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CHANGES OF MORPHOLOGICAL CHARACTERISTICS OF 7 YEAR OLD BOYS BASED ON VARIABLES OF MOTOR ABILITIES UNDER THE INFLUENCE OF PHYSICAL EXERCISE TREATMENT

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Abstract

Introduction: Identification of the motor abilities in relation to initial biomotor variables based on two sources of variability (natural development and treatment programme effects) establishes global principles of general support for growth and development of children.

Aim of the study: The innovative approach of this research was to separate the natural and the intentional processes of morphological characteristics based on different initial motor abilities. The focus of the study was on biological processes, we were not especially interested in local data as elementary statistical indicators.

Materials and methods: The investigation concerned 249 boys (7 years old) who were divided into three groups: motorically inferior, moderate, superior and who participated in a transformational process lasting 18 months. They were measured three times and described by 26 biomotor variables. Their morphological status, as well as its changes, were to a great extent characterized by the initial motor configuration. Discriminant analysis was used to data which were first transformed into universal range (1.0-5.0). Only the common variability in the space of morphological measures was retained for further procedures.

Results: For measurements repeated three times, two discriminant functions were computed: first, more pronounced, differentiated the inferior from the superior subjects exclusively on the basis of fatty tissue measures; second, somewhat less pronounced, differentiated the motorically moderate subjects on the basis of all other morphological indicators.

Conclusions: The programme ensured the conditions for better improvement for the motorically poorer, in contrast with the motorically more proficient subjects, so inferior boys got better support for their growth and development then superior.

Key words: *changes, morphological variables, boys, motor abilities, influence, treatment*

Introduction

Knowledge or recognition of any phenomenon that actually exists in our environment is related to many concepts we are relying on in our inference. These concepts are results of previous knowledge accumulation (1). Most cognitions, concepts and inferences are not limited exclusively to utilitarian and partial cases, but they are situated in, we can undoubtedly state it, integral and universal cognition area within which each individual tries to build up a network of his/her own information, knowledge, cognition and rules, thus changing that area. Obviously, changes can be regarded as quantitative ones (linear shifts), structural ones (changes of relations among variables), as a process (changes of dynamics) and taxonomic ones (changes of types). If a group of entities displays recognizable and evident differences in conglomeration, then the restructuring among existent types has undoubtedly occurred. In addition, the types are responsible for the level of ecosensitivity, even final achievements. This model undoubtedly belongs to the class of typology change models. For selection purposes, we can estimate fundamental changes in morphologic or motor dimensions, like Bouhlel et al. (2) who found significant correlations between peak anaerobic power, body mass and muscle volume in trained young boys. Similarly, Lewandowska et al. (3) found out that the boys from sports secondary schools expressed more advanced maturity status than the boys of the same age from non-sports schools. Abbott and Collins (4) discussed the models based on a static and one-dimensional concept of talent with 12 years old boys, and concluded that those models were likely to lead to the premature de-selection of many talented children. An alternative process based on a dynamic and multi-dimensional concept of talent was also discussed. Bunc et al. (5) found, investigating 8 years old players, that, as in other sports where skills play a decisive role, the physiological data could not be a sole predictor of performance and competitive success. In addition, the participation in intervening physical activities during after school care, based on social cognitive theory and incorporating instruction in self-management and self-regulatory skills, was associated with the significant improvements in measures of exercise-related self-efficacy, perceived physical appearance, and physical self-concept over 12 weeks, but no difference in changes on these factors was associated with participants' age, or with children being in either the concrete operations or formal operations stage of cognitive development (6). Faigenbaum (7) discusses strength training that had been proven to be a safe and effective method of conditioning for adults. It now appears that a growing number of children and adolescents also train to improve their health, fitness, and sports performance. Poplawska et al. (8) investigated the secular trend in body adiposity of children and youths from the rural areas of East Poland. The extent of those changes appeared to be differentiated depending on the adiposity measure applied, as well as sex and stage of ontogenetic development of subjects. Okely et al. (9) found out that there was no consistent association between prevalence of skill mastery and socio-economic status. Harrison et al. (10) discussed the development of a drive for muscularity among boys that has been linked to various cultural influences, one of which was exposure to mass media depicting the muscular male body ideal. Obviously, it is very hard to determine stable principles with young entities because of their expressed development.

