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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.

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Application and development of statistical methods and statistical-mathematical methods and models in the field of physical education in Serbia

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1. Introduction

The beginnings of organized work effort and the formation of statistical service in our country date from the end of the 19th century (1862), and were primarily used for obtaining a census of the population and natural and economic resources. The work of these services led to the need for new research in all the fields of social life and work, and thus in the field of physical education. All types of knowledge, including the knowledge obtained in the field of physical education, are obtained by means of a scientific research method. Certain methods are used in this type of work, and researchers resort to certain courses. The methodology of scientific research work in physical education studies and systematizes these courses, methods, and research procedures, so as to be able to answer the important questions the researcher has to answer regarding his scientific-research work. Methodology in physical education can be defined as a part of physical education which deals with the evaluation of the means by which scientific knowl-

edge is obtained in this field. Statistics is a part of the internal structure of the methodology which evaluates the models, methods and algorithms for evaluation of data processing and hypothesis testing. The statistical methods which are used in physical education research can be found in the group of scientific disciplines which are directly or indirectly used in various forms of physical education, such as physical education classes, sport and recreational activities, or in other anthropological sciences. The very application and development of statistical methods in physical education are also closely related to the development of kinesmetrics, computer science and cybernetics.

2. Application and development of statistical methods and models in physical education

2. 1. Phase I

Statistical research during the 1950s and 60s in Serbia primarily took place in the Institute of Physical Education and Sports Medicine and also at various faculties of physical education, either as an independent scientific discipline or as part of other scientific disciplines. At the very beginning of the use of statistical methods and procedures it was primarily the features of a mass of participants which was being studied and whose units were classified, grouped into sequences with absolute or relative expressions of size and were shown in the form of tables and graphs. In the following phase we perform statistical analysis in which numerical data are obtained regarding the features of the analyzed occurrence and interpretation which leads to the possibility of drawing a conclusion. Generally speaking, during the first 20 years or so, the application of statistics in physical education in Serbia mainly began and ended with the following statistical procedures: taking a certain statistical group as a characteristic value marked as the parameter, its measure of central tendency or means were calculated, as well as its deviations from these means. The means are of different types and are selected according to group type: as the modus (Mo), the value which occurs most often, the median (Md) which is in the middle of the distribution and the calculated means which include the arithmetic means (M), geometric means (G) and harmonic means (H). These means only partially characterize the group, since the significance of the greater or smaller dispersion is greater than the means. This dispersion indicates the homogeneity of the group and the extent of the confidence interval of the means. The following step includes determination of the dispersion measures such as the range of results, the variance, standard deviation, and the coefficient

of variance. After that we take into consideration the chronological sequence as the extent of the growth or the decline of a certain occurrence of the phenomenon over a certain period of time. The most frequent occurrences are the continuous developmental tendencies which are marked as a trend or as a line of movement during usually a longer period of time. It can either be linear increasing or decreasing, or curvilinear. The logical conclusion of this is the need to check all the individual influences in the movement of the occurrence and connection between certain variables in the movement of the occurrence. The extent of the connection is calculated through the correlation coefficient (r). If the degree of the connection between the occurrences is a complete correlation coefficient, it equals (1) and if the connection does not have a correlation coefficient, it equals (0). In physical education, we mostly come across incomplete (stochastic) connections, that is, the occurrence of a value of + or – for the correlation coefficient, or whether the increase in one variable follows the decrease in the other variable. Of the different correlation coefficients the ones most often used is Pearson's correlation coefficient (rxy), rank correlation (ρ), the biserial coefficient (rbi), and the contingency coefficient (C). After working on the previous problems of evaluation we move on to the comparison of the characteristics between the groups. On the comparison basis we determine whether any of the previously proposed hypotheses will be accepted or rejected, or in other words, we begin the hypothesis testing. This was carried out by means of the T-test, F-test and $\chi 2$-test. During the first phase of the development of statistical research in physical education, every procedure usually ended with the aforementioned statistical procedures.

2. 2. Phase II

We could say that the previous statistical procedures close off the first phase of the application of statistical methods in physical education in Serbia. Namely, research procedures in statistics were used for scientific purposes mostly regarding data which are quantified, that is, numerically expressed through measurement, while the measuring enables the use of statistical and thus mathematical methods. There is an opinion that the condition of a particular science can be evaluated by the extent to which its essence can be accounted for mathematically, that is, to which extent it could use math, even though mathematical methods are not the only ones which can be used in science. By observing the development of science we can see that the sciences whose subject matter is such that it facilitates the use of mathematical methods developed more quickly than those sciences in which it was difficult to use mathematics. The application of mathematics depends on the possibility of carrying out a measuring. Namely, where the dimensions of a particular occurrence can easily be abstracted from its whole and where they are

under relatively small influence of various factors, the measuring is easy, and vice versa. Towards the end of the 20th century, it was the use of statistical mathematical methods and models on the computer that opened an almost limitless field of possibility for deeper understanding of natural kinesiological processes and transformational processes which are used to form, shape, model, program, plan and follow them.

It is well known that the manifest anthropological space is irrelevant for the determination of the kinesiological laws for several reasons:

- Its dimensionality is virtually limitless,
- The manifested variables contain within themselves a specific variance and a variance of error,
- The interpretation of the manifested phenomena is either impossible or superficial and the stability of the results with the aim of their application during the prediction is significantly greater in the latent space than in the manifest space (Momirović, 1975).

The real kinesiological area is for these reasons only the space of latent kinesiological dimensions. Modern scientific methods, which include statistics as a method of scientific research, represent the scientific essence of the study of any phenomenon in physical education.

In physical education then, as well as now, scientific results have to enable the explication, prediction and transformation of the studied phenomena and processes in certain scientific disciplines which at the same time represent scientific laws as well. Numerous models exist for their operationalization, as well as methods, algorithms, and programs for the multivariate processing of data which are contained within various statistical packages, and are almost impossible to enumerate (Momirović et al. 1999). For the same reason their classification is limited to three classic scientific laws, or four different groups of methods which are most characteristic of kinesiological anthropological research (Malacko & Popović, 1997):

The methods for the determination of structure and classification:

- factor analysis,
- taxonomic analysis;

For determining influence and relations:

- regression analysis,
- canonical correlation analysis;

For determining differences and effects:

- multivariate analysis of variance and covariance,
- canonical discriminant analysis;

To determine changes and development:

- canonical analysis of change, and
- analysis of the development curve. (Popović, 1990, Malacko & Popović, 2001)

Even though the statistical-mathematical methods and models originate from the beginning and middle of the 20th century (the diagonal method of the factor extraction (Cholesky, 1915), the centroid method described by Thurstone (1935, 1947), the simple summation method described by Burt (1949), the canonical factor analysis by Lawley (1940), the varimax criterion suggested by Kaiser (1958), we did not need to wait long for their use in physical education (Stanković, 2000). To quote Štalec (2011), "real statistics only came into use from 1965 when professor Konstantin Momirović travelled from the Physical Education College in Zagreb to Ljubljana, and asked for a few correlational matrices to be calculated for what today is considered a small number of variables and participants (he remembers that there were 30 variables and 150 participants). Until then his associates had carried out analyses on hand-held calculators", data processing was partially done in Ljubljana under the guidance of professor Klas, and no computing center to be found in Yugoslavia in that day could (according to him) carry out those analyses on a computer. "Considering the fact that we successfully met these demands, the professor increased his appetite and he started designing more extensive studies and using various methods of multivariate data analysis". They programmed regression analyses, factor analyses, discriminant analyses and the multivariate multi-factor analysis of variance. This kind of prepared program was supposed to be fed into a computer, prepared in the form of a reading tape with the data on it and it was supposed to start the performance by means of a certain command on the computer stand. The program carried out command after command, no translation was necessary. Unfortunately not a single copy of the results can be found today.

In his overall lifework, dr Konstantin Momirović attempted to bring together Croatian and Serbian views and approaches as much as possible, acting as a fine connection between the two. The first paper written on physical education with the use of the statistical-mathematical method was written by dr Konstantin Momirović (1966) and it was entitled "Primjena latentnih antropometrijskih varijabli pri selekciji vrhunskih sportaša" (The use of latent anthropometric variables in the selection process of top athletes). Immediately afterwards he published his second article (1968) entitled "Faktorska struktura antropometrijskih varijabli" (The factor structure of anthropometric variables) published by the Kinesiology Institute of the Faculty of Physical Education in Zagreb, where he was working at the time.

In his PhD thesis entitled "Struktura morfoloških, motoričkih, kognitivnih i konativnih dimenzija u dizača tegova" (The structure of morphological, motor, cognitive and conative dimensions among weight lifters, 1976), which was defended at the Faculty of Physical Education in Belgrade, he also applied a multivariate statistical method including factor and regression analyses.

In 1979 dr Dragan Popović started working in Niš on the application and development of the DRSOFT program package for home and personal computers which work with CP/M, PS-DOS, MS-DOS and XENIX operative systems, and which deal with quantitative data processing. All the programs and sub-programs that the professor wrote in Fortran and Basic were tested over several dozen MSc theses and PhD theses and their descriptions were explicitly stated in the handbook "Programi i potprogrami za analizu kvantitativnih promena" (The programs and sub-programs for the analysis of quantitative changes) (1993) at the Center for Multidisciplinary research of the Faculty of Physical Education in Priština established in 1992, whose head professor Popović has been ever since it was established. Today we can say that it was a pioneer endeavor since, as far as the author was able to determine, at the time no one was writing statistical programs for these types of computers. Computing centers up till then were engaged in adapting program packages which were written for the IBM 1130 computers (the well-known SSP package) as well as for other computers which were installed throughout Yugoslavia at the time (PDP and the greatest computer installed up till then, the UNIVAC computer at the SRCE center in Zagreb. The first pioneer papers by professor Momirović and professor Popović were a modification of the algorithms and programs written in FORTRANU 4 of the well-known handbook by Cooley & Lohnes (1971) "Multivariate data analysis".

2. 3. Phase III

In a great number of research projects, the solution to the research issue in physical education could not be found in the closed algebraic form and because of that the solution had to be sought out in some numerical algorithms. As it is well known, up to now several hundred of these algorithms which were efficient enough to be retained in practice were proposed, and thus found their place in textbooks; several dozen of these algorithms were implemented in the most frequently used statistical program systems or packages such as SAS, GENSTAT, SPSS, Statistica, BMDP, SYSTAT and others, and were not necessarily worse program products. The use of these products in different sciences or fields derived from these sciences have shown that their effectiveness varies significantly not only from method to method, and from implementation to implementation, but also from problem to problem, defined by the configuration of the vectors of

the objects in the variable space. In such situations it is natural that the solution to the problem could be found in the space of heuristic methods and thus in the space of neural networks, for the simple reason that neural networks can be used to emulate any method of data analysis. These networks have been constructed in such an enormous number up to date, that it is virtually impossible to count them. Nevertheless, they are not all equally accessible, nor equally effective, and have not been checked in a rigorous enough fashion. With the arrival of professor Momirović to Belgrade (1991), Serbia became one of the world's centers for the development of neural networks, which in addition to the other social sciences found their use in kinesiology. Professor Momirović developed the following program packages: SS, GENSTAT and SPSS and wrote several hundred algorithms and programs for them. In collaboration, Momirović & Popović 2003, wrote one of the seminal works of our field which refers to neural networks "Konstrukcija i primena taksonomskih neuronskih mreža" (The construction and application of taxonomic neural networks). Professor Momirović and professor Popović developed networks which were implemented in the SPSS environment until 2003, and for a very simple reason, the fact that the SPSS environment is, on the one hand, easy to use and it requires no knowledge of programming and, on the other hand, is available to all the users of statistical packages. It is precisely for this reason that there are such great limitations and possibilities for the serious use of neural networks. That's why professor Popović decided on the implementation of the neural network in the SAS environment. There were two important reasons. The first reason is that the SAS environment has been designed in a much more serious form and of itself can offer the user far more, while the second reason is that it is the only environment which can fully satisfy all users and especially those who are knowledgeable regarding the production of algorithms and programs.

3. Conclusion

The beginnings of the organized work effort and the formation of a department for statistical analysis in Serbia date from the end of the 19th century (1862), which had the aim of completing a population census, as well as a census of natural and economic resources. At the very beginning when these statistical methods and procedures were being used for the first time, they were mostly descriptive statistics and tests statistics. After the second phase which is characterized by a long period of the use of statistical-mathematical methods for determining the structure, differences, the influence and relations within and between the analyzed anthropological spaces, we come to the phase of application of neural networks by means of which we can emulate any method of data analysis. These

networks are so numerous nowadays that it is practically impossible to count them all. Nevertheless, they are not all equally accessible, are not equally effective and they have not all been evaluated in a rigorous enough fashion. Further development of anthropological sciences (kinesiology, psychology, genetics, pedagogy, sociology, etc.) can necessarily be expected to be promoted if information technology improves, including the use of mathematic and cybernetic methods in the application and development of neural networks.

Lately there has been much abuse of the statistical packages and even terror in the so-called field of data processing. Having worked all these years with professor Popović, who is the only true follower of professor Momirović and his heir, first as an assistant and now as a professor myself, and having spent most of my time with him in the field of scientific research work, I have learned that it is impossible to accept the widespread belief that it is enough to come into possession of computer equipment, to obtain the cheapest statistical package and with a little good will carry out any serious scientific research. We would not be quoting and citing the names of certain authors who designed the name "data processors" if they did not in fact understand the basic logic of some of the multivariate analyses, or, for instance, hyper and hypo factorization in the factor analysis. What are we to do: either the modern young researchers of today will learn the basics of programming and the logic of multivariate models which have explicitly been covered to date in the numerous textbooks by many of our co-authors, so that they could use some of the more serious program packages, for instance, SAS and neural networks, or this hard work will all be in vain.

4. References

[1.] Cooley, W. W. & Lohnes, P. R. (1971). Multivariate data analysis. New York, etc: Wiley.

[2.] Kurelić, N., Momirović, K., Stojanović, M., Šturm, J., Radojević, Đ. & Viskić-Štalec, N. (1975). Struktura i razvoj morfoloških i motoričkih dimenzija omladine. Beograd: Institut za naučna istraživanja Fakulteta fizičkog vaspitanja.

[3.] Малацко, J. (1970). Валидација инструмената за испитивање психосоматског стања и степена тренираности рвача. Одобрен и реализован научни пројекат. Београд: Савез за физичку културу Југославије.

[4.] Малацко, J. (1976). Структура морфолошких, моторичких, когнитивних и конативних димензија у дизача тегова.

Необјављена докторска дисертација. Београд: Факултет за физичко васпитање.

[5.] Malacko, J (1994). Антрополошка статистичка методологија. Нови Сад: СИА.

[6.] Malacko, J. & Popović, D. (1997). Metodologija kineziološko antropoloških istraživanja. Приштина: Универзитет у Приштини, Факултет за физичку културу.

[7.] Momirović, K. (1966). Primjena latentnih antropometrijskih varijabli pri selekciji vrhunskih sportaša. Zagreb: Institut za kineziologiju.

[8.] Momirović, K. (1968). Faktorska struktura antropometrijskih varijabli. Zagreb: Institut za kineziologiju.

[9.] Momirović, K. (1975). Metode za transformaciju i kondenzaciju kineziloških informacija. Zagreb: Fakultet za fizičku kulturu.

[10.] Momirović, K., Wolf, B. & Popović, D. (1999): Uvod u teoriju merenja 1, interne metrijske karakteristike kompozitnih mernih instrumenata. Priština: Fakultet za fizičku kulturu.

[11.] Momirović, K. & Popović, D. (2003). Konstrukcija i primena taksonomskih neuronskih mreža. Leposavić: Univerzitet u Prištini.

[12.] Popović, D. (1990). Metodologija istraživanja u fizičkoj kulturi. Niš: Naučni podmladak.

[13.] Popović, D. (1993). Programi i potprogrami za analizu kvantitativnih promena. Priština: Fakultet za fizičku kulturu.

[14.] Stanković, V. (2000). Testiranje i primena programa za utvrđivanje strukture i razlika u međusobno povezanim prostorima kod rukometaša u toku jednogodišnjeg trenažnog procesa. Neobjavljena doktorska disertacija. Priština: Fakultet za fizičku kulturu.

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Application and development of statistical methods and statistical-mathematical methods and models in the field of physical education in Serbia

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Summary

The beginnings of an organized work effort and the formation of a department for statistical analysis in our country date from the end of the 19th century (1862), and were primarily used for obtaining a census of the population and natural and economic resources. The work of these services led to the need for new research in all the fields of social life and work, and thus in the field of physical education. Modern scientific methods, such as statistics as a scientific method of research, represent the scientific basis of the study of any phenomenon in physical education. The statistical methods applied to physical education research can also be used in a group of related scientific disciplines which were used, directly or indirectly, in various forms of physical education in general, physical education in the curriculum, in sport and recreational activities. At the very beginning, the statistical method and procedures used were primarily those that evaluated the features of a studied group, whose units were classified and grouped into sequences with absolute or relative expressions of size, and which were presented in

the form of tables and graphs. After the second phase, characterized by extended periods of use of statistical methods to determine the structure, differences, influence and relations within and between the analyzed anthropological spaces, we come to the current phase characterized by the use of neural networks for the simple reason that neural networks can emulate any method of data analysis. Many of these networks have been constructed up to date, so many in fact that their number practically cannot be determined. Among them there is a definite, although not big, number of taxonomic neural networks. Nevertheless, they are not all equally available, not all equally effective, and have not all been evaluated in a rigorous manner.

Key words: statistical methods, statistical models, neural networks, historical development, Serbia

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Algorithm and program for determining differences in the level of personality characteristics of male and female dancers in Mahalanobis' space

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1. Introduction

Most of the goals of sports activities could hardly be achieved without knowing the area of conative factors since they restrict or stimulate human activities. For that reason, conative factors are the subject of a large number of researches to find out to what extent it is possible to influence those dimensions. So far, it has become obvious that some of these dimensions can be affected by a training process in a positive and negative sense. The whole sphere, however, hasn't been thoroughly researched. Some relatively less researched aspects, especially in our population, involve the space of factors responsible for behavior modalities. Apart from these researches, whose goal was validation of measuring instruments, and some partial researches, there have been no other major or more

important researches, in our population, of conative characteristics of male and female dancers especially occupied with Latin American dances. Therefore, this research is all the more important for both theory and practice of future teachers in dancing schools, especially for the preparation for dancing competitions.

2. The methods of research

2. 1. The sample of examinees

The sample of examinees is conditioned by financial capabilities necessary for accomplishing the research. Besides, the sample depends on the number of qualified and trained measurers, the instruments and the standardized conditions under which the planned research should be conducted.

In order to conduct the research properly with valid, sufficient results regarding the sampling error, it is necessary to include an adequate number of examinees into the sample. Most samples for this type of research are preconditioned by the aims and tasks of the research, the size of the population, and the degree of variability in the applied system of parameters.[1]

According to the selected statistical-mathematical model and the aim of the research, 131 female and 136 male dancers, aged from 11 to 13, performing standard and Latin American dances in Serbian dancing schools were involved.

The size of the defined sample should satisfy the following criteria:

- The effectives of the sample should be planned so as to allow as many degrees of freedom as necessary for any coefficient in the pattern or correlation matrix, equal to or higher than 0.22, to be considered as different from zero, with an inference error less than 0.01;
- In order to successfully aply the adequate statistical methods, according to the latest opinions, the number of subjects in the sample must be five times bigger than the number of the applied variables;
- In order to determine any possible differences, under the influence of training on relevant spheres, it was necessary to carry out two measurements on the examinees of both sexes, the first measurement before the beginning of a competitive season and the second one after the end of it.

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

Throughout all these factor procedures it should always be kept in mind that the results of the analysis depend on three major systems which determine the selection and transformations of information: on the sample of variables, sample of examinees and the selected extraction, or rotation, method.[2]

2. 2. The sample of variables

For estimating the dimensions of personality, the measuring instruments are selected so that they could cover the dimensions of the model of the functioning of conative regulatory mechanisms. The model assumes a hierarchical organization of the mechanisms for regulation and control of behavior modalities; and it is constructed so as to avoid artificial dichotomy to normal and pathological conative factors.

The following measuring instruments have been selected:

1) Activity regulator (EPSILON)
2) Regulator of organic functions (HI)
3) Regulator of defensive reactions (ALFA)
4) Regulator of offensive reactions (SIGMA)
5) System for coordination of regulative functions (DELTA)
6) System for integration of regulative functions (ETA)

The mechanism for activity regulation is one of the elementary and lowest positioned systems in the hierarchy. Its function is the regulation and modulation of the activating function of the reticular formation; therefore, it is directly responsible for the activity and energy level on which other subsystems, including cognitive processes, function.

Disorders of this system can form the energy basis for hypomanic or depressive reactions and they probably affect the information flow rate in the central nervous system.

The mechanism for regulation and control of organic functions is defined by the effectiveness of coupling between subcortical regulatory functions of organic systems and higher-ranking cortical systems for regulation and control.

Disorders of this system are manifested by a functional disorder of the primary organic systems, such as cardiovascular, respiratory and gastrointestinal systems, as well as by the functional disorders of input and output operations.

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

The mechanism for regulation and control of the defensive reactions is defined by the appropriate modulation of tonic arousal, probably based on the adequacy of programs that are of genetic origin or that are formed during the evolution and positioned in the center of defence reactions regulation.

Disorders of the system for regulation of defence reactions are manifested by various symptoms of anxiety and they form the basis for specially modulated pathological reactions, such as phobia, obsession and compulsion.

The mechanism for regulation and control of offensive reactions is also defined by the appropriate modulation of tonic arousal, based on the adequacy of programs transmitted by the genetic code or formed under the influence of conditioning and positioned in the center of regulation of offensive reactions.

Disorders of the system for regulation and control of offensive reactions are manifested by various aggressive reactions and by poor control of immediate impulses.

The mechanism for homeostatic regulation is determined by the coordination of activities of functionally and hierarchically different subsystems, especially including the coordination of functions of the conative regulatory systems and intellectual processors. Owing to this, homeostatic regulation system is functionally superior to the systems for regulation of organic functions, defensive and offensive reactions, and furthermore it controls the processes occurring in the system for excitation and inhibition regulation.

Disorders of the system for homeostatic regulation inspire dissociation and disorganization of conative and intellectual processes, including the motor functions that depend on the movement structuring.

The mechanism for integration of regulatory functions is responsible for the integration of conative regulatory processes under the guise of the structure of social domain and changes within it. The set of programs, which determine its functioning, is formed mostly during the educational process. Social disadaptation is an immediate consequence of functioning of the mechanism.[3]

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

2. 3. Methods of data processing

Now canonical discriminant analysis can be defined as a solution of the quasi canonical problem

$$M_{xk} = k_k,\ Gy_k = l_k \mid c_k = k_k{}^t l_k = \text{maximum},\ x_k{}^t x_q = y_k{}^t y_q = \delta_{kq}$$

$$k = 1,...,s;\ s = \min((g - 1), m) = m$$

where δ_{kq} is the Kroneker symbol and x_k and y_k are unknown m - dimensional vectors.

Since $c_k = x_k{}^t A y_k$, the function that should be maximized, for k = 1, is

$$f(x_k, y_k, \lambda_k, \eta_k) = x_k{}^t A y_k - 2^{-1}\lambda_k(x_k{}^t x_k - 1) - 2^{-1}\eta_k(y_k{}^t y_k - 1).$$

By differentiating this function by elements of vector x_k

$$\partial f/\partial x_k = Ay_k - \lambda_k x_k,$$

and by differentiating by the elements of vector y_k

$$\partial f/\partial y_k = Ax_k - \eta_k y_k;$$

after equating with zero

$$Ay_k - \lambda_k x_k$$

and

$$Ax_k - \eta_k y_k.$$

By differentiating by λ_k and η_k it is easy to obtain, from the condition $x_k{}^t x_k = 1$ and $y_k{}^t y_k = 1$, that $\lambda_k = \eta_k$. As $A^t = A$, by multiplying the first result by $x_k{}^t$ and the second result by $y_k{}^t$

$$x_k{}^t A y_k = \lambda_k$$

and

$$y_k{}^t A x_k = \lambda_k$$

so that $x_k = y_k$ and the problem is reduced to an ordinary problem of eigenvalues and the vector of matrix A, in other words, it is reduced to the solution of the problem

$$(A - \lambda_k I)x_k = 0,$$

$$k = 1,..., m$$

therefore

$$c_k = \rho_k{}^2 = x_k{}^t A x_k = \lambda_k,$$

$$k = 1,..., m$$

are the squares of the canonical correlations between linear combinations of variables from M and G which are proportional to the differentiation of the centroids of the subsamples defined by the selector matrix S in the space stretched by the vectors from M.

Let $\rho^2 = (\rho_k^2)$, k = 1,..., m be a diagonal matrix whose elements are the squares of canonical correlations, let $X = (x_k)$, k = 1,..., m be a matrix of eigenvectors obtained by resolving the canonical discriminative problem, let

$$K = MX$$

be a matrix of discriminative functions and let

$$L = GX = PMX$$

be a matrix of discriminative functions projected into the hypercube determined by the vectors of matrix S. As

$$K^tL = X^tAX = \rho^2$$

and, of course, $K^tK = I$ and $L^tL = \rho^2$, the canonical discriminative analysis produces two biorthogonal sets of the vectors of variables by the transformation of the vectors of variables from M and G, which 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 noncorresponding vectors from K and L are equal to zero, because the correlations between the variables from K and L are

$$K^tL\rho^{-1} = X^tAX\rho^{-1} = \rho.$$

The vectors x_k from X are, evidently, the vectors of the standardized partial regression coefficients of the variables from M, that generate discriminative functions k_k which together with discriminative functions l_k, constructed by vectors of standardized partial regression coefficients x_k from the variables from G, have maximal correlations. But, since

$$M^tK = X,$$

the elements of the matrix X are, simultaneously, the correlations between variables from M and discriminative variables from K, which unlike the standard canonical discriminative model, permits simple testing of hypothesis about partial influence of variables on forming discriminative functions. For the identification of discriminative functions of certain significance there could be the elements of the cross-structural matrix defined as correlations between variables from M and L, therefore, the elements of the matrix

$$Y = M^tL\rho^{-1} = AX^{\rho-1} = X\rho;$$

Note, by the way, that Y is the factor matrix of matrix A, since, certainly,

$$YY^t = X\rho^2X^t.$$

Since x_{jk} elements of the matrix X and y_{jk} elements of the matrix Y are ordinary correlations, their asymptotic variances are

$$\sigma_{xjk}^2 = (1 - x_{jk}^2)^2n^{-1},$$

respectively

$$\sigma_{yjk}^2 = (1 - y_{jk}^2)^2n^{-1},$$

so the hypotheses of type H_{0xjk} or H_{0yjk} could be tested on the basis of the function

$$f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2)),$$

respectively

$$f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2)),$$

because under those hypotheses these functions have the Fisher - Snedecor F distribution with the degree of freedom $\nu_1 = 1$ and $\nu_2 = n - 2$.

Unfortunately, with the normal application of canonical discriminative analysis, the main, and usually the only set of the hypotheses related to the parameters of that model is the set

$$H_0 = \{\varphi_k = 0, k = 1,..., m\}$$

where φ_k are the hypothetical values of canonical correlations in population P.

For testing the hypotheses like

$$H_{0k}: \varphi_k = 0$$

$$k = 1,..., m$$

the function of the well-known Wilks measure is commonly applied:

$$\lambda_k = \Sigma_{t+1}^s \log_e (1 - \rho_{t+1}^2)$$

$$k = t + 1, t = 0, 1,..., m - 1$$

proposed by Bartlett (1941), who found that under 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

$$\nu_k = (m - k + 1)(g - k)$$

degrees of freedom.

However, the results of Bartlett's test are not, even for large samples, in the best accordance with the results of the tests like

$$z_k = \rho_k/\sigma_k$$

$$k = 1,...,s$$

which are based on the fact that canonical correlations also have asymptotic normal distributions with the parameters φ_k and

$$\sigma_k^2 \sim (1 - \varphi_k^2)^2 n^{-1}$$

(Kendall and Stuart, 1976; Anderson, 1984).

The centroids of subsamples E_p, p = 1,..., g from E on the discriminative functions, obligatory for the identification of the content of discriminative functions, are, of course, the elements of the matrix

$$C = (S^tS)^{-1}S^tK = (S^tS)^{-1}S^tMX = (S^tS)^{-1}S^tZR^{-1/2}X$$

So, it is clear that those are, in fact, the centroids of the subsamples on the variables transformed into the Mahalanobi's form projected into the discriminative space.

Projection in the space with standard metrics

The optained solution is easily changed into the form obtained under the canonical model of discriminative analysis.

The matrix of discrimination coefficients could be defined as a matrix of partial regression coefficients, obtained by solving the problem

$$ZW = K + E \mid trag(E^tE) = minimum.$$

Since, actually

$$K = ZR^{-1/2}X,$$

it is immediately clear that E = 0 and that

$$W = R^{-1/2}X.$$

For this reason vectors w_k from W are proportional to the coordinates of the vectors of discriminative functions in the oblique coordinate system composed of vectors from Z and cosines of the angles between the coordinate axes which are equal to the elements of the correlation matrix R. Since discriminative analysis can be interpreted as a special case of component analysis with the principal components transformed, by some permissible singular transformation, in the way to maximize the distance between the centroids of subsets E_p, that is, canonical cor-

relation ρ_k (Cooley and Lohnes, 1971; Hadžigalić, 1984; Momirović and Dobrić, 1984), it is customary that the identification of the content of discriminative functions is based on the structural vectors f_k from the matrix

$$F = Z^tK = RW = R^{1/2}X = (f_k) = (Rw_k),$$

which is analogue to the identification of the content of canonical variables obtained by Hotelling's method of biorthogonal canonical correlation analysis, because the simple calculation can show that F factor matrix is matrix R (Zorić and Momirović, 1996; Momirović, 1997).

