UNIVERSITY IN PRIŠTINA
FACULTY OF SPORT AND PHYSICAL EDUCATION

KINESMETRICS

International scientific journal KINESMETRICS | December 2014 | Vol. 3, No. 1 | ISSN 2217-9968

Leposavić, 2014.

International scientific journal KINESMETRICS

ISSN 2217-9968, Vol. 3 No. 1

Leposavić, December 2014.

KINESMETRICS is a discipline to develop and apply measurement theory, statistics, and mathematical analysis to the field of kinesiology (Zhu, 2003). The term "kinesmetrics" was coined by Weimo Zhu in 1999 when he created a new doctoral program at the University of Illinois at Urbana-Champaign, USA. Although the term was introduced more than a decade ago, it is still unknown to many professionals in Kinesiology, especially outside North America. "Kinesmetrics" is a composite word, where "kines" presents kinesiology, or human movement, and "metrics" means scale and quantity. The major components to Kinesmetrics include research design, statistical/mathematical models, data characteristics, computers technology, and measurement theory.

KINESMETRICS is an international scientific journal that publishes articles on the theory of measurement in sports and physical education, and studies from bio-medical, humanistic, social and natural sciences; with unpublished results of scientific researches and new empirical experiences.

PUBLISHER:

THE FACULTY OF SPORTS AND PHYSICAL EDUCATION OF THE UNIVERSITY OF PRIŠTINA TEMPORARILY BASED IN LEPOSAVIĆ

Address:

KINESMETRICS JOURNAL
Leposavić, Dositej Obradović st., nn

Telephone: +381 28 84700
Fax: +381 28 84701

Press:

"SIGRAF plus" - Kruševac

Circulation:

200 copies

THE JOURNAL IS PUBLISHED ONE A YEAR
Faculty of sports and physical education of the University of Priština temporarily based in Leposavić, based on the decision no. 05-210 of March 30th, 2011.
The annual subscription to the journal "Kinesmetrics": for institutions 1000 RSD,
for individuals 1000 RSD, for students 500 RSD. The price of a single issue: 1000 RSD.
The price outside Serbia: 20 EUR. Payments on current account no. 840-1235666-82,
Faculty of Sports and Physical Education, reference number 97-42-7423.

Contents:

Original scientific paper *UDC 793.31.071.1(497.11):159.942.072*
COBISS.SR-ID 214863884

Differences in the level of conative dimensions of male and female folk dancers

Jasna Popovic [1], Dragan Popovic[1], Evagelia Boli[1],
Eyal Shagal[2], Biljana Karanov[3] & Milica Bojovic[1]
[1]Faculty of Sport and Physical Education, University of Pristina
temporarily based in Leposavic, Serbia
[2]The Ribstein Center for Sport Medicine Sciences
and Research Wingate Institute, Israel
[3]Sports Academy, Belgrade
e-mail:jasna.popovic@pr.ac.rs

Abstract

Let $\boldsymbol{\rho}^2 = (\rho_k^2)$, k = 1,..., m be a diagonal matrix whose elements are squares of canonical correlations, let $\mathbf{X} = (\mathbf{x}_k)$, k = 1,..., m be a matrix of eigenvectors obtained by solving the canonical discriminant problem, let $\mathbf{K} = \mathbf{MX}$ be a matrix of discriminant functions and let $\mathbf{L} = \mathbf{GX} = \mathbf{PMX}$ be a matrix of the discriminant functions projected in the hypercube defined by the vectors of matrix **S**. As $\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{AX} = \boldsymbol{\rho}^2$ and as, of course, $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ and $\mathbf{L}^t\mathbf{L} = \boldsymbol{\rho}^2$, the canonical discriminant analysis produces two biorthogonal sets of vectors of variables by such transformation of vectors from **M** and **G** that orthogonalizes those vectors and maximizes cosines of the angles between the corresponding vectors from **K** and **L** , with the additional condition that the cosines of noncorresponding vectors from **K** and **L** are equal to zero because the correlations between variables from **K** and **L** are $\mathbf{K}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{X}^t\mathbf{AX}\ \boldsymbol{\rho}^{-1} = \boldsymbol{\rho}$.

Vectors $\mathbf{x}_k$ from **X** are, obviously, the vectors of standardized partial regression coefficients of the variables from **M** which generate discriminant functions $\mathbf{k}_k$ that, together with discriminant functions $\mathbf{l}_k$ formed by the vectors of standardized partial regression coefficients $\mathbf{x}_k$ from variables of **G**, have maximum correlations. But as $\mathbf{M}^t\mathbf{K} = \mathbf{X}$, the elements of matrix **X** are, at the same time, the correlations of variables from **M** and discriminant variables from **K**, which, unlike the standard canonical discriminant model, allows for easy testing of hypotheses on the partial impact of variables on the formation of discriminant functions.

To identify discriminant functions, the elements of the cross structural matrix defined as correlations between variables from **M** and **L**, that is, the elements of matrix $\mathbf{Y} = \mathbf{M}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{A}\mathbf{X}\boldsymbol{\rho}^{-1} = \mathbf{X}\boldsymbol{\rho}$, can also be of certain significance; note, by the way, that **Y** is a factor matrix of matrix **A** as, of course, $\mathbf{Y}\mathbf{Y}^t = \mathbf{X}\boldsymbol{\rho}^2\mathbf{X}^t$.

As x_{jk} elements of matrix X and y_{jk} elements of matrix Y are ordinary correlations, their asymptotic variances are $\sigma_{xjk}^2 = (1 - x_{jk}^2)^2 n^{-1}$, respectively, $\sigma_{yjk}^2 = (1 - y_{jk}^2)^2 n^{-1}$, therefore, the hypotheses of type $H_{0xjk,}$ or $H_{0yjk,}$ can be tested on the basis of the functions $f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2))$, or $f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2))$, because under the hypotheses these functions have the Fisher-Snedecor F-distribution with the degrees of freedom of $\nu_1 = 1$ and $\nu_2 = n - 2$.

Keywords : / matrix / variance / correlation / function / discriminant / vector /

1. Introduction

The beginning of dance cannot be determined with accuracy. Dance was a need for expressing religious, warlike and other feelings in search of beauty, in the desire for entertainment, in the need of man to transfer the rhythm to the movements of everyday life and work.

It is closely related to music, rhythm and gymnastics, and it is assumed that dance is the first artistic aspiration of man or source of art which created music and rhythm, painting and sculpture, poetry and theatre.

For primitive man, dance meant a tool in the struggle for life. It depended on the dance whether hunting would be successful, harvest would be good, the enemy would be defeated, disease would be forced out of the village, whether the sun would come quicker, and winter would be chased away. Primitive man danced on every occasion, out of love or hatred, joy and sorrow. Dances featuring animals are immortalized in Stone Age cave paintings. These dances are still present among the primitive tribes.

For the development of the art of dance in Christian countries, the most unfavorable period was the Middle Ages. Christianity found dancing as a custom

rooted in the people and at first it tolerated it, but later dancing was increasingly being banned and persecuted throughout the entire centuries. The people, despite all Church prohibitions, performed their traditional and entertainment dances.

After the Crusades, social dance among Western Europe nations began to flourish. The thirteenth and fourteenth centuries are characterized by two types of dance: "low", stepping dances, or basse danse, and "high" dances. Dance teachers were hired (at courts) to compose, arrange, or create new dances.

In the seventeenth century in Paris, thirteen most renowned dance masters established the Royal Academy of Dance. At the end of the eighteenth century, interest in dances declined, partially because everything remained the same and partially because of the difficult political circumstances that led to the revolution. After the revolution, dances again came alive.

Modern dances are characterized by their dynamic changes and development which are almost daily, and therefore, sometimes difficult to follow.

2. Methods

2.1. The sample of respondents

The population from which the sample was taken for this study can be defined as a population of male and female dancers from folk dance ensembles of Serbia aged 18-24.

Based on the posed problem, subject and objective of the research, taking into account the organizational and financial capabilities necessary for the research procedure, an optimal number of subjects was taken into the sample in order to conduct the research correctly and obtain exact results.

The respondents fulfilled the following criteria: the age of respondents was defined on the basis of chronological age, so that the research covered 18-24-year-old respondents who did not suffer from organic and somatic diseases and were active members of folk dance ensembles.

The research was conducted in the following folk dance ensembles: „Vuk Stefanovic Karadzic" from BackaTopola, "Svetozar Markovic" from Novi Sad, "Zeleznicar", "Vila" from Novi Sad, "Ravangrad" from Sombor, "Kosta Abrasevic" from Backa Palanka, "Stepino Kolo" from Stepanovicevo, "Taras Sevcenko" from Djurdjevo, "Kisac" from Kisac, "Sonja Marinkovic" from Novi Sad, "Soko" from Indjija. The sample of respondents consisted of 248 male and female folk dancers, which was the optimal number for the planned research.

2.2. Sample of conative variables

There are a number of theories about the structure of conative factors which are based on empirical data and formulated in the form of structural or functional models and which enable an objective verification of the adequacy of these theories. The model of conative functions arising from the research of our authors (Momirovic, Horga, & Bosnar, 1982), served as a basis for this research.

The items that define the isolated hypothetical factors of the efficiency of conative functioning in the most representative, most reliable and best way were selected. By applying the above procedures, six 30-item tests were made with the following subject of measurement: activity regulation (EPSILON), regulation of organic functions (CHI), regulation of defense reactions (ALPHA), regulation of attack reactions (SIGMA), coordination of regulatory functions (DELTA), integration of regulatory functions (ETA).

The items are formulated in the form of statements, and the results are recorded by circling x, one out of 5 responses on Likert scale. The testing time is not limited (about 30 minutes for the whole battery of tests). The respondents` responses to certain items are scored as follows: absolutely true – 5 points, mostly true – 4 points, I`m not sure – 3 points, mostly incorrect -2 points, totally wrong – 1 point.

The method of calculating results of each test is usually summing the results bearing 1-5 points, which means that the final score of each test may range from 30 to 150 points.

2.3. Data processing methods

The value of a study depends not only on the sample of respondents and sample of variables, that is, the values of the basic information, but also on the applied procedures for transformation and condensation of that information. Some scientific problems can be solved with the help of a number of different, and sometimes equally valuable, methods. However, with the same basic data, from the results of different methods, different conclusions can be drawn. Therefore, the problem of selecting certain data processing methods is rather complex.

Taking this into account, the researchers, for the purpose of this study, selected those methods that corresponded to the nature of the problem and did not leave too heavy restrictions on the basic information. To determine differences between the groups, a method of discriminant analysis in Mahalanobis space was applied.

All the data in this research were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

Discriminant analysis in Mahalanobis space

Canonical discriminant analysis can now be defined as a solution of the quasi-canonical problem $\mathbf{M}\mathbf{x}_k = \mathbf{k}_k$, $\mathbf{G}\mathbf{y}_k = \mathbf{l}_k | c_k = \mathbf{k}_k{}^t\mathbf{l}_k$ = maximum, $\mathbf{x}_k{}^t\mathbf{x}_q = \mathbf{y}_k{}^t\mathbf{y}_q = \delta_{kq}$ k = 1,...,s; s = min((g - 1), m) = m where δ_{kq} is the Kronecker symbol and $\mathbf{x}_k$ and $\mathbf{y}_k$ are unknown m-dimensional vectors.

As $c_k = \mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k$, the function to be maximized is, for k = 1, $f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k - 2^{-1}\lambda_k(\mathbf{x}_k{}^t\mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k{}^t\mathbf{y}_k - 1)$.

After differentiating this function by elements of vectors $\mathbf{x}_k$, $\partial f/\partial \mathbf{x}_k = \mathbf{A}\mathbf{y}_k - \lambda_k\mathbf{x}_k$, and after differentiating it by elements of vectors $\mathbf{y}_k$, $\partial f/\partial \mathbf{y}_k = \mathbf{A}\mathbf{x}_k - \eta_k\mathbf{y}_k$; after equalizing with zero, $\mathbf{A}\mathbf{y}_k = \lambda_k\mathbf{x}_k$ and $\mathbf{A}\mathbf{x}_k = \eta_k\mathbf{y}_k$. Through differentiating by λ_k and η_k, from the condition that $\mathbf{x}_k{}^t\mathbf{x}_k = 1$ and $\mathbf{y}_k{}^t\mathbf{y}_k = 1$, it is easily obtained that $\lambda_k = \eta_k$.

As $\mathbf{A}^t = \mathbf{A}$, multiplying the first result by $\mathbf{x}_k{}^t$ and the second result by $\mathbf{y}_k{}^t$, $\mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k = \lambda_k$ and $\mathbf{y}_k{}^t\mathbf{A}\mathbf{x}_k = \lambda_k$, therefore, $\mathbf{x}_k = \mathbf{y}_k$ and the problem boils down to an ordinary problem of eigenvalues and eigenvectors of matrix **A**, that is, the solution of the problem $(\mathbf{A} - \lambda_k\mathbf{I})\mathbf{x}_k = \mathbf{0}$, k = 1,..., m, so $c_k = \rho_k{}^2 = \mathbf{x}_k{}^t\mathbf{A}\mathbf{x}_k = \lambda_k$, k = 1,..., m are squares of canonical correlations between the linear combinations of variables from **M** and **G** which are proportional to the differentiation of centroids of the subsamples defined by selector matrix **S** in the space spanned by the vectors of variables from **M**.

Let $\rho^2 = (\rho_k{}^2)$, k = 1,..., m be a diagonal matrix whose elements are squares of canonical correlations, let $\mathbf{X} = (\mathbf{x}_k)$, k = 1,..., m be a matrix of the eigenvectors obtained by solving the canonical discriminant problem, let $\mathbf{K} = \mathbf{MX}$ be a matrix of discriminant functions and let $\mathbf{L} = \mathbf{GX} = \mathbf{PMX}$ be a matrix of the discriminant functions projected in the hypercube defined by vectors of matrix **S**. As $\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{A}\mathbf{X} = \rho^2$ and as, of course, $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ and $\mathbf{L}^t\mathbf{L} = \rho^2$, the canonical discriminant analysis produces two biorthogonal sets of vectors of variables by such transformation of the vectors of variables that orthogonalizes those vectors and maximizes cosines of the angles between the corresponding vectors from **K** and **L**, with the additional condition that the cosines of the angles of non-corresponding vectors from **K** and **L** are equal to zero because the correlations between the variables from **K** and **L** are $\mathbf{K}^t\mathbf{L}\rho^{-1} = \mathbf{X}^t\mathbf{A}\mathbf{X}\,\rho^{-1} = \rho$.

Vectors $\mathbf{x}_k$ from **X** are, obviously, the vectors of standardized partial regression coefficients of variables from **M** that generate discriminant functions $\mathbf{k}_k$ which, together with discriminant functions $\mathbf{l}_k$ formed by vectors of standardized partial regression coefficients $\mathbf{x}_k$ of variables from **G**, have maximum correlations. But as

$\mathbf{M}^t\mathbf{K} = \mathbf{X}$, the elements of matrix **X** are, at the same time, the correlations of variables from **M** and discriminant variables from **K** , that, unlike the standard canonical discriminant model, allows easy testing of hypotheses on partial impact of variables on the formation of discriminant functions. For the identification of discriminant functions, the elements of the cross structural matrix defined as correlations between variables from **M** and **L**, that is, the elements of matrix $\mathbf{Y} = \mathbf{M}^t\mathbf{L}\rho^{-1} = \mathbf{A}\mathbf{X}\rho^{-1} = \mathbf{X}\rho$, can also be of certain significance; note, by the way, that **Y** is a factor matrix of matrix **A** because, naturally, $\mathbf{Y}\mathbf{Y}^t = \mathbf{X}\rho^2\mathbf{X}^t$.

As elements x_{jk} of matrix **X** and elements y_{jk} of matrix **Y** are ordinary correlations, their asymptotic variances are $\sigma_{xjk}^2 = (1 - x_{jk}^2)^2n^{-1}$, respectively $\sigma_{yjk}^2 = (1 - y_{jk}^2)^2n^{-1}$, therefore, hypotheses of type H_{0xjk}, or H_{0yjk}, can be tested on the basis of the functions $f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2))$, or $f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2))$, because under these hypotheses, the functions have the Fisher Snedecor F-distribution with the degrees of freedom of $\nu_1 = 1$ and $\nu_2 = n - 2$.

Unfortunately, with a usual application of canonical discriminant analysis, the main, and often the only, set of hypotheses related to the parameters of that model is the set $H_0 = \{\varphi_k = 0, k = 1,..., m\}$ where φ_k are hypothetical values of canonical correlations in population **P**.

To test the hypotheses of type H_{0k}: $\varphi_k = 0$ k = 1,..., m, researchers usually apply the function of the known Wilks measure $\lambda_k = \Sigma_{t+1}^s \log_e (1 - \rho_{t+1}^2)$ k = t + 1, t = 0, 1,..., m – 1 proposed by Bartlett (1941) who found that under the hypothesis H_{0k}: $\varphi_k = 0$, the functions $\chi_k^2 = -(n - (m + g + 3)/2)\ \lambda_k$ k = 1,..., m have, approximately, χ^2 distribution with the $\nu_k = (m - k + 1)(g - k)$ degree of freedom.

However, the results of Bartlett test are not, even when dealing large samples, in full accordance with the results of the tests of type $z_k = \rho_k/\sigma_k$ k = 1,...,s which are based on the fact that canonical correlations have also asymptotic normal distributions with parameters φ_k and $\sigma_k^2 \sim (1 - \varphi_k^2)^2n^{-1}$. (Kendall & Stuart, 1976; Anderson, 1984).

The centroids of the subsamples E_p, p = 1,..., g from E on discriminant functions necessary to identify the content of the discriminant functions are, of course, the elements of the matrix $\mathbf{C} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{K} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{M}\mathbf{X} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{Z}\mathbf{R}^{-1/2}\mathbf{X}$, and it is clear that they are, in fact, the centroids of the subsamples on the variables transformed into a Mahalanobis form projected into the discriminant space.

3. Discussion

To achieve high sports results in each kinesiological activity, as well as in dance, application of scientific research in the training process is crucial. As success in sports depends on a number of factors, it is very important to have reliable indicators of what

are the dimensions and to what extent they influence the achievement of maximum results. Conative space represents the part of personality which is responsible for the modalities of human behavior. As there are normal and pathological modalities of behavior, analogically, there are normal and pathological conative factors.

The characteristic of normal conative factors is that they are mostly independent of each other and normally distributed in the population. Attempts of researching normal behavioral modalities and normal conative factors are rare, therefore, this personality subspace is not defined clearly enough.

In previous studies, pathological conative factors were much better defined than normal conative factors, and in most cases there are certain theoretical explanations for them.

Pathological conative factors are considered to be responsible for those behavioral forms which reduce the adaptive level of a person, with regards to his or her potential capabilities. The influence of conative factors is not the same for all the activities: there are activities which are slightly sensitive to the influence of conative factors, and there are those for which the influence of these factors is crucial. This influence can be positive or negative depending on the type of factors and activities. So, there is no activity that would be completely independent of the influence of conative factors, therefore, determination of the structure of conative regulatory mechanisms in folk dancing is also very important.

The cause of the increase in the number of studies of an athlete`s personality should be sought in the characteristics of a sport activity which imposes exceptional and different requirements not only on cognitive abilities but also the personality. Therefore, it is reasonable to presume that active and successful participation in particular sports, as well as in folk dancing, requires a specific pattern of personality dimensions, most suitable for these sports, or a pattern of personality dimensions suitable for participation in sports but not in other activities.

Therefore, the assessment of specific latent dimensions in such studies is possible when based on simple confirmatory algorithms which are suitable not only because of considerable efficiency and economy, but because they provide easy interpretation of the results as Vidakovic, M., Popovic, D., Kacumi, N., Popovic, M., Savic, V. (2013) demonstrated in their research.

The algorithm used in this study, together with the accompanying program, tries to solve the specificity of latent dimensions of the treated space in the simplest possible way similar to that demonstrated in the research conducted by Vidakovic, M., Boli, E., Popovic, D., Berstajn, P.R., Savic, V., Bojovic, M. (2013).

The results of the discriminant analysis in cognitive space are shown in Tables 1, 2, 3 and 4. By analyzing them closely, it is possible to determine that significant

canonical correlation of (.34) is obtained. It explains 100.0% of valid variance of the whole system of the evaluated space.

This discriminant function is defined by the activity regulator that, at the same time, models the activating part of the reticular formation and thus is directly responsible for the energy level at which other systems function, including cognitive and motor processors.

Other regulators which define this function are the regulator for control of organic functions, regulator for coordination of regulatory functions and regulator of defense reactions located in the limbic system - it models tonic arousal. Because of the energy potential necessary for the regulation of aggression, such a model assumes a positive correlation between the attack regulator and activity regulator.

Based on the values and signs of the centroids for the first discriminant function of the groups, it can be concluded that male dancers have the ability to adequately model their tonic arousal on the basis of the programs, transferred by the genetic code or formed under the effect of learning, which are located in the centers for regulation and control of defense and attack reactions. They are able to coordinate functionally and hierarchically different subsystems, both cognitive and conative. Female dancers are able to adequately model the excitatory-inhibitory processes, which contributes to achieving better results compared to male dancers in this discipline.

DISCRIMINANT ANALYSIS OF CONATIVE VARIABLES

Table 1

Function	Eigenvalues	Variance %	Cumulative V %	Can. R	Wilks Lambda	Chi-skor	df	Sig
1	.13	100.0	100.0	.34	.88	30.91	6	.00

MATRIX M

Table 2

	FUNCTION 1
EPSILON	.14
CHI	-.01
ALPHA	.96
SIGMA	-.18
DELTA	-.93
ETA	.15

STRUCTURE OF CONATIVE VARIABLES

Table 3

	FUNCTION 1
EPSILON	-.54*
CHI	.49*
DELTA	.39*
ALPHA	.19*
SIGMA	.09
ETA	.09

CENTROIDS OF THE GROUPS

Table 4

Group	CEN1
female dancers	.30
male dancers	-.43

4. Conclusion

The research was conducted in order to determine differences in the structure of conative dimensions in male and female folk dancers.

To determine differences in the structure of conative dimensions of male and female folk dancers, 103 male and 145 female dancers aged 18-25 actively engaged in folk dancing were tested.

For the assessment of conative characteristics, CON6 measurement instrument was selected to assess the following conative regulators: activity regulator, regulator of organic functions, regulator of defense reactions, regulator of attack reactions, system for coordination of regulatory functions, system for integration of regulatory functions.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

To determine differences between the groups, a method of discriminant analysis was applied.

The results of the discriminant analysis in cognitive space are shown in Tables 1, 2, 3 and 4. By analyzing them closely, it is possible to determine that a significant canonical correlation of (.34) is obtained. It explains 100.0% of valid variance of the whole system of the evaluated space.

This discriminant function is defined by the activity regulator which, at the same time, models the activating part of the reticular formation and thus is directly responsible for the energy level at which other systems function, including conative and motor processors.

Other regulators that define this function are the regulator for control of organic functions, regulator for coordination of regulatory functions and regulator of defense reactions located in the limbic system - it models tonic arousal. Because of the energy potential necessary for the regulation of aggression, such a model assumes a positive correlation between the attack regulator and activity regulator.

Based on the values and signs of the centroids for the first discriminant function of the groups, it can be concluded that male dancers have the ability to adequately model their tonic arousal on the basis of the programs, transferred by the genetic code or formed under the effect of learning, which are located in the centers for regulation and control of defense and attack reactions. They are able to coordinate functionally and hierarchically different subsystems, both cognitive and conative. Female dancers are able to adequately model the excitatory-inhibitory processes, which contributes to achieving better results compared to male dancers in this discipline.

5. References

Anderson, T. W. (1984): *An introduction to multivariate statistical analysis* (2nd edition). New York: Wiley.

Boli, E., Popovic, D. & A. Hosek. (2009): Sport and Crime. Leposavic, University of Pristina, Multidisciplinary Research Center, Faculty of Sport and Physical Education.

Boli, E., Popovic, D.& Popovic, J. (2012): Differences in the level of musical abilities of male and female dancers. International scientific journal *Kinesmetrics*, 1 (67-89).

Boli, E., Popovic, D.& Popovic, J. (2012): Differences in the level of cognitive abilities of male and female dancers. International scientific journal *Kinesmetrics*, 1 (107-119).

Boli, E.: (1996) The structure of intellectual and musical abilities and personal traits of girls involved in standard and Latin dance, Master`s thesis. Universityof Pristina, Faculty of Physical Education.

Boli, E.: (2011) *The structure of anthropological dimensions of male and female dancers and development of methods for their evaluation and monitiring*. (Monograph). Leposavic, University of Pristina, Multidisciplinary Research Center, Faculty of Sport and Physical Education.

Guttman, L. (1945): Basis for test-retest reliability analysis. *Psychometrika*, **10**:255-282.

Kendall, M. G.& Stuart, A. (1968): *The advanced theory of statistics, 3*. London: Griffin.

Momirovic, D, Wolf, B.& Popovic, D. (1999): *Introduction to the theory of measurement and internal metric properties of composite measurement instruments* (textbook). University of Pristina, Faculty of Physical Education, Pristina.

Momirovic, K.; Horga, S. & Bosnar, K. (1982): Cybernetic model of cognitive functioning : Attempts of synthesis of some theories about the structure of cognitive abilities. *Kineziologija,* **14**. 5: 63-82.

Momirovic, K & Popovic, D. (2003): Construction and application of taxonomic neural networks. Multidisciplinary Research Centre, Faculty of Physical Education

Momirovic, K. (1999): Two measures of low and high reliability of tests with regulatory and singular matrix of particle covariance.

Popovic, D. (1980): Research Methodology in Physical Education. University of Nis, Scientific Youth, Nis.

Popovic, D. (1988): Methods of application of factor analysis for determining morphological types. *4rd International symposium on the methodology of matematical modelling*, Varna, Bulgarija.

Popovic, D. (1990): *Research Methodology in Physical Education* (textbook). University of Nis, Scientific Youth, Nis.

Popovic, D. (1992): *Research Methodology in Physical Education*. Athens, Greece.

Popovic, D. (1993): *Determination of the structure of psychosomatic dimensions in combats and development of methods for their evaluation and monitoring* (monograph). University of Priština, Faculty of Physical Education, Pristina.

Popovic, D. (1993): *Programs and subprograms for the analysis of quantitative modifications* (textbook). University of Priština, Faculty of Physical Education, Multidisciplinary Research Center, Priština.

Popovic, D. (2005): GUTTMAN, Programs for analysis of metric characteristics of composite mesurement instruments in Savic, Z.: Influence of situational training on transformation of some anthropological dimensions in selected footballers (doctoral thesis). Leposavic, Faculty of Physical Education.

Popovic, D., Antic, K., Stankovic, V., Petkovic, V. & Stankovic, S. (1989): The procedures for objectification of estimating the effectiveness in performing judo techniques. *Scientific Youth*, 21(1-2), 83-89.

Popovic, D., Boli, E., Shagal, E.& Savic, V. (2013): Influence of cognitive abilities, conative characteristics and social status of students on their school grades in mother tongue. International scientific journal *Kinesmetrics*, Vol. 2, No. 1, (5-23.)

Popovic, D., Kocic, J., Boli, E. & Stankovic, V. (1995): Conative characteristics of female dancers. *International Congress "Images of Sport in the World",* 75th Anniversary of the German Sport University, Abstract Volume, (pp. 96), Open Forum, Cologne, Germany.

Popovic, D., Petrovic, J., Boli, E. & Stankovic, V. (1995): The personality structure of female dancers. *3rd International Congress on Physical education and Sport*, Exercise & Society supplement issue No. 11 (pp. 196), Komotini, Greece.

Popovic, D., Stankovic, V., Kulic, R. & Grigoropulos, P. (1996): The structure of personality of handball players. *4th International Congress on Physical Education and Sport*, Exercise & Society supplement issue No. 15 (pp. 164), Komotini, Greece.

Vidakovic, M., Popovic, D., Katsumi, N., Popovic, M., Savic, V. (2013): Canonic discriminative analysis in Mahalanobis'space as a method for determining differences between conative dimensions of athletes who practice judo and karate. International scientific journal *Kinesmetrics*, Vol. 2, No. 1, (25-39.)

Vidakovic, M., Boli, E., Popovic, D., Berstajn, P.R., Savic, V., Bojovic, M.: (2013).Canonic discriminant analysis projected in space with standard matrix as optimum method for determining differences between athletes. International scientific journal *Kinesmetrics*, Vol. 2, No. 1, (109-123.)

Received on 08th June 2014.
Accepted on 02th November 2014.

Original scientific paper *UDC 793.31.071.1(497.11):159.942.072*
COBISS.SR-ID 214863884

Razlike u nivou konativnih dimenzija plesača i plesačica narodnih plesova

Jasna, Popović,[1], Dragan Popović[1], Evagelia Boli[1],
Eyal Shagal[2], Biljana Karanov[3] i Milica Bojović[1]
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[2]The Ribstein Center for Sport Medicine Sciences
and Research Wingate Institute, Israel
[3]Sporska Akademija, Beograd, Srbija
e-mail:jasna.popovic@pr.ac.rs

Sažetak

Neka je $\rho^2 = (\rho_k^2)$, $k = 1,..., m$ dijagonalna matrica čiji su elementi kvadrati kanoničkih korelacija, neka je $X = (x_k)$, $k = 1,..., m$ matrica svojstvenih vektora dobijenih rešavanjem kanoničkog diskriminativnog problema, neka je $K = MX$ matrica diskriminativnih funkcija i neka je $L = GX = PMX$ matrica diskriminativnih funkcija projektovanih u hiperkub definisan vektorima matrice S. Kako je $K^tL = X^tAX = \rho^2$ i kako je, naravno, $K^tK = I$ i $L^tL = \rho^2$, kanonička diskriminativna analiza proizvodi dva biortogonalna skupa vektora varijabli takvom transformacijom vektora varijabli iz M i G koja ortogonalizira te vektore i maksimizira kosinuse uglova između korespodentnih vektora iz K i L uz dodatni uslov da su kosinusi uglova nekorespodentnih vektora iz K i L jednaki nuli, jer su korelacije izmđ|u varijabli iz K i L $K^tL\rho^{-1} = X^tAX\,\rho^{-1} = \rho$.

Vektori x_k iz X su, očigledno, vektori standardizovanih parcijalnih regresijskih koeficijenata varijabli iz M koji generišu diskriminativne funkcije k_k koje sa diskriminativnim funkcijama l_k, formiranim vektorima standardizovanih parcijalnih regresijskih koeficijenata x_k iz varijabli iz G, imaju maksimalne korelacije. Ali, kako je $M^tK = X$, elementi matrice X su, istovremeno, i korelacije varijabli iz M i diskriminativnih varijabli iz K, što, za razliku od standardnog kanoničkog diskriminativnog modela, dopušta jednostavno testiranje hipoteza o parcijalnom uticaju varijabli na formiranje diskriminativnih funkcija. Za identifikaciju diskriminativnih funkcija od izvesnog značaja mogu biti i elementi kros strukturalne matrice, definisani kao korelacije između varijabli iz M i L, dakle elementi matrice $Y = M^tL\rho^{-1} = AX\rho^{-1} = X\rho$; uočimo, uzgred, da je Y faktorska matrica matrice A, jer je, naravno, $YY^t = X\rho^2X^t$.

Kako su elementi x_{jk} matrice X i elementi y_{jk} matrice Y obične korelacije, njihove asimptotske varijanse su $\sigma_{xjk}^2 = (1 - x_{jk}^2)^2n^{-1}$, odnosno $\sigma_{yjk}^2 = (1 - y_{jk}^2)^2n^{-1}$, pa se hipoteze tipa H_{0xjk} odnosno H_{0yjk} mogu testirati na osnovu funkcija $f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2))$, odnosno $f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2))$, jer pod tim hipotezama ove funkcije imaju Fisher - Snedecorovu F raspodelu sa stepenima slobode $\nu_1 = 1$ i $\nu_2 = n - 2$.