The idea of our research was to monitor taxonomic typology changes across 18 months of physical exercise transformation process with three groups of boys aged seven at the beginning of the programme. Groups were established according to children's motor abilities assessed in the initial measurement (superior, moderate, and inferior group), and monitored by the Momirovic's robust discriminant analysis procedure, after the data had been rescaled onto image metrics (11).

Purpose and aim

Children's development is a complex process, consisting of several parallel and integrated biological processes that have to be identified. Its investigation is a serious and difficult task. Because of integrated development, the purpose of this research was to separate natural and intentional transformation processes of morphological characteristics based on different motor initial abilities. This is a very new and avant-garde approach. According to that aim, we tried to locate primary biological processes and were not especially interested in local data as elementary statistical indicators. Anyway, such elementary parameters were already published (1,12,13).

Materials and Methods

A sample of 249 boys, 7 years old, was measured at the beginning, in the middle, and at the end of a kinesiological treatment, or programme, aimed at offering the general support for physical functions and of growth and development of children. The treatment lasted 18 months (12,13). The superior group consisted of 83 boys, moderate group of 83 and the inferior group of 83**.** Three times, in time intervals of nine months, the children were measured and described by 26 biomotor variables, which were meant to cover well their morphological and motor dimensions. For the purpose of this paper, 14 morphological measures were analysed: body height (ALBH), leg length (ALLL), arm length (ALAL), wrist diameter (ATWD), knee diameter (ATKD), biacromial width (ATBW), bicristal width (ATCW), body weight (AVBW), forearm circumference (AVFC), lower leg circumference (AVLC), average chest circumference (AVCC), upper arm skin fold (AFAS), back skin fold (AFBS), and abdominal skin fold (AFDS), as well as 12 motor measures: side steps (MCSS), obstacle course backwards (MCOB), balance bench stand (MB2O), straddle seat forward bent (MXFB), hand tapping (MFTH), foot tapping (MFTF), standing broad jump (MESB), ball throwing for distance (MEBT), 20m run from the standing start (ME20), sit-ups (MRSU), bent arm hang (MSBA), and one simple measure of physiological functional capacity – 3min run (F3MR). All the motor tests' data were rescaled beforehand, so the higher result meant the better one (MCSS, MMCPB, ME20).

The measurement precision units were: body height (millimeters) - e.g. 146.3 cm, leg length (millimeters) - e.g. 77.4 cm, arm length (milimeters) - e.g. 65.4 cm, wrist diameter (millimeters) - e.g. 4.2 cm, knee diameter (millimeters) - e.g. 6.7 cm, biacromial width (millimeters) - e.g. 32.7 cm, bicristal width (millimeters) - e.g. 22.5 cm, body weight (10 the of kilograms) - e.g. 45.6 kg, forearm circumference (millimeters) - e.g. 25.5 cm, lower leg circumference (millimeters) - e.g. 38.3 cm, average chest circumference (millimeters) - e.g. 66.7 cm, upper arm skin fold (10 the of millimeters) - e.g. 9.5 mm, back skin fold (10-th of millimeters) - e.g.- 14.4 mm abdominal skin fold (10-th of millimeters) - e.g. 15.2 mm, side steps (10-th of seconds) - e.g. 16.4 s, obstacle course backwards (10-th of seconds) - e.g. 24.6 s, balance bench stand (10-th of seconds) - e.g. 7.4 s, straddle seat forward bent (millimeters) - e.g. 37.5 cm, hand tapping (10-th of seconds) - e.g. 17.8 s, foot tapping (10-th of seconds) - e.g. 19.4 s, standing broad jump (centimeters) - e.g. 165 cm, ball throwing for distance (10-th of meter) - e.g. 5.4 m, 20m run from the standing start (10- th of seconds) - e.g. 4.5 s, sit-ups (number of correct actions) - e.g. 12, bent arm hang (10-th of seconds) - e.g. 11.3 s, 3min run (meters) - e.g. 545 m.

