

# The structure of dancers' motor skills

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## 1. Introduction

In every motor act, a complex multidimensional integral activity of the nervous system is carried out: the analysis of incoming impulses, interference of external and internal conditions, production of the complex of command signals and control of their manifestation.

Therefore, if a movement is observed, not isolated, but in inseparable connection with the specific situation, many important indicators of the functioning of all human systems may be determined by its motor characteristics. The terms such as strength, speed, agility, expressiveness and rationality of movement, etc, have long been known. Those terms include the research and observation of motor functions. The motor abilities are closely related to the specific situation because only their integrative development leads to favorable results, namely to the victory.

The approach to the analysis of motor abilities and determination of the manifested and latent motor dimensions has been noticeably improved since the earliest studies. The classical approach to the problem of motor abilities con-

sisted in determination of motor factors defined as certain latent motor structures responsible for various manifestations. In the determination of the structure of motor abilities and in attempts to apply certain relevant information about motor abilities in diagnostic, prognostic, and transformation processes, measuring instruments, namely motor tests, represent the weakest link. The main disadvantage of the measuring instruments is their unreliability. Aside from poor reliability, the motor tests typically emit an extremely small amount of information. In order to reduce these disadvantages, multi-item tests are increasingly being constructed and applied, by which, first of all, measurement error is reduced. Both the problem of reducing measurement error and specifics of single-item tests (tests of repetitive and static strength) still burden researchers because of the examinees' inability to manage several successive maximal loads during a short period of time.

## 2. The methods

### 2.1. The sample of examinees

The sample of examinees is influenced by financial capabilities to conduct the research. Moreover, the sample depends on the number of qualified and trained measurers, instruments and standardized conditions for conducting the planned research.

In order to have the research correctly conducted and the results valid and stable, it is necessary to include a sufficient number of examinees into the sample. The size of the sample for this type of research is conditioned by the aims and tasks of the research, by the size of the population as well as the degree of variability of the applied system of parameters.<sup>5</sup>

On the basis of the selected statistical-mathematical model and the aim of the research, the sample of examinees includes 267 dancers, aged from 11 to 13, actively involved in standard and Latin American dances in Serbian dancing clubs.

Most of the so determined sample should fulfil the following criteria:

- The effectiveness of the sample must be planned in the way to provide as many degrees of freedom as necessary for any coefficient in a pattern

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<sup>5</sup> Popović, D.: Determining the structure of psychosomatic dimensions in fights and developing the procedures for their evaluation and monitoring - The Monograph, the Faculty of Physical Education, University of Priština, Priština, 1993.

or correlation matrix, which is equal to or higher than 0.22, to be considered different from zero with an inference error less than 0.01

- In order to successfully apply the adequate statistical methods, according to the latest convictions, the number of the subjects in the sample must be five times larger than the number of the applied variables.

During all these factor procedures, it should be kept in mind that the analysis results depend on the three major systems which determine the selection and transformation of the information: the sample of variables, sample of examinees and selected extraction, or rotation, method.<sup>6</sup>

## 2. 2. The sample of variables

This research could not cover the whole space of motor abilities. That is why certain reduction of the tests was carried out and only those segments that could supply adequate and significant for this research information were used.

As being previously stated, when selecting the tests which define the motor space, it was taken into account that based on the Yugoslavian population by the previous researches, they had been verified as relevant for this age. The final construction of the test battery was greatly influenced by the intention to get the possibility to compare the obtained results with those obtained by the group of authors: Kurelić et al. (1971. and 1975.), Momirović et al. (1969.) and Gredelj et al. (1975.).

For estimating the motor abilities there were used 20 motor tests, selected according to the structural model of Gredelj, Metikoš, Hošek and Momirović in 1975, defined as a mechanism for movement structuring (MSK), a mechanism for functional synergies and tonus regulation (SRT), a mechanism for regulation of the excitation intensity (RIE), and a mechanism for regulation of excitation duration.

