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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]

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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 correlation 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 defined 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.

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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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