Miroslav Dodig*[1]

CHANGES IN LATENT STRUCTURE OF MOTOR DIMENSIONS UNDER THE INFLUENCE OF KINESIOLOGIC OPERATORS

SPREMEMBE V LATENTNI STRUKTURI MOTORIČNIH DIMENZIJ POD VPLIVOM KINEZIOLOŠKIH OPERATERJEV

Abstract

On the sample of 216 male examiners 15 years of age, kinesiologic operators with context of mono-structural movement and cyclic and acyclic type were applied, and then the basic operators of isometric and isotonic type and poly-structural complex movement. The application lasted four months, with three trainings a week; each training lasted 60 min. The intensity and volume of applied operators in the initial state were 70% of maximal value of each individual, being progressively discontinuously programmed. A battery of 24 motor tests was applied to determine motor dimensions at the initial and final state of examinees and then analyzed. The factor structure of motor dimensions at the initial and final examinees state were analyzed (Little Jiffy) (Kaiser, & Rice 1974) and existence, transformation and congruence (the Tucker method) of the received structure under the influence of applied operators were established. Effected differences in factor structure are based on the formation of quality structure and on structural unity of latent dimensions. This refers to the mechanism for intensity and duration of excitation, the mechanism for movement structuring, and the mechanism of functional synergy and tonus regulation.

Key words: motor abilities, transformations process, factor analysis, congruence, latent structure, male, quantitative changes, qualitative changes

[1] ***Faculty of Maritime Studies, University of Rijeka, Croatia***

****Corresponding author:***
Studentska 2.
51000 Rijeka Croatia,
Tel: +385 51 338 411.
E-mail: dodig@pfri.hr

Izvleček

Na vzorcu 216-ih merjencev moškega spola, starih 15 let, so bili aplicirani monostrukturni kinetični dejavniki cikličnega in acikličnega tipa, osnovni dejavniki izotoničnega in izometričnega tipa in polistrukturna kompleksna gibanja. Vadba je potekala tri mesece, trikrat na teden. Posamična vadba je trajala 60 minut. Intenzivnost in obseg (v začetku 70% od maksimalnih vrednot začetnega stanja posameznika), sta bila progresivno diskontinuirano programirana. Za ocenitev motoričnih dimenzij začetnega in končnega stanja merjencev je bila uporabljena baterija 24 motoričnih testov, na osnovi katerih je bila izvedena analiza. Ugotovljena je bila faktorska struktura gibalnih dimenzij začetnega in končnega stanja (Little Jiffy) (Kaiser in Rice, 1974) ter ugotovljen eksistenca, transformacija in kongruenca dobljenih struktur pod vplivom uporabe vadbenih dejavnikov (Tuckerjeva metoda). Spremembe, ki so se pokazale v faktorskih strukturah, temeljijo na njihovem kvalitativnem oblikovanju in na strukturalni enotnosti latentnih dimenzij. To se nanaša na mehanizme za uravnavanje intenzivnosti in trajanja ekscitacije, za strukturiranje gibanja ter za funkcionalno sinergijo in regulacij tonusa.

Ključne besede: motorične sposobnosti, transformacijski proces, latentna struktura, moški, faktorska analiza, kongruenca, kvantitativne spremembe, kvalitativne spremembe.

INTRODUCTION

Recently, and especially the last few years, much has been done to construct reliable motor measurement gauges and to systematically analyse the structure of the motor sphere. A large number of factorial studies have been done and a model of motor sphere structure has been created. Structurally directed research of motor sphere based on the cybernetic model gave significant results from the structural and functional points of view. The studies of internal structures and functional mechanisms based on afferent and reafferent processes (Bernstajn, 1947) made the defining of physiological processes, responsible for the variability and co-variability of manifested motor reactions, possible.

On the basis of extensive research, the structure of motor dimensions is defined by the mechanism for movement structuring, the mechanism for functional synergy and tonus regulation, the mechanisms for excitation intensity regulation and excitation duration regulation. In the higher order sphere, these four mechanisms make the factors for movement regulation and excitation duration, while in the lower order sphere the following phenomenological measurement groups exist: strength, speed, balance, precision, flexibility and coordination (Kurelić, Momirović, Stojanović, Šturm, Radojević, & Viskić – Štalec, 1975; Gredelj, Metikoš, Hošek, & Momirović, 1975; Šturm, Strel, & Ambrožič, 1990; Pistotnik, & Milić, 1996; Dodig, 1979, 1998, 2002); Pišot, (1998).

It is still not possible to create a consistent hierarchical model for the motor space structure. The integral development of motor abilities allows the formation, development and change of the central nervous system structure responsible for different motor manifestations. In such a way, the creation of different adaptive programmes in the central nervous system under the influence of kinesiologic operators is made possible (Anohin, 1970.).

This study is oriented towards the latent structure of motor sphere and changes of this structure under the influence of transformation processes. The research represents an exploratory formal model that is directed towards defining the structural changes of motor dimensions under the influence of kinesiologic operators.

METHODS

Participants

The basic task of this research was to define the latent structures of motor dimensions, as well as their changes influenced by kinesiologic operators. The population from which the sample was defined consisted of male persons 15 years of age. Because of the nature of the group and the research done, the examinees had to fulfil, besides the general terms, the term not to interrupt the continuity of exercise more than three times per training. Due to this, out of 240 examinees some of them were eliminated; the final sample consisted of 216 examinees. The size of the sample allowed for as many degrees of freedom in obtaining a correlation coefficient (equal to or larger than 0.12) that is different from zero, with the conclusive error smaller than 0.01 or the degree of reliability greater than 0.99.

