THE CANONICAL DISCRIMINANT ANALYSIS AND ITS EFFECTS ON DETERMINING THE DIFFERENCES BETWEEN THE MOTOR ABILITIES OF ADOLESCENTS

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ABSTRACT

There is no doubt that motor skills represent a very complex field of the psychosomatic dimensions of the human being. Even though a lot of information has been gathered on the subject, the basic problem is that there are very few congruent pieces of information which have been gathered and processed by means of valid and reliable mathematical-statistical procedures. The aim of the research was to determine the quantitative and qualitative differences in terms of motor skills, based on a sample of 240 schoolboys divided into 4 sub-samples of 60 participants each, aged 15-18. For this measuring program the significant motor dimensions were evaluated using 12 measuring instruments. The differences obtained between the four groups of entities were calculated using a program for the canonical discriminant analysis in Mahalanobis space. Following the processing of the data using a program for the canonical discriminant analysis in Mahalanobis space, the obtained results indicated that between the boys, if we take into consideration chronological age, within the entire system (multivariate) of applied motor variables, a statistically significant difference can be found. On the basis of the results obtained in this fashion, we can conclude that the growth trend is such that almost all of the motor skills increase significantly in terms of chronological age. On the basis of the displayed theoretical and practical values of this paper, the authors would like to create the optimal conditions for regular in-class work and extracurricular activities as well as for monitoring, noting and evaluating the sports results of schoolchildren, to increase work intensity in the classroom, to modernize in-class work and to create a greater collaboration between physical education teachers, psychologists, physicians and schoolchildren. On the basis of the obtained and analyzed multivariate and univariate results in this research, generally speaking we can conclude that the results that were obtained were satisfactory and expected.

Key words: boys, motoric skill, differences

INTRODUCTION

There is no doubt that motor abilities represent a very complex sub-field of the psycho-somatic dimensions of humans. Even though a great deal of literature exists on the subject, the basic problem lies in the fact that very little congruent information has been compiled and processed using valid and reliable mathematical procedures. Data processing, which has predominantly been carried out with a significant error in measurement, and which only to a lesser extent dealt with the main subject of the measuring, did not enable anything other than the dissemination of suspect theories and speculation, often devoid of any kind of scientific basis. Over the last 35years, much has been done to construct reliable measuring instruments and to systematically analyze the structure of anthropological space (Momirović, Wolf & Popović, 1999; Malacko & Popović, 2001).

In the research carried out to date, the greatest number of authors have studied the problems of the structure of motor abilities, that is, the identification of latent structures which were used to define these spaces (Kurelić, Momirović, Stojanović, Šturm, Radojević & Viskić-Štalec, 1975; Stanković, 2001; Stanković & Malacko, 2008; Stanković & Popović, 2000, 2001, 2002, 2010, Stanković, Popović & Popović, 2011). The kinesiological studies which focused on solving problems and determining the laws of the space of physical education have shown that such an approach will continue to enable researchers to investigate the manifest and latent dimensions of anthropological status.

The aim of the research was to determine the statistically significant differences in the motor abilities of adolescents aged 15-18.

METHODS

The sample of participants

A system of 12 variables of motor abilities was used on a sample of 240 adolescents (divided into four sub-samples of 60 participants each), aged from 15 to 18.

The sample of variables

In order to evaluate the motor abilities, the following predictor variables were used: *for the structuring of movement:* 1. HTA - hand tapping, 2. FTA – foot tapping, FTW – foot tapping against a wall; *for the regulation of tonus and synergy regulation*: 4. STA - standing on one leg, 5. EXT - hyperextensions, 6. DAR - darts; *for the regulation of excitation intensity:* 7. 20R - the 20m run with a high start, 8. JUM – the high jump (Abalak), 9. TJU – the triple jump; *for the regulation of excitation duration:* 10. PUS – push-ups, 11. TLI - torso lifts, 11. TEX – hand extensions on a bench.

Statistical analyses

In order to determine the differences between the motor abilities of children of various ages, the canonical discriminant analysis was used. The discriminant model is interpreted as a special type of factor analysis which contains components which are best at separating groups in the variable space. The general statistical significance of the between-group discriminance was calculated using the F-test. Discriminant variables are obtained based on the discriminant coefficients which depend on the variance of each variable from the applied system of variables and which provide original results. The discriminant strength of the applied variables was determined using Wilks' lambda, while the level of significance of the discriminant equation was determined using Bartletts' test. Each taxonomy algorithm can be defined as an extremization of the function

$f(Z) = S¦alfa(Z,S) = maximum$

where Z is the data matrix in a suitable metric, S an unknown selector matrix, and (alfa) a suitable selected measure of similarity. The taxonomy algorithms, thus, differ based on the metric selected for the operation

$Z = E \otimes V$,

where Eis a group of objects, and Vis a group of variables, how the measure of the similarity (alfa) has been defined and which function f was selected for the extremization of that measure.