For this measurement program, the significant motor dimensions were estimated, with the help of the following measuring instruments:

- a) the mechanism for movement structuring (MSK)
  - 1) agility on the ground (MONT)
  - 2) hand tapping (MTAR)
  - 3) foot tapping (MTAN)

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6 Popović, D.: Determining the structure of psychosomatic dimensions in fights and developing the procedures for their evaluation and monitoring - The Monograph, the Faculty of Physical Education, University of Priština, Priština, 1993.

- 4) coordination with a bat (MKOOP)
- 5) hand and foot drumming (MBNIR)
- b) the mechanism for functional synergy and tonus regulation (SRT)
  - 1) deep forward bend (MDPK)
  - 2) transverse standing on a beam (MPSG)
  - 3) flex by bat (MISP)
  - 4) darts (MPIK)
  - 5) horizontal target shooting (MGHC)
- c) the mechanism for excitation intensity regulation (RIE)
  - 1) long jump from place (MSDM)
  - 2) 20m running high start (M20VS)
  - 3) throwing a medicine ball from a supine position (MBMIL)
  - 4) high jump from place (MSVIS)
  - 5) hand dynamometry (MDŠAK)
- d) the mechanism for excitation duration regulation (RTE)
  - 1) flexed-arm-hang for endurance (MIZG)
  - 2) pull-ups by grasping a bar (MZGP)
  - 3) a 60-second trunk lift (MPTR)
  - 4) leg lifting from a supine position (MDNL)
  - 5) seated leg lift for endurance (MINP)

### 2. 3. Methods for data processing

Except for Mulak's well-known textbook on the factor analysis, in which there are some issues on the evaluation of reliability of the principal components (Mulak, 1972), and Kaiser and Caffrey's work, where, based on maximizing the reliability of latent dimensions, their method of alpha factor analysis was derived (Kaiser and Caffrey, 1965), it seems that the constructors of various methods of component and factor analysis and the authors of books on this class of methods for latent structure analysis, were not so concerned about the level of reliance on the real existence of latent dimensions obtained by these methods. It also refers to the latent dimensions obtained by orthoblique transformation of principal components, the method that has become a standard procedure for latent structure analysis among all those who did not acquire their information on factor analysis reading seriously written articles on this scientific field with their fingers, or those who do not analyze their findings with the help of some sadly conceived and even

worse written commercial statistical software packages, such as, but not limited to, SPSS, CSS, Statistica, Statgraphics and BMDP, not to mention other products whose popularity is much lower, but not necessarily because they are much weaker than those applied today by only ignorant scientists and a special kind of human beings called a strain of processors.

Nevertheless, in one text where a competitive application of semiorthogonal transformation of principal components in the explorative and confirmative analyses of the latent structures (Momirović, Erjavec, and Radaković, 1988), was presented, a procedure for estimating the reliability of latent dimensions is proposed based on Cronbach's strategy for the evaluation of generalizability; but, the procedure is justified as much as the assumptions, from which Cronbach's  $\alpha$  coefficient is derived are justified, and even today, for unknown reasons, it is called by his name, although long before him and with virtually the same assumptions, Spearman and Brown, Kuder and Richardson, Guttman proposed it, in a slightly simplified form and Momirović, Wolf and Popović (1999) described it as well as some other psychometrics scientists who worked and created in a nascent stage of development of the measurement theory, and in the period unaffected by the computer revolution.

Therefore, the aim of this research is to propose three measures for lower limits of reliability of latent dimensions, obtained by semiorthogonal transformations of the principal components. All those measures are derived within the classical model of variance decomposition of some quantitative variables; the measures, derived from some other models in the theory of measurement, will be proposed in some of the further works. The first is the evaluation measure of the absolute lower limit of reliability, and its logic basis is the same as the logic basis of Guttman's measure  $\lambda_1$ . The second measure is the evaluation of the lower limit of reliability of latent dimensions on the basis of evaluation of the lower limit of reliability of variables with the same field of meaning; and its logic basis is identical to the logic basis of Guttman's measure  $\lambda_6$ . The third measure is determined on the assumption that the reliability coefficients of variables, which are the subject of the analysis, are known; therefore, it depends on the value of the processes by which the coefficients are calculated or estimated.