In this metrics, the cross-structure of discriminative functions will be

$$U = Z^tL\rho^{-1} = Z^tPZW\rho^{-1} = W\rho$$

since, naturally, $W^tZ^tPZW = \rho^2$, it is clear that the U factor matrix of matrix Z^tPZ, or the matrix of intergroup covariances determined in the space of the standard I metrics.

Since the elements f_{jk} of matrix F and elements u_{jk} of matrix U act as normal product-moment correlation coefficients, and since they are the function of normally distributed variables, and therefore are themselves asymptotically normally distributed, their asymptotic variables, of course, are

$$\sigma_{jk}^2 \sim (1 - \Phi_{jk}^2)^2 n^{-1}$$

$$j = 1,..., m; k = 1,..., s$$

respectively

$$\xi_{jk}^2 \sim (1 - \upsilon_{jk}^2)^2 n^{-1}$$

$$j = 1,..., m; k = 1,..., s$$

and they could be applied in testing the hypothesis of type H_{jk}: $f_{jk} = \Phi_{jk}$, respectively H_{jk}: $u_{jk} = \upsilon jk$, where Φjk and υ_{jk} are some hypothetic correlations between the variables from V and discriminative functions in population P because the asymptotic distribution of coefficients f_{jk} is

$$f(f_{jk}) \sim N(\Phi_{jk}, \sigma_{jk}^2),$$

and asymptotic distribution of coefficients u_{jk} is

$$f(u_{jk}) \sim N(\upsilon_{jk}, \xi_{jk}^2),$$

where *N* is a mark for normal distribution.

Reliability, informativeness and significance of discriminative functions

Let

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

be a diagonal matrix whose elements of the estimation of unique variances of variables from V. Now, as shown by Momirović and Zorić (1996), reliability or more precisely, generalizability of discriminative functions could be estimated on the basis of values of diagonal elements of the matrix

$$\alpha = (\text{diag } (W^t(R - V^2)W))(\text{diag } (W^tRW))^{-1},$$

relative informativeness based on the elements of a diagonal matrix is

$$\iota^2 = (I - \alpha)^{-1}m^{-1}$$

and amount of these functions according to the elements of the diagonal matrix

$$\zeta = \iota^2\rho.$$

Reasonably, for making judgements about what the real significance of discriminative functions is, these data can be of much greater importance than the results of the tests for evaluation of significance of canonical correlation.

3. Results and discussion

The results of the discriminant analysis in a conative space are presented in (Table 1) and if it is carefully analyzed it can be concluded that one significant canonical correlation has been obtained (.32), which explains a hundred valid variances of the whole system of the estimated space.

The discriminative function is defined by the tests for estimating the efficiency of the system for homeostatic regulation and it is determined by the activity regulation of the functionally and hierarchically different subsystems, especially coordination of conative regulatory systems and intellectual processors. Therefore, the system for homeostatic regulation is functionally superior to the systems for regulation of organic functions, defensive and offensive reactions and it also controls the processes within the system for excitation and inhibition regulation.

The second test which determines this function is a test for estimating the mechanism for regulation and control of organic functions. It is necessarily de-

fined by the efficiency of the coupling between subcortical regulatory functions of organic systems and, superior to them, cortical systems for regulation and control.

The next test, which defines the already stated function, is responsible for the mechanism for integration of regulatory functions and it integrates the conative regulatory processes in the form of the structure of social domain and its modifications. The set of programs which determine its functioning is mostly formed during the educational process. Social disadaptation is a direct consequence of disorders of this mechanism.[4]

Somewhat lower are the projections on the first function determined by the tests for estimating the mechanism for regulation and control of offensive reactions, probably on the basis of appropriate modulation of tonic arousal, adequacy of the programs transmitted by a genetic code or formed under the influence of conditioning and located in the center for regulation of offensive reactions.

Finally, still very significant in defining this function is the test for estimating the mechanism for regulation and control of defensive reactions, which is determined by the appropriate modulation of tonic arousal, probably based on the adequacy of the programs that are of genetic origin or formed during the evolution and located in the center for regulation of defensive reactions.

The test for estimating the mechanism for activity regulation, which is one of the elementary and lowest located systems in the hierarchy, has the lowest projection on the function. Its function is regulation and modulation of the activation function of the reticular formation, so it is directly responsible for activity and energy level on which other subsystems, including cognitive processes, function.

According to the size and sign of function the centroid for discriminative function, the following could be concluded: Dancers are able to adequately model the tonic arousal based on the programs transmitted by the genetic code or formed under the influence of learning, which are located in the center for regulation of offensive reactions. They are capable of coordinating functionally and hierarchically different subsystems, both cognitive and conative. Then, they are able to make, effectively, the coupling between subcortical regulatory functions of organic systems and cortical systems, which provide their regulation and control.

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

DISCRIMINANT ANALYSIS OF TESTS FOR CONATIVE CHARACTERISTSCS

Table 1.

Fen	1*
Eig. val.	.1785
Pet of Vari.	100.00
Cum. Pet.	100.00
Can. Cor.	.32
Wilks' Lambda	.84
Chi.	41.56
DF	4
Sig.	.00

** FUNCTION FUNC 1*

Table 2.

DEL	.70
HI	.38
ETA	.34
SIG	.32
ALF	.18
EPS	-.10

CENTROIDS OF GROUPS

Table 3.

GROUPS	FUNC1
FEMALE DANCERS 1	-.41
MALE DANCERS 2	.42

4. Conclusion

The research was conducted in order to determine the differences in the structure of personality characteristics of dancers involved in Standard and Latin American dances.

For estimating the differences in the structure of personality characteristics of male and female dancers, 267 dancers were involved, aged from 11 to 13, actively performing Standard and Latin American dances.

For estimating personality dimensions, measuring instruments were selected so as to cover dimensions of the model of functioning of mechanism for conative regulatory functioning. The model involves a hierarchical organization of the mechanisms for regulation and control of the behavior modalities, and is constructed so that the artificial dichotomy to normal and pathological conative factors could be avoided.

The selected measuring instruments are:

1) Activity regulator (EPSILON)
2) Regulator of organic functions (HI)
3) Regulator of defensive reactions (ALFA)
4) Regulator of offensive reactions (SIGMA)
5) System for coordination of regulative functions (DELTA)
6) System for integration of regulative functions (ETA)

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programs developed by Popović, D. (1980, 1993) i Momirović, K. and Popović, D. (2003).

By transformation and condensation of variables in the space of conative characteristics, there was isolated only one discriminative function, which maximally separates groups of athletes on the basis of discriminative coefficients. According to the size and sign of the projection of centroids on the first discriminative function, it could be concluded that dancers have the capability for appropriate modelling of tonic arousal, on the basis of the programs transmitted by the genetic code or formed under the effect of learning, which are also located in the center for regulation of offensive reactions. They are able to coordinate functionally and hierarchically different systems, both cognitive and conative. Furthermore, they are able to effectively make the coupling between subcortical regulatory functions of organic systems and cortical systems which carry out their regulation and control.

5. References

[1.] Boli, E.: (2000)) Differences in the level of musical, cognitive abilities and personality characteristics of male and female dancers before and after the period of dancing competition (PhD thesis) Leposavić: The University of Priština, Faculty of Physical Education.

[2.] Boli, E., Popović, D., Stanković, V. & Grigoropulos, P.: (2001) [Differences in the level of conative characteristics among male and female dancers involved in standard and Latin American dances], Petrovac: 9th Summer School for Pedagogues of Physical Education of Montenegro, Physical Education.

[3.] Boli, E., Popović, D., A. Hošek.: (2009) Sports and Crime, (Scientific Monograph), Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sports and Physical Education.

[4.] Boli, E.: (2011) The Structure of Anthropological Dimensions of Male and Female Dancers and Development of Procedures for Their Evaluation and Monitoring, (Scientific monograph), Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sports and Physical Education.

[5.] Momirović, D, Wolf, B. i Popović, D: (1999) Introduction to the theory measurement and internal metric characteristics of composite measuring instruments (textbook), Priština: The University of Priština, Faculty of Physical Education.

[6.] Momirović, K i Popović, D.: (2003) Construction and application of taxonomic neuronal matrices (monograph), Leposavić: The University of Priština, Faculty of Physical Education.

[7.] Momirović, K, A. Hošek i Popović, D.: (2007) Sexual Dimorphism (monograph), Leposavić: The University of Priština, Faculty of Physical Education.

[8.] Popović, D.: (1991) Methodology of research in physical education (textbook), Niš: The University of Niš, Scientific Youth.

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

[10.] 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.

[11.] Popović, D.: (1993) Establishing the structures of psychosomatic dimensions in fights and development of procedures for their application and monitoring (monograph), Priština: The University of Priština, Faculty of Physical Education.

[12.] Popović, D., Stanković, V. & Grigoropulos, P.: (1998) Discriminative analysis of motor skills and morphological characteristics of promising basketball and handball players, Physical Education, 19(2), 31-35.

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Algorithm and program for determining the differences in the level of personality characteristics of male and female dancers in Mahalanobis' space

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Summary

The research was conducted in order to determine the differences in the structure of personality characteristics of dancers performing standard and Latin American dances. For estimating those differences, 267 dancers aged from 11 to 13, were involved. For estimating personality dimensions, measuring instruments were selected so as to cover the dimensions of the model of the functioning of conative regulatory mechanisms. The model assumes the organization of the mechanisms for regulation and control of behaviour models, and is constructed so that the artificial dichotomy to normal and pathological conative factors could be avoided. The selected measuring instruments are: the activity regulator (EPSILON), the regulator of organic functions (HI), the regulator of defensive reactions

(ALFA), the regulator of offensive reactions (SIGMA), the system for coordination of regulatory functions (DELTA), the system for integration of regulatory functions (ETA). All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. By transformation and condensation of variables in the space of conative characteristics, there was isolated only one discriminative function, which maximally separates groups of athletes and is based on discriminative coefficients. On the basis of size and sign of the projection of centroids on the first discriminative function, it could be concluded that dancers have the capability for appropriate modelling tone arousal, according to the programs transmitted by the genetic code or formed under the effect of learning, which are located in the center for regulation of offensive reactions. They are able to coordinate functionally and hierarchically different systems, both cognitive and conative. Furthermore, they are able to effectively make the coupling between subcortical regulatory functions of organic systems and cortical systems which carry out their regulation and control.

Key words: /capability/subcortical/hierarchy/multidiscipline research/mechanism/

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The structure of dancers' motor skills

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1. Introduction

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

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

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

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

2. The methods

2. 1. The sample of examinees

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

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

On the basis of the selected statistical-mathematical model and the aim of the research, the sample of examinees includes 267 dancers, aged from 11 to13, actively involved in standard and Latin American dances in Serbian dancing clubs.

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

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

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

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

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

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

2. 2. The sample of variables

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

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

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

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

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

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

4) coordination with a bat (MKOOP)
5) hand and foot drumming (MBNIR)

b) the mechanism for functional synergy and tonus regulation (SRT)
1) deep forward bend (MDPK)
2) transverse standing on a beam (MPSG)
3) flex by bat (MISP)
4) darts (MPIK)
5) horizontal target shooting (MGHC)

c) the mechanism for excitation intensity regulation (RIE)
1) long jump from place (MSDM)
2) 20m running high start (M20VS)
3) throwing a medicine ball from a supine position (MBMIL)
4) high jump from place (MSVIS)
5) hand dynamometry (MDŠAK)

d) the mechanism for excitation duration regulation (RTE)
1) flexed-arm-hang for endurance (MIZG)
2) pull-ups by grasping a bar (MZGP)
3) a 60-second trunk lift (MPTR)
4) leg lifting from a supine position (MDNL)
5) seated leg lift for endurance (MINP)

2. 3. Methods for data processing

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

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

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

Therefore, the aim of this research is to propose three measures for lower limits of reliability of latent dimensions, obtained by semiorthogonal transformations of the principal components. All those measures are derived within the classical model of variance decomposition of some quantitative variables; the measures, derived from some other models in the theory of measurement, will be proposed in some of the further works. The first is the evaluation measure of the absolute lower limit of reliability, and its logic basis is the same as the logic basis of Guttman's measure λ_1.The second measure is the evaluation of the lower limit of reliability of latent dimensions on the basis of evaluation of the lower limit of reliability of variables with the same field of meaning; and its logic basis is identical to the logic basis of Guttman's measure λ_6. The third measure is determined on the assumption that the reliability coefficients of variables, which are the subject of the analysis, are known; therefore, it depends on the value of the processes by which the coefficients are calculated or estimated.

SEMIORTHOGONAL TRANSFORMATION OF THE PRINCIPAL COMPONENTS

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

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

Let

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

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

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

Define the scalar k so 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 according to PB criterion of Štalec and Momirović (Štalec and Momirović, 1971).

Let $\Lambda = (\lambda_p)$; p = 1,...,k be a diagonal matrix of the first k eigenvalues of the matrix R and let $X = (x_p)$; p = 1,...,k be a matrix of the associated eigenvectors scaled so that $X^tX = I$. Let T be some orthonormal matrix, such that it can optimize the function

$$XT = Q = (q_p); p (Q) = \text{extremum}, T^tT = I,$$

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

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

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

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

$$K = ZX,$$

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

$$L = KT = ZXT.$$

The covariance matrix of those dimensions is

$$C = L^tLn^{-1} = Q^tRQ = T^t\Lambda T;$$

Denote the matrix of their covariances as

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

If the latent dimensions are standardized by the operation

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

in the matrix

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

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

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

$$F = Z^tDn^{-1} = RXTS^{-1} = X\Lambda TS^{-1};$$

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

$$A = FM^{-1} = XTS.$$

But since

$$A^tA = S^2$$

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

ESTIMATES OF THE RELIABILITY OF LATENT DIMENSIONS

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

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

$$Y = Z - G.$$

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

$$Y^tG = 0$$

and

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

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

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

if

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

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

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

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

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

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

with the covariance matrix

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

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

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

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

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

$$p = 1,...,k$$

Proposition 1.

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

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

Proof:

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

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

$$\beta_p = 1 - (q_p{}^t U^2 q_p)(q_p{}^t R q_p)^{-1}$$

$$p = 1,...,k$$

which are derived from the procedure identical to the one by which the coefficients γ_p with the definition $E^2 = U^2$, were derived, that is, in the same way as Guttman derived his measure λ_6.

Proposition 2.

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

Proof:

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

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

in the same way as Guttman derived his measure λ_1. For this purpose, set $E^2 = I$. Then

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

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

Proposition 3.

All the coefficients α_p are always less than 1.

Proof:

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

The measures of type β_6 (Momirović, 1996) that are determined by the functions α_1 i α_2 will be, for the result defined by the function h,

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

and

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

It is not difficult to demonstrate that, for the regular sets of particles, measures of type α_1 the estimates of the lower limit of reliability of the measures of type λ_6 and β_6, and the measures of type α_2 are the estimates of the upper limit of the measures of type λ_6 and β_6.

3. Results and discussion

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

The intercorrelation matrix has been taken as a starting matrix for the extraction of latent variables by the method of the principal components, while their number has been determined according to Momirović's β_6 criterion. The preference for this method of the principal components has been determined particularly by the entropy that emits the total amount of information. Maximal entropy will emit the part of the system that is connected with the characteristic roots which are equal to or bigger than the requirements of β_6. The principal components present such system of linear combinations of variables within which each subsequent factor draws the maximum possible part of the variability of the system. According to Momirović's β_6 criterion, four characteristic roots have been declared significant and, based on this, the manifested space of motor abilities is reduced to the same number of latent dimensions.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

THE MATRIX OF THE PRINCIPAL COMPONENTS OF MOTOR VARIABLES OF DANCERS

Table 1.

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

THE PATTERN MATRIX OF MOTOR VARIABLES OF DANCERS

Table 2.

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

THE STRUCTURE MATRIX OF MOTOR VARIABLES OF DANCERS

Table 3.

Variable	OBL1	OBL2	OBL3	OBL4
MONT	-.80	.06	.61	-.25
MTAR	.78	.41	-.24	.36

Table continued on next page...

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

THE INTERCORRELATION MATRIX OF OBLIMIN FACTORS

Table 4.

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

4. Conclusion

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

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

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

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

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

5. References

[1.] Boli, E.: (1996) The structure of intellectual and musical abilities and personality traits of girls involved in standard and Latin American dance, Master thesis, Priština: University of Priština, Faculty of Physical Education.

[2.] Boli, E., Popović, D., A. Hošek.: (2009) Sport and crime, Leposavić: University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[3.] Boli, E.: (2011) The structure of anthropological dimensions of male and female dancers and developing procedures for their evaluation and monitoring. (Monograph), Leposavić: University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[4.] Momirović, D, Wolf, B. and Popović, D: (1999) The introduction to the theory of measurement and internal metric properties of composite measuring instruments (textbook), Priština: University of Priština, Faculty of Physical Education.

[5.] 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.

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

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

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

[9.] Popović, D.: (1988) Application methods of factorial analysis for determining morphological types, Varna: 4th international symposium on the methodology of mathematical modelling, Bulgaria.

[10.] Popović, D.: (1991) Research methodology in Physical Education (textbook), Niš: University of Niš, Scientific Youth.

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

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

[13.] Popović, D.: (1993) Determination of the structure of psychosomatic dimensions in fights and developing procedures for their evaluation and monitoring (monograph), Priština: University of Priština, Faculty of Physical Education.

[14.] Stanković, V. & Popović, D. (2009). The results of various factor procedures for establishing the cognitive abilities of handball players, Banja Luka: I International scientific congress "Anthropological aspects of sport, physical education and recreation", pp. 209-213, Bosnia and Herzegovina.

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The structure of dancers' motor skills

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Summary

The research was conducted in order to determine the structure of motor abilities of dancers performing standard and Latin American dance. For estimating motor abilities, 267 dancers, aged from 11 to13, participated. Twenty motor tests for the evaluation of the motor abilities were used, selected according to the structural model of Gredelj, Metikosh, Hoshekov and Momirović of 1975, defined as the mechanisms for movement structuring, for synergy and tonus regulation, and mechanism for the regulation of intensity and excitation duration. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, The University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. The analysis of factor structure of motor dimensions indicates that four factors were obtained: the first factor is responsible for movement structuring, the second for the regulation of excitation

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

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

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Differences in the level of musical abilities of male and female dancers

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1. Introduction

Students of sport and physical education need to be introduced to the basic elements of music because they have both educational and incentive role. The culture of movement accompanied by music has a beneficial effect on the body, thoughts and spirit. The connection between the auditory and the visual in the form of movement is necessary for teaching dance, rhythmic gymnastics, sports gymnastics, synchronized swimming and so on.

Music is the art which uses tones as means of its expression. It extends to our conscience, with the help of sense of hearing. Therefore, it may be concluded that music is apprehended by listening. In music, enjoying property is estimated according to the nature of the feeling it produces. To feel and to understand are not the synonyms. A person should feel in order to understand.

Above all, each individual has to feel his or her body in order to perform a beautiful movment, and each movement is beautiful if it is musically performed.

The human body should be conceived as the most perfect musical instrument. Music is the art of permanent motion, since it is composed of tones which are themselves undulation, motion. For this reason it is capable of making us move. Music drives us to the dance. We can, for instance, march to the sounds of music cheerfully, vigorously. Besides its force to make us dance or march, music has the greatest ability of all arts to evoke various feelings and moods. While listening to music, we are capable of sensing grief and pain, sadness or happiness, we cry or laugh, being full of sorrow or vigor.

Music is capable of imitating the movements in nature by its artistic means. A composer may, with the help of musical tones, present water gurgling, storm, wind, drizzling, forest murmur, buzzing of bees, ringing of bells etc. This is not music, but if it is expressed in musical tones, it gets the full artistic value.

In order to mark as accurately as possible a special character of some composition as a whole or its part, many diverse expressions are applied. Those expressions could be utilized either independently or combined with a tempo mark, and are indicated at the beginning of a composition or even in its further course (excitedly, restlessly, gracefully, tenderly, enthusiastically, passionately, brightly, facetiously, quietly, melodiously, affectionately, warmly, firmly, distinctly, painfully, expressively, wildly, solemnly, proudly, sadly, relaxed, grandly, nobly, heavily, willingly, freely, rapidly, simply, emotionally, cheerfully, in a flying manner, noisily, gently, extinguished, awakened, tempestuously, piously etc.

2. The methods of research

2. 1. The sample of examinees

The sample of examinees is conditioned by the financial capabilities which are necessary for conducting the research procedure. Nevertheless, the sample depends on the number of qualified and trained measurers, on the instruments and standardized conditions under which the planned research should be realized.

In order to conduct the research correctly and to provide sufficiently stable results, in the terms of the sampling error, it is required to hire a satisfactory number of examinees for the sample. Most of the samples for this type of research

should be conditioned by the aims and tasks of the research, as well by the size of population and the degree of variability of the applied system of parameters.[7]

According to the selected statistical-mathematical model and the aim of research, the sample of examinees includes 131 female dancers and 136 male dancers, aged from 11 to 13, that are actively involved in standard and Latin American dances in the Serbian dancing clubs.

The size of the so determined sample should satisfy the following criteria:

- The effectives of the sample should be planned so that it allows as many degrees of freedom as necessary for any coefficient in the pattern or correlation matrix, which is equal to or bigger than 0.22, to be considered as different from zero with an inference error less than 0.01.
- In order to successfully apply the adequate statistical methods based on the most recent convictions, the number of subjects in the sample must be five times larger than the number of the applied variables.

During all the factor procedures, it should always be kept in mind that the results of the analysis depend on three major systems that determine the selection and transformation of information: the sample of variables, the sample of examinees and the selected extraction, or rotation, method.[8]

2. 2. The sample of variables

The evaluation of musical abilities has been accomplished on the basis of the well-known Seashore test battery that estimates musicality. This test lasts for 30 minutes and it consists of 6 groups of tasks that are listened to from an audiotape, and the answers are noted on the prepared answer sheets for that purpose. Auditory is provided by the regular schedule of the sound system and the volume so that all the examinees could be put under the same experimental conditions.

This test estimates the following dimensions:

- Pitch discrimination test: it consists of five columns, and each column contains ten tasks. For each task two tones are played. The examinee is

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

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

to determine whether the second tone was higher or lower than the first one.

- Tone intensity discrimination: it consists of five columns. Each column contains ten tasks. For each task two tones are played. The examinee is to determine whether the second tone was louder or quieter than the first one.
- Rhythm recognition test: it consists of three columns. Each column contains ten tasks. For each task two rhythmical structures are played. The examinee is to determine whether the second rhythmical structure was the same or different from the first one.
- Tone duration discrimination test: it consists of five columns. Each column contains ten tasks. For each task two tones with different duration are played. The examinee is to determine whether the second tone was longer or shorter than the first one.
- Timbre discrimination test: it consists of five columns, and each column contains ten tasks. For each task two tones are played. The examinee is to determine whether the second tone was the same or different from the first one.
- Tonal memory test: it consists of three columns. Each column contains ten tasks. On the column A for each task two melodies are played three times. On the column B two melodies of four tones are played, and on the column C two melodies of five tones are played. The examinee is to determine for each task in which tone the second played melody differs from the first one. For the column A: the first, second or third tone, for the column B: the first, second, third or fourth tone and for the column C: the first, second, third, fourth or fifth tone.

The evaluation is carried out so that each correct answer for each task in all the tests is worth one point. The total sum of points scored in particular tasks of each test separately, constitutes the result. The result expressed in points should be converted to percentages. The female examinees, according to the number of points obtained on particular tests, depending on their age, are classified in certain classes from "A" to "E".

2. 3. The methods for data processing

In the discussion on the results of an empirical research (Vučić, Vukmirović, Vukmirović i Radojičić, 1997), presented at the tenth meeting of the Section for

classifications of the Union of Statistical society of Yugoslavia, PhD Boris Wolf warned that the results obtained by the canonical discriminant analysis were absurd, because despite the canonical correlations of 0.99 and 0.85 the structural vectors of both discriminant functions were practically the null vectors. It took only a few minutes to determine that it was due to the fact that the analysis was performed by the program Discriminant... from the program package SPSS which explicitly defines the structure of discriminant factors as a matrix of cross-correlations between the variables, from which the effects of belonging to a group, that were the subject of the analysis and discriminant functions defined according to the standard formulation of canonical discriminant problem, were partialized. Since such an implementation of canonical discriminant analysis is typical of many, but, fortunately, not all the statistical program packages or systems, in this study, after the reformulation of canonical discriminant analysis, derived under the model of canonical correlation analysis, it was demonstrated that the implementation of the standard definition of a discriminant model had caused, in some marginal cases, insuperable numerical difficulties, and that the definition of the structure of canonical factors, which followed from the standard discriminant model, was completely absurd, because the components of the variables, according to which the discriminant functions were formed, had no influence on the structure of the so determined discriminant factors. This is the reason for applying the algorithm and program for canonical discriminant analysis from the program system SAS.

DEFINITIONS

Let

$$E = \{e_i;\ i = 1,..., n\} \subseteq P = U_p^g P_p \mid P_p \cap P_q = O,\ p \neq q$$

be a random sample from some heterogeneous population of objects that consists of g subpopulations P_p and let

$$W = \{w_p;\ p = 1,..., g\}$$

be a nominal variable whose categories w_p define the obligatory and unique properties of the objects from the subpopulations P_p.

Let

$$V = \{v_j;\ j = 1,..., m\} \subseteq U$$

be a set of qualitative and quantitative variables that are multivariately normally distributed in each subpopulation P_p from P selected so that they represent a universe of variables U defined by some consistent and operationalizable theory about the behaviour of the objects from P.

Let $e = (e_i)$, $i = 1,...,n$: $e_i = 1 \; \forall \; e_i$ be a summing vector of rank n. Let

$$Z = E \otimes V \mid Z^t e = 0, \; \text{diag}\,(Z^t Z) = I$$

be a data matrix in the standard normal metrics obtained by the description of the set E on the set V, and let

$$S = (s_{ip}) = E \otimes W$$

be the indicatory matrix whose elements s_{ip}, $i = 1,...,n$; $p = 1,..., g$ are defined by the function

$$\{s_{ip} = 1 \mid e_i \in w_p, \; s_{ip} = 0 \mid e_i \notin w_p\}.$$

Let

$$R = Z^t Z$$

be the matrix by which, based on the maximum likelihood criterion, the intercorrelations of variables from V are evaluated; assume that matrix is nonsingular and mark the regular inverse of that the matrix with R^{-1}.

Let

$$P = S(S^t S)^{-1} S^t$$

be a projector into the hypercube defined by the vectors s_p from S, and let

$$Q = I - P$$

be a projector into the hypercube that is orthogonal to the hypercube defined by the vectors s_p from S because, certainly, $PQ = 0$.

Let

$$G = PZ$$

be a matrix obtained by the projection of the vectors z_j from Z into the hypercube defined by the vectors s_p from S, and let

$$H = QZ = Z - PZ$$

be a matrix obtained by the projection of the vectors z_j from Z into the hypercube that is orthogonal to the hypercube defined by the vectors s_p from S.

The covariance matrix of the variables from G will be

$$A = G^t G = Z^t P Z;$$

we find that the matrix A is, concurrently, the cross co-variance matrix of the variables from Z and G.

The covariance matrix of the variables from H will be

$$W = H^tH = Z^tQZ = R - A;$$

It's evident that the matrix W, is concurrently, the cross-covariance matrix of the variables from Z and H, and the intercorrelation matrix of the variables from Z may be decomposed so that

$$R = A + W.$$

Let

$$\Lambda = (\lambda_j) = \text{diag } W$$

and let

$$H^2 = (\eta_j^2) = \text{diag } A = I - \Lambda.$$

It could be easily shown (Guttman, 1988; Momirović, 1989; Momirović and Zorić, 1996) that, in this metrics, the elements λ_j of the matrix Λ are actually Wilks' measures of the relative intragroup dispersion and therefore the elements η_j^2 of the matrix H^2 are the squares of Fisher's intergroup correlation coefficients, so it is possible to reformulate Rao's (Rao, 1948; 1975) method of canonical discriminant analysis in the manner that makes the sense of the discriminant factors and structural matrices of the discriminant factors usually applied to indentify the content of those functions much clearer.[9]

RAO'S METHOD OF CANONICAL DISCRIMINANT ANALYSIS

The method known as canonical discriminant analysis (Rao, 1948; 1952; 1968; 1973; Rao and Slater, 1949) may be defined in a many different, but basically equivalent ways (Anderson, 1966; Anderson, 1984; Bryan, 1951; 1975; Cooley and Lohnes, 1971; Glahn, 1968; Hadžigalić, 1984; Hadžigalić, Bogdanović, Tenjović and Wolf, 1994; Ivanović, 1963; 1977; Kendall and Stuart, 1976; Kovačić, 1994; Momirović, Gredelj and Szirovicza, 1977; Momirović and Dobrić, 1984; Momirović, Knežević, Kuzeljević and Radović, 1994; Momirović and Zorić, 1996; Mulaik, 1972; Romeder, 1973). Although, it is most frequently deduced as a generalisation of multivariate analysis of variance (Rao, 1948; 1952; 1968; 1973; Rao and Slater, 1949; Anderson, 1966; Anderson, 1984; Bryan, 1951; 1975; Cooley and Lohnes, 1971; Kendall and Stuart, 1976; Kovačić, 1994; Momirović, Gredelj and Szirovicza, 1977; Romeder, 1973), yet it is treated or di-

9 This will be performed in the manner similar but not identical to the one proposed in the works of Hadzigalić (1984), Momirović and V. Dobrić (1984) and Momirović and Zorić (1996). The modification of their deductions was made so that the level of absurdity of some implementations of canonical discriminant analysis in commercial statistical program products be clearer, as well as the dangers to which those who blindly apply the program products are exposed.

rectly performed as a special case of canonical correlation analysis (Glahn, 1968; Anderson, 1984; Hadžigalić, Bogdanović, Tenjović and Wolf, 1994; Momirović, Knežević, Kuzeljević and Radović, 1994; Momirović and Zorić, 1996) or as a special case of a component model of factor analysis (Mulaik, 1972; Hadžigalić, 1984; Momirović and Dobrić, 1984); in a special case when g = 2, famous as Fisher's case, it may be derived as a special case of regression analysis.