Ključne reči: */ matrica / varijansa / korelacija / funkcija /diskriminativna / vektor /*

Jasna Popović
Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
e-mail:jasna.popovic@pr.ac.rs

Original scientific paper *UDC 793.31.071.1(497.11)*
COBISS.SR-ID 214867980

Application of a quasi-canonical discriminant model in determining differences between groups of athletes

Evagelia Boli[1], Veroljub Stankovic[1], Dragan Popovic[1], Biljana Karanov[2], Kiriakos Taxildaris[3] & Marina Jovanovic
[1]Faculty of Sport and Physical Education, University of Pristina
temporarily seated in Leposavic, Serbia
[2]Sports Academy, Belgrade
[3]Democritius University of Thrace
Department of physical education Komotini,Greece.
e-mail:evagelia.boli@pr.ac.rs

Abstract

Canonical discriminant analysis can now be defined as a solution of the quasi-canonical problem $\mathbf{Mx}_k = \mathbf{k}_k$, $\mathbf{Gy}_k = \mathbf{l}_k | c_k = \mathbf{k}_k{}^t\mathbf{l}_k$ = maximum, $\mathbf{x}_k{}^t\mathbf{x}_q = \mathbf{y}_k{}^t\mathbf{y}_q = \delta_{kq}$ k = 1,...,s; s = min((g - 1), m) = m where δ_{kq} is the Kronecker symbol and $\mathbf{x}_k$ and $\mathbf{y}_k$ are unknown m- dimensional vectors.

As $c_k = \mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k$, the function to be maximized is, for k = 1, $f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k - 2^{-1}\lambda_k(\mathbf{x}_k{}^t\mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k{}^t\mathbf{y}_k - 1)$.

After differentiating this function by elements of vector $\mathbf{x}_k$, $\partial f/\partial \mathbf{x}_k = \mathbf{A}\mathbf{y}_k - \lambda_k\mathbf{x}_k$, and after differentiating it by elements of vector $\mathbf{y}_k$, $\partial f/\partial \mathbf{y}_k = \mathbf{A}\mathbf{x}_k - \eta_k\mathbf{y}_k$; after equalizing with zero, $\mathbf{A}\mathbf{y}_k = \lambda_k\mathbf{x}_k$ and $\mathbf{A}\mathbf{x}_k = \eta_k\mathbf{y}_k$. Through differentiating by λ_k and η_k,

it is easily obtained, from the conditions $\mathbf{x}_k^t\mathbf{x}_k = 1$ and $\mathbf{y}_k^t\mathbf{y}_k = 1$, that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, multiplying the first result by $\mathbf{x}_k^t$ and the second result by $\mathbf{y}_k^t$, $\mathbf{x}_k^t\mathbf{A}\mathbf{y}_k = \lambda_k$ and $\mathbf{y}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k$, so $\mathbf{x}_k = \mathbf{y}_k$ and the problem comes down to an ordinary problem of eigenvalues and eigenvectors of matrix A, that is the solution of the problem $(\mathbf{A} - \lambda_k\mathbf{I})\mathbf{x}_k = \mathbf{0}$, k = 1,..., m, so $c_k = \rho_k^2 = \mathbf{x}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k$, k = 1,..., m are squares of canonical correlations between the linear combinations of variables from **M** and **G** which are proportional to the differentiation of centroids of the subsamples defined by selector matrix **S** in the space spanned by the vectors of variables from **M**.

Let $\boldsymbol{\rho}^2 = (\rho_k^2)$, k = 1,..., m be a diagonal matrix whose elements are squares of canonical correlations, let $\mathbf{X} = (\mathbf{x}_k)$, k = 1,..., m be a matrix of eigenvectors obtained by solving the canonical discriminant problem, let $\mathbf{K} = \mathbf{MX}$ be a matrix of discriminant functions and let $\mathbf{L} = \mathbf{GX} = \mathbf{PMX}$ be a matrix of the discriminant functions projected into the hypercube defined by vectors of matrix **S**. As $\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{A}\mathbf{X} = \boldsymbol{\rho}^2$ and as, of course, $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ i $\mathbf{L}^t\mathbf{L} = \boldsymbol{\rho}^2$, the canonical discriminant analysis produces two biorthogonal sets of vectors of variables by such transformation of vectors of variables from **M** and **G** that orthogonalizes those vectors and maximizes cosines of the angles between corresponding vectors from **K** and **L**, with the additional condition that cosines of the angles of non-corresponding vectors from **K** and **L** are equal to zero, because the correlations between the variables from **K** and **L** are $\mathbf{K}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{X}^t\mathbf{A}\mathbf{X}\,\boldsymbol{\rho}^{-1} = \boldsymbol{\rho}$.

Keywords: / matrix / centroids / canonical / function / discriminant / vector /

1. Introduction

Dancing, as a form of human activity associated with music, represents a part of the rich tradition and artistic creativity of people. It is a part of people`s spirit, perceptions and aspirations, the mirror of human life, thoughts and activities in general. Dancing originated with man, followed him throughout life and work and developed in accordance with the development of human society; at different levels of development it was changed, modified and enriched until it reached its final form as stylized artistic dance. Conceptually, it can be characterized as a structure of specific movement elements composed into a visible form through which the complexity of man's inner life is expressed.

Dance, first of all, expresses its creators` ideas through various structures of motions and movements as well as gestures, i.e. the dancer expresses the conceptions through his or her body activities. Dance is made up of freely thought-out or special structural movements composed into certain figures or units which alternate in the same or different order, at the same or different tempo and rhythm.

Motions and movements are mainly emphasized by the lower limbs, while the whole body follows the expression shaping the whole story into one unit. Dance elements have particularly made a major contribution to the improvement of movement coordination, formation of motor skills, development of movement memory, ear for music , rhythm and memory, contribution to physical development of functional abilities, increase of neuromuscular coordination, and, very significantly, associated with music or a song, they create an optimistic, joyful atmosphere, strengthen friendships and cooperation in a group, develop a sense of socialization and cooperation between the sexes, and represent an excellent tool in physical education.

These activities are very closely related to the aesthetic formation of personality through body training process carried out through pedagogical application of aesthetic regularities, or aesthetic education. The role of aesthetic education is to teach trainees to recognize the beauty in body training and sport activities which they will experience, express and creatively introduce in all areas of their lives.

The content of aesthetic education in a body training process is to form the beauty of the human body which implies proportional harmony, correct posture, body shaping, harmonious development of motor skills and physical properties, formation of knowledge, skills and agility, which are a prerequisite of the beauty of movement expression that means the unity of technical perfection and style when developing movement and motor skills during body training and sport activities, as well as development of sense of rhythm through expression of music by movements in daily locomotion.

2. Methods

2.1. Sample of respondents

The population from which the sample was taken for this research can be defined as a population of male and female dancers from folk ensembles of Serbia aged 18-25 years. Based on the posed problem, subject and aim of the research, and taking into account the organizational financial capabilities necessary for the implementation of the research procedure, an optimal number of respondents was taken into the sample in order to carry out the research correctly and obtain exact results. The sample of respondents consisted of 248 male and female dancers, members of folk ensembles of Serbia, which was an optimal number for the planned research.

The respondents met the following conditions:

- the age of respondents was defined on the basis of chronological age, so the respondents covered by the research were 18-25 years old

- they did not suffer from organic or somatic diseases
- they were active members of folk ensembles.

The research was conducted in the folk ensembles as follows: "Vuk St. Karadzic" from Backa Topola, "Svetozar Marković" from Novi Sad, "Zeleznicar", "Vila" from Novi Sad, "Ravangrad" from Sombor, "Kosta Abrasevic" from Backa Palanka, "Stepino Kolo" from Stepanovicevo, "Taras Sevcenko" from Djurdjevo, "Kisac" from Kisac, "Sonja Marinkovic" from Novi Sad, "Soko" from Indjija.

2.2. Sample of variables of musicality

The measurement of musical abilities was performed using the Seashore test battery that assesses the basic musical abilities and contains the following components: pitch distinction (***PITCH***), loudness distinction (***LOUDNESS***), rhythm memory (***RHYTHM***), tone duration distinction (***TIME***), tone timbre distinction (***TIMBRE***), tone memory (***MEMORY***).

2.3. Data processing methods

There is no researcher nowadays who during his or her career years did not use, at least once, a model of multivariate analysis without understanding its logic. Therefore, the problem of selecting certain data processing methods is rather complex. That is why the value of a research depends not only on the sample of respondents and sample of variables, that is, the values of basic information, but also on the applied procedures for transformation and condensation of such information. Some scientific problems can be solved with the help of a number of different, and sometimes equally valuable, methods. However, with the same basic data, different conclusions can be drawn from the results of different methods.

In order to come to satisfactory scientific solutions , the researchers used, first of all, correct and then adequate, impartial and comparable procedures conforming to the nature of the posed problem and allowing extraction and transformation of the appropriate dimensions, testing of hypotheses on those dimensions, determination of differences and regularities within the research area.

Taking this into account, the methods that correspond to the nature of the problem and do not leave too heavy restrictions on the basic information were selected for the purpose of this research. To determine differences between the groups, a method of quasi-canonical discriminant analysis was applied.

In this research, all the data were processed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina, through the

system of data processing programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

Quqsi-canonical discriminant analysis

Canonical discriminant analysis can now be defined as a solution of the quasi-canonical problem $\mathbf{Mx}_k = \mathbf{k}_k$, $\mathbf{Gy}_k = \mathbf{l}_k | c_k = \mathbf{k}_k{}^t\mathbf{l}_k$ = maximum, $\mathbf{x}_k{}^t\mathbf{x}_q = \mathbf{y}_k{}^t\mathbf{y}_q = \delta_{kq}$ k = 1,...,s; s = min((g - 1), m) = m where δ_{kq} is the Kronecker symbol and $\mathbf{x}_k$ and $\mathbf{y}_k$ are unknown m-dimensional vectors.

As $c_k = \mathbf{x}_k{}^t\mathbf{Ay}_k$, the function to be maximized is, for k = 1, $f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k{}^t\mathbf{Ay}_k - 2^{-1}\lambda_k(\mathbf{x}_k{}^t\mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k{}^t\mathbf{y}_k - 1)$.

After differentiating this function by elements of vector $\mathbf{x}_k$, $\partial f/\partial \mathbf{x}_k = \mathbf{Ay}_k - \lambda_k\mathbf{x}_k$ and after differentiating it by elements of vector $\mathbf{y}_k$, $\partial f/\partial \mathbf{y}_k = \mathbf{Ax}_k - \eta_k\mathbf{y}_k$; after equalizing with zero, $\mathbf{Ay}_k = \lambda_k\mathbf{x}_k$ and $\mathbf{Ax}_k = \eta_k\mathbf{y}_k$. Through differentiating by λ_k and η_k , it is easily obtained, from the condition that $\mathbf{x}_k{}^t\mathbf{x}_k = 1$ and $\mathbf{y}_k{}^t\mathbf{y}_k = 1$, that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, multiplying the first result by $\mathbf{x}_k{}^t$ and the second results by $\mathbf{y}_k{}^t$, $\mathbf{x}_k{}^t\mathbf{Ay}_k = \lambda_k$ and $\mathbf{y}_k{}^t\mathbf{Ax}_k = \lambda_k$, so $\mathbf{x}_k = \mathbf{y}_k$ and the problem boils down to an ordinary problem of eigenvalues and eigenvectors of matrix **A**, that is, the solution of the problem $(\mathbf{A} - \lambda_k\mathbf{I})\mathbf{x}_k = \mathbf{0}$, k = 1,..., m, so $c_k = \rho_k{}^2 = \mathbf{x}_k{}^t\mathbf{Ax}_k = \lambda_k$, k = 1,..., m are squares of canonical correlations between the linear combinations of variables from **M** and **G** which are proportional to the differentiation of centroids of the subsamples defined by selector matrix **S** in the space spanned by vectors of variables from **M**.

Let $\boldsymbol{\rho}^2 = (\rho_k{}^2)$, k = 1,..., m be a diagonal matrix whose elements are squares of canonical correlations, let $\mathbf{X} = (\mathbf{x}_k)$, k = 1,..., m be a matrix of the eigenvectors obtained by solving the canonical discriminant problem, let $\mathbf{K} = \mathbf{MX}$ be a matrix of discriminant functions and let $\mathbf{L} = \mathbf{GX} = \mathbf{PMX}$ be a matrix of the discriminant functions projected into the hypercube defined by vectors of matrix **S**. As $\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{AX} = \boldsymbol{\rho}^2$ and as, of course, $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ and $\mathbf{L}^t\mathbf{L} = \boldsymbol{\rho}^2$, the canonical discriminant analysis produces two biorthogonal sets of vectors of variables by the transformation of vectors of variables from M and G that orthogonalizes those vectors and maximizes cosines of the angles between correspondent vectors from **K** and **L**, with the additional condition that cosines of the angles of non-correspondent vectors from **K** and **L** are equal to zero because the correlations between variables from **K** and **L** are $\mathbf{K}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{X}^t\mathbf{AX}\,\boldsymbol{\rho}^{-1} = \boldsymbol{\rho}$.

Vectors $\mathbf{x}_k$ from **X** are , obviously, the vectors of standardized partial regression coefficients of variables from **M** that generate discriminant functions $\mathbf{k}_k$ which, together with discriminant functions $\mathbf{l}_k$ formed by vectors of standardized partial regression coefficients $\mathbf{x}_k$ from variables of **G**, have maximum correlations. But as $\mathbf{M}^t\mathbf{K} = \mathbf{X}$, the elements of matrix **X** are, at the same time, correlations of variables from **M** and discriminant variables from **K**, that, unlike the standard canonical discriminant model, allows easy testing of hypotheses on partial impact

of variables on the formation of discriminant functions. To identify discriminant functions, the elements of a cross structural matrix defined as correlations between variables from **M** and **L** , that is, the elements of matrix $\mathbf{Y} = \mathbf{M}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{A}\mathbf{X}\boldsymbol{\rho}^{-1} = \mathbf{X}\boldsymbol{\rho}$, can also be of certain significance; note, by the way, that **Y** is a factor matrix of matrix **A**, as, of course, $\mathbf{Y}\mathbf{Y}^t = \mathbf{X}\boldsymbol{\rho}^2\mathbf{X}^t$.

As elements x_{jk} of matrix **X** and elements y_{jk} of matrix **Y** are ordinary correlations, their asymptotic variances are $\sigma_{xjk}^2 = (1 - x_{jk}^2)^2 n^{-1}$, respectively, $\sigma_{yjk}^2 = (1 - y_{jk}^2)^2 n^{-1}$, so the hypotheses of type H_{0xjk}, or H_{0yjk}, can be tested based on the functions $f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2))$, respectively, $f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2))$, because under the hypotheses, these functions have the Fisher-Snedecor F-distribution with the degrees of freedom of $\nu_1 = 1$ and $\nu_2 = n - 2$.

Unfortunately, with a usual application of canonical discriminant analysis, the main, and often the only, set of hypotheses related to the parameters of that model is the set $H_0 = \{\phi_k = 0, k = 1,..., m\}$ where ϕ_k are hypothetical values of canonical correlations in population P.

To test the hypothesis of type H_{0k}: $\phi_k = 0$ k = 1,..., m , researchers usually apply the function of the known Wilks measure $\lambda_k = \Sigma_{t+1}^{s} \log_e (1 - \rho_{t+1}^2)$ k = t + 1, t = 0, 1,..., m – 1 proposed by Bartlett (1941) who found that under the hypothesis H_{0k}: $\phi_k = 0$, functions $\chi_k^2 = -(n - (m + g + 3)/2)\ \lambda_k$ k = 1,..., m have, approximately, χ^2 distribution with the $\nu_k = (m - k + 1)(g – k)$ degree of freedom.

However, the results of Bartlett`s test are not, even when dealing with large samples, in full accordance with the results of the tests of type $z_k = \rho_k/\sigma_k$ k = 1,...,s which are based on the fact that canonical correlations have also asymptotically normal distributions with parameters φ_k and $\sigma_k^2 \sim (1 - \varphi_k^2)^2 n^{-1}$,(Kendall & Stuart, 1968; Anderson, 1984).

The centroids of subsamples E_p, p = 1,..., g from E on the discriminant functions necessary to identify the content of the discriminant functions, are, of course, the elements of matrix C = (STS) -1StK = (STS) -1StMX = (StS) -1StZR-1 / 2X, and it is clear that they are, in fact, the centroids of the subsamples on the variables transformed into a Mahalanobis form projected into the discriminant space.

3. Discussion

As previously stated, musical abilities are a special “factor”, or a special type of intelligence.

Modern studies have found that music stimulates not only one “music center”, but a number of them. The brain processes component by component, with the help of specific neural circuits. It handles tone pitch, intensity, duration, and timbre. Higher

brain centers bring this information together creating a melody, rhythm, tempo, meter, and, ultimately, phrases and whole compositions in the representation.

The pitch, sounds and timbre of different instruments, as well as tempo, rhythm, loudness are processed in different parts of the brain. For higher cognitive functions such as listening to music, musical attention, musical memory, tracking tone lines, harmonies and rhythm patterns, as well as tracking harmonic structure and musical form structure, particular neural processing networks are built in the brain.

The results of discriminant analysis in the space of musicality are shown in Tables 1, 2, 3 and 4. Through analysis, it can be determined by that a significant canonical correlation of (.32) is obtained, and it explains100% of valid variance of the entire system of the space being evaluated.

Female dancers have a better ability to distinguish tone duration, while male dancers have a better ability to distinguish loudness, pitch, rhythm, they have better overall musicality (as in the research conducted by Boli, E., Popovic, D., Popovic, J., 2012).

It is very important to observe once more the elements of music, or the fact that rhythm, where the male dancers achieved better results (variable RHYTHM), is defined as a sequence of tones or sounds of unequal duration, where female dancers achieved better results (variable TIME). The male dancers demonstrated a better sense of loudness which is a key factor when determining the meter, as well as rhythm (male dancers had better results in the rhythm assessment), which is quite logical because rhythm and meter are inseparable.

Compared to the research conducted by Boli, E. (2011) with the same measuring instruments but on a sample of younger respondents (11-13 years of age) engaged in another dance type (ballroom dancing - Latin and standard), the results also indicate that female dancers have a better ability to distinguish tone duration (as in that research) and male dancers also have a better ability to distinguish loudness (as in that research). The difference is that female performers of Latin and standard dances have a better ability of tone memory, rhythm recognition and timbre perception. In this research, male dancers generally achieve better results. The cause can be sought in a completely different conception of folk, on the one hand, and ballroom (Latin and standard) dances, on the other hand. Namely, a female ballroom dancer plays a dominant or equal role in the performance of dance structures, and a male ballroom dancer has a supporting role, while male folk dancers, compared to female folk dancers, perform motor, and thus rhythmically more complicated, dance structures.

DISCRIMINANT ANALYSIS OF VARIABLES OF MUSICALITY

Table 1

Function	Eigenvalues	Variance %	Cumulative %	Can. R	Wilks Lambda	Chi-skor	df	Sig
1	.09	100.0	100.0	.32	.95	21.44	6	.05

MATRIX M

Table 2

	FUNCTION 1
PITCH	.51
RHYTHM	.29
TIME	-.84
TIMRE	.07
MEMORY	.20

STRUCTURE OF VARIABLES OF MUSICALITY

Table 3

	FUNCTION 1
TIME	-.52
LOUDNESS	.43
PITCH	.42
RHYTHM	.24
OVERALL MUS.	.23
MEMORY	.16
TIMBRE	.13

CENTROIDS OF THE GROUPS

Table 4

N.G.	CEN1
female dancers	-.18
male dancers	.26

4. Conclusion

The research was conducted in order to determine differences in the structure of musical dimensions of male and female folk dancers.

To determine differences in the structure of musical dimensions of male and female folk dancers,103 male and 145 female dancers aged 18 to 28 years, who were actively engaged in folk dancing, were tested.

For the assessment of musical abilities, the researchers used the Seashore test battery that assesses the basic musical abilities and contains the following components: pitch distinction, loudness distinction, rhythm memory, tone duration distinction, timbre distinction, and tone memory.

All the data in this research were processed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina, through the system of data processing programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

To determine differences between the groups, a method of discriminant analysis was applied.

The results of discriminant analysis in the space of musicality are shown in Tables 1, 2, 3 and 4. Through analysis, it can be determined that a significant canonical correlation of (.32) is obtained, and it explains 100% of valid variance of the overall system of the space being evaluated.

Female dancers have a better ability to distinguish tone duration, and male dancers have a better ability to distinguish tone intensity, pitch, rhythm and overall musicality.

It is very important to observe once more the elements of music, or the fact that rhythm, where the male dancers achieved better results (variable RHYTHM), is defined as a sequence of tones or sounds of unequal duration, where the female dancers achieved better results (variable TIME). The male dancers demonstrated a better sense of loudness which is a key factor when determining the meter, as well as rhythm (male dancers had better results in the rhythm assessment), which is quite logical as rhythm and meter are inseparable.

Compared to the research conducted by Boli, E. (2011) with the same measuring instruments but on a sample of younger respondents (11-13 years of age) engaged in another dance type (ballroom dancing - Latin and standard), the results also indicate that female dancers have a better ability to distinguish tone duration (as in that research) and male dancers also have a better ability to distinguish loudness (as in that research). The difference is that female performers of Latin and standard dances have a better ability of tone memory, rhythm recognition and timbre perception. In this research male dancers generally achieve better results.

5. References

Anderson, T. W. (1984): *An introduction to multivariate statistical analysis* (2nd edition). New York: Wiley.

Boli, E.: (1996) The structure of intellectual and musical abilities and personal traits of girls involved in standard and Latin American dance, Master thesis, University in Priština, Faculty of physical education.

Boli, E., Popović, D., A. Hošek.: (2009) Sport i crime, Leposavić, University in Priština, Center for multidisciplinary research of the Faculty of Sport and Physical Education.

Boli, E.: (2011) The structure of anthropological dimensions of male and female dancers and procedures processing for their evaluation and monitiring. (Monograph), Leposavić.University in Priština, Center for multidisciplinary research of the Faculty of Sport and Physical Education.

Boli, E., Popović, D., Popović, J.: (2012) Differences in the level of musical abilities of male and female dancers, International scientific magazine Kinesmetric, 1 (67-89).

Boli, E., Popović, D., Popović, J.: (2012) Differences in the level of cognitive abilities of male and female dancers, International scientific magazine Kinesmetric, 1 (107-119).

Guttman, L. (1945): A basis for analysis test-retest reliability.*Psychometrika*, **10**:255-282.

Kendall, M. G.; Stuart, A. (1968): *The advanced theory of statistics, 3*. London: Griffin

Momirović, D, Wolf, B. and Popović, D: (1999) The introduction to the theory of measurement and internal metric properties of composite measuring instruments (textbook), University in Priština, Faculty of physical education, Priština.

Momirovic, K. (1999):Two measures of low and high reliability of tests with regulatory and singular matrix of particles covariance.

Momirovic, K i Popović, D. (2003):Construction and aplication of taxonomy neural networks Centre for Multidisciplinary Research, Faculty of Physical Education

Popović, D.: (1980) Research methodology in Physical education, University in Niš, Scientific Youth, Niš.

Popović, D., Antić, K., Stanković, V., Petković, V. & Stanković, S.: (1989) The procedures for objectification of estimating the effectiveness in performing the judo techniques. *Scientific Youth*, 21(1-2), 83-89.

Popović, D., Kocić, J., Boli, E. & Stanković, V.: (1995) Conative characteristics of female dancers. *International Congress "Images of Sport in the World",* 75th Anniversary of the German Sport University, Abstract Volume, (pp. 96), Open Forum, Cologne, Germany.

Popović, D., Petrović, J., Boli, E. & Stanković, V.: (1995) The structure of the personality of female dancers. *3rd International Congress on Physical education and Sport*, Exercise & society supplement issue No. 11 (pp. 196), Komotini, Greece.

Popović, D., Stanković, V., Kulić, R. & Grigoropulos, P.: (1996) The structure of personality of handball players. *4th International Congress on Physical education and Sport*, Exercise & society supplement issue No. 15 (pp. 164), Komotini, Greece.

Popović, D. (2005):GUTTMAN, Programs for analysis of metrical characteristics of composite mesurement instruments in Savić, Z.: Influence of situational training on transformation of some anthropological dimensions in selected footballers (doctoral thesis) Leposavić, Faculty of Physical Education.

Popović, D.: (1988) Application methods of factorial analysis for determining morphological types. *4rd international symposium on the methodology of matematical modelling*, Varna, Bulgarija.

Popović, D.: (1991) Research methodology in Physical education (textbook), University in Niš, Scientific Youth, Niš.

Popović, D.: (1992) Methodology of research in physical education, Athens, Greece.

Popović, D.: (1993) Programs and subprograms for the analysis of quantitative modifications (textbook), University in Priština, Faculty of physical education, Center for multidisciplinary research, Priština.

Popović, D.: (1993) Determination of the structure of psychosomatic dimensions in combats and procedures processing for their evaluation and monitoring (monograph), University in Priština, Faculty of physical education, Priština.

Received on 28th June 2014.
Accepted on 22th October 2014.

Original scientific paper *UDC 793.31.071.1(497.11)*
COBISS.SR-ID 214867980

Primena jednog kvazi kanoničkog diskriminativnog modela u utvrđivanju razlika među grupama sportista

Evagelia Boli[1], Veroljub Stanković[1], Dragan Popović[1], Biljana Karanov[2], Kiriakos Taxildaris[3] i Marina Jovanović
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini sa privremenim sedištem u Leposaviću, Srbija
[3]Democritius University of Thrace
Department of physical education Komotini,Greece.
[2]Sporska Akademija, Beograd, Srbija
e-mail:evagelia,boli@pr.ac.rs

Sažetak

Kanonička diskriminativna analiza može se sada definisati kao rešenje kvazi kanoničkog problema $Mx_k = k_k$, $Gy_k = l_k|c_k = k_k{}^t l_k$ = *maximum,* $x_k{}^t x_q = y_k{}^t y_q = \delta_{kq}$ k = *1,...,s;* $s = min((g - 1), m) = m$ *gde je* δ_{kq} *Kronekerov simbol a* x_k *i* y_k *nepoznati m - dimenzionalni vektori.*

Kako je $c_k = x_k{}^t A y_k$, *funkcija koju treba maksimizirati je, za* $k = 1$ $f(x_k, y_k, \lambda_k, \eta_k) = x_k{}^t A y_k - 2^{-1}\lambda_k(x_k{}^t x_k - 1) - 2^{-1}\eta_k(y_k{}^t y_k - 1)$.

Diferenciranjem ove funkcije po elementima vektora x_k $\partial f/\partial x_k = Ay_k - \lambda_k x_k$, *a diferenciranjem po elementima vektora* y_k $\partial f/\partial y_k = Ax_k - \eta_k y_k$; *nakon izjednačavanja*

sa nulom $Ay_k = \lambda_k x_k$ i $Ax_k = \eta_k y_k$. Diferenciranjem po λ_k i η_k lako se dobija, iz uslova $x_k^t x_k = 1$ i $y_k^t y_k = 1$, da je $\lambda_k = \eta_k$. Kako je $A^t = A$, množenjem prvog rezultata sa x_k^t i drugog rezultatat sa y_k^t $x_k^t Ay_k = \lambda_k$ i $y_k^t Ax_k = \lambda_k$ pa je $x_k = y_k$ i problem se svodi na običan problem svojstvenih vrednosti i vektora matrice A, dakle na rešenje problema $(A - \lambda_k I)x_k = 0$, $k = 1,..., m$ pa su $c_k = \rho_k^2 = x_k^t Ax_k = \lambda_k$, $k = 1,..., m$ kvadrati kanoničkih korelacija između linearnih kombinacija varijabli iz M i G koje su proporcionalne diferencijaciji centroida subuzoraka derinisanih selektorskom matricom S u prostoru koga razapinju vektori varijabli iz M.

Neka je $\rho^2 = (\rho_k^2)$, $k = 1,..., m$ dijagonalna matrica čiji su elementi kvadrati kanoničkih korelacija, neka je $X = (x_k)$, $k = 1,..., m$ matrica svojstvenih vektora dobijenih rešavanjem kanoničkog diskriminativnog problema, neka je $K = MX$ matrica diskriminativnih funkcija i neka je $L = GX = PMX$ matrica diskriminativnih funkcija projktovanih u hiperkub definisan vektorima matrice S. Kako je $K^tL = X^tAX = \rho^2$ i kako je, naravno, $K^tK = I$ i $L^tL = \rho^2$, kanonička diskriminativna analiza proizvodi dva biortogonalna skupa vektora varijabli takvom transformacijom vektora varijabli iz M i G koja ortogonizuje te vektore i maksimizira kosinuse uglova između korespodentnih vektora iz K i L uz dodatni uslov da su kosinusi uglova nekorespodentnih vektora iz K i L jednaki nuli, jer su korelacije izmđu varijabli iz K i L $K^tL\rho^{-1} = X^tAX\,\rho^{-1} = \rho$.

Ključne reči: */ matrica / centroidi / kanonička / funkcija / diskriminativna / vektor /*

Evagelia Boli
Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
e-mail:evagelia.boli@pr.ac.rs

Original scientific paper *UDC 793.31.071.1(497.11):159.922.72.072*
COBISS.SR-ID 214871308

Differences in the level of cognitive dimensions of male and female folk dancers

Biljana Karanov[1], Dragan Popovic[2], Evagelia Boli[2],
Katsumi Namba[3], Milica Bojovic[2] & Marina Jovanovic
[1]Sports Academy, Belgrade
[2]Faculty of Sport and Physical Education, University of Pristina
temporarily based in Leposavic, Serbia
[3]Takihava instistut, Tokijo, Japan
e-mail:biljana.karanov.ples@gmail.com

Abstract

Unfortunately, in ordinary application of canonical discriminant analysis, the main, and often the only, set of hypotheses related to the parameters of this model is the set $H_0 = \{\phi_k = 0, k = 1, ..., m\}$ where ϕ_k are hypothetical values of canonical correlations in population P.

To test hypotheses of type $H_{0k} : \phi_k = 0$ $k = 1, ..., m$, researchers usually apply a function of the known Wilks measure $\lambda_k = \Sigma_{t+1}^{s} \log_e (1 - \rho_{t+1}^2)$ $k = t + 1$, $t = 0, 1,..., m – 1$ proposed by Bartlett who found that under the hypothesis H_{0k}: $\phi_k = 0$, the functions $\chi_k^2 = -(n - (m + g + 3)/2) \lambda_k$ $k = 1,..., m$ have, approximately, χ^2 distribution with $\nu_k = (m - k + 1)(g - k)$ degrees of freedom.

However, the Bartlett test outcomes are not, even when dealing with large samples, in full accordance with the outcomes of tests of type $z_k = \rho_k/\sigma_k$ $k = 1,...,s$ based

on the fact that canonical correlations also have asymptotically normal distributions with the parameters ϕ_k and σ_k^2 $(1 - \phi_k^2)^2 n^{-1}$ (Kendall & Stuart, 1976; Anderson, 1984).

Centroids of the subsamples E_p, p = 1,..., g from E on the discriminant functions necessary to identify the content of the discriminant functions are, of course, elements of the matrix $\mathbf{C} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{K} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{MX} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{ZR}^{-1/2}\mathbf{X}$, so it is clear that they are, in fact, centroids of the subsamples on the variables transformed into a Mahalanobis form projected into the discriminant space.

Keywords: / distribution / correlation / centroids / discriminant / function / canonical /

1. Introduction

The beginning of dance cannot be determined with accuracy. It was positioned as a need for expression of religious, warlike and other feelings, in search of beauty, in the desire for entertainment, in the need of man to transfer the rhythm to the movements of everyday life and work.

It is connected to music, rhythm and gymnastics, and it is assumed that dance is the first artistic aspiration of man or the source of art that created music and rhythm, painting and sculpture, poetry and theater.

For primitive man, dance meant a means to fight for life. It was dance on which it depended whether hunting would be successful, harvest would be good, whether the enemy would be defeated, illness forced out of the village, the sun would come quicker, and winter would be chased away. Primitive man danced on every occasion, out of love or hatred, joy or sorrow. Dances featuring animals are immortalized in Stone Age cave paintings. These dances are still present among the primitive tribes.