Finally, data were rescaled into the range between 1.0 and 5.0. Worst result gets value of 1.0 and best result gets 5.0. All other results were redefined on that line according to real position, so distances between individual results remain preserved. In that way we get easily comparable vectors of variables where best result is really the best (and maximal), equal to 5.0. With that original assumption simple summation of individual results create a new vector where we can allocate each individual, and simply form three groups (Inferior, Moderate, Superior).

The 83 individuals with maximal sum are really superior group. Our rescaling procedure always gives the same range for each variable. Typical standardized z-scores (given by the formula z = (x - MEAN) / ST DEV) do not have this property.

Our rescaling was done to make actual scores as obvious as possible. Groups with identical number of entities were defined at the beginning of transformation process, by simple summation of data after rescaling (universal bounds of 1.0 – 5.0). Means of variables of such groups: inferior, moderate and superior (INF, MOD, and SUP) and discriminative functions (D1, D2) in morphological space are presented in tables that explain 1, 2 and 3 measurement.

Results

The results of the discriminant analysis were presented in three tables. Each table contains data which were first transformed into universal range (1.0-5.0).

As displayed in Table 1, the results of the initial measurement allowed actually the definition of distinct groups of entities according to motor variables. Morphological variables indicate that the motorically **inferior** entities have higher values of arm length, bicristal width, lower leg and chest circumferences, as well as of all fatty tissue measures. Lower values in this group of entities were registered only for forearm circumference.

Therefore, it can be said that the motorically inferior entities in the sample have in general larger body mass, **adiposity**. The ***superior*** entities, on the contrary, displayed mainly higher values of longitudinal dimensions (body height, arm and leg length), and of the majority of transversal dimensions (wrist and knee diameter, and body mass). They have markedly low volume values (lower leg and chest), and extremely low expressions of fatty tissue. They can be easily described as the **bony** ones. The entities who were ***moderate, average*** on motor abilities expressed especially low values of all solid tissue measures (bone growth in length and transversally), whereas the other dimensions are on the sample average. Therefore, they can be easily described as the **poorly developed** ones. The applied discriminant analysis confirmed these inferences since it displayed two discriminant functions; the first function differentiated motorically inferior entities from the motorically superior entities exactly on the measures of volumes and fatty tissue, whereas the second one differentiated motorically average from all the others entities on the basis of the measures of bone growth in length and width.

According to the indicators in Table 2, the motor status remained in the second measurement mainly preserved, although the total differences of ranges became smaller (7.02), but the morphological status was changed. Motorically ***inferior*** entities displayed the predominance in body height, leg length, knee diameter, bicristal width, and body weight, as well as in lower leg and chest circumferences and in all measures of fatty tissue.

It seems as if now we are dealing with fairly **corpulent** entities. The motorically ***superior*** entities displayed a sequence of low values of transversal dimensions

Table 1. *Results of the first measurement*

Motor Var.	INF	MOD	SUP	D
side steps	3.24	3.62	3.89	0.65
obstacle course	3.67	4.08	4.32	0.65
balance bench stand	1.94	2.35	2.60	0.66
straddle seat	2.56	2.70	2.96	0.40
hand tapping	2.17	2.61	2.89	0.71
foot tapping	2.60	3.04	3.25	0.65
standing broad jump	2.61	3.17	3.54	0.93
ball throwing	2.22	2.45	2.97	0.75
20m run	2.94	3.49	3.91	0.97
sit-ups	2.78	3.20	3.65	0.86
bent arm hang	1.56	1.77	2.26	0.69
3min run	3.09	3.42	3.76	0.67
			Sum	8.60