Although, under some conditions, all those manners are equivalent for the evaluation of canonical correlation coefficients, this is not so for the definition of discriminant functions and identification structures associated with those functions; and since the deduction which is based on the generalization of the variance analysis assumes that the condition the covariance matrices of variables in subpopulations, which should be discriminated, are identical, is also fulfilled, what is rather an exception than the rule, here will be proposed a reformulation of canonical discriminant analysis that treats the method as a special case of Hotelling's model of biorthogonal canonical correlation analysis (Hotelling, 1936) which follows the main lines of the reformulation of the method suggested by Momirović and Zorić (1996).[10]

Let B be an unknown matrix of order (g, m) such that

$$SB = Z - E \mid \varepsilon^2 = \text{trag}\,(E^tE) = \text{minimum}.$$

Naturally, it is a special case of the multivariate regression problem, so the solution is easily obtained by differentiating the function

$$f(B) = \text{trag}\,((Z - SB)^t(Z - SB))$$
$$= \text{trag}\,(R) - \text{trag}\,(B^tS^tZ) - \text{trag}\,(Z^tSB) + \text{trag}\,(B^tS^tSB)$$

by the elements of B matrix.

Since trag (B^tS^tZ) = trag (Z^tSB) i trag (R) = m,

$$\partial f(B) / \partial B = - 2S^tZ + 2S^tSB,$$

and after dividing by 2 and reducing to zero,

$$S^tSB = S^tZ;$$

and since, certainly, S^tS is a regular diagonal matrix,

$$B = (S^tS)^{-1}\, S^tZ$$

so that it is obvious that the elements of the matrix

$$G = PZ = SB = (g_{ij})$$

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10 Basically similar but formally different reformulation of canonical discriminant analysis defined in way that it is not immediately clear that this is about the method suggested by Anderson (1984).

$$i = 1,...,n;\ j = 1,...,m,$$

$$g_{ij} = (s_p{}^t s)^{-1} s_p{}^t z_j \mid e_i \in w_p$$

$$i = 1,...,n;\ j = 1,...,m,$$

are therefore the arithmetic mean of normalized and standardized variables in the subsamples that the objects from E belong to.

That is why the canonical discriminant analysis may be defined as a solution of the canonical problem

$$Zx_k = k_k,\ Gy_k = l_k \mid \rho_k = k_k{}^t l_k = \text{maximum},\ k_k{}^t k_k = l_k{}^t l_k = \delta_{kq},\ k_k{}^t l_q = 0 \mid k \neq q$$

$$k = 1,...,s;\ s = \min((g - 1), m)$$

where δ_{kq} is Kroneker's symbol and x_k and y_k are unknown m - dimensional vectors.

Since $\rho_k = x_k{}^t A y_k$, $k_k{}^t k_k = x_k{}^t R x_k$ and $l_k{}^t l_k = y_k{}^t A y_k$, for k = 1 the function to be maximized is

$$f(x_k, y_k, \lambda_k, \eta_k) = x_k{}^t A y_k - 2^{-1}\lambda_k(x_k{}^t R x_k - 1) - 2^{-1}\eta_k(y_k{}^t A y_k - 1).$$

By differentiating this function by the elements of x_k vector

$$\partial f / \partial x_k = A y_k - \lambda_k R x_k,$$

and by differentiating by the elements of the vector y_k

$$\partial f / \partial y_k = A x_k - \lambda_k A y_k.$$

After equalling to zero

$$A y_k = \lambda_k R x_k$$

and

$$A x_k = \lambda_k A y_k.$$

By differentiating by λ_k and η_k it is easy to obtain, from the condition $x_k{}^t R x_k = 1$ and $y_k{}^t A y_k = 1$, that $\lambda_k = \eta_k$. By multiplying the first result by R^{-1}

$$x_k \lambda_k = R^{-1} A y_k$$

then

$$x_k = R^{-1} A y_k \lambda_k{}^{-1}.$$

According to the second result

$$A x_k \lambda_k{}^{-1} = A y_k$$

so that

$$y_k = x_k \lambda_k^{-1}.$$

Therefore,

$$R^{-1}Ax_k\lambda_k^{-1} = x_k\lambda_k;$$

so by multiplying this result by λ_k

$$R^{-1}Ax_k = x_k\lambda_k^2,$$

is obtained so that the problem is reduced to solving the general problem of eigenvalues

$$(R^{-1}A - \lambda_k I)x_k = 0,$$

$$k = 1,..., s$$

respectively

$$(A - \lambda_k R)x_k = 0$$

$$k = 1,..., s$$

and

$$\rho_k = x_k^t Ay_k = x_k^t Ax_k\lambda_k^{-1} = \lambda_k,$$

$$k = 1,..., s$$

are canonical correlations between the linear combinations of the variables from Z and G which are proportional to the differentiation of the centroids of the subsamples defined by the selection matrix S in the space stretched by the vectors from the variables from Z.

Like all the other statistical methods that are special cases of canonical correlation analysis, canonical discriminant analysis is invariant to any nonsingular transformation of the variables, therefore it is also metrically invariant.

Let H be any nonsingular matrix of order (m), let

$$Z_h = ZH$$

and let

$$G_h = PZ_h.$$

Then

$$R_h = Z_h^t Z_h = H^t RH,$$

$$A_h = G_h^t G_h = Z_h^t G_h = H^t AH,$$

and, since the matrices $R^{-1}A$ and $H^{-1}R^{-1}AH$ are similar, the problem is reduced to solving the characteristic equation

$$(H^{-1}R^{-1}AH - \lambda_k I)H^{-1}x_k = 0$$

so it is evident that the discriminant functions k_k and canonical correlations ρ_k are really invariant to the metrics of the variables from V.

Let $\rho = (\rho_k)$, k = 1,..., s be a diagonal matrix whose elements are canonical correlations, let $X = (x_k)$ and $Y = (y_k) = X\rho^{-1}$, k = 1,..., s be matrices of eigenvectors obtained by solving the canonical discriminant problem. Let

$$K = ZX$$

be a matrix of discriminant functions and let

$$L = GY = PZX\rho^{-1}$$

be a matrix of discriminant functions projected into a hypercube defined by the vectors of S matrix set to 1 after that projection. Obviously,

$$K^tL = X^tAX\rho^{-1} = X^tAY = \rho$$

since, of course, $K^tK = I$ and $L^tL = I$, are canonical discriminant analysis that produces two biorthogonal sets of vectors of the variables by such a transformation of the vectors of the variables from Z and G that it 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 between the noncorresponding vectors from K and L are equal to zero.

However, that transformation maximizes, simultaneously, Euklidean distances between the centroids of the subsamples Ep from the sample E determined by the values on the nominal variable W on the discriminant functions from K. Let

$$M = (S^tS)^{-1}S^tK = BZX = (\mu_{pk})$$

$$p = 1,..., g; k = 1,..., s$$

be a matrix of the centroid of the subsample E_p on the discriminant functions, and let e_g be a summing vector of order g. Since $Z^te = 0$, then also $M^te_g = 0$, so the diagonal elements of the matrix

$$D^2 = \text{diag}\,(M^tM) = \text{diag}\,(X^tZ^tS(S^tS)^{-2}S^tZX)$$

are equal to the sum of the squares of the Euklidean distances between the elements μ_p of the vector μ_k from M. Let

$$\Omega = (S^tS)^{1/2}M = (\omega_{pk}) = (n_p{}^{1/2}\mu_{pk})$$

$$p = 1,..., g; k = 1,..., s;$$

obviously,

$$\Omega^t\Omega = X^tZ^tS(S^tS)^{-1}S^tZX = X^tAX = \rho^2,$$

and since $\rho_k^2 = \text{maximum } \forall\rho_k^2$, $k = 1,..., s \mid x_k^tRx_q = y_k^tAy_q = \delta_{kq}$, the maximization of the coefficients of correlation between the canonical variables from K and L which is equivalent to the maximization of the distances between the centroids of the subsample E_p on the discriminant functions.

Vectors x_k from X are, evidently, vectors of standardized partial regression coefficients of the variables from Z which generate the discriminant functions k_k that together with the discriminant functions l_k, formed by the vectors of the standardized partial regression coefficients $y_k = x_k\rho_k^{-1}$ from the variables from G, have the maximal correlations. Therefore the vectors x_k are proportional to the coordinates of the vectors of the discriminant functions in the oblique coordinate system that is composed of the vectors from Z with the cosines of the angles between the coordinate axes which are equal to the elements of the correlation matrix R. Hence the interpretation of the discriminant functions based on the set of those vectors is very complicated if the number of the variables from V is large enough to make the set V a satisfactorily representative sample from the set U.[11] Since the discriminant analysis may be interpreted as a special case of component analysis with the principal components transformed, by a permissible singular transformation, to maximize the distances between the centroids of the subsamples E_p, that is canonical correlations ρ_k (Cooley and Lohnes, 1971; Mulaik, 1972; Hadžigalić, 1984; Momirović and Dobrić, 1984; Hadžigalić, Bogdanović, Tenjović and Wolf, 1994), Cooley and Lohnes were, probably the first to suggest that the identification of the discriminant functions content should be based on the structural vectors f_k from the matrix

$$F = Z^tK = RX = (f_k) = (Rx_k),$$

analogous to the identification of the content of the canonical variables obtained by Hotelling's method of biorthogonal canonical correlation analysis. Since the elements f_{jk} of the matrix F behave as the regular product-moment correlation coefficients, and since they are the function of the normally distributed variables, therefore they are asymptotically normally distributed, their asymptotic variances are, of course,

$$\sigma_{jk}^2 \sim (1 - \phi_{jk}^2)^2n^{-1}$$

$$j = 1,..., m; k = 1,..., s$$

11 A special problem is to test the hypothesis about the elements of the vector x_p, because so far no acceptable procedure for the evaluation of the matrices of the covariances of those elements has been proposed, except in the case of $g = 2$, because only then the canonical discriminant analysis could be treated as a special case of the regression analysis; then the matrix of the covariances of the elements of the single vector x is, certainly, $C_x = (1 - \rho^2)R^{-1}(n - m - 1)^{-1}$ (Seber, 1977; Štalec, Momirović and Zakrajšek, 1983; Anderson, 1984).

and could be used for testing the hypothesis of type H_{jk}: $f_{jk} = \phi_{jk}$, where ϕ_{jk} are some hypothetical correlations between the variables from V and discriminant functions in the population P because the asymptotic distribution of the coefficients f_{jk} is

$$f(f_{jk}) \sim N(\phi_{jk}, \sigma_{jk}^2)$$

where N is the symbol for normal distribution.

Momirović and Zorić (1996) also suggested the inspection of the cross-structural vectors c_k from the matrix

$$C = Z^tL = AY = RX\rho = F\rho$$

thus the factor matrix of A matrix, because, since $XX^t = R^{-1}$,

$$CC^t = RX\rho^2X^tR = X\rho^2X^{-1} = A.$$

It may easily be shown that F is a factor matrix of R matrix. Let

$$\Delta^2 = \text{diag}\,(X^tX)$$

and let

$$V = X\Delta^{-1}.$$

Then

$$\Delta^{-2} = V^tRV$$

is a diagonal matrix of the standardized variances of discriminant functions and

$$FF^t = RXX^tR = RV\Delta^2V^tR.$$

If s = m,

$$\Delta^2 = V^{-1}R^{-1}V^{-t}$$

and

$$XX^t = R^{-1}$$

so that

$$FF^t = R.$$

If s < m,

$$FF^t = RV(V^tRV)^{-1}V^tR$$

which is a special case of the general Guttman theorem on the factorization of any squared symmetrical matrix of rank m with any matrix of rank r < m.

In canonical discriminant analysis the main, and usually the only, set of hypotheses related to the parameters of that model is the set

$$H_0 = \{\varphi_k = 0, k = 1,..., s\}$$

where φ_k are hypothetical values of the canonical correlations in the population P.[12]

The hypotheses of type

$$H_{0k}: \varphi_k = 0$$

$$k = 1,..., s$$

may, especially in the case of g = 2, therefore s = 1, be tested in several ways. Most implementations of the canonical discriminant analysis apply one function of Wilks' (Wilks, 1932; 1935; 1962) measure

$$\lambda_k = \Sigma_{t+1}^{s} \log_e (1 - \rho_{t+1}^2)$$

$$k = t + 1, t = 0, 1,..., s - 1$$

proposed by Bartlett (1941), who found that under the hypothesis $H_{0k}: \varphi_k = 0$ the functions

$$\chi_k^2 = - (n - (m + g + 3)/2)\lambda_k$$

$$k = 1,..., s$$

had, approximately, χ^2 distribution with

$$\nu_k = (m - k + 1)(g - k)$$

degrees of freedom.

However, a more sensitive test of the hypotheses $H_{0k}: \varphi_k = 0$ is a function derived according to the maximum likelihood criterion suggested by Rao (Rao, 1951; 1973; Momirović, Gredelj and Szirovicza, 1977; Anderson, 1984). Let

$$a = ((m^2(g - 1)^2 - 4)/(m^2 + (g - 1)^2 - 5))^{1/2},$$

and let

$$\nu_{1k} = (m - k + 1)(g - k)$$

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12 Hypothesis $H_{01}: \varphi_1 = 0$, which simply means that the arithmetic mean of all the variables from V may not be different in subpopulations P_p, p = 1,..., g from P is a subject, for unclear reasons, of a special statistical method which is commonly called multivariate analysis of variance. Naturally, if m = 1, then it is about one-factor analysis of variance which evidently comes down to the test of the hypothesis $\varphi = \eta = 0$, where η is Fisher's coefficient of intergroup correlation of a single variable v and nominal variable W; if nevertheless g = 2, this is certainly about the t - test for differences between the arithmetic mean of two independent subpopulations, that is a test of the hypothesis whether the point biserial coefficient of the correlation $\varphi = \eta = \rho_{pb}$ between v and {w1, w2} equals zero. This author has to admit that it has never been clear to him why the special cases of canonical discriminant analysis, that can easily be described in several lines of a footnote, are treated as special methods and described in separate chapters in most statistical textbooks and so taught to unsuspecting students of mathematical or applied statistics.

and

$$\nu_{2k} = a((n - 1) - (m - g)/2 - (m - k + 1)(g - k) - 2)/2.$$

Then the functions

$$f_k = (1 - \lambda_k^{-a})\lambda_k^{-a}(\nu_{2k}/\nu_{1k})$$

$$k = 1,...,s$$

have, under H_{0k}: $\varphi_k = 0$, the Fisher – Snedekorov F distribution with ν_{1k} and ν_{2k} degrees of freedom.[13]

Of course, although the discriminant functions are orthogonal, neither the tests of type χ_k^2, nor the tests of type f_k are really independent (Anderson, 1984); besides, the results of those tests, especially of Bartlett's test which is most frequently applied, are not, even when large samples are involved, in the best accordance with the results of the tests like

$$z_k = \rho_k/\sigma_k$$

$$k = 1,...,s$$

that are based on the fact that canonical correlations also have the asymptotical normal distributions with the parameters φ_k and

$$\sigma_k^2 \sim (1 - \varphi_k^2)^2 n^{-1}$$

(Kendall and Stuart, 1976; Anderson, 1984).[14]

ABOUT HOW TO CALCULATE DISCRIMINANT FUNCTIONS AND THE STRUCTURE OF DISCRIMINANT FACTORS IN SOME STATISTICAL SOFTWARE PRODUCTS

Although, it is obvious that, the canonical discriminant analysis, from a mathematical point of view, a rather simple method, and from a statistical point of view not too much complicated, some programmers employed in factories of commercial statistical program products have discovered, apparently, the way

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13 This test is installed in the CANDISC program of the SAS program system accompanied by four independent tests of hypothesis $\varphi_1 = 0$ suggested by Wilks, Lawley and Hotelling, Pillai and Bartlett, Nanda and Pillai and Roy. These tests are described by Anderson (1984, pp. 321-333) but here they will not specially be considered because the trivial hypothesis $\mu_{jp} = 0 \; \forall \; \mu_{jp}$; j = 1,..., m; p = 1,...,g is rarely of significant interest to the majority of those whose structure of data requires the application of canonical discriminant analysis.

14 Because canonical discriminant analysis invariant to an arbitrary affine transformation of the variables, it may be derived as a special case of the canonical analysis of correlation between the variables from Z and S (Hadžigalić, 1984) or as a special case of canonical analysis of the covariances between the variables from $M = ZR^{-1/2}$ and S (Hadžigalić, Bogdanović, Tenjović and Wolf, 1995). However, in that case the consequences of the reckless definition of the problem that is supposed to be solved and the incorrect definitions of the structure of discriminant factors would not be so immediately clear.

and manner to introduce unnecessary confusion, thus proving that Steinitz's theorem is relevant in all segments of the human population.

The main, but not the only, reason for that confusion is the fact that in most texts dedicated to the canonical discriminant analysis (Rao, 1948; 1952; 1968; 1973; Rao and Slater, 1949; Anderson, 1966; Bryan, 1951; 1975; Cooley and Lohnes, 1971; Ivanović, 1963; 1977; Kendall and Stuart, 1976; Kovačić, 1994; Momirović, Gredelj and Szirovicza, 1977; Romeder, 1973) that method is defined, in accordance with the model of the multivariate analysis of variance, as a problem solution

$$\xi_k^2 = (v_k^t A v_k)(v_k^t W v_k)^{-1} = \text{maximum} \mid (v_k^t W v_q) = \delta_{kq},\ k,q = 1,...,s$$

which is, after few simple algebraic manipulations, reduced to the solution of the general problem of eigenvalues

$$(A - \xi_k^2 W)v_k = 0$$

$$k = 1,..., s.$$

Let $V = (v_k)$ i $\xi^2 = (\xi_k^2)$, $k = 1,..., s$. Since

$$V^t W V = I,$$

then

$$V^t A V = V^t W V \xi^2 = \xi^2$$

and hence

$$V^t R V = I + \xi^2$$

so that

$$X = V(I + \xi^2)^{1/2}$$

and

$$\rho^2 = \xi^2(I + \xi^2)^{-1}.$$

Although such a solution is formally equivalent to the solution of a discriminant problem under the canonical model, it may easily be shown that in marginal cases this leads to the fact that the problem could not be resolved at all, or that the solution is burdened with so many numerical problems that the final result must be completely doubtful.

Since

$$X^t R X = X^t(A + W)X = I,$$

$$X^t W X = I - \rho^2 = \Lambda_W = (\lambda_{Wk})$$

$$k = 1,..., s$$

where λ_{Wk} Wilks' measures are now associated with the discriminant functions k_k from K. But, since

$$G^tH = 0,$$

then, if $Z \rightarrow PZ$, that is when the subpopulations P_p from P are almost totally quantitatively different, and thus $\rho \rightarrow I$, $H \rightarrow 0 \Rightarrow W \rightarrow 0$ and the problem of canonical discriminant analysis, defined in an ordinary way[15], becomes unsolvable, or the solution is numerically incorrect because of the weak conditioning of W matrix.

But while the problem of model choice is a consequence of the habit of the programmers and users of the ready-made statistical software products, but also, unfortunately, some professional statisticians, to read the statistical texts with their fingers, the forming of the structural matrices of discriminant functions in most of the commercial statistical program products[16] is simply a consequence of lack of thinking.

Those programs, however, consider cross-correlations between the variables from H and K thus correlations between the discriminant functions and those components of the variables from Z which are not at all included in the formation of those functions to be the structure of canonical discriminant functions. Actually, since $\Lambda = \text{diag } W$ is variance matrix of the variables from H, those programs define a structure matrix as

$$U = \Lambda^{-1/2}H^tK = \Lambda^{-1/2}Z^tQZX = \Lambda^{-1/2}WX = \Lambda^{-1/2}(R - A)X = \Lambda^{-1/2}(F - AX)$$

so that those variables from V, in which the subpopulations P_p from P mostly differ, define the structure of discriminant factors most poorly. Certainly, in a marginal case when $Z \rightarrow PZ$, and therefore, of course, $\rho \rightarrow I$, $U \rightarrow 0$ which is such evident nonsense that it is simply unbelievable that the programmers, who are normally very intelligent, did not see it immediately while writing or testing their own programs.

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15 That is, certainly, true for both multivariate and univariate analyses of variance, which is sufficient evidence that the classical treatment of those methods should be abandoned and they should be considered as special cases of canonical correlation analysis.

16 As usual, SAS is an exception; program CANDISC from that system calculates the structural matrix of discriminant functions correctly but probably in order to satisfy the needs of those who are accustomed to the solutions suggested by other more popular program products, it calculates that matrix en passant and in the same senseless manner as the analogue programs from the package like Statistica and SPSS conduct.

INSTEAD OF DISCUSSION: ABOUT WHAT SHOULD AND SHOULDN'T BE DONE

Actually, it is simpler to determine what shouldn't be done: one shouldn't apply the programs for canonical discriminant analysis within which a canonical problem is defined in the classical Bryan's manner and which calculate, just for that reason, the structure of discriminant factors on the basis of the correlations between the variables from which the factors that differentiate the group are partialized as well as the discriminant functions no matter how those functions have been calculated. This practically means that there is no sense, at least when it is about the problems that have to be resolved by canonical discriminant analysis or by any other special case of a canonical discriminant model, to apply any commercial statistical software package, except for SAS, and the programs for the discriminant analysis specially written in some statistical metalanguages, like GENSTAT and SS.[17]

If SAS were available, in every sense of that word, to the users of statistical software products, it would be easy to say what should be done: The canonical discriminant analysis should be performed by the program CANDISC from that system, or by the analogous programs written in SS or GENSTAT language. Unfortunately, SAS is not available to the unprofessional statisticians not only for administrative or economic reasons, but also for something more serious, and that concerns SS and even more it concerns GENSTAT: Those systems are not intended for the unprofessional statisticians, so a regular user does not know how to use them, because there is no time, nor prior knowledge, to learn how to use them; that is obvious from the fact that the majority avoids to apply them even though they have them, since in some way they have overcome the administrative and economic problems.

Accordingly, there is only one reasonable way out which is possible because SPSS is far by the most popular statistical package and there is still one, although very cumbersome, language in which it is possible to program in SPSS environment. That way out implies persuading or forcing someone to write a correct program for canonical discriminant analysis in the Matrix language and to implement it as an additional part of the SPSS syntax. The one, who will do it, will doubtlessly accomplish, a good deed, since the canonical discriminant

17 The program CANDID (Momirović, 1987), written in the SS language, calculates the discriminant functions in the Mahalanobis's space in the manner described in one later published work of Hadžigalić, Bogdanović, Tenjović and Wolf (1995) in order to avoid some numerical problems and to enable testing the significance of the discriminant coefficients. Similarly the algorithm is easily performed even with a few simple manipulations by the commands of the GENSTAT language, because the function for the canonical discriminant analysis, which behaves in that language as an elementary command, calculates the parameters of the discriminant model correctly.

analysis is a method without which serious research is impossible neither in any natural nor social science, even in any technological discipline derived from those sciences.

3. Results and discussion

In table 59 there are the eigenvalues (Sv. vre.), percentage of the explained intergroup variability (Proc. var.), canonical correlation coefficient (Kan. Kor.), Wilks' Lamda values (Lamda), values of Bartlet's chi test (Chi), degrees of freedom (DF), statistical significance (Sig), set of the discriminant functions of the motor variables (FUNC1, FUNC2) and centroids of the groups indicated by the discriminant functions (C1 i C2).

By transformation and condensation of the variables in the space of musical abilities only one discriminant function, which maximally separates the groups of athletes according to discriminant coefficients, has been isolated.

This discriminant function explains the differences with 100 percent of the intergroup variability in the space of musical abilities of the applied discriminant variables.

Examining the coefficients that determine the first discriminant function, it could be noticed that it separates the dancers on the basis of all the tests used for the evaluation of musical abilities except the test which estimates the pitch. On the basis of the value and sign of the projection of the centroids on the first discriminant function, it may be concluded that the female dancers have a more pronounced ability to recognize the duration of tone, memory, rhythm and the ability to register the timbre of the tone. The male dancers have a more developed sense of registering the volume of a tone that is receptive signal.

DISCRIMINANT ANALYSIS OF THE TESTS OF MUSICAL ABILITIES

Table 1.

Fen	1*
Eig.val.	.4579
Pet of Vari.	100.00
Cum. Pet.	100.00
Can. Cor.	.56
Wilks' Lambda	.68
Table continued on next page...	

...Table continued from previous page	
Chi	95.19
DF	5
Sig	.00

** FUNCTION FUNC 1*

DUT	.78
MEM	.68
RIT	.25
JAT	-.24
BOT	.23
VIT	.05

CENTROIDS OF THE GROUPS

GROUPS	FUNC1
FEMALE DANCERS 1	.66
MALE DANCERS 2	-.68

4. Conclusion

The research was conducted with the aim to determine the differences in the structure of musical abilities of the male and female dancers involved in standard and Latin American dances.

In order to determine the differences in the structure of musical abilities of male and female dancers, 267 examinees were involved, aged from 11 to 13, who are actively engaged in standard and Latin American dances.

For estimating the musical abilities, the well-known Seashore test battery to evaluate musicality was used. This battery estimates the following tests: pitch discrimination test, tone volume discrimination test, test for recognizing the rhythm, test for discrimination of the duration of a tone, test for discrimination of the timbre of a tone and a tonal memory test.

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, University

of Priština, supported by the system of data processing programs developed by Popović, D. (1980), (1993), Momirović, K. and Popović, D. (2003).

By applying transformation and condensation of the variables in the space of musical abilities, there was isolated only one discriminative function, which maximally classifies the groups of athletes on the basis of discriminant coefficients. Examination of the coefficients, that determine the first discriminant function, allows classification of the dancers according to nearly all the tests for estimating musical abilities except the tests for the evaluation of pitches. According to the value and sign of the projection of centroids on the first discriminant function, it could be concluded that female dancers have a more pronounced ability to recognize the volume of tones, memory, rhythm and, moreover, the ability to register the timbre of tones. The male dancers have a more developed sense of registering the volume of tones, that is, receptive signals.

5. References

[1.] Boli, E.: (2000) Differences in the level of musical, cognitive abilities and conative characteristics of the male and female dancers before and after the competition period (PhD thesis), Leposavić: The University of Priština, Faculty of Physical Education.

[2.] Boli, E., Popović, D., Stanković, V. & Grigoropulos, P.: (2001) [Differences in the level of conative characteristics of male and female dancers involved in standard and Latin American dances], Petrovac: 9th Summer School for Pedagogues of Physical Education of Montenegro, Physical Education.

[3.] Boli, E., Popović, D., A. Hošek.: (2009) Sports and Crime, (Scientific monograph) The University of Priština, Boli, E.: (2011) Struktura antropoloških dimenzija plesača i plesačica i izrada postupaka za njihovu procenu i praćenje, (Naučna monografija), Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sports and Physical Education.

[4.] Momirović, D, Wolf, B. and Popović, D: (1999) Introduction to the measurement theory and internal metric characteristics of the composite measuring instruments (textbook), Priština: The University of Priština, Faculty of Physical Education.

[5.] Momirović, K and Popović, D.: (2003) Construction and application of the taxonomic neuronal webs (monograph), Leposavić: The University of Priština, Faculty of Physical Education.

[6.] Momirović, K, A. Hošek and Popović, D.: (2007) Sexual Dimorphism (monograph), Leposavić: The University of Priština, Faculty of Physical Education.

[7.] Popović, D.: (1991) Methodology of the research in Physical Education (textbook), Niš: University in Niš, Scientific Youth.

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

[9.] 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.

[10.] Popović, D.: (1993) Determination of the structure of psychosomatic dimensions in fights and data processing for their evaluation and monitoring (monograph), Priština: The University of Priština, Faculty of Physical Education.