In Christian countries, for the development of the art of dance, the most unfavorable period was the Middle Ages. The Middle Ages was not the epoch favorable for the development of the art of dance. Christianity found dance as a custom ingrained in people and tolerated it at first, but later increasingly banned and persecuted it throughout the entire centuries. People, however, despite all the church prohibitions, danced their traditional and entertainment dances.

After the Crusades, social dance among the people of Western Europe began to develop more vividly. The thirteenth and fourteenth centuries are characterized by two types of dance: “low”, stepping dances, or basse danse, and “high” dances. Dance teachers were engaged (at court) to compose, arrange, or create new dances. In the seventeenth century in Paris, thirteen most renowned dance masters, established the “Academy of Dance.” At the end of the eighteenth century, interest in dancing

declined partly because everything remained the same, and partly because of the difficult political circumstances that led to the revolution. After the revolution, dances came back to life.

Modern dances are characterized their dynamic change and development that are almost daily and sometimes hard to follow.

2. Methods

2.1. Sample of respondents

The population from which the sample was taken for this study can be defined as a population of male and female dancers from folk dance ensembles of Serbia aged 18-28 years.

Based on the posed research problem, subject and objective, and taking into account the organizational and financial capabilities necessary for the study implementation, an optimal number of subjects was taken into the sample in order to conduct the study correctly and obtain exact results. The respondents fulfilled the following criteria: their age was defined on the basis of chronological age, so the study covered respondents aged 18-28 years who had no organic and somatic diseases and were active members of folk dance ensembles.

The research was conducted in the folk dance ensembles as follows:

„Vuk St. Karadzic" from Backa Topola, „Svetozar Markovic" from Novi Sad, „Zeleznicar", „Vila" from Novi Sad, "Ravangrad" from Sombor, „Kosta Abrashevic" from Backa Palanka, „Stepino Kolo" from Stepanovicevo, „Taras Shevchenko" from Djurdjevo, „Kisac" from Kisac, „Sonja Marinkovic" from Novi Sad, „Soko" from Indjija. The sample of respondents consisted of 248 performers of folk dances, which was the optimum number for the planned research.

2.2. Sample of variables

The starting point of the study was the results of the studies of the structure of cognitive dimensions conducted in this country (Momirovic, Bosnar & Horga, 1982) that were largely congruent with the results of studies conducted in other countries.

These studies proved unambiguously that the structure of cognitive abilities was of hierarchical type, with the general cognitive factor below which are three primary factors of cognitive abilities related to the efficiency of the perceptual

processor (or perceptual reasoning), efficiency of the parallel processor (i.e. the ability to perceive relations and correlates) and efficiency of the serial processor (or symbolic reasoning).

The factor of perceptual reasoning is defined as a latent dimension that is responsible for receiving and processing information and solving those problems whose elements are given directly in the field of perception or representation. This factor represents the intelligence based on Thurston`s factors, similar to Alexander`s practical factor, Chattel`s general perceptual factor and Horn and Stankov`s general function factor.

The factor of symbolic reasoning is defined as a latent dimension that is responsible for the processes of abstraction and generalization as well as for solving those problems whose elements are in the form of any, especially verbal, symbols. This factor corresponds to Cattell`s factor of crystallized intelligence which is formed in the process of acculturation and represents the integration of Thurstone`s both verbal and numerical factors.

The factor of eduction of relations and correlates is defined as a latent dimension responsible for the establishment of relations between the elements of a structure and essential characteristics of such structures in solving those problems in which the establishing and restructuring processes are independent of previously acquired amounts of information. This factor corresponds to Cattell`s factor of fluid intelligence.

To assess the efficiency of the input processor, or perceptual reasoning, the IT-1matching test, designed to assess perceptual identification and discrimination, was selected. The test consisted of 30 tasks, the testing time was limited to 4 minutes. The test analysis indicates the difficulty of the tasks and their intercorrelations showing that this is not a typical speed test.

To assess the efficiency of the serial processor, or symbolic reasoning, F.L. Wells` AL-4 synonyms-antonyms test was selected, designed to assess the identification of denotative meanings of verbal symbols. It includes 40 alternative-response tasks. The testing time was 2 minutes, so this test belongs to the category of speed tests. The first main subject of measurement was defined mainly by the tasks from the second half of the test and interpreted as the ability to quickly identify the denotative meanings of verbal symbols.

To assess the efficiency of the parallel processor, or identification of relations and correlates, the S-1 test was selected. The test consists of 30 tasks to choose one of the four response options offered. The testing time was 10 minutes.

2.3. Data processing methods

The value of a study depends not only on the sample of respondents and sample of variables, i.e. the values of the basic information, but also on the applied procedures for transformation and condensation of the information. Some scientific problems can be solved with the help of a number of different, and sometimes equally valuable, methods. However, with the same basic data, from the results of different methods, different conclusions can be drawn. Therefore, the problem of selecting particular data processing methods is rather complex.

In order to reach satisfactory scientific solutions in the study, the researchers used, primarily, correct and then adequate, impartial and comparable procedures that conformed to the nature of the stated problem and provided extraction and transformation of appropriate dimensions, testing of the hypotheses about these dimensions, determination of differences as well as establishment of regularities within the research area.

Considering that, for the purposes of this study, the researchers selected those methods that are considered to correspond to the nature of the problem and not to leave too heavy restrictions on the basic information. To determine differences between the groups, a method of canonical discriminant analysis was applied.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

Canonical discriminant analysis

Canonical discriminant analysis can now be defined as a solution of the quasi-canonical problem $\mathbf{M}\mathbf{x}_k = \mathbf{k}_k$, $\mathbf{G}\mathbf{y}_k = \mathbf{l}_k | c_k = \mathbf{k}_k{}^t\mathbf{l}_k$ = maximum, $\mathbf{x}_k{}^t\mathbf{x}_q = \mathbf{y}_k{}^t\mathbf{y}_q = \delta_{kq}$ k = 1,...,s; s = min((g - 1), m) = m where δ_{kq} is the Kroneker simbol, and $\mathbf{x}_k$ and $\mathbf{y}_k$ are unknown m – dimensional vektors.

As $c_k = \mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k$, the function to be maximized is, for k = 1, $f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k - 2^{-1}\lambda_k(\mathbf{x}_k{}^t\mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k{}^t\mathbf{y}_k - 1)$.

After differentiating this function by elements of vectors $\mathbf{x}_k$, $\partial f/\partial \mathbf{x}_k = \mathbf{A}\mathbf{y}_k - \lambda_k\mathbf{x}_k$, and after differentiating it by elements of vectors $\mathbf{y}_k$, $\partial f/\partial \mathbf{y}_k = \mathbf{A}\mathbf{x}_k - \eta_k\mathbf{y}_k$; after equalizing with zero, $\mathbf{A}\mathbf{y}_k = \lambda_k\mathbf{x}_k$ i $\mathbf{A}\mathbf{x}_k = \eta_k\mathbf{y}_k$. By differentiating by λ_k and η_k, it is easy to obtain, from the conditions $\mathbf{x}_k{}^t\mathbf{x}_k = 1$ and $\mathbf{y}_k{}^t\mathbf{y}_k = 1$, that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, by multiplying the first result by $\mathbf{x}_k{}^t$ and the second result by $\mathbf{y}_k{}^t$, $\mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k = \lambda_k$ and $\mathbf{y}_k{}^t\mathbf{A}\mathbf{x}_k = \lambda_k$, so $\mathbf{x}_k = \mathbf{y}_k$ and the problem comes down to a simple problem of eigenvalues and eigenvectors of matrix $\mathbf{A}$, or the solution of the problem $(\mathbf{A} - \lambda_k\mathbf{I})\mathbf{x}_k = \mathbf{0}$, k = 1,...,

m and $c_k = \rho_k^2 = \mathbf{x}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k$, k = 1,..., m are squares of the canonical correlations between the linear combinations of variables from **M** and **G** which are proportional to the differentation of the centroids of the subsamples defined by selector matrix **S** in the space spanned by the vectors of variables from **M**.

Let $\rho^2 = (\rho_k^2)$, k = 1,..., m be a diagonal matrix whose elements are squares of canonical correlations, let $\mathbf{X} = (\mathbf{x}_k)$, k = 1,..., m be a matrix of eigenvectors obtained by solving the canonnical discriminant problem, let **K** = **MX** be a matrix of discriminant functions and let L = GX = PMX be a matrix of the discriminant functions projected into the hypercube defined by the vectors of matrix **S**. As $\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{A}\mathbf{X} = \rho^2$ and as, of course, $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ i $\mathbf{L}^t\mathbf{L} = \rho^2$, the canonical discriminant analysis produces two biorthogonal sets of vector of variables by such transformation of the vectors of variables from **M** and **G** that orthogonalizes those vectors and maximizes the cosines of the angles between the corresponding vectors from **K** and **L**, with the additional condition that the cosines of the angles of noncorresponding vectors from **K** and **L** equal to zero, because the correlations between the variables from **K** and **L** are $\mathbf{K}^t\mathbf{L}\rho^{-1} = \mathbf{X}^t\mathbf{A}\mathbf{X}\,\rho^{-1} = \rho$.

Vectors $\mathbf{x}_k$ from **X** are, obviously, the vectors of the standardized partial regression coefficients of the variables from **M** that generate discriminant functions $\mathbf{k}_k$ which together with discriminant functions $\mathbf{l}_k$, formed by the vectors of the standardized partial regression coefficients of variables $\mathbf{x}_k$ from **G**, have maximum correlations. But, as $\mathbf{M}^t\mathbf{K} = \mathbf{X}$, elements of matrix **X** are, at the same time, correlations between variables from **M** and discriminant variables from **K**, which, unlike the standard canonical discriminant model, allows for easy testing of hypoteses about the partial impact of variables on the formation of discriminant functions. To identify discriminant functions, the elements of the cross structural matrix defined as correlations between variables from **M** and **L**, or the elements of the matrix $\mathbf{Y} = \mathbf{M}^t\mathbf{L}\rho^{-1} = \mathbf{A}\mathbf{X}\rho^{-1} = \mathbf{X}\rho$, could also be of certain significance; note, by the way, that **Y** is a factor matrix of matrix **A** because, naturally, $\mathbf{Y}\mathbf{Y}^t = \mathbf{X}\rho^2\mathbf{X}^t$.

As x_{jk} elements of matrix **X** and y_{jk} elements of matrix **Y** are ordinary correlations, their asymptotic variances are $\sigma_{xjk}^2 = (1 - x_{jk}^2)^2 n^{-1}$, respectively $\sigma_{yjk}^2 = (1 - y_{jk}^2)^2 n^{-1}$, so the hypoteses of type H_{0xjk}, respectively H_{0yjk}, can be tested on the basis of the functions $f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2))$, or $f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2))$, because under the hypotheses, these functions have Fisher- Snedecor F-distribution with the degrees of freedom $\nu_1 = 1$ and $\nu_2 = n - 2$.

Unfortunately, in usual application of canonical discriminant analysis, the main, and often the only, set of hypotheses related to the parameters of this model is the set $H_0 = \{\varphi_k = 0, k = 1, ..., m\}$ where φ_k are hypothetical values of canonical correlations in population P.

To test the hypotheses of type H_{0k}: $\varphi_k = 0$ k = 1, ..., m, researchers usually apply a function of the known Wilks measure $\lambda_k = \Sigma_{t+1}{}^{s} \log_e (1 - \rho_{t+1}{}^2)$ k = t + 1, t = 0, 1,..., m – 1 proposed by Bartlett (1941) who found that, under the hypothesis H_{0k}: $\varphi_k = 0$, the functions $\chi_k{}^2 = -(n - (m + g + 3)/2)\ \lambda_k$ k = 1,..., m have, approximately, χ^2 distribution with the $\nu_k = (m - k + 1)(g - k)$ degrees of freedom.

However, the Bartlett test outcomes are not, even when dealing with large samples, in full accordance with the outcomes of the tests of $z_k = \rho_k/\sigma_k$ k = 1,...,s type based on the fact that canonical correlations also have asymptotically normal distributions with the parameters φ_k and $\sigma_k{}^2 \sim (1 - \varphi_k{}^2)^2 n^{-1}$ (Kendall & Stuart, 1968; Anderson, 1984).

Centroids of the subsamples E_p, p = 1,..., g from E on the discriminant functions necessary to identify the content of the discriminant functions are, of course, elements of the matrix $\mathbf{C} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{K} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{M}\mathbf{X} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{Z}\mathbf{R}^{-1/2}\mathbf{X}$, and it is clear that they are, in fact, centroids of the subsamples of the variables transformed into a Mahalanobis form projected into the discriminant space.

3. Discussion

According to previous studies, intelligence is multiple, not single, that however, the researchers accept the existence and strength of the so-called general intelligence, they agree that there are statistically independent mental abilities, such as spatial, verbal, analytical and practical intelligences.

The largest source of discussions and debates is the origin and individual differences, or what is the proportion of heredity and environment.

The results of the discriminant analysis in the cognitive space are shown in Tables 1, 2, 3, and 4. By analyzing the data, it can be determined that the significant canonical correlation of (.36) is obtained. It explains 100% of the valid variance of the entire system of the evaluated space.

Based on the values and signs of the centroids for the first discriminant function of the groups, it can be concluded that female dancers have a more efficient serial processor, or symbolic reasoning, and of the higher efficiency input processor, or perceptual reasoning, while male dancers have better efficiency of the parallel processor, or identification of relations and correlations.

Statistically, the male and female dancers are significantly different in all three tests. The female dancers have a more efficient serial processor, i.e. they handle symbolic reasoning better, which is reflected in the better results achieved on the test AL4. According to the results of the regression analysis, male and female dancers whose serial processor is more effective, or who handle symbolic reasoning better,

achieve better results at competitions, when the predictor system of cognitive abilities is involved. Female dancers also have a more efficient input processor, or perceptual reasoning, which is reflected in the better results on the test IT1, while male dancers have a more effective parallel processor, or identification of relations and correlates, which is reflected in the better results on the test S1.

DISCRIMINANT ANALYSIS OF COGNITIVE VARIABLES

Table 1

Function	Eigenvalues	Variance %	Cumulative %	Can. R	Wilks Lambda	Chi-skor	df	Sig
1	.15	100.0	100.0	.36	.86	35.18	3	.00

MATRIX M

Table 2

	FUNC 1
AL4	.87
S1	-.72
IT1	.26

STRUCTURE OF COGNITIVE VARIABLES

Table 3

	FUNC 1
AL4	.74
S1	-.38
IT1	.26

CENTROIDS OF THE GROUPS

Table 4

Centroids of the groups	
GROUP	CEN1
Female dancers	.33
Male dancers	-.46

4. Conclusion

The research was conducted in order to determine differences in cognitive dimensions between male and female folk dancers.

In order to determine differences in the structure of cognitive dimensions between male and female performers of folk dances, 103 male and 145 female dancers aged 18-28 actively engaged in folk dancing were tested.

For the assessment of intellectual abilities, three measurement instruments were applied, selected so that that the structure analysis could be solved on the basis of the cybernetic model designed by Das, Kirby and Jarman, or the model constructed by Momirovic, Bosnar and Horgen (1982), taking into account the fact that the selected tests measure three types of intellectual processing.

To assess the efficiency of the input processor, or perceptual reasoning, test IT-1 was selected, to assess the efficiency of the serial processor, or symbolic reasoning, test AL-4 was selected, and to assess the effectiveness of the parallel processor, or identification of relations and correlates, test S1was selected.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

For the determination of differences between the groups, a method of discriminant analysis was used.

The results of the discriminant analysis in the cognitive space are shown in Tables 1, 2, 3, and 4. By analyzing them, it can be determined that the significant canonical correlation of (.36) is obtained. It explains 100% of the valid variance of the entire system of the evaluated space.

Based on the values and signs of the centroids for the first discriminant function 0f the groups, it can be concluded that female dancers have a more efficient serial processor, or symbolic reasoning, and higher efficiency of the input processor, or perceptual reasoning, while male dancers have better efficiency of the parallel processor, or identification of relations and correlates.

Statistically, the male and female dancers are significantly different in all three tests. The female dancers have a more efficient serial processor, i.e. they handle symbolic reasoning better, which is reflected in the better results achieved on the test AL4. According to the results of the regression analysis, male and female dancers, whose serial processor is more effective, or who handle symbolic reasoning better, achieve better results at competitions, when the predictor system of cognitive abilities is involved. Female dancers also have a more efficient input processor, or perceptual

reasoning, which is reflected in the better results on the test IT1, while male dancers have a more effective parallel processor, or identification of relations and correlates, which is reflected in the better results on the test S1.

5. References

Anderson, T. W. (1984): *An introduction to multivariate statistical analysis* (2nd edition). New York: Wiley.

Boli, E. (1996): The structure of intellectual and musical abilities and personal traits of girls involved in standard and Latin dances, Master`s thesis. University of Pristina, Faculty of Physical Education.

Boli, E. (2011): *The structure of anthropological dimensions of male and female dancers and development of methods for their evaluation and monitiring* (Monograph). Leposavic, University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

Boli, E., Popovic, D. & Hosek, A. (2009): Sport and Crime. Leposavic, University of Pristina, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

Boli, E., Popovic, D. & Popovic, J. (2012): Differences in the level of musical abilities of male and female dancers. International scientific journal *Kinesmetric*s, 1 (67-89).

Boli, E., Popovic, D. & Popovic, J. (2012): Differences in the level of cognitive abilities of male and female dancers. International scientific journal *Kinesmetric*s, 1 (107-119).

Guttman, L. (1945): Basis for test-retest reliability analysis. *Psychometrika*, **10**:255-282.

Harris, C. W.; Kaiser, H. F. (1964): Oblique factor analytic solutions by orthogonal transformations. *Psychometrika*, **29**:347-362.

Kaiser, H. F. (1958): The varimax criterion for analytic rotation in factor analysis. *Psychometrika*, **23**:187-200.

Kendall, M. G. & Stuart, A. (1968): *The advanced theory of statistics, 3.* London: Griffin.

Momirovic, D, Wolf, B. & Popovic, D. (1999): *Introduction to the theory of measurement and internal metric properties of composite measurement instruments* (textbook). University of Pristina, Faculty of Physical Education, Pristina.

Momirovic, K & Popovic, D. (2003): Construction and application of taxonomic neural networks. Multidisciplinary Research Center, Faculty of Sport and Physical Education

Momirovic, K. (1999): Two measures of low and high reliability of tests with regulatory and singular matrices of particles covariance.

Momirovic, K.; Horga, S. & Bosnar, K. (1982): Cybernetic model of cognitive functioning : Attempts of synthesis of some theories about the structure of cognitive abilities. *Kineziologija,* **14**. 5: 63-82.

Popovic, D. (1980): Research Methodology in Physical Education. University of Nis, Scientific Youth, Nis.

Popovic, D. (1988): Application of factorial analysis methods for the determination of morphological types. *4rd international symposium on the methodology of matematical modelling*, Varna, Bulgaria.

Popovic, D. (1990): *Research Methodology in Physical Education* (textbook). University of Nis, Scientific Youth, Nis.

Popovic, D. (1992): *Research Methodology in Physical Education*. Athens, Greece.

Popovic, D. (1993): *Determination of the structure of psychosomatic dimensions in combats and and development of methods for their evaluation and monitoring* (monograph). University of Priština, Faculty of Physical Education, Pristina.

Popovic, D. (1993): *Programs and subprograms for the analysis of quantitative modifications* (textbook). University of Priština, Faculty of Physical Education, Multidisciplinary Research Center, Pristina.

Popovic, D. (2005): GUTTMAN, Programs for analysis of metric characteristics of composite mesurement instruments in Savic, Z.: Influence of situational training on transformation of some anthropological dimensions in selected footballers (doctoral thesis). Leposavic, Faculty of Physical Education.

Popovic, D., Antic, K., Stankovic, V., Petkovic, V. & Stankovic, S. (1989): The procedures for objectification of estimating the effectiveness in performing judo techniques. *Scientific Youth*, 21(1-2), 83-89.

Popovic, D., Kocic, J., Boli, E. & Stankovic, V. (1995): Conative characteristics of female dancers. *International Congress "Images of Sport in the World",* 75th Anniversary of the German Sport University, Abstract Volume, (pp. 96), Open Forum, Cologne, Germany.

Popovic, D., Petrovic, J., Boli, E. & Stankovic, V. (1995): The personality structure of female dancers. *3rd International Congress on Physical education and Sport*, Exercise & Society supplement issue No. 11 (pp. 196), Komotini, Greece.

Popovic, D., Stankovic, V., Kulic, R. & Grigoropulos, P. (1996): The personality structure of handball players. *4th International Congress on Physical education and Sport*, Exercise & Society supplement issue No. 15 (pp. 164), Komotini, Greece.

Received on 18th July 2014.
Accepted on 07th November 2014.

Original scientific paper *UDC 793.31.071.1(497.11):159.922.72.072*
COBISS.SR-ID 214871308

Razlike u nivou kognitivnih dimenzija plesača i plesačica narodnih plesova

Biljana Karanov[1], Dragan Popović[2], Evagelia Boli[2],
[3]Katsumi Namba, Milica Bojović[2] i Marina Jovanović
[1]Sporska Akademija, Beograd, Srbija
[2]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[4] Takihava instistut, Tokijo, Japan
e-mail: biljana.karanov.ples@gmail.com

Sažetak

Nažalost, pri uobičajenoj primeni kanoničke diskriminativne analize glavni, i obično jedini, skup hipoteza povezanih sa parametrima tog modela je skup $H_0 = \{\varphi_k = 0, k = 1,..., m\}$ *gde su* φ_k *hipotetske vrednosti kanoničkih korelacija u populaciji P.*

Za testiranje hipoteza tipa H_{0k}: $\varphi_k = 0$ $k = 1,..., m$ *obično se primenjuje se jedna funkcija poznate Wilksove mere* $\lambda_k = \Sigma_{t+1}^{s} \log_e (1 - \rho_{t+1}^2)$ $k = t + 1$, $t = 0, 1,..., m - 1$ *koju je predložio Bartlett (1941), koji je našao da pod hipotezom* H_{0k}: $\varphi_k = 0$ *funkcije* $\chi_k^2 = -(n - (m + g + 3)/2) \lambda_k k = 1,..., m$ *imaju, aproksimativno,* χ^2 *distribuciju sa* $\nu_k = (m - k + 1)(g - k)$ *stepeni slobode.*

Međutim, ishodi Bartlettovog testa nisu, ni kada se radi o velikim uzorcima, u najboljem skladu sa ishodima testova tipa $z_k = \rho_k/\sigma_k k = 1,...,s$ *koji se temelje na*

činjenici da kanoničke korelacije imaju takođe asimptotski normalne distribucije sa parametrima φ_k *i* σ_k^2 $(1 - \varphi_k^2)^2 n^{-1}$ *(Kendall i Stuart, 1976; Anderson, 1984).*

Centoidi subuzoraka E_p, $p = 1,..., g$ *iz* E *na diskriminativnim funkcijama, neophodni da bi se identifikovao sadržaj diskriminativnih funkcija, su, naravno, elementi matrice* $C = (S^tS)^{-1}S^tK = (S^tS)^{-1}S^tMX = (S^tS)^{-1}S^tZR^{-1/2}X$ *pa je jasno da su to, u stvari, centroidi subuzoraka na varijablama transformisanim u Mahalanobisov oblik projektovani u diskriminativni prostor.*

Ključne reči: */ distribucija / korelacija / centroidi / diskriminativna /funkcija / kanonička /*

Biljana Karanov
Sporska Akademija, Beograd, Srbija
e-mail: biljana.karanov.ples@gmail.com

Original scientific paper *UDC 572.5.087:793.31.071.2(497.11)*
COBISS.SR-ID 214873612

Reliability estimation for the lower bound of latent dimensions of morphological variables

Marina Jovanovic, Evagelia Boli[1], Dragan Popovic[1]
Daniela Dasheva[2], Vladimir Savic[1] & Marina Kostic
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[2]National Sports Academy "Vassil Levski", Bulgaria
e-mail: marina.r.jovanovic@gmail.com

Abstract

Proposition 1.

Coefficients γ_p vary in the range (0,1) and can assume the value 1 if and only if **P** = **I,** so if all variables have been estimated without errors, and the value is 0 if and only if both **P** = **0** and **R** = **I,** so if the total variance of all variables consists only of the variance of the errors of estimate, the 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 errors of estimate, it is then necessary that $\mathbf{E^2} = \mathbf{I}$ and **R** = **I**, therefore all coefficients γ_p equal zero. The first part of the Proposition is evident from the definition of coefficients γ_p; this means that reliability of each latent dimension,

irrespective of the manner of defining that latent dimension, equals 1 if variables, from which that dimension has been derived, are estimated without errors.

However, the matrix of the reliability coefficients $\mathbf{P} = (\rho_j)$ is often unknown, and therefore the matrix of the variances of the errors of estimate $\mathbf{E^2}$ is also unknown. But, if variables from V are chosen so as to represent some universe of variables U with the same field of meaning, the upper bound for the variances of the errors of estimate is defined by the elements of the matrix $\mathbf{U^2}$ (Guttman, 1945; 1953), hence by the unique variances of those variables. Consequently, in that case, the lower bound for the latent dimensions' reliability can be estimated by the coefficients β_p… which have been derived by the procedure identical to that used to derive the coefficients γ_p with the definition $\mathbf{E^2} = \mathbf{U^2}$, therefore in the same way Guttman derived his λ_6 estimate.

Key words: / distribution / set / variable / coefficient / variance /

1. Introduction

The concept of morphological characteristics implies the system of the structure of morphological dimensions bounded by a limited number of the manifest, directly measurable anthropometric measures.

In the course of physical growth and development, each body part follows a different curve, reaching its maximum at different point of time. For this reason, the morphological structure of the body, which is based on mutual interactions between all anthropometric measures at different stages of development, can be different, that is, individual morphological characteristics can at different points of time participate with different coefficients of participation in a particular morphological structure of the body.

However, the development of individual morphological characteristics is also largely governed by the structure of endogenous and exogenous factors which determine different physiological age for different subjects in the same development period. In some morphological characteristics, especially those mostly affected by exogenous factors, variations within the population of the same chronological age can be very high.

On the basis of many to date studies carried out by applying the **factorial approach and procedures** (Momirović, Kurelić, Stojanović, Hošek, and others), it can be safely argued that morphological space is essentially four-dimensional, which means that we have a model of the structure of morphological characteristics that consists of the following four factors:

L – longitudinal dimensionality of the skeleton, responsible for the bone growth in length;

T – transversal dimensionality of the skeleton, responsible for the bone growth in width;

V – body mass and volume, responsible for total body mass and volumes;

M – subcutaneous adipose tissue, responsible for total body fat amount.

As the longitudinal dimensionality of the skeleton correlates most with the transversal dimensionality of the skeleton, and body mass and volume correlate with the subcutaneous adipose tissue, with respect to gender and age, these factors are sometimes connected to form two factors: **the dimensionality of the skeleton** (longitudinal and transversal) and **body volume** (body mass and volume and subcutaneous adipose tissue).

Interaction factorial procedures were used to also isolate **a general factor of growth** (E), responsible for the total growth of all morphological characteristics.

A great number of studies in kinesiological anthropology deal with **genetics and somatotypes.** Namely, in the literature the terms such as **constitutiology** (constitution, constitutional type, or body type or build) and **somatotypology** (somatotype) are often used in parallel.

Historically viewed, **constitutiology** is the oldest term used in anthropology to determine bodily individuality of man. Today, this term has a broader sense and denotes the wholeness of morphological and functional characteristics (inherited and acquired) that determines the features of body's reactivity (intensity of reaction) and dynamics of ontogenesis. Also, in the literature the concepts of general and individual (chromosomal, physical, biochemical, physiological, neurodynamic) constitution have been developed. Studying the body at different levels (micromorphological, macromorphological, biochemical, etc), one can observe that individual bodily constitutions have a common core (common line) connecting them in the form of genetic program which is realized during ontogenesis and under particular environmental conditions.

Somatotypology deals with classifying humans into constitutional types and such attempts date back virtually to the times of Hippocrates (2500 years ago) and his hypotheses about the existence of four structural elements of body type. Even though the systems for identifying the somatotype are numerous (their number equals the number of researchers dealing with this issue), body proportions, the amount of adipose tissue, the development level of the muscular system and skeleton are commonly taken for the criterion and classifications. In this regard, it should be highlighted that there is still no single realistic criterion, i.e. a model, which can

be used to select relevant morphological variables, so as to reliably indicate, via an optimal condensation, that some morphological type exists.

On the grounds of different **typologies** (Kretschmer, Conrad, Sheldon), in recent studies the concept accepted by a larger number of authors (Burt, Thurstone, Conrad, and others) starts from the hypothesis that each subject takes a single, relatively stable position on each of several multivariate continuous taxonomic variables. In order to test this hypothesis, it was needed to exclude the classical procedures of 'cluster' analysis and apply the procedures based on the factorial or taxonomic model, the procedures belonging to the family of TAXOBOL algorithms, and thereby to achieve in an adequate way the typological goals of the study.

Taxonomic (T) approach and procedures. Despite a scarce number of studies are still applied (Hošek, Stojanović, and others), and regardless of the trends in constitutiology, a general morphological theoretical model is underpinned by the following taxons:

δ – skeletomorphy, responsible for skeleton longitudinality and partially bone width;

π – pycnomorphy, responsible for the prevalence of adipose tissue;

α – athletomorphy, responsible for the size and amount of muscle mass and skeleton dimensionality;

ε – endomesomorphy, responsible for the prevalance of muscle and adipose tissue.

Although all mentioned taxons are individually identified, they manifest themselves in an integrated manner and are, more or less, related to other characteristics of the anthropological status.

2. Methods

1.1.Subject sample

The sample was taken from the population of folk dancers, members of Serbian cultural artistic societies, aged 15-18 years.

Starting from the set up problem, subject and aim of the study, and taking into account the organizational and financial conditions required for conducting the study, the number of subjects included in the sample was maximum in order to make the study procedure regular and to obtain the results as much exact as possible.

The sample itself comprised 117 folk dancers, members of Serbian cultural artistic societies, which is an optimal number for the scheduled study. The subjects had to satisfy the following conditions: subjects' age was defined based on their chronological age, so that the study included the subjects aged 15-18 years, absence of organ and somatic diseases was another requirement, and still another was active membership in cultural artistic societies.

The study was conducted in the cultural artistic societies of Kraljevo, Čačak and Leposavić.

1.2.Variable sample

Subjects' morphological characteristics were estimated by applying 20 anthropometric variables, chosen according to the International Biological Program (IBP) to cover the 4D space defined as the longitudinal dimensionality of the skeleton, the transversal dimensionality of the skeleton, body mass and volume, and subcutaneous adipose tissue.

a) Longitudinal dimensionality of the skeleton: body height, sitting height, arm length, leg length, arm span.

b) Transversal dimensionality of the skeleton: biacromial range, bicristal range, wrist diameter, hand width, transverse thoracic diameter.

c) Body mass and volume: body mass, average thorax volume, upper arm volume, lower arm volume, upper leg volume.

d) Subcutaneous adipose tissue: upper arm skin fold, back skin fold, abdominal skin fold, armpit skin fold, lower leg skin fold.

1.3.Methods of data processing

The value of any research does not depend only on the sample of subjects and the sample of variables, i.e. on the value of basic information items, but also on the procedures applied to transform and condense information. Some scientific problems can be solved by the help of a larger number of different and sometimes equally valuable methods. However, different conclusions can be inferred from identical basic data and from the results obtained by different methods. That is why the problem of the choice of methods for data processing is rather complex.

To arrive at the satisfactory scientific solutions, the study employed, first of all, correct, adequate, objective and comparable procedures appropriate for the character of the set up problem, enabling the extraction and transformation of corresponding dimensions as well as setting up the regularities within the research area.

Taking into account above mentioned, the procedures chosen for the study were those considered to suit the nature of the problem and those not imposing the restrictions to information items.

In the past years a large number of researchers have misused their position and published an increasing number of quasi-scientific papers not founded primarily on mathematical artifacts. In addition, they are using the existing statistical products, but they have never had any basic understanding of the logic of the majority of multivariate models. That is why particular attention of this paper is directed to statistical data processing and to the choice of algorithms and programs that really have practical value.

