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The Structure of Intellectual Abilities of Special Olympics Football Players

Dragan Popovic, Evagelia Boli, Jasna Popovic, Vladimir Savic, Milos Popovic, Milica Bojovic
Faculty of Sport and Physical Education, University of Pristina
Temporarily seated in Leposavic, Serbia

Abstract **– The research was conducted in order to determine the structure of cognitive abilities in Special Olympics athletes and partners in football. For this purpose, 140 athletes and partners engaged in football were tested. For the assessment of cognitive abilities, Raven's Colored Progressive Matrices which measure IQ were selected. All the data in this research were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina by the system of data processing programs DRSOFT developed by [13,19],[12]. The algorithms and programs implemented in this research have been fully presented and the results of these programs have been analyzed.**

Keywords **– Transformation, Matrix, Eigen, Orthogonal, Vectors, Variance.**

I. INTRODUCTION

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

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

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

The IQ levels given are provided as a guide and should not be applied rigidly. The IQ should be determined from standardized, individually administered intelligence tests appropriate to the individual's level of functioning and additional specific handicapping conditions, e.g. language problems, hearing impairment, physical involvement. Scales of social maturity and adaptation, again locally standardized, should be completed if at all possible by interviewing a parent or care-provider who is familiar with the individual's skills in everyday life. Without the use of standardized procedures, the diagnosis must be regarded as provisional. (Geneva, 1992, FCD-10).

II. METHODS

Sample of respondents

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

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

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

Based on the chosen statistical-mathematical model and program, objectives and hypotheses, we opted for a sample of 140 respondents, a total of 140 for each subsample (100 Special Olympics athletes and 40 partners). The size of such a sample should meet the following criteria: the size of the sample effective should permit as many degrees of freedom as to make it possible for any coefficient in the pattern matrix or any correlation coefficient equal to or

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greater than .30 to be considered different from zero with an inference error less than .01. to apply adequate statistical methods successfully, according to the latest beliefs, the number of subjects in the sample should be five times larger than the number of the variables applied.

In addition, respondents were to meet the following specific requirements: respondents were required to be male, the age of respondents was defined on the basis of chronological age, so the research covered respondents aged 15 to 18 years plus-minus 0.5 years, respondents were required to be members of a society that brings together Special Olympics athletes, respondents were required to attend training classes regularly, what was determined on the basis of records kept by the coaches.

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

Sample of cognitive variables

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

The aforementioned instrument determines an overall IQ.

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

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

Data processing methods

Except for Mulaik's famous textbook on factor analysis, which contains some information about estimation of reliability of principal components [10], and the work of Kaiser and Caffrey who derived a method of Alpha factor analysis based on maximizing reliability of latent dimensions [24], it seems that producers of various methods of component and factor analyses as well as authors of books on this class of methods for latent structure analysis did not care about how much they could trust the real existence of the latent dimensions obtained with those methods. This fact also refers to the latent dimensions obtained by orthoblique transformation of principal components, a method that has become a standard procedure for analyzing latent structures among all those who have not acquired information about factor analysis as they used their fingers when reading seriously written texts in this area, or those who analyze their data using some of the commercially written statistical software packages, such as, but not exclusively, SPSS, CSS, Statistica, BMDP, and Statgraphics, not to mention other products whose popularity is mu ch lower, but not always because they are significantly weaker than those abused today by some scientists and special sort of human beings called the "data processor " strain.

All the data in this study were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina by the system of data processing programs DRSOFT developed by [13,19], [12].

SEMI-ORTHOGONAL TRANSFORMATION OF PRINCIPAL COMPONENTS

Let Z be a matrix of the standardized data obtained by describing set E of n entities on a V set of m quantitative, normally or at least elliptically distributed variables. Let R be an intercorrelation matrix of these variables. Assume that R is surely a regular matrix and it is possible to reject the hypothesis that variables in V have a spherical distribution, that is, eigenvalues of the correlation matrix in population P from which the E sample was drawn are equal. Let $U^2 = (\text{diag } R^{-1})^{-1}$ is Guttman`s estimate of unique variances of variables from V and let λ_p , p = 1,...,m be eigenvalues of matrix R. Let c = trag $(I - U^2)$. Define a scalar k such that $\Sigma_p^k \lambda_p > c$, $\Sigma_p^{k-1} \lambda_p < c.k$ is now a number of principal components of matrix Z defined on the basis of Štalec and Momirović`s PB criterion. Let $\Lambda = (\lambda_p)$; 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 with them eigenvectors scaled so that $X^tX = I$. Let T be an orthogonal matrix such as to optimize the function XT = Q = (q_p) ; p (Q) = extremum, $T^tT = I$, where p (Q) is a parsimonic function, for example, an ordinary varimax function $\Sigma_i^m \Sigma_p^k q_{ip}^4 - \Sigma_p^k (\Sigma_i^m q_{ip}^2)^2$ = maximum, where coefficients q_{ip} are elements of matrix Q [24]. Now the transformation of the principal components defined by the vectors in the matrix K = ZX into semi-orthogonal latent dimensions determined by the type II orthoblique procedure [26] is defined by the operation L = KT = ZXT. The covariance matrix of these dimensions is $C = L^tL\, n^{-1} = Q^tRQ = T^t\Lambda T$. Denote the matrix of their variances with $S^2 = (s_p^2) = \text{diag } C$. If we standardize the latent dimensions 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 formed latent dimensions are not orthogonal in the space of entities from E. The matrix of correlations between variables from V and latent variables, which is commonly referred to as a factor structure matrix, will be $F = Z^tDn^{-1} = RXTS^{-1} = X\Lambda TS^{-1}$; and as the elements of matrix F are orthogonal projections of vectors from Z over vectors from D, the coordinates of these vectors in the space spread by vectors from D are elements of the matrix $A = FM^{-1} = XTS$. But since $A = S^2$, the latent dimensions obtained by this method are orthogonal in the space spread by the vectors of variables from Z; the squared norms of the vectors of those dimensions in the space of variables are equal to the variances of the dimensions.

III. RESULTS

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

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the effectiveness of parallel processor RK, or the ability to identify relations and correlates was assessed, are relatively high and can be considered satisfactory.

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

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

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

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

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

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

Principal components of cognitive variables of athletes and partners

Table 1

	FAC1	FAC2	h^2
PP	(,80)	-,08	,66
SR	-,22	(,93)	,92
RK	(,74)	,38	,70
Lambda	1,26	1.02	
%	41.99	34,12	
Cum. %	41,99	76,12	

Pattern of oblimin factors of cognitive variables of athletes and partners

Table 2

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

Structure of oblimin factors of cognitive variables of athletes and partners

Table 3

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

Intercorrelations of oblimin factors of cognitive variables of athletes and partners

Table 4

	OBL1	OBL2
OBL1	1,00	-,04
OBL2	-,04	1,00

Based on the above, it may be concluded that the basic cognitive processes can be reduced to the functions of perceptual, parallel and serial processors which are probably under control of the central processor responsible for coordinating all cognitive functions.

IV. Conclusion

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

For this purpose, 140 athletes and partners engaged in football were tested. For the assessment of cognitive abilities, Raven's Colored Progressive Matrices which measure IQ were selected.

All the data in this research were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina by the system of data processing programs DRSOFT developed by [13, 19], [12].

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

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

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