Morphological Var.	INF	MOD	SUP		D1	D2
body height	2.75	2.74	2.79		0.21	1.01
leg length	3.09	3.04	3.08		0.16	0.95
arm length	2.76	2.75	2.80		0.21	1.00
wrist diameter	2.75	2.72	2.79		0.01	0.93
knee diameter	2.66	2.62	2.69		-0.06	0.87
biacromial width	3.73	3.72	3.79		-0.07	0.89
bicristal width	3.24	3.15	3.17		-0.32	0.79
body weight	2.59	2.50	2.50		-0.43	0.71
forearm circumference	2.68	2.73	2.68		-0.48	0.46
lower leg circumference	2.77	2.77	2.76		-0.48	0.55
average chest	2.48	2.46	2.41		-0.60	0.47
upper arm skin fold	3.73	3.88	4.04		0.90	-0.16
back skin fold	4.19	4.34	4.49		1.00	0.02
abdominal skin fold	4.22	4.34	4.47		0.92	-0.10
				CINF	-0.14	0.03
				CMOD	0.00	-0.05
				CSUP	0.14	0.02

Legend: Var. - used variable; INF, MOD, SUP - means of inferior, moderate, superior group; D=max. differences, Sum.-total difference; D1, D2- discriminant functions; CINF, CMOD, CSUP - group centroids

Table 2. *Results of the second measurement*

Motor Var.	INF	MOD	SUP	D
side steps	3.04	3.43	3.69	0.65
obstacle course	3.52	3.82	4.16	0.65
balance bench stand	2.17	2.47	2.60	0.44
straddle seat	2.70	2.88	2.98	0.28
hand tapping	2.49	2.82	2.94	0.45
foot tapping	2.56	2.93	3.20	0.64
standing broad jump	2.40	2.92	3.30	0.90
ball throwing	2.17	2.50	2.88	0.71
20m run	3.07	3.55	3.82	0.75
sit-ups	2.92	3.22	3.45	0.53
bent arm hang	1.85	2.06	2.42	0.57
3min run	2.60	2.95	3.06	0.46
			Sum	7.02

Morphological Var.	INF	MOD	SUP		D1	D2
body height	2.95	2.94	2.94		-0.68	0.35
leg length	3.25	3.18	3.21		-0.75	0.48
arm length	2.72	2.71	2.74		-0.53	0.25
wrist diameter	2.88	2.91	2.87		-0.34	-0.33
knee diameter	2.69	2.67	2.67		-0.37	-0.32
biacromial width	3.56	3.56	3.56		-0.53	-0.17
bicristal width	2.94	2.86	2.83		-0.84	0.00
body weight	2.61	2.57	2.51		-0.69	-0.22
forearm circumference	2.61	2.68	2.65		-0.20	-0.72
lower leg circumference	2.69	2.67	2.67		-0.59	-0.33
average chest circumference	2.54	2.54	2.50		-0.52	-0.44
upper arm skin fold	3.63	3.79	3.88		0.94	0.04
back skin fold	4.08	4.26	4.35		0.96	0.01
abdominal skin fold	4.10	4.30	4.36		0.99	-0.03
				CINF	-0.14	0.01
				CMOD	0.03	-0.03
				CSUP	0.11	0.02

Legend: Var. - used variable; INF, MOD, SUP - means of inferior, moderate, superior group; D=max. differences, Sum.-total difference; D1, D2- discriminant functions; CINF, CMOD, CSUP - group centroids