If we exclude Mulaik's famous textbook of factor analysis, where there is something about reliability estimation of principal components (Mulaik, 1972) and the work by Kaiser and Caffrey who derived the method of Alpha factor analysis based on maximizing latent dimensions reliability (Kaiser and Caffrey, 1965), it seems that producers of various component and factor analysis and book writers in this area on the class of methods for the analysis of latent structures did not care about how much they can trust the real existence of the latent dimensions obtained by those methods. This fact also applies to the latent dimensions obtained by the orthoblique transformation of principal components, the method that has become a standard procedure for analyzing latent structures, employed by all those who have not acquired information about factor analysis using their fingers when reading seriously written texts in this area, or by those who do not analyze their data using some of poorly conceived, or even worse, written commercial statistical program packages, such as, but not exclusively, SPSS, CSS, Statistica, BMDP and Statgraphics, not to mention other products whose popularity is considerably smaller, but not always because they are essentially less good than those exclusively applied today by ignorant scientists and special type of human beings referred to as data processor species.

Indeed, one paper that proposes a competitive application of the semi-orthogonal transformations of principal components in exploratory and confirmatory analyses of latent structures suggests the use of a procedure for reliability estimation of latent dimensions founded on Cronbach's strategy for generalizability evaluation. However, that procedure is as justifiable as the assumptions from which the Cronbach α coefficient has been derived, today called after him for unknown reasons, despite the fact that totally identical measure, long before him, and with virtual assumptions, was offered by Spearman and Brown, Kuder and Richardson, Guttman, and in somewhat more simplified form described by Momirović, Wolf and Popović (1999), as well as by some psychometricians who worked in the nascent stage of the measurement theory development and in the age not caught in the PC revolution.

Therefore, the aim of this paper is to propose a measure for the lower bound of reliability of the latent dimensions obtained by the semi-orthogonal transformations of principal components.

All data collected in this study were processed at the Center for Multidisciplinary Studies, Faculty of Sports and Physical Education, University of Priština, using the system of data processing program developed by Popović, D. (1980; 1993) and Momirović, K. and Popović, D. (2003).

Semi-orthogonal transformation of principal components

Let **Z** be the standardized data matrix obtained by the description of some set E of n entities on some set V of m quantitative, normally or at least elliptically distributed variables. Let **R** be the matrix of those variables inter-correlations. Assume that **R** is for certain a regular matrix and that the hypothesis that variables from V have a spherical distribution can be safely rejected, and therefore the matrix eigenvalues being the correlation in population P wherefrom the sample E has been extracted are equal. Let $\mathbf{U}^2 = \mathbf{(diag\ R^{-1})^{-1}}$.

Guttman estimation of unique variances of the variables from V, and let λ_p , p = 1, …m be the eigenvalues of the matrix **R**. Let c = trag (I – U^2). Let us define scalar **k** such that $\Sigma_p^{\ k} \lambda_p > c$, $\Sigma_p^{\ k-1} \lambda_p < c$. Now, k is the number of principal components of the matrix **Z,** determined based on the Štalec and Momirović PB criteria (Štalec and Momirović, 1971).

Let $\Lambda = (\lambda_p)$; p = 1, … k be the diagonal matrix of the first eigenvalues of matrix **R** and let $\mathbf{X} = (x_p)$ be the matrix of eigenvectors appended to them, scaled such that $\mathbf{X^tX = I.}$ Let **T** be some orthonormal matrix such that it optimizes the function $\mathbf{XT = Q} = (\mathbf{q}_p)$; p (**Q**) = extremum, $\mathbf{T^tT = I}$, where p(**Q**) is some parsimonious function e.g. ordinary Varimax function $\Sigma_j^{\ m} \Sigma_p^{\ k} q_{jp}^{\ 4} - \Sigma_p^{\ k} (\Sigma_j^{\ m} q_{jp}^{\ 2})^2$ = maximum, where the coefficients q_{jp} are the elements of the matrix **Q** (Kaiser, 1958).

Now, the transformation of principal components, defined by the vectors in the matrix **K = ZX**, into semi-orthogonal latent dimensions determined by the type II of the orthoblique procedure (Harris and Kaiser, 1964), is defined by the operation **L = KT = ZXT**. The covariance matrix of those dimensions is $\mathbf{C = L'L\ n^{-1} = Q'RQ}$ $\mathbf{T^t\Lambda T}$; let us denote with $\mathbf{S}^2 = (s_p^{\ 2})$ = diag **C** the matrix of their variances. If latent dimensions are standardized by the operation $\mathbf{D = LS}^{-1}$, their inter-correlations will be in the matrix $\mathbf{M = D^tDn}^{-1} = \mathbf{S}^{-1}\mathbf{T^t\Lambda TS}^{-1}$; note that neither **C,** and therefore nor **M,** can be the diagonal matrices, so thus obtained latent dimensions are not orthogonal in the entity space from E.

The correlations matrix, between the variables from V and latent variables, commonly referred to as the factor structure matrix, will be $\mathbf{F = Z^tDn}^{-1} = \mathbf{RXTS}^{-1}$ $= \mathbf{X\Lambda TS}^{-1}$; since the elements of matrix **F** are orthogonal projections of the vectors

from **Z** onto the vectors from **D**, those vectors coordinates in the space spanned by the vectors from **D** are the elements of the matrix $\mathbf{A = FM^{-1} = XTS}$

However, as $\mathbf{A^tA = S^2}$ the latent dimensions obtained by this procedure are orthogonal in the space spanned by the vectors of the variables from **Z**; quadratic norms of the vectors of those dimensions in the space of the variables equal the variances of these dimensions.

Reliability estimation of the lower bound of latent dimensions

For simplicity and clear algebraic and geometric meaning and latent dimensions and identification structures appended to those dimensions, reliability of latent dimensions obtained by the orthoblique transformation of principal components can be determined clearly and unequivocally.

Let $\mathbf{G = (g_{ij})}$; I = 1, … n; j = 1, …m and let us allow it be the unknown matrix of the errors of estimate in describing the set E on the set V. The true entities results matrix from E on the variables from V will then be $\mathbf{Y = Z – G.}$

If we assume, in accordance with classical measurement theory (Gulliksen, 1950; Lord and Novick, 1968; Pfanzagl, 1968), that matrix **G** is such that $\mathbf{Y^tG = 0}$ i $\mathbf{G^tGn^{-1} = E^2 = (e_{jj}^2)}$, where E^2 is a diagonal matrix, the true results covariance matrix will be $\mathbf{H = Y^tYn^{-1} = R - E^2}$ if $\mathbf{R = Z^tZn^{-1}}$ is the variables inter-correlations matrix from V defined on the set E.

Let us assume that the reliability coefficients of the variables from V are known; let **P** be a diagonal matrix, whose elements ρ_j are those reliability coefficients. Then the variance of the errors of estimate for standardized results on the variables from V will be exactly the elements of the matrix $\mathbf{E^2 = I – P}$.

Now, the real values on the latent dimensions will be the elements of the matrix $\mathbf{\Gamma = (Z – G)Q}$ along with the covariance matrix $\mathbf{\Omega = \Gamma^t\Gamma n^{-1} = Q^tHQ = Q^tRQ - Q^tE^2Q} = (\omega_{pq})$.

Accordingly, the latent dimensions true variances will be the diagonal elements of the matrix **Ω;** let us denote those elements with ω_p^2. On the basis of formal definition of some variable reliability coefficient $\rho = \delta_t^2 / \delta^2$ where δ_t^2 is the true variance of some variable and δ^2 is the total variance of that variable, that is, the variance that also includes the error variance, then the latent dimensions reliability coefficients, if we know the reliability coefficients of the variables from which those dimensions are derived, will be $\gamma_p \gamma_p = \mathbf{\omega_p^2 / s_p^2} = 1 - (\mathbf{q_p^tE^2q_p})(\mathbf{q_p^tRq})^{-1}$ p 1,.....,k

Proposition 1.

Coefficients γ_p vary in the range (0,1) and can assume the value 1 if and only if **P = I,** so if all variables have been estimated without errors, and the value is 0 if and only if both **P = 0** and **R = I,** so if the total variance of all variables consists only of the variance of the errors of estimate, the 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 errors of estimate, it is then necessary that $\mathbf{E^2 = I}$ and **R =I,** and therefore all coefficients γ_p equal zero. The first part of the Proposition is obvious from the definition of the coefficients γ_p; this means that reliability of each latent dimension, regardless of the manner of determining that latent dimension, equals 1 if the variables, from which that dimension has been derived, are estimated without errors.

However, the matrix of reliability coefficients $\mathbf{P} = (\rho_j)$ is often unknown, and therefore the matrix of the variances of the errors of estimate $\mathbf{E}^2$ is unknown. However, if variables from V are chosen in such way to represent some universe of variables U with the same field of meaning, the upper bound for the variances of the errors of estimate is defined by the elements of the matrix $\mathbf{U}^2$ (Guttman, 1945; 1953), hence by the unique variances of those variables. Accordingly, in that case, the lower bound for the latent dimensions' reliability can be estimated by the coefficients $\boldsymbol{\beta_p} = 1 - (\mathbf{q}_p^t\mathbf{U}^2\mathbf{q}_p)(\mathbf{q}_p^t\mathbf{R}\mathbf{q}_p)^{-1}$ $p = 1,..., \mathbf{k}$ which have been derived by the procedure identical to that used to derive the coefficients γ_p with the definition $\mathbf{E^2 = U^2}$, therefore in the same way Guttman derived his λ_6 estimate.

3. Discussion

Morphological characteristics of human anthropological status most often imply a particular system of the basic anthropometric latent dimensions. Today, a serious scheduling of any moving activity cannot be done without knowledge about the morphological structure, its effects on the activity as well as the effects of that activity on the morphological characteristics development.

Morphological characteristics and somatotype features have always attracted researchers' interest on account of the need to identify the regularities of development in general, especially athlete's body, and therefore to establish the contribution of those characteristics to realizing particular motor abilities and habits.

THE MATRIX OF PRINCIPAL COMPONENTS OF ANTHROPOMETRIC VARIABLES

Tab. 1.

	FAC1	FAC 2	FAC 3	FAC 4	h^2
AVIS	,84	-,36	,24	,00	.90
ASV	,81	-,29	,15	,01	.77
ADR	,74	-,39	,26	,03	.78
ADN	,77	-,39	,33	,01	.86
ARR	,86	-,38	,17	,00	.92
AŠR	,81	-,08	-,08	,11	.69
AŠK	,81	-,08	,05	,08	.67
ADRZ	,75	-,33	-,19	-.10	.72
AŠŠ	,66	-,30	-,19	-,30	.66
ATDGK	,84	,15	-,21	-,07	.78
AMAS	,18	,01	-,51	,49	.54
ASOGK	,86	,12	-,30	,04	.86
AONADL	,85	,24	-,28	,02	.87
AOPODL	,86	,11	-,35	,00	.88
AONATK	,57	,35	,00	,11	.46
AKNN	,56	,63	,17	-,16	.76
AKNL	,67	,59	,00	-,03	.81
AKNT	-,01	-,02	,21	,76	.63
AKNPAZ	,50	,47	,36	,19	.63
AKNPOT	,50	,63	,34	-,12	.77
Charcte. roots	10.18	2.49	1.31	1.05	
%	50.94	12.48	6.56	5.28	
Cumula. %	50.94	63.43	69.99	75.28	

THE MATRIX OF ANTHROPOMETRIC VARIABLES TAXON

Tab. 2.

	OBL1	OBL2	OBL3	OBL4
AVIS	,97	,02	,08	,04
ASV	,85	,05	-,00	,01
ADR	,94	-,03	,11	,09
ADN	,99	-,01	,17	,10
ARR	,97	-,01	,01	,01
AŠR	,58	,18	-,29	-,00
AŠK	,63	,23	-,14	,03
ADRZ	,69	-,10	-,24	-,24
AŠŠ	,61	-,09	-,12	-,41
ATDGK	,34	,40	-,34	-,23
AMAS	-,10	-,09	-,76	,19
ASOGK	,34	,35	-,48	-,17
AONADL	,24	,47	-,46	-,18
AOPODL	,33	,32	-,50	-,23
AONATK	,08	,56	-,20	,05
AKNN	-,07	,89	,07	-,17
AKNL	-,04	,84	-,16	-,09
AKNT	,10	-,00	-,19	,79
AKNPAZ	,10	,74	,08	,28
AKNPOT	-,03	,91	,21	-,00

THE MATRIX OF THE STRUCTURE ANTHROPOMETRIC VARIABLES

Tab. 3.

	OBL1	OBL2	OBL3	OBL4
AVIS	,94	,39	-,25	-,12
ASV	,87	,40	-,31	-,14
ADR	,87	,31	-,19	-,06
ADN	,90	,34	-,15	-,05
ARR	,96	,38	-,32	-,15
Table continued on next page...				

... Table continued from previous page				
AŠR	,76	,49	-,53	-,15
AŠK	,77	,52	-,42	-,11
ADRZ	,77	,26	-,48	-,38
AŠŠ	,68	,22	-,35	-,53
ATDGK	,67	,65	-,58	-,37
AMAS	,08	,01	-,68	,14
ASOGK	,69	,63	-,70	-,32
AONADL	,64	,70	-,68	-,32
AOPODL	,68	,61	-,72	-,37
AONATK	,38	,64	-,36	-,04
AKNN	,29	,86	-,12	-,20
AKNL	,38	,88	-,36	-,19
AKNT	,02	-,00	-,15	,75
AKNPAZ	,33	,74	-,10	,19
AKNPOT	,26	,85	,00	-,07

INTER-CORRELATIONS BETWEEN OBLIMIN FACTORS

Tab.4.

	OBL1	OBL2	OBL3	OBL4
OBL1	1,00	,41	-,34	-,18
OBL2	,41	1,00	-,23	-,10
OBL3	-,34	-,23	1,00	,09
OBL4	-,18	-,10	,099	1,00

The start matrix for identifying the structure in component analysis is the total matrix of inter-correlations. From the thus obtained matrix of inter-correlations 75.28% of variability of the applied system of variables is interpreted by the component analysis. Using Guttman λ_6 criterion, four principal components were obtained with characteristic roots fulfilling the specified criterion (Tab. 1).

The first principle component with the characteristic root of 10.18 and variance of 50.94% is explained by all variables of longitudinal, transversal and circular dimensionality, as well as two variables for estimating dancers' back and armpit adiposity (AKNL and AKNPAZ). Based on high correlations between mentioned variables and the first principal component, it can be safely assumed that it behaves as a general factor of young dancers' growth and development.

The second principal component explains the total of 12.48% of the common variance. It is a dual factor of measures for estimating the upper arm subcutaneous adipose tissue (AKNNAD) and the lower leg subcutaneous adipose tissue (AKNPOT), and based on this factor it can be concluded that mentioned ballast fat tissue is a significant but not dominant characteristic of selected young dancers.

The third principal component is also single, i.e., the factor of body mass (AMAS), and the fourth component, also a single one, is the factor of abdominal skin fold (AKNT).

The communality size for all variables is satisfactory.

In order to obtain the parsimonius structure, to make such clear structure even more simplified, the obtained initial coordinate system was transformed into an oblique oblimin position, with the same number of factors retained afterwards. For the reason that the applied transformation method yields the total of three matrices, the matrix of parallel variable projections onto the factors (Tab. 2), the matrix of orthogonal variable projections onto the factors (Tab. 3) and the matrix of obtained factors inter-correlations (tab. 4), all three matrices were simultaneously interpreted.

The first oblimin factor of the largest projections has longitudinal and transversal dimensionalities with the variables. It can be interpreted no doubt as a general factor of the skeleton growth in young, selected dancers.

The second oblimin factor is defined by the variables for adipose tissue estimation in young dancers. The highest saturation of this factor is provided by the variables such as lower leg skin fold (AKNPOT), upper arm skin fold (AKNN), back skin fold (AKNL), armpit skin fold (AKNPAZ) as well as by a single variable for estimating the skeleton circular dimensionality of the upper leg volume (AONAT). This is a factor not generated by several years' training process, because the sample of subjects consists of young dancers and the factor is the result of endogenous effects. This factor can be defined as the factor of subcutaneous adipose tissue or endomorphy.

The third oblimin factor is also easy to interpret. It represents the factor of the volume and body mass, i.e., the variables that have an important role in the total body mass percentage.

The fourth oblimin factor is a single factor of abdominal skin fold, so this must be the product of hyperfactorization.

Of the isolated factors, statistically significant correlations exist between the first three oblimin factors, which makes sense because the young selected dancers have somewhat larger accumulation of subcutaneous adipose tissue and voluminosity which correlate with a general factor of growth.

Some morphological characteristics of dancers have a considerable correlation level with folk dancing achievement. In a series of studies it has been found that tall

dancers and those with longer legs and arms have the advantage over shorter dancers, that is, those with short extremities, their moves in dancing look more elegant, whereas dancers having higher amount of adipose tissue are superior in rhythmic structures. The impact level of specific morphological structure in folk dancing achievement should be identified by determining the correlation degree between total anthropometric test battery and dancing achievement. It can be expected that the length of arm, leg, foot, biacromial range, weight, volume of thorax, upper arm, lower arm and upper leg, hand and foot width, wrist diameter, abdominal and back skin fold are all in a more significant correlation with dancing achievement than other measures. From all above mentioned it follows that the structure obtained in the morphological space corresponds to the body build of folk dances performers.

4.Conclusion

The aim of the study was to identify the structure of morphological dimensions in dancers performing folk dances.

In order to identify the structure of the treated anthropometric dimensions, 117 dancers, members of Serbian cultural artistic societies, were examined.

To estimate the subjects' morphological characteristics, 20 anthropometric variables were applied, chosen according to the International Biological Program (IBP) to cover the four-dimensional space defined as the longitudinal dimensionality of the skeleton, the transversal dimensionality of the skeleton, body mass and volume, and subcutaneous adipose tissue.

All data collected in this study were processed at the Center of Multidisciplinary Studies, Faculty of Sport and Physical Education, University of Priština, using the system of programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).

To identify the latent morphological structure in dancers, the method of the Principal Components Factor Analysis was applied. Using the Guttmann λ_6 criterion, four principal components were obtained, whose characteristic roots fulfill the specified criterion (Tab. 1).

The first principal component with a characteristic root of 10.18 and variance of 50.94% is interpreted by all variables of longitudinal, transversal and circular dimensionality, as well as by two variables for the estimation of back and armpit adiposity in boxers (AKNL and AKNPAZ). On the grounds of high correlations between mentioned variables and the first principal component, it can be safely assumed that that it behaves as a general factor of growth and development in young dancers.

The second principal component interprets the total of 12.48% of the common variance. It represents a dual factor of measures for estimating the upper arm subcutaneous adipose tissue (ANN) and the lower leg subcutaneous adipose tissue (AKNPOT), on the basis of which it can be deduced that this ballast tissue represents a significant but not dominant characteristic of young, selected dancers.

The third principal component is also a single factor of body mass (AMAS); the fourth component is a single factor of abdominal skin fold (AKNT). The size of communality for all variables is satisfactory. To obtain the parsimonious structure and to make such a clear structure even more simplified, the obtained initial coordinate system has been transformed into an oblique oblimin position, retaining the same number of factors after that. For the same reason that the applied method for transformation yields the total of three matrices, the matrix of parallel projections of variables onto the factors (Tab. 2), the matrix of orthogonal projections of the variables onto the factors (Tab. 3) and the matrix of inter-correlations between the obtained factors (Tab. 4), all three matrices were simultaneously interpreted.

The first oblimin factor of the largest projections has longitudinal and transversal dimensionalities with the variables. It can be interpreted no doubt as a general factor of the skeleton growth in young, selected dancers.

The second oblimin factor is defined by the variables for adipose tissue estimation in young dancers. The highest saturation of this factor is provided by the variables such as lower leg skin fold (AKNPOT), upper arm skin fold (AKNN), back skin fold (AKNL), armpit skin fold (AKNPAZ) as well as by a single variable for estimating the skeleton circular dimensionality of the upper leg volume (AONAT). This is a factor not generated by several years' training process, because the sample of subjects consists of young dancers and the factor is the result of endogenous effects. This factor can be defined as the factor of subcutaneous adipose tissue or endomorphy.

The third oblimin factor is also easy to interpret. It represents the factor of the body mass and volume, i.e., the variables that have an important role in the total body mass percentage.

The fourth oblimin factor is a single factor of abdominal skin fold, so this must be the product of hyperfactorization. Statistically significant correlations among the isolated factors exist between the first three oblimin factors, which makes sense because the young selected dancers have somewhat larger accumulation of subcutaneous adipose tissue and voluminosity which correlate with a general factor of growth.

The author leaves an open issue of further studies on anthropological dimensions, especially the dimensions of musicality and functional mechanisms as well as the quality of acquired techniques in dancers performing folk dances, not involved by this study.

5. References

Guttman, L. (1945): Basis for test-retest reliability analysis. *Psychometrika*, **10**:255-282.

Popović, D. (1987). Morfološka struktura džudista pionira, III Kongres pedagoga fizičke kulture Jugoslavije, Novi Sacl, 351-356.

Popović, D. (1993). Utvrdivanje strukture psihosomatskih dimenzija u borenjima i izrada postupaka za njihovu procenu i praćenje - Monografija. Fakultet za fizičku kulturu Univerziteta u Prištini, Priština,

Popović, D., & sar. (1988). Application methods of factorial analysis for determining morphological types. IV international symposium on the methodology of matematical modelling, Varna, Bulgarija,

Popović, D., & sar. (1990). Morfološke karakteristike, motoričke sposobnosti i muzikalnost kod studenata fizičke kulture, 4 Kongres sportskih pedagoga Jugoslavije i prvi internacionalni simpozium, Ljubljana-Bled,

Popović, D., & sar. (1990). Uticaj animacijskog programa iz RSG na razvoj morfoloških osobina i motoričkih sposobnosti, 4 Kongres sportskih pedagoga Jugoslavije i prvi internacionalni simpozium, Ljubljana-Bled,

Popović, D., & sar. (1998). The differences in structure of morphological characteristics og handbal players and students. 6th International congress on Physical Education and Sport. Komotini, Greece,

Popović, D., & sar. (1998.). The structure of morphologycal characteristics og young basketball players. 6th International congress on Physical Education and Sport. Komotini, Greece,

Popović, D., & sar. (2002). Relationship among suppleness, morphological characteristics and motor abilities of boys, 7th Annual Congress of the European College of Sport Science. Cologne, German,.

Popović, D., & sar. 1998): The structure of morphologycal characteristics og young hanball players. 6th International congress on Physical Education and Sport. Komotini, Greece

Popović, D., & sar.(1996). The structure of morphological dimensions of hanball players. 4th International congress on Physical Education and Sport. Komotini, Greece,

Received on 25th May 2014.
Accepted on 21th October 2014.

Original scientific paper *UDC 572.5.087:793.31.071.2(497.11)*
COBISS.SR-ID 214873612

Procena pouzdanosti donje granice latentnih dimenzija morfoloških varijabli

Marina Jovanović, Evagelia Boli[1], Dragan Popović[1]
Daniela Dasheva[2], Vladimir Savić[1] i Marina Kostić
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[2]National Sports Academy "Vassil Levski", Bulgaria
e-mail: marina.r.jovanovic@gmail.com

Sažetak

Propozicija 1.

Koeficijenti γ_p variraju u rasponu (0,1) i mogu poprimiti vrednost 1 onda i samo onda ako je P = I, dakle ako su su sve varijable izmerene bez greške, a vrednost 0 onda i samo onda ako je i P = 0 i R = I, dakle ako se cela varijansa svih varijabli sastoji samo od varijanse greške merenja, a varijable iz V imaju sferičnu normalnu distribuciju.

Dokaz:

Ako se cela varijansa svake varijable iz nekog skupa varijabli sastoji samo od varijanse greške merenja, onda je nužno $E^2 = I$ i R = I, pa su svi koeficijenti γ_p jednaki nuli. Prvi deo propozicije očigledan je iz definicije koeficijenata γ_p ; to

znači da je pouzdanost svake latentne dimenzije, bez obzira kako je ta latentna dimenzija određena, jednaka 1 ako su varijable iz kojih je ta dimenzija izvedena izmerene bez greške.

Međutim, matrica koeficijenata pouzdanosti $P = (\rho_j)$ je često nepoznata, pa je nepoznata i matrica varijansi greške merenja E^2 . Ali, ako su varijable iz V izabrane tako da reprezentuju neki univerzum varijabli U sa istim poljem značenja, gornja granica varijansi greške merenja definisana je elementima matrice U^2 (Guttman, 1945; 1953), dakle uniknim varijansama tih varijabli. Zbog toga se, u tom slučaju, donja granica pouzdanosti latentnih dimenzija može proceniti koeficijentima $\beta_p = 1 - (q_p^t U^2 q_p)(q_p^t R q_p)^{-1}$ $p = 1,..., k$ koji su izvedeni postupkom koji je identičan postupku kojim su izvedeni i koeficijenti γ_p uz definiciju $E^2 = U^2$, dakle na isti način na koji je Guttman izveo svoju meru λ_6 .

Ključne reči: */ distribucija / skup / varijabla / koeficijenti / varijansa / plesači /*

Marina Jovanović

e-mail: marina.r.jovanovic@gmail.com

Original scientific paper

UDC 796.422.12.012.1
796.323.012.1
COBISS.SR-ID 214875148

Specifics of cognitive abilities of track-and-field athletes and basketball players

Dragan Popovic[1], Izet Rađo[2], Veroljub Stankovic[1],
Evagelia Boli[1], Vladimir Savic[1] & Milica Bojovic[1]
[1]Faculty of Sport and Physical Education, University of Pristina,
temporarily based in Leposavic, Serbia
[2]Faculty of Sport and Physical Education University of Sarajevo
e-mail: dragan.popovic@pr.ac.rs

Abstract

The research was conducted in order to determine the structure and differences in cognitive dimensions of track-and-field athletes and basketball players.

For the purpose of determining the structures and their differences in the manifest and latent cognitive spaces, 100 male respondents aged 14 and 18 was tested. This sample can be considered representative of athletes of those ages.

For the assessment of cognitive abilities, the researchers used 6 measurement instruments selected so that the structure analysis could be performed on the basis of the cybernetic model designed by (Das, Kirby & Jarman 1979) and by (Bosnar & Horga, 1981), (Momirovic, Bosnar & Horga 1982), taking into account the fact that the selected tests measure three types of cognitive processing . To assess the effectiveness of the input processor, or perceptual reasoning, CF-2 and GT-7 were selected, to assess the effectiveness of the parallel processor, or identification of relations and correlates - IT-2 and D-4S, and to assess the effectiveness of the serial processor, or symbolic reasoning, ALPHA-7 and G-SIN were selected.

All the data in this research were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).To determine differences between the groups, canonical discriminant analysis was applied.

The researchers calculated the discriminant coefficient values, canonical correlation coefficients, percentage of the explained group variability, Bartlett`s chi-square test values, degrees of freedom, Wilks' Lambda values, and error probability in the rejection of the hypothesis that the actual canonical correlation value is equal to zero.

They also calculated the standardized coefficients of the participation of the tests in the formation of significant discriminant functions, as well as centroids of the groups on the significant discriminant functions.

The results of the discriminant analysis of cognitive variables show that athletes of different sports differ from each other significantly.

By means of condensation of variables in cognitive space, two discriminant variables, which maximally separated the groups of athletes based on the discriminant coefficients, were isolated.

1. Introduction

Transformation processes, incurred as a result of the adaptation of an athlete`s organism to the training stimuli, are the phenomena caused by the regularities in the relations of internal physiological, biomechanical and psychological systems, as well as in the relations between the athlete as an integral anthropological entity and the environment. Today we can only speculate about the transformation processes, induced by synchronous effects of endogenous and exogenous factors, on the basis of the final effects of the exercise, and we know very little about the nature of the phenomena of adaptation of the athlete`s organism to the established exercise load. Modern science uses interdisciplinary approaches to such complex research areas. For the convergence of different scientific disciplines and their compliance with empirical evidence and requirements, a common basis is necessary.

It is cybernetics, with its modern methodological procedures, that significantly contributes to the sciences of physical culture, especially sport, in their transcending the descriptive level. If the process of athlete education is understood in the context of cybernetic planning as a system, familiarization with the system structure and relations in the system, as well as the relations between the system and environment, contributes to discovering the principles, methods and tools that lead to achievement

of optimal management, which is the aim pursued in modern sport. Systematic training is essentially a transformation process through which an athlete, as a system, is transformed from one state into another in accordance with the requirements of a given sport or sport discipline. Since it is necessary to master the regularities which the transformation processes undergo to achieve efficient management, it is necessary to know the structure and relations among the constituent elements of the system.

Through modeling, it is possible to receive the sets of the system elements which are considered to be responsible for the studied phenomenon. Modeling as a method is characterized by the creation of a system that is, in its essential characteristics, analogous to the real phenomenon being examined. If the model structures do not represent all the essential characteristics of the studied original, they will be partial models. A partial model, despite its abundance, is a process model and can describe transformation processes in an athlete`s body caused by systematic training in essential characteristics. For the rational creation of a model of transformation processes, "conditio sine qua non" is a model of the anthropological space structure, i.e. a model that integrates all known anthropological qualities considered to be responsible for motor manifestations and therefore, for top sport results.

However, it should be noted that, at the current level of knowledge, the deterministic models of human locomotion can be applied in a limited number of cases. This refers, first of all, to the modeling and then to the simulation of simple movements which generally characterize competition results of primarily individual sports such as track-and-field. In other sports and sport games, which fall under the category of polystructural sports and where athletes` performance takes place under changing conditions, deterministic modeling can be used for the purpose of improvement of crisis technical elements, while competition performance modeling primarily, but not exclusively, should be of stochastic character. Because of that, as well as because of the fact that stochastic models generally have (for the same observed parameters) lower diagnostic and prognostic levels, they should include the highest possible number of athletes` anthropological characteristics that are known or expected with some degree of probability to contribute to sport results. Previous studies show that there are relations between cognitive space and other anthropological subspaces in stochastic modeling.

2.1. Sample of respondents

The selection of a sample of respondents is conditioned, among other things, by the organizational and financial capabilities necessary for the implementation of the research process.

It was necessary to ensure a sufficient number of trained and qualified measurers, appropriate instrumentation and standardized conditions under which the research could be implemented. Limited financial resources and organizational capabilities influenced the decision to perform the measurement not throughout Kosovo and Methohia but only in one of its regions.

The research was carried out on randomly selected samples representative of whole Kosovo and Methohia. The measurement was performed in the following sports: track-and-field and basketball. To do the research correctly and obtain results stable enough in terms of sampling error, it was necessary to take a sufficient number of respondents into the sample. The sample size for this type of research is conditioned by the research objectives and tasks, the population size and degree of variability of the applied system of parameters. In addition, the number of respondents in the sample also depends on the level of statistical inference and the choice of mathematical and statistical models.

Based on the selected statistical-mathematical model and program, objectives and tasks, 100 respondents were included in the sample. In all factor procedures, should constantly be kept in mind that the analysis results depend on three main systems that determine the selection and transformation of information: the sample of variables, sample of respondents and selected extraction or rotary methods. Taking these criteria into account, based on the experience from previous studies, the sample of 100 respondents is considered to be sufficient for this study. In defining the population from which the sample was drawn, except for the above, no other restrictions or stratification variables were used.

2.2. Sample of variables for assessment of cognitive abilities

The starting basis for the research was the findings of the studies of the structure of cognitive dimensions conducted in Yugoslavia (Bosnar & Horga, 1981), (Momirovic, Bosnar & Horga 1982), (Boli, E., Popovic, D., Popovic, J., 2012) that were largely congruent with the results of studies carried out in other countries.

These studies have provided unequivocal evidence that the structure of cognitive abilities is of hierarchical type, where at the top is the general cognitive factor below which are three primary factors of cognitive abilities related to: the effectiveness of the perceptual processor (perceptual reasoning), effectiveness of the parallel processor (ability to identify relations and correlates), and the effectiveness of the serial processor (symbolic reasoning).

The factor of perceptual reasoning is defined as a latent dimension responsible for receiving and processing information and solving those problems whose elements are given directly in the field of perception or representation. This factor represents the intelligence of Thurstone perceptual factors and is similar to Alexander `s practical factor, Cattell`s general perceptual factor and Horn and Stankov`s general function factor.