[11.] Popović, D., Stanković, V. & Grigoropulos, P.: (1998) Discriminant analysis of motor abilities and morphological characteristics of the prospective basketball and handball players. Physical Education, 19(2), 31-35

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Differences in the level of musical abilities of male and female dancers

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Summary

The research was conducted to determine the differences in the structure of musical abilities of female and male dancers engaged in standard and Latin American dances. For estimating the differences, 267 dancers aged from 11 to 13 were involved. For estimating musical abilities, the well-known Seashore test battery for the assessment of musicality was used. This battery evaluates the following tests: a test for pitch discrimination, a test for tone intensity discrimination, a test for the recognition of rhythm, a test for tone duration discrimination, a test for timbre discrimination and a tonal memory test. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programs developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. By transformation and condensation of the variables in the space of musical abilities, there was isolated only one discriminative function, which maximally separates the groups of athletes on the basis of the

discriminative coefficients. Examination of the coefficients which determine the first discriminative function, allows the classification of the dancers according to almost all the tests for estimating musical abilities except the tests for the evaluation of pitches. Based on the value and sign of the projection of centroids on the first discriminative function, it could be concluded that female dancers have a more pronounced ability of recognition of the volume of tones, memory, rhythm and, moreover, the ability of registering the timbre of tones. The male dancers have a more developed sense of registering the volume of tones, that is receptive signals.

Keywords: /signal/centroid/coefficient/separate/ability/tone/rhythm/timbre/pitch/memory/

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The structure of intellectual abilities of dancers

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1. Introduction

In the psychological literature three types of definitions of intelligence are most frequently mentioned. In behavioristic circles intelligence is usually identified with the "capacity for learning", that is the ability to acquire new knowledge. Rarely it is the identification of intelligence with the "ability of abstract thinking". The definition of intelligence as the "ability of adaptation in new situations" deserves special attention. It is the most frequent definition in animal psychology. Here, it is, certainly, referred neither to the adaptation in the sense of tolerance to exogenous factors, nor to the adaptation in the clinical sense.

The central nervous system primarily has an integrative function, so that it enables purposeful and adaptive behavior of a human being. Of the utmost importance is the integration at the cortical level, since purposeful behavior is in direct relation to intelligence at the cortical level, although it is less flexible. Integration of functions at the subcortical level provides reaction in standard situations, the situations that require automatic performance of routine programs. Cognitive

processes and cognitive functioning are the central mechanisms of cortical integration.

2. The methods of research

2. 1. The sample of examinees

The sample of examinees is determined by financial capabilities which are required for performing the research procedure. Besides, the sample also depends on the number of qualified and trained measurers, on the instruments and standardized conditions in which the planned research should be realized.

In order to conduct the research properly and provide satisfactorily stable results, in the sense of sampling error, it is necessary to include a satisfactory number of examinees into the sample. The size of the sample for this type of research is conditioned by the aims and tasks of the research, size of the population and degree of the applied variability of the system of parameters.[18]

Based on the selected statistical-mathematical model and the aim of the research, the sample of examinees included 267 dancers, aged from 11 to 13, actively involved in standard and Latin American dance in the Serbian dancing clubs.

The size of the so defined sample should satisfy the following criteria:

- the effectives of the sample should be planned so that it allows as many degrees of freedom as any coefficient in the pattern or correlation matrix which is equal to or higher than 0.22 could be considered as different from zero with an inference error less than 0.01
- in order to successfully apply the adequate statistical methods according to the latest convictions, the number of subjects in the sample must be five times bigger than the number of the applied variables.

During all these factor procedures, it should always be kept in mind that the results of the analysis depend on three major systems which determine the selection and transformations of information: the sample of variables, the sample of examinees and the selected extraction, or rotation, method.[19]

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

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

2. 2. The sample of variables

For estimating cognitive dimensions some measuring instruments have been selected so that the cybernetic model may be covered, paying attention to the fact that the selected tests measure three types of cognitive processing.

For estimating the efficiency of the input processor, that is, perceptual reasoning, there has been selected the test:

IT-1: the test of matching the drawings is designed for the evaluation of perceptual identification and discrimination. The test consists of 30 tasks, and the test execution time is limited to 4 minutes. The analysis of the test has shown that the difficulty of the tasks and their intercorrelation indicate that this is a typical speed test.

For estimating the efficiency of the parallel processor, that is the identification of relations and correlates, the following measuring instrument has been selected:

S-l: the spatial reasoning test is designed to evaluate fast simultaneous of spatial relations. It consists of 30 tasks, where should be determined which of the 4 transversal projections of the brick cluster corresponds to the specified picture of brick cluster. The test execution time is 10 minutes.

For estimating the efficiency of the serial processor, or symbolical reasoning, the following measuring instrument has been selected:

AL-4: the synonym-antonym test is designed to evaluate identification of the denotative meaning of the verbal symbols. It consists of 40 tasks of double choice format. The test execution time is 2 minutes, so this test belongs to the category of speed tests. The first major subject for measuring is defined mostly by the tasks from the second half of the test and interpreted as the ability of rapid identification of the denotative meaning of verbal symbols.

2. 3. The methods of data processing

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, The University of Priština, supported by the system of data processing programs developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. Apart from the very old but even today in many respects unrivalled textbook on factor analysis, intended primarily to psychologists (Thomson, 1951; 1956), in the textbooks on factor analysis, there is not now and never was before, a mention of the a

criterion-oriented factor analysis.[20] Therefore, that method is not mentioned, at least in the explicit form, in any statistical software package or system, except the software package SRCE*SS-MACRO, written in SS, one of the many presently dead statistical metalanguages.

Still, the criterion-oriented factor, and even more, criterion-oriented component analysis, is not unknown to either specialists for factor analysis or researchers from various areas, above all, of course, psychologists. Although most of them believe that H. J. Eysenck (1950) proposed the method, and that it was his greatest, and perhaps the only real contribution to the statistics, virtually the same method had been applied long before by Reyburn and Taylor in the analysis of the structure of conative characteristics (Reyburn i Taylor, 1939; 1941). A formal description of the criterion-oriented factor analysis may be found in the previously mentioned Eysenck's work and in the later editions of Thomson's textbook (Thomson, 1951; 1956), a logical discussion about its significance, and, of course, a formal description of that method in one of Fruchter's papers (Fruchter, 1966), and the proofs of several important theorems on a class of the methods of component analysis, which also includes the criterion-oriented component analysis, in one of Schoenemann and Steiger (Schoenemann i Steiger, 1976). One algorithm for the criterion-oriented component analysis, which is still relevant today, was proposed by Momirović, Gredelj and Štalec (1977), who also wrote a program for deriving, by that method, latent structure analyses of variables in several researches within the sphere of biological anthropology, kinesiology, psychology and sociology.

Unfortunately, since it is mentioned neither in the actual textbooks, nor in popular statistical program products, this plain, but, by its properties, extremely significant method is slowly falling into oblivion. But as Eysenck was right when, proposing that method, he claimed that the criterion-oriented factor analysis was one of the major means of the hypothetical-deductive research method, nowadays accepted by the vast majority of researchers in psychology, as well in the derived from psychology sciences or related sciences, it was reasonable to make an effort to revitalize it. Consequently, the aim of this work was to propose an algorithm from which the properties of that method would be immediately clear, and to propose a computer program which enables the application of criterion-oriented component analysis in the standard SAS environment, in which most users of the ready made statistical software products work today.

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20 View, for instance, Thurstone, 1947; Cattell, 1952; Fruchter, 1954; Horst, 1965; Harman, 1967; Lawley and Maxwell, 1971; Mulaik, 1972; Jolliffe, 1986; Flury, 1988, etc. Certainly, because of this not a single word is written about the criterion-oriented factor or component analysis in the chapters devoted to the factor and component analyses in the textbooks of the multivariate statistical analysis or multivariate data analysis.

THE DEFINITIONS

Let

$$E = \{e_i;\ i = 1,...,n\} \subset P$$

be a random sample from some homogeneous population P. Let

$$V = \{v_j;\ j = 1,...,m < n\} \subset U$$

be a sample of the quantitative, normally distributed variables in P, selected according to some theoretical model in order to be representative of the universe of the variables U. Let

$$W = \{w_p;\ p = 1,...,k < m\} \subset U$$

be a set of normally distributed hypothetical latent dimensions by which the structure of the universe U is defined; assume that the variables from W can be determined or estimated independently of the variables from V.

Let $e = (e_i) \mid e_i = 1\ \forall\ e_i$, $i = 1,...,n$ be a summing vector of order n and let I_m and I_k be identity matrices of order m, respectively of order k. Let

$$Z = E \otimes V \mid Z^t e = 0,\ \text{diag}\ (Z^t Z) = I_m$$

be a data matrix, in a standard normal form, obtained by the description of the set E over the set V, and let

$$X = E \otimes W \mid X^t e = 0,\ \text{diag}\ (X^t X) = I_k$$

be a data matrix, also in a standard normal form, obtained by the description of the set E over the set of the hypothetical latent dimensions W. In this case

$$R = Z^t Z$$

will be an intercorrelation matrix of variables from V,

$$U = X^t X$$

will be an intercorrelation matrix of hypothetical variables from W, and

$$Q = Z^t X$$

will be a cross-correlation matrix of variables from V and hypothetical variables from W, all the three estimated under the maximum likelihood criterion.

If $V \cap W = 0$, and W is a set of hypothetical latent dimensions that indeed determines the structure of the set U, the latent structure of variables from V may be determined in a very simple way (Eysenck, 1950; Thomson, 1956; Schoenemann and Steiger, 1976; Momirović, Gredelj and Štalec, 1977).

THE ALGORITHM

The criterion-oriented component analysis is, actually, based on the solution of the multivariate regression problem

$$Z\beta = X - E \mid \varepsilon^2 = \text{trag}\,(E^tE) = \text{minimum},$$

where some β is an unknown matrix of order (m,k).

Since

$$\varepsilon^2 = \text{trag}\,((X - Z\beta)^t(X - Z\beta)) = \text{trag}\,(U - \beta^tQ - Q^t\beta + \beta^tR\beta),$$

and trag (U) = k and trag (β^tQ) = trag ($Q^t\beta$), the function that should be minimized is

$$\varepsilon^2 = k - \text{trag}\,(2\beta^tQ + \beta^tR\beta).$$

By differentiation of this function by the elements of the matrix β

$$\partial\,\beta^2 / \partial\,\beta = - 2Q + 2R\beta,$$

so by dividing by 2 and reducing to zero

$$R\beta = Q,$$

is obtained, from which it follows that

$$\beta = R^{-1}Q$$

is a matrix of partial regression coefficients for estimating hypothetical latent variables from X by linear combinations of variables from Z.

Those evaluations will be the elements of the matrix

$$\Phi = Z\beta$$

with the covariance matrix

$$C = \Phi^t\Phi = \beta^tR\beta = Q^tR^{-1}Q.$$

Let

$$D^2 = (d_p^{\,2}) = \text{diag}\,C$$

be a variance matrix of variables from Φ.

Proposition 1.

The elements $d_p^{\,2}$, p = 1,...,k of the matrix D^2 are the determination coefficients of the hypothetical latent dimensions from X based on the linear combinations of variables from Z, therefore $\rho_p = d_p$, p = 1,...,k are the multiple correlations of the hypothetical latent dimensions from X with variables from Z.

Proof:

Let

$$\Psi = \Phi D^{-1} = ZR^{-1}QD^{-1}$$

be a matrix of standardized evaluations of variables from X by linear combinations of variables from Z. The covariances of the hypothetical latent dimensions and their evaluations will be the elements of the matrix

$$X^t\Phi = Q^tR^{-1}Q = C,$$

and their cross-correlations will be the elements of the matrix

$$X^t\Psi = Q^tR^{-1}QD^{-1} = CD^{-1};$$

thus the elements of the matrix

$$\rho = (\rho_p) = (\text{diag } C)(\text{diag } C)^{-1/2} = D^2D^{-1} = D = (d_p)$$

will be the multiple correlation coefficients of variables from V and hypothetical latent dimensions from W, and the elements d_p^2, p = 1,...,k of matrix D^2 will be the determination coefficients of latent dimensions, what was required to be proved.

The factor structure matrix of latent dimensions from Ψ, thus the cross-correlation matrix of variables from Z and variables from Ψ will be

$$F = Z^t\Psi = QD^{-1};$$

and since the intercorrelation matrix of variables from Ψ is

$$M = \Psi^t\Psi = D^{-1}CD^{-1},$$

then the pattern matrix of those dimensions, or the matrix of the projections of the vectors of variables from Z to the coordinate axis defined by the vectors from Ψ, will be

$$A = FM^{-1} = QC^{-1}D.$$

Proposition 2.

A and F are factor matrices of the correlation matrix R.

Proof:

$$AF^t = AMA^t = FM^{-1}F^t = Q(Q^tR^{-1}Q)^{-1}Q^t$$

which is reduced to the Guttman theorem on the factorization of the squared symmetrical matrix R by the operator Q, from which it follows that

$$T = Q(Q^tR^{-1}Q)^{-1}Q^t$$

is a factor approximation of the matrix R with a matrix of rank k, what was required to be proved.

Therefore the communalities of variables will be the elements of the matrix

$$H^2 = (h_j^2) = \text{diag } T,$$

and the matrix

$$L = R - T$$

will be the matrix of the residual variances and covariances of the variables whose latent structure is determined by this method of the confirmative component analysis.

3. Results and discussion

Examining the matrix of the tests for estimating the intellectual abilities (table 1), it can be noticed that there is the greatest connection between the test IT-1 designed to evaluate perceptual identification of the denotative meaning of verbal symbols with equal correlations IT-1 and AL-4 and the S-l test of spatial reasoning designed to evaluate rapid simultaneous eduction of spatial relations. In some case, even on the basis of the intercorrelation matrix, it is possible to assume factor patterns.

In this case it may be concluded that the whole system of intellectual variables is based on the substantial common variability, sufficient for the approximation of one general factor of intellectual abilities.

The factor structure of intellectual abilities is analyzed on the basis of all the information provided by the matrix of significant principal components (table 2). Based on the Kaizer-Guttman criterion, only one latent dimension was isolated, which signifies the entire space of the three cognitive tests with about 47% of the common variance. This may be accepted as satisfactory for this type of research.

The isolated latent dimension may be interpreted as a general cognitive factor. The minimun projection is in the test IT-1 by which the efficiency of the input processor, or perceptual reasoning, was estimated, then in the test S-l by

which the efficiency of the parallel processor, that is, discerning the relations and correlates, was estimated and finally in the test AL-4 of synonyms-antonyms for estimating the efficiency of the serial processor, or symbolical reasoning.

THE INTERCORRELATION MATRIX

Table 1.

Value	IT1	AL1	SI
IT1	1.00		
AL1	.21	1.00	
SI	.14	.24	1.00

THE MATRIX OF THE PRINCIPAL COMPONENTS

Table 2.

Value	FAC1	h^2
IT1	.63	.40
AL1	.74	.55
SI	.67	.45
LAMBDA	1.41	
%	47.0	
CUM %	47.0	

4. Conclusion

The research was conducted with the aim to determine the structure of intellectual abilities of female dancers involved in standard and Latin American dance.

For estimating the structure of intellectual abilities, 267 dancers, aged from 11 to 13, were involved, who were actively occupied with standard and Latin American dance.

For the evaluation of intellectual abilities, three measuring instruments were applied so that the structure analysis could be resolved according to the cybernetic model of Das, Kirby and Jarman, respectively, Momirović, Bosnar and

Horge (1982.), especially regarding the fact that the selected tests could measure three types of intellectual processing.

For estimating the efficiency of the perceptual processor, test IT-1 was selected, for estimating the efficiency of the serial processor-test AL-4, and for estimating the efficiency of the parallel processor-test S-l.

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, The University of Priština, supported by the system of data processing programs developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003.

The analysis of the factor structure of cognitive dimensions indicates that the whole system of cognitive variables is based on the substantial common variability, sufficient for the approximation of *the general factor of intellectual abilities*.

5. References

[1.] Boli, E.: (1996) The structure of intellectual and musical abilities and personality traits of girls involved in standard and Latin American dance, Master thesis, Priština: University of Priština, Faculty of Physical Education.

[2.] Boli, E., Popović, D., A. Hošek.: (2009) Sport and Crime, Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[3.] Boli, E.: (2011) Structure of anthropological dimensions of male and female dancers and data processing for their evaluation and monitoring. (Monograph), Leposavić: University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[4.] Momirović, D, Wolf, B. i Popović, D: (1999) Introduction to the measurement theory and internal metric characteristics of composite measuring instruments (textbook), Priština: University of Priština, Faculty of Physical Education.

[5.] Popović, D., Antić, K., Stanković, V., Petković, V. & Stanković, S.: (1989) Procedures for objectification of evaluation of the efficiency in performing judo techniques. Scientific Youth, 21(1-2), 83-89.

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

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

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

[9.] Popović, D.: (1988) Application methods of factorial analysis for determining morphological types, Varna: 4th international symposium on the methodology of mathematical modelling, Bulgaria.

[10.] Popović, D.: (1991) Methodology of the research in Physical education (textbook), Niš: University of Niš, Scientific Youth.

[11.] Popović, D.: (1992) Methodology of research in Physical Education, Athens, Greece.

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

[13.] Popović, D.: (1993) Determination of the structure of psychosomatic dimensions in fights and data processing for their evaluation and monitoring (monograph), Priština: University of Priština, Faculty of Physical Education.

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The structure of intellectual abilities of dancers

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Summary

The research was conducted in order to determine the structure of intellectual abilities of dancers involved in standard and Latin American dance. The research involved 267 dancers, aged from 11 to 13. For the evaluation of intellectual abilities, three measuring instruments were applied, previously selected so as to solve the structure analysis on the basis of the cybernetic model of Das, Kirby and Jarman, respectively Momirović, Bosnar and Horge 1982, taking into account the fact that the chosen tests could measure three types of intellectual processing. For estimating the efficiency of the perceptual processor, test IT-1 was selected; for estimating the efficiency of the serial processor, test AL-4; and for estimating the efficiency of the parallel processor, test S-1. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. The analysis of component structure of cog-

nitive dimensions indicates the fact that the whole system of cognitive variables is based on the substantial common variability, sufficient for the approximation of the general factor of intellectual abilities.

Key words: /structure/analysis/dimension/factors/reasoning/processor/model/

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Differences in the level of cognitive abilities of male and female dancers

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1. Introduction

Although among authors there is considerable disagreement about the definition of cognitive abilities, it is quite certain, that it is about the abilities of a person which are more directly connected with the reception, processing and transmission of information. Some authors regard this as a successful solution of the tasks which include abstractions, others believe that intelligence is the ability of learning, and the third group of authors discusses the abilities of acting in new and unpredictable situations. It is debatable whether the cognitive ability (intelligence) is a unique ability or composed of various different, particular abilities.

However, a more detailed analysis of the definition of intelligence, shows that there is great disagreement about what intelligence is, so it is obvious that there is no generally accepted definition of intelligence. There are also huge discrepancies about the influence of endogenous and exogenous factors on the cognitive functions and their measuring. Though, what is definite about intelligence,

is the fact that it appears as the ability significant for a range of human activities – professional, social, scientific, sporting, artistic and other ones.

The beginnings of the evaluation (testing) of cognitive abilities date back to Galtona (1860). With the construction of the measuring instrument known as the Binet-Simon scale, the process of mental testing began, which contributed greatly to the research of intellectual abilities. Nowadays in the psychometric techniques there are a vast number of tests for testing cognitive (intellectual) abilities, which are designed for various needs and various populations (samples) of examinees. As considered, the selection of one tight battery may cover rather wide interests for the needs of different areas (Wolf, Momirović and Džamonja 1992).

2. The methods of research

2. 1. The sample of examinees

The sample of examinees is influenced by financial capabilities necessary for conducting the research procedure. Furthermore, the sample depends on the number of qualified and trained measurers, the instruments and standardized conditions in which the planned research will be conducted.

In order to conduct the research properly with valid stable results regarding the sampling error, it is necessary to include a sufficient number of examinees into the sample. The size of the sample for research of this type is also preconditioned by the aims and tasks of the research, size of the population and the level of variability of the applied system of parameters.[21]

According to the selected statistical-mathematical model and the aim of the research, the sample of examinees included 131 female dancers and 136 male dancers, aged from 11 to 13, actively involved in standard and Latin American dances in the Serbian dancing clubs.

The size of the so defined sample should satisfy the following criteria:

- the effectives of the sample should be planned so that it enables as many degrees of freedom as necessary for any coefficient in the pattern or correlation matrix, which is equal to or bigger than 0.22, to be considered different from zero with an inference error less than 0.01

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

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

During all factor procedures, it should always be kept in mind that the results of the analysis depend on three major systems which determine the selection and transformation of information: the sample of variables, sample of examinees, and the selected extraction, or rotational, method.[22]

2. 2. The sample of variables

2. 2. 1. The sample of cognitive variables

For estimating intellectual dimensions the measuring instruments are selected so that the cybernetic model may be covered, paying attention to the fact that the selected tests can measure three types of cognitive processing.

For estimating the efficiency of input processor, respectively the perceptual reasoning, this test has been selected:

IT-1: test for matching the drawings designed for the evaluation of perceptive identification and discrimination. The test consists of 30 tasks, and the test execution time is limited to 4 minutes. The analysis of the test has revealed that the difficulty of the tasks and their intercorrelation indicate that this is a typical speed test.

For estimating the efficiency of a parallel processor, identification of relations and correlates, the following measuring instrument has been selected:

S-l: the spatial reasoning test is designed for the evaluation of rapid simultaneous eduction of spatial relations. It consists of 30 tasks, where it should be determined which of the 4 transversal projections of the brick cluster corresponds to the specified picture of the brick cluster. The test execution time is 10 minutes.

For estimating the efficiency of a serial processor, or symbolic reasoning, the following measuring instrument has been selected:

AL-4: the synonym-antonym test is designed for the evaluation of identification of the denotative meaning of verbal symbols. It consists of 40 tasks of double-choice format. The test execution time is 2 minutes, therefore this test belongs to the category of speed tests. The first main subject to measure is defined

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

mostly by the tasks from the second half of the test and interpreted as the ability of rapid identification of the denotative meaning of the verbal symbols.

2. 3. The methods of data processing

All the data in this research, have been processed in the Multidiscipline Research Center of the Faculty of Sport and Physical Education of the University of Priština by means of the quasi canonical analysis and system of data processing programs developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003). Quasicanonical discriminant analysis (Štalec and Momirović, 1984; Dobrić and Momirović, 1984) may be defined as a solution of the canonical problem

$$Zv_k = t_k,\ Gw_k = h_k \mid \phi_k = t_k{}^t h_k = \text{maximum},\ v_k{}^t v_q = w_k{}^t w_q = \delta_{kq}$$
$$k = 1,...,s;\ s = \min((g - 1), m) = m$$

where δ_{kq} is the Kroneker symbol and v_k and w_k are unknown m - dimensional vectors.

Since $\phi_k = v_k{}^t A w_k$, for k = 1, the function to be maximized is

$$f(v_k, w_k, \lambda_k, \eta_k) = v_k{}^t A w_k - 2^{-1}\lambda_k(v_k{}^t v_k - 1) - 2^{-1}\eta_k(w_k{}^t w_k - 1).$$

By differentiation of this function by the elements of the vector v_k

$$\partial f/\partial v_k = Aw_k - \lambda_k v_k,$$

and by differentiation by the elements of the vector w_k

$$\partial f/\partial w_k = Av_k - \eta_k w_k,$$

after equalization with zero

$$Aw_k = \lambda_k v_k$$

and

$$Av_k = \eta_k w_k.$$

By differentiation by λ_k and η_k it is easily obtained, from the condition $v_k{}^t v_k = 1$ and $w_k{}^t w_k = 1$, that $\lambda_k = \eta_k$. By multiplying the first result by $v_k{}^t$ and the second result by $w_k{}^t$ it is easily obtained, since $A = A^t$, that $v_k = w_k$ and the problem is reduced to the spectral decomposition

$$v_k{}^t A v_k = \lambda_k = \phi_k;$$

but as A is also in a general case positive semidefinite matrix, its singular values are equal to the eigenvalues, and the problem is reduced to the general problem of the eigenvalues

$$(A - \phi_k I)v_k = 0$$

$$k = 1,...,m.$$

Let $V = (v_k)$, $k = 1,...,m$ be a matrix of the eigenvectors of the matrix A, and let $\Phi = (\phi_k)$ be a diagonal matrix of the associated eigenvalues. Quasicanonical discriminant functions obtained by the linear combinations of the variables from the matrix Z will be the vectors of the matrix

$$T = ZV,$$

and quasicanonical discriminant functions obtained by the linear combinations of the variables from the matrix G will be the vectors of the matrix

$$H = GV = PZV.$$

The covariance matrix of the discriminant functions from T will be

$$\Omega = T^tT = V^tRV;$$

Since that matrix cannot, in the general case, be a diagonal matrix, because the vectors from V are not the eigenvectors of the matrix R, the so defined quasicanonical discriminant function cannot be orthogonal. Denote the variance matrix of those functions with

$$\Sigma^2 = \text{diag } \Omega$$

and the matrix whose vectors ψ_k; $k = 1,...,m$ are standardised discriminant functions, with

$$\Psi = T\Sigma^{-1} = ZV\Sigma^{-1}.$$

Since

$$H^tH = V^tAV = \Phi,$$

the quasicanonical discriminant functions obtained as linear combinations of the variables from G are orthogonal, and are actually, nothing but the principal components of the variables from the matrix G, that is the principal components of the variables from the matrix Z projected into the hypercube composed of the binary vectors from the matrix S. Standardized principal components of the matrix G accordingly will be the vectors of the matrix

$$\Theta = H\Phi^{-1/2}.$$

Quasicanonical correlations between the variables from Ψ and Θ will be the elements of the diagonal matrix

$$\Gamma = \Psi^t\Theta = \Sigma^{-1}\Phi^{1/2} = (\gamma_k),$$

and since those correlations are not directly extremized, their asymptotic variances

$$\xi_k^{\,2} = (1 - \gamma_k^{\,2})^2 n^{-1}$$

will be a good estimate of their true variances, and as the approximate tests of the hypotheses that those correlations are equal to zero, there may be applied the functions

$$f_k = \gamma_k^{\,2}((n - 2)(1 - \gamma_k^{\,2})^{-1})$$

because under those hypotheses the functions f_k have, approximately, the Fisher – Snedecor F-distribution with the degrees of freedom $\nu_1 = 1$ and $\nu_2 = n - 2$.

The covariance matrix of the variables from G and variables from Θ

$$U = G^t\Theta = AV\Phi^{-1/2} = V\Phi^{1/2}$$

is, evidently, the factor matrix of the matrix A since

$$UU^t = V\Phi V^t.$$

Slightly more complicated are the identification structures for the quasicanonical discriminant functions from the matrix Ψ, since those functions, in the general case, are not orthogonal.

The crosscorrelarion matrix of the variables from Z and Ψ, or a structural matrix of the quasicanonical discriminant functions, is

$$Q = Z^t\Psi = RV\Sigma^{-1};$$

and as the matrix of intercorrelation of these discriminant functions is

$$M = \Psi^t\Psi = \Sigma^{-1}V^tRV\Sigma^{-1},$$

then their pattern matrix, thus the matrix of vector coordinates of the variables from Z in the coordinate system composed of the vectors of the variables from Ψ, is

$$J = QM^{-1} = V\Sigma$$

if s = m, respectively

$$J = QM^{-1} = RV(V^tRV)^{-1}\Sigma$$

if s < m.

In any case J and Q are the factor matrices of the intercorrelation matrix R because, if s = m,

$$JQ^t = R,$$

and if s < m,

$$JQ^t = RV(V^tRV)^{-1}V^tR$$

which is the general form of approximation of the matrix R to some matrix of a lower rank formed by some operator V.

3. Results and discussion

The results of the discriminant analysis of cognitive variables, indicate that the female dancers in relation to the male dancers are significantly different. The canonical correlation coefficient (Kan. kor.) is .39. The significance of this discrimination tested by Wilks test and Bartlett chi-test with 3 degrees of freedom (DF.) demonstrates great significant differences among the groups of the tested athletes since Sig.=.00 and the results of chi=42.91 for the only obtained square root.

By condensation of the variables in the cognitive space only one discriminant function has been isolated, which maximally separates the groups of athletes according to the discriminant coefficients.

The first discriminant function explains the differences with 100 percent of the intergroup variability in the cognitive space of the applied discriminant variables.

Examining table 1, it can be seen that the first discriminant function, separates the athletes on the basis of IT1 and AL4. IT1 is a test that in the initial measuring estimates the mechanism for receiving and processing information and solving those problems whose elements are directly given in the field of perception or performance. This is actually a mechanism generally known in cybernetics as the input processor.

The second test AL4 is a test which in the initial measuring estimates the mechanism for regulation and control of defence reactions, defined by the appropriate modulation of tonic arousal.

Female dancers need to have the ability to efficiently identify the spatial relations, respectively they need to have the possibility of receiving and processing information and solving those problems whose elements are immediately given

in the field of perception and performance as they have to follow up the dance as well.

It can also be concluded that female dancers have a better expressed ability for the processes of abstraction and generalization, which is understandable considering the requirements imposed by this sport discipline.

On the basis of the value and sign of the projection of the centroid onto the only obtained discriminant function, it can be concluded that male dancers have a better expressed factor of symbolic reasoning, ie they better understand verbal contents and solving the problem whose elements are immediately given in the field of perception and performance, is not primary for them, and their stereotypes of motion are very important, that is they are very dependent on the previously acquired amount of information. Dance is such an activity where there is no need to solve complex motor tasks but the result depends on the level of the adopted dancing techniques and other abilities primarily of musical talent.

DISCRIMINANT ANALYSIS OF TESTS OF COGNITIVE ABILITIES

Table 1.