#### *SEMIORTHOGONAL TRANSFORMATION OF THE PRINCIPAL COMPONENTS*

Let the matrix  $Z$  of the standardized data be obtained by the description of some set  $E$  of  $n$  entity on some set  $V$  of  $m$  quantitative, normally or at least elliptically distributed, variables. Allow the matrix  $R$  to be the intercorrelation matrix

of those variables. Assume,  $R$  is a surely regular matrix and there can be rejected with certainty the hypothesis that the variables from  $V$  have spherical distribution, therefore they are the eigenvalues of the correlation matrix in the population  $P$  from which the sample  $E$  has been drawn.

Let

$$U^2 = (\text{diag } R^{-1})^{-1}$$

be Guttman's estimate of the unique variances of the variables from  $V$ , and let  $\lambda_p$ ,  $p = 1, \dots, m$  be the eigenvalues of the matrix  $R$ . Let

$$c = \text{trag } (I - U^2).$$

Define the scalar  $k$  so that

$$\sum_p^k \lambda_p > c, \sum_p^{k-1} \lambda_p < c.$$

Now,  $k$  is the number of principal components of the matrix  $Z$  determined according to PB criterion of Štalec and Momirović (Štalec and Momirović, 1971).

Let  $\Lambda = (\lambda_p)$ ;  $p = 1, \dots, k$  be a diagonal matrix of the first  $k$  eigenvalues of the matrix  $R$  and let  $X = (x_p)$ ;  $p = 1, \dots, k$  be a matrix of the associated eigenvectors scaled so that  $X'X = I$ . Let  $T$  be some orthonormal matrix, such that it can optimize the function

$$XT = Q = (q_p); p(Q) = \text{extremum}, T'T = I,$$

where  $p(Q)$  is a parsimonomic function, for instance, a regular Varimax function

$$\sum_j^m \sum_p^k q_{jp}^4 - \sum_p^k (\sum_j^m q_{jp}^2)^2 = \text{maximum}$$

where the coefficients  $q_{jp}$  are the elements of the matrix  $Q$  (Kaiser, 1958).

Now, the transformation of the principal components, defined by the vectors in the matrix

$$K = ZX,$$

into semiorthogonal latent dimensions determined by type II of orthoblique procedure (Harris & Kaiser, 1964), is defined by the operation

$$L = KT = ZXT.$$

The covariance matrix of those dimensions is

$$C = L'Ln^{-1} = Q'RQ = T'\Lambda T;$$

Denote the matrix of their covariances as

$$S^2 = (s_p^2) = \text{diag } C.$$

If the latent dimensions are standardized by the operation

$$D = LS^{-1},$$

in the matrix

$$M = D^t D n^{-1} = S^{-1} T^t \Lambda T S^{-1}$$

there will be their intercorrelations; notice that neither  $C$ , and therefore nor  $M$  can be diagonal matrices, and the latent dimensions obtained in this way are not orthogonal in the space of the entity from  $E$ .

The matrix of correlations between the variables from  $V$  and latent variables, which is usually classified as the matrix of the factor structure, will be

$$F = Z^t D n^{-1} = R X T S^{-1} = X A T S^{-1};$$

and since the elements of the matrix  $F$  are orthogonal projections of a vector from  $Z$  on the vectors from  $D$ , the coordinates of these vectors in the space stretched by the vectors from  $D$  are the elements of the matrix

$$A = F M^{-1} = X T S.$$

But since

$$A^t A = S^2$$

the latent dimensions obtained by this procedure are orthogonal in the space stretched by the vectors of the variables from  $Z$ . The squared norms of the vectors of these dimensions in the space of the variables are equal to the variances of these dimensions.

### *ESTIMATES OF THE RELIABILITY OF LATENT DIMENSIONS*

Owing to its simplicity and clear algebraic and geometric meaning as well as the latent dimensions and identification structures associated with these dimensions, the reliability of the latent dimensions obtained by orthoblique transformation of the principal components could be determined clearly and unambiguously.