The factor of education of relations and correlates is defined as a latent dimension responsible for determining relations between the elements of a structure and essential characteristics of such structures in solving those problems in which the processes of determining and restructuring are independent of the previously acquired amounts of information. This factor corresponds to Cattell`s factor of fluid intelligence.

The factor of symbolic reasoning is defined as a latent dimension responsible for the processes of abstraction and generalization and for solving those problems whose elements are given in the form of any, and especially verbal, symbols. This factor corresponds to Cattell`s factor of crystallized intelligence which is formed in the process of acculturation and represents the integration of both Thurstone verbal factors and their numerical factors.

To assess the effectiveness of the input processor, or perceptual reasoning, the researchers selected the tests as follows:

TEST CF-2: a test of latent model representing the adaptation of Thurstone`s Drawing Test which is, as a marker test, applied for assessing flexibility, or the factor of convergent production of figural transformations (according to Guilford`s classification). The test contains 20 tasks; the testing time is limited to 3 minutes. The analysis of this test shows that the test had good characteristics.

TEST GT-7: B. Dvorak`s test of matching drawings to assess perceptual identification. It contains 4 blocks of 12-18 geometric drawings made in two differently organized contexts. It consists of 60 tasks, and the testing time is limited to 6 minutes. The analysis of the test shows that this test has all the characteristics of a speed test.

To estimate the effectiveness of the parallel processor, or identification of relations and correlates, the researchers selected the following measurement instruments:

TEST IT-2: Thurstone and Dvorak`s test of general visualization designed to assess the efficiency of perception of spatial relations. It contains 39 multiple choice tasks to determine which of the four given geometric bodies matches the drawing. The testing time is 10 minutes, so this test falls under the category of power tests.

TEST D-4S: Anstey`s Dominoes Test to assess the general factor of intelligence. In this study, the researchers applied a revision of the original form Momirovic that

did not contain the four tasks which were very poorly saturated with the common measurement subject of other tasks. The test includes 40 tasks each of which consists of 4-8 dominoes arranged in a certain order where the gap should be filled in with the appropriate value to fit into the given structure. The testing time is 15 minutes, therefore, the test belongs to the category of power tests.

To assess the effectiveness of the serial processor, or symbolic reasoning, the following measurement instruments were selected:

TEST ALPHA-7: F. L. Well`s Analogies Test to measure verbal comprehension. The test contains 39 tasks and the testing time is 3 minutes, which characterizes it as a speed test. The first main subject of measurement of the test is defined, in the first place, by less difficult tasks and interpreted as the ability to perceive simple analogies on symbolic material.

TEST G-SIN: Synonyms Test by for the assessment of rapid identification of semantic meanings of verbal symbols. It contains 39 multiple choice tasks of identifying among 5 words the one closest in the meaning to the given word. The test falls under the category of speed tests because the testing time is 3 minutes.

2.3. Data processing methods

The value of a research does not only depend on the sample of respondents and sample of variables, that is, the values of basic information, but also on the applied methods for transformation and condensation of the information. Certain scientific problems can be solved with the help of a number of different, and sometimes equally valuable, methods. However, with the same basic data, from the results of different methods, different conclusions can be drawn. Therefore, the problem of selecting data processing methods is rather complex.

In order to obtain satisfactory scientific solutions in a research, it is necessary to use, first of all, correct, then adequate, unbiased and comparable procedures which correspond to the nature of the problem and provide extraction and transformation of appropriate dimensions, the testing of hypotheses about those dimensions, and establishment of basic regularities within the research area.

Taking this into account, for the purposes of this study, the researchers selected those methods which were considered to correspond to the nature of the problem.

To determine differences between the groups, a method of discriminant analysis was applied. The researchers calculated the discriminant coefficient values (Eigenval.), canonical correlation coefficients (Can. Cor.), percentage of the explained group variability (chi-square test (Chi)), degrees of freedom (DF), Wilks' Lambda values (WL), and error probability in the rejection of the hypothesis that the actual canonical correlation value is equal to zero (Sig).

They also calculated the standardized coefficients of participation of the tests in the formation of significant discriminant functions, as well as the centroids of the groups on the significant discriminant functions.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

Projection into a space with standard metric

The resulting solution is very easy to convert into a form obtained under the canonical model of discriminant analysis.

The matrix of discriminant coefficients can be defined as a matrix of partial regression coefficients that is obtained by solving the problem $\mathbf{ZW} = \mathbf{K} + \mathbf{E}$ |trag($\mathbf{E}^t\mathbf{E}$) = minimum.

As $\mathbf{K} = \mathbf{ZR}^{-1/2}\mathbf{X}$, it is clear that $\mathbf{E} = \mathbf{0}$ and $\mathbf{W} = \mathbf{R}^{-1/2}\mathbf{X}$. Therefore, vectors $\mathbf{w}_k$ from $\mathbf{W}$ are proportional to the coordinates of the vectors of discriminant functions in the tilted coordinate system formed by vectors from $\mathbf{Z}$ with cosines of the angles between the coordinate axes equal to the elements of correlation matrix $\mathbf{R}$. Since discriminant analysis can also be interpreted as a special case of component analysis with principal components transformed by a permissive singular transformation so as to maximize distances between centroids of subsets E_p , or canonical correlations ρ_k (Cooley & Lohnes, 1971), the custom is to identify the content of discriminant functions on the basis of structural vectors $\mathbf{f}_k$ from the matrix $\mathbf{F} = \mathbf{Z}^t\mathbf{K} = \mathbf{RW} = \mathbf{R}^{1/2}\mathbf{X} = (\mathbf{f}_k) = (\mathbf{Rw}_k)$, which is analogous to the identification of the content of canonical variables obtained by Hotelling`s method of biorthogonal canonical correlation analysis because it is possible to show by easy calculation that $\mathbf{F}$ is a factor matrix of matrix $\mathbf{R}$

In this metric, the cross structure of discriminant functions will be $\mathbf{U} = \mathbf{Z}^t\mathbf{L}\rho^{-1} = \mathbf{Z}^t\mathbf{PZW}\rho^{-1} = \mathbf{W}\rho$ as, of course, $\mathbf{W}^t\mathbf{Z}^t\mathbf{PZW} = \rho^2$, and it is clear that $\mathbf{U}$ is a factor matrix of the matrix $\mathbf{Z}^t\mathbf{PZ}$, or intergroup covariance matrix defined in the space with standard metric.

As elements f_{jk} of matrix $\mathbf{F}$ and elements u_{jk} of matrix $\mathbf{U}$ behave like ordinary product-moment correlation coefficients, and as they are a function of normally distributed variables, and therefore, they themselves are asymptotically normally distributed, their asymptotic variances are, of course, $\sigma_{jk}^2 \sim (1 - \phi_{jk}^2)^2 n^{-1}$ j = 1,..., m; k = 1,..., s, respectively, ξ_{jk}^2 $(1 - \upsilon_{jk}^2)^2 n^{-1}$ j = 1,..., m; k = 1,..., s, and can be used for testing hypotheses of type H_{jk}: $f_{jk} = \phi_{jk}$, or H_{jk}: $u_{jk} = \upsilon_{jk}$, where ϕ_{jk} and υ_{jk} are some hypothetical correlations between variables from V and discriminant functions in population P because the asymptotic distribution of coefficients f_{jk} is $f(f_{jk}) \sim N(\phi_{jk},$

σ_{jk}^2), and the asymptotic distribution of coefficients u_{jk} is $f(u_{jk})$ $N(\upsilon_{jk}, \xi_{jk}^2)$, where *N* is a symbol of normal distribution.

Reliability, informativeness and significance of discriminant functions

Let $\mathbf{V}^2 = (\text{diag } \mathbf{R}^{-1})^{-1}$ be a diagonal matrix whose elements are estimates of unique variances of variables from V. Now, as shown by Momirovic, reliability, or, more precisely, generalizability of discriminant functions can be assessed based on the values of diagonal elements of the matrix $\alpha = (\text{diag } (\mathbf{W}^t(\mathbf{R} - \mathbf{V}^2)\mathbf{W}))(\text{diag } (\mathbf{W}^t\mathbf{R}\mathbf{W}))^{-1}$, relative informativeness - based on the elements of the diagonal matrix $\iota^2 = (\mathbf{I} - \alpha)^{-1}m^{-1}$, and redundancy of these functions – based on the elements of the diagonal matrix $\zeta = \iota^2\rho$.

Of course, for making judgments about what is the real meaning of discriminant functions, these data can be of much greater importance than the results of the tests of significance of canonical correlations.

DISC PROGRAM

This algorithm is almost literally implemented into the program DRDISC written in a matrix language so that it can be realized in the standard SPSS environment. The activation method and some details of the program can be seen from the program symbolic code which is stored at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, and clear instructions are given to make it possible for anyone, who needs it, to apply the canonical discriminant analysis correctly. Modification of this program and its practical implementation in the SAS environment were carried out by D. Popovic in 2004, and the scientists interested in its application can contact the author at any time.

3. Discussion

The results of the discriminant analysis of cognitive variables show that athletes of different sports differ from each other considerably. The canonical correlation coefficients (Can. Cor.) are .90 and .51. The significance of this discrimination tested by means of Wilks` test and Bartlett`s chi-test with 8 and 3 degrees of freedom (DF) indicates high significant differences between the groups of the tested athletes because Sig. = .00 for both roots, and chi = 4.88 for the first root and chi = 75.12 for the second root.

Through condensation of variables in the cognitive space, two discriminant variables, which maximally separated the groups of athletes on the basis of discriminant coefficients, were isolated.

The first discriminant function explains the differences with 92.52 percent of intergroup variability in the cognitive space of the applied discriminant variables.

Analyzing Table 2 reveals that the first discriminant function separates the athletes on the basis of IT-2 which is, in its initial subject of measurement, designed to assess the effectiveness of spatial relations. This factor is actually subordinated to the mechanism responsible for the determination of relations between the elements of a structure and essential characteristics of such structures in solving those problems in which the determination and reconstruction processes are independent of the amounts of the previously acquired information (it is a generally known mechanism for parallel processing).

Another factor that determines this function is CF2 which in the initial measurement estimates convergent productions of figural transformations and it is subordinated to the mechanism responsible for receiving and processing information and solving those problems whose elements are given directly in the field of perception and representation. It is, in fact, a mechanism commonly known in cybernetics as an input processor.

Based on the value and sign of the projection of the centroid onto the first discriminant function, it can be concluded that track-and-field athletes have a better expressed factor of symbolic reasoning, i.e. they better understand verbal contents and it is not so important for them to solve those problems whose elements are given directly in the field of perception and representation, and their movement stereotypes are very important, that means they are very dependent on the previously acquired amounts of information. It is a sport where there is no need for solving complex motor tasks, but the result depends on the level of acquisition of the techniques and on other abilities, primarily motor and cardiovascular ones.

Basketball players must have the ability to efficiently perceive spatial relations, i.e. they must have the ability to receive and process information and solve those problems whose elements are given directly in the field of perception and representation.

The second discriminant function, though it exhausts the smaller variance, can still be meaningfully interpreted, and is determined by ALPHA-7 which assesses the ability to understand verbal contents, or effectiveness of parallel processing, and by GT-7 which assesses perceptual identification, or effectiveness of the input processor.

Based on the value and sign of the centroid on the second discriminant function, it can be concluded that basketball players have a more expressed ability for abstraction and generalization processes and a better ability to receive and

process information, which is understandable considering the complexity of the sport discipline and requirements it imposes on the athletes.

DISCRIMINANT FUNCTIONS IN COGNITIVE SPACE

Table 2

Func.	Eigenval.	Var. %	Cum. %	Can.Cor.	Wilks' Lam	Chi² - test	DF	Sig
1*	4.46	92.52	92.52	.90	.13	488.88	8	.00
2*	.36	7.48	100.00	.51	.73	75.12	3	.00

STRUCTURE MATRIX

	FUNC 1	FUNC 2
IT-2	.98*	-.08
CF-2	.67*	-.05
D-4S	.52	.30*
ALPHA-7	-.17	.24*
GT-7	-.05	.21*
G-SIN	.05	-.09

CENTROIDS OF THE GROUPS

GROUP	C1	C2
Track-and-field athletes 1	-2.64	-.03
Basketball players 2	1.56	.67

4. Conclusion

The study was conducted in order to determine the structures and their differences in cognitive dimensions of track-and-field athletes and basketball players.

For the purpose of determining the structure and their differences in manifest and latent cognitive spaces, 100 male respondents aged 14 and 18 were tested. This sample can be considered representative of athletes of those ages.

For the assessment of cognitive abilities, the researchers applied 6 measurement instruments selected so that to the structure analysis could be performed on the basis of the cybernetic model designed by (Das, Kirby, & Jarman 1979), and by (Momirovic,

Gredelj, Hosek 1980), taking into account the fact that the selected tests measured three types of cognitive processing. To assess the effectiveness of the input processor, or perceptual reasoning, CF-2 and GT-7 were selected, to assess the effectiveness of the parallel processor, or perception of relations and correlates - IT-2 and D-4S, and to assess the effectiveness of the serial processor, or symbolic reasoning, ALPHA-7 and G-SIN were selected.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D . (2003).To determine differences between the groups, canonical discriminant analysis was applied.

The researchers calculated the discriminant coefficient values, canonical correlation coefficients, percentage of the explained group variability, Bartlett`s chi-square test value, degrees of freedom, Wilks' Lambda values, and error probability in the rejection of the hypothesis that the actual canonical correlation value is equal to zero.

They also calculated the standardized coefficients of participation of the tests in the formation of significant discriminant functions, as well as the centroids of the groups on the significant discriminant functions.

The results of the discriminant analysis of cognitive variables show that athletes of different sports significantly differ from each other.

Through the condensation of variables in the cognitive space, two discriminant variables that maximally separated the groups of athletes on the basis of discriminant coefficients were isolated.

Analyzing Table 2 reveals that the first discriminant function separates the athletes on the basis of IT-2 which is, in the initial subject of measurement, aimed at assessing the effectiveness of spatial relations. This factor is actually subordinated to the mechanism responsible for determining relations between the elements of a structure and essential characteristics of such structures in solving those problems in which the determination and reconstruction processes are independent of the previously acquired amounts of information (mechanism for parallel processing).

Another factor that determines this function is CF-2 which, in the initial measurement, estimates convergent productions of figural transformations and it is subordinated to the mechanism responsible for receiving and processing information and solving those problems whose elements are given directly in the field of perception or representation. It is a mechanism known in cybernetics as an input processor.

Based on the value and sign of the projection of the centroid onto the first discriminant function, it can be concluded that track-and-field athletes have a better expressed factor of symbolic reasoning, i.e. they better understand verbal contents

and it is not so important for them to solve those problems whose elements are given directly in the field of perception and representation, and their movement stereotypes are very important, that means they are heavily dependent on the previously acquired amounts of information. It is a sport where there is no need for solving complex motor tasks, but the result depends on the level of acquisition of the techniques and on other abilities, primarily motor and cardiovascular ones.

Basketball players must have the ability to efficiently perceive spatial relations, i.e. they must have the ability to receive and process information and solve those problems whose elements are given directly in the field of perception and representation.

The second discriminant function, though it exhausts the smaller variance, can still be meaningfully interpreted and is determined by ALPHA-7 which assesses the ability to understand verbal contents, or effectiveness of parallel processing, and by GT-7 which assesses perceptual identification, or effectiveness of the input processor.

Based on the value and sign of the centroids on the second discriminant function, it can be concluded that basketball players have a better expressed ability for abstraction and generalization processes, as well as a better ability to receive and process information, which is understandable considering the complexity of the sport discipline and requirements it imposes on the athletes.

5. References

Anderson, T. W. (1984). *An introduction to multivariate statistical analysis* (2nd edition). New York: Wiley.

Boli, E. (1996). *The structure of intellectual and musical abilities and personal traits of girls involved in standard and Latin dances*, Master`s thesis. University of Pristina, Faculty of Physical Education.

Boli, E. (2011). *The structure of anthropological dimensions of male and female dancers and development of methods for their evaluation and monitiring* (Monograph). Leposavic, University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

Boli, E., Popovic, D. & Popovic, J. (2012). Differences in the level of cognitive abilities of male and female dancers. International scientific journal *Kinesmetric*s, 1 (107-119).

Bosnar. K., Horga, S. (1981). Analysis of some results of cognitive abilities tests and personality tests obtained on promising athletes of SR Croatia. *Kinesiology*, 1-2, Zagreb,.

Cooley, W. W., & Lohnes, P. R.(1971). *Miltivariate data analisis.* New York-London-Sidney-Toronto:John Wiley and sons, INC.

Das, J, P., Kirby, J R., Jarman, R. F. (1979). *Simultaneous anb successive conetive processers.* New York, NY: Academic Press.

Guttman, L. (1945): Basis for test-retest reliability analysis. *Psychometrika*, **10**:255-282.

Kendall, M. G. & Stuart, A. (1968). *The advanced theory of statistics, 3*. London: Griffin.

Momirovic, D, Wolf, B. & Popovic, D. (1999). *Introduction to the theory of measurement and internal metric properties of composite measurement instruments* (textbook). University of Pristina, Faculty of Physical Education, Pristina.

Momirovic, K & Popovic, D. (2003). Construction and application of taxonomic neural networks. Multidisciplinary Research Center, Faculty of Sport and Physical Education

Momirovic, K., Gredelj, M., Hosek, A. (1980). Functions of perceptual, parallel and serial processors in the system for movement structuring. *Kinesiology*, Vol. no. 3, , p. 5-10.

Momirovic, K.; Horga, S. & Bosnar, K. (1982). Cybernetic model of cognitive functioning : Attempts of synthesis of some theories about the structure of cognitive abilities. *Kineziologija,* **14**. 5: 63-82.

Popovic, D. & Radisavljevic. D. (1990). The structure of cognitive abilities of judoists. Conference, Valorization of the effects of Physical Culture programs, Novi Sad.

Popovic, D. (1980). Research Methodology in Physical Education. University of Nis, Scientific Youth, Nis.

Popovic, D. (1988). Application of factorial analysis methods for the determination of morphological types. *4rd international symposium on the methodology of matematical modelling*, Varna, Bulgaria.

Popovic, D. (1990). *Research Methodology in Physical Education* (textbook). University of Nis, Scientific Youth, Nis.

Popovic, D. (1992): *Research Methodology in Physical Education*. Athens, Greece.

Popovic, D. (1993). *Determination of the structure of psychosomatic dimensions in combats and and development of methods for their evaluation and monitoring* (monograph). University of Priština, Faculty of Physical Education, Pristina.

Popovic, D. (1993). *Programs and subprograms for the analysis of quantitative modifications* (textbook). University of Priština, Faculty of Physical Education, Multidisciplinary Research Center, Pristina.

Popovic, D. (2005). GUTTMAN, Programs for analysis of metric characteristics of composite mesurement instruments in Savic, Z.: Influence of situational training on transformation of some anthropological dimensions in selected footballers (doctoral thesis). Leposavic, Faculty of Physical Education.

Popovic, D. et al. (1990). Relations between cognitive abilities and efficiency of performance of judo techniques. IV Congress of Sports Educators of Yugoslavia and I International Symposium, Ljubljana-Bled.

Popovic, D., Antic, K., Stankovic, V., Petkovic, V. & Stankovic, S. (1989). The procedures for objectification of estimating the effectiveness in performing judo techniques. *Scientific Youth*, 21(1-2), 83-89.

Popovic, D., Kocic, J., Boli, E. & Stankovic, V. (1995). Conative characteristics of female dancers. *International Congress "Images of Sport in the World",* 75th Anniversary of the German Sport University, Abstract Volume, (pp. 96), Open Forum, Cologne, Germany.

Popovic, D., Petrovic, J., Boli, E. & Stankovic, V. (1995). The personality structure of female dancers. *3rd International Congress on Physical education and Sport*, Exercise & Society supplement issue No. 11 (pp. 196), Komotini, Greece.

Received on 21th June 2014.
Accepted on 11th October 2014

Original scientific paper

UDC 796.422.12.012.1
796.323.012.1
COBISS.SR-ID 214875148

Specifičnosti kognitivnih sposobnosti atletičara i košarkaša

Dragan Popović[1], Izet Rađo[2], Veroljub Stanković[1],
Evagelia Boli[1], Vladimir Savić[1] i Milica Bojović[1]
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[2]Fakultet sporta i tjelesnog odgoja u Sarajevu, BIH
e-mail:dragan.popovic@pr.ac.rs

Sažetak

Istraživanje je sprovedeno sa ciljem da se utvrdi struktura i razlike u kognitivnim dimenzijama atletičara i košarkaša.

U svrhu utvrdivanja strukture i njihovih razlika u manifestnom i latentnom kognitivnom prostoru ispitano je 100 ispitanika muškog pola, starih 14 i 18 godina. Ovaj uzorak se može smatrati reprezentativnim za sportiste tog uzrasta.

Za procenu kognitivnih sposobnosti primenjeno je 6 mernih instrunienata koji su odabrani tako da se analiza strukture vrši na osnovu kibernetskog modela Dasa, Kirbija i Jarmana, odnosno Momirovića, Bosnara i Horge (1982), vodeći računa o tome da izabrani testovi mere tri tipa kognitivnog procesiranja. Za procenu efikasnosti input procesora, odnosno perceptivnog rezonovanja, izabrani su CF-2 i GT-7, za procenu efikasnosti paralelnog procesora, odnosno uočavanja relacija i korelata IT-2 i D-4S i za procenu efika.snosti serijalnog procesora, odnosno simboličkog rezonovanja ALFA-7 i G-SIN.

Svi podaci u ovom istraživanju su obrađeni u centru za multidisciplinarna istaživanja Fakulteta za sport i fizičko vaspitanje Univerziteta u Prištini pomoću sistema programa za obradu podataka koji je razvio Popović, D. (1980), (1993) i Momirović, K. i Popović, D. (2003).

Da bi se utvrdila razlika izmedu grupa primenjena. je kanonička diskriminativna analiza.

Izračunate su i vrednosti koeficijenta diskriminacije, koeficijenti kanoničke korelacije, procenat objašnjenog grupnog varijabiliteta, vrednost Barttletovog hikvadrat testa, stepeni slobode, vrednosti Wilks' Lambda. i oznaka verovatnoće greške pri odbacivanju hipoteze da je stvarna vrednost kanoničke korelacije jednaka nuli.

Takode su izračunati normirani koeficijenti učešća testova u formiraiiju značajnih diskriminativnih funkcija, kao i centroidi grupa na značajnim diskriminativnim funkcijama.

Rezultati diskriminativne analize kognitivnih varijabli, pokazuju cla se sportisti u odnosu na preferiranu granu sporta značajno razlikuju.

Kondenza.cijom varija.bli u kognitivnom prostoru izolovane su dve diskriminativne varijable koje maksimalno separiraju grupe sportista na osnovu diskriminativnih koeficijenata.

Dragan Popović
Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
e-mail:dragan.popovic@pr.ac.rs

Original scientific paper

UDC 796.422.12.012.1:159.942.072
796.323.012.1:159.942.072
COBISS.SR-ID 214875916

Specifics of conative characteristics of track-and-field athletes and basketball players

Veroljub Stankovic [1], Dragan Popovic[1], Dobromir Bonancin[2],
Evagelia Boli[1], Vladimir Savic[1] & Marina Jovanovic
[1]Faculty of Sport and Physical Education, University of Pristina,
temporarily based in Leposavic, Serbia
[2]Faculty of Education, Travnik, University of Travnik, Bosnia & Herzegovina
e-mail:veroljub.stankovic@pr.ac.rs

Abstract

The research was conducted in order to determine differences in cognitive dimensions between track-and-field athletes and basketball players.

For the purpose of determining the structures and their differences in manifest and latent cognitive spaces, 100 male respondents aged 14 and 18 were tested. This sample can be considered representative of athletes of those ages.

For the assessment of conative characteristics, the researchers applied 13 primary variables selected so as to perform the structure analysis on the basis of the cybernetic model of conative factors designed by (Momirovic, Horga & Bosnar, 1982), taking into account the subjects of assessment: the mechanism for the regulation and control of organic functions, mechanism for the regulation and control of defense reactions, mechanism for the regulation and control of attack reactions, and the mechanism for homeostatic regulation.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D . (2003). In order to determine differences between the groups, canonical discriminant analysis was applied.

The researchers calculated the discriminant coefficient values, canonical correlation coefficients, percentage of the explained group variability, Bartlett`s chi-square test value, degrees of freedom, Wilks' Lambda values, and error probability in the rejection of the hypothesis that the true canonical correlation value is equal to zero.

They also calculated the standardized coefficients of involvement of the tests in the formation of significant discriminant functions, as well as the centroids of the significant discriminant functions.

The results of the discriminant analysis in cognitive space are shown in Table 3 and through its careful analysis, it can be determined that two significant canonical correlations, and therefore, two discriminant functions, were obtained.

1. Introduction

Success in all activities depends on the psychosomatic personality dimensions. For this reason, in order to achieve top results, it is necessary to carry out timely and accurate sport orientation and selection of the persons whose structure of psychosomatic characteristics is best suited for a particular sport discipline. It is known that for superior athletic performance, a large amount and high intensity of exercise are required. In order to optimize athletic training, studies contributing to changes of this process are constantly conducted. This is understandable considering the fact that a person`s achievements are confined to his or her potentials.

Therefore, the experts` obligation is to find, among other things, new methods that permit the identification of factors, or psychosomatic dimensions, which are responsible for achieving success in sport activities. With the advent of theoretical-research orientation in kinesiology which requires the inclusion of situational variables in behavior prediction, an interactionist model was constructed to be used in the examination of individuals who are engaged in some activity.

In sport, this orientation acquired a particularly large number of supporters, due to, among other things, the specificity of the sport activity, its complexity, analyzability, requirements it imposes on athletes in accordance with the performance levels, etc. It opens space for the study of new problems and provides opportunities, regardless of the complexity of its implementation, to determine specific factors

which should be taken into consideration in the process of preparation of athletes and their influence on the behavior changes relevant for success in sport.

While earlier studies were limited to the determination of the structure and differences in the structure of certain psychosomatic characteristics, or differences in their manifestation, today the research area is extending to the study of the nature, differences and specificities of certain sports. This reliably suggests the need to possess certain abilities and psychosomatic characteristics in order to succeed in a sport. Therefore, the aim of this study is to apply appropriate methodological procedures for determining the specificities of anthropological dimensions and their differences with regard to the preferred kind of sport and to classify sports on the basis of psychosomatic requirements.

2.1. Sample of respondents

The selection of the sample of respondents is conditioned, among other things, by the organizational and financial capabilities necessary for the implementation of the research process.

It was necessary to ensure a sufficient number of qualified and fully trained measurers, appropriate instrumentation and standardized conditions to carry out the research. Limited financial resources and organizational capabilities influenced the decision to perform the measurement not throughout Kosovo and Methohia, but only in one of its regions.

The research was conducted on randomly selected samples representative of whole Kosovo and Methohia. The measurement was performed in the following sports: track-and-field and basketball. In order to conduct the research correctly, and obtain stable enough results in terms of the sampling error, it was necessary to include a sufficient number of respondents in the sample. The sample size for this type of research was conditioned by the objectives and tasks of the research, the population size and the degree of variability of the applied system parameters. In addition, the number of respondents in the sample depends on the level of statistical inference and the choice of mathematical and statistical models.

Based on the chosen statistical-mathematical model and program, objectives and tasks, 100 respondents were included in the sample. In all factor procedures, it should constantly be kept in mind that the analysis results depend on three main systems that determine the selection and transformation of information: a sample of variables, sample of respondents and selected extraction or rotary methods. Taking into account these criteria, based on experience from previous studies, a sample of 100 respondents is considered to be sufficient for this study. In defining the population from which the sample was drawn, except for the above, no other restrictions or stratification variables were applied.

2.2. Sample of variables for assessment of conative characteristics

There are a number of theories about the structure of conative factors based on empirical data which can be formulated in the form of structural or functional models and allow for an objective verification of the adequacy of these theories: (Cattell, 1973), (Eysenck, 1953). Measurement instruments were constructed on the basis of these theories and used in numerous factor studies. The cybernetic model of conative functions designed by Yugoslav authors (Momirovic, Horga & Bosnar, 1982), served as a basis in this research.

The model assumes a hierarchical organization of the following mechanisms for the regulation and control of behavioral modalities: the mechanism for the regulation and control of organic functions, mechanism for the regulation and control of defense reactions, mechanism for the regulation and control of attack reactions, mechanism for homeostatic regulation, mechanism for the integration of regulatory functions, and the mechanism for the regulation of excitation and inhibition.

1. The mechanism for regulation and control of organic functions is defined by the effectiveness of the coupling between the efficiency subcortical regulatory functions, organic systems and superior cortical systems for regulation and control.

   Disorders of this system are manifested by functional disorders of the basic organic

   systems such as cardiovascular, respiratory and gastrointestinal systems, and by

   functional disorders of the basic systems for input and output operations.

2. The mechanism for regulation and control of defense reactions is defined by the appropriate modulation of tonic arousal, probably on the basis of the adequacy of the programs that are genetic in origin or formed during their development (as a rule, under the influence of conditioning) and located in the (hypothetical) center for regulation of defense reactions.

   Disorders of the system for regulation of defense reactions are manifested by various anxiety symptoms and form a basis for specially modulated pathological reactions such as phobias, obsessions and compulsions.

3. The mechanism for regulation and control of attack reactions is also defined by the appropriate modulation of tonic arousal on the basis of the adequacy of the programs transferred by genetic code or formed under the influence of conditioning and located in the (hypothetical) center for regulation of attack reactions.

Disorders of the system for regulation and control of attack reactions are manifested in a variety of aggressive reactions and weak control of direct impulses.

4. The mechanism for homeostatic regulation is determined by the coordination of activities of functionally and hierarchically different subsystems, including, in particular, the coordination of functions of conative regulatory systems and cognitive processors. Therefore, the system for homeostatic regulation is functionally superior to the systems for regulation of organic functions, defense reactions and attack reactions, and it also controls the processes taking place in the system for regulation of excitation and inhibition.

   Disorders of the system for homeostatic regulation cause dissociation and disorganization of conative and cognitive processes, including motor functions which depend on the system for movement structuring.

   Schizoid, paranoid and manic symptoms are a direct product of disorders of this system. Severe disorders of this system produce disturbances in the functioning of all the systems that are functionally subordinate to it.

5. The mechanism for integration of regulatory functions is responsible for the integration of conative regulatory processes under the guise of the structure of the social field and changes in that field. The set of programs which determine its functioning is mainly formed during the educational process. Social disadaptation is a direct consequence of functional disorders of this mechanism.

6. The mechanism for regulation of excitation and inhibition is one of the elementary and lowest located systems in the hierarchy. Its function is to regulate and modulate the activating functions of the reticular formation, and therefore, it is directly responsible for the activity and the energy level at which other subsystems, including cognitive processes, function. Extroverted and introverted behavior models depend on the functioning of this system.

   Disturbances of this system can produce an energy basis for hypomanic or depressive reactions, and they probably affect the speed of the information flow in the central nervous system**.**

Measurement instruments were selected for this study so that they could cover the dimensions of the model of the functioning of conative regulatory mechanisms designed by (Momirovic, Horga, & Bosnar. 1982). [1]The model assumes hierarchical organization of the mechanism for regulation and control of behavior modalities and is constructed so as to avoid artificial dichotomy between normal and pathological conative factors.

1 The system for integration of regulatory functions is not assessed in this study.

The researchers selected the following measurement instruments:

1. To assess the effectiveness of the system for regulation and control of organic functions:

- (CAVC) cardiovascular conversion from the battery C.I. - N4
- (GAIC) gastrointestinal conversion from the battery C.I. - N4
- (INHC) inhibitor conversion from the battery C.I. - N4
- (HYPC) hypochondria from the battery C.I. - N4.

2. To assess the effectiveness of the system for regulation and control of defense reactions:

- (ANXT) anxiety from the battery C.I. - N4
- (OBS) obsessiveness from the battery C.I. - N4
- (HYPS) hypersensitivity from the battery C.I. - N4
- (PHOB) phobias from the battery C.I. - N4.

