STRUCTURE OF STUDENTS COORDINATION

Ratko Pavlović
Faculty of Physical Education, University of East Sarajevo, BiH

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Summary
It is said for coordination that it is a form of mobility intelligence, and that it presents one of the most complex mobility dimensions. Looking at it from physiology aspect, it is justified, because the quality of coordination is based on adaptive capability of CNS (central nervous system). As a mobility capability, it takes part, more or less, in all mobility activities. Regarding the multidimensional coordination and its complexity, it is very important to define factors that would be universal for this basic mobility capability. However, all dimensions of coordination depend on several factors: cognitive age factors, emotional state, concentration, motivation, previous mobility experience. For establishing coordination, 13 tests have been applied. The testing sample included 160 full-time students of the male sex, age group 20-21years (± 6 months). The basic goal of research was to determine the structure coordination level on the basis of the applied manifest variables. For the purpose of reduction of larger number of manifest variables, for the smaller number of latent dimensions in explanation of total variability, the factors analysis has been used. On the basis of analysis results, the assumption about relatively high level of student's structure coordination has not been confirmed.

Key words*: coordination, factors analysis, manifest variables, latent dimensions.*

Introduction

Coordination is a basic mobility activity which specially attracted attention of the experts and scientists, although the results of the research still do not give enough data by which this mobility activity could be considered as well studied. The reason could be found in the fact that there are big differences in thinking and defining related to coordination, but as one of the most important reasons is insufficient knowledge of brain functioning, where even the neurologists don´t have final answers. Most authors agree that coordination means ability of human to coordinately and efficiently control the movements of his body, especially in newer more complex and unpredictable situations (Gajić, 1985; Kukolj, 1986; Nićin, 2000; Stojiljković, 2003). It is evident that it represents one of the most complex mobility dimensions. It can be said that it is a form of mobility intelligence (Nićin, 2000). Observing from physiological aspect it is justified, since the quality of coordination is based on adaptive ability of CNS. The result of this is that mobility learning is based on activity of higher mobility centers of nervous system.

Zaciorsky states Bernsteins theory of coordination of the structure of motion on four levels (reflex level, sinergy level, space field level, departmentalized action level). This structure means engagement of different parts of CNS depending on mobility task. The leading role is related to sensitive and mobility centers in hypotalamus cortex.

Coordination as mobility ability participates more-less in all mobility activities. This especially prevails in marshal arts sports and sports games, as well as in those activities where unstereotype motion dominates. Considering the multidimensionality of coordinaton and its complexity, it is very hard to define factors that would be universal for this basic mobility activity. Nevertheless, all dimensions of coordination depend on several factors: cognitive factor (intelligence) influence on learning speed of the new mobility tasks, that is on faster overcoming of the complex coordinated structures; age factor of which depends coordination, more intensively develops from 6 to 7 years (with CNS maturing), and after puberty it can be very little influenced, previous mobility experience is significant factor of coordintion beacuse the richness of motion and movement acquired through education, it enables to practicers learning easier and faster new coordinated structures; emotional condition can negatively influence on performing of complex motions, beacuse there could come to inhibition of motion and movements that violates coordination and further performing technique (for example shot on basket); concentration is very significant factor beacuse the attention is directed on certain motion, that is performing the certain mobility structure; motivation in some situations can urge the one who practices that as never before perform some coordinated complex motion.

Problem and goal

Analysing the complex space of coordination, we come to the conclusion that it is defined by mobility variables of phenomenal model in demonstrating space and the pure movement realization and that it happens according to the laws of functional model, that is according to changes in CNS. It is indirect index of connection of coordinated structures of motion with higher centers in hypothalamus cortex.

On the basis of previous research, in which the determination of the structure of space coordination (Kurelić, 1975; Metikoš & Hošek, 1972; Hošek, 1976; Momirović et all, 1979) on the population of grown ups was a measurement problem, it has unambiguously been determined that there, in the scope of primary dimensions, exist a greater number of coordinating factors in which a mutual basis real stability has unique mechanism for motion structuring under control of central regulation factors.