Let  $G = (g_{ij})$ ;  $i = 1, \dots, n$ ;  $j = 1, \dots, m$  be some, tolerably unknown, matrix of measurement errors in the description of set  $E$  on set  $V$ . Then the matrix of real results of the entity from  $E$  on the variables from  $V$  will be

$$Y = Z - G.$$

If, in accordance with the classical theory of measurement (Gulliksen, 1950; Lord and Novick, 1968; Pfanzagl, 1968) it can be assumed that the matrix  $G$  is such that

$$Y^tG = 0$$

and

$$G^tGn^{-1} = E^2 = (e_{jj}^2)$$

where  $E^2$  is a diagonal matrix, then the covariance matrix of real results will be

$$H = Y^tYn^{-1} = R - E^2$$

if

$$R = Z^tZn^{-1}$$

the intercorelation matrix of variables from  $V$  is determined on the set  $E$ .

Hypothetically, the reliability coefficients of variables from  $V$  are known; let  $P$  be a diagonal matrix whose elements  $\rho_j$  are the reliability coefficients. Therefore, the measurement error variances for the standardized results on the variables from  $V$  will be precisely those elements of the matrix

$$E^2 = I - P.$$

Now the real values of latent dimensions will be the elements of the matrix

$$\Gamma = (Z - G)Q$$

with the covariance matrix

$$\Omega = \Gamma^t\Gamma n^{-1} = Q^tHQ = Q^tRQ - Q^tE^2Q = (\omega_{pq}).$$

Hence, the real variances of latent dimensions will be the diagonal elements of the matrix  $\Omega$ ; mark those elements as  $\omega_p^2$ . According to the formal definition of reliability coefficients of some variable

$$\rho = \sigma_t^2 / \sigma^2$$

where  $\sigma_t^2$  is the real variance of a variable, and  $\sigma^2$  is the total variance of that variable, that is the variance which includes the error variance, the reliability coefficients of latent dimensions, if the reliability coefficients of variables are known, will be

$$\gamma_p = \omega_p^2 / s_p^2 = 1 - (q_p^tE^2q_p)(q_p^tRq_p)^{-1}$$

$$p = 1, \dots, k$$

### *Proposition 1.*

The coefficients  $\gamma_p$  vary in the range of (0,1) and they may adopt the value 1 only when  $P = I$ , i.e. if all the variables are measured without error, and the

value 0 only when  $P = 0$  and  $R = I$ , that is if the total variance of all the variables consists only of the variance of the measurement error, and variables from  $V$  have a spherical normal distribution.

*Proof:*

If the total variance of each variable from some set of variables consists only of the variance of the measurement error, then necessarily  $E^2 = I$  and  $R = I$ , so that all the coefficients  $\gamma_p$  are equal to zero. The first part of the proposition is evident from the definition of the coefficients  $\gamma_p$ ; this means that the reliability of each latent dimension, no matter how that latent dimension is determined, equals 1 if the variables from which that dimension was derived, are measured with no errors.

However, the matrix of the reliability coefficients  $P = (\rho_j)$  is often unknown, so that the matrix of measurement error variance  $E^2$  is also unknown. But, if the variables from  $V$  are selected so as to represent a set of variables  $U$  with the same field of meaning, the upper limit of the measurement error variance is defined by the elements of the matrix  $U^2$  (Guttman, 1945; 1953), is the unique variances of those variables. Because of this, in that case, the lower limit of reliability of latent dimensions may be evaluated by the coefficients

$$\beta_p = 1 - (q_p^t U^2 q_p)(q_p^t R q_p)^{-1} \quad p = 1, \dots, k$$

which are derived from the procedure identical to the one by which the coefficients  $\gamma_p$  with the definition  $E^2 = U^2$ , were derived, that is, in the same way as Guttman derived his measure  $\lambda_c$ .

*Proposition 2.*

The coefficients  $\beta_p$  vary in the range of  $(0,1)$ , but still they cannot reach the value 1.

*Proof:*

If  $R = I$ , then  $U^2 = I$ , so all the coefficients  $\beta_p$  equal zero. But, since  $U^2 = 0$  is not possible if the matrix  $R$  is regular, all the coefficients  $\beta_p$  are necessarily less than 1 and tend towards 1 when the unique variance of the variables, from which the latent dimensions are derived, tends towards zero.