3. To assess the effectiveness of the system for regulation and control of attack reactions:

- (IMPULS) impulsiveness from the battery C.I. - N4
- (AGGR) aggressiveness from the battery C.I. - N4.

4. To assess the effectiveness of the system for homeostatic regulation:

- (PARN) paranoidness from the battery C.I. - N4
- (DEPS) depressiveness from the battery C.I. - N4.[2]

2.3. Data processing methods

The value of a research depends not only on the sample of respondents and sample of variables, that is, the values of basic information, but also on the applied

2 The author of the standardization of Cornell`s index version (C.I.-.N4) is Momirovic K., (1964).

procedures for transformation and condensation of the information. Some scientific problems can be solved with the help of a number of different, and sometimes equally valuable, methods. However, with the same basic data, different conclusions can be drawn from the results of different methods. Therefore, the problem of selecting certain data processing methods is rather complex.

In order to obtain satisfactory scientific solutions in a research, it is necessary to use, in the first place, correct, then adequate, unbiased and comparable procedures, which correspond to the nature of the problem and provide extraction and transformation of appropriate dimensions, the testing of hypotheses about those dimensions and establishment of basic regularities within the research area.

Taking this into account, for the purposes of this study, the researchers selected those procedures that were considered to correspond to the nature of the problem.

To determine differences between the groups, a method of discriminant analysis was applied. The researchers calculated the discriminant coefficient values (Eigenval.), canonical correlation coefficients (Can. Cor.), percentage of the explained group variability (chi-square test (Chi)), degrees of freedom (DF), Wilks' Lambda values (W.L.), and error probability in the rejection of the hypothesis that the actual canonical correlation value is equal to zero (Sig).

They also calculated the standardized coefficients of participation of the tests in the formation of significant discriminant functions, as well as the centroids of the groups on the significant discriminant functions.

All the data in this research were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

Canonical discriminant analysis in Mahalanobis space

Canonical discriminant analysis can now be defined as a solution of the quasi-canonical problem $\mathbf{M}\mathbf{x}_k = \mathbf{k}_k$, $\mathbf{G}\mathbf{y}_k = \mathbf{l}_k | c_k = \mathbf{k}_k{}^t\mathbf{l}_k$ = maximum, $\mathbf{x}_k{}^t\mathbf{x}_q = \mathbf{y}_k{}^t\mathbf{y}_q = \delta_{kq}$ k = 1,...,s; s = min((g - 1), m) = m where δ_{kq} is the Kronecker symbol and $\mathbf{x}_k$ and $\mathbf{y}_k$ are unknown m-dimensional vectors.

As $c_k = \mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k$, the function to be maximized is, for k = 1, $f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k - 2^{-1}\lambda_k(\mathbf{x}_k{}^t\mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k{}^t\mathbf{y}_k - 1)$.

After differentiating this function by elements of vectors $\mathbf{x}_k$, $\partial f/\partial \mathbf{x}_k = \mathbf{A}\mathbf{y}_k - \lambda_k\mathbf{x}_k$, and after differentiating it by elements of vectors $\mathbf{y}_k$, $\partial f/\partial \mathbf{y}_k = \mathbf{A}\mathbf{x}_k - \eta_k\mathbf{y}_k$; after equalizing with zero, $\mathbf{A}\mathbf{y}_k = \lambda_k\mathbf{x}_k$ and $\mathbf{A}\mathbf{x}_k = \eta_k\mathbf{y}_k$.

Through differentiating by λ_k and η_k, from the condition that $\mathbf{x}_k{}^t\mathbf{x}_k = 1$ and $\mathbf{y}_k{}^t\mathbf{y}_k = 1$, it is easily obtained that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, by multiplying the first result by $\mathbf{x}_k{}^t$

and the seconf result by $\mathbf{y}_k^t$, $\mathbf{x}_k^t\mathbf{A}\mathbf{y}_k = \lambda_k$ and $\mathbf{y}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k$, so $\mathbf{x}_k = \mathbf{y}_k$ and the problem comes down to an ordinary problem of eigenvalues and eignevectors of matrix **A**, or the solution of the problem $(\mathbf{A} - \lambda_k\mathbf{I})\mathbf{x}_k = \mathbf{0}$, k = 1,..., m, and $c_k = \rho_k^2 = \mathbf{x}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k$, k = 1,..., m are squares of the canonical correlations between linear combinations of variables from **M** and **G** which are proportional to the differenciation of centorids of the subsamples defined by selector matrix S in the space spanned by the vectors of variables from **M**.

Let $\rho^2 = (\rho_k^2)$, k = 1,..., m be a diagonal matrix whose elements are squares of canonical correlations, let $\mathbf{X} = (\mathbf{x}_k)$, k = 1,..., m be a matrix of eigenvectors obtained by solving the canonical discriminant problem, let $\mathbf{K} = \mathbf{M}\,\mathbf{X}$ be a matrix of discriminant functions and let L = GX = PMX be a matrix of the discriminant functions projected into the hypercube defined by vectors of matrix **S**. As $\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{A}\mathbf{X} = \rho^2$ and as, of course, $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ and $\mathbf{L}^t\mathbf{L} = \rho^2$, the canonical discriminant analysis produces two biorthogonal sets of vectors of variables by such transformation of the vectors of variables from **M** and **G** that orthogonalizes those vectos and maximizes cosines of the angles between the corresponding vectors from **K** and **L**, with the additional condition that cosines of the angles of non-corresponding vectors from **K** and **L** are equal to zero because correlations between variables from **K** and **L** are $\mathbf{K}^t\mathbf{L}\rho^{-1} = \mathbf{X}^t\mathbf{A}\mathbf{X}\,\rho^{-1} = \rho$.

Vectors $\mathbf{x}_k$ from **X** are, obviously, the vectors of standardized partial regression coefficients of variables from **M** that generate discriminant functions $\mathbf{k}_k$ which, together with discriminant functions $\mathbf{l}_k$ formed by the vectors of standardized partial regression coefficients $\mathbf{x}_k$ of variables from **G**, have maximum correlations. But as $\mathbf{M}^t\mathbf{K} = \mathbf{X}$, the elements of matrix **X** are, at the same time, the correlations of variables from **M** and discriminant variables from **K** , which, unlike the standard canonical discriminant model, allows for easy testing of hypotheses on partial impact of variables on the formation of discriminant functions. For the identification of discriminant functions, the cross structure matrix elements defined as correlations between variables from **M** and **L**, that is, the elements of matrix $\mathbf{Y} = \mathbf{M}^t\mathbf{L}\rho^{-1} = \mathbf{A}\mathbf{X}^{-1}\rho = \mathbf{X}\rho$, can also be of certain significance; note, by the way, that **Y** is a factor matrix of matrix **A** because, naturally, $\mathbf{Y}\mathbf{Y}^t = \mathbf{X}\rho^2\mathbf{X}^t$.

As elements x_{jk} of matrix **X** and elements y_{jk} of matrix **Y** are ordinary correlations, their asymptotic variances are $\sigma_{xjk}^2 = (1 - x_{jk}^2)^2n^{-1}$, respectively $\sigma_{yjk}^2 = (1 - y_{jk}^2)^2n^{-1}$, therefore, hypotheses of type H_{0xjk}, or H_{0yjk}, can be tested on the basis of the functions $f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2))$, or $f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2))$, because under these hypotheses, the functions have the Fisher Snedecor F-distribution with the degrees of freedom $\nu_1 = 1$ and $\nu_2 = n - 2$.

Unfortunately, with usual application of canonical discriminant analysis, the main, and often the only, set of hypotheses related to the parameters of that model

is the set $H_0 = \{\varphi_k = 0, k = 1,..., m\}$ where φ_k are hypothetical values of canonical correlations in population **P**.

To test hypotheses of type H_{0k}: $\varphi_k = 0$ k = 1,..., m, researchers usually apply the function of the known Wilks measure $\lambda_k = \Sigma_{t+1}^{s} \log_e (1 - \rho_{t+1}^2)$ k = t + 1, t = 0, 1,..., m – 1 proposed by Bartlett (1941) who found that under the hypothesis H_{0k}: $\varphi_k = 0$, the functions $\chi_k^2 = -(n - (m + g + 3)/2)\ \lambda_k$ k = 1,..., m have, approximately, χ^2 distribution with the $\nu_k = (m - k + 1)(g - k)$ degrees of freedom.

However, the results of Bartlett`s test are not, even when dealing with large samples, in full accordance with the results of the tests of type $z_k = \rho_k/\sigma_k$ k = 1,...,s which are based on the fact that canonical correlations also have asymptotic normal distributions with parameters φ_k and $\sigma_k^2 \sim (1 - \varphi_k^2)^2 n^{-1}$. (Kendall & Stuart, 1968); Anderson, 1984).

Centroids of subsamples E_p, p = 1,..., g from E on the discriminant functions necessary to identify the content of the discriminant functions are, of course, the elements of the matrix $\mathbf{C} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{K} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{M}\mathbf{X} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{Z}\mathbf{R}^{-1/2}\mathbf{X}$, and it is clear that they are, in fact, the centroids of the subsamples on the variables transformed into a Mahalanobis form projected into the discriminant space.

DISC PROGRAM

This algorithm is almost literally implemented into DRDISC program written in a matrix language so that it can be realized in the standard SPSS environment. The activation method and some details of the program can be seen from the program symbolic code which is stored at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, and clear instructions for correct application of the canonical discriminant analysis are given. Modification of the program and its implementation in the SAS environment were carried out by Popovic D. in 2004, and the scientist interested in its application can contact the author any time.

3. Discussion

The results of the discriminant analysis in cognitive space are shown in Table 1, and its careful analysis reveals that two significant canonical correlations (.64, .47) explaining 71.68%, respectively 28.32%, of the valid variance of the overall system of the evaluated space have been obtained.

The first discriminant function is defined by the inhibitor conversion, gastrointestinal conversion and cardiovascular conversion which assess the effectiveness of the system for regulation and control of organic functions. It is also defined by depressiveness that estimates the effectiveness of homeostatic regulation.

Based on the value and sign of the projection of the centroid for the first discriminant function, it can be seen that track-and-field athletes have good regulation and control of organic functions defined by the effectiveness of the coupling between subcortical regulatory functions of the organic systems and superior cortical systems for regulation and control.

Further analysis shows that basketball players have a well-built mechanism for homeostatic regulation which is determined by the coordination of activities of functionally and hierarchically different subsystems, including, in particular, the coordination of functions of conative regulatory systems and cognitive processors. These two associated regulatory mechanisms are superior mechanisms for control of defense reactions and attack reactions, and they also control the processes taking place in the system for regulation of excitation and inhibition. Basketball players are more depressed, which is probably caused by a variety of situations that a basketball match imposes.

The second function is defined by obsessiveness and hypersensitivity, paranoidness and aggression. The first two factors assess the mechanism for regulation and control of organic functions, the second factor assesses the mechanism for homeostatic regulation, and the third factor assesses the mechanism for regulation and control of attack reactions. Based on the value and sign of the centroid on the second discriminant function, the following can be concluded: track-and-field athletes have the ability to adequately model tonic arousal on the basis of the programs transferred by the genetic code or formed under the influence of learning that are also located in the center for regulation of attack reactions. They are able to coordinate functionally and hierarchically different subsystems, both cognitive and conative. Then, they are able to effectively make a connection between subcortical regulatory functions of organic systems and cortical systems that perform their regulation and control.

DISCRIMINANT FUNCTIONS IN CONATIVE SPACE

Table 1

Func.	Eigenval.	Var. %	Cum. %	Can.Cor.	Wilks' Lam	Chi^2 - test	DF	Sig
1*	.72	71.68	71.68	.64	.44	192.33	22	.00
2*	.28	28.32	100.00	.47	.77	60.80	10	.00

STRUCTURE MATRIX

	FUNC 1	FUNC 2
INHC	.27*	-.26
GAIC	.26*	-.16
CAVC	.15*	-.07
DEPS	-.12*	-.01
OBS	-.36	-.55*
HYPS	.27	-.55*
PARN	-.12	-.49*
TOTA	.09	-48*
AGGR	-.15	-41*
HYPC	.12	-.40
IMPULS	.11	-.38
PHOB	.06	.26
ANXT	.03	-.08

CENTROIDS OF THE GROUPS

GROUP	C1	C2
Track-and-field athletes 1	.66	-.52
Basketball players 2	-1.14	-.03

4. Conclusion

The research was conducted in order to determine differences in cognitive dimensions between track-and-field athletes and basketball players.

For the purpose of determination of the structures and their differences in manifest and latent cognitive spaces, 100 male respondents aged 14 and 18 were tested. This sample can be considered representative of athletes of those ages.

For the assessment of conative characteristics, 13 primary variables selected so that the structure analysis could be performed on the basis of the cybernetic model of conative factors designed by (Momirovic, Horga, & Bosnar. 1982) to assess the following: the mechanism for regulation and control of organic functions, mechanism for regulation and control of defense reactions, mechanism for regulation and control of attack reactions, and the mechanism for homeostatic regulation.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D . (2003). In order to determine differences between the groups, canonical discriminant analysis was applied.

The researchers calculated the discriminant coefficient values, canonical correlation coefficients, percentage of the explained group variability, Bartlett`s chi-square test values, degrees of freedom, Wilks' Lambda values, and error probability in the rejection of the hypothesis that the actual canonical correlation value is equal to zero.

They also calculated the standardized coefficients of participation of the tests in the formation of significant discriminant functions, as well as the centroids of the groups on the significant discriminant functions.

The results of the discriminant analysis in conative space are shown in Table 1, and its careful analysis reveals that two significant canonical correlations, and therefore, two discriminant functions, have been obtained.

The first discriminant function is defined by the inhibitor conversion, gastrointestinal conversion and cardiovascular conversion which assess the effectiveness of the system for the regulation and control of organic functions. It is also defined by depressiveness that estimates the effectiveness of the system for homeostatic regulation. Based on the value and sign of the centroid projection for the first discriminant function, it can be seen that track-and-field athletes have good regulation and control of organic functions, which is defined by the effectiveness of the coupling between subcortical regulatory functions of the organic systems and superior cortical systems for regulation and control.

Further analysis shows that basketball players have a well-built mechanism for homeostatic regulation which is determined by the coordination of activities of functionally and hierarchically different subsystems, including, in particular, the coordination of functions of conative regulatory systems and cognitive processors. These two associated regulatory mechanisms are superior mechanisms for control of defense reactions and attack reactions, and they control the processes taking place in the system for regulation of excitation and inhibition. Basketball players are more depressed, which is probably caused by various situations which a basketball match imposes.

The second function is defined by obsessiveness and hypersensitivity, paranoidness and aggressiveness. The first two factors assess the mechanism for regulation and control of organic functions, the second factor estimates the mechanism for homeostatic regulation, and the third factor assesses the mechanism for regulation and control of attack reactions. Based on the value and sign of the

centroid for the second discriminant function, the following can be concluded: track-and-field athletes have the ability to adequately model tonic arousal on the basis of the programs transferred by the genetic code or formed under the influence of learning that are located in the center of regulation of attack reactions. They are able to coordinate functionally and hierarchically different subsystems, both cognitive and conative. Then, they are able to efficiently make a coupling between subcortical regulatory functions, organic systems and cortical systems which perform their regulation and control.

In addition, some of these relations made it possible to put forward a hypothesis about different effectiveness of the functioning of regulatory mechanisms in the central nervous system depending on the type of sports activity.

5. References

Anderson, T. W. (1984): *An introduction to multivariate statistical analysis* (2nd edition). New York: Wiley.

Boli, E.: (1996) *The structure of intellectual and musical abilities and personal traits of girls involved in standard and Latin dance,* Master`s thesis. Universityof Pristina, Faculty of Physical Education.

Boli, E.: (2011) *The structure of anthropological dimensions of male and female dancers and development of methods for their evaluation and monitiring*. (Monograph). Leposavic, University of Pristina, Multidisciplinary Research Center, Faculty of Sport and Physical Education.

Boli, E., Popovic, D.& Popovic, J. (2012): Differences in the level of musical abilities of male and female dancers. International scientific journal *Kinesmetrics*, 1 (67-89).

Boli, E., Popovic, D.& Popovic, J. (2012): Differences in the level of cognitive abilities of male and female dancers. International scientific journal *Kinesmetrics*, 1 (107-119).

Cattell, R.B. (1973). The 16 PF and basic personality structure: a reply to *Journal Behavioral Science* 3.

Eysenck, H.J. (1953). *The structure of human personality*. N.Y. Wiley,

Guttman, L. (1945): Basis for test-retest reliability analysis. *Psychometrika*, **10**:255-282.

Momirovic, D, Wolf, B.& Popovic, D. (1999): *Introduction to the theory of measurement and internal metric properties of composite measurement instruments* (textbook). University of Pristina, Faculty of Physical Education, Pristina.

Kendall, M. G.& Stuart, A. (1968): *The advanced theory of statistics, 3*. London: Griffin.

Momirovic, K., Horga, S., & Bosnar, K. (1982). Cybernetic model of cognitive functioning : Attempts of synthesis of some theories about the structure of cognitive abilities. *Kineziologija,* **14**. 5: 63-82.

Momirovic, K. (1999): Two measures of low and high reliability of tests with regulatory and singular matrix of particle covariance.

Momirovic, K & Popovic, D. (2003): *Construction and application of taxonomic neural networks.* Multidisciplinary Research Centre, Faculty of Physical Education

Popovic, D. (1980): Research Methodology in Physical Education. University of Nis, Scientific Youth, Nis.

Popovic, D., Antic, K., Stankovic, V., Petkovic, V. & Stankovic, S. (1989): The procedures for objectification of estimating the effectiveness in performing judo techniques. *Scientific Youth*, 21(1-2), 83-89.

Popovic, D., Kocic, J., Boli, E. & Stankovic, V. (1995): Conative characteristics of female dancers. *International Congress "Images of Sport in the World",* 75th Anniversary of the German Sport University, Abstract Volume, (pp. 96), Open Forum, Cologne, Germany.

Popovic, D., Petrovic, J., Boli, E. & Stankovic, V. (1995): The personality structure of female dancers. *3rd International Congress on Physical education and Sport*, Exercise & Society supplement issue No. 11 (pp. 196), Komotini, Greece.

Popovic, D., Stankovic, V., Kulic, R. & Grigoropulos, P. (1996): The structure of personality of handball players. *4th International Congress on Physical Education and Sport*, Exercise & Society supplement issue No. 15 (pp. 164), Komotini, Greece.

Popovic, D. (2005): GUTTMAN, Programs for analysis of metric characteristics of composite mesurement instruments in Savic, Z.: Influence of situational training on transformation of some anthropological dimensions in selected footballers (doctoral thesis). Leposavic, Faculty of Physical Education.

Popovic, D. (1988): Methods of application of factor analysis for determining morphological types. *4rd International symposium on the methodology of matematical modelling*, Varna, Bulgarija.

Popovic, D. (1990): *Research Methodology in Physical Education* (textbook). University of Nis, Scientific Youth, Nis.

Popovic, D. (1992): *Research Methodology in Physical Education*. Athens, Greece.

Popovic, D. (1993): *Programs and subprograms for the analysis of quantitative modifications* (textbook). University of Priština, Faculty of Physical Education, Multidisciplinary Research Center, Priština.

Popovic, D. (1993): *Determination of the structure of psychosomatic dimensions in combats and development of methods for their evaluation and monitoring* (monograph). University of Priština, Faculty of Physical Education, Pristina.

Popovic, D., Boli, E., Shagal, E.& Savic, V. (2013): Influence of cognitive abilities, conative characteristics and social status of students on their school grades in mother tongue. International scientific journal *Kinesmetrics*, Vol. 2, No. 1, 5-23.

Received on 21th June 2014.
Accepted on 01th October 2014.

Original scientific paper *UDC 796.422.12.012.1:159.942.072*
796.323.012.1:159.942.072
COBISS.SR-ID 214875916

Specifičnosti konativnih karakteristika atletičara i košarkaša

Veroljub Stanković [1], Dragan Popović[1], , Dobromir Bonancin[2] ,
Evagelia Boli[1] Vladimir Savić[1] i Marina Jovanović
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[2]Sveučilište Hercegovina, Beograd
e-mail:veroljub.stankovic@pr.ac.rs

Sažetak

Istraživanje je sprovedeno sa ciljem da se utvrde razlike u konativnim dimenzijama između atletičara i košarkaša.

U svrhu utvrdivanja strukture i njihovih razlika u manifestnom i latentnom konativnom prostoru ispitano je 100 ispitanika muškog pola, starih 14 i 18 godina. Ovaj uzorak se može smatrati reprezentativnim za sportiste tog uzrasta.

Za procenu konativnih karakteristika primenjeno je 13 primarnih varijabli koje su odabrane tako da se struktura analize vrši na osnovu kibernetskog modela konativnih faktora Momirovića i sar. (1982), vodeći računa o tome da se procenjuje: mehanizam za regulaciju i kontrolu orga.nskih funkcija, mehanizain za regulaciju i kontrolu odbrambenih reakcija, mehanizam za regulaciju i kontrolu reakcije napada, mehanizam za homeostatičku regulaciju.

Svi podaci u ovom istraživanju su obrađeni u centru za multidisciplinarna istaživanja Fakulteta za sport i fizičko vaspitanje Univerziteta u Prištini pomoću sistema programa za obradu podataka koji je razvio Popović, D. (1980), (1993) i Momirović, K. i Popović, D. (2003). Da bi se utvrdila razlika izmedu grupa primenjena. je kanonička diskriminativna analiza.

Izračunate su i vrednosti koeficijenta diskriminacije, koeficijenti kanoničke korelacije, procenat objašnjenog grupnog varijabiliteta, vrednost Barttletovog hikvadrat testa, stepeni slobode, vrednosti Wilks' Lambda. i oznaka verovatnoće greške pri odbacivanju hipoteze da je stvarna vrednost kanoničke korelacije jednaka nuli.

Takode su izračunati normirani koeficijenti učešća testova u formiraiiju značajnih diskriminativnih funkcija, kao i centroidi grupa na značajnim diskriminativnim funkcijama.

Rezultati diskriminativne analize u konativnom prostoru prikazani su u tabeli 3. i pažljivom analizom može se utvrditi da su dobijene dve značajne kanoničke korelacije, pa prema toine i dve diskriminativne funkcije.

Veroljub Stanković
Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
e-mail:veroljub.stankovic@pr.ac.rs

Original scientific paper

UDC 796.422.12.012.1
796.323.012.1
COBISS.SR-ID 214877196

Specifics of motor abilities of track-and-field athletes and basketball players

Dragan Popovic[1], Evagelia Boli[1], Veroljub Stankovic[1],
Nicolae Ochiana[2], Vladimir Savic[1] & Milica Bojovic[1]
[1]Faculty of Sport and Physical Education , University of Pristina,
temporarily based in Leposavic, Serbia
[2]Faculty of Movement, Sports and Health Sciences, Bacau, Romania
e-mail:dragan.popovic@pr.ac.rs

Abstract

The research was conducted in order to determine differences in motor dimensions between track-and-field athletes and basketball players.

For the purpose of determining the differences in the manifest and latent motor spaces, 100 male respondents aged 14 and 18 were tested. This sample can be considered representative of athletes of those ages. To assess motor abilities, 20 motor tests were selected so that the structure analysis could be performed at the level of the second-order factors according to the structural model designed by (Gredelj, Metikos, Hosek & Momirovic 1975), which was defined as

1. Movement structuring
2. Muscle tone regulation and synergistic regulation
3. Regulation of excitation intensity
4. Regulation of excitation duration.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D . (2003). In order to determine differences between the groups, canonical discriminant analysis was applied.

The researchers calculated the discriminant coefficient values, canonical correlation coefficients, percentage of the explained group variability, Bartlett`s chi-square test value , degrees of freedom, Wilks' Lambda values, error probability in rejecting the hypothesis that the actual canonical correlation value equals zero.

The standardized coefficients of participation of the tests in the formation of significant discriminant functions, as well as centroids of the groups on the significant discriminant functions, were also calculated.

The discriminant analysis of motor variables of track-and-field athletes and basketball players shows that there is a difference in their motor abilities and this difference is determined by two discriminant functions.

Keywords: / coefficient / variable / discriminant analysis / track-and-field / basketball / motor abilities /

1. Introduction

It is known today that for achieving superior athletic performance, a large amount and high intensity of exercise are necessary. In order to optimize the athletic training, studies contributing to the changes of this process are constantly conducted. This is understandable taking into account the fact that a person`s achievements are limited by his or her physiological and genetic potentials. Careful analysis of the work and achievements realized in modern elite sports in Serbia and abroad will reveal lack of substantive efforts aimed at modernizing the technology of work in the preparation of elite athletes. Attention has, in fact, been more focused on providing financial, technical, spatial, organizational, programmatic and other conditions, while very little has been done on providing conditions for accurate programming, monitoring and controlling the effectiveness of the process of preparation of athletes. Therefore, in most cases, the achieved effects are not equivalent to the investments and cannot be a relevant indicator of the efforts made and public funds invested. These facts are the final consequence of neglecting the organized scientific research and professional work in this area, which results in application of the obsolete technologies of work in elite sports. That means it is necessary to bear in mind that successful development of this part of physical education cannot only be provided by mere increase of the number of facilities, professional staff, funding, institutional and

other organizational conditions because the expected effects can only be achieved through a qualitatively different approach to the process of training and competitions. Achievement of top results in modern sport is increasingly being conditioned by applying the latest scientific findings in the processes of selection and orientation of athletes, programming and control of training, recovery programming, and planning and programming of competition performance. Therefore, efficient and economical work toward achieving top athletic results depends substantially on the systematic collection and use of the information and training programs, determination of the content, scope and intensity of the activities composing the training programs, selected recovery method, athletic shape planning and competition performance planning.

The amount of time and effort, as well as the amount of funding, required for achieving top sports results is steadily growing. This trend can be slowed down or stopped only by making the training more efficient and economical, when devoting the same amount of money and energy, the best possible results are achieved. This is not possible without collecting a big amount of information about the degree of an athlete`s preparation as well as synthesis and creative interpretation of the data which are continually collected in a systematic way, processed and forwarded to the experts who make decisions of crucial importance for themselves and those who they work with.

In the last decades, a substantial increase of the importance of measurement in sport is conditioned by the general tendencies of the development of the modern science of physical culture. The progress of science and technology has provided development of metrologic techniques and methods applied in the field of physical culture. It sounds almost unbelievable that in the last fifty years, the timing error in sport has declined from 0.1 sec. to 0.0001 sec.[1]and in the science of physical culture these measurements have been overcome to observe the studied phenomena more objectively. The newest measurement instruments immediately find their place in sport research institutions, which is not surprising given that rationally organized measurement is the only method of gaining an objective experience, a prerequisite of any scientific knowledge.

Such knowledge provides timely selection and orientation of sport talents as well as contributes to the optimization of sports training. Determination of the degree of development of certain psychosomatic characteristics makes it possible, at a certain age, to pay more or less attention to some psychomatic dimension.

In anthropology and kinesiology, it is not possible to directly measure the factors relevant for success in any human activity. We conclude about the existence of these factors on the basis of their indicators, or reactions. Therefore, one of the

1 Agrez, F. Unification of tests and methodology of testing of elite athletes, Belgrade, 1983

basic tasks of kinesiology is to find those methods that enable us to determine the factors, or psychomatic characteristics, which are responsible for achieving success in kinesiologic activities.

2. Methods

2.1. Sample of respondents

The selection of the sample of respondents is conditioned, among other things, by the organizational and financial capabilities required for the implementation of the research process.

It was necessary to ensure a sufficient number of qualified and fully trained measurers, appropriate instrumentation and standardized conditions to carry out the research. Limited financial resources and organizational capabilities caused the decision not to perform the measurement throughout Kosovo and Methohia, but only in one of its regions.

The measurement was carried out on randomly selected samples representative of whole Kosovo and Methohia. The measurement was conducted in the following sports: track-and-field and basketball. In order to carry out the research correctly and obtain results stable enough in terms of sampling error, it was necessary to take a sufficient number of respondents into the sample. The sample size for this type of research is conditioned by the research objectives and tasks, population size, and the degree of variability of the applied system of parameters. In addition, the number of respondents in the sample depends on the level of statistical inference and the choice of mathematical and statistical models.

Based on the selected statistical-mathematical model and programs, objectives and tasks, 100 respondents were included in the sample. In all factor procedures, it should constantly be kept in mind that the analysis results depend on three main systems which define the selection and transformation of the information: a sample of variables, sample of respondents and the selected extraction, or rotary, method. Taking these criteria into account, based on the experience from previous studies, a sample of 100 respondents is considered to be sufficient for this research. In defining the population from which the sample was drawn, no other restrictions or stratification variables, except for the above, were applied.

2.2. Sample of variables

For the assessment of motor abilities, the researchers used 20 motor tests selected according to the structural model which was designed by Gredelj, Metikos,

Hosek and Momirovic in 1975 and defined as a mechanism for movement structuring (MMS), mechanism for functional synergies and regulation of muscle tone (SRT), mechanism for regulation of excitation intensity (REI), and a mechanism for regulation of excitation duration (RED).

For this measurement program, significant motor dimensions were assessed by using the following measurement instruments:

a) the mechanism for movement structuring (MMS)
    1. agility on the ground (MAOG)
    2. hand tapping (MHT)
    3. foot tapping (MFT)
    4. coordination with a stick (MCS)
    5. hand and foot drumming (MHFDR)

b) the mechanism for functional synergies and regulation of muscle tone (SRT)
    1. deep forward bend (MDFB)
    2. standing sideways on a balance beam (MSSBB)
    3. shoulder flexion with exercise bar (MSF)
    4. darts (MD)
    5. horizontal target shooting (MHTS)

c) the mechanism for regulation of excitation intensity (REI)
    1. standing long jump (MSLJ)
    2. 20m run from a standing start (M20SS)
    3. lying medicine ball throw (MLMBT)
    4. standing high jump (MSHJ)
    5. hand dynamometry (MHD)

d) the mechanism for regulation of excitation duration (RED)
    1. flexed arm hang (MFAH)
    2. chin-up hang (MCUH)
    3. 60-second trunk lift (MTL)
    4. lying straight leg raise (MLSLR)
    5. straight-leg hanging leg raise for leg muscle endurance (MSLHLR)

2.3. Data processing methods

The value of a study does not only depend on the sample of respondents and sample of variables, or the values of basic information, but also on the applied

procedures for transformation and condensation of the information. Some scientific problem can be solved by means of a number of different, and sometimes equally valuable, methods. However, with the same basic data, different conclusions can be drawn from the results of different methods. Therefore, the problem of selecting certain data processing methods is rather complex.

In order to obtain satisfactory scientific solutions in a research, it is necessary to use, in the firstplace, correct and then adequate, unbiased and comparable procedures which correspond to the nature of the stated problem and provide extraction and transformation of appropriate dimensions, the testing of hypotheses about those dimensions and establishment of basic regularities within the research area.

Taking this into account, for the purposes of this study, the researchers selected those methods that were considered to correspond to the nature of the problem.

To determine differences between the groups, a method of discriminant analysis was applied. The values of discriminant coefficients (Eigenval.) were calculated as well as canonical correlation coefficients (Can. Cor.), percentage of the explained group variability (chi-square test (Chi)), degrees of freedom (DF), Wilks' Lambda values (WL), and error probability in the rejection of the hypothesis that the actual canonical correlation value equals zero (Sig).

The standardized coefficients of the participation of the tests in the formation of significant discriminant functions, as well as centorids of the groups on the significant discriminant functions, were also calculated.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D. (2003).

Canonical discriminant analysis in Mahalanobis space

Canonical discriminant analysis can now be defined as a solution of the quasi-canonical problem $\mathbf{Mx}_k = \mathbf{k}_k$, $\mathbf{Gy}_k = \mathbf{l}_k | c_k = \mathbf{k}_k{}^t\mathbf{l}_k$ = maximum, $\mathbf{x}_k{}^t\mathbf{x}_q = \mathbf{y}_k{}^t\mathbf{y}_q = \delta_{kq}$ k = 1,...,s; s = min((g - 1), m) = m where δ_{kq} is the Kronecker symbol and $\mathbf{x}_k$ and $\mathbf{y}_k$ are unknown m-dimensional vectors.