It is quite clear that a problem defined in this manner cannot be solved in closed algebraic form and that the solution must be sought in a numeric algorithm. As it is well-known, to date several hundreds of these algorithms have been proposed, and were sufficient enough to be retained in practice and find their place in textbooks; dozens of these algorithms have even been implemented into the most frequently used statistical program systems of packages including SAS, GENSTAT, SPSS, Statistica, BMDP, SYSTAT and other,

not necessarily less reliable programs. The application of these products in various sciences or professions derived from them has shown that their effectiveness, estimated by means of the reproduction of the matrix Susing a discriminant procedure, significantly varies not only from method to method and from one implementation to another, but from problem to problem, defined by the configuration of the vectors of objects in the space of the variables. The effectiveness of the classification is evaluated by the program on the basis of the value of the Fisher discriminant analysis in the full space of the transformed variables (Popović, 1993).

THE RESULTS

From the calculated statistical values presented in the following numeric table, we can clearly see that a statistically significant difference can be determined between the means (p=00) of the groups of adolescents of different age groups in the system of the 12 applied (univariate) motor variables.

Table 1 The differences in the arithmetic means of the variables between adolescents of various ages (M_15),(M_16), (M_17)and (M_18) and their statistical significance (p)

	M_15	**M_16**	**M_17**	**M_18**	F	**p**
HTA – hand tapping	37.72	36.67	37.13	36.58	.58	.62
FTA – foot tapping	27.32	26.33	28.42	26.45	4.18	**.00***
FTW – foot tapping against a wall	20.13	19.45	19.83	19.60	.40	.74
STA – standing on one leg	79.17	94.50	81.83	76.00	5.76	**.00***
EXT – hyperextensions	31.25	29.10	27.67	30.98	6.00	**.00***
DAR – darts	19.32	18.60	18.87	18.67	.27	.84
20R – the 20m run	41.68	40.95	41.48	41.97	.87	.45
JUM – the high jump (Abalak)	30.97	29.62	31.37	28.90	3.17	**.02***
TJU – the triple jump	472.67	463.75	461.50	446.92	3.07	**.02***
PUS – push-ups	41.40	38.98	25.13	40.78	13.80	**.00***
TLI – torso lifts	16.20	17.53	18.40	17.83	2.86	**.03***
TEX – torso extensions	6.22	6.23	5.33	6.63	3.94	**.00***

Table 2 The canonical correlations and the outcome of the tests of their significance

DFunc	**Eigenvalue**	**% of Var**	**Cum %**	**CanCorr**	**Wilks' L**	**Chi-square**	**df**	**p**
1	.38	61.8	61.8	.52	.57	126.49	36	**.00***
2	.14	22.7	84.4	.35	.80	51.63	22	**.00***
3	.09	15.6	100.0	.29	.91	21.25	10	**.01***

Table 3 Structure Matrix

	D_1	**D_2**	**D_3**
PUS – push-ups	**.67***	.06	.10
HEX – hyperextensions	**.38***	.37	.03
TEX – torso extensions	**.34***	.03	-.19
FTA – foot tapping	**-.33***	.23	.19
STA – standing on one leg	.00	**-.68***	.26
20R – the 20m run	.02	.25	-.13
FTW – foot tapping against a wall	-.01	.14	.14
TJU – the triple jump	-.02	-.01	**.63***
TLI – torso lifts	-.19	-.15	**-.43***
JUM – the high jump (Abalak)	-.22	.14	**.42***
HTA – hand tapping	-.02	.13	.22
DAR - darts	.00	.10	.13

Table 4 Group Centroids

Gender	GC_1	GC_2	GC_3
15	.34	.35	.40
16	.27	-.61	.08
17	-1.05	.04	-.03
18	.43	.21	-.45

In the space of the manifest variables of motor abilities, the applied ANOVA has shown that there are statistically significant differences in the following motors tests: FTA – foot tapping, which was used to evaluate the structuring of movement; STA – standing on one leg and HEX – hyperextensions, which were used to evaluate the regulation of tonus and synergy regulation; JUM – the high jump (Abalak) and TJU – the triple jump, which was used to evaluate the mechanism for excitation intensity regulation; PUS – push-ups, TLI – torso lifts and TEX – torso extensions which were used to evaluate the mechanism for the regulation of excitation duration. Considering the fact that

univariate statistical procedures leave behind certain restrictions in the process of drawing conclusions, the data were also processed using a canonical discriminant analysis.