By applying the same technology it is simple to derive the measures of the absolute lower limit of reliability of latent dimensions defined by this procedure

in the same way as Guttman derived his measure  $\lambda_1$ . For this purpose, set  $E^2 = I$ . Then

$$\alpha_p = 1 - (q_p {}^t R q_p)^{-1}$$

will be the measures of the absolute lower limit of reliability of latent dimensions, because, naturally,  $Q {}^t Q = I$ .

*Proposition 3.*

All the coefficients  $\alpha_p$  are always less than 1.

*Proof:*

It is obvious that all the coefficients  $\alpha_p$  are necessarily less than 1, and that they tend towards 1 in the case when  $m$ , the number of variables in the set  $V$ , tends towards infinity, because then every squared form of the matrix  $R$  tends towards infinity. If  $R = I$ , then, evidently, all the coefficients  $\alpha_p$  equal zero. However, the lower value of the coefficients  $\alpha_p$  doesn't have to be zero, since it is possible, but not for all the coefficients  $\alpha_p$ , that the variance  $s_p^2$  of some latent dimension is less than 1. Certainly, the latent dimension which emits less information than any other variable from which it is derived has no sense, and maybe it could be best discovered on the basis of the values of the coefficients  $\alpha_p$ .

The measures of type  $\beta_6$  (Momirović, 1996) that are determined by the functions  $\alpha_1$  i  $\alpha_2$  will be, for the result defined by the function  $h$ ,

$$\beta_{61} = \gamma^2 \lambda^{-2}$$

and

$$\beta_{62} = 1 - \delta^2 \lambda^{-2}.$$

It is not difficult to demonstrate that, for the regular sets of particles, measures of type  $\alpha_1$  the estimates of the lower limit of reliability of the measures of type  $\lambda_6$  and  $\beta_6$ , and the measures of type  $\alpha_2$  are the estimates of the upper limit of the measures of type  $\lambda_6$  and  $\beta_6$ .

### 3. Results and discussion

The interpretation of correlations of certain tests from the set of measuring instruments for evaluation of motor abilities is based on the primary hypothetical latent dimensions.

The intercorrelation matrix has been taken as a starting matrix for the extraction of latent variables by the method of the principal components, while their number has been determined according to Momirović's  $\beta_6$  criterion. The preference for this method of the principal components has been determined particularly by the entropy that emits the total amount of information. Maximal entropy will emit the part of the system that is connected with the characteristic roots which are equal to or bigger than the requirements of  $\beta_6$ . The principal components present such system of linear combinations of variables within which each subsequent factor draws the maximum possible part of the variability of the system. According to Momirović's  $\beta_6$  criterion, four characteristic roots have been declared significant and, based on this, the manifested space of motor abilities is reduced to the same number of latent dimensions.

The first principal component with the characteristic of root 8.25 explains 40.12% of the overall explained variability that amounts 70.45% (table 1). Since it concerns the first principal component, the percentage of the explained variability completely satisfies and with that percentage of the variance it is possible to classify the first principal component as a general motor factor. The greatest projections on the first principal component are obtained by the coordination tests (MONT, MTAP, MTAN, MKOP, MBNR), tests of equilibrium (MPSG), precision (MPIK), speed (M20m), explosive strength (MSV), repetitive strength (MDNL, MPTR, MZBP) and force (MIZG).

Although other principal components can not be given a particular kinesiological reality as in the case of the first principal component, it is possible, through their inspection, to identify those generators of variability, that are, according to their significance position, responsible for the variability of the analyzed space.

The greatest projections with the second principal component are obtained by the tests for estimating strength-hand dynamometry (MDŠ), explosive strength-throwing a medicine ball from a supine position (MBML), long jump (MSD) and flexibility-flex by bat (MIP). The second principal component explains 16.34% of the overall variability and may be considered as a general strength factor.

The third principal component is accomplished by the test for a trunk force-leg endurance in a seated leg lift (MINP), and it stands for a single factor of this test. The one with the characteristic root of 2.11 explains 7.98% of the variance of the overall variability.

The fourth principal component is accomplished by the horizontal target shooting precision test (MGHC). This principal component with the characteristic root of 1.33 explains 6.01% of the variance of the total variability. It may be interpreted as a single factor of the shooting precision.