As $c_k = \mathbf{x}_k{}^t\mathbf{Ay}_k$, the function to be maximized is, for k = 1, $f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k{}^t\mathbf{Ay}_k - 2^{-1}\lambda_k(\mathbf{x}_k{}^t\mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k{}^t\mathbf{y}_k - 1)$.

After differentiating this function by elements of vectors $\mathbf{x}_k$, $\partial f/\mathbf{x}_k = \mathbf{Ay}_k - \lambda_k\mathbf{x}_k$, and after differentiating it by elements of vectors $\mathbf{y}_k$, $\partial f/\partial\mathbf{y}_k = \mathbf{Ax}_k - \eta_k\mathbf{y}_k$; after equalizing with zero, $\mathbf{Ay}_k = \lambda_k\mathbf{x}_k$ and $\mathbf{Ax}_k = \eta_k\mathbf{y}_k$.

Through differentiating by λ_k and η_k, from the condition that $\mathbf{x}_k{}^t\mathbf{x}_k = 1$ and $\mathbf{y}_k{}^t\mathbf{y}_k = 1$, it is easily obtained that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, by multiplying the first result by $\mathbf{x}_k{}^t$

and the seconf result by $\mathbf{y}_k^t$, $\mathbf{x}_k^t\mathbf{A}\mathbf{y}_k = \lambda_k$ and $\mathbf{y}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k$, so $\mathbf{x}_k = \mathbf{y}_k$ and the problem comes down to an ordinary problem of eigenvalues and eignevectors of matrix **A**, or the solution of the problem $(\mathbf{A} - \lambda_k\mathbf{I})\mathbf{x}_k = \mathbf{0}$, k = 1,..., m, and $c_k = \rho_k^2 = \mathbf{x}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k$, k = 1,..., m are squares of the canonical correlations between linear combinations of variables from **M** and **G** which are proportional to the differenciation of centorids of the subsamples defined by selector matrix S in the space spanned by the vectors of variables from **M**.

Let $\rho^2 = (\rho_k^2)$, k = 1,..., m be a diagonal matrix whose elements are squares of canonical correlations, let $\mathbf{X} = (\mathbf{x}_k)$, k = 1,..., m be a matrix of eigenvectors obtained by solving the canonical discriminant problem, let $\mathbf{K} = \mathbf{M}\,\mathbf{X}$ be a matrix of discriminant functions and let L = GX = PMX be a matrix of the discriminant functions projected into the hypercube defined by vectors of matrix **S**. As $\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{A}\mathbf{X} = \rho^2$ and as, of course, $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ and $\mathbf{L}^t\mathbf{L} = \rho^2$, the canonical discriminant analysis produces two biorthogonal sets of vectors of variables by such transformation of the vectors of variables from **M** and **G** that orthogonalizes those vectos and maximizes cosines of the angles between the corresponding vectors from **K** and **L**, with the additional condition that cosines of the angles of non-corresponding vectors from **K** and **L** are equal to zero because correlations between variables from **K** and **L** are $\mathbf{K}^t\mathbf{L}\rho^{-1} = \mathbf{X}^t\mathbf{A}\mathbf{X}\,\rho^{-1} = \rho$.

Vectors $\mathbf{x}_k$ from **X** are, obviously, the vectors of standardized partial regression coefficients of variables from **M** that generate discriminant functions $\mathbf{k}_k$ which, together with discriminant functions $\mathbf{l}_k$ formed by the vectors of standardized partial regression coefficients $\mathbf{x}_k$ of variables from **G**, have maximum correlations. But as $\mathbf{M}^t\mathbf{K} = \mathbf{X}$, the elements of matrix **X** are, at the same time, the correlations of variables from **M** and discriminant variables from **K** , which, unlike the standard canonical discriminant model, allows for easy testing of hypotheses on partial impact of variables on the formation of discriminant functions. For the identification of discriminant functions, the cross structure matrix elements defined as correlations between variables from **M** and **L**, that is, the elements of matrix $\mathbf{Y} = \mathbf{M}^t\mathbf{L}\rho^{-1} = \mathbf{A}\mathbf{X}^{-1}\rho = \mathbf{X}\rho$, can also be of certain significance; note, by the way, that **Y** is a factor matrix of matrix **A** because, naturally, $\mathbf{Y}\mathbf{Y}^t = \mathbf{X}\rho^2\mathbf{X}^t$.

As elements x_{jk} of matrix **X** and elements y_{jk} of matrix **Y** are ordinary correlations, their asymptotic variances are $\sigma_{xjk}^2 = (1 - x_{jk}^2)^2 n^{-1}$, respectively $\sigma_{yjk}^2 = (1 - y_{jk}^2)^2 n^{-1}$, therefore, hypotheses of type H_{0xjk}, or H_{0yjk}, can be tested on the basis of the functions $f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2))$, or $f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2))$, because under these hypotheses, the functions have the Fisher Snedecor F-distribution with the degrees of freedom $\nu_1 = 1$ and $\nu_2 = n - 2$.

Unfortunately, with usual application of canonical discriminant analysis, the main, and often the only, set of hypotheses related to the parameters of that model

is the set $H_0 = \{\varphi_k = 0, k = 1,..., m\}$ where φ_k are hypothetical values of canonical correlations in population **P**.

To test hypotheses of type H_{0k}: $\varphi_k = 0$ k = 1,..., m, researchers usually apply the function of the known Wilks measure $\lambda_k = \Sigma_{t+1}^{s} \log_e (1 - \rho_{t+1}^2)$ k = t + 1, t = 0, 1,..., m – 1 proposed by Bartlett (1941) who found that under the hypothesis H_{0k}: $\varphi_k = 0$, the functions $\chi_k^2 = -(n - (m + g + 3)/2)\ \lambda_k$ k = 1,..., m have, approximately, χ^2 distribution with the $\nu_k = (m - k + 1)(g - k)$ degrees of freedom.

However, the results of Bartlett`s test are not, even when dealing with large samples, in full accordance with the results of the tests of type $z_k = \rho_k/\sigma_k$ k = 1,...,s which are based on the fact that canonical correlations also have asymptotic normal distributions with parameters φ_k and $\sigma_k^2 \sim (1 - \varphi_k^2)^2 n^{-1}$. (Kendall & Stuart, 1976; Anderson, 1984).

Centroids of subsamples E_p, p = 1,..., g from E on the discriminant functions necessary to identify the content of the discriminant functions are, of course, the elements of the matrix $\mathbf{C} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{K} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{M}\mathbf{X} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{Z}\mathbf{R}^{-1/2}\mathbf{X}$, and it is clear that they are, in fact, the centroids of the subsamples on the variables transformed into a Mahalanobis form projected into the discriminant space.

DISC PROGRAM

This algorithm is almost literally implemented into DRDISC program written in a matrix language so that it can be realized in the standard SPSS environment. The activation method and some details of the program can be seen from the program symbolic code which is stored at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, and clear instructions for correct application of the canonical discriminant analysis are given. Modification of the program and its practical implementation in the SAS environment was carried out by Popovic D. in 2004, and the scientists interested in its application can contact the author at any time.

3. Discussion

Table 1 shows eigenvalues (Eigenval.), percentage of the explained intergroup variability (Var. %), canonical correlation coefficient (Can. Cor.), Wilks` Lambda values(Lambda), Bartlett`s chi test values (Chi), degrees of freedom (DF), statistical significance (Sig.), pattern of discriminant functions of motor variables (FUNC1, FUNC2), and centroids of the groups indicated by discriminant functions (C1, C2).

Two discriminant variables which maximally separated the groups of athletes on the basis of discriminant coefficients were isolated by means of transformation and condensation of variables in the motor space.

The first discriminant function explains the differences with 70.10% of the intergroup variability in the motor space of the applied discriminant variables.

Having examined the coefficients which determine the first discriminant function, it can be noticed that it separates the athletes on the basis of most of the tests for assessment of the following mechanisms: the mechanism for movement structuring, mechanism for synergistic regulation and regulation of muscle tone, mechanism of excitation intensity, and the mechanism for excitation duration.

Based on the value and sign of the projection of the centroids onto the first discriminant function, it can be concluded that track-and-field athletes have a better expressed factor of repetitive strength, better mobility, balance and speed, while basketball players have good coordination, speed, mobility, and all the forms of power manifestation.

The second function is defined by the tests for assessment of coordination, balance, speed, repetitive strength and flexibility. Based on the value and sign of the centroid projection onto the first discriminant function, it can be seen that basketball players have well-built mechanisms for energy regulation and central movement regulation, while track-and-field athletes have a good ability for simple movement frequency, repetitive strength, flexibility, balance, and mechanism for synergistic regulation and muscle tone regulation.

DISCRIMINANT FUNCTIONS IN MOTOR SPACE

Table 1

Func.	Eigenval.	Var. %	Cum. %	Can.Cor.	Wilks' Lam	Chi^2 - test	DF	Sig
1*	.70	70.10	70.10	.62	.42	190.10	36	.00
2*	.26	26.10	100.00	.45	.79	57.11	17	.00

STRUCTURE MATRIX

	FUNC 1	FUNC 2
MDSAK	.74*	-.16
MFLLP	.69*	-.12
MDNLE	.46*	.09
MSUSM	.47*	.37
MDPNK	-.28*	-.26
MKOOP	-.29*	.07
MTAPR	.29*	.04

Table continued on next page...

... Table continued from previous page		
MSPAG	-.27*	.14
MTAPN	.11*	.04
MMSTT	.10*	.03
MINNS	.09*	.02
MS3ME	-.15	.59*
M20VS	-.04	-.48*
MSKLR	.29	.46*
MSUKL	-.09	-.33*
MTTUP	.19	.33*
MPOLN	-.10	-.30*
MPSNK	-.09	.28*
MISKR	.06	-.26*
MBMIL	.04	.24*

CENTROIDS OF THE GROUPS

GROUP	C1	C2
Track-and-field athletes 1	-.44	-.26
Basketball players 2	.58	-.10

4. Conclusion

The research was conducted in order to determine the structures and their differences in motor dimensions of track-and-field athletes and basketball players.

For the purpose of determining the structures and their differences in the manifest and latent motor spaces, 100 male respondents aged 14 and 18 were tested. This sample can be considered representative of athletes of those ages. To assess motor abilities, the researchers used 20 motor tests which were selected so that the structure analysis could be performed at the level of second-order factors according to the structural model designed by Gredelj, Metikos, Hosek and Momirovic (1975) and defined as:

1. Movement structuring
2. Muscle tone regulation and synergistic regulation
3. Regulation of excitation intensity
4. Regulation of excitation duration.

All the data in this study were processed at the Multidisciplinary Research Center of the Faculty of Sport and Physical Education, University of Pristina, through the system of data processing software programs developed by Popovic, D. (1980), (1993) and Momirovic, K. & Popovic, D . (2003). In order to determine differences between the groups, canonical discriminant analysis was applied.

The researchers calculated discriminant coefficient values, canonical correlation coefficients, percentage of the explained group variability, Bartlett`s chi-square test values, degrees of freedom, Wilks' Lambda values, error probability in rejecting the hypothesis that the actual canonical correlation value equals zero.

The standardized coefficients of participation of the tests in the formation of significant discriminant functions, as well as centroids of the groups on the significant discriminant functions, were also calculated.

The discriminant analysis of motor variables of track-and-field athletes and basketball players has shown that there is a difference in their motor abilities, and this difference is determined by two discriminant functions.

Having examined the coefficients that determine the first discriminant function, it can be seen that it separates the athletes on the basis of most of the tests for assessment of the following mechanisms: the mechanism for movement structuring, mechanism for synergistic regulation and muscle tone regulation, mechanism for excitation intensity, and the mechanism for excitation duration.

Based on the value and sign of the centroid projection onto the first discriminant function, it can be concluded that track-and-field athletes have a better expressed factor of repetitive strength, better mobility, balance and speed, while basketball players have good coordination, speed, all forms of manifestation of strength and mobility.

The second function is defined by the tests for assessment of coordination, balance, speed, repetitive strength and flexibility. Based on the value and sign of the centroid projection onto the first discriminant function, it can be observed that basketball players have well-constructed mechanisms for energy regulation and central movement regulation, while track-and-field athletes have a better ability for simple movement frequency, repetitive strength, flexibility, balance and a solid mechanism for synergistic regulation and muscle tone regulation.

In addition, some of these relations made it possible to put forward hypotheses about different effectiveness of the functioning of regulatory mechanisms in the central nervous system depending on the type of sports activity.

5. References

Anderson, T. W. (1958). *An Introduction to Multivariate Statistical Analysis*. John Wiley & Sons, Inc. New York.

Bosnar. K., Horga, S. (1981). Analysis of some results of cognitive abilities tests and personality tests obtained on promising athletes of SR Croatia. *Kinesiology*, 1-2, Zagreb.

Gredelj, M., Metikos, D., Hosek, A., Momirovic, K. (1975). Model of the hierarchical structure of motor skills. I. The results obtained using a neoclassical method for assessment of latent dimensions. *Kinesiology,* Vol. 5, no. 1-2, p.7.

Kendall, M. G. & Stuart, A. (1968). *The advanced theory of statistics, 3.* London: Griffin.

Momirovic, D, Wolf, B. & Popovic, D. (1999). *Introduction to the theory of measurement and internal metric properties of composite measurement instruments* (textbook). University of Pristina, Faculty of Physical Education, Pristina.

Momirovic, K & Popovic, D. (2003). Construction and application of taxonomic neural networks. Multidisciplinary Research Center, Faculty of Sport and Physical Education

Popovic, D. (1993). *Programs and subprograms for quantitative change analysis*. Faculty of Physical Culture, University of Pristina. Pristina.

Popović, D., & sar. (1997). Canonical conection between cognitive abilities and motorical information of handball players, II Spor Bilimleri Kongresi, Istanbul, Turkey.

Popović, D., & sar. (1997). Relations between morphological characteristics and motorical information of handball players, II Spor Bilimleri Kongresi, Istanbul, Turkey.

Popović, D., & sar. (1987). Motoric Abilities Relations and The Estimate of Successfulness of the Execution of Judo Techniqes, Proceedings of Fisu\Cesu conference universiade. Zagreb, Jugoslavija.

Popović, D., & sar. (1990). Mogućnost primene kibernetike u razvoju motoričkog prostora perspektivnih sportista, 4 Kongres sportskih pedagoga Jugoslavije i prvi internacionalni simpozium, Ljubljana-Bled.

Popović, D., & sar. (1990). Relacije motoričkih i intelektualnih sposobnosti dece predškolskog uzrasta, 4 Kongres sportskih pedagoga Jugoslavije i prvi internacionalni simpozium, Ljubljana-Bled.

Popović, D., & sar. (1990). Uticaj programskih sadržaja nastave fizičkog vaspitanja na razvoj motoričkih dimenzija učenika srednjih škola, 4 Kongres sportskih pedagoga Jugoslavije i prvi internacionalni simpozium, Ljubljana-Bled.

Popović, D., & sar. (1994). Human body orientation in space as an important factory in the motoractivity at a man. 2nd International congress on Physical Education and Sport. Komotini, Greece.

Popović, D., & sar. (1997). The structure of handball players motoric skills. 5th International congress on Physical Education and Sport. Komotini, Greece.

Popović, D., & sar. (1998). The differences in the motorical abillties of young basketball and handball players. 6th International congress on Physical Education and Sport. Komotini, Greece.

Popović, D., & sar. (1998). The structure of motorical abilities in selected pupils for handball. 6th International congress on Physical Education and Sport. Komotini, Greece.

Popović, D., & sar. (2001). Motorical latent variables of handball players throuch application of different statistical mathods. 9th International congress on Physical Education and Sport. Komotini, Greece

Popović, D., & sar.(2002). Different statistical methods presented by motoric latent variables of handball players, 7th Annual Congress of the European College of Sport Science. Cologne, German.

Received on 11th June 2014.
Accepted on 01th October 2014.

Original scientific paper

UDC 796.422.12.012.1
796.323.012.1
COBISS.SR-ID 214877196

Specifičnosti motoričkih sposobnosti atletičara i košarkaša

Dragan Popović[1], Evagelia Boli[1], Veroljub Stanković[1],
Nicolae Ochiana[2], Vladimir Savić[1] i Milica Bojović[1]
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[2]Faculty of Movement, Sports and Health Sciences, Bacau, Romania
e-mail:dragan.popovic@pr.ac.rs

Sažetak

Istraživanje je sprovedeno sa ciljem da se utvrde razlike u motoričkim dimenzijama između atletičara i košarkaša.

U svrhu utvrdivanja razlika u manifestnom i latentnom motoričkom, prostoru ispitano je 100 ispitanika muškog pola, starih 14 i 18 godina. Ovaj uzorak se može smatrati reprezentativnim za sportiste tog uzrasta. Za procenu motoričkih sposobnosti upotrebljeno je 20 motoričkih testova, koji su odabrani tako da se analiza. strukture vrši na nivou faktora drugog reda, preina strukturalnom niodelu Gredelja, Metikoša, Hošek i Momirovića (1975), definisanom kao:

1. *Strukturiranje kretanja*
2. *Regulacija tonusa i singerijska regulacija*
3. *Regulacija. intenziteta ekscitacije*
4. *Regulacija trajanja ekscitacije.*

Svi podaci u ovom istraživanju su obrađeni u centru za multidisciplinarna istaživanja Fakulteta za sport i fizičko vaspitanje Univerziteta u Prištini pomoću sistema programa za obradu podataka koji je razvio Popović, D. (1980), (1993) i Momirović, K. i Popović, D. (2003).

Da bi se utvrdila razlika izmedu grupa primenjena. je kanonička diskriminativna analiza.

Izračunate su i vrednosti koeficijenta diskriminacije, koeficijenti kanoničke korelacije, procenat objašnjenog grupnog varijabiliteta, vrednost Barttletovog hikvadrat testa, stepeni slobode, vrednosti Wilks' Lambda. i oznaka verovatnoće greške pri odbacivanju hipoteze da je stvarna vrednost kanoničke korelacije jednaka nuli.

Takode su izračunati normirani koeficijenti učešća testova u formiraiiju značajnih diskriminativnih funkcija, kao i centroidi grupa na značajnim diskriminativnim funkcijama.

Diskrimiiiativiia aiiahza motoričkih varijabli izmedu atletičara i košarkaša ukazala je da postoji razlika u motoričkim sposobnostima preferiranih sportova i da tu razliku determinišu dve diskriminativne funkcije.

Ključne reči: */ koeficijent / varijabla / diskriminativna analiza / atletika / košarka / motorika /*

Dragan Popović
Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
e-mail:dragan.popovic@pr.ac.rs

Original scientific paper *UDC 796.032.2-056.26/.36*
796.034:159.922.72.072-056.26/.36
COBISS.SR-ID 214878220

Structure of Intellectual Abilities of Special Olympics Athletes and Unified Partners in Football

Milos Popovic[1], Hana Valkova[2],
Dragan Popovic[1] & Veroljub Stankovic[1]
[1]Faculty of Sport and Physical Education, University of Pristina
temporarily seated in Leposavić, Serbia
[2]Palacky University, Faculty of Physical Culture, Department of APA,
Olomouc, Czech Republic
e-mail:milos.popovic@pr.ac.rs

Abstract

The research was conducted in order to determine the structure of cognitive abilities in Special Olympics athletes and partners in football.

For this purpose, 80 athletes and partners engaged in football were tested. For the assessment of cognitive abilities, Raven's Colored Progressive Matrices which measure IQ were selected.

All the data in this research were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina by the system of data processing programs DRSOFT developed by Popović, D. (1980, 1993), and Momirović, K. & Popović, D. (2003).

The algorithms and programs implemented in this research have been fully presented and the results of these programs have been analyzed.

1. Introduction

World Health Organization classification of mental and behavioral disorders (1CD-10, 1992) gives the classification and diagnostic guidelines on MR: „Mental retardation is a condition of arrested or incomplete development of the mind, which is especially characterized by impairment of skills manifested during the developmental period, which contribute to the overall level of intelligence, i.e. cognitive, language, motor, and social abilities. Retardation can occur with or without any other mental or physical disorder. However, mentally retarded individuals can experience the full range of mental disorders, and the prevalence of other mental disorders is at least three to four times greater in this population than in the general population. In addition, mentally retarded individuals are at greater risk of exploitation and physical/sexual abuse. Adaptive behavior is always impaired, but in protected social environments where support is available this impairment may not be at all obvious in subjects with mild mental retardation. Intelligence is not a unitary characteristic but is assessed on the basis of a large number of different, more or less specific skills. Although the general tendency is for all these skills to develop to a similar level in each individual, there can be large discrepancies, especially in persons who are mentally retarded. Such people may show severe impairment in on particular area (e.g. language), or may have a particular area of higher skill (e.g. in simple visuo-spatial tasks) against a background of severe mental retardation.

This presents problems when determining the diagnostic category in which a retarded person should be classified. The assessment of intellectual level should be based on whatever information is available, including clinical findings, adaptive behavior (judged in relation to the individual's cultural background), and psychometric test performance. For a definite diagnosis of mental retardation, there should be reduced level of intellectual functioning resulting in diminished ability to adapt to the daily demands of the normal social environment.

Associated mental or physical disorders have a major influence on the clinical picture and the use made of any skills. The diagnostic category chosen should therefore be based on global assessments of ability.

The IQ levels given are provided as a guide and should not be applied rigidly. The IQ should be determined from standardized, individually administered intelligence tests appropriate to the individual's level of functioning and additional specific handicapping conditions, e.g. language problems, hearing impairment, physical involvement. Scales of social maturity and adaptation, again locally standardized, should be completed if at all possible by interviewing a parent or care-provider who is familiar with the individual's skills in everyday life. Without the use

of standardized procedures, the diagnosis must be regarded as provisional. (Geneva, 1992, FCD-10).

2. Methods

2.1. Sample of respondents

The selection of a sample of respondents was conditioned by organizational and financial capabilities necessary for the implementation of the research process. It was necessary to ensure a sufficient number of qualified and fully trained measurers, certain instrumentation and standardized conditions under which the planned research was to be conducted. The measurement was conducted on a sample that was representative of the central part of Serbia.

The measurement was carried out in the organizations and schools that bring together children with special needs.

In order to do the research correctly and get results stable enough in terms of sampling error, it was necessary to include a sufficient number of respondents in the sample. The sample size for such type of research is conditioned by the objectives and tasks of the research, by the population size and degree of variability of the applied system of parameters.

Based on the chosen statistical-mathematical model and program, objectives and hypotheses, we opted for a sample of 40 respondents, a total of 80 for each subsample (40 Special Olympics athletes and 40 partners). The size of such a sample should meet the following criteria:

- the size of the sample effective should permit as many degrees of freedom as to make it possible for any coefficient in the pattern matrix or any correlation coefficient equal to or greater than .30 to be considered different from zero with an inference error less than .01.

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

In addition, respondents were to meet the following specific requirements:

- respondents were required to be male,

- the age of respondents was defined on the basis of chronological age, so the research covered respondents aged 15 to 18 years plus-minus 0.5 years,

- respondents were required to be members of a society that brings together Special Olympics athletes,

- respondents were required to attend training classes regularly, what was determined on the basis of records kept by the coaches.

In defining the population from which the sample was drawn, except the above, no other restrictions or stratification variables were applied.

2.2. Sample of cognitive variables

For the assessment of cognitive abilities, Raven's colored matrices were used.

The aforementioned instrument determines an overall IQ.

However, the test allows assessment of perceptual PP, symbolic reasoning SR and identification of relations and correlates RK.

A 1-12 concrete thinking, AB 1-3 concrete thinking, 4-11 functional thinking, 12 abstract thinking, B 1-3 concrete thinking, 4-7 functional thinking, 8-12 abstract thinking.

2.3. Data processing methods

Except for the Mulaik's known textbook on factor analysis, which has something about the assessment of reliability of principal components (Mulaik, 1972), and Kaiser and Caffrey`s work in which their method of Alpha factor analysis was derived on the basis of maximizing the reliability of latent dimensions (Kaiser & Caffrey, 1965), it seems that the producers of various methods of component and factor analyses, as well as writers of books about this class of methods for latent structures analysis were not too worried about how much the real existence of the latent dimensions obtained by these methods could be trusted. 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.

All the data in this study were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina by the system of data processing programs DRSOFT developed by Popović, D. (1980, 1993) and Momirović, K. & Popović, D. (2003).

Semi-orthogonal transformation of principal components

Let **Z** be a matrix of the standardized data obtained by describing set E of n entities on a V set of m quantitative, normally or at least elliptically distributed variables. Let **R** be an intercorrelation matrix of these variables. Assume that **R** is surely a regular matrix and it is possible to reject the hypothesis that variables in V have a spherical distribution, that is, eigenvalues of the correlation matrix in population P from which the E sample was drawn are equal.

Let $U^2 = (diag\ R^{-1})^{-1}$ is Guttman`s estimate of unique variances of variables from V and let λ_p , p = 1,...,m be eigenvalues of matrix **R**.

Let c = trag (**I** - $\mathbf{U}^2$).

Define a scalar k such that $\Sigma_p^{\,k} \lambda_p > c,\ \Sigma_p^{\,k-1} \lambda_p < c.$

k is now a number of principal components of matrix **Z** defined on the basis of Štalec and Momirović`s PB criterion.

Let $\mathbf{\Lambda} = (\lambda_p)$; p = 1,...,k be a diagonal matrix of the first k eigenvalues of matrix **R** and let $\mathbf{X} = (\mathbf{x}_p)$; p = 1,...,k be a matrix of the associated with them eigenvectors scaled so that $\mathbf{X}^t\mathbf{X} = \mathbf{I}$. Let **T** be an orthogonal matrix such as to optimize the function

$$\mathbf{XT} = \mathbf{Q} = (\mathbf{q}_p)\ ;\ p\ (\mathbf{Q}) = \text{extremum},\ \mathbf{T}^t\mathbf{T} = \mathbf{I},$$

where p (**Q**) is a parsimonic function, for example, an ordinary varimax function

$\Sigma_j^{\,m} \Sigma_p^{\,k} q_{jp}^{\,4} - \Sigma_p^{\,k} (\Sigma_j^{\,m} q_{jp}^{\,2})^2 = \text{maximum},$

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

Now the transformation of the principal components defined by the vectors in the matrix **K** = **ZX** into semi-orthogonal latent dimensions determined by the type II orthoblique procedure (Harris & Kaiser, 1964) is defined by the operation **L** = **KT** = **ZXT**.

The covariance matrix of these dimensions is

$$\mathbf{C} = \mathbf{L}^t\mathbf{L}\ n^{-1} = \mathbf{Q}^t\mathbf{R}\mathbf{Q} = \mathbf{T}^t\mathbf{\Lambda}\mathbf{T}.$$

Denote the matrix of their variances with $\mathbf{S}^2 = (s_p^{\,2}) = \text{diag}\ \mathbf{C}$.

If we standardize the latent dimensions by the operation $\mathbf{D} = \mathbf{L}\mathbf{S}^{-1}$, in the matrix $\mathbf{M} = \mathbf{D}^t\mathbf{D}n^{-1} = \mathbf{S}^{-1}\mathbf{T}^t\mathbf{\Lambda}\mathbf{T}\mathbf{S}^{-1}$, there will be their intercorrelations. Notice that **C**, and therefore **M**, cannot be diagonal matrices, so thus formed latent dimensions are not orthogonal in the space of entities from E.

The matrix of correlations between variables from V and latent variables, which is commonly referred to as a factor structure matrix, will be $\mathbf{F} = \mathbf{Z}^t\mathbf{D}n^{-1} = \mathbf{RXTS}^{-1} = \mathbf{X\Lambda TS}^{-1}$; and as the elements of matrix **F** are orthogonal projections of vectors from **Z** over vectors from **D**, the coordinates of these vectors in the space spread by vectors from **D** are elements of the matrix $\mathbf{A} = \mathbf{FM}^{-1} = \mathbf{XTS}$.

But since $\mathbf{A}^t\mathbf{A} = \mathbf{S}^2$,

the latent dimensions obtained by this method are orthogonal in the space spread by the vectors of variables from **Z**; the squared norms of the vectors of those dimensions in the space of variables are equal to the variances of the dimensions.

3. Results

The factor structure of intellectual abilities was analyzed on the basis of all the information provided by the matrix of significant principal components (Table 1). Based on Momirović`s B6 criterion, two latent dimensions that delimit the entire space of three cognitive tests with about 76.12% of the common variance were isolated. It can be accepted as satisfactory for this type of research. The communalities of variables, except for the tasks by which the effectiveness of parallel processor RK, or the ability to identify relations and correlates was assessed, are relatively high and can be considered satisfactory.

The variable for assessing perceptual abilities PP has the highest correlation with the isolated cognitive dimension. A large number of authors have determined a positive correlation between perceptual abilities and motor abilities. Although perceptual measurement instruments are considerably saturated by cognitive factors (in the literature it is often written about cognitive functioning at the perceptual level), it would be too free to declare them cognitive measurement instruments, though in a certain sense they are. Positive correlation between perceptual and motor abilities, usually of medium height, was determined by Horne, Fitts, Harrison, Fleishman, Neeman, Hempel, et al. The authors also found that motor activity had a positive effect on the development of perceptual abilities. The isolated cognitive dimension is also clearly defined by the tasks which assessed symbolic reasoning SR with relatively high projection for the assessment of the efficiency of the serial processor that corresponds to Cattell`s factor of crystallized intelligence.

Only the test for evaluation of parallel processor, or identification of relations and correlates RK, is projected on the second principal component. It explains 16.34% of the total variability and can be considered as a factor responsible for parallel processing of information.

The factor structure of cognitive abilities was analyzed in parallel on the basis of the information provided by oblimin transformation of significant principal components, i.e. based on the parallel projections of variables over the factors (Table 2) of the correlation matrix of variables and factors (Table 3) of intercorrelations of the factor matrix (Table 4).

Judging by the variance value, the first factor is the most important of the isolated dimensions. It is defined by the tasks for assessing the input processor and by the tasks for assessing the serial processor. The second latent dimension is defined by the variable for the assessment of the parallel processor.

Correlation between cognitive abilities and success in a football game has been proved in numerous studies. It is assumed that better adaptation of cognitive abilities to specific living conditions to which players of all levels, especially those of the top level, are exposed, is also responsible for the relationship between cognitive abilities and success in a football game. For this reason, understanding the cognitive structure of players is of particular importance for the planning and reorganization of work and prediction of success in every sport including football.

Obtaining such a result is understandable when taking into consideration the fact that football is characterized by diversity and a wide range of technical elements, movements of the whole body and limbs in different directions at variable speed. During a football game, dynamic situations are constantly changing depending on the movement of the ball on the ground and the players are forced to apply various movement techniques as well as different tactical options.

PRINCIPAL COMPONENTS OF COGNITIVE VARIABLES OF ATHLETES AND PARTNERS

Tabla 1.

	FAC1	FAC2	H
PP	(,80)	-,08	,66
SR	-,22	(,93)	,92
RK	(,74)	,38	,70
Svijstvene. V.	1,26	1,02	
%	41,99	34,12	
Kumula. %	41,99	76,12	

PATTERN OF OBLIMIN FACTORS OF COGNITIVE VARIABLES OF ATHLETES AND PARTNERS

Table 2

	OBL1	OBL2
PP	,76	-,24
SR	,00	,96
RK	,81	,22

STRUCTURE OF OBLIMIN FACTORS OF COGNTIVE VARIABLES OF ATHLETES AND PARTNES

Table 3.

	0BL1	OBL2
PP	,77	-,28
SR	-,03	,96
RK	,80	,19

INTERCORRELATIONS OF OBLIMIN FACTOR OF KOGNITIVE VARIABLES OF ATHLETES AND PARTNERS

Table 4

	0BL1	OBL2
OBL1	1,00	-,04
OBL2	-,04	1,00

Based on the above, it may be concluded that the basic cognitive processes can be reduced to the functions of perceptual, parallel and serial processors which are probably under control of the central processor responsible for coordinating all cognitive functions.

4. Conclusion

The research was conducted in order to determine the structure of cognitive abilities in Special Olympics athletes and partners in football.

For this purpose, 80 athletes and partners engaged in football were tested. For the assessment of cognitive abilities, Raven's Colored Progressive Matrices which measure IQ were selected.