Instruments

Toward the international measurement subject, a battery consisting of 24 motor tests (that were already information carriers in many kinesiologic researches) was constructed. Since the minimal number of tests necessary for the identification of latent dimensions amounts is three, for every hypothetical primary factor in this research, three tests were conducted. For each test, the full name, cipher and ordinal number is stated in the tables.

1. EXPLOSIVE STRENGTH (ES); 1) standing long jump (MDM), 2) throwing a medicine ball from the chest (MBMP), 3) hop, skip and jump without running (MTRS)
2. REPETITIVE STRENGTH (RS); 1) jump upon a small bench with one third of weight (MNK), 2) trunk erection – on Swedish crate (MITS), 3) mixed crossbar body lifting (MMZ)
3. STATIC STRENGTH (SS); 1) maintenance in crossbar body lifting (MIZG), 2) maintenance in half knee-bend with one half of body weight (MIZP), 3) maintenance on parallel bars (MIZS)
4. PRECISION (PP); 1) darts (MPIK), 2) aiming at vertical target with leg (MGAN), 3) aiming at horizontal target with arm (MGAR)
5. FLEXIBILITY (FL); 1) inversion with stick (MISP), 2) sitting inversion (MPS), 3) side string (MSPA)
6. SPEED (SP); 1) hand tapping (MTAR), 2) foot tapping (MTAN), 3) trunk lifting in 30 seconds (MD30)
7. COORDINATION (CO); 1) dexterity with stick (MKOP), 2) slalom with three balls (MS3M), 3) dexterity in air (MOZ)
8. BALANCE (BA); 1) standing on one foot with closed eyes (MSZO), 2) cross standing on a low bench (MSG), 3) standing on turned bench for balance (MSOK)

Procedure

At the beginning and the end of experiment, motor task testing was conducted over two days. The total number of tests applied was divided into two parts. The test sequence was organized in such a way to minimise influence of the preceding test on the next one exists. Prior to kinesiologic operator application, examinees were divided into groups of twenty. During the three-month research period, examinees had three trainings per week, with days of rest in between.

The duration of the training was 60 minutes. The content of kinesiologic operators was applied in the form of: mono-structural cyclic and acyclic motions, basic operators for the kinesiologic transformations of isometric and isotonic character, and poly-structural complex motions.

The intensity and range of the applied operators amounted to 70% of the maximal value in the initial state, and discontinuously rose to 120% by the end of experiment. Methods of work included circular cell work and group work. Before the beginning of the research, examinees were informed about the complete programme and work plan, as well as the way they should conduct personal logs. As the programme was individually gauged, every examinee could succeed in the programme.

Methods for transformation, condensation and mathematical data processing were chosen according to the requirements for data analysis. Latent structure analysis of motor dimensions in the initial and final states was done using the same algorithm. The programme Little Jiffy, Mark

IV (Kaiser, & Rice, 1974) was used. The congruence coefficients of factorial structures obtained from the matrices of orthogonal projections of vector variables on factors in the initial and final states were calculated using the Tucker algorithm (Tucker, Koopman, & Linn, 1969; Harman, 1970).

RESULTS

The research results are presented as data analysis required. The obtained results, as well as their interpretation are divided in three sections: factor structure analysis of the initial state, factor structure analysis of the final state, and congruence analysis of the both obtained structures. The results are presented in tables as computer symbols.

Factor structure of the initial state

The variable correlation in the initial state that served for estimation of hypothetical factors, though not too high, permits the conclusion that the gauges in question represent the defined sphere relatively well. The average correlation between motor variables is rather low (.17). It results from low average correlations of particular variables with the rest of them. Several motor reactions variables have a very low reciprocal correlation, while the rest do not differ much from the average correlation. Flexibility and balance motor reactions have lower average correlations than other motor variables. On the contrary, motor reactions in whose variance of mechanisms for structure regulation of complex motor reactions, excitation duration and excitation intensity take part, have a greater correlation with other motor variables. The variability of determination coefficients that are defined as systematic communality estimation is rather low.

Motor reactions in whose variance the mechanisms linked with excitation process take part have greater variances, while motor reactions where the mechanisms for regulation of synergists and tonus are responsible for the variability (flexibility, balance and precision) have smaller variances in the image sphere, and therefore an insecure stability. Conversely, motor reactions such as strength, speed and coordination have considerable communalities that represent relatively homogenous vector bundles. The expected communality values are smaller than expected due to small number of variables. It results that the specific variance value of the used variables is very high, which does not give a good possibility of obtaining well-defined latent dimensions. The representative of the analysed group of variables for the estimation of latent motor dimensions is medium (.72). Most gauges have weak representative coefficients. This suggests that the variables are burdened with partial variances, and therefore the structure of latent dimensions will be rather badly defined. It is obvious that there is no especially good factor analysis information. The coefficients of representative, sensibility for the number of variables, factors and examinees, as well as the level of correlation in general contributed to this.

On basis of the characteristic covariance matrix values of the analysed tests, it can be concluded that in the sphere covered by these seven variable dimensions exists as resulting from the applied Guttman–Kaiser criterion (Guttman, 1940, 1953; Kaiser, 1958, 1970; Harris, & Kaiser, 1964 – the Kaiser–Harris independent groups model). Through the orthoblique transformation (Harris, & Kaiser, 1964 – quartimax criteria) and the factor simplicity index (IFS1) of the analysed motor variables in the initial state (Table 1), the matrix complex was obtained. It shows a fairly good degree of factor structure simplicity (.79). The result might have been better if the complexity of

Table 1: Factor structure of the motor variables in the initial state

Variables	RS	ES	CO	SP	SS	FL	BA	IFS1
MDM	.02	.61*	-.11	.40*	.34	.31	.19	.88
MBMP	-.09	.43*	.10	.31	.13	.25	.02	.43
MTRS	-.09	.56*	.02	.31	.26	.21	.19	.86
MNK	.41*	.35	-.41*	.12	.16	.22	.17	.56
MITS	.34*	.14	-.38*	-.07	.05	.13	.17	.24
MMZ	-.08	.45*	.01	.44*	.45*	.28	.29	.39
MIZG	.11	.26	-.13	.20	.40*	.09	.25	.82
MIZP	.68*	-.10	-.52*	-.37	-.19	-.11	.01	.98
MIZS	-.23	.25	.16	.44*	.57*	.23	.34	.87
MPIK	.26	.01	-.16	.01	.02	-.07	.10	.40
MGAN	-.28	.16	.27	.29	.23	.23	.09	.63
MGAR	-.33*	.22	.22	.27	.26	.31*	.11	.74
MISP	-.17	.06	.14	.09	.14	-.12	-.01	.43
MPS	.08	.10	-.21	.08	.06	.36*	.03	.89
MSPA	-.17	.31	.14	.37*	.13	.26	.01	.48
MTAR	-.33	.25	.22	.51*	.39*	.24	.18	.90
MTAN	-.25	.13	.14	.38*	.27	.15	.11	.81
MD30	-.31	.27	.20	.46*	.41*	.15	.14	.39
MKOP	-.47*	-.02	.59*	.20	.10	-.08	-.05	.98
MS3M	-.53*	.03	.57*	.29	.22	-.03	.10	.64
MOZ	.01	-.30	.22	-.30	-.27	-.32*	-.23	.56
MSZO	.04	.07	-.04	.08	.20	.07	.31*	.82
MSG	.13	.09	-.14	.04	.16	.02	.36*	.97
MSOK	-.31	.26	.18	.33*	.30	.13	.30*	.59

Legend: MDM – standing long jump; MBMP – throwing medicine ball while lying down; MTRS – hop, skip and jump without running; MNK – jump upon a small bench with one third of weight; MITS – trunk erection – on Swedish crate; MMZ mixed crossbar body lifting; MIZG – maintenance in crossbar body lifting; MIZP – maintenance in half knee-bend with one half of body weight; MIZS – maintenance on parallel bars; MPIK – darts; MGAN – aiming at vertical target with leg; MGAR – aiming at horizontal target with arm; MISP – inversion with stick; MPS – sitting inversion; MSPA – side string; MTAR – hand tapping; MTAN – foot tapping; MD30 – trunk lifting in 30 seconds; MKOP – dexterity with stick; MS3M – slalom with three balls; MOZ – dexterity in air; MSZO – standing on one foot with closed eyes; MSG – cross standing on a low bench; MSOK – standing on turned bench for balance.

RS – Repetitive Strength
ES – Explosive Strength
CO – Coordinatio
SP – Speed
SS – Static Strength
FL – Flexibility
BA – Balance
* – salients marked with asterix
IFS1 – indeks of factorial simplicity, for each variable

certain variables had been smaller. The so obtained simple structure offers a low degree of probability; therefore the factor interpretation should be accepted with a certain level of insecurity. Factor interpretation was executed on basis of: vector variables coordinates in the factor sphere, correlations between motor tests and motor dimensions, and inter-correlations of isolated latent dimensions. The factor structure matrix is in Table 1, while the inter correlation matrix of latent dimensions in Table 2. The percentage of variance contribution of each latent dimension to the total extracted variance ($W^2 1$) and the level of generalization index (q1) of the obtained orthoblique factors are in Table 2.

Table 2: Intercorrelations of motor factors, reliability index and mutual variance percentages belonging to motor factors in the initial state

Factors	**RS**	**ES**	**CO**	**SP**	**SS**	**FL**	**BA**	**q1**	**$W^2 1$**
RS	1.00	-.05	-.77	-.47	-.26	-.10	.01	.81	23.98
ES		1.00	-.07	.62	.50	.47	.31	.79	20.79
CO			1.00	.29	.11	-.15	-.09	.79	16.20
SP				1.00	.70	.51	.33	.83	14.77
SS					1.00	.32	.58	.77	13.35
FL						1.00	.19	.68	5.64
BA							1.00	.66	5.26

Legend (see Table 1)

q1 – domain validity (indeks of realiability of the factors)

$W^2 1$ – relative contributions of factors (percentagees)

In the coordinate system obtained from orthoblique transformation, the first factor is predominantly defined by motor reactions whose variance depends on the ability of long lasting repetition of simple movements manifested as repetitive strength (RS). The function of this factor is manifested in long lasting energy mobilisation, which confirms the existence of its dimension as repetitive strength.