Table 3. *Results of the third measurement*

Motor Var.	INF	MOD	SUP	D
side steps	3.26	3.58	3.80	0.54
obstacle course	3.29	3.66	3.93	0.63
balance bench stand	2.19	2.43	2.50	0.31
straddle seat	2.88	3.07	3.08	0.21
hand tapping	2.54	2.82	2.92	0.38
foot tapping	2.49	2.78	3.02	0.54
standing broad jump	2.27	2.70	3.01	0.73
ball throwing	2.13	2.44	2.78	0.65
20m run	3.16	3.57	3.78	0.63
sit-ups	2.89	3.12	3.26	0.36
bent arm hang	1.83	2.00	2.34	0.51
3min run	2.56	2.89	2.92	0.36
			Sum	5.84

Morphological Var.	INF	MOD	SUP		D1	D2
body height	3.01	2.99	2.98		-0.02	-0.68
leg length	3.24	3.18	3.19		-0.02	-0.59
arm length	2.88	2.87	2.89		0.17	-0.81
wrist diameter	2.82	2.86	2.79		0.13	-0.98
knee diameter	2.59	2.58	2.55		0.12	-0.96
biacromial width	3.18	3.20	3.17		0.03	-0.92
bicristal width	3.07	2.99	2.95		-0.50	-0.47
body weight	2.63	2.60	2.53		-0.34	-0.68
forearm circumference	2.62	2.67	2.63		-0.03	-0.92
lower leg circumference	2.61	2.59	2.57		-0.38	-0.62
average chest circumference	2.62	2.64	2.58		-0.31	-0.69
upper arm skin fold	3.51	3.67	3.74		0.99	-0.24
back skin fold	3.97	4.15	4.22		0.98	-0.38
abdominal skin fold	4.02	4.20	4.26		0.97	-0.34
				CINF	-0.13	0.01
				CMOD	0.03	-0.04
				CSUP	0.10	0.03

Legend: Var. - used variable; INF, MOD, SUP - means of inferior, moderate, superior group; D=max. differences, Sum.-total difference; D1, D2- discriminant functions; CINF, CMOD, CSUP - group centroids

and body volumes, as well as fatty tissue. It seems as if the restructuring and redistribution has occurred which is directed at higher optimization of movement, so these entities look now more like **athletic** ones. Motorically ***moderate*** entities are still of a markedly low body height with a few slightly more pronounced measures (wrist diameter, biacromial width, forearm circumference). Body shape of these entities is still **tiny**; they have a modest body constitution. Discriminant analysis indicates serious changes induced by the applied treatment, although both discriminant functions are still significant. The first function describes the differences between the motorically superior and the inferior entities, absolutely in favour of the superior ones, whereas the second discriminant function, with a somewhat smaller intensity than in the first measurement, differentiates the motorically moderate, average subjects from the rest of entities. So it can be said that the first part of the transformational process accentuated the differences in the space of morphology between the extremely polarized groups as regarded their motor abilities, but it decreased the differences between the motorically average entities and the rest of the sample.

According to the data in Table 3, in the final measurement the significant decrease in the range values of extreme scores was registered (total=5.84), which were far smaller than the values registered in previous measurements, especially in the first one (8.60). We can say that the total range was cut in half.

This fact suggests that the motorically superior and inferior boys drew closer in the space of morphology. Serious changes are also visible in the fact that the motorically ***inferior*** boys became superior in numerous morphological parameters (body height, leg length, knee diameter, bicristal width, body weight, lower leg circumference and, as in previous measurement, all variables of fatty tissue). The motorically ***superior*** boys are at this time point morphologically inferior in almost all variables (body height, all four transversal measures and all measures of body volume and, as in previous measurement, with markedly small amount of fatty tissue). Simultaneously, motorically ***moderate*** entities displayed a sequence of expressed values (diameters of joints, biacromial width and measures of body voluminosity). Discriminant analysis still generates two discriminant functions: the first one, more pronounced, which differentiated the inferior from the superior entities exclusively on the basis of fatty tissue measures; and the second, somewhat less pronounced, which differentiated the motorically moderate entities from the others literally in every morphological indicator. So, after the partitioning of the first characteristic (fatty tissue), the rest in the space of morphology was going in favour of the motorically average entities.