All the data in this research were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina by the system of data processing programs DRSOFT developed by Popović, D. (1980, 1993), and Momirović, K. & Popović, D. (2003).

The algorithms and programs implemented in this research have been fully presented and the results of these programs have been analyzed.

The factor structure of cognitive abilities was analyzed in parallel on the basis of the information provided by oblimin transformation of significant principal components, i.e. based on the parallel projection of variables over the factors (Table 2) of the correlation matrix of variables and factors (Table 3) of the factor intercorrelation matrix (Table 4).

Judging by the variance value, the first factor is the most important of the isolated dimensions. It is defined by the tasks for assessment of the input processor and by the tasks for assessing the serial processor. The second latent dimension is defined by the variable for assessing the parallel processor.

Correlation between cognitive abilities and success in a football game has been proved in numerous studies. It is assumed that better adaptation of cognitive skills to specific living conditions to which players of all levels, especially those of the top level, are exposed, is also responsible for the relationship between cognitive abilities and success in a football game. For this reason, understanding the cognitive structure of players is of particular importance for the planning and reorganization of work and prediction of success in every sport including football.

Obtaining such a result is understandable when taking into account the fact that football is characterized by a variety and a wide range of technical elements, movements of the whole body and limbs in different directions at variable speed. During a football match, dynamic situations are constantly changing, depending on the movement of the ball on the ground, and the players are forced to apply various movement techniques as well as different tactical approaches.

5. References

Andrejević, D. (2000). Problem samozapošljavanja i zapošljavanja invalida i drugih hendikepiranih lica u Republici Srbiji. Belgrade, Serbia: Republički zavod za tržište rada i Institut za mala i srednja preduzeća.

Arsić, R., & Stanković, V. (2014). Analysis of the sports results achieved at national level competitions organized for the hearing-impaired children of Serbia. In S. Simović, V. Stanković (Eds.), V *Međunarodni naučni kongres „Antropološki aspekti sporta, fizičkog vaspitanja i rekreacije"*. Banja Luka, Bosnia and Herzegovina.

Bartlett, M. S. (1941). The statistical significance of canonical correlations. *Biometrika*, **32**: 29-38.

Boli E., Popovic D., Kocic J,. Γρηγοροπουλος Π.: (1997) Επιδραση των γνωστικων ικανοτητων στην εκτελεση των χορευτικων δομων σε λατινο-αμερικανικους χορους. 5th International congress on Physical Education and Sport. Komotini, Greece.

Boli, E., Popović, D., & Popović, J. (2012).Structure of intellectual abilities of dancers. *Kinesmetric*, 1, 91-105.

Boli, E.: (2011) The structure of anthropological dimensions of male and female dancers and procedures processing for their evaluation and monitoring. (Monograph), Leposavić: University in Priština, Center for multidisciplinary research of the Faculty of Sport and Physical Education.

Gunzberg, H. (1973). Procena sposobnosti kod umereno i teže retardirane dece. Zagreb, Croatia.

Harris, C. W.; Kaiser, H. F. (1964). Oblique factor analytic solutions by orthogonal transformations. *Psychometrika*, **29**:347-362.

http://en.unesco.org/themes/education-21st-century (date: 12.10.2014)

http://www.unesco.org/education/nfsunesco/doc/isced_1997.htm (date: 12.10.2014)*ECSS,* PP26-4 (p. 330), Belgrade, Serbia.

http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/right-to-education/normative-action/fundamental-principles/equality-of-opportunity-and-treatment/ (date: 12.10.2014)

Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis.

Kaiser, H. F.; Caffrey, J. (1965), Alpha factor analysis. *Psychometrika*, 30:1-14.

Momirović, D, Wolf, B., & Popović, D. (1999). The introduction to the theory of measurement and internal metric properties of composite measuring instruments. Priština, Serbia: Faculty of Physical Education, Centre for Multidisciplinary Research.

Momirović, K. & Popović, D. (2003). Construction and aplication of taxonomy neural networks. Leposavić, Serbia: Faculty of Physical Education, Centre for Multidisciplinary Research.

Mulaik, S.A. (1972). *The foundations of factor analysis*. Newj York: cGraw-Hill.

Popović, D. (1992). Methodology of research in physical education. Athens, Greece.

Popović, D. (1993). Programs and subprograms for the analysis of quantitative modifications. Priština, Serbia: Faculty of physical education, Center for multidisciplinary research.

Popović, D., & sar. (1995).Cognitive abilities of female dancers. 3th International congress on Physical Education and Sport. Komotini, Greece,

Popović, D., & Stanković, V. (2005a). The differences of the levels of cognitive abilities and personality characteristics among grammar school and medical school students.In N. Dikic, S. Zivanic, S. Ostojic, and Z. Tornjanski (Eds), *10th Annual Congress of the*

Popović, D., Kocić, J., Boli, E. & Stanković, V. (1995a). Conative characteristics of female dancers. International Congress "Images of Sport in the World", 75th Anniversary of the German Sport University, Abstract Volume, (pp. 96), Open Forum, Cologne, Germany.

Popović, D.: (1980) Research methodology in Physical education. Niš, Serbia: University of Niš. *Psychometrika*, **23**:187-200.

Received on 15th May 2014.
Accepted on 11th September 2014.

Original scientific paper *UDC 796.032.2-056.26/.36*
796.034:159.922.72.072-056.26/.36
COBISS.SR-ID 214878220

Struktura intelektualnih sposobnosti atleta i saradnika Specijalne Olimpijade

Miloš Popović[1], Hana Valkova[2],
Dragan Popović[1] i Veroljub Stanković[1]
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[2]Palacky University, Faculty of Physical Culture, Department of APA,
Olomouc, Czech Republic
e-mail:milos.popovic@pr.ac.rs

Sažetak

Istraživanje je sprovedeno sa ciljem da se utvrdi struktura kognitivnih sposobnosti, kod atleta i saradnika Specijalne Olimpijade u fudbalu.

U tu svrhu ispitano je 80 atleta i sradnika koji se bave fudbalom. Za procenu kognitivnih sposobnosti izabrane su RAVENOVE progresivne matrice u boji koje procenjuju IQ.

Svi podaci u ovom istraživanju, obrađeni su u Centru za multidisciplinarna istraživanja Fakulteta za sport i fizičko vaspitanje Univerziteta u Prištini pomoću sistema programa za obradu podataka DRSOFT koji je razvio Popović, D. (1980 i 1993) i Momirović, K. i Popović, D. (2003).

Algoriatm koji je realizovan u okviru ovog rada u potpunosti je prikazan a rezultati tog algoritma su detaljno analizirani.

Ključne reči: */transformacija /matrica/svojstvene /ortonormalna/vektori/ varijansa/*

Miloš Popović
Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
e-mail:milos.popovic@pr.ac.rs

Original scientific paper

UDC 796.032.2-056.26/.36
796.034-056.26/.36:159.942.072
COBISS.SR-ID 214878988

Influence of Conative Characteristics on Special Olympics Athletes and Unified Partners` Success in Football

Milos Popovic[1], Veroljub Stankovic[1],
Dragan Popovic[1] & Hana Valkova[2]
[1]Faculty of Sport and Physical Education, University of Pristina
temporarily seated in Leposavić, Serbia
[2]Palacky University, Faculty of Physical Culture, Department of APA,
Olomouc, Czech Republic
e-mail:milos.popovic@pr.ac.rs

Abstract

The research was conducted in order to determine influence of conative characteristics on the criterion variables in Special Olympics athletes and partners in football.

For this purpose, 80 athletes and partners engaged in football were tested. For the assessment of conative characteristics, the measurement instrument CON6 was selected by which the following conative regulators were evaluated: activity regulator, organ function regulator, defense reaction regulator, attack reaction regulator, system for coordination of regulatory functions, system for integration of regulatory functions, and system for excitation and inhibition.

To assess success in a football game, the following variables were used: evaluation of the effectiveness of the techniques, evaluation of the performance effectiveness in the offensive phase, evaluation of the performance effectiveness in the defensive phase, evaluation of individual creativity during the game, team responsibility evaluation, engagement evaluation, behavior evaluation, general evaluation of success in the game.

All the data in this research were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina, by the system of data processing programs DRSOFT developed by Popović, D. (1980, 1993) and Momirović, K. & Popović, D. (2003).

The algorithms and programs implemented within this thesis have been fully presented and the results of the programs have been analyzed.

Keywords: / reliability / latent / dimension / matrix / vectors / variance /

1. Introduction

The United Nations experts` estimates indicate that today there are about 800 million people in the world to whom the term „people with disabilities“ can be applied. That amounts almost 10% of the world population (WHO, 2000) and represents a major health, social, economic and political problem that tends to increase.

Based on UNESCO provisions (1990, 1995, 1997), great attention is paid to early treatment of children, and according to their new classification, a new system of primary education continues after the preschool treatment, so that professional orientation could start in primary school to continue and grow into vocational rehabilitation in high school. New ideas and suggestions contributing to further solution of all the issues of diagnosis, rehabilitation and protection of disabled persons are of vital importance for their further treatment.

In 2000 the World Congress in Beijing pointed out that application of new methods, techniques and technologies during education, vocational training and employment of disabled persons, facilitates career choice and success at work (Andrijević, 2000). Much faster and more modern application of new aids for school, work and overall life make it easier for handicapped people to achieve success in all fields. Ongoing monitoring and inclusion of the system of disabled people in the mental health movement, which is spreading, aim at preventing growing forms of mental stress and diseases by informing the public about the abilities and opportunities of these people, discovering new ways and forms of assistance. Among disabled people, there are certainly a great number of those with mild mental disabilities. The society

is increasingly making efforts to improve the lives of people with such personality profile and their involvement in sports is surely very useful for them.

2. Methods

2.1. Sample of respondents

To carry out the research correctly and obtain results stable enough in terms of sampling error, it was necessary to take a sufficient number of respondents in the sample. The sample size for this type of research was conditioned by the objectives and tasks of the research, the population size and degree of variability of the applied system of parameters.

Based on the chosen statistical-mathematical model and program, objectives and hypotheses, we opted to include 40 respondents in the sample, a total of 80 in each subsample (40 Special Olympics athletes and 40 partners). The size of such a sample should meet the following criteria:

- the effective of the sample should be such as to permit as many degrees of freedom as to make it possible for any coefficient in the pattern matrix or any correlation coefficient equal to or larger than .30 to be considered different from zero with an inference error less than .01,

- to use adequate statistical methods successfully, according to the latest beliefs, the number of subjects in the sample should be five times larger than the number of the variables applied.

In addition, respondents were to meet the specific requirements:

- respondents were male,

- the age of respondents was defined on the basis of chronological age, so the research covered respondents aged 15 to 18 years plus - minus 0.5 years,

- respondents were required to be members of a society that brings together Special Olympics athletes,

- respondents were required to attend training classes regularly what was determined on the basis of records kept by the coaches.

In defining the population from which the sample was drawn, except the above, no other restrictions or stratification variables were applied. The measurement was carried out in organizations and schools that bring together children with special needs.

2.2. Sample of conative variables

For the assessment of conative characteristics, the measurement instrument CON6 was selected by which the following conative regulators were evaluated:

Activity regulator (EPSILON)

Organ function regulator (CHI)

Defense reaction regulator (ALPHA)

Attack reaction regulator (SIGMA),

System for coordination of regulatory functions (DELTA) and

System for integration of regulatory functions (ETA).

2.3. Sample of variables for evaluation of success in a football game

For the evaluation of success in a football game, the following elements were measured by this program:

1. Football Techniques (STEH)
2. Offensive tactics (SNAP)
3. Creativity (SSTC)
4. Defensive tactics (SODB)
5. Playing behavior (SPON)
6. Responsibility (SODG)
7. Engagement (SANG)
8. General assessment of success in the game (SOUS)

2. 4. Data processing methods

As regression analysis in the Mahalanobis space has very convenient comparative characteristics relative to the standard canonical model of multivariate regression analysis, an algorithm that generates the largest amount of usable information about the parameters of the model will be described here. The algorithm is implemented by a program written in the Matrix language and the performance of the program is shown in some previous studies.

Multivariate regression analysis of criterion variables from $\mathbf{Z}_c$ in the space of Mahalanobis variables from **M** can be defined as a solution to the problem

$$\mathbf{M}\beta = \mathbf{Z}_c + \mathbf{E}|\text{trag}(\mathbf{E}^t\mathbf{E}) = \text{minimum}.$$

As $\mathbf{M}^t\mathbf{M} = \mathbf{I}$, the solution easily obtained by differentiating the function trag $(\mathbf{E}^t\mathbf{E})$ is

$$\beta = \mathbf{M}^t\mathbf{Z}_c = \mathbf{R}_{rr}^{-1/2}\mathbf{R}_{rc},$$

so the matrix of partial regression coefficients is, in fact, a matrix of ordinary product- moment coefficients of correlation between the regressors transformed in a Mahalanobis form and criterion variables. Of course, that is why the asymptotic variance of coefficients β_{jp} from matrix β is simply $\sigma_{jp}^2 = (1 - \beta_{jp}^2)^2 n^{-1}$,

and the tests of hypotheses $H_{0jp}: \beta_{jp}^* = 0$ are easily $f_{jp} = \beta_{jp}^2((n - 2)(1 - \beta_{jp}^2)^{-1})$, because under $H_{0jp}: \beta_{jp}^* = 0$, variables f_{jp} have the Fisher-Snedecor F-distribution with 1 and n – 2 degrees of freedom.

The regression functions are now defined by the operation $\Psi = \mathbf{M}\beta$ with the covariance matrix $\mathbf{G} = \Psi^t\Psi = \beta^t\beta = \mathbf{R}_{cr}\mathbf{R}_{rr}^{-1}\mathbf{R}_{rc}$, so the diagonal elements of the matrix $\rho^2 = (\rho_p^2) = \text{diag}\,\mathbf{G}$ are normal coefficients of determination, and since $\mathbf{Z}_c{}^t\Psi = \mathbf{R}_{cr}\mathbf{R}_{rr}^{-1}\mathbf{R}_{rc} = \mathbf{G}$, elements ρ_p of matrix ρ are ordinary multiple correlation coefficients, and the tests of hypotheses $H_{0p}: \rho_p^* = 0$ are defined by the functions $f_p = (\rho_p^2(1 - \rho_p^2)^{-1})((n - m - 1)m^{-1})$, because under $H_{0p}: \rho_p^* = 0$, functions f_p have the Fisher-Snedecor F-distribution with m and n – m – 1 degrees of freedom.

As the matrix of residual variables is $\mathbf{E} = \mathbf{Z}_c - \mathbf{M}\beta$, then $\mathbf{W} = \mathbf{E}^t\mathbf{E} = \mathbf{R}_{cc} - \mathbf{G}$

is a matrix of their covariances. Their correlations defined by the matrix $\mathbf{C} = \rho^{-1}\mathbf{G}\,\rho^{-1}$ are sometimes helpful for identification of regression functions as well as correlations of residual variables defined by the matrix $\Phi = \Sigma^{-1}\mathbf{W}\Sigma^{-1}$ where $\Sigma^2 = \text{diag}\,\mathbf{W}$ is a matrix of variances of residual variables.

The structure of regression factors in the Mahalanobis space is simply $\mathbf{S} = \mathbf{M}^t\mathbf{M}\beta\rho^{-1} = \beta\rho^{-1}$, so elements sjp of matrix S are ordinary product-moment correlation coefficients. Therefore, the asymptotic variance of coefficients sjp from matrix S is $\xi_{jp}^2 = (1 - s_{jp}^2)^2 n^{-1}$ and the tests of hypotheses $H_{0jp}: s_{jp}^* = 0$ are defined by the functions $f_{jp} = s_{jp}^2((n - 2)(1 - s_{jp}^2)^{-1})$, because under $H_{0jp}: s_{jp}^* = 0$, variables f_{jp} have the Fisher-Snedecor F-distribution with 1 and n – 2 degrees of freedom.

As β is, in fact, a correlation matrix, in the matrix

$$\mathbf{V}^2 = \beta\bullet\beta = (v_{jp}^2),$$

where $\bullet$ is an operator of Hadamard multiplication, there will be components of the variances of the regressor and criterion variables under this model of regression analysis. If we now denote the sum vector of row g with $\mathbf{e}_g$ and the sum vector of row m with $\mathbf{e}_m$, the elements of the vector

$$\mathbf{j}^2 = \mathbf{V}^2\mathbf{e}_g$$

will be fractions of the variance of each regressor which was involved in the prediction of a set of criterion variables. Of course, in the vector $(\mathbf{e}_m{}^t\mathbf{V}^2)^t = \text{vec } \rho^2$ there will be coefficients of determination, and the elements in the columns of matrix $\mathbf{V}^2$ are parts of the variance of each criterion variable that can be attributed to certain regressor variables.

All the data in this research were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina by the system of data processing programs DRSOFT developed by Popović, D. (1980, 1993) and Momirović, K. & Popović, D. (2003).

3. Results

Modern sports development is increasingly based on scientific research and the cybernetic approach in modeling sports training process. Such an approach requires discovering regularities and relationships between different areas of psychosomatic status responsible for or involved in the execution of various motor tasks in sports.

Modern football has a large complexity and variability of motor actions that are aimed at achieving the highest possible tempo, dynamics and attractiveness, the optimal personality development of players and finally success in sports competitions.

Football coaches in this country, do not yet use sufficiently scientific research and principles in planning and programming sports training process making it impossible to achieve better athletic performance.

Success in football is possible only if an integral method is used to define the phenomena which are of primary importance for structuring basic movements in a football game, regularities of target transformations and basic generators of kinesiological activities.

Statistically significant multiple correlation coefficient .33 was obtained by regression analysis of performance effectiveness in a football game as a criterion and predictor system of conative characteristics, indicating that the total valid variance of 11% with its significance Sig = .00 was explained. Only one statistically significant direct and partial correlation with the predictor variable was obtained, together with the system for integration of regulatory functions. Based on this sample, it can be said that success in a football game is possible to be explained only by the effectiveness of the system for integration of regulatory functions.

It is reflected in the hypo- or hyperfunction of inhibitory mechanisms in certain situations followed by inhibition of some physiological processes and enhanced egotonicity. This factor of the first row belongs to asthenic (anxiety) syndrome

characterized by decreased excitation of the higher centers for regulation and control. It is obvious that it reduces adaptation in sports because it deactivates those structures of the nervous system which are responsible for that. This regulator is in a two-way relationship with the defense reaction regulation that modulates tonic arousal.

REGRESSION ANALYSIS OF CRITERIA AND CONATIVE CHARACTERISTICS

Tab. 1 .

	R	**Partial R**	**Beta**	**t**	**Sig.**
EPSILON	,03	,03	,041	,45	,65
CHI	-,06	-,06	-,114	-,79	,42
ALPHA	-,05	-,05	-,103	-,69	,48
SIGMA	,01	,01	,013	,14	,88
DELTA	,12	,13	,176	1,61	,10
ETA	-,13	-,14	-,238	-1,79	,05
R	**R %**	**df1**	**df2**	**F**	**Sig**
,33	,11	6	70	3,27	00

4. Conclusion

The research was conducted in order to determine influence of conative characteristics on the criterion variables in Special Olympics athletes and partners in football.

For this purpose, 80 athletes and partners engaged in football were tested. For the assessment of conative characteristics, the measurement instrument CON6 was selected by which the following conative regulators were evaluated: activity regulator, organ function regulator, defense reaction regulator, attack reaction regulator, system for coordination of regulatory functions, system for integration of regulatory functions, and system for excitation and inhibition.

To assess success in a football game, the following variables were used: evaluation of the effectiveness of the techniques, evaluation of the performance effectiveness in the offensive phase, evaluation of the performance effectiveness in the defensive phase, evaluation of individual creativity during the game, team responsibility evaluation, engagement evaluation, behavior evaluation, general evaluation of success in the game.

All the data in this research were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina, by the system of data processing programs DRSOFT developed by Popović, D. (1980, 1993) and Momirović, K. & Popović, D. (2003).

The algorithms and programs implemented within this thesis have been fully presented and the results of the programs have been analyzed.

Statistically significant multiple correlation coefficient .33 was obtained by regression analysis of performance effectiveness in a football game as a criterion and predictor system of conative characteristics, indicating that the total valid variance of 11% with its significance Sig = .00 was explained. Only one statistically significant direct and partial correlation with the predictor variable was obtained, together with the system for integration of regulatory functions. Based on this sample, it can be said that success in a football game is possible to be explained only by the effectiveness of the system for integration of regulatory functions.

It is reflected in the hypo- or hyperfunction of inhibitory mechanisms in certain situations followed by inhibition of some physiological processes and enhanced egotonicity. This factor of the first row belongs to asthenic (anxiety) syndrome characterized by decreased excitation of the higher centers for regulation and control. It is obvious that it reduces adaptation in sports because it deactivates those structures of the nervous system which are responsible for that. This regulator is in a two-way relationship with the defense reaction regulation that modulates tonic arousal.

5. References

Andrejević, D. (2000). Problem samozapošljavanja i zapošljavanja invalida i drugih hendikepiranih lica u Republici Srbiji. Belgrade, Serbia: Republički zavod za tržište rada i Institut za mala i srednja preduzeća.

Arsić, R., & Stanković, V. (2014). Analysis of the sports results achieved at national level competitions organized for the hearing-impaired children of Serbia. In S. Simović, V. Stanković (Eds.), V *Međunarodni naučni kongres „Antropološki aspekti sporta, fizičkog vaspitanja i rekreacije"*. Banja Luka, Bosnia and Herzegovina.

Boli, E., Popović, D., & Popović, J. (2012). The structure of personality characteristic of dancers. *Kinesmetric*, 1, 161-177.

Boli, E., Popović, D., Hošek-Momirović, A., Popović, J. & Savić, V. (2012). Algorithm and program for determining differences in the level of personality characteristics of male and female dancers in Mahalanobis` space. *Kinesmetric*, 1, 17-43.

Gunzberg, H. (1973). Procena sposobnosti kod umereno i teže retardirane dece. Zagreb, Croatia.

http://en.unesco.org/themes/education-21st-century (date: 12.10.2014)

http://www.unesco.org/education/nfsunesco/doc/isced_1997.htm (date: 12.10.2014)

http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/right-to-education/normative-action/fundamental-principles/equality-of-opportunity-and-treatment/ (date: 12.10.2014)

Momirović, D, Wolf, B., & Popović, D. (1999). The introduction to the theory of measurement and internal metric properties of composite measuring instruments. Priština, Serbia: Faculty of Physical Education, Centre for Multidisciplinary Research.

Momirović, K. & Popović, D. (2003). Construction and aplication of taxonomy neural networks. Leposavić, Serbia: Faculty of Physical Education, Centre for Multidisciplinary Research.

Popović, D. (1992). Methodology of research in physical education. Athens, Greece.

Popović, D. (1993). Programs and subprograms for the analysis of quantitative modifications. Priština, Serbia: Faculty of physical education, Center for multidisciplinary research.

Popović, D., Kocić, J., Boli, E. & Stanković, V. (1995a). Conative characteristics of female dancers. International Congress "Images of Sport in the World", 75th Anniversary of the German Sport University, Abstract Volume, (pp. 96), Open Forum, Cologne, Germany.

Popović, D., Petrović, J., Boli, E. & Stanković, V.: (1995b) The structure of the personality of female dancers. 3rd International Congress on Physical education and Sport, Exercise & society supplement issue No. 11 (pp. 196), Komotini, Greece.

Popović, D., Stanković, V., Kulić, R. & Grigoropulos, P. (1996). The structure of personality of handball players. 4th International Congress on Physical education and Sport, Exercise & society supplement issue No. 15 (pp. 164), Komotini, Greece.

Popović, D.: (1980) Research methodology in Physical education. Niš, Serbia: University of Niš.

Received on 10th April 2014.
Accepted on 11th October 2014.

Original scientific paper *UDC 796.032.2-056.26/.36*
796.034-056.26/.36:159.942.072
COBISS.SR-ID 214878988

Uticaj konativnih karakteristika na uspeh u fudbalu kod atleta i saradnika Specijalne Olimpijade

Miloš Popović[1], Veroljub Stanković[1],
Dragan Popović[1] i Hana Valkova[2]
[1]Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
[2]Palacky University, Faculty of Physical Culture, Department of APA,
Olomouc, Czech Republic
e-mail:milos.popovic@pr.ac.rs

Sažetak

Istraživanje je sprovedeno sa ciljem da se utvrdi uticaj, konativnih karakteristika na kriterijske varijable kod atleta i saradnika Specijalne Olimpijade u fudbalu.

U tu svrhu ispitano je 80 atleta i sradnika koji se bave fudbalom. Za procenu konativnih karakteristika izabran je merni instrument KON6 kojim su se procenjivali sledeći konativni regulatori: Regulator aktiviteta, regulator organskih funkcija, regulator reakcija odbrane, regulator reakcija napada, sistem za koordinaciju regulativnih funkcija, sistem za integraciju regulativnih funkcija i sistem za ekcitaciju i inhibiciju.

Za procenu uspešnosti u fudbalskoj igri bile su primenjene sledeće varijable: ocena uspešnosti tehnike, ocena uspešnosti igre u fazi napada , ocena uspešnosti igre u fazi odbrane, ocena individualnog stvaralaštva u igri, ocena timske odgovornosti, ocena angažovanosti, ocena ponašanja, opšta ocena uspeha u igri .

Svi podaci u ovom istraživanju, obrađeni su u Centru za multidisciplinarna istraživanja Fakulteta za sport i fizičko vaspitanje Univerziteta u Prištini pomoću sistema programa za obradu podataka DRSOFT koji je razvio Popović, D. (1980 i 1993) i Momirović, K. i Popović, D. (2003).

Algoriatm koji je realizovan u okviru ovog rada u potpunosti je prikazan a rezultati tog algoritma su detaljno analizirani.

Ključne reči: */ pouzdanost / latentna / dimenzija / matrica / vektori / varijansa*

Miloš Popović
Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini
sa privremenim sedištem u Leposaviću, Srbija
e-mail:milos.popovic@pr.ac.rs

Guidelines for authors

GUIDELINES FOR AUTHORS

"Kinesmetrics" journal publishes papers on the theory of measurement in sport and physical education, and from the field of related biomedical, humanistic, social and natural sciences, with the unpublished results of scientific research and new empirical experiences. The submitted manuscript, not prepared according to the Guidelines for authors will be immediately returned to the author for revision. The author is fully responsible for the content and vocabulary of the paper. All articles will be reviewed. The publisher provides proofreading and translation into the English language. The author receives notification whether the paper is accepted. The published papers are not remunerated.

CATEGORIZATION OF THE PAPERS

The magazine publishes articles, polemics, reviews, book reviews, thematic bibliographies, patents, reports and news on the scientific meetings, and other similar documents significant for the domain of sport and physical education.

The category of an article is determined by the reviewer and the editorial board. The reviewed papers are classified into the following categories:

- Original scientific papers
- Scientific critiques, polemics and reviews
- Professional papers
- Informative article (preliminary communications, comments, etc.)
- Reviews (of a book, computer program, case, scientific event, etc.)

MANUSCRIPT

The manuscript should be submitted in the Serbian language, written in Latin alphabet, and in English, font Times New Roman, font size 12, single spacing.

The manuscript shall include: manuscript formatting, text, footnotes, quoted literature, inserts (tables, pictures, charts, etc.).

Two copies of the printed manuscript are submitted in Serbian and English, and one in the electronic format (diskette, cd or e-mail:vladimir.savic@pr.ac.rs).

MANUSCRIPT PREPARATION

This includes two pages marked with Roman numerals.

PAGE 1

The following data are required to be listed:

a) Names and surnames of all the authors in the order in which they will be published;
b) The title of the paper;
c) If the paper is an extract from the graduate, master or doctoral thesis, a thorough bibliographic description of the source should be presented as follows: the full title of the graduation, master or doctoral thesis, the type of the work, town, country, the name of the institution where the thesis was defended, the year of the defence;
d) If the paper originates from a research survey, a thorough bibliographic description of the source should be presented as follows: the full title of the survey, the type of the work, the name of the institution where the survey was conducted, town, country, the name of the author or authors;
e) If the paper is presented at some scientific-professional conference, details on the conference should be listed as follows: the type of the conference, the full title of the conference, town, country, the date of the conference;
f) Acknowledgements if there are any;
g) Particulars about each author according to the following format: academic title, name and surname, profession, contact address, postal code, place, state, street and number, telephone and fax numbers, e-mail address.

PAGE II

a) The title of the paper;
b) The abstract of the paper of maximum 250 words in one paragraph. The abstract outlines, the aim of the research, the applied methods and main results;
c) Key words (three to ten), written in the singular, capital letters, separated by a slash.

TEXT

The length of the text is limited to ten printed pages, exceptionally it may be longer by the arrangement with the editor, paper format B5, margins 2cm. Generally, the text should be written in the following chapters: introduction, method, results with discussions, conclusion.

In the paper text literature is cited according to the APA (Author Date) system (e.g: Publication Manual of the American Psychological Association, www.apastyle.org).

FOOTNOTES

The usage of footnotes is not recommended. If they are still necessary, type them as a separate list. The list should begin on a new page (after the text) entitled as Footnotes, with a continuous pagination in Arabic numerals. The list should be arranged in the order of quoting.

REFERENCES

Along with the text there should only be included a list of the works cited in the text. The works are referenced according to the APA system (e.g: Publication Manual of the American Psychological Association). The list should begin on a new page (after the text) entitled References, with continuous pagination in Arabic numerals. Reference list entries should be alphabetized by the last name of the author of each work, or the title of each journal (if the authors are not stated).

The example of a bibliographic description for a book:

Author, A.A. (publication year). The title of the book. Town. Publisher.

Popović, D.: (1993) Programs and subprograms for the analysis of quantitative modifications (textbook), Priština, the University of Priština, Faculty of Physical Education, Multidisciplinary Research Center.

The example of a bibliographic description for a journal article:

Author, A.A. (publication year). The title of the article. The title of the journal. Volume (number), pages:

Popović, D.: (1987) Canonical correlation analysis as the optimal method for determining relations between two sets of variables. Scientific Youth, The Notebook for natural-mathematical and technical sciences, XIX, 1-2: 63 69.

The example of a bibliographic description for chapters in books:

Author, A.A. (publication year). The title of the chapter. On behalf of the editor. The title of the book (pages of the chapter). Town. Publisher.

The example of a bibliographic description for the proceedings of congresses, conferences, etc:

Author, A.A. (publication year). The title of the article. On behalf of the editor. A collection of papers from: the name of a congress, conference, etc. Town. Publisher:

Popović D., Petrović, J., Boli, E. & Stanković, V.: (1995) The structure of the personality of female dancers. 3rd International Congress on Physical Education and Sport, Exercise & Society supplement issue No.11 (pp.196), Komotini, Greece.

The example of a bibliographic description for graduation, master or doctoral theses:

Author, A.A. (publication year). The title of the work (type of work). Town. Institution.

Boli,E.: (1996) The structure of intellectual and musical abilities and personality traits of female dancers involved in standard and Latin American dances, (Master thesis), Priština, the University of Priština, Faculty of Physical Education.

APPENDICES

Appendices include tables, drawings, charts, schemes and supplements (e.g., presentation of a questionnaire). The list of appendices should be submitted on a separate page arranged according to types of supplements: tables, charts, schemes, etc. with serial numbers within each type (e.g. table 1-5; photographs

1-3, etc.). Each table or illustration is required to be understandable without reference to the text.

Manuscripts should be submitted to the address:

KINESMETRICS JOURNAL
Leposavić, Dositej Obradović st., nn
Telephone: +381 28 84700
Fax: +381 28 84701
e-mail: dragan.popovic@pr.ac.rs

CIP - Cataloguing in publication
The National library of Serbia, Belgrade
796.012
KINESMETRICS : international scientific journal /
Editor-in-Chief: Dragan Popović. - 2014,Vol. 3, No. 1 (december)
- Leposavić : The faculty of sport and physical education of the University of Priština,
2014 - (Kruševac : Sigraf plus). - 30 cm. - pages 145
One a year
ISSN 2217-9968 = Kinesmetrics
COBISS.SR-ID 193322252