The tasks that in the factor sphere are closest to the well-defined second orthoblique factor are homogeneous in their manifest content. The maximal vector projections onto this dimension have those motor reactions that estimate the explosive strength factor (ES). The character of motor reactions was performed as the ability to give great force to one's own body or to a certain object. The function of this factor is manifested in short lasting mobilisation of maximal energy; this confirmed the existence of this dimension as explosive strength. The variances of manifested reactions, which define the third orthoblique factor, are those whose variance depends on the ability to regulate and form the motion structures. This regulation of movement structures is decisive for coordination. The group of motor reactions whose vectors have maximal projection onto this dimension is very homogeneous in terms of its manifested content. This confirms their hypothetic assignment. The characteristic of this factor, as a regulative function of movement structures, confirmed the existence of this dimension as coordination (CO).

The forth latent dimension, with an explicitly simple structure, is defined by motor reactions whose variance depends on the ability of frequency speed in task realization. The primary ability for variability performing these tests is the capability to perform the largest possible number of simple movements in two opposite directions with maximal speed in a time unit. The results of motor reactions are dependant on the ability of the mechanisms for synergic regulation, tonus control of agonists and antagonists. This is decisive for the efficiency of these types of motor reactions. Maximal projections onto this dimension have variables of motor movements with analogous manifested content, which confirms the stability of this dimension as the speed factor (SP).

The fifth orthoblique factor is predominantly defined by motor reactions of static endurance and those motor reactions of dynamic endurance where certain static strain appears in some phases. The primary ability for variability in these motor reactions is the ability of long lasting energy mobilisation, which confirmed the existence of this dimension as static strength factor (SS).

The sixth orthoblique factor has a very complicated structure, mostly defined by motor flexibility (FL) reactions and, to a lower extent, precision. The primary ability for variability in these motor reactions is the ability to perform simple movements of maximal amplitude and precision. The results in motor movements depend on the mechanism ability for synergic and tonus regulation. The absence of distinctly high coordinates is probably the result of gauges that mostly measure the morphologic sphere than the functional characteristics of this factor.

Motor reactions closest to the seventh orthoblique factor in the factor sphere are responsible for balance factor estimation (BA). Vector projections onto this dimension are not well expressed which means that the actual existence of this dimension within this sphere is doubtful. The primary variability ability in these motor reactions is represented by the ability of the body to keep its balance in a given position. The characteristic of this factor is manifested through automatic regulation mechanisms of a lower order that are based on information from the static, visual and kinaesthetic analyzers. The low quantity of the explained variance and the generality coefficient suggest that this dimension (like the previous one) can be considered an artefact of hyper-factorisation.

Factor structure of the final state

The correlation of motor reaction variables in the final state (after operator application) is greater than in the initial state, which suggests that certain changes occurred, and that the sphere, formed as a result of operator application, is stable. The correlation between motor reactions after operator application has considerably improved; its average now being .25. Transformations of regulation mechanisms for excitation duration manifested as static and repetitive strength, and of mechanisms for tonus and agonists/antagonists regulation manifested as motion frequency speed are mainly responsible for the increase in average correlation. Other mechanisms also showed an increase in average correlation, but here the increase is not so expressed. Flexibility, precision and balance motor reactions did not show a considerable increase in the average correlation. Determination coefficients represent a systematic estimation of communality. They have improved considerably after operator application, except those that have lower variances in the image sphere (precision, flexibility and balance), which means they are unstable. Strength and speed (as simple motor reactions), and coordination (as a more complex motor reaction) all have relatively homogenous vector complexes. It is obvious that in these gauges a reduction of specific variance occurred under the operator influence, and this affected the homogeneity of the tests. The communality value would probably be higher if there were a larger number of tests and examinees. The representative of motor reactions in the analysed population for the estimation of latent motor dimensions is somewhat better (.85). Most of the gauges for the

Table 3: Factorial structure of motor variables in the final state

Variables	SP	SS	RS	ES	FL	CO	BA	IFS2
MDM	.33	.45	.50*	.59*	.38	-.43	-.05	.64
MBMP	.48*	.22	.14	.59*	.33	-.04	-.04	.74
MTRS	.33*	.12	.05	.57*	.17	-.03	-.02	.86
MNK	.26	.63*	.73*	.31	.46	-.61*	-.08	.92
MITS	.37	.61*	.66*	.24	.49	-.56*	.01	.54
MMZ	.61*	.72*	.62*	.55*	.71*	-.51*	-.17	.39
MIZG	.46	.73*	.63*	.27	.69*	-.58*	-.11	.37
MIZP	.25	.68*	.60*	.21	.53*	-.54*	.10	.82
MIZS	.57*	.61*	.47	.38	.71*	-.39	.05	.91
MPIK	.02	.20	.22	-.01	.07	-.24	.03	.56
MGAN	.35	.38*	.27	.25	.37	-.29	-.07	.40
MGAR	.47*	.34	.29	.31	.36	-.27	-.02	.50
MISP	-.17	.01	-.13	-.07	.30	.13	.04	.27
MPS	.16	.10	.19	.16	.21	-.10	.17	.37
MSPA	.36	.35*	.34	.33	.38	-.28	-.10	.39
MTAR	.72*	.32	.20	.48*	.52*	-.11	-.06	.88
MTAN	.59*	.35	.24	.25	.49*	-.17	.01	.75
MD30	.42	.56*	.57*	.27	.55*	-.44	-.03	.64
MKOP	-.16	-.43	-.48*	-.16	-.31	.55*	.02	.94
MS3M	.36	-.12	-.24	.18	.13	.36	-.13	.58
MOZ	-.38	-.44	-.44*	-.32	-.41	.50*	.12	.78
MSZO	.25	.21	.12	.19	.28	-.09	.37*	.91
MSG	-.06	.24	.20	-.03	.13	-.30	.28*	.50
MSOK	.56*	.11	-.03	.46*	.33	.03	.06	.42

Legend (see Table 1)

measurement of precision, flexibility and balance factors are greatly burdened with partial co-variances. Therefore, the structure of these dimensions is unstable, which raises questions about their existence in this sphere. The number of factors in this sphere was also determined with the Guttman-Kaiser criterion. Seven significant latent dimensions are derived from this criterion. Characteristic values of the covariance matrix of the analysed tests allow for the conclusion that in this sphere of tests there was no change in the number of dimensions due to operator application. On basis of the orthoblique transformations and the factor simplicity indices (IFS2) of the analysed motor tests in the final state (Table 3), a smaller, but still satisfactory, degree of factor structure simplicity was obtained (.71). A great contribution to such a result came from the large degree of factor complexity in certain tests, which increased under the influence of applied operators. This made the interpretation of factors more difficult and the uncertainty in accepting the solutions obtained increased. Factor interpretation was executed on basis of: vector variables coordinates in the factor sphere, correlations between motor tests and motor dimensions, and inter-correlations of isolated latent dimensions. Factor structure matrix is mentioned in Table

4, while the inter-correlation matrix of latent dimensions in Table 4. The percentage of variance contribution of each latent dimension to the total extracted variance ($W^2 2$) and the level of generalization index (q2) of the obtained orthoblique factors are stated in Table 4.

Table 4: Intercorrelations of motor factors, reliability index and mutual variance percentages belonging to motor factors in the final state

Factors	**SP**	**SS**	**RS**	**ES**	**FL**	**CO**	**BA**	**q2**	**$W^2 2$**
SP	1.00							.88	25.02
SS	.52	1.00						.87	19.21
RS	.37	.84	1.00					.86	17.56
ES	.64	.42	.36	1.00				.80	14.00
FL	.75	.84	.62	.49	1.00			.84	11.47
CO	-.26	-.75	-.85	-.26	-.51	1.00		.84	9.84
BA	-.10	-.02	-.05	-.10	-.02	-.01	1.00	.42	3.04

Legend (see Table 2)

TMaximal variable vector projections on the first orthoblique factor have those motor reactions, for whose variability the mechanisms for tonus, agonist and antagonist regulation are responsible, manifested as speed (SP). Obviously, the operator application affected the variance of this latent dimension. These changes usually relate to the capability of the mechanisms for regulation and tonus control, and regulation of agonists and antagonists. The exchange of role of active muscle groups takes place; as with every alteration of innervations, the signal is taken over. Clearly expressed change in this latent dimension under the influence of operator application in form of quantitative changes, also influenced the changes of essential structural unity of the latent dimension in a qualitative sense.

The second latent dimension in the final state, which is obtained in the factor space through orthoblique transformation, has a notably complicated structure. It is defined by motor reactions whose variance depends on the mechanisms for regulation of excitations' duration, expressed as static force (SS). High projections on this dimension are found in those motor reactions whose variance depends on the synergistic regulation and tonus regulation, manifested as flexibility and precision. The projections of flexibility vector are greatly expressed both in the initial and the final state, which means the movement amplitude plays an important role in movements where maximal excitation duration is required. The changes induced by operator application in this dimension originated as an essential change, mostly based on the increased possibility of activating a large number of motor units, and on keeping this activity in isometric type of muscle strains over a longer time period.

Motor reactions in the factor field which are the closest to the third orthoblique factor, defined in the final state, depend on the mechanism for regulation of excitation duration manifested as repetitive strength (RS). Specifically, the group of tests whose vectors have maximal projections onto this dimension indicate that considerable quantitative changes took place in this structure under the influence of applied operators. The greatest changes and their structural formation are represented by the changes relating to the regulation of excitation duration and the capability of centres to postpone inhibition irradiation in the activated zones. Therefore, under operator influence, the improvement of regulation process of excitation duration of the primary motor centres occurred. Maximal vector projections on the forth orthoblique factor in the final state are found with those motor reactions whose variance depends on the mechanism for the regulation of excitation intensity manifested as explosive strength (ES). By operator application, a quantitative change occurred in the structure of this dimension, which is obvious since vector projections are greater than in the initial state. Therefore, changes occurred on the deepest level of latent structure, meaning that an increase in short lasting mobilisation of maximal energy happened, and this in time sequences in which different muscle groups are included in the movement structure.

The fifth latent dimension in this sphere has a distinctly complicated structure. Its variability in motor reactions depends on the mechanism for tonus regulation and synergic regulation manifested as flexibility (FL). High projections onto this dimension are found with those motor reactions whose variability and co-variability respond to the mechanisms for regulation of excitation duration manifested as static strength. High and negative projections have motor manifested reactions of precision. Though it seems that simple motor reactions are in question where results depend on maximal movement amplitude, a high saturation with the mechanism for regulation of excitation duration manifested as static strength is obvious. Therefore, changes evident in this dimension after the operator application mostly occurred as a result of interactions with the mechanism for the regulation of excitation duration.

Motor reactions, which are, after the operator application, next to the well defined sixth orthoblique factor in the coordinate system, are homogenous in their manifest content. The primary quality for variability in these motor reactions is the mechanism capability for structuring of complicated movements manifested as coordination (CO). Maximal vector projections onto this dimension are greater in the final state, which occurred as a result of operator application. In question is the ability responsible for the fast performing of complex movements. The essential changes of the structural unity of this dimension occurred on the deepest level of latent dimension, consisting of the efficiency increase of the reticular system and the control of sub-cortical regulation mechanisms. This influenced the regulation and integration of partial motor functions with the task of solving and achieving motor information, on the controlled application of force and speed, when solving complex motor tasks.

The seventh latent dimension in this sphere distinctly has the weakest structure; its vector projections are badly expressed even after the operator application. This latent dimension is defined by motor reactions for whose variability the process regulation mechanisms from the static analyzer, visual analyzer and kinaesthetic receptors are responsible. It is beyond doubt that the balance factor (BA) is not completely an elementary motor ability. The applied operators left no trace in terms of structural change. It is completely obvious that the isolated balance dimension in this defined field represents an artefact of hyper-factorisation and can hardly be treated as a real motor ability. It is especially true after the operator application where the coefficient of generality is even lower, and where the participation in the total quantity of the explained variance is even smaller.

Congruency of factor structures of the initial and final states

Congruency coefficients of factor structures obtained from the matrix of orthogonal projections of variable vectors on factors in the initial and final state, gave information about structural changes in the obtained solutions (Table 5). The direct comparison of solutions' congruence

Table 5: Matrix of congruence coefficients for the factorial structures in the initial and final states

Factors	SP	SS	RS	ES	FL	CO	BA
RS	.73	.80	.62	.98	.88	.60	.52
ES	.82	.80	.75	.94	.87	.60	.54
CO	.84	.78	.81	.89	.82	.59	.51
SP	.60	.87	.53	.93	.78	.61	.47
SS	.80	.83	.70	.99	.93	.62	.57
FL	.99	.94	.97	.98	.95	.75	.67
BA	.72	.74	.71	.85	.89	.62	.77

Legend (see Table 2 and 4)

obtained in the initial and final state gave information about the real latent structure and its quality changes, under the influence of applied kinesiological operators. The specific determinacy of structures in the initial state is expressed by its inner determination and specificity of its inner complex. It qualitatively differs from structural specificity and inner complex in the final state. The basic structure of the factors remained identical after the operator application, which confirms the existence of basic functional mechanisms in the factor structure. The changes that occurred in the structures are based on qualitative formation of structures, as well as on the structural unity of latent dimensions.

The quantitative change of structure induced by the system of operator application in the first complex structure indicates the essential changes of structural unity of latent dimensions. The congruence of the first complex is poorly expressed (.60), which is understandable, as the first factor in the initial state is defined with the structure of mechanism for regulation of excitation duration manifested as repetitive strength. In the final state, the first factor is defined with the structure of mechanism for tonus and the synergetic regulation of agonists and antagonists manifested as speed. Qualitative changes of the structural unity of latent dimensions are a result of the influence of operators on the latent structure, as they increase speed possibilities of movements that are based on the mechanism for the regulation of excitation duration. Qualitative formation of speed factor structure under the influence of applied operators is oriented towards the change of mechanism for tonus and synergic regulation of agonists and antagonists from the initial to final state. In the initial state, the speed factor has considerable congruence coefficients with the mechanism responsible for energetic regulation, especially those responsible for intensity regulation and excitation duration under explosive and static strength. Congruence is a slightly smaller with the mechanism for flexibility regulation. This means that a motor reaction manifested as a repetition of a larger number of fast movements in opposite directions is congruent with the release of a huge force for ideal movement trajectory in time sequences where the initial impulse occurs. A similar congruence appears with the structure that is defined by isometric excitation duration of large muscle groups that fixate other muscles (especially muscles of extremities). A smaller congruency with stability factor occurred because of the influence of longitudinal skeleton dimensionality (in terms of lever lengths). In the final state, after operator application, a qualitative formation of the latent structure occurred, which is visible from greater congruency coefficients. A smaller congruence than in the initial state, but still a considerable one, exists with the mechanism for intensity regulation and excitation duration. A greater congruency occurred with the mechanism for regulation and formation of movement structures manifested as coordination. Besides the apparent simplicity of motor reactions manifested as movement performance frequency speed, the complete movement path is not defined, so, due to faster movement, this mechanism is probably more engaged in defining the optimal trajectory of movement. The greatest congruency occurs between the speed factor and the flexibility factor, which means that no considerable changes occurred between these two mechanisms; the reason should be found in the morphological influence on flexibility. The qualitative formation of speed structure in the frequency of simple movements is based on the development of mechanism for tonus and synergy regulation of agonists and antagonists in terms of greater coordination of movement. This applies to optimal movement trajectory. In such a way, the mechanisms for energetic regulation are less engaged, which had influence on more economical performance of fast movements. The congruency of structure before and after application of operator is very small which confirms qualitative changes in this structure. They permit the prediction that in the sphere of motor reactions different structures of speed movements can exist, and that application of kinesiology operators induces quantitative changes, which inevitably lead to qualitative changes in this sphere due to the multivariability of the sphere.

Structure congruency of the second complex obtained from the orthogonal projections of vector on isolated factors in the initial and final state shows that structural changes happened in this dimension. In the initial state, the second complex is defined by the mechanism for regulation of excitation intensity manifested as explosive strength. In the final state, this complex is defined by the mechanism for regulation of excitation duration, manifested as static strength. Qualitative formation occurred as a result of operators' application, which induced a change in this complex in terms of long lasting mobilisation with isometric muscle strain. Before operator application, the static strength factor shows a congruency with the structures for which mechanisms for tonus and synergic regulation of agonists and antagonists for speed, excitation intensity under explosive strength, and flexibility factor are responsible. The structural change in the static strength factor is considerable after the operator application (.83). The congruency of this mechanism is expressed with all mechanisms excluding the mechanism for balance. Congruency with mechanisms for regulation of excitation duration for repetitive strength, excitation intensity, synergy regulation of agonists and antagonists, tonus regulation and regulation of complex movement structures, shows a qualitative formation of static strength structure. The changes in the structure of this factor occurred as a greater possibility of long lasting mobilisation of energy under isometric strain of great muscle groups. The outcome was a greater congruency with other structures because a fixed point was offered, especially when peripheral parts of the body were moved under repetitive strength, explosive strength and simple movement frequency speed, which led to a change in relations of movement coordination. The greatest congruency coefficient with the flexibility factor, which did not change considerably, can be explained with a great saturation of flexibility factor with the longitudinal dimensionality of skeleton that had influence on the maximal movement amplitude (due to length of arms and legs). The changes that occurred in this dimension are based on the changes of mechanisms for regulation of excitation duration under static strength, in terms of the increase in ability of long lasting energy mobilisation. Besides quantitative changes in the regulation of excitation duration, the changes are also directed towards the structural unity of latent dimension. The mechanism for regulation of excitation duration rationalizes the process of energy usage, together with the mechanisms for regulation of excitation intensity, excitation duration, tonus and synergy regulation of agonists and antagonists. This is possible through better cooperation with the mechanism for regulation of complex movement structures. After the operator application, the static strength factor is on a higher qualitative level.

The third complex of variable vector congruency on isolated factors in the initial and final states obviously has a congruent structure. The qualitative changes in this complex are distinctly oriented towards projections changes that, in the initial state, have determined the specificity of the latent structure for regulation of complex movements performances manifested as coordination. Furthermore, the change in the complex is oriented towards the latent structure of mechanisms for regulation of excitation duration, expressed as repetitive strength. The structural changes that occurred in the third complex are mostly based on changes in the regulation of excitation duration, manifested as repetitive strength. Before operator application, the regulation mechanism of excitation intensity manifested as repetitive strength has considerable congruency coefficients with the static strength factor, simple movement frequency speed and flexibility. The congruency between these dimensions is completely understandable. The movement is proceeding in two different directions; the role of agonists and antagonists is interchanging at each change of direction, speed elements included. The muscle groups that generate force and assure the best possible foothold in terms of fixation of some parts of the body are activated in the same time. In the final state, the congruency of this structure with other structures' mechanisms considerably changed, tending towards greater differentiation. After operator application, the congruency with the factor of explosive and static strength diminished, while the congruency with flexibility and coordination factors was increased. By development of the excitation duration process under repetitive strength, the influence of mechanism for regulation of excitation intensity and duration under static strength was diminished. This led to a greater synergic regulation of agonist and antagonist type of flexibility under the primary influence of higher mechanisms for structuring purposeful movements manifested as coordination. The congruency of repetitive strength factors inside their own structure is poorly expressed (.62), which suggests a qualitative change in this structure (that is now more oriented towards the regulation mechanism of fast and coordinated movement) occurred. This led to the synchronization of primary motor centres in order to postpone the irradiation of inhibitory processes.

The fourth complex also quantitatively changed under the influence of applied operators, in terms of the structural unity of the latent dimension. In the initial state, this complex was determined with manifested reactions for whose variability and co-variability the mechanism for regulation of tonus and synergy of agonists' and antagonists' work was responsible, expressed as frequency speed. Differently from the initial state, in the final state this complex is mostly defined with the mechanism for excitation intensity regulation, manifested as explosive strength. The congruence of the solutions obtained from this sphere is expressed though identical dimensions are not in question. Before operator application, the mechanism for regulation of excitation intensity is manifested as explosive strength. It is congruent with the factors of speed, static strength and flexibility. It is completely obvious that the expression of great force for an optimal movement, from the point of view of ideal movement trajectories and time successions, results with the inclusion of different muscle groups in the structural motor action, which represents structural congruence with regard to the real content. After operator application, the congruence of explosive strength structures is expressed with all other dimensions, especially those where mobilisation of maximal energy is necessary. This applies to the mechanism for regulation of excitation duration under static and repetitive strength. Besides the mechanisms responsible for the duration of energy release, the way a movement (where a release of energy occurs) is done is also important. Due to this last characteristic, the congruence with the factors of coordination, speed, flexibility and, partially, balance is understandable. The congruence of factor structure for explosive strength in the initial and final states is well expressed (.94). The applied operators did not considerably affect the change of structure within the explosive strength factor. The quantitative changes are oriented towards structural unity with other dimensions. Without doubt, the explosive strength factor has the greatest congruence with other dimensions after operator application. Obviously, the mechanism for regulation of excitation intensity has the ability to generate a greater force in a longer period of time, as well as to regulate this force by synergic regulation of agonists and antagonists, especially when complex movements are concerned. Generally speaking, the mechanism for regulation of excitation intensity, after operator application, shows a higher level of auto-regulation.