In order to obtain a parsimonious structure the initial coordinate system is rotated to an oblique oblimin solution, after which the same number of latent variables is retained. The applied oblimin rotation causes the sum of the squared factor coefficients for the same variable to be different, after the rotation, from the sum obtained before the rotation. For the reason that there are two sorts of coordinates in the oblique frame of the reference, which differ in factor analysis, but arise from different projections of the test vectors, after applying oblimin rotation there was obtained a pattern matrix that includes parallel projections of the vectors of particular variables (table 2), the structure of a matrix, with orthogonal projections of the vectors of variables (table 3) and a factor intercorrelation matrix (table 4).

The first latent dimension has the greatest projection with the tests used for estimating the movement structuring mechanism: foot and hand drumming (MBNP), coordination with a bat (MKOP), agility on the ground (MONT), hand tapping (MTAR) and foot tapping (MTAN). Since it concerns the instruments whose variability depends on the spacial and temporal accuracy of movement but as well on the movement performing with constant amplitude, this latent dimension may be defined as a mechanism for structuring of movement of factor coordination.

The largest projections on the second oblimin factor were obtained by the tests which estimated the mechanism the regulation of the excitation intensity: hand dynamometry (MDŠ), throwing a medicine ball from a supine position (MBML), high jump (MSV), long jump from a place (MSD) and 20-meter running (M20m). It is obvious that this is about a complex mechanism characteristic of the selected young dancers. For performing the motor tasks like explosive strength, the energy component has a dominant significance. The explosive strength is the one that relates to the "ability to expend a maximum of energy in one explosive act" (Fleishman). The imperfection of this definition lies in the limitation to only one movement. Good indicators of the explosive strength may be even smaller groups of several explosive movements related to the whole, as in the performance of the 20-meter running test. According to Kurelić, explosive strength is the ability of short-time maximal mobilisation of the muscular tissues for acceleration of body movement, that is reflected either in moving the body in space or in affecting the objects in that environment. In the research of explosive strength, it is also defined as: the ability of the system of an organism to develop, within a short period of time, the maximal amount of force used for accelerating the own body, partner or projectile; as the ability which is subordinated to the functioning of the mechanism for regulation and control of the excitation intensity in the primary motor and subcortical centers which takeover the role of an amplifier or a modulator. In the energy output, that mechanism is responsible for a number

of activated motor units and for the transmitting impulses from the center to the effector. It depends on activating the muscular units and is manifested in those activities which require activation of a large amount of energy within the shortest possible time period. This strength factor is a dimension of a general type, i.e. it is not determined topologically. This latent motor dimension could be defined as a mechanism for regulation of the excitation intensity.

The largest projections on the third oblimin factor is provided by the tests for evaluation of force and repetitive strength: leg lifting in a supine position (MDNL), seated leg lift for endurance (MINP), flexed arm-hang for endurance (MIZG), pull-ups by grasping a bar (MZGP) and a test for trunk lifting in a supine position (MPTR). Efficient performance of those tests depends either on the prolonged maintenance of isometric muscle contraction in a certain position, or on the prolonged dynamic contraction where the eccentric and concentric contractions alternate. A physiologically significant source of energy for prolonged muscle work is glycogen under the conditions of oxidative processes. Rapid enzymatic degradation of glycogen to a pyruvic acid and lactic acid releases energy that is used to convert ADP to ATP, and ATP afterwards may be used directly as a source of energy for muscle contraction or for replenishment of the phosphocreatine stores. The final source of energy is the process of oxidative metabolism. That means combining oxygen with cellular nutritive matters in order to release ATP. More than 95% of the complete energy used by a muscle for a maintained prolonged contraction comes from this source. Considering the projections of these tests, this factor may be defined as a mechanism for regulation of excitation continuance and this mechanism is expressed in dancers when they perform the elements specific to eastern dances with standing on one leg and fast steps with squats as required for some Russian dances.