Researches have been also concducted on population of the students (Babić, 1985; Ivanović, 2001, 2005) and somewhat less on population of students of Physical Education and it treated the problem of coordination and its structure (Pavlović, 2004). It can be assumed that results of this research, although it is about students, can confirm similar structure of space coordination as in earlier research, and that the mechanism of motion structuring under cortical control is responsible for its structures. On the basis of previous research and assumption, the problem of the research was to conduct the analysis of the space coordination complexity at Physical Education students.

The basic goal was to determine the level of structure coordination on the basis of applied demonstrating mobility variables.

Methods

On the sample of 160 students of Physical Education, aged 20-21 years, the system of 13 variables has been applied by phenomena model. These variables mostly covered the complex field of coordination which included the following variables: variables for body coordination evaluation, 1-coordination with stick (MKOP), 2- agility in air (MOZ); variables for evaluation of ability of the dynamic stereotype reorganization, 1-the long jump backwards (MSDU), 2-proving ground backwards (MPOL); variables for legs coordination evaluation, 1-slalom with legs (feet) whith two balls (MS2L), 2-slalom with weaker leg of one ball (MS1L); variables for hands coordination evaluation, 1-dribbling by hand in slalom (MVLR), 2- dribbling with weaker hand (MVLSR); variables for evaluation of the fast complex motions performing evaluation, 1-slalom with three balls (MS3L), 2-permeating and jumping over (MPP); variables for agility evaluation, 1-forward backward roll with running (MKNN), 2-eight with bending (MOS), 3- agility on ground (MONT). The central and dispersion parameters have been calculated for all variables. The normality of the each variable distribution has been tested on the basis of: skewness, kurtosis. In order to define the number of latent dimensions, that is the level of coordination structure, the factors analysis has been applied on the basis of greater number of demonstrating variables among which there exists a maximal parsimony.

Results

Table 1. Descriptive parameters

	mean	min	max	range	SD	Skew	Kur
MKOP	4.84	3.10	6.70	3.60	.93	.28	-.72
MOZ	3.47	2.68	4.70	2.02	.39	.31	.27
MSDU	106.90	75.00	150.00	75.00	4.60	.24	.61
MPOL	9.76	7.11	13.35	6.24	1.54	.86	-.08
MS3L	25.07	20.00	32.00	12.00	2.62	.53	.20
MPP	12.50	10.59	18.35	7.76	1.11	2.41	12.04
MVKL	9.58	8.00	11.70	3.70	.87	.40	-.56
MVSR	10.40	8.68	13.20	4.52	.99	.35	-.34
MS2L	49.00	21.02	76.00	54.98	4.92	.13	-1.04
MS1L	13.02	10.00	17.80	7.80	1.82	.04	-1.12
MOS	14.05	12.40	17.30	4.90	2.41	.31	-.83
MKNN	5.21	3.40	7.00	3.60	.87	.18	-.24
MONT	15.81	10.08	20.00	9.92	2.38	.03	-1.05

The analysis of the descriptive statistics results inidicates a normal distribution of applied variables inside Gauss distribution (table 1). Almost in all analyzed variables, the distribution pictures the symmetry where value of skewness doesn't exceed value 1.00, except in the case of the variable permeating-jumping over (MPP). In range of the minimal and maximal results, there are sufficient number of standard deviations, which enables the statement of high sensitivity of the variables researched in this study. The normality of the tested variables distribution on univariant level allows the use of multivariant factors analysis for the needs of this research. Through survey of intercorrelation variables matrices, statisticaly significant coeficients of correlations are evident (table 2). The correlative matrix of applied variables gave 28 different values of correlative coefficients on the level from $p<.05$, in the range from low .28 (MSDU-MONT) to high .81 (MS1L-MKNN).

Table 2. Correlation matrix

	MKOP	MOZ	MSDU	MPOL	MS3L	MPP	MVKL	MVSