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

Evagelia Boli, Dragan Popović & Jasna Popović

Faculty of Sports and Physical Education, the University of Priština temporarily based in Leposavić, Serbia

e-mail: evagelia.boli@pr.ac.rs

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

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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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Evagelia Boli, Dragan Popović & Jasna Popović

Faculty of Sports and Physical Education, the University of Priština temporarily based in Leposavić, Serbia

e-mail: evagelia.boli@pr.ac.rs

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/

Evagelia Boli
Faculty of Sports and Physical Education, the University of Priština
temporarily based in Leposavić, Serbia
e-mail: evagelia.boli@pr.ac.rs