The fourth oblimin factor is explained by the tests for evaluating the mechanism for tonus regulation and synergy regulation: horizontal precision shooting tests (MGHC), darts (MPIK) and deep bend on bench-flexibility test (MDP). Precision as a basic motor ability is related to the accuracy of the assessment of spacial and temporal parameters of a given system. It is well-known that precision, being an extremely sensitive ability, depends on the emotional state. In previous studies many authors emphasize a high negative correlation with neuroticism and dissociative syndrome. The mutual basis of, at first sight, completely different motor movements (precision and flexibility) lies in muscular synergism, because, muscular coactivation, as well as synergistic action of the muscles that are located at both sides of the passive elements of the locomotor apparatus, are responsible for successful performing of both motor tasks. Undoubtedly, this factor may be defined as a mechanism of synergistic regulation and tonus regulation.

The factor intercorrelation matrix (table 33) indicates that the obtained correlations of the first, third and fourth factors are statistically significant, which leads to the conclusion that the factor axes are not distant from each other, i.e. the cosine of the angle that they form together is bigger. Based on the structural analysis of Latin American and standard dances, it is logical that motor abilities, speed and explosive strength are considered as the most necessary for a successful dance in most of the dances. Without these extremely pronounced motor abilities it is impossible to achieve even average results in dancing.

Different types of speed (a speed of reaction, a speed of motion and a speed of movement) enable dancers' harmonious and continuous movement and performance of various dancing elements. A high level of explosive strength, especially of legs, as well as high level of speed, are basic characteristics of quality dancers.

The explosive strength of legs is important for dancers because it provides faster movement (bouncing) in performing very complex elements in dance structures.

During the performance of some dancing elements, dancers must synchronize the footwork (movement) with the coordination of arms, change the direction swiftly, realize closed motor structures quickly, and complex motor structures by moving the whole body in space, which requires a high level of coordination.

One of the characteristics of quality dancers is the ability to quickly change the direction and combine various techniques of dance structures, which implies that agility influences the success in dancing to a great extent.

Leg coordination is the ability which allows the dancers to establish the balance and maintain it in terms of dance performance, as well as combine various manners of movement.

The necessity of quick performance of all basic movement structures in a dance that are concurrently polystructural, demands from dancers a significant level of coordination defined as "a speed of performing complex motor tasks".

As Latin American dance performers are characterized by continuous movement and execution of very complex dance structures, it may be stated that body coordination has certain influence on the success of dance.

For that reason, the obtained results of the factor analysis, confirm or rather justify, its application in this research. Hence the factor analysis in this case could be treated as a confirmative method.

*THE MATRIX OF THE PRINCIPAL COMPONENTS OF MOTOR VARIABLES OF DANCERS*

Table 1.

Variable	FAC1	FAC2	FAC3	FAC4	$h^2$
MONT	(-.68)	.45	.16	.32	.79
MTAR	(.72)	.05	.27	-.29	.67
MTAN	(.79)	-.02	.09	-.10	.64
MKOP	(-.77)	.35	.09	.31	.82
MBNR	(.74)	-.24	.38	-.19	.80
MDP	(.68)	-.11	.08	.27	.56
MPSG	(.62)	-.22	.29	-.38	.66
MIP	-.12	(.62)	-.09	-.15	.43
MPIK	(.57)	-.31	.25	.33	.59
MGHC	.37	-.08	.52	(.54)	.70
MSD	.59	(.69)	-.02	.09	.74
M20m	(-.74)	-.35	.04	-.12	.68
MBML	.54	(.70)	.14	.04	.80
MSV	(.66)	.57	-.03	-.05	.76
MDŠ	.27	(.85)	.00	-.05	.79
MIZG	(.55)	-.38	-.19	.34	.59
MZGP	(.74)	-.06	-.21	.12	.61
MPTR	(.80)	-.04	-.19	.05	.68
MDNL	(.59)	-.08	-.54	.18	.68
MINP	.38	-.11	(-.66)	-.02	.60
LAMBDA	8.25	4.01	2.11	1.33	
%	40.12	16.34	7.98	6.01	
CUM %	40.12	56.46	64.44	70.45	

*THE PATTERN MATRIX OF MOTOR VARIABLES OF DANCERS*

Table 2.