The results of the canonical discriminant analysis of the motor abilities indicate that the studied groups of adolescents differ significantly based on their age. Three coefficients of the canonical correlation were obtained, among which the first was the most significant, and carried the greatest informative value of .52(table 1). The significance of this discrimination was tested using Wilks' lambda (.56) and Bartlett's test (χ^2=126.49). The obtained results indicates statistically significant differences between the groups (Sig = .00). As it has previously been stated, by means of the transformation and condensation of the variables in the motor space, three discriminant functions were isolated, which maximally separate the groups of adolescents on the basis of the discriminant coefficients. By gaining insight into the coefficients which determine the first discriminant function, we can note that it separates the adolescents on the basis of the tests used to evaluate repetitive strength, flexibility and segmentary speed. On the basis of the extent of the sign and the projection of the centroid onto the first discriminant function, we can conclude that the participants who were first and fourth-year high school students scored better results on the tests used to evaluate their motor abilities. The second discriminant function discriminates between the groups on the basis of balance, and the third discriminant function on the basis of the tests for explosive and repetitive strength, also in favor of first and fourth-year participants.

DISCUSSION

Considering that the levels of biological potential, viewed multivariately, do not simply represent chronologically developing groups of children, but instead the actual levels of capacity for task appropriation, resource accumulation and the manifestation of the realization of movement in accordance with the existing biological composites, there is no regular increase in the results for the tested abilities.

The information which is most pertinent for this conclusion is contained in the group centroids of the discriminant function, since they can be used to precisely locate the position of each group, which in this case describes their motor status. We can note that the obtained discriminant functions primarily divide the group of 15 and group of 18-year-olds from the group of 16 and group of 17-year-olds. Considering the fact that we are dealing with a test of the integral motor space, we can conclude that adolescents aged 15 and 18 manifest better motor status, while adolescents aged 16 and 17 have weaker motor status. It was expected that the obtained functions would change, not only under the influence of kinesiological or other treatments, but primarily under the influence of growth and development.

The reasons for this lie in the number of active class hours taught by the teachers, as well as in the motivation or lack thereof for participating in physical education in high school. The focus on the problem of motivation is by no means accidental. Psychologists pose series of questions regarding it: what conditions it, what promotes it and what hinders it from occurring in a particular human activity. We could say that all these influences, including institutional-informal ones (those pertaining to the family) an institutional and formal ones (those pertaining to the school) can, ultimately, bring about two possible outcomes:

- They will either interfere with the 'internal capacities' which could lead to optimized achievement
- They can act as inhibitors, which would decrease the capacity or potential which the personality of the child has at its disposal. (Popović & Simonović 2008; Stanković, Popović & Popović, 2011).

The group of motives which motivate most boys and girls to take part in physical exercise can be classified as a need for movement (the emotional attraction of physical exercise), the need to fulfil duties (the responsibility motive) and the need for the activity itself.

It is clear that the students involved in the field of physical education should be given more room to maneuver in, so that better results could be expected in the teaching process in higher grades. High-school students are exposed to very extensive changes in terms of psycho-somatics and it is necessary to view motivation for physical exercise as an integral part of growth and development. The interest which children have for sport and kinesiological research should motivate pedagogues to further guide such students, help them achieve their maximum satisfaction and satisfy the need to prove themselves.

CONCLUSION

The aim of the current research was to apply a system of 12 motor abilities variables on a sample of 240 adolescents (divided into four sub-samples of 60 participants each), aged from 15 to 18, and determine the differences between the groups of adolescents, so as to make a proper and objective evaluation of the process of development of motor sills based on chronological age. On the basis of the obtained results, the conclusion can be drawn that adolescents aged 15 and 18 have better developed mechanisms for:

- The regulation of excitation duration,
- Synergy regulation and tonus regulation,
- The structuring of movement.

It would seem at first sight that the situation is quite straightforward. However, a more careful inspection of the results could help us note that the results are quite good but that in the light of other indicators, it is clear that age is a great suppressor of the realization of movement and the manifestation of motor abilities. Even though there may be some discrepancies in terms of the purpose and focus of our activities involving school-aged children, the results of this research make it possible for us to claim that a completely different approach is needed for the development of these abilities. Whether kinesiological operators should be used as an end or as a means, and when or why to use them at all, is a separate issue altogether. Adolescents should be allowed to precisely dose transformational operators, which will enable the achievement of those tasks that have been deemed real and possible. In addition, it is quite clear that these results are influenced by the motivation, or lack thereof, for active participation in physical exercise.

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