Fen	1*
Eig.val.	.1845
Pet of Vari.	100.00
Cum. Pet.	100.00
Can. Cor.	.39
Wilks' Lambda	.84
Chi.	42.91
DF	3
Sig	.00

** FUNCTION FUNC 1*

IT1	.80
AL4	.78
SI	.14

CENTROIDS OF GROUPS

GROUPS	FUNC1
FEMALE DANCERS 1	.41
MALE DANCERS 2	-.43

4. Conclusion

The research was conducted in order to determine the differences in the structure of cognitive abilities of male and female dancers involved in standard and Latin American dances.

For estimating the differences in the structure of cognitive abilities of male and female dancers, 267 examinees, aged from 11 to 13, were involved who were actively engaged in standard and Latin American dances.

For the evaluation of cognitive abilities three measuring instruments were applied, selected so that the structure analysis might be resolved according to the cybernetic model of Das, Kirby and Jarman, as well as, Momirović, Bosnar and Horge (1982.), paying attention to the fact that the selected tests could measure three types of cognitive processing.

For estimating the efficiency of the perceptual processor, IT-1 test has been selected, for estimating the efficiency of the serial processor-test AL-4 and for estimating the efficiency of the parallel processor-test S-l.

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programs developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003.

The results of the discriminant analysis of cognitive variables show that there are vast differences between female and male dancers. Condensation of the variables in the cognitive space led to the isolation of only one discriminative function, which maximally separates the groups of athletes, on the basis of IT1 and AL4. IT1 is a test which initially estimates the mechanism responsible for receiving and processing information and, furthermore, for solving the problems whose elements are specified in the space of perception and performance. It is, in fact, a mechanism generally known in cybernetics as the input processor. The second test AL4 is a test which in the initial measuring estimates the mechanisms for regulation and control of defensive reactions, and it is defined by the appropriate modulation of tonic arousal. The conclusion necessarily follows that female

dancers possess a more developed capability for abstraction and generalization processes, which is understandable considering the requirements imposed by this sport discipline.

5. References

[1.] Boli, E.: (2000) Differences in the level of musical, cognitive abilities and personality characteristic of male and female dancers before and after the competition period, PhD thesis, Priština: University of Priština, Faculty of Physical Education.

[2.] Boli, E., Popović, D., Stanković, V. & Grigoropulos, P.: (2001) [Differences in the level of conative characteristics among male and female dancers involved in standard and Latin American dances], Petrovac: 9th Summer School for Pedagogues of Physical Education of Montenegro, Physical Education.

[3.] Boli, E., Popović, D., A. Hošek.: (2009) Sport and Crime, (Scientific monograph), Leposavić: University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[4.] Boli, E.: (2011) The structure of anthropology dimensions of male and female dancers and procedure processing for their evaluation and monitoring (Scientific monograph), Leposavić: University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[5.] Momirović, D, Wolf, B. and Popović, D: (1999) Introduction to the measurement theory and internal metric characteristics of the composite measuring instruments (textbook), Priština: University of Priština, Faculty of Physical Education.

[6.] Momirović, K and Popović, D.: (2003) Construction and application of taxonomic neural networks (monograph), Leposavić: University of Priština, Faculty of Physical Education.

[7.] Momirović, K, A. Hošek and Popović, D.: (2007) Sexual Dimorphism (monograph), Leposavić: University of Priština, Faculty of Physical Education.

[8.] Popović, D.: (1991) Methodology of research in physical education (textbook), Niš: University of Niš, Scientific Youth.

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

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

[11.] Popović, D.: (1993).: Determination of the structure of psychosomatic dimensions in fights and data processing for their evaluation and monitoring (monograph), Priština: University of Priština, Faculty of Physical Education.

[12.] Popović, D., Stanković, V. & Grigoropulos, P.: (1998) Discriminant analysis of motor abilities and morphological characteristics of the prospective basketball and handball players. Physical Education, 19(2), 31-35.

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Differences in the level of cognitive abilities of male and female dancers

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Summary

The research was conducted to determine the differences in the structure of cognitive abilities of female and male dancers, occupied with standard and Latin American dances. For estimating those differences, 267 dancers, aged from 11 to 13, were involved. For the evaluation of cognitive abilities, three measuring instruments were applied, previously selected so that the analysis of the cybernetic model of Das, Kirby and Jarman, as well as Momirović, Bosnar and Horge 1982, taking into account the fact that the chosen tests measure three types of intellectual processing. For estimating the efficiency of the perceptual processor, test IT-1 was selected; for estimating the efficiency of the serial processor-test AL-4; and for estimating the efficiency of the parallel processor-test S-1. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programs developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. The results of the discriminant analysis of

cognitive variables show that there are vast differences between female and male dancers. Condensation of the variables in the cognitive space led to the isolation of only one discriminative function, which maximally separates the groups of athletes, according to IT1 and AL4. IT1 is a test which in the initial measuring estimates the mechanism responsible for receiving and processing information and, furthermore, for solving the problems whose elements are specified in the space of perception and performance. It is, in fact, a mechanism generally known in cybernetics as the input processor. The second test AL4 is a test which initially estimates the mechanisms for regulation and control of defensive reactions, and it is defined by the appropriate modulation of tonic arousal. The conclusion necessarily follows that female dancers possess a more developed capability for abstraction and generalization processes, which is understandable considering the requirements imposed by this sport discipline.

Key words: /discriminant analysis/abstraction/generalization/capability/ processor/ structure/cognitive variables/

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The structure of musical abilities of dancers

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1. Introduction

Music is an art that uses tones as a means of its expression. It reaches our consciousness through the sense of hearing. We, therefore, understand music by listening.

There are various theories about the origin of music. It was considered that music appeared as a result of great energy, at the moment of affect (Spencer), as well as it is a means of rapprochement between the opposite sexes (Darwin), still some relate it to the production, meaning working process (Buher). It may be stated that the simplest theory is the one which relates music to magic.

In his book "The State" Plato wrote : "The better music in a state, the better the state will be". Bergon established that only music may reveal the secret of life, and Pythagoreans believed that cosmos is music in large, and music is cosmos in small.

For a man of the postmodern era, music is the subject of business, a sort of entertainment, or a symbol of social status (opera equally as rock or folk concert). Music is incomparably more beautiful to experience through immediate perform-

ance or listening than to think, read, learn or write about it. But playing music has always been followed by this other aspect. The mysterious power that music has, awareness of it was long ago symbolically transformed into the myth of Orpheus, awakened a desire to learn more about its nature. The word "music" among the ancient Greeks meant the overall development of the spiritual life, "a musical person" was an educated man. Therefore, in this research one of the aims which have been set is to determine the structure of dancers' musical abilities.

2. The methods of research

2. 1. The sample of examinees

The sample of examinees is conditioned by the financial opportunities necessary of the research procedure. Besides, the sample depends on the number of qualified and trained measurers, on the instruments and standardized conditions in which the planned research may be realized.

In order to conduct a correct research with satisfactorily stable results, in the sense of sampling error, it is necessary to include a sufficient number of examinees into the sample. The size of the sample for research of this type is conditioned by the aims and tasks of the research, size of the population and the degree of variability of the applied system of parameters.[23]

According to the selected statistical-mathematical model and the aim of the research, the sample of examinees included 131 female dancers and 136 male dancers, aged from 11 to 13, actively involved with standard and Latin American dances in the Serbian dancing clubs.

The size of the so defined sample should satisfy the following criteria:

- the effectives of the sample should be planned so that it enables as many degrees of freedom as necessary for any coefficient in a pattern or correlation matrix which is equal to or bigger than 0.22, to be considered different from zero with an inference error less than 0.01.
- in order to successfully apply the adequate statistical methods according to the latest convictions, the number of subjects in the sample must be five times bigger than the number of the applied variables.

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

During all factor procedures, it should always be kept in mind that the results of the analysis depend on three major systems which determine the selection and transformation of information: the sample of variables, sample of examinees, and the selected extraction, that is rotation method.[24]

2. 2. The sample of variables

The evaluation of musical abilities has been accomplished according to the well-known Seashore test battery that estimates musicality. This test lasts for 30 minutes and it consists of 6 groups of tasks that are listened to from an audiotape, and the answers are noted on the prepared answer sheets for that purpose. Auditory is provided by the regular schedule of the sound system and their volume so that all the examinees could be exposed to the equal experimental conditions.

This test estimates the following dimensions:

- Pitch discrimination test: it consists of five columns, and each column contains ten tasks. For each task two tones are played. An examinee is to determine whether the second tone was higher or lower than the first one.
- Tone intensity discrimination test: it consists of five columns. Each column contains ten tasks. For each task two tones are played. An examinee is to determine whether the second tone was louder or quieter than the first one.
- Rhythm recognition test: it consists of three columns. Each column contains ten tasks. For each task two rhythmical structures are played. An examinee is to determine whether the second rhythmical structure was the same or different from the first one.
- Tone duration discrimination test: it consists of five columns. Each column contains ten tasks. For each task two tones with different duration are played. An examinee is to determine whether the second tone was longer or shorter than the first one.
- Timbre discrimination test: it consists of five columns, and each column contains ten tasks. For each task two tones are played. An examinee is to determine whether the second tone was the same or different from the first one.

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

- Tonal memory test: it consists of three columns. Each column contains ten tasks. On the column A for each task two melodies are played three times. On the column B two melodies of four tones are played, and on the column C two melodies of five tones are played. An examinee is to determine for each task in which tone the second played melody differs from the first one. For the column A: the first, second or third tone, for the column B: the first, second, third or fourth tone and for the column C: the first, second, third, fourth or fifth tone.

The evaluaton is carried out so that each correct answer for each task in all the tests is worth one point. The total sum of points scored in particular tasks of each test separately, constitutes the result. The result expressed in points should be converted to percentages. The female examinees, according to the number of points obtained on particular tests, depending on their age, are classified in certain classes from "A" to "E".

2. 3. The methods of data processing

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programs developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. There are several reasons for defining an algorithm and writing a program for component analysis of some set of quantitative variables derived by the orthoblique transformation of type II (Harris & Kaiser, 1964) of the principal components whose number is determined according to PB criterion of Štalec and Momirović (Štalec and Momirović, 1971) and whose reliability is estimated by the procedures recently suggested for this type of analysis of the latent dimensions (Momirović, 1996). The first reason is that from all the commercial statistical programs available on the computers that work in DOS or Windows environment (SAS, SPSS, CSS, CS, Statistica, Statgraphics, MicroStat, SyStat etc.) only SAS enables the orthoblique transformation of some basic solution, although, for the majority of problems in psychology and other anthropological sciences, precisely this type of transformation of the principal components is the most frequent solution that is closest to the real latent structure of the analyzed set of variables. The second reason is that none of these programs contains an option to determine the number of the retained components so that their total variance reaches or even exceeds the common variance of the analyzed variables, although this criterion in almost all cases provides more certain evaluations of the actual number of the latent dimensions than the usual Guttman – Kaiser criterion. The third reason is that none of the

commercial statistical packages estimates the reliability of the latent dimensions in any manner, especially the one that is consistent with the algorithm by which those dimensions are determined.

Due to this, the aim of this work is to propose one consistent algorithm for latent structures analysis which is included in the orthoblique transformations of the principal components significant according to PB criterion with the additional operations for the analysis of variance components of manifested and latent variables, and for the evaluation of reliability of latent variables, and to describe a program, written in the Matrix language for SPSS which functions in Windows environment, that is a program available to nearly all users of personal computers or workstations.

THE ALGORITHM

Let Z be the standardized data matrix obtained by the description of some set E of n entity on the set V of m quantitative, normally or at least elliptically distributed variables. Let R be an intercorrelation matrix of those variables. Assume, R to be surely a regular matrix and we can surely reject the hypothesis that the variables from V have spherical distribution, that is the eigenvalues of the correlation matrices in population P out of which the sample E has been drawn, are equal.

Let

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

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

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

If the scalar k is defined as

$$\Sigma_p^{\,k} \lambda_p \geq c, \Sigma_p^{\,k-1} \lambda_p < c.$$

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

Let $\Lambda = (\lambda_p)$; p = 1,...,k be the diagonal matrix of the first k eigenvalues of the matrix R and let $X = (x_p)$; p = 1,...,k be the matrix of the associated eigenvectors scaled so that $X^tX = I$. The principal components of the analyzed set of variables will be the vectors of the matrix

$$K = ZX$$

with the covariance matrix

$$K^tK = \Lambda;$$

if the so defined latent dimensions are standardized by the operation

$$P = K\Lambda^{-1/2}$$

the elements of the matrix

$$H = Z^tPn^{-1} = X\Lambda^{1/2}$$

therefore correlations between the variables and the principal components will, simultaneously, be the coordinates of the vectors of variables in the space stretched by the standardized vectors of the principal components. The variances of standardized variables, projected into k – dimensional space of the principal components, will consequently be the elements of the vector

$$h^2 = \text{vec diag } (HH^t) = \text{vec diag } (X\Lambda X^t);$$

and since, evidently,

$$H^tH = \Lambda,$$

the principal components analysis does not maximize only the variances of the so defined latent dimensions, but also the correlations between those dimensions and the analyzed variables.

Although the principal components have a simple and clear mathematical meaning, their interpretation is frequently extremely complex, especially when the vectors of variables form clusters in the component space. Consequently, practically always, the coordinate system composed of the vectors of the principal components undergoes some parsimonic transformation, while the primary aim of all such transformations is to make it possible for the new coordinate axes to pass through the clusters of the vectors of variables. For that purpose, many methods have been proposed; but orthoblique transformation of type II, proposed by Chester Harris and Henry Kaiser (Harris & Kaiser, 1964) is not only the simplest of them all, but also closest to the basic idea of parsimonic transformations.

Let T be an orthonormal matrix so that it optimizes the function

$$XT = Q = (q_p) \mid p\,(Q) = \text{extremum}, \; T^tT = I,$$

where p (Q) is a parsimonic function, for example, the regular Varimax function

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

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

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

$$K = ZX,$$

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

$$L = KT = ZXT.$$

The covariance matrix of those dimensions is

$$C = L^tLn^{-1} = Q^tRQ = T^t\Lambda T;$$

denote the matrix of their variances as

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

If the latent dimensions are standardized by the operation

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

in the matrix

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

there will be their intercorrelations; notice, that C, and therefore M, cannot be diagonal matrices, so thus obtained latent dimensions are not orthogonal in the space of the entity from E.

The matrix of correlations between the variables from V and latent variables, that is commonly classified as a factor structure matrix, will be

$$F = Z^tDn^{-1} = RXTS^{-1} = X\Lambda TS^{-1};$$

But since the elements of the matrix F of the orthogonal projection of the vector from Z to the vectors from D, the coordinates of those vectors in the space stretched by the vectors from D are the elements of the matrix

$$A = FM^{-1} = XTS.$$

But since

$$A^tA = S^2$$

then the latent dimensions, obtained by this procedure are orthogonal in the space stretched by the vectors of the variables from Z; the squared norms of the vectors of those dimensions in the space of variables are equal to the variances of those dimensions.

Naturally, the matrices A and F are the factor matrices of the matrix R since

$$AF^t = AMA^t = FM^{-1}F^t = HH^t = X\Lambda X^t;$$

Consequently the operation

$$W = (w_{jp}) = A \bullet F$$

where • is a sign of Hadamard multiplication, forms the matrix whose rows include the variance components of variables that may be attributed to orthoblique factors, and the columns contain variance components of orthoblique factors that may be attributed to variables.

Because of its simplicity and clear algebraic and geometric meaning and latent dimensions, as well as identification structures attributed to those dimensions, the reliability of the latent dimensions obtained by the orthoblique transformation of the principal components could be determined in a clear and unambiguous manner (Momirović, 1996).

Let $G = (g_{ij})$; i = 1,...,n; j = 1,...,m be a permissibly unknown matrix of measurement errors when describing the set E on the set V. Then the matrix of the real results of the entity from E on the variables from V will be

$$Y = Z - G.$$

If we, according to the classical measurement theory, assume that the matrix G is such that

$$Y^tG = 0$$

and

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

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

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

if

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

is an intercorrelation matrix of the variables from V defined on the set E.

Assume that, the coefficients of reliability of the variables from V are known; let P be a diagonal matrix whose elements ρ_j are those reliability coefficients. Then the variances of measurement errors for the standardized results on the variables from V will be just the elements of the matrix

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

Now the true values on the latent dimensions will be the elements of the matrix

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

with the covariance matrix

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

Therefore, the true variances of the latent dimensions will be diagonal elements of the matrix Ω; let's denote these elements by ω_p^2. Based on the formal definition of reliability coefficient of some variable

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

where σ_t^2 is the true variance of some variable, and σ^2 is the total variance of that variable, hence the variance which includes the variance of error; the coefficients of reliability of latent dimensions, if reliability coefficients of the variables from which those dimensions have been derived are known, will be

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

$$p = 1,...,k.$$

The coefficients γ_p vary in the range (0,1) and may adopt the value 1 only if P = I, accordingly if all the variables have been measured without error, what is, evidently, theoretically impossible, and the value 0 if and only if P = 0 and R = I, that is, if the total variance of all the variables consists of only one variance of the measurement error, and variables from V have spherical normal distribution. Because if the total variance of each variable from some set of variables consists only of the variance of measurement error, then necessarily $E^2 = I$ and R = I, so that all the coefficients γ_p are equal to zero.

However, the matrix of reliability coefficients $P = (\rho_j)$ is usually unknown, so the matrix of the variances of measurement error E^2 is unknown as well. But, if the variables from V are selected so that they represent some universe of U variables with the same field of meaning, the upper limit of variance of measurement error is defined by the elements of the matrix U^2 (Guttman, 1945), that is, the unique variances of those variables. Consequently, in that case, the lower limit of reliability of latent dimensions can be estimated by the coefficients

$$\alpha_p = 1 - (q_p^tU^2q_p)(q_p^tRq_p)^{-1}$$

$$p = 1,...,k$$

which are derived by the procedure identical to the procedure by which the coefficients γ_p are derived with the definition $E^2 = U^2$, that is, in the same way as

Guttman derived his measure λ_6. Of course, the coefficients α_p vary in the range (0,1), but they cannot reach the value 1. Because if R = I, then $U^2 = I$, so all the coefficients α_p are equal to zero. But, since $U^2 = 0$ is not possible if the matrix R is regular, all the coefficients α_p are inevitably less than 1 and tend to 1, when the unique variance of the variables from which the latent dimensions have been derived tends to zero.

Equally, it is simple to derive measures of the absolute lower limit of reliability of latent dimensions defined by the orthoblique factors. For that purpose, presume $E^2 = I$. Then

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

will be the measures of the absolute lower limit of the latent dimensions reliability, since, evidently, $Q^tQ = I$.

It is obvious that inevitably all the coefficients β_p are less than 1, and that they tend to 1 when m, the number of variables in the set V, tends to infinity, because then each squared form of the matrix R tends to infinity. If R = I, then, naturally, all the coefficients β_p are equal to zero. However, the lower limit of these coefficients does not have to be zero, since it is possible, although not for all the coefficients β_p, that the variance s_p^2 of some latent dimension may be less than 1. Naturally, the latent dimension which emits less information than any other variable out of which it has been derived, has no sense, and it is probably best to discover on the basis of the values of coefficients β_p.

3. Results and discussions

The analysis of the system of six primary musical factors by which the efficiency of the functioning of the regulative mechanisms of musical abilities was estimated, has shown that it contains about 80.90% of the common variance.

At that percentage of the common variance, based on PB criterion of Štalec and Momirović (Štalec and Momirović, 1971), three characteristic roots are isolated. On the basis of the isolated characteristic roots and their corresponding characteristic vectors, the main axes of the covariance of the variables presented in table 2 are calculated.

THE FIRST PRINCIPAL COMPONENT which exhausts 33.00% of a variance, is obviously, a measure of efficient functioning of the whole set of musical abilities. The sequence of definitions of the factors that define musicality is expressed as follows: in the first place there is a mechanism for estimating rhythm, and in the second place is a mechanism for estimating pitches.

THE SECOND PRINCIPAL COMPONENT with a relative variance of 30.30% has a bipolar character. At one pole it is defined by the mechanism for estimating memory, and at the second pole by the mechanism for estimating volume.

THE THIRD PRINCIPAL COMPONENT with a relative variance of 17.60% represents a single factor. This component is defined by the mechanism for estimating timbre.

The factor structure of musical abilities is simultaneously analyzed on the basis of information provided by oblimin transformation of the significant principal components, i.e. on the basis of parallel projections of the variables on the factors (table 3) of the matrix of correlations between variables and factors (table 4) and intercorrelation matrix of factors (table 5).

In respect to the size of variance, the first factor is the most significant among all isolated dimensions. It is defined by the test for estimating volume, rhythm and finally pitch.

The second latent dimension is best defined by the test for estimating duration of a tone on the one hand, and by the test for estimating memory on the other.

The third latent dimension is defined only by the test for estimating timbre.

MATRIX OF INTERCORRELATIONS

Table 1.

Variable	VIT	JAT	RIT	DUT	BOT	MEM
VIT	1.00					
JAT	.35	1.00				
RIT	.42	.40	1.00			
DUT	-.12	-.09	.47	1.00		
BOT	.36	.12	.13	-.01	1.00	
MEM	-.10	- .30	.18	.58	.20	1.00

MATRIX OF PRINCIPAL COMPONENTS

Table 2.

Variable	FAC1	FAC2	FAC3	h^2
VIT	.65	-.48	.22	.70
JAT	.51	-.57	-.35	.72
RIT	.85	.07	-.35	.86
DUT	.46	.76	-.27	.87
BOT	.49	-.11	.77	.86
MEM	.31	.80	.27	.82
LAMBDA	1.97	1.81	1.05	
%	33.00	30.30	17.60	
CUM %	33.30	63.30	80.90	

PATTERN MATRIX

Table 3.

Variable	FAC1	FAC2	FAC3
VIT	.55	-.12	.54
JAT	.82	-.20	-.01
RIT	.77	.52	.02
DUT	.14	.92	-.17
BOT	-.04	.04	.93
MEM	-.29	.81	.25

STRUCTURE MATRIX

Table 4.

Variable	FAC1	FAC2	FAC3
VIT	.63	-.11	.62
JAT	.82	-.22	.09
RIT	.76	.50	.15
DUT	.09	.90	-.11
BOT	.09	.08	.92
MEM	-.28	.83	.24

MATRIX OF INTERCORRELATIONS OF OBLIMIN FACTORS

Table 5.

Variable	OBL1	OBL2	OBL3
OBL1	1.00		
OBL2	-.02	1.00	
OBL3	.14	.04	1.00

4. Conclusion

The research was conducted to determine the structure of musical abilities of dancers, occupied with Standard and Latin American dances.

In order to determine the structure of musical abilities, 267 dancers engaged in standard and Latin American dances, aged from 11 to 13, were examined.

For estimating musical abilities, the well-known Seashore battery of tests for the assessment of musicality was used. This battery evaluates the following tests: pitch discrimination test, tone intensity discrimination test, rhythm recognition test, tone duration discrimination test, timbre discrimination test and tonal memory test.

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003.

The factor structure of musical abilities was simultaneously analyzed on the basis of information obtained by oblimin transformation of the significant principal components, actually on the basis of parallel projections of the variables on the factors (table 3), matrix of correlation between variables and factors (table 4) and intercorrelation matrix of factors (table 5). Judging by the value of variance, the first factor is the most important among all the isolated dimensions, it is defined by the test for estimation of tone intensity, test for recognition of rhythm and finally the test for estimation of pitches. Another latent dimension is best defined by the test for estimating the tone duration, on the one hand, and test for estimating tonal memory, on the other hand. The third latent dimension is defined by the test for estimating the timbre of tones.

5. References

[1.] Boli, E.: (1996) Structure of intellectual and musical abilities and conative characteristics of girls involved in Standard and Latin American dances, Master thesis, Priština: The University of Priština, Faculty of Physical Education.

[2.] Boli, E., Popović, D., A. Hošek.: (2009) Sport and Crime, Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[3.] Boli, E.: (2011) Structure of anthropological dimensions of male and female dancers and data processing for their evaluation and monitoring. (Monograph), Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[4.] Momirović, D, Wolf, B. And Popović, D: (1999) Introduction to the measurement theory and internal metric characteristics of composite measuring instruments (textbook), Priština: The University of Priština, Faculty of Physical Education.

[5.] Popović, D., Antić, K., Stanković, V., Petković, V. & Stanković, S.: (1989) Procedures for objectification of assessing efficiency of performing judo techniques Scientific Youth, 21(1-2), 83-89.

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

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

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

[9.] Popović, D.: (1988) Application methods of factorial analysis for determining morphological types, Varna: 4th international symposium on the methodology of mathematical modelling, Bulgaria.

[10.] Popović, D.: (1991) Methodology of research in physical education (textbook), Niš: The University of Niš, Scientific Youth.

[11.] Popović, D.: (1992) Methodology of Research in Physical Education, Athens, Greece.

[12.] Popović, D.: (1993) Programs and subprograms for analysis of quantitative modifications (textbook), Priština: The University of Priština, Faculty of Physical Education, Multidisciplinary Research Center.

[13.] Popović, D.: (1993) Determining the structure of psychosomatic dimensions in fights and developing the procedure for their evaluation and monitoring (monograph), Priština: The University of Priština, Faculty of Physical Education.

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The structure of musical abilities of dancers

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Summary

The research was conducted to determine the structure of musical abilities of dancers engaged in standard and Latin American dances. For estimating the structure of musical abilities, 267 dancers, aged from 11 to 13, were involved. For estimating musical abilities, the well-known Seashore battery of tests for the assessment of musicality was used. This battery evaluates the following tests: the pitch discrimination test, tone intensity discrimination test, rhythm recognition test, tone duration discrimination test, timbre discrimination test and the tonal memory test. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. The factor structure of musical abilities was parallel analyzed on the basis of information obtained by the oblimin transformation of the significant principal components, actually on the basis of parallel projections of the variables on factors (table 3), the matrix of correlations between variables and factors (table 4) intercorrelation matrix of factors (table 5). Judging by the value of variance, the

first factor is the most important among all the isolated dimensions, it is defined by the tone intensity test, test for the evaluation of rhythm and finally the test for the evaluation of pitches. Another latent dimension is best defined by the test for estimating tone duration on the one hand, and the test for estimating the tonal memory, on the other hand. The third latent dimension is defined by the test for estimating the timbre of tones.

Key words: /tone/ matrix/correlation/variable/factor/rhythm/duration/timbre/memory/

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Canonical correlation between musical and cognitive abilities of dancers

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1. Introduction

When talking about activities in the sphere of musical art it should be mentioned that they are, as just like all other human activities, conditioned by the abilities of people who are occupied with them. The ability of people to notice, comprehend, and reproduce rhythmic, melodic and harmonic elements of music, which is classified as musicality, depends primarily on the role of cognitive personality factors. It may be supposed that cognitive factors will influence the success in musical activities, but it seems that the influence of a spatial factor would be the most significant. Spacialization is defined as the ability to determine relations in a space or to solve many problems considered as spatial problems.

Nevertheless, other cognitive factors are certainly important for every aspect of musical activity. However, cognitive factors are not the only ones that are crucial for the success in some activity, including musical activities. In this work, the relations between musicality and cognitive abilities will be researched.

2. The research methods

2. 1. The sample of examinees

The sample of examinees is conditioned by the financial capabilities necessary of the research procedure. Besides, the sample depends on the number of qualified and trained measurers, on the instruments and standardized conditions in which the planned research can be realized.

In order to conduct the research correctly and get satisfactorily stable results, in the sense of sampling error, it is necessary to include a satisfactory number of examinees into the sample. The size of the sample for the research of this type is as well conditioned by the aims and tasks of the research, the size of the population and the degree of variability of the applied system of parameters.[25]

Based on the selected statistical-mathematical model and the aim of the research, the sample of examinees included 131 female dancers and 136 male dancers, aged from 11 to 13, actively involved in standard and Latin American dances in the Serbian dancing clubs.

The size of the so defined sample should satisfy the following criteria:

- the effectives of the sample should be planned so that it enables as many degrees of freedom as necessary for any coefficient in a pattern or correlation matrix, which is equal to or bigger than 0.22, to be considered different from zero with an inference error less than 0.01.
- in order to successfully apply the adequate statistical methods based on the latest convictions, the number of subjects in the sample must be five times bigger than the number of the applied variables.

During all the factor procedures, it should always be kept in mind that the results of the analysis depend on three major systems which determine the selec-

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

tion and transformation of information: the sample of variables, sample of examinees, and the selected extraction, that is, rotational, method.[26]

2. 1. 1. The sample of variables of musical abilities

The evaluation of musical abilities has been accomplished on the basis of the well-known Seashore test battery that estimates musicality. This test lasts for 30 minutes and it consists of 6 groups of tasks that are listened to from an audiotape, and the answers are noted on the answer sheets prepared for that purpose. Auditory is provided by the regular schedule of the sound system and their volume so that all the examinees could be exposed to equal experimental conditions.

This test estimates the following dimensions:

- Pitch discrimination test: it consists of five columns, and each column contains ten tasks. For each task two tones are played. An examinee is to determine whether the second tone was higher or lower than the first one.
- Tone intensity discrimination test: it consists of five columns. Each column contains ten tasks. For each task two tones are played. An examinee is to determine whether the second tone was louder or quieter than the first one.
- Rhythm recognition test: it consists of three columns. Each column contains ten tasks. For each task two rhythmical structures are played. An examinee is to determine whether the second rhythmical structure was the same or different from the first one.
- Tone duration discrimination test: it consists of five columns.Each column contains ten tasks. For each task two tones of different duration are played. An examinee is to determine whether the second tone was longer or shorter than the first one.
- Timbre discrimination test: it consists of five columns, and each column contains ten tasks. For each task two tones are played. An examinee is to determine whether the second tone was the same or different from the first one.

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

- Tonal memory test: it consists of three columns. Each column contains ten tasks. On the column A for each task two melodies are played three times. On the column B two melodies of four tones are played, and on the column C two melodies of five tones are played. An examinee is to determine for each task in which tone the second played melody differs from the first one. For the column A: the first, second or third tones, for the column B: the first, second, third or fourth tones and for the column C: the first, second, third, fourth or fifth tones.

The evaluation is carried out so that each correct answer for each task in all the tests is worth one point. The total sum of points scored in particular tasks of each test separately constitutes the result. The result expressed in points should be converted to percentages. The female examinees, according to the number of points obtained on particular tests, depending on their age, are classified in certain classes from "A" to "E".

2. 1. 2. The sample of cognitive variables

For estimating intellectual dimensions the measuring instruments are selected so that the cybernetic model may be covered, paying attention to the fact that the selected tests can measure three types of the cognitive processing.

For estimating the efficiency of an input processor, respectively the perceptual reasoning, this test has been selected:

IT-1: test for matching the drawings designed for the evaluation of the perceptual identification and discrimination. The test consists of 30 tasks, and the test execution time is limited to 4 minutes. The analysis of the test has revealed that the difficulty of the tasks and their intercorrelation indicate that this is a typical speed test.

For estimating the efficiency of a parallel processor, or identification of relations and correlates, the following measuring instrument has been selected:

S-l: spatial reasoning test is designed for the evaluation of rapid simultaneous eduction of spatial relations. It consists of 30 tasks, where it should be determined which of the 4 transversal projections of the brick cluster corresponds to the specified picture of the brick cluster. The test execution time is 10 minutes.

For estimating the efficiency of a serial processor, or symbolic reasoning, the following measuring instrument has been selected:

AL-4: synonym-antonym test is designed for the evaluation of identification of the denotative meaning of the verbal symbols. It consists of 40 tasks of double-choice format. The test execution time is 2 minutes, therefore this test

belongs to the category of speed tests. The first main subject to measure is defined mostly by the tasks from the second half of the test and interpreted as the ability of rapid identification of the denotative meaning of the verbal symbols.

2. 2. The methods of data processing

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programs developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003.

The method for asymmetry-based overlap analysis proposed in this work is based on the previosly published work of Momirović, Štalec and Zakrajšek (1973) on the generalised image transformations and on the method for decomposition of latent structures proposed by Dobrić, Karaman and Momirović (1983). The essence of the proposed method is canonical covariance analysis (Momirović, Dobrić i Karaman, 1983) of one set of variables and image transformation of that set of variables performed by the projection of that set into the space stretched by the vectors of some other set of variables. Although the aim of the proposed method, in a certain sense, is similar to the aim of the classical method for the overlap analysis (Van Den Wollenberg, 1977) and method for canonical factor overlap analysis (De Sarbo, 1981), a criterion function of canonical covariance analysis in a generalised image space is different from the criterion function of Van Den Wollenberg and De Sarb's method, thus the interpretation of the obtained measures of association is based on completely different assumptions.

THE ALGORITHM

Let Z_1 be a data matrix, in the standard normal form, obtained by the description of a random sample E from n objects on the sample V_1 of m_1 quantitative or quantified variables, and let Z_2 be another data matrix, also in the standard normal form, obtained by the description of E on the sample V_2 of quantitative or quantified variables that $V_1 \cap V_2 = 0$. Assume, without losing the possibility of generalisation, $m_2 \leq m_1$, and denote by $R_{11} = Z_1^tZ_1$ and $R_{22} = Z_2^tZ_2$ the intercorrelation matrices, estimated under the maximum likelihood criterion, of the variables from V_1 and V_2, and by $R_{12} = R_{21}^t = Z_1^tZ_2$ the matrix of crosscorrelations between the variables from V_1 and V_2.

Let $B = R_{11}^{-1}R_{12}$ be a matrix of the standardized regression coefficients obtained by resolving the regression problem $Z_1B = Z_2 - E \mid \text{trag}\,(E^tE) = \text{minimum}$, and let $G = Z_1B$ be a matrix of the image variables from V_2 in the space stretched

by the vectors of variables V_1. Denote, finally, by $M = G^tG = B^tR_{11}B$ as a covariance matrix of variables from G.

The canonical covariance analysis in a generalised covariance image space may be defined as a solution of the problem

$$Z_2x_p = k_p,\ Gy_p = l_p \mid c_p = k_p{}^tl_p = \text{maximum},\ x_p{}^tx_q = y_p{}^ty_q = \delta_{pq}$$

where δ_{pq} are the Kroneker symbols. The covariances

$$c_p = k_p{}^tl_p = x_p{}^tMy_p$$

among the linear combinations of variables from Z_2 and linear combinations of variables from G can be maximized by the maximization of the function

$$f(x_p, y_p, \lambda_p, \eta_p) = x_p{}^tMy_p - 1/2\ \lambda_p\ (x_p{}^tx_p - 1) - 1/2\ \eta_p\ (y_p{}^ty_p - 1)$$

$$p = 1,...,m2$$

where λ_p and η_p are some unknown Lagrange multipliers.

Differentiation of the function f in regard to the elements of the vector x_p and then in regard to the elements of the vector y_p provides, for p = 1,

$$\partial f/\partial x_p = My_p - \lambda_p x_p \Rightarrow My_p = \lambda_p x_p$$

$$\partial f/\partial y_p = Mx_p - \eta_p y_p \Rightarrow Mx_p = \eta_p y_p$$

so that, by multiplying the first result by $x_p{}^t$, and the second result by $y_p{}^t$,

$$x_p{}^tMy_p = \lambda_p,\ y_p{}^tMx_p = \eta_p \Rightarrow \lambda_p = \eta_p = c_p$$

is obtained and, since $M^t = M$, $x_p = y_p$ and the problem is reduced to the simple problem of the characteristic values and the vector of the matrix M

$$(M - \lambda_p I)x_p = 0$$

$$p = 1,...,m2,$$

basically, to the problem of the principal components of the variables from G.

Let now $\delta^2 = (\text{trag } M)/m^2$ be a generalised canonical index defined on the relations between the variables from Z_1 and Z_2. A rational procedure for determining the number of significant latent dimensions, which are the generators of the relations between the analyzed sets of variables, is the well-known MEIG criterion, defined by

$$k = \text{num}\ (\lambda_p \geq \delta^2).$$

If $X = (x_p)$; p = 1,...,k is a matrix of eigenvectors associated with the significant latent dimensions, and $C = (c_p)$; p = 1,...,k is a diagonal matrix of the first k

covariances between the variables k_p and l_p, the latent dimensions obtained by the linear combinations of variables from Z_2 will be the vectors of the matrix

$$K = Z_2X,$$

the latent dimensions obtained by the linear combinations of variables from G will be the vectors of the matrix

$$L = GX,$$

and

$$C = K^tL = X^tMX$$

will be the matrix of covariances between the variables from K and L, and, simultaneously, the matrix of covariances of the variables from L, because, obviously,

$$C = L^tL = X^tMX.$$

Accordingly, the variables from K and L form one semibiorthogonal system, since

$$V = K^tK = X^tR_{22}X$$

is not, in a general case, a diagonal matrix.

Let D^2 = diag V be a variance matrix of variables from K. Therefore, the diagonal elements of the matrix

$$P = D^{-1}K^tLC^{-1/2} = D^{-1}C^{1/2} = (\rho_p)$$

will be quasicanonical correlations between the significant latent dimensions of variables from Z_2 and image variables from G.

Asymptotic variances of quasicanonical correlations ρ_p are, naturally,

$$\sigma_p^2 = (1 - \rho_p^2)^2 / n,$$

thus equal to the asymptotic variances of product-moment coefficient of any type of correlation. This fact may be used for the construction of approximate intervals of reliability and testing the hypothesis H_p: $\rho_p = \rho_{ph}$, where ρ_{ph} are hypothetical quasicanonical correlation coefficients.

Identification of the content of latent dimensions from L is very simple since, because of orthogonality of those dimensions both in the space of objects and in the space of variables from G, the matrix

$$S = G^tL = XC$$

is, concurrently, a pattern matrix and a structure matrix of nonstandardized latent dimensions, and the matrix

$$T = G^tLC^{-1/2} = XC^{1/2}$$

is a factor matrix of the matrix M.

Identification of the content of latent dimensions K is slightly more complicated, since

$$W = D^{-1}VD^{-1},$$

the intercorelation matrix of the variables from K, is not, in a general case, a diagonal matrix. The structure matrix, in the space of standardized latent dimensions, is

$$F = Z_2{}^tKD^{-1} = R_{22}XD^{-1}$$

so that, in the same space,

$$A = FW^{-1} = R_{22}X(X^tR_{22}X)^{-1}D$$

is a pattern matrix of variables Z_2; note that A and F are factor matrices of the matrix R_{22}, because

$$AF^t = R_{22}X(X^tR_{22}X)^{-1}X^tR_{22}$$

which is the proof that variables from K are the factors, in the factor-analytical sense, of the variables Z_2.

3. Results and discussion

By canonical covariance analysis (Momirović, Dobrić and Karaman, 1983), there have been determined the relations between the sets of variables for estimating musical and intellectual abilities of female examinees actively engaged in Standard and Latin American dances.

In (table 1) cross-correlations of musical and intellectual variables are presented, (table 4) shows coefficients of canonical correlations, the square roots of the canonical equation and their significances, and in (tables 2 and 3) correlations of variables for estimating musical and intellectual abilities with canonical dimensions are presented.

By inspecting the cross-correlation matrix of musical and intellectual variables, it can be noticed that there has been obtained statistically significant relationship between the efficient processing of the input processor and the test for the evaluation of the pitch, volume and timbre of a tone. Also it may be observed that significant correlation between the efficiency of the serial processor and tests for the evaluation of the duration of a tone, rhythm, pitch, tonal memory and timbre of a tone have been obtained, as well as positive correlation between the

efficiency of the parallel processor and tests for estimating memory, duration of a tone and rhythm.

The analysis of characteristic roots indicates that the significant correlation for rejecting the null hypothesis is possible for two roots, which means that from three hypothetical possible canonical dimensions, two are sufficient to explain the relations between two examined systems of variables (table 4).

In the space of musical abilities (table 2) the first canonical factor is defined as having a negative sign by the tests for evaluation of tonal memory, tone duration and rhythm. The correspondence factor in the space of intellectual abilities is defined by the tests for evaluation of parallel processor and of the efficiency of serial processing.

From all of the above stated, it necessarily follows that in this sport discipline, the ability to memorize music layouts, recognize the rhythm and duration of tones are directly related to the efficiency of the parallel and serial processors, and the ability to determine the pitch and timbre of tones is somehow connected with the input processor. It is also necessary to known that auditory sensitivity depends on the tone volume but concurrently on the pitch of a tone. Auditory sensitivity is greater with high than deep tones so it seems that a higher tone is stronger than a deep tone of the same acoustic intensity.

On the other hand, auditory sensitivity does not increase equally as volume. The strongest sense of a tone is about 30 times stronger than the weakest.

The second canonical factor in the space of musical abilities is best defined by the test for recognizing the pitch and timbre of a tone.

The correspondence factor in the space of cognitive abilities, is defined only by the test for estimating the efficiency of the input processor.

The analysis of both canonical dimensions leads to the conclusion that the input processor and the abilities to discriminate pitches may probably be subordinated to a common regulatory mechanism which coordinates the functioning of those two abilities. If all the previously obtained information is summarized, it could be concluded the following:

Spatial or simultaneous integration of information related to the rhythmic figures (or beyond the rhythmic structures) doubtlessly includes the eduction factor, meaning that there are relations between the elements of dance structures and the elements of rhythmic structures as well as there is some regularity which regulates the whole process of thinking regarding rhythmic tasks or problems.

However, since simultaneous information integration almost never appears independently, because most of the problems cannot be resolved in only one manner, that is simultaneously or serially. The information, and therefore rhythmic information of the dancers, also processed in time-structured series, thus serial

and successive processing, evaluated by verbal and numerical tests, significantly influence the reception, retention and processing of rhythmic operations.

The connection of input processors with musical abilities of dancers should also be emphasized.

CROSSCORRELATIONS BETWEEN VARIABLES OF MUSICALITY AND COGNITIVE ABILITIES OF DANCERS

Table 1.

TEST	IT1	AL4	SI
VIT	.33	.33	.03
JAT	.26	-.04	-.07
RIT	.08	.36	.31
DUT	-.02	.37	.39
BOT	.14	.27	.10
MEM	-.03	.28	.57

FACTOR STRUCTURE OF MUSICALITY VARIABLES

Table 2.

TEST	CAN1	CAN2
VIT	-.19	-.85
JAT	.19	-.39
RIT	-.61	-.24
DUT	-.73	-.00
BOT	-.28	-.44
MEM	-.84	.29

FACTOR STRUCTURE OF INTELLECTUAL VARIABLES

Table 3.

TEST	CAN1	CAN2
IT1	-.01	-.71
AL4	-.69	-.63
SI	-.84	.27

CANONICAL VARIABLES

Table 4.

R	R-sqr.	Chi-sqr.	df	p	A
.68	.47	123.48	18	.00	.47
.48	.23	45.93	10	.00	.77

4. Conclusion

The research was conducted in order to determine the relations between musical and intellectual abilities of the dancers engaged in the standard and Latin American dance.

For estimating relations between musical and intellectual abilities, 267 dancers, aged from 11 to 13, actively engaged in standard and Latin American dances were involved.

For estimating musical abilities the well-known Seashore test battery for the evaluation of musicality was used. This battery evaluates the following tests: pitch discrimination test, tone volume discrimination test, rhythm recognition test, tone duration discrimination test, timbre discrimination test and a tonal memory test.

For the evaluation of cognitive abilities, three measuring instruments were applied, selected so that the structure analysis could be solved on the basis of the cybernetic model of Das, Kirby and Jarman, respectively Momirović, Bosnar and Horge 1982, taking into account the fact that the chosen tests measure three types of intellectual processing.

For estimating the efficiency of the perception processor, test IT-1 was selected; for estimating the efficiency of the serial processor, test AL-4; and for estimating the efficiency of the parallel processor, test S-1.

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. The canonical correlation analysis determined the correlations between the sets of variables for estimating musical and intellectual abilities of the examinees who are actively engaged in standard and Latin American dance. The analysis of characteristic roots points to the fact that the significant correlation for rejecting the null hypothesis

is possible only for two roots, which means that out of three hypothetic possible canonical dimensions two are sufficient for explaining the relations between the two examined systems of variables. In the space of musical abilities the first canonical factor is defined as having a negative sign by the test for estimating the tonal memory, the duration of tones, and rhythm. The correspondence factor in the space of intellectual abilities is defined by the test for estimating parallel and serial processing. The second canonical factor in the space of musical abilities is best defined by the test for recognition of pitches and for discrimination of the timbre of tones. The correspondence factor in the space of intellectual abilities is defined only by the test for evaluation of the efficiency of the input processor.

5. References

[1.] Boli, E., Popović, D., A. Hošek.: (2009) Sport and Crime, Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[2.] Boli, E.: (2011) Structure of anthropological dimensions of male and female dancers and data processing for their evaluation and monitoring. (Monograph), Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[3.] Momirović, D, Wolf, B. i Popović, D: (1999) Introduction to the measurement theory and internal metrical characteristics of the measuring instruments (textbook), Priština: The University of Priština, Faculty of Physical Education.

[4.] Popović, D. & Stanković, V. (2005). Canonical coherence between motor abilities and efficiency in performing judo techniques, Plenary lecture, Pančevo: 1st international scientific symposium "The effect and influences of different models of training process to anthropological status of sportsmen in fighting skills", (pp. 11-18), Serbia. (Plenary session – invited lecture).

[5.] Popović, D. Antić, K., Stanković, V., Petković, V. & Stanković, S.: (1989) Relations between morphological characteristics and efficiency in performing judo techniques. Scientific Youth, 21(1-2), 75-83.

[6.] Popović, D., Boli, E., Malacko, J., Dragić, B., Toskić, D. & Stanković, V. (2002). Relationship between abilities dependent upon moving regulation and upon energetic regulation, Athens: In M. Koskolou, N. Geladas, V. Klissouras (Eds), 7th Annual Congress of the ECSS, (pp. 1173), vol 2, Greece.

[7.] Popović, D., Stanković, S., R. Popović, Petković, V. & Stanković, V.: (1987) Canonical correlation analysis as an optimal method for determining relations between two sets of variables, Scientific Youth, 19(3-4), 63-71.

[8.] Popović, D., Stanković, V. & Stanković, S.: (1997) The canonical connection between cognitive abilities and motor information of handball players, Istanbul: II Spor Bilimleri Kongresi, Book of abstracts (pp. 46), Turkey.

[9.] Popović, D.: (1987) Motor Abilities Relations and the Estimate of Successfulness of the Execution of Judo Techniques, Zagreb: Proceedings of Fisu\Cesu conference universiade 1987., Yugoslavia.

[10.] Popović, D.: (1990) Relations between conative characteristics and efficiency in performing judo techniques by young athletes, Ljubljana-Bled: 4th Congress of pedagogues from Yugoslavia and first international symposium.

[11.] Popović, D.: (1991) Methodology of research in physical education, Niš: The University of Niš, Scientific Youth.

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

[13.] Popović, D.: (1993) Programs and subprograms for analysis of quantitative modifications (textbook), Priština: The University of Priština, Faculty of Physical Education, Multidisciplinary Research Center.

[14.] Popović, D.: (1993) Determining the structure of psychosomatic dimensions in fights and data processing for their evaluation and monitoring (monograph), Priština: The University of Priština, Faculty of Physical Education.

[15.] Popović, D.: (1997) Canonical correlation between cognitive abilities and motor information of handball players, Istanbul: II Spor Bilimleri Kongresi, Turkey.

[16.] Popović, D.:(1990) Relations between conative characteristics and efficiency in performing judo techniques by young athletes, Ljubljana-Bled: 4th Congress of pedagogues from Yugoslavia and first international symposium.

[17.] Stanković, V. & Popović, D.: (1988) Relations between motor abilities and efficiency in performing judo techniques, Scientific Youth, 20(1-2), 15-25.

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Canonical correlation between musical and cognitive abilities of dancers

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Summary

The research was conducted in order to determine the relations between musical and intellectual abilities of the dancers occupied with the standard and Latin American dance. For estimating the relations between musical and intellectual abilities, 267 dancers, aged from 11 to 13 were involved. For estimating musical abilities the well-known Seashore test battery for the assessment of musicality was used. This battery evaluates the following tests: pitch discrimination test, tone intensity discrimination test, rhythm recognition test, tone duration discrimination test, timbre discrimination test and a tonal memory test. For the evaluation of cognitive abilities, three measuring instruments were applied, selected so that the structure analysis could be solved on the basis of the cybernetic model of Das, Kirby and Jarman, respectively Momirović, Bosnar and Horge 1982, taking into account the fact that the chosen tests measure three types of intellectual processing. For estimating the efficiency of the perception processor,

test IT-1 was selected; for estimating the efficiency of serial processor, test AL-4; and for estimating the efficiency of parallel processor, test S-1. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. The canonical correlation analysis determined the correlation between the sets of variables for estimating musical and intellectual abilities of the examinees who are actively engaged in standard and Latin American dance. The analysis of characteristic roots points to the fact that the significant correlation for rejecting the null hypothesis is possible only for two roots, which means that out of three hypothetic possible canonical dimensions two are sufficient for explaining the relations between the two examined systems of variables. In the space of musical abilities the first canonical factor is defined as having a negative sign by the test for estimating tonal memory, tone duration and rhythm. The correspondence factor in the space of intellectual abilities is defined by the test for estimating parallel and serial processing. The second canonical factor in the space of musical abilities is best defined by the test for pitch recognition and for determining the timbre. The correspondence factor in the space of intellectual abilities is defined only by the test for the assessment of efficiency of the input processor.

Key words: /input processor/pitch/timbre/tone duration/analysis/tonal memory/root/hypothesis/

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The structure of personality characteristics of dancers

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1. Introduction

The efficiency of performing any human activity, and therefore dancing, is not independent of the characteristics that regulate the behavioral modalities. Some characteristics from the cognitive space constrain the efficiency in different activities directly, while in others indirectly, for instance, because of the contaminating effect on cognitive functions or on some other abilities. There cannot be excluded the possibility that the same conative traits in some activities are the restrictor while in others they are the stimulator of efficiency, if, certainly, they take part in the success of a certain activity.

There is also a valid rule that there are not even two subjects with the completely identical structure of any, and therefore those traits, regardless of their final number. This is the reason why the knowledge of the complexity of any activity, which also includes the space of conative traits, is a significant assumption of operationalization of the goal of every activity, including dancing.

2. The research methods

2. 1. The sample of examinees

The sample of examinees is conditioned by the financial capabilities necessary for the research procedure. Besides, the sample depends on the number of qualified and trained measurers, on the instruments and standardized conditions in which the planned research may be realized.

In order to conduct a correct research with satisfactorily stable results, in the sense of sampling error, it is necessary to include a satisfactory number of examinees into the sample. The size of the sample for research of this type is as well conditioned by the aims and tasks of the research, size of the population and the level of variability of the applied system of parameters.[27]

According to the selected statistical-mathematical model and the aim of the research, the sample of examinees included 131 female dancers and 136 male dancers, aged from 11 to 13, actively engaged in standard and Latin American dances in the Serbian dancing clubs.

The size of the so defined sample should satisfy the following criteria:

- the effectives of the sample should be planned so that it enables as many degrees of freedom as necessary for any coefficient in a pattern or correlation matrix, which is equal to or bigger than 0.22, to be considered different from zero with an inference error less than 0.01.
- in order to successfully apply the adequate statistical methods according to the latest convictions, the number of subjects in the sample must be five times bigger than the number of the applied variables.

During all factor procedures, it should always be kept in mind that the results of the analysis depend on three major systems which determine the selection and transformation of information: the sample of variables, sample of examinees, and the selected extraction, that is rotation, method.[28]

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

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

2. 2. The sample of variables

2. 2. 1. The sample of personality variables

For estimating personality dimensions, the following measuring instruments have been selected so that they may cover the dimensions of the model of the functioning of conative regulatory mechanisms. The model assumes a hierarchical organization of the mechanisms for regulation and control of the behavioral modalities, and it is constructed so as to avoid the artificial dichotomy to normal and pathological factors.

The selected measuring instruments are:

1) Activity regulator (EPSILON)
2) Regulator of organic functions (HI)
3) Regulator of defensive reactions (ALFA)
4) Regulator of offensive reactions (SIGMA)
5) System for the coordination of regulatory functions (DELTA)
6) System for the integration of regulatory functions (ETA).

The activity regulation mechanism is one of the elementary and lowest positioned systems in the hierarchy. Its function is the regulation and modulation of the activation function of the reticular formation; therefore, it is responsible for the activity and energy level at which other subsystems, including cognitive processes, function. Extroverted and introverted behaviour models depend on the functioning of the system.

Disorders of this system can produce the energy basis for hypomanic or depressive reactions and they probably affect the speed of information stream in the central nervous system.

The mechanism for regulation and control of organic functions is defined by the effectiveness of the coupling between subcortical regulation functions of the organic systems and higher-ranking cortical systems for regulation and control.

Disorders of this system are manifested by a functional disorder of the primary organic systems, such as cardiovascular, respiratory and gastrointestinal systems, and by functional disorders of input and output operations.

The mechanism for regulation and control of the defensive reactions is defined by the appropriate modulation of tonic arousal, probably based on the adequacy of programs that are of genetic origin or are formed during the evolution and positioned in the center for the regulation of defensive reactions.

Disorders of the system for regulation of defence reactions are manifested by various symptoms of anxiety and they form the basis for specially modulated pathological reactions, such as phobia, obsession and compulsion.

The mechanism for regulation and control of offence reactions is also defined by the appropriate modulation of tonic arousal, based on the adequacy of the programs transmitted by the genetic code or formed under the influence of conditioning and positioned in the center for the regulation of offensive reactions.

Disorders of the system for regulation and control of offensive reactions are manifested in various aggressive reactions and in poor control of immediate impulses.

The mechanism for homeostatic regulation is determined by the coordination of activities of functially and hierarchically different subsystems, especially including the coordination of functions of conative regulatory system and intellectual processors. Owing to this, the homeostatic regulatory system is functionally superior to the systems for the regulation of organic functions, defensive and offensive reactions, and furthermore it controls the processes occurring in the system for the regulation of excitation and inhibition.

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

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 within it. The set of programs which determine its functioning is mostly formed during the educational process. Social disadaptation is an immediate consequence of the functioning of this mechanism.[29]

2. 3. Methods for results processing

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. Therefore the aim of this work is to propose one consistent algorithm for the analysis of latent structures which consists in orthoblique transformation of the principal components significant by PB criterion with additional operations for the analysis of the

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

components of variances of manifest and latent variables as well as for the evaluation of the reliability of latent variables.

THE ALGORITHM

Let Z be a matrix of the standardized data obtained by the description of some set E of n entity on some set V of m quantitative, normally or, at least, elliptically distributed variables. Let R be an intercorrelation matrix of those variables. Assume, R is a surely a regular matrix, and there can with certainty be rejected the hypothesis that variables from V have spherical distribution, i.e. the eigenvalues of the correlation matrix of population P, from which the sample E has been drawn, are equal.

Let

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

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

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

Define the scalar k as

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

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

Let $\Lambda = (\lambda p)$; p = 1,...,k be a diagonal matrix of the first k eigenvalues of matrix R and let $X = (x_p)$; p = 1,...,k be a matrix of the associated eigenvectors scaled so that $X^tX = I$. Let T be some orthonormal matrix such that it optimizes the function

$$XT = Q = (q_p); p(Q) = \text{extremum}, T^tT = I,$$

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

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

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

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

$$K = ZX,$$

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

$$L = KT = ZXT.$$

The covariance matrix of those dimensions is

$$C = L^tLn^{-1} = Q^tRQ = T^t\Lambda T;$$

Denote a matrix of their variances as

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

If the latent dimensions are standardized by the operation

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

in the matrix

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

there will be their correlations; it can be seen, that C, and therefore M, cannot be diagonal matrices, so that thus obtained latent dimensions are not orthogonal in the space of E entity.

The matrix of correlations between variables from V and latent variables, usually classified as a factor structure matrix, will be

$$F = Z^tDn^{-1} = RXTS^{-1} = X\Lambda TS^{-1};$$

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

$$A = FM^{-1} = XTS.$$

But since

$$A^tA = S^2$$

then the latent dimensions obtained by this procedure are orthogonal in the space stretched 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 those dimensions.

EVALUATION OF THE RELIABILITY OF LATENT DIMENSIONS

For its simplicity and clear algebraic and geometric meaning and latent dimensions, and the identification structures associated with those dimensions, the reliability of the latent dimensions obtained by orthoblique transformation of principal components, may be determined in a clear and unambiguous manner.

Let $G = (g_{ij})$; i = 1,...,n; j = 1,...,m be an acceptably unknown matrix of measurement errors when describing the set E on the set V. Then the matrix of the real results of entity E on the variables from V will be

$$Y = Z - G.$$

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

$$Y^tG = 0$$

and

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

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

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

since

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

is an intercorrelation matrix of variables from V defined on the set E.

Assume, the reliability coefficients of variables from V are known; let P be a diagonal matrix whose elements ρ_j are those reliability coefficients. Then the variances of measurement errors for standardized results on variables from V will precisely be the elements of the matrix

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

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

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

with the covariance matrix

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

Accordingly, the real variances of latent dimensions will be diagonal elements of matrix Ω; detote those elements as ω_p^2. Based on the formal definition of reliability coefficients of some variable

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

where σ_t^2 is the real variance of some variable, and σ^2 is the total variance of that variable, that is, the variance which includes the error variance, the coefficients

of reliability of latent dimensions, if the reliability coefficients of variables from which those dimensions have been derived are known, will be

$$\gamma_p = \omega_p^2 / s_p^2 = 1 - (q_p^t E^2 q_p)(q_p^t R q)^{-1}$$

$$p = 1,...,k$$

Proposition 1.

Coefficients γ_p vary in the range of (0,1) and may adopt the value 1 when and only when P = I, that is, if all the variables are measured without errors, and the value 0 when and only when P = 0 and R = I, that is, if the total variance of all the variables consists only of the variance of measurement error and variables from V have spherical normal distribution.

Proof:

If the total variance of each variable from some set consists only of the variance of measurement error, then it is obligatory that $E^2 = I$ and R = I, so all the coefficients γ_p equal zero. The first part of the proposition is obvious from the definition of coefficients γ_p; which means that the 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 measured without error.

