentiation of motor abilities. Local measurements of changes show that these changes within the experimental group are mostly conditioned by the development of the motor abilities of balance, coordination, speed and explosive strength of the jumping type, and in the girl experimental group by the development of balance, speed, and coordination.

Due to the facts that the process of physical education was guided by the same experts, we ascribe the differences between the subjects and the positive effects to an enhanced physical activity of experimental group.

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