Discussion

The obtained results indicate a few very important facts. First of all, under the influence of the applied programme, that is transformational process, the two interrelated transformational effects occurred. The first effect was produced in a way that the motorically inferior entities, especially in the second part of the treatment (between the second and the third measurement), markedly improved their morphological status, whereas the superior ones were stagnating obviously. Therefore, it is feasible to say that the differentiating character of the treatment was discovered - the programme ensured the conditions for better improvement to the motorically poorer, in contrast to the motorically more proficient entities, whose benefits from the treatment in supporting their growth and development were fewer. As the treatment lasted 18 months, with the total sample of 249 seven years old boys, these effects could hardly be regarded as induced by chance. Preferably, we can infer that the general lower limit of motor tasks realization has been elevated, which was expressed as the better support for morphologically less developed boys, who so gained the chance to develop additionally.

At the same time, motorically more efficient children probably were not even in a position to improve considerable their morphological and body shape capacities; they simply continued with routine exploitation of their constitutional features in movement structure realizations, which led to a relative stagnation, in the context of the whole sample.

Simply, motorically less proficient children started, slowly but steadily, to gain on the more efficient children, so the differences in motor efficiency became ever smaller. Reconfiguration of morphological characteristics in children more sensitive to stimuli and support was naturally directed at optimization, integration and incorporation of resources into the organism.

This is confirmed also by the morphological indicators of the motorically moderate children, because the changes were registered also in this group and they can be described only as the support for growth and development. Since all the observed children progressed, the intergroup relations changed the structure of morphological capacity for additional development, which resulted in the equalization of morphological characteristics. The motorically less proficient and the moderately efficient children obtained in this way a strong leverage in the support for heir growth and development, which was identifiable by means of the applied research methods. Although the changes might be regarded as slow and seemingly modest, one cannot overlook the considerably decreased ranges in literally all the variables describing the differences in morphological measures between the extremely distant groups. All these considerations allow us to state that the applied treatment ensured uneven conditions for the support for children's morphological growth and development as regards their initial motor features, and all in favour of, mostly, motorically less efficient children.

This research indicates that it is possible to identify the processes which were occurring during the treatment, depending on the initial motor status, hence also on the sensitivity to the applied stimuli. The trend of equalization of all three groups was noticed in the space of motor abilities (inferior, moderate, and superior). Also, it was noticed that the morphological status, as well as its changes, was markedly characterised by the initial motor configuration. Restructuring of morphological characteristics was directed at the actual and long-term optimization of motor and morphological system, which was recognizable after only 18 months of treatment performed in school. The universal model of process parameter identification was established upon the differences among the groups with the data. For further analysis only the common variability in the space of morphological measures was retained. In that way the non-systematic elements of the total results was partitioned, so eventually the data consisted of only the part of the variability which was generated exclusively from of the following two sources: 1) natural development, and 2) treatment programme effects. Therefore it is feasible to presume that transformational processes, even when conducted in different way, will produce the same effects.

Undoubtedly, the capacities of movement and other kinds of stimulations are not limitless. They allow relatively greater improvement shifts of the inferior boys and the better support for growth and development than is the case with the motorically superior boys. Only an extremely small number of superior children will presumably continue their total motor and morphological development, and even that, only if more intensive stimuli will be applied. However, when it comes to the question of high intensity workouts applied to children, no one can be quite sure that such stimuli are still within the acceptable bio-medical (health-related) boundaries, which is obviously the issue pertaining to the problems of adequate selection for international quality level sport.

The aim of the research was to establish global principles of general support for growth and development of 7 year old boys in order to identify epistemological characteristics of future transformational process programmes which necessarily should take into account the initial position within motor area, which is reflected by general energetic and other accumulations with the effects in morphological area. These goals were reached in this paper.

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