However, the matrix of reliability coefficients $P = (\rho_j)$ is frequently unknown, so the matrix of variances of measurement error E^2 is as well unknown. But, if the variables from V are selected so that they may represent some universe of variables U with the same field of meaning, the upper limit of variances of measurement errors is defined by the elements of the matrix U^2 (Guttman, 1945; 1953), that is by the unique variances of those variables. Consequently, in that case, the lower limit of the reliability of latent dimensions may be estimated by the coefficients

$$\beta_p = 1 - (q_p^t U^2 q_p)(q_p^t R q_p)^{-1}$$

$$p = 1,...,k$$

which are derived from the procedure identical to the procedure by which the coefficients γ_p have been derived with the definition $E^2 = U^2$, therefore in the same way as Guttman derived his own measure λ_6.

Proposition 2.

Coefficients β_p vary in the range of (0,1), although they cannot reach the value 1.

Proof:

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

By applying the same technology, it is simple to derive measures of the absolute lower limit of reliability of latent dimensions defined by this procedure in the same way as Guttman derived his measure λ_1. For this purpose, set $E^2 = I$. Then

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

will be the measures of the absolute lower limit of reliability of latent dimensions, since, naturally,

$$Q^t Q = I.$$

Proposition 3.

All the coefficients α_p are always less than 1.

Proof:

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

The measures of type β_6 (Momirović, 1996) defined by the functions α_1 and α_2 will be, for the result defined by function h,

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

and

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

It is not difficult to show that, for the regular sets of particles, measures of type α_1 are the estimates of the lower limit of reliability of measures of type λ_6 and β_6, and that the measures of type α_2 are the estimates of the upper limit of reliability of measures of type λ_6 and β_6.

3. Results and discussion

In order to determine the characteristics of the basic space of conative variables, transformation and condensation of data in the intercorrelation matrix have been accomplished, and thus the features of measuring instruments are obtained.

Examining the structure of the matrix of intercorrelations among conative variables, it may be noticed that most of the intercorrelations are at a high level. (table 1).

The matrix is structured so that it forms a few blocks for which it could be said that they have decent intercorrelations. However, a real insight into the structure of personality traits could be gained after the factor extraction (table 2). According to the Gutman-Kaiser criterion, two latent dimensions with the total of 73.70% of the common variance have been isolated.

THE FIRST PRINCIPAL COMPONENT exhausts 55.10% of the total variance of the whole system of variables and it acts as a general factor of personality traits. All the variables that define this factor have very high correlations except the variable for estimating activity.

THE SECOND PRINCIPAL COMPONENT exhausts still decent 18.70% of the remaining variability and behaves as a single factor. It is defined by the activity regulator.

In order to obtain a simple structure, the initial reference system is rotated to the oblimin position and afterwards three more matrices are obtained: the pattern matrix, the structure matrix, and the correlation matrix of oblimin factors (tables 3, 4, and 5).

By parallel analysis of the pattern matrix and structure matrix, it may be noticed that the first latent dimension best of all defines the test for the evaluation of the system for integration of regulatory functions, and then, equally well, the test for the evaluation of the system for coordination of regulatory functions and regulation of defensive reactions, and then the test for the evaluation of regulation of organic functions and regulation of offensive reactions.

Considering that it is a discipline which requires a high degree of coordination abilities and their control with coordinated muscle tone and timely processing of the sensory musical stimulus as well as visual control of the space and elements in the visual field, i.e. it is necessary to harmonize the coordination of all movements with the partner and to take into account the whole space and other dancers who are performing dancing elements on the same dance floor. That, certainly, imposes at the same time the need for efficient functioning of the system for integration of regulatory functions, coordination of regulatory functions, defence regulation, regulation of organic systems and regulation of offensive reactions.

The second latent dimension is defined by the variable for estimating the excitatory-inhibitory processes. That dimension is similar to the second factor in the research of Momirović (1982.) and the third latent dimension of Popović (1990.). Since the regulation of the activating function of the reticular formation is the most probable physiological basis of variability and covariability of the test which defines it, presumably it is most adequate to interpret this factor as a measure of the efficiency of the mechanism for regulation of activity or regulation of processes of irritation and inhibition in accordance with some researches of Popović (1995, 1996).

It should be mentioned that in some researches thus obtained factor may be interpreted as a measure of extraversion (Aizenk) and even as a measure of Cattell's ehvia.

Considering the significance of this dimension, that is, the significance of the mechanism for activity regulation, it is, apparently, very well expressed in dancers engaged in standard and Latin American dance.

INTERCORRELATION MATRIX

Table 1.

Variable	EPS	XI	ALF	SIG	DEL	ETA
EPS	1.00					
XI	.04	1.00				
ALF	-.14	.56	1.00			
SIG	.09	.33	.65	1.00		
DEL	-.01	.21	.59	.75	1.00	
ETA	.28	.63	.63	.58	.71	1.00

MATRIX OF PRINCIPAL COMPONENTS

Table 2.

Variable	FAC1	FAC2	h^2
EPS	.09	.97	.95
XI	.64	.08	.42
ALF	.84	-.28	.79
SIG	.83	-.05	.69
DEL	.82	-.11	.69
ETA	.88	.26	.85
LAMBDA	3.30	1.12	
%	55.10	18.70	
CUM %	55.10	73.70	

PATTERN MATRIX

Table 3.

Variable	FAC1	FAC2
EPS	.00	.97
XI	.63	.10
ALF	.87	-.25
SIG	.83	- .02
DEL	.83	-.08
ETA	.85	.29

STRUCTURE MATRIX

Table 4.

Variable	FAC1	FAC2
EPS	.06	.97
XI	.64	.14
ALF	.85	-.20
SIG	.83	.02
DEL	.82	-.03
ETA	.87	.34

MATRIX OF INTERCORRELATIONS OF OBLIMIN FACTORS

Table 5.

Variable	OBL1	OBL2
OBL1	1.00	
OBL2	-.06	1.00

4. Conclusion

The research was conducted in order to determine the structure of personality characteristics of dancers, engaged in standard and Latin American dances.

For determining the structure of personality characteristics, 267 dancers, aged from 11 to 13, actively engaged in standard and Latin American dances were involved.

For estimating personality dimensions, measuring instruments were selected to cover the dimensions of the model of the functioning of conative regulatory mechanisms. The model implies hierarchical organization of the mechanisms for regulation and control of the behavioural modalities, and it is constructed so as to avoid artificial dichotomy to normal and pathological conative factors.

The selected measuring instruments are: an activity regulator (EPSILON), a regulator of defensive reactions (ALFA), a regulator of offensive reactions (SIGMA), a system for coordination of regulatory functions (DELTA), a system for integration of regulatory functions (ETA).

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003.

In order to determine characteristics of the basic space of conative variables, transformation and condensation of the data into an intercorrelation matrix were performed and thus characteristics of the measuring instruments were obtained.

By examining the structure of the intercorrelation matrix of conative variables, it may be noticed that most of the intercorrelations are at a high level. The matrix is structured so that it forms a few blocks for which it could be stated that they have decent intercorrelations. Based on the Gutman-Kaizer criterion, two latent dimensions with the total of 73.70% of the common variability are isolated.

The first principal component exhausts 55.10% of the total variance of the whole system of variables and it acts as a general factor of personality traits. The second principal component exhausts still decent 18.70% of the remaining variability and it acts as a single factor. It is defined by the activity regulator.

5. References

[1.] Boli, E.: (1996) Structure of intelectual and musical abilities and personality traits of girls engaged in standard and Latin American dances, Master thesis, Priština: The University of Priština, Faculty of Physical Education.

[2.] Boli, E., Popović, D., A. Hošek.: (2009) Sport and Crime, Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[3.] Boli, E.: (2011) Structure of anthropological dimensions of male and female dancers and data processing for their evaluation and monitoring. (Monograph), Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[4.] Momirović, D, Wolf, B. i Popović, D: (1999) Introduction to the measurement theory and internal metric characteristics of the composite measuring instruments (textbook), Priština: The University of Priština, Faculty of Physical Education.

[5.] Popović, D., Antić, K., Stanković, V., Petković, V. & Stanković, S.: (1989) Procedures for objectification of evaluation of the efficiency of performing judo techniques. Scientific Youth, 21(1-2), 83-89.

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

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

[8.] Popović, D., Stanković, V., Kulić, R. & Grigoropulos, P.: (1996) The personality structure of handball players, Komotini: 4th Inter-

national Congress on Physical Education and Sport, Exercise & society supplement issue No. 15 (pp. 164), Greece.

[9.] Popović, D.: (1988) Application methods of factorial analysis for determining morphological types, Varna: 4th international symposium on the methodology of mathematical modelling, Bulgaria.

[10.] Popović, D.: (1991) Methodology of research in Physical Education (textbook), Niš: The University of Niš, Scientific Youth.

[11.] Popović, D.: (1992) Methodology of Research in Physical Education, Athens, Greece.

[12.] Popović, D.: (1993)) Programs and subprograms for analysis of quantitative modifications (textbook), Priština: The University of Priština, Faculty of Physical Education, Multidisciplinary Research Center.

[13.] Popović, D.: (1993) Determining the structure of psychosomatic dimensions in fights and data processing for their evaluation and monitoring (monograph), Priština: The University of Priština, Faculty of Physical Education.

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The structure of personality characteristics of dancers

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Summary

The research was conducted in order to determine the structure of personality of dancers, engaged in standard and Latin American dances, 267 dancers, aged from 11 to 13, were involved. For estimating personality dimensions, measuring instruments were selected to cover the dimensions of the model of the functioning of conative regulatory mechanisms. The model implies hierarchical organization of the mechanisms for regulation and control of the behavioural modalities, and it is constructed so as to avoid artificial dichotomy for normal and pathological conative factors. The selected measuring instruments are: an activity regulator (EPSILON), a regulator of defensive reactions (ALFA), a regulator of offensive reactions (SIGMA), a system for coordination of regulatory functions (DELTA), a system for integration of regulatory functions (ETA). All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980,

1993, K. Momirović and D. Popović 2003. In order to determine characteristics of the basic space of conative variables, transformation and condensation of the data into an intercorrelation matrix were performed, and thus characteristics of measuring instruments were obtained.

By examining the intercorrelation matrix of conative variables, it can be seen that the majority of intercorrelations is at an acceptable level. The matrix is structured so that it forms a few blocks for which it could be stated that they have decent intercorrelations. Based on the Gutman-Kaiser criterion, two latent dimensions are isolated with the total of 73.70% of the common variability. The first principal component exhausts 55.10% of the total variance of variables of the whole system and it acts as a general factor of personality traits. The second principal component exhausts still decent 18.70% of the remaining variability and it acts as a single factor. It is defined by the activity regulator.

Key words: /acts/extraction/intercorrelation/variability/dimension/latent/ space /regulator/

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Canonical correlation between personality traits and intellectual abilities of dancers

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1. Introduction

Conative characteristics and cognitive abilities as segments of psychological features of human beings, do not exist independently, but are manifested in the complex interaction with other abilities. Covariability of different abilities is caused by the activity of various functional structures, which are to greater or lesser extent mutually dependent. One of the primary indications that are present in various forms of behavior, is orientation towards the achievement of a purposeful aim. Every meaningful behavior necessarily implies the optimal integration of functional structures of the central nervous system. One of the most frequent attempts in explaining the relationship between conative characteristics and cognitive abilities is based precisely on emphasizing the functions of the central nervous system.

The central nervous system has primarily an integrative function and enables meaningful and adaptive behavior of human beings. The most important is the integration at the cortical level, since purposeful behavior is directly related to

the integrated function of the cortex. The integration also exists at the subcortical level, although it is less flexible. The integration of functions at the subcortical level enables reaction in standard situations, that is, situations which require automatic reaction. Cognitive processes and cognitive functioning are central mechanisms of the cortical regulation.

The relationship between the conative and cognitive fields at the level of regulatory mechanisms is difficult to explain, first of all, due to the lack of sufficient amount of information about the function of the mechanisms. Another problem is of methodological nature, and it is reflected in the choice of the adequate models of analysis of the collected data.

For this reason one of the aims of this research was to determine the relations and interconnection of the two sets of data, one of which relates to the personality traits of examinees, and the other to the evaluation of cognitive abilities of the examinees.

2. Research methods

2. 1. The sample of examinees

The sample of examinees is conditioned by financial capabilities necessary for the research procedure. Besides, the sample depends on the number of qualified and trained measurers, on the instruments and standardized conditions in which the planned research may be realized.

In order to conduct a correct research with satisfactorily stable results, in the sense of sampling error, it is necessary to include a satisfactory number of examinees into the sample. The size of the sample for research of this type is as well conditioned by the aims and tasks of the research, size of the population and the degree of variability of the applied system of parameters.[30]

According to the selected statistical-mathematical model and the aim of the research, the sample of examinees included 131 female dancers and 136 male dancers, aged from 11 to 13, actively engaged in standard and Latin American dances in the Serbian dancing clubs.

The size of the so defined sample should satisfy the following criteria:

- the effectives of the sample should be planned so that it enables as many degrees of freedom as necessary for any coefficient in the pattern

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

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

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

During all factor procedures, it should always be kept in mind that the results of the analysis depend on three major systems which determine the selection and transformation of information: the sample of variables, sample of examinees, and the selected extraction, namely rotation, method.[31]

2. 2. The sample of variables

2. 2. 1. The sample of personality variables

For estimating personality dimensions the following measuring instruments have been selected so that they may cover the dimensions of the model of the functioning of conative regulatory mechanisms. The model implies hierarchical organization of the mechanisms for regulation and control of behavioral modalities, and it is constructed so as to avoid an artificial dichotomy to normal and pathologic factors.

The selected measuring instruments are:

1) Activity regulator (EPSILON)
2) Regulator of organic functions (HI)
3) Regulator of defensive reactions (ALFA)
4) Regulator of offensive reactions (SIGMA)
5) System for the coordination of regulatory functions (DELTA)
6) System for the integration of regulatory functions (ETA).

The mechanism for activity regulation is one of the elementary and lowest positioned systems in the hierarchy. Its function is regulation and modulation of activiting function of the reticular formation; therefore, it is responsible for the activity and energy level according at which other subsystems, including cognitive processes, function.

Disorders of this system can form the energy basis for hypomanic or depressive reactions and they probably affect the speed of information stream in the central nervous system.

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

The mechanism for regulation and control of organic functions is defined by the effectiveness of the coupling between subcortical regulation functions of the organic systems and higher-ranking cortical systems for regulation and control.

Disorders of this system are manifested by a functional disorder of the primary organic systems, such as cardiovascular, respiratory and gastrointestinal systems, as well as they are manifested by functional disorders of input and output operations.

The mechanism for regulation and control of defensive reactions is defined by the appropriate modulation of tonic arousal, probably based on the adequacy of the programs of genetic origin or formed during the evolution and positioned in the center for regulation of defensive reactions.

Disorders of the system for regulation of defensive reactions are manifested by various symptoms of anxiety and they form the basis for specially modulated pathological reactions such as phobia, obsession and compulsion.

The mechanism for regulation and control of offensive reactions is also defined by the appropriate modulation of tonic arousal, based on the adequacy of the programs transmitted by the genetic code or formed under the influence of conditioning and positioned in the center for regulation of offensive reactions.

Disorders of the system for regulation and control of offensive reactions are manifested in various aggressive reactions and in poor control of immediate impulses.

The mechanism for homeostatic regulation is determined by the coordination of activities of functially and hierarchically different subsystems, including, especially the coordination of functions of conative regulatory system and intellectual processors. Owing to this, homeostatic regulatory system is functionally superior to the systems for regulation of organic functions, defensive and offensive reactions, and it controls the processes occurring in the system for excitation and inhibition regulation.

The disorders of the system for homeostatic regulation cause dissociation and disorganization of conative and intellectual processes, including motor functions that depend on the system of movement structuring.

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 within it. The set of programs which determine its functioning is formed mostly during the educational process. Social disadaptation is an immediate consequence of the functioning of this mechanism.[32]

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

2. 2. 2. The sample of cognitive variables

For estimating cognitive dimensions, the measuring instruments are selected so that the cybernetic model can be covered, paying attention to the fact that the selected tests can measure three types of cognitive processing.

For estimating the efficiency of the input processor, or perceptual reasoning, this test has been selected:

IT-1: the test for matching the drawings is designed for the evaluation of the perceptual identification and discrimination. The test consists of 30 tasks, and the test execution time is limited to 4 minutes. The analysis of the test has revealed that the difficulty of the tasks and their intercorrelation indicate that this is a typical speed test.

For estimating the efficiency of the parallel processor, or identification of relations and correlates, the following measuring instrument has been selected:

S-l: the spatial reasoning test is designed for the evaluation of rapid simultaneous eduction of spatial relations. It consists of 30 tasks, where it should be determined which of the 4 transversal projections of the brick cluster corresponds to the specified picture of the brick cluster. The test execution time is 10 minutes.

For estimating the efficiency of the serial processor, or symbolic reasoning, the following measuring instrument has been selected:

AL-4: the synonym-antonym test is designed for the evaluation of identification of the denotative meaning of verbal symbols. It consists of 40 tasks of double-choice format. The test execution time is 2 minutes, therefore this test belongs to the category of speed tests. The first main subject to measure is defined mostly by the tasks from the second half of the test and interpreted as the ability of rapid identification of the denotative meaning of the verbal symbols.

2. 3. Methods of data processing

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003.

For determining the relations of particular segments of the psychosomatic status of dancers, the canonical correlation analysis has been applied. However, it should be known that there are some difficulties in the application of the canonical correlation analysis especially during the interpretation of canonical variables. This interpretation is complex even when the canonical correlation analysis is used not only as a statistical method, but also as a method for the data analysis

which belongs to the general factor model. Statistically significant canonical dimensions do not have to be informatically important variables, which leads to new difficulties. Further on, the problem appears because the canonical factors do not have a simple structure, therefore the interpretation of those factors is also uncertain.

Some problems may appear in case of nearly singular sets of variables, because then the basic matrix for determination of canonical correlations and vectors of transformation of variables into canonical variables is very vaguely determined.

The algorithm applied in this research attempts to reduce to some extent most of the mentioned problems. It retains as interpretatively important only those canonical dimensions associated with canonical correlations, whose squares are bigger than the average coefficients of determination of any of the analyzed sets of variables determined on the basis of another set.

Furthermore, the algorithm transforms the retained canonical dimensions into the orthogonal parsimony position, which may also facilitate the interpretation of canonical factors, because after that transformation the vectors of canonical variables stretch the same common space.

This, as well, determines the canonical relations of the sets of variables after their transformation into the principal components with non-zero variances, thus avoiding the problem of incorrectly determined inverses of the correlation matrix of nearly singular sets of variables and then it facilitates the interpretation of canonical factors by explicit determination of the relations of those factors and principal components of the analyzed sets.

3. Results and discussion

In order to accomplish the analysis of the results, it was necessary to analyze, first of all, the relations within the sets, and then to find more detailed explanations through the analysis of partial correlations between the variables of one set and the variables of the other.

By examining (table 1) which shows cross correlations between the tests for evaluation of conative regulatory mechanisms and the instruments for evaluation of cognitive abilities, it could be noticed that significant correlation between the mechanism for integration of regulatory functions and the input processor is obtained.

By further analysis of cross correlations, it can be noticed that the greatest connection with a negative sign is between the system for activity regulation and efficiency of serial processing of information at the cognitive level, that is symbolical reasoning. Then follow the connections between the system for integration of regulatory functions and system for regulation of defensive and offensive reactions.

It may also be noticed that there have also been obtained negative correlations between the efficiency of parallel processing of information on a cognitive level and regulation of organic functions, and the regulator of defensive reactions, regulator of offensive reactions and coordination system.

By examining (table 4), it can be seen that two canonical correlations statistically significant at the level .00 are obtained. These two canonical correlations were sufficient to explain the connection between conative regulatory mechanisms and cognitive information processing.

The first canonical correlation, which is otherwise the largest information carrier, amounts .81 which is about 66% of the explained variance. Namely, predictor and criterion variables are in a high and statistically significant relationship.

The first canonical factor in the space of canonical dimensions, is best defined by the mechanism for estimating coordination and integration of regulatory functions. Then follows the mechanism for estimating regulatory organic functions, afterwards the mechanism for estimating the regulator of defensive and offensive reactions, and finally, the mechanism for activity regulation (table 2).

The corresponding canonical dimension is isolated from the space of intellectual variables, it is best defined by the tests for estimating the efficiency of parallel and serial processing on a cognitive level with a negative sign. (table 3).

The parallel analysis of the first pair of canonical factors in both sets leads to the conclusion that efficient recognition of relations and correlates as well as good symbolical reasoning is directly connected with proper functioning of the mechanism for coordination and integration of regulatory functions.

The second canonical correlation amounts .60 which is a total of 36% of the explained variance. The second canonical factor in the space of conative dimensions is bipolar, it is defined with a negative sign by the mechanism for activity regulation and the mechanism for integration of regulatory functions but it is also defined with a positive sign by the mechanism for coordination of regulatory functions.

The corresponding factor in the space of cognitive abilities is defined, to the greatest extent, by the efficiency of the input processor, that is perceptual reasoning.

By parallel analysis of these two factors, it may be concluded that perceptual reasoning is in direct relationship with the mechanism for excitation and inhibition regulation and it enables better information flow in the central nervous system of those people in whom this mechanism is stable, and extrovert and introvert behavior models are directly dependent on the functioning of this system.

CROSSCORRELATIONS BETWEEN CONATIVE CHARACTERISTICS AND COGNITIVE ABILITIES OF DANCERS

Table 1.

TEST	IT1	AL4	SI
EPS	.16	-.51	-.01
HI	.06	-.16	.20
ALF	.01	-.24	.26
SIG	.07	-.27	-.22
DEL	.16	-.17	-.26
ETA	.20	-.33	.00

FACTOR STRUCTURE OF PERSONALITY CHARACTERISTICS

Table 2.

TEST	CAN1	CAN2
EPS	.54	-.65
HI	.37	-.01
ALF	.50	.06
SIG	.03	.38
DEL	-.05	.60
ETA	.38	-.52

FACTOR STRUCTURE OF INTELLECTUAL VARIABLES

Table 3.

TEST	CAN1	CAN2
IT1	.11	-.64
AL4	-.58	.53
SI	.62	.47

CANONICAL VARIABLES

Table 4.

R	R-sqr.	Chi-sqr.	df	p	A
.81	.66	202.61	18	.00	.38
.60	.36	70.25	10	.00	.71

4. Conclusion

The research was conducted in order to determine the relations between personality traits and conative abilities of dancers occupied with standard and Latin American dances.

For determining the relations between the personality traits and cognitive abilities, 267 dancers, aged from 11 to 13, actively engaged in standard and Latin American dances, were involved.

For estimating personality dimensions, measuring instruments were selected so as to cover the dimensions of the model of the functioning of conative regulatory mechanisms. The model implies hierarchical organization of the mechanisms for regulation and control of the behavioural modalities, and it is constructed so that the artificial dichotomy to normal and pathological conative factors could be avoided.

For determining the latent structure of dancers the method of component factor analysis has been applied.

The following measuring instruments have been selected:

1) Activity regulator (EPSILON)
2) Regulator of organic functions (HI)
3) Regulator of defensive reactions (ALFA)
4) Regulator of offensive reactions (SIGMA)
5) System for the coordination of regulatory functions (DELTA)
6) System for the integration of regulatory functions (ETA).

For the evaluation of intellectual abilities, three measuring instruments were applied, previously selected so as to solve the structure analysis, on the basis of the cybernetic model of Das, Kirby and Jarman, respectively Momirović, Bosnar and Horge 1982, taking into account the fact that the chosen tests measure three types of intellectual processing.

For estimating the efficiency of the perceptual processor, test IT-1 was selected; for estimating the efficiency of the serial processor, test AL-4; and for estimating the efficiency of the parallel procession, test S-1.

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003.

After conducting the canonical correlation analysis, statistically significant correlation between predictor and criterion variables was obtained. The first canonical factor in the space of canonical dimensions is best defined by the mechanism for estimating coordination and integration of regulatory functions. Then follows the mechanism for the assessment of regulatory organic functions and then the mechanism for the assessment of the regulator of defensive and offensive reactions and, finally, the mechanism for activity regulation. The corresponding canonical dimension is isolated from the space of intellectual variables, it is best defined by the tests for estimating parallel and serial processing of information on the cognitive level but with a negative sign. The second canonical factor in the space of conative dimensions is bipolar, it is defined, with a negative sign, by the mechanisms for activity regulation and for the integration of regulatory functions, and with a positive sign by the mechanism for the coordination of regulatory functions. The corresponding factor in the space of intellectual abilities is defined mostly by the efficiency of the input processor, respectively, perceptual reasoning.

5. References

[1.] Boli, E., Popović, D., A. Hošek.: (2009) Sport and Crime, Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[2.] Boli, E.: (2011) Structure of anthropological dimensions of male and female dancers and data processing for their evaluation and monitoring. (Monograph), Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[3.] Momirović, D, Wolf, B. i Popović, D: (1999) Introduction to the measurement theory and internal metric characteristics of the measuring instruments (textbook), Priština: The University of Priština, Faculty of Physical Education.

[4.] Popović, D. & Stanković, V. (2005). Canonical correlation between motor abilities and efficiency in performing judo techniques. Pančevo: Plenary lecture, 1st international scientific-symposium "The effect and influences of different models of training process to anthropological status of sportsmen in fighting skills", (pp. 11-18), Serbia. (Plenary session – invited lecture).

[5.] Popović, D. Antić, K., Stanković, V., Petković, V. & Stanković, S.: (1989) Relations between morphological characteristics and efficiency in performing judo techniques, Scientific Youth, 21(1-2), 75-83.

[6.] Popović, D., Boli, E., Malacko, J., Dragić, B., Toskić, D. & Stanković, V. (2002). Relationship between abilities dependent upon movement regulation and upon energy regulation, Athens: In M. Koskolou, N. Geladas, V. Klissouras (Eds), 7th Annual Congress of the ECSS, (pp. 1173), vol 2, Greece.

[7.] Popović, D., Stanković, S., R. Popović, Petković, V. & Stanković, V.: (1987) Canonical correlation analysis as an optimal method for determining relations between two sets of variables, Scientific Youth, 19(3-4), 63-71.

[8.] Popović, D., Stanković, V. & Stanković, S.: (1997) The canonical correlation between cognitive abilities and motor information of handball players, Istanbul: II Spor Bilimleri Kongresi, Book of abstracts (pp. 46), Turkey.

[9.] Popović, D.: (1987) Motor Abilities Relations and the Estimate of Successfulness of the Execution of Judo Techniques, Zagreb: Proceedings of Fisu\Cesu conference universiade 1987., Yugoslavia.

[10.] Popović, D.:(1990) Relations between cognitive abilities and efficiency of the performance of judo techniques by young athletes, Ljubljana - Bled: 4th Congress of pedagogues from Yugoslavia and first international symposium.

[11.] Popović, D.: (1991) Methodology of Research in Physical Education (textbook), Niš: The University of Niš, Scientific Youth.

[12.] Popović, D.: (1992) Methodology of Research in Physical Education, Athens, Greece.

[13.] Popović, D.: (1993)) Programs and subprograms for analysis of quantitative modifications (textbook), Priština: The University of Priština, Faculty of Physical Education, Multidisciplinary Research Center.

[14.] Popović, D.: (1993) Determining the structure of psychosomatic dimensions in fights and data processing for their evaluation and monitoring (monograph), Priština: The University of Priština, Faculty of Physical Education.

[15.] Popović, D.: (1997) Canonical correlation between cognitive abilities and motor information of handball players, Istanbul: II Spor Bilimleri Kongresi, Turkey.

[16.] Popović, D.:(1990) Relations between conative characteristics and efficiency in performing judo techniques by young athletes, Ljubljana - Bled: 4th Congress of pedagogues from Yugoslavia and first international symposium.

[17.] Stanković, V. & Popović, D.: (1988) Relations between motor abilities and efficiency in performing judo techniques, Scientific Youth, 20(1-2), 15-25.

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Canonical correlation between personality traits and intellectual abilities of dancers

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Summary

The research was conducted in order to determine the relations between personality traits and intellectual abilities of dancers occupied with standard and Latin American dances. In this research, 267 dancers, aged from 11 to 13, were involved. For estimating personality dimensions, some measuring instruments were selected so that they could cover the dimensions of the model of the functioning of conative regulatory mechanisms. The model implies hierarchical organization of the mechanisms for regulation and control of the behavioural modalities and it is constructed so that the artificial dichotomy to normal and pathological conative factors could be avoided. For estimating the dancers' latent structure, the method of component factor analysis was applied. The selected measuring instruments are: an activity regulator (EPSILON), the regulator of defensive reactions (ALFA), the regulator of offensive reactions (SIGMA), the system for the coordination of regulatory functions (DELTA), the system for the integration of regulatory functions (ETA). For the evaluation of intellectual abilities,

three measuring instruments were applied, previously selected so as to solve the structure analysis of the cybernetic model of Das, Kirby and Jarman, respectively Momirović, Bosnar and Horge 1982, taking into account the fact that the chosen tests measure three types of intellectual processing. For estimating the efficiency of the perceptual processor, test IT-1 was selected; for estimating the efficiency of the serial processor, test AL-4; and for estimating the efficiency of the parallel processor, test S-1. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. After conducting the canonical correlation analysis, the statistically significant correlation between predictor and criterion variables was obtained. The first canonical factor in the space of canonical dimensions is best defined by the mechanism for estimating coordination and integration of regulatory functions. Then follows the mechanism for the assessment of regulatory organic functions and then the mechanism for the assessment of the regulator of defensive and offensive reactions and, finally, the mechanism for activity regulation. The corresponding canonical dimension is isolated from the space of intellectual variables, it is best defined by the tests for estimating parallel and serial processing of information on the cognitive level but with a negative sign. The second canonical factor in the space of conative dimensions is bipolar, it is defined, with a negative sign, by the mechanism for activity regulation and for the integration of regulatory functions, and with a positive sign by the mechanism for the coordination of regulatory functions. The corresponding factor in the space of intellectual abilities is defined mostly by the efficiency of the input processor, that is, perceptual reasoning.

Key words: /input processor/integration/function/factor/reasoning/perception/mechanism/.

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The structure of the social status of dancers

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1. Introduction

Sociological characteristics imply the characteristics of some groups or social institutions related to a man.

Within the integral anthropological status, in the social sphere, the subjects of a vast number of previous researches were related to the position of a person in the social sphere, respectively to the problems of social differentiation, social stratification and social mobility (A. Hošek-Momirović, 1979). While the notion of social mobility is relatively clear, the notions of social differentiation and social stratification are frequently substituted, and sometimes identified with the notion of class differences. One of the reasons of such state is certainly the lack of adequate cybernetic models on which research on social differences could be established.

In previous researches, with the help of factor procedures, various factors of the social status of the first line, within some subsystems were identified:

Socialization subsystem:

- Educational status – the level of the individual's education in the society,
- Basic residential status – characteristics of the place where the subject spent his/her early childhood;

Institutionalized subsystem:

- Professional status – level of the individual's expert power or individual's position in the working organization,
- Sociopolitical status – the individual's position in sociopolitical organizations,
- Political orientation;

Sanction subsystem:

- Basic - economic status – net income in the family and objects standard for a family,
- Life style – above-average living standard
- Residential status – characteristics of the place where people live.

There is only one model of social status presently available that has enabled a real scientific approach to the study of the structure of stratification dimensions. The model was constructed by S. Saksida, which later served as a base for many researches conducted by other authors (Saksida and Petrović 1972, Saksida, Caserman and Petrović 1974, Momirović and Hošek 1975). Constructed as a phenomenological model, it has undergone several modifications over time, but it still remains suitable for studying social changes.

2. Research methods

2. 1. The sample of examinees

The sample of examinees is conditioned by the financial capabilities necessary for the research procedure. Besides, the sample depends on the number of qualified and trained measurers, on the instruments and standardized conditions in which the planned research may be realized.

In order to conduct the research properly, with satisfactorily stable results, in the sense of sampling error, it is necessary to include a satisfactory number of examinees into the sample. The size of the sample for research of this type is as

well conditioned by the aims and tasks of the research, size of the population and the degree of variability of the applied system of parameters.[33]

According to the selected statistical-mathematical model and the aim of the research, the sample of examinees included 131 female dancers and 136 male dancers, aged from 11 to 13, actively engaged in standard and Latin American dances in the Serbian dancing clubs.

The size of the so defined sample should satisfy the following criteria:

- the effectives of the sample should be planned so that it enables as many degrees of freedom as necessary for any coefficient in the pattern or correlation matrix, which is equal to or bigger than 0.22, to be considered different from zero with an inference error less than 0.01.
- in order to successfully apply the adequate statistical methods according to the latest convictions, the number of subjects in the sample must be five times bigger than the number of the applied variables.

During all the factor procedures, it should always be kept in mind that the results of the analysis depend on three major systems which determine the selection and transformations of information: the sample of variables, sample of examinees, and the selected extraction, that is rotation, method.[34]

2. 2. The sample of variables

For the evaluation of the social status, there was applied the model constructed by Saksida and Petrović 1972; Saksida, Caserman and Petrović 1974; Momirović and Hošek 1975. In this research the appendix INST2, the questionnaire SSMIN were applied.

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

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

VARIABLES FOR EVALUATION OF STATUS CHARACTERISTICS

Table 1.

No.	VARIABLE	LABEL
1	Father's education	OBRO
2	Mother's education	OBRM
3	Knowledge of foreign languages	JEZ
4	Father's knowledge of foreign languages	JEZO
5	Mother's knowledge of foreign languages	JEZM
6	Type of school	ŠKOLA
7	Type of school which father finished	ŠKOLAO
8	Type of school which mother finished	ŠKOLAM
9	Father's qualifications	KVALO
10	Mother's qualifications	KVALM
11	Paternal grandfather's education	DEDAO
12	Maternal grandfather's education	DEDAM
13	School performance	USPEH
14	Grade repetition	PON
15	Intensity of sport activities	SPORT
16	Type of place where childhood was spent	M15
17	Type of place where father spent his childhood	M15O
18	Type of place where mother spent her childhood	M15M
19	Type of current place of respondent's residence	MESTO
20	Who took care of the respondent during early childhood	ČUVAO
21	Number of children of respondent's parents	DECAR
22	Sexual partner's education	OBRS
23	Best friend's education	OBRP
24	Father's sports results	SPORTO
25	Mother's sports results	SPORTM
26	Number of books in the home library	KNJIGE
27	Father's membership and activity in left-wing political parties	LEVIO

Table continued on next page...

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28	Mother's membership and activity in left-wing political parties	LEVIM
29	Father's membership and activity in right-wing political parties	DESNIO
30	Mother's membership and activity in right-wing political parties	DESNIM
31	Father's membership and activity in center political parties	CENTARO
32	Mother's membership and activity in center political parties	CENTARM
33	Father's professional position in the working organization	PROFO
34	Mother's professional position in the working organization	PROFM
35	Father's involvement in governmental bodies	DPZO
36	Mother's involvement in governmental bodies	DPZM
37	Father's function in sport clubs	FNSPORTO
38	Mother's function in sport clubs	FNSPORTM
39	Father's social commitment	FNDRUŠTO
40	Mother's social commitment	FNDRUŠTM
41	Colour TV	TV
42	Car	AUTO
43	Under two years old car	AUTON
44	Weekend cottage	VIK
45	Video recorder	VIDEO
46	Stereo system	MUZIK
47	Computer	KOMP
48	Freezer	FRIZ
49	Dishwasher	MSUD
50	Washing machine	MVEŠ
51	Size of apartment	KVSTAN
52	Comfort of apartment	KOMFOR
53	Monthly household income	PRIHOD

2. 3. Data processing methods

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. Therefore the aim of this work is to propose a consistent algorithm for latent structure analysis which consists in orthoblique transformation of principal components significant by PB criterion with additional operations for variance component analysis of manifested and latent variables as well as for the evaluation of the reliability of latent variables, and to describe a program, written in the Matrix language for SPSS, that functions in Windows environment, that is, the program which will be available to almost all users of personal computers or workstations.

THE ALGORITHM

Let Z be a matrix of standardized data obtained by the description of some set E of n entity on some set V of m quantitative, normally or at least elliptically obtained distributed variables. Let R be an intercorrelation matrix of those variables. Assume, R is surely regular matrix, and there could with certainty be rejected the hypothesis according to which variables from V have spherical distribution, i.e. the eigenvalues of the correlation matrix in the population P, from which the sample E has been drawn, are equal.

Let

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

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

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

Define the scalar k so that

$$\Sigma_p^{\ k} \lambda_p \geq c, \Sigma_p^{\ k-1} \lambda_p < c.$$

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

Let $\Lambda = (\lambda_p)$; p = 1,...,k be a diagonal matrix of the first k eigenvalues of matrix R and let $X = (x_p)$; p = 1,...,k be a matrix of the associated eigenvectors scaled so that $X^tX = I$. The principal components of the analyzed set of variables will be the vectors of the matrix

$$K = ZX$$

with the covariance matrix

$$K^tK = \Lambda;$$

if the latent dimensions, thus defined, are standardized by the operation

$$P = K\Lambda^{-1/2}$$

the elements of the matrix

$$H = Z^tPn^{-1} = X\Lambda^{1/2}$$

that is, the correlations between the variables and principal components, will, simultaneously, be the coordinates of the vectors of variables in the space stretched by the standardized vectors of principal components. The variances of the standardized variables, projected into the k – dimensional space of the principal components, will therefore be the elements of the vector

$$h^2 = \text{vec diag } (HH^t) = \text{vec diag } (X\Lambda X^t);$$

and since, obviously,

$$H^tH = \Lambda,$$

the analysis of principal components maximizes not only the variances of the so defined latent dimensions, but also the correlations between those dimensions and analyzed variables.

Although the principal components have simple and clear mathematical meaning, their interpretation is very complex, especially when the vectors of variables form clusters in the component space. Therefore, almost always, the coordinate system formed by the vectors of principal components undergoes some parsimonic transformation, wherein the primary aim of all the transformations is that new coordinate axes are passing through the clusters of the vectors of variables. For that purpose, a lot of methods have been proposed; but out of them the orthoblique transformation of type II, proposed by Chester Harris and Henry Kaiser (Harris and Kaiser, 1964) is not only the most simple, but the closest to the main idea of parsimonic transformation.

Let T be some orthonormal matrix such that it optimizes the function

$$XT = Q = (q_p) \mid p\,(Q) = \text{extremum}, \; T^tT = I,$$

where p (Q) is some parsimonic function, for instance 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 the coefficients q_{jp} are the elements of matrix Q (Kaiser, 1958).

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

$$K = ZX,$$

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

$$L = KT = ZXT.$$

The covariance matrix of those dimensions is

$$C = L^tLn^{-1} = Q^tRQ = T^t\Lambda T;$$

Denote the matrix of their variances as

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

If latent dimensions are standardized by the operation

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

in the matrix

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

there will be their intercorrelations; notice, that C, and therefore M, cannot be diagonal matrices, so that the latent dimensions, thus obtained, are not orthogonal in the space of the entity from E.

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

$$F = Z^tDn^{-1} = RXTS^{-1} = X\Lambda TS^{-1};$$

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

$$A = FM^{-1} = XTS.$$

But as

$$A^tA = S^2$$

then the latent dimensions obtained by this procedure are orthogonal in the space stretched 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 those dimensions.

Naturally, matrices A and F are factor matrices of matrix R because

$$AF^t = AMA^t = FM^{-1}F^t = HH^t = X\Lambda X^t;$$

consequently the operation

$$W = (w_{jp}) = A \bullet F,$$

where • is a symbol of Hadamard's multiplication, forms a matrix whose rows include the variance components of variables that may be attributed to orthoblique factors, and columns contain the variance components of orthoblique factors which may be attributed to variables.

For its simplicity and clear algebraic and geometrical meaning and latent dimensions, also the identification structures associated with those dimensions, reliability of latent dimensions obtained by orthoblique transformation of principal components may be determined in a clear and unambiguous manner (Momirović, 1996).

Let $G = (g_{ij})$; $i = 1,...,n$; $j = 1,...,m$ be an acceptably unknown matrix of measurement errors when describing set E on set V. Then the matrix of the true results of the entity from E on the variables from V will be

$$Y = Z - G.$$

If, in accordance with the classical measurement theory (Gulliksen, 1950; Lord and Novick, 1968; Pfanzagl, 1968) we assume that the matrix G is such that

$$Y^tG = 0$$

and

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

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

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

if

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

is an intercorrelation matrix of variables from V defined on set E.

Assume, the reliability coefficients of variables from V are known; let P be a diagonal matrix whose elements ρ_j are those reliability coefficients. Then the variances of measurement errors for standardized results on variables from V will precisely be the elements of the matrix

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

At present the true values on the latent dimensions will be the elements of the matrix

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

with the covariance matrix

$$\Omega = \Gamma^t \Gamma n^{-1} = Q^t J Q = Q^t R Q - Q^t E^2 Q = (\omega_{pq}).$$

Accordingly, the true variances of latent dimensions will be the diagonal elements of matrix Ω; let's mark those elements as ω_p^2. Based on the formal definition of coefficients of reliability of some variable

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

where σ_t^2 is a true variance of some variable, and σ^2 is a total variance of that variable, that is, the variance which also includes the error variance, the coefficients of reliability of latent dimensions, if the reliability coefficients of the variables from which those dimensions have been derived are known, will be

$$\gamma_p = \omega_p^2 / s_p^2 = 1 - (q_p^t E^2 q_p)(q_p^t R q_p)^{-1}$$

$$p = 1,...,k$$

Coefficients γ_p vary in the range of (0,1) and can take the value 1 only when P = I, that is, if all the variables are measured without errors, and the value 0 only when P = 0 and R = I, that is, if the total variance of all variables consists only of the variance of measurement error, and variables from V have a spherical normal distribution. Because if the total variance of each variable from some set of variables consists only of the variance of measurement error, then it is obligatory that $E^2 = I$ and R = I, so all coefficients γ_p are equal to zero.

However, the matrix of reliability coefficients $P = (\rho_j)$ is often unknown, so the matrix of the variances of measurement error E^2 is as well unknown. But, if the variables from V are selected so that they represent some universe of variables U with the same field of meaning, the upper limit of the variances of measurement error is defined by the elements of the matrix U^2 (Guttman, 1945; 1953), or unique variances of those variables. That is why, in that case, the lower limit of reliability of latent dimensions may be estimated by the coefficients

$$\alpha_p = 1 - (q_p^t U^2 q_p)(q_p^t R q_p)^{-1}$$

$$p = 1,...,k$$

which are derived by the procedure identical to the procedure by which the coefficients γ_p are derived with the definition $E^2 = U^2$, that is, in the same way as Guttman derived his own measure λ_6. Coefficients α_p vary in the range of (0,1),

although they cannot reach the value 1. Because R = I, then $U^2 = I$, so all coefficients α_p are equal to zero. But, since $U^2 = 0$ is not possible if the matrix R is regular, all coefficients α_p are necessarily less than 1 and tend to 1 when the unique variance of variables, from which the latent dimensions have been derived, tends to zero.

By applying the same technology, it is simple to derive measures of the absolute lower limit of reliability of latent dimensions defined by orthoblique factors. For this purpose, set $E^2 = I$. Then

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

will be the measures of the absolute lower limit of reliability of latent dimensions, since, naturally, $Q^tQ = I$.

Obviously it is necessary that all coefficients β_p are less than 1, and tend to 1 when m, the number of variables in set V, tends to infinity, since then each squared form of matrix R tends to infinity. If R = I, then, of course, all coefficients β_p are equal to zero. However, the lower limit of those coefficients need not be zero, because it is possible, but not for all coefficients β_p, that variance s_p^2 of some latent dimension is less than 1. Naturally, the latent dimension which emits less information than any other variable from which it was derived, has no sense, and it is probably best discovered on the basis of the values of coefficients β_p.

3. Results and discussion

By componential analysis of variables for estimating the social status of the selected young dancers of standard and Latin American dances, by applying Momirović's B6 criterion four characteristic roots have been obtained which may be considered as statistically important. The total percentage of the explained variability of the applied system of variables amounts 56.28%. What can be seen by the inspection of (table 1) is monotonic declining of both the characteristic root and percentage of the explained variance by 14.22% for the second principal component and by 4.89% for the fourth principal component, so they could be considered as products of hyper factorization. Most probably this occurred when also the communalities of variables whose values in the whole matrix equals one, were taken into account.

The largest projections on the first oblimin factor are of the groups of variables by which the institutionalized subsystem has been evaluated, precisely the professional status by which a degree of expert power of an individual in a working organization has been determined, socio-political status, by which a certain

position of an individual in socio-political and sport organizations has been determined, where the test vector which explains this subsystem (DRORGM), the mother's function in socio-political or professional organizations, is dominantly representative. The second group of variables which significantly determine this oblimin factor belongs to the group of the sanction subsystem where the variable of the total household income (PRIH) is a dominant feature of the basic economic status, or the net income in the family. The features of this oblimin factor are, also, the variables for estimating the lifestyle (above-average living standard but as well as the parents' knowledge of foreign languages by which the educational status is quantified) that is subordinated to socialization subsystem. Recognizing the real fact that dancers as entities realise during their lives various roles in various groups, it becomes clear that the first oblimin factor, to which the most important kinesiological reality is given, presents a dominant feature of the selected young dancers of folk dance, so it is possible to nominate a social status factor.

The second oblimin factor is defined by the variables of the parents' educational status with a negative sign which belong to the socialization subsystem as well as the parents' political orientation which belongs to the institutional subsystem.

This latent dimension is bipolar which has as a dominant feature a low lifestyle, poor education of parents, ignorance of the subject's language, but also mostly left political orientation of parents.

The third oblimin factor is explained by variables of the achieved success in the final school year (USPEH), approximate amount of books in the home library (KNJIGE), sports results achieved by parents (SPORTO i SPORTM) and the variable of whether the family has a weekend cottage or not. The dominant feature of young dancers is a low level of education of an individual, low life status and a low professional position of the mother.

The fourth oblimin factor has the highest correlation with the variables of the parents' education level, then the variables of basic residential status (M15, M15O i M15M), as well as the lifestyle variables like whether the family owns a TV and an automobile (TV and AUTO). This space of dancers involved in standard and Latin American dances requires further research with new methods and new instruments for its evaluation in order to enter a deeper and more comprehensive analysis of dancers' social status.

MATRIX OF THE PRINCIPAL COMPONENTS OF DANCERS' SOCIAL STATUS

Table 1.

Variable	FAC1	FAC2	FAC3	FAC4
OBRO	-.10	-.87	.20	.11
OBRM	-.11	-.86	.14	.17
JEZ	.04	-.54	.01	.13
JEZO	.53	-.26	-.14	-.03
JEZM	.64	.21	.18	.13
ŠKOLA	.66	.04	.21	.10
ŠKOLAO	-.19	.06	.54	.50
ŠKOLAM	.67	-.01	.18	.15
KVALO	-.31	-.18	.25	.68
KVALM	-.33	.13	-.30	.55
DEDAO	.08	-.30	-.21	.39
DEDAM	-.10	-.02	-.46	-.01
USPEH	-.22	-.25	-.83	.01
PON	-.51	-.39	-.31	.17
SPPORT	-.49	-.58	.17	.37
M15	.01	-.16	.06	.65
M15O	-.21	.30	.14	.69
M15M	.47	.19	-.24	.54
MESTO	.14	-.02	-.21	.52
CUVAO	-.24	.04	-.68	.22
DECAR	-.33	-.31	-.30	.40
OBRS	-.45	.10	-.31	.27
OBRP	-.67	-.23	.02	.50
SPORTO	-.39	.18	-.71	.22
SPORTM	-.38	.33	-.71	.17
KNJIGE	-.19	.09	-.84	-.07
LEVIO	-.13	.70	-.24	.28

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LEVIM	-.42	.61	-.09	.47
DESNIO	-.35	.60	.09	.59
DESNIM	-.10	.48	-.20	.10
CENTARO	-.35	.55	.06	.50
CENTAR	-.15	.37	-.77	.00
PROFO	-.09	-.57	-.18	.07
PROFM	-.28	.09	-.71	.18
POLITO	.45	.21	-.37	-.27
POLITM	.64	.08	.01	-.16
SPORGO	.85	.13	-.01	-.35
SPORGM	.84	.09	.26	-.30
DRORGO	.40	-.04	.14	-.04
DRORGM	.92	.05	.29	-.21
TV	.11	.19	.43	.60
AUTO	.12	.05	.03	.53
AUTON	.44	.00	-.07	.02
VIK	.17	.14	-.73	-.13
VIDEO	.61	-.09	-.24	-.12
MUZIK	.65	-.30	.22	-.13
KOMP	.82	-.06	.25	-.11
FRIZ	.66	-.16	.15	-.08
MSUD	.68	.15	.47	.01
MVES	.69	-.16	.40	-.04
STAN	.69	-.41	.31	-.18
KOMF	.10	-.91	.15	-.20
PRIH	.83	-.23	.36	-.32
LAMBDA	13.77	7.05	5.94	3.53
%	27.14	14.22	10.03	4.89
CUM %	27.14	41.36	51.39	56.28

PATTERN MATRIX OF DANCERS' SOCIAL STATUS

Table 2.

Variable	OBL1	OBL2	OBL3	OBL4
OBRO	-.12	-.88	.22	.13
OBRM	-.11	-.86	.14	.17
JEZ	.03	-.54	.01	.13
JEZO	.53	-.26	-.14	-.03
JEZM	.64	.21	.18	.13
ŠKOLA	.66	.04	.21	.10
ŠKOLAO	-.19	.06	.54	.50
ŠKOLAM	.67	-.01	.18	.15
KVALO	-.31	-.18	.25	.68
KVALM	-.33	.13	-.30	.55
DEDAO	.08	-.30	-.21	.39
DEDAM	-.10	-.02	-.46	-.01
USPEH	-.22	-.25	-.83	.01
PON	-.51	-.39	-.31	.17
SPPORT	-.49	-.58	.17	.37
M15	.01	-.16	.06	.65
M15O	-.21	.30	.14	.69
M15M	.47	.19	-.24	.54
MESTO	.14	-.02	-.21	.52
CUVAO	-.24	.04	-.68	.22
DECAR	-.33	-.31	-.30	.40
OBRS	-.37	.07	-.25	.19
OBRP	-.62	-.25	.10	.39
SPORTO	-.26	.12	-.66	.16
SPORTM	-.26	.28	-.66	.10
KNJIGE	-.09	.03	-.83	-.10
LEVIO	-.05	.68	-.19	.25

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LEVIM	-.34	.59	.01	.38
DESNIO	-.27	.59	.18	.52
DESNIM	-.06	.47	-.16	.07
CENTARO	-.28	.54	.15	.43
CENTAR	-.03	.32	-.76	-.03
PROFO	-.06	-.59	-.20	.08
PROFM	-.15	.04	-.69	.15
POLITO	.48	.20	-.43	-.19
POLITM	.65	.09	-.09	-.04
SPORGO	.84	.14	-.15	-.20
SPORGM	.80	.12	.14	-.15
DRORGO	.46	-.030	.07	.04
DRORGM	.89	.06	.16	-.05
TV	.16	.20	.43	.63
AUTO	.23	.03	.00	.57
AUTON	.48	-.00	-.14	.10
VIK	.27	.09	-.77	-.09
VIDEO	.66	-.10	-.34	.01
MUZIK	.63	-.28	.11	.00
KOMP	.81	-.04	.12	.04
FRIZ	.66	-.15	.04	.05
MSUD	.65	.18	.38	.13
MVES	.67	-.13	.29	.10
STAN	.65	-.39	.19	-.04
KOMF	.05	-.90	.08	-.15
PRIH	.76	-.19	.23	-.16

STRUCTURE MATRIX OF DANCERS' SOCIAL STATUS

Table 3.

Variable	OBL1	OBL2	OBL3	OBL4
OBRO	-.10	-.89	.25	.12
OBRM	-.11	-.87	.17	.15
JEZ	.01	-.54	.05	.10
JEZO	.52	-.26	-.05	-.13
JEZM	.64	.19	.26	.01
ŠKOLA	.68	.02	.31	-.03
ŠKOLAO	-.20	.05	.50	.53
ŠKOLAM	.67	-.02	.28	.02
KVALO	-.39	-.17	.20	.73
KVALM	-.48	.17	-.36	.62
DEDAO	-.02	-.27	-.18	.37
DEDAM	-.16	.01	-.48	.03
USPEH	-.35	-.19	-.85	.05
PON	-.58	-.36	-.36	.26
SPPORT	-.53	-.57	.13	.44
M15	-.10	-.14	.06	.64
M15O	-.33	.32	.08	.74
M15M	.32	.21	-.19	.46
MESTO	.01	.00	-.19	.50
CUVAO	-.38	.09	-.72	.28
DECAR	-.45	-.27	-.34	.46
OBRS	-.45	.10	-.31	.27
OBRP	-.67	-.23	.02	.50
SPORTO	-.39	.18	-.71	.22
SPORTM	-.38	.33	-.71	.17
KNJIGE	-.19	.09	-.84	-.07
LEVIO	-.13	.70	-.24	.28

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...Table continued from previous page				
LEVIM	-.42	.61	-.09	.47
DESNIO	-.35	.60	.09	.59
DESNIM	-.10	.48	-.20	.10
CENTARO	-.35	.55	.06	.50
CENTAR	-.15	.37	-.77	.00
PROFO	-.09	-.57	-.18	.07
PROFM	-.28	.09	-.71	.18
POLITO	.45	.21	-.37	-.27
POLITM	.64	.08	.01	-.16
SPORGO	.85	.13	-.01	-.35
SPORGM	.84	.09	.26	-.30
DRORGO	.40	-.04	.14	-.04
DRORGM	.92	.05	.29	-.21
TV	.11	.19	.43	.60
AUTO	.12	.05	.03	.53
AUTON	.44	.00	-.07	.02
VIK	.17	.14	-.73	-.13
VIDEO	.61	-.09	-.24	-.12
MUZIK	.65	-.30	.22	-.13
KOMP	.82	-.06	.25	-.11
FRIZ	.66	-.16	.15	-.08
MSUD	.68	.15	.47	.01
MVES	.69	-.16	.40	-.04
STAN	.69	-.41	.31	-.18
KOMF	.10	-.91	.15	-.20
PRIH	.83	-.23	.36	-.32

INTERCORRELATION MATRIX OF OBLIMIN FACTORS

Table 4.

Variable	OBL1	OBL2	OBL3	OBL4
OBL1	1.00	-.02	.15	-.19
OBL2	-.02	1.00	-.06	.04
OBL3	.15	-.06	1.00	-.01
OBL4	-.19	.04	-.01	1.00

4. Conclusion

The research was conducted in order to determine the structure of the social status of dancers, occupied with the Latin American and standard dances.

In order to determine the structure of sociological status, 267 male dancers, aged from 11 to 13, actively engaged in standard and Latin American dances, were involved.

The model constructed by Saksida and Petrović 1972, Saksida, Caserman and Petrović 1974, Momirović and Hošek 1975 was used for the evaluation of the social status. Appendix INST2, questionnaire SSMIN were also applied in the research.

All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003.

Using the component analysis of variables for the evaluation of the social status of the selected young dancers of Latino American and standard dances, applying Momcilović's B6 criterion, four characteristic roots were obtained and thus four factors that could be considered as statistically significant. The greatest projections on *the first oblimin factor* are of the groups of the variables, which were used for estimating the institutional subsystem, especially professional status and then the variables included in the group of the sanction subsystem. *The second oblimin factor* was defined by the variables of educational statuses of the father and mother with the negative sign, which belong to the socialization system, political orientation of the parents included in the institutional subsystem. *The third oblimin factor* is explained by the variables, that dominantly mark a low level of the individual's education, low average life status and low professional

position of the mother. *The fourth oblimin factor* has the highest correlation with the variables of the educational level of the parents' education and variables of the basic residential status.

5. References

[1.] Boli, E.: (1996) 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.

[2.] Boli, E., Popović, D., A. Hošek.: (2009) Sport and Crime, Leposavić: The University of Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[3.] Boli, E.: (2011) Structure of anthropologic dimensions of male and female dancers and data processing for their evaluation and monitoring. (Monograph), Leposavić: The University in Priština, Multidisciplinary Research Center of the Faculty of Sport and Physical Education.

[4.] Momirović, D, Wolf, B. i Popović, D: (1999) Introduction to the measurement theory and internal metric characteristics of the composite measuring instruments (textbook), Priština: The University of Priština, Faculty of Physical Education.

[5.] Popović, D., Antić, K., Stanković, V., Petković, V. & Stanković, S.: (1989) Procedures for objectification of evaluation of the efficiency in performing judo techniques. Scientific Youth, 21(1-2), 83-89.

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

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

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

[9.] Popović, D.: (1988) Application methods of factorial analysis for determining morphological types, Varna: 4th international symposium on the methodology of mathematical modelling, Bulgaria.

[10.] Popović, D.: (1991) Methodology of research in Physical Education (textbook), Niš: The University of Niš, Scientific Youth.

[11.] Popović, D.: (1992) Methodology of research in Physical Education, Athens, Greece.

[12.] Popović, D.: (1993) Programs and subprograms for analysis of quantitative modifications (textbook), Priština: The University of Priština, Faculty of Physical Education, Multidisciplinary Research Center.

[13.] Popović, D.: (1993) Determining the structure of psychosomatic dimensions in fights and data processing for their evaluation and monitoring (monograph), Priština: The University of Priština, Faculty of Physical Education.

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The structure of the social status of dancers

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Summary

The research was conducted in order to determine the structure of the social status of dancers, occupied with the Latin American and standard dances. This research involved 267 male dancers, aged from 11 to 13. The model constructed by Saksida and Petrović 1972, Saksida, Caserman and Petrović 1974, Momcilović and Hoshek 1975 was used for the evaluation of the social status. Appendix INST2, questionnaire SSMIN were also applied in the research. All the data collected in this research were processed in the Multidiscipline Research Centre of the Faculty of Sports and Physical Education, the University of Priština, supported by the system of data processing programmes developed by D. Popović, 1980, 1993, K. Momirović and D. Popović 2003. Using the component analysis of variables for the evaluation of the social status of the selected young Latin American and standard dancers, applying Momcilović's B6 criterion, four characteristic roots were obtained as well as four factors that could be considered as statistically significant. The greatest projections on the first oblimin factor are of

the groups of variables, which were used for estimating the institutional subsystem, especially professional status and then variables included in the group of the sanction subsystem. The second oblimin factor was defined by the variables of educational status of the father and mother with the negative sign, included in the social system, but also political orientation of the parents included in the institutional system. The third oblimin factor was explained by the variables, that dominantly marked a low level of the individual's education, low average life status and low professional position of the mother. The fourth oblimin factor has the highest correlation with the variables of the educational level of the parents' education and variables of the basic residential status.

Key words: /education/group/subsystem/structure/social status/questionnaire/model/

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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

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