The changes in the structure of this sphere's fifth complex under the influence of operator application are mainly based on the changes of latent structures defining this complex. In the initial state, the complex is defined with manifestations for which the variability and co-variability of the mechanism for regulation of excitation duration under static strength is responsible. In contrast, in the final state this complex is defined with the mechanisms for tonus and synergy regulation manifested as flexibility. The factors' congruence in this complex shows that structural changes, applying to mechanisms for flexibility regulation, occurred. In the initial state, the flexibility factor has considerable and expressed congruence coefficients with the mechanisms for tonus regulation and regulation of agonists' and antagonists' synergy under movement frequency speed, as well as with the mechanism for energetic regulation. There was a considerable increase in the congruence of the flexibility factor with the factors for coordination and balance under the influence of operator. The congruence of the flexibility factor structure between the initial and final states is very prominent (.95). This implies that the influence of applied operators has not considerably changed the structure of the flexibility factor. The qualitative changes are more oriented towards the structural unity with other dimensions. The congruence of the structures probably occurred as a result of the increased synergic regulation of agonists and antagonists, which had influence on the performance of movements with greater real burden (specific absolute or relative burden) for which the mechanism for energetic regulation is responsible. However, the alleviated performance of the mechanisms for energetic regulation had influence on the activity of lever arm length in the motion amplitude. As a result, the speed of movement performance increased. Obviously, the mechanism for movement structuring is responsible for the realization of such a co-operation.

The sixth complex of vector variables' congruency on the isolated factor in the initial and final states obviously has a poorly expressed structure congruence. The changes in the structure of the sixth complex under the influence of applied operators are based on the changes of latent structures defining this complex. In the initial state, this complex is defined by the mechanisms for tonus and synergic regulation manifested as flexibility. This flexibility enables the achievement of maximal motion amplitude. In the final state, determinability is conditioned by the mechanism for regulation of complex movement structures manifested as coordination. The changes that occurred in the structure of this complex under the influence of applied operators relate to changes in latent dimension, mechanisms of which are aimed at regulating complex motor tasks and movement structuring. In the initial state the coordination factor has considerable congruency coefficients with mechanisms responsible for tonus regulation and synergic regulation of agonists and antagonists under speed, as well as with the mechanism for regulation of excitation duration and intensity under static, repetitive and explosive strength, and, partially, flexibility. It is understandable that some structural movements must be performed under a certain resistance, and some with fast performance of synchronised movements. This depends on the ability of movement structuring. In the final state, after the application of operator, the congruence of this structure changed considerably. Not even one congruency coefficient is great enough to show the congruence of structures. The absence of congruence is probably a result of greater functional differentiation of motor centres that are responsible for movement coordination. The congruence of coordination factors between the initial and final states is the poorest within the whole sphere (.59). What makes it mostly different is a considerably greater range of regulation and movement structuring on which its existence depends. The qualitative changes are directed towards structural unity with other dimensions. This is expressed through structure optimization of a certain movement, as well as the creation of ideomotor movement structures on which the form of performed movement depends, even though this mechanism shows motion control.

The congruence of the seventh complex obtained from orthogonal vector variables' projections onto isolated factors in the initial and final states indicates that no significant structural changes occurred. The seventh complex, which is structurally identical in the initial and final states, has a well expressed congruency (.77). The projections of this latent dimension are insignificant. For the existence of this dimension the mechanism for process regulation of the static analyzer, visual analyzer and kinesthetic receptor is responsible. It is obvious that upon finalization of the operator application process neither considerable quantitative nor qualitative changes occurred in this structure. Vector projections due to their shortness in the coordinate system of this sphere indicate the hyper-factorisation of this dimension. Low congruency coefficients indicate that balance is not a completely elementary motor ability.

DISCUSSION

The research was done on a sample of 216 male examinees of 15 years of age with the aim of investigating the changes of the inner structure and functional mechanisms responsible for variability and co-variability of manifested motor reactions under the influence of applied kinesiologic operators. A battery of 24 motor tests was applied to examine the motor dimensions of examinees in the initial and final states. The factorial structure of motor dimensions of the initial and final states (Little Jiffy, Mark IV Kaiser, & Rice, 1974) was analysed. The existence, transformation and congruence (Tucker method) of the structures obtained under the influence of applied operators were determined.

From the manifested variable sphere, seven latent dimensions were extracted in both the initial and final states, and then interpreted as factors of, repetitive and explosive strength, coordination, speed, static strength, flexibility and balance. The specific definition of latent structures in the final state is expressed through inner determination and specificity prior to application of kinesiologic operators. This difference is expressed as quantitative changes of structure in the dimensions of speed, static strength, repetitive strength, explosive strength, flexibility and coordination. No considerable change occurred in the structure of balance. The congruency of latent structures in the initial state with structures obtained in the final state led to information about real latent structure and qualitative structural changes under the influence of applied kinesiologic operators. Changes in the latent structures of motor dimensions that occurred under the influence of kinesiologic operators are based on qualitative formation of structure, as well as on the structural unity of latent dimensions. This applies to the mechanisms for regulation of excitation intensity and excitation duration; the mechanism for movement structuring; and the mechanism for functional synergy and tonus regulation. Changes in regulation mechanisms had influence on the achievement of adequate results in the following manifested reactions: explosive, repetitive and static strength, speed, coordination and flexibility. In contrast, there were no important changes in the balance structure.

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