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High limit measures of reliability of tests with a singular covariance matrix in determination of the structure of cognitive dimensions of selected football players

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Abstract

If ξ^2 is a variance of any defined total result, if τ^2 is a variance of thus defined true result, and if ε^2 is a variance of the variation mistake of some composite measuring instrument.
As

$$\mathbf{G}^t\mathbf{E} = \mathbf{U}^2 - \mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2$$

For tests with regular, and

$$\mathbf{G}^t\mathbf{E} = \mathbf{U}^2 - \mathbf{U}^2\mathbf{R}^{-}\mathbf{U}^2$$

For tests with singular matrix of particles' covariance, two theoretical definitions of reliability

$$\alpha_1 = \tau^2\sigma^{-2}$$

and

$$\alpha_2 = 1 - \varepsilon^2\sigma^{-2}$$

are not equivalent when it comes to measuring model based on Guttman image theory. Let us first consider λ_6 measure type (Guttman, 1945.) defined by functions α_1 and α_2. For the result defined by function **b**, those measures will be

$$\lambda_{61} = \eta^2\sigma^{-2},$$

and

$$\lambda_{62} = 1 - \theta^2\sigma^{-2}.$$

β_6 measure types (Momirović, 1996.) defined by functions α_1 i α_2, for the result defined by function **h**,

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

and

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

It is not hard to demonstrate that, for the regular particle clusters, α_1 type measures of low reliability limit of λ_6 i β_6 measure types, and that α_2 type measures of low reliability measures type λ_6 i β_6.

Key words: variance, matrix, covariance, singular, function, measure

1. Introduction

In researches in applied psychology as well as other anthropological sciences, latent dimensions, as a rule, are estimated on the basis of groups of variables formed within theoretical models which were verified in previous, explorative or confirmative analyses of latent structure of manifested anthropological variables.

Hypothetical latent structure in applied researches is therefore explicitly defined, while hypothetical latent dimensions covered by a greater number of noticeable variables, the subjects of which measurements are known from previous analyses or they can be assumed with high probability based on theoretical, as a rule cybernetically formulated models.

In psychological literature, most often three types of definitions of intelligence are mentioned. In bihevioristic circles intelligence is frequently identified as a "learning capacity", i.e. capability for acquiring new knowledge. Intelligence is less frequently equated with "capability for abstract thinking". Definition of intelligence as a "capability for adaptation to new situations" requires particular attention. It is rather frequent in animal psychology. Adaptation here is not referred to as a tolerance to exogenous factors, or as to adaptation in clinical terms.

Central nervous system has primarily integrative function, thus enabling purposeful and adaptable behavior of human being. Integration on cortical level is of the greatest importance since purposeful behavior is directly related to intelligence on cortical level, but it is less flexible. Integration of function on subcortical level enables reacting in standard situations, the situations which demand for routine performance. Cognitive processes and cognitive functioning are central mechanisms of cortical integration.

2. Methods

2.1. Sample of subjects

Sample of subjects depended on organizational and financial resources required for the research. Sufficient number of qualified and trained personnel performing measurements, defined instruments and standardized conditions of the research planned were provided. Measurements were performed on the sample which is representative for the whole Republic of Serbia.

-subjects were male

-age was defined on the basis of chronological age, so that the research was performed on subjects from 18 to 27 years of age plus-minus 0.5 years

-subjects were registered players of the national competition rank (two highest levels of competition)

-subjects had regular trainings, which was confirmed by evidence kept by coaches

-we chose a sample of 107 subjects based on statistical-mathematical model and program, aims set by hypotheses.

No other exclusion criteria or stratification variables were used in defining of the population from which the sample of subjects was taken apart from the listed ones.

2.2 Sample of the variables

SAMPLE OF THE VARIABLES FOR EVALUATION OF COGNITIVE CAPACITIES

IT-1 test was chosen for evaluation of efficiency of input processors, i.e. perceptive reasoning.

S-1 test was chosen for evaluation of efficiency of parallel processor, i.e. identification of relations and correlates.

Measurement instrument AL-4 was chosen for evaluation of efficiency of serial processor, i.e. symbolic reasoning.

2. 3. Methods of processing of the results

Value of a research does not depend only on the sample of subjects and the sample of variables, that is on value of basic information, but also on the applied procedures for transformation and condensation of those information. Some scientific problems can be solved by multiple different, and sometimes equally trustworthy methods. However, with the same basic data and based on results of different methods, different conclusions can be drawn. Therefore the problem of selection of particular methods for data processing is rather complex.

In order to reach satisfactory scientific solutions, the research was based on, primarily acceptable, adequate, unbiased and comparable procedures, which were appropriate to the nature of the problem posed and which enabled extraction and transformation of appropriate dimensions, hypotheses testing of those dimensions, defining differences, relations, prognosis and diagnosis, as well as definition of principles within the research field.