Variable	OBL1	OBL2	OBL3	OBL4
MONT	-.75	.23	.35	.14
MTAR	.75	.28	.11	.03
MTAN	.55	.24	-.19	.14
MKOP	-.82	.09	.23	.05
MBNR	.82	.02	.14	.23
MDP	.18	.13	-.27	.49
MPSG	.88	-.02	.15	-.03
MIP	-.16	.55	.09	-.31
MPIK	.19	-.09	-.11	.63
MGHC	-.07	.07	.19	.88
MSD	.02	.79	-.16	.13
M20m	-.16	-.58	.28	-.22
MBML	.09	.86	.05	.14
MSV	.21	.76	-.16	.01
MDŠ	-.08	.90	.06	-.10
MIZG	.01	-.18	-.55	.42
MZGP	.20	.18	-.52	.20
MPTR	.30	.23	-.49	.16
MDNL	-.04	.11	-.81	.06
MINP	-.05	.01	-.79	-.23

*THE STRUCTURE MATRIX OF MOTOR VARIABLES OF DANCERS*

Table 3.

Variable	OBL1	OBL2	OBL3	OBL4
MONT	-.80	.06	.61	-.25
MTAR	.78	.41	-.24	.36
Table continued on next page...				

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MTAN	.73	.38	-.48	.44
MKOP	-.88	-.08	.56	-.35
MBNR	.86	.17	-.27	.56
MDP	.53	.24	-.47	.64
MPSG	.81	.12	-.22	.32
MIP	-.24	.48	.17	-.36
MPIK	.50	.02	-.33	.73
MGHC	.25	.12	.01	.81
MSD	.29	.83	-.29	.24
M20m	-.48	-.66	.46	-.41
MBML	.29	.88	-.12	.24
MSV	.42	.82	-.33	.21
MDŠ	.01	.87	.02	-.07
MIZG	.39	-.07	-.63	.53
MZGP	.55	.30	-.68	.43
MPTR	.63	.35	-.68	.43
MDNL	.34	.20	-.82	.23
MINP	.22	.08	-.74	-.05

*THE INTERCORRELATION MATRIX OF OBLIMIN FACTORS*

Table 4.

Variable	OBL1	OBL2	OBL3	OBL4
OBL1	1.00	.18	-.42	.43
OBL2	.18	1.00	-.11	.09
OBL3	-.42	-.11	1.00	-.22
OBL4	.43	.09	-.22	1.00

## 4. Conclusion

The research has been conducted with the aim to establish the structure of motor abilities of the dancers involved in the standard and Latin American dances.

For the purpose of estimating the structure of motor abilities, 267 dancers, aged from 11 to 13, participated.

For the evaluation of motor abilities 20 motor tests were used, and they were selected according to the structural model of Gredelj, Metikoš, Hošek and Momirović of 1975 defined as a mechanism for movement structuring, mechanism for synergy and tonus regulation, mechanism for regulation of excitation intensity, and mechanism for the regulation of excitation duration.

All the data in this research were processed in the Multidisciplinary Research Center of the Faculty of Sport and Physical Education of the University of Priština with the assistance of the system of data processing programs developed by Popović, D. (1980), (1993), Momirović, K. and Popović, D. (2003).

The analysis of the structure of motor dimensions indicates that four factors were obtained: the first factor responsible for the movement structuring, the second for regulation of excitation intensity, the third for the excitation duration, and the fourth responsible for the regulation of tonus and synergy.

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## *The structure of dancers' motor skills*

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### *Summary*

*The research was conducted in order to determine the structure of motor abilities of dancers performing standard and Latin American dance. For estimating motor abilities, 267 dancers, aged from 11 to 13, participated. Twenty motor tests for the evaluation of the motor abilities were used, selected according to the structural model of Gredelj, Metikosh, Hoshekov and Momirović of 1975, defined as the mechanisms for movement structuring, for synergy and tonus regulation, and mechanism for the regulation of intensity and excitation duration. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, The University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. The analysis of factor structure of motor dimensions indicates that four factors were obtained: the first factor is responsible for movement structuring, the second for the regulation of excitation*

*intensity, the third for excitation duration and the fourth is responsible for tonus and synergy regulation.*

*Key words: /dancers/motor abilities/factor analysis/mechanisms/factors/excitation/intensity/*

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