Taking all this into account, for the purpose of this research we chose procedures which are considered to be appropriate to the nature of the problem which do not impose too severe restrictions on the basic information.

If ξ^2 is variance of any defined total result, if τ^2 is variance of thus defined accurate result, and if ε^2 is variance of measurement deviation of some composite measurement instrument.

As

$$\mathbf{G}^t\mathbf{E} = \mathbf{U}^2 - \mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2$$

Is for tests with regular, and

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For tests with singular matrices of particle covariance, two theoretical definitions of reliability,

$$\alpha_1 = \tau^2\sigma^{-2}$$

and

$$\alpha_2 = 1 - \varepsilon^2\sigma^{-2}$$

are not equivalent when it comes to the measurement model based on Guttman image theory.

Let us first consider λ_6 measurements (Guttman, 1945) defined by functions α_1 i α_2. For the result defined by function **b**, those measures will be

$$\lambda_{61} = \eta^2\sigma^{-2},$$

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β_6 measure types (Momirović, 1996.) defined by functions α_1 i α_2 for the result defined by function **h** will be

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

and

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

It is not hard to prove that for regular particle clusters α_1 measure types of the estimated low limit of reliability of λ_6 i β_6 measure types, and that $\alpha_2$measure types are estimates of high level of reliability of λ_6 i β_6 measure types.

Hypothesis 1

Coefficients γ_π vary in the range (0,1) and can reach value 1 only if **P** = **I**, if all the variables are measured correctly, and value 0 only if both **P** = **0** and **P** = **I**, that is if the entire variance of all variables consists only of variance of measurement deviation, and variables from V have spherical normal distribution.

Proof:

If the whole variance of each variable from some variable cluster consists only of variance of measurement deviation, then $\mathbf{E^2} = \mathbf{I}$ and **P** = **I**, so all coefficients γ_π equal zero. The first part of hypothesis is obvious from the definition of coefficient γ_π; this means that reliability of each latent dimension, regardless of how that latent dimension was determined, equals 1 if all variables from which the dimension was deduced were measured correctly.

However, reliability coefficient matrix $\mathbf{P} = (\rho_j)$ is frequently unknown, so that matrix of measurement deviation variance $\mathbf{E}^2$ is also unknown. But, if variables from V are selected to represent some range of U variables with the same array of importance, high limit of measurement deviation variances is defined by elements of $\mathbf{U}^2$ matrix (Guttman, 1945, 1953), that is by unique variances of those variables. This is why, in that case, low limit of reliability of latent dimensions can be estimated by coefficient

$$\beta_p = 1 - (\mathbf{q}_p{}^t\mathbf{U}^2\mathbf{q}_p)(\mathbf{q}_p{}^t\mathbf{R}\mathbf{q}_p)^{-1} \qquad p = 1,...,k$$

which were reached by the procedure identical to the one used for reaching coefficients γ_π with definition of $\mathbf{E}^2 = \mathbf{Y}^2$, that is the same way Guttman reached his measure λ_6 .

Hypothesis 2

Coefficients β_π vary in the range of (0,1), but they cannot reach value 1.

Proof:

If $\mathbf{P} = \mathbf{I}$, then also $\mathbf{Y}^2 = \mathbf{I}$, so that all coefficients β_π equal zero. However, as $\mathbf{Y}^2 = \mathbf{0}$ is not possible if matrix $\mathbf{P}$ is regular, all coefficients β_π are necessarily less than 1 and tend towards 1when unique variance of variables from which latent dimensions are deduced inclines towards zero.

By means of the same technique it is easy to determine measures of absolute low limit of reliability of latent dimensions defined by this procedure the same way Guttman determined his measure λ_1. For that purpose, we will assume that $\mathbf{E}^2 = \mathbf{I}$. In that case

$$\alpha_p = 1 - (\mathbf{q}_p{}^t\mathbf{R}\mathbf{q}_p)^{-1}$$

will be measures of absolute low limit of reliability of latent dimensions, as, obviously, $\mathbf{\Theta}^\tau\mathbf{\Theta} = \mathbf{I}$.

Hypothesis 3

All the coefficients α_π are always less than 1.

Proof:

It is obvious that all the coefficients must α_π be less than 1, and that they all incline towards 1 when m, number of variables in V cluster, inclines towards infinity, since in that case square form of matrix $\mathbf{P}$ inclines towards infinity. If $\mathbf{P} = \mathbf{I}$, then, obviously, all the coefficients α_π equal zero. However, low limit of coefficient α_π needs not to be zero, since it is possible, but not for all α_π coefficients, that variance $\sigma_\pi{}^2$ of some latent dimension is less than 1. Certainly, latent dimension which provides less information than any variable from which it was derived makes no sense, and the best way to show that is by coefficient α_π.

Measure types β_6 defined by α_1 i α_2 functions (Momirović, 1996) will be, for the result defined by function $\boldsymbol{\eta}$,

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

and

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

It is not hard to prove that, for regular particle clusters, measure types α_1 are estimated low limits of reliability of measures type λ_6 ι β_6, while α_2 measure types are estimated high limits of measure types λ_6 ι β_6.

Hypothesis 4

If $m \geq 2$, $|\mathbf{R}| \neq 0$ and $T \subset \boldsymbol{\alpha}$, where $\boldsymbol{\alpha}$ is cluster of all vectors which are in the positive hyperquadrant R^m of the space, so that $r_{jk} \geq 0 \ \forall \ t_j, t_k$; j,k = 1,...,m, then, for $\mathbf{x}$: $\mathbf{x}^t\mathbf{x} = 1$ is such that $\mathbf{x}^t\mathbf{R}\mathbf{x} = \lambda^2$ = maximum,

$$0 \leq \lambda_{61} \leq \beta_{61} < 1.$$

Proof:

Obviously, $0 = \lambda_{61} = \beta_{61}$ only when $\mathbf{C} = \mathbf{0}$, i.e. $\mathbf{R} = \mathbf{I}$. Ako $\mathbf{x} \neq \mathbf{e}$, $\lambda^2 \geq \sigma^2$, which is why it is crucial to determine what is the difference between functions $(\mathbf{x}^t\mathbf{C}\mathbf{x})(\mathbf{x}^t\mathbf{R}\mathbf{x})^{-1}$ and $(\mathbf{e}^t\mathbf{C}\mathbf{e})(\mathbf{e}^t\mathbf{R}\mathbf{e})^{-1}$. As

$$(\mathbf{x}^t\mathbf{C}\mathbf{x})(\mathbf{x}^t\mathbf{R}\mathbf{x})^{-1} - (\mathbf{e}^t\mathbf{C}\mathbf{e})(\mathbf{e}^t\mathbf{R}\mathbf{e})^{-1} = (\mathbf{x}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{x})\lambda^{-2} - 2(\mathbf{x}^t\mathbf{U}^2\mathbf{x})\lambda^{-2} - (\mathbf{e}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{e})\sigma^{-2} + 2(\mathbf{e}^t\mathbf{U}^2\mathbf{e})\sigma^{-2}$$

and as

$$(2(\mathbf{e}^t\mathbf{U}^2\mathbf{e})\sigma^{-2} - 2(\mathbf{x}^t\mathbf{U}^2\mathbf{x})\lambda^{-2}) > ((\mathbf{e}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{e})\sigma^{-2} - (\mathbf{x}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{x})\lambda^{-2}),$$

since matrix elements outside diagonal $\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2$ are negative if $T \subset \alpha$ and x vector elements in the negative correlation with matrix elements $\mathbf{U}^2$, then $\lambda_{61} \leq \beta_{61}$, which is exactly what needed to be proved.

In a similar manner we can demonstrate that relations defined by hypotheses 1, 2, 3 i 4 stand in case if $|\mathbf{R}| = 0$ and $\mathbf{U}^2 = (\text{diag } \mathbf{R}^-)^{-1}$, taking into account that $\mathbf{R}\mathbf{R}^- = \mathbf{X}\mathbf{X}^t$, where $\mathbf{X}$: $\mathbf{X}^t\mathbf{X} = \mathbf{I}$ and matrices typical of vectors of matrix $\mathbf{R}$ coupled with typical values of that matrix other than zero. However, in that case, due to inflation of uniqueness in the zone of singularity, there will almost always occur reduction of all measures of reliability which are based on estimation of unique particle variance (Momirović, 1999).

3. Results

Factorial structure of intellectual capabilities was analyzed based on all information provided by matrix of significant main components (Table 1). Based on α_2 Guttman measure only one latent dimension which marks the entire space of the three cognitive tests with around 69.97% of common variance. This can be appropriate for this kind of research. Communalities of variables of all estimated capabilities by these tests are relatively high and can be taken as appropriate.

The strongest connection with the isolated cognitive dimension has the variable for estimation of perceptive capabilities IT1. Several authors discovered the positive connection between perceptive capabilities and motor abilities, (Boli. 1996). Although perceptive measurement instruments are significantly saturated by cognitive factors (literature frequently mentions cognitive functioning on perceptive level), it would have been unsupported to call them cognitive measurement instruments, although that is what they are in a way. Positive connection, most frequently average, between perceptive capabilities and motor abilities was discovered by Horne, Fitts, Harison, Fleishman, Neeman, Hempel etc. authors have also discovered that motor activity positively influences development of perceptive capabilities. Cognitive dimension was clearly defined by test AL4 with relatively low projection for estimation of serial processor which corresponds to Cattell's factor of crystallized intelligence and test for estimation of efficiency of parallel processor, i.e. spotting relations and correlates of S-1.

Connection between cognitive capabilities and success in football was proven in numerous researches. It is assumed that better adaptation of cognitive capabilities to specific life conditions of players of all levels, and particularly of those of highest level influences connection of cognitive capabilities and success in football. For that reason recognizing cognitive structure of footballers is of particular importance for planning and reorganization of training and prognosis of success in game and in football itself.

Obtaining of this result is understandable if we take into account that football is characterized by variety and abundance of technical elements, whole body and extremities movements into different directions with varying pace. During a game, dynamic situations constantly change depending on movement of players with different techniques.

Taking all into account, we can conclude that basic cognitive processes are functions of perceptive, parallel and serial processor, which are probably under control of some central processor in charge of coordination of all cognitive functions.

MAIN COMPONENTS OF FOOTBALLERS' COGNITIVE VARIABLES

Table 1.

	FAC1	h2
IT-1	.93	.88
AL-4	.89	.79
S-1	.81	.69
Typical values	2.53	
% Variance	69.97	
Cummulative.%	69.97	

4. Conclusion

The research was conducted in order to determine structure of cognitive capabilities of sportsmen playing football. In order to discover structure of the treated anthropological dimensions, the research was conducted on 107 football players.

For investigation of cognitive capabilities measurement instrument CON3 was chosen, which estimates the following cognitive mechanisms: for estimation of input processors, i.e. perceptive reasoning, IT-1 was chosen. For evaluation of efficiency of parallel processor, i.e. identification of relations and correlates, S-1 test was used. For evaluation of efficiency of serial processor, i.e. symbolic reasoning, measurement instrument AL-4 was chosen.

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

Factorial structure of intellectual abilities was analyzed based on all information provided by matrix of significant main components (Table 1). Based on Guttman $\boldsymbol{\alpha}_2$ measure only one latent dimension was isolated, which marks the entire space of the three cognitive tests with around 69.97% of common variance. This can be accepted as appropriate for a research of this type. Communalities of variables of all the estimated abilities by the tests used are relatively high and can be considered to be satisfactory.

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5. Literature

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

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

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

[4.] Gredelj, M., D. Metikoš, A. Hošek, K. Momirovic (1975): A model of hierarchical structure of motor abilities. Kinesiology, 5 (1-2), 7-81.

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

[6.] Knežević, G.; Momirović, K. (1996): Algorithm and program for orthoblique transformation of the main components of which the importance is based on PB criterion. Technical report, Institute of criminological and sociological research, Belgrade

[7.] Momirović, K. (1996): About the reliability measures of latent dimensions determined by semiorthogonal transformations of the main components in S. Bogosavljević and M. Kovačević, *Grouping Analyses,* **2.**
Belgrade: National Institute for Statistics

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

[9.] Momirović, K. (1999): Two measures of low and high reliability levels of the tests with regular and singular matrix of particles' covariance

[10.] Momirović, K.; Erjavec, N.; Radaković, J. (1988): Method, algorithm and program for concurrent validation of measuring instruments under confirmative and explorative model of component analysis, *Applied Psychology,* **9**: 157-162

[11.] Momirovic, K and Popović, D. (2003): Construction and applied taxonomy of neural webs, Leposavić, University in Priština, Center for multidisciplinary researches of the Faculty of Physical Education.

[12.] Mulaik, S. A. (1972): The foundations of factor analysis. New York: McGraw-Hill.

[13.] Popović, D.: (1980) Research methodology in Physical Education, University in Niš, Scientific Youth, Niš.

[14.] 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.

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

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

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

[18.] Popović, D. (2005): GUTTMAN, Programs for the analyses of metrical characteristics of composite measuring instruments, in Savić, Z.: The influence of situational training on the transformation of some anthropological elements of selected football players (doctorial thesis), Leposavić, Faculty of Physical Education.

[19.] Popović, D.: (1988) Application methods of factorial analysis for determining morphological types. *4rd international symposium on the methodology of mathematical modeling*, Varna, Bulgarija.

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

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

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

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

[24.] Kaiser, H. F. (1958): The varimax criterion for analytic rotation in factor analysis. P*sychometrics*, **23**:187-200.

[25.] Kurolić, N., et. al. (1975): Structure and development of motor and morphological dimensions of the youth. Belgrade: Institute for scientific research, Faculty of Physical Education, University in Belgrade.

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

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

[28.] Štalec, J.; Momirović, K. (1971): The total amount of acceptable variance as the basis of the criterion for determining the number of important main components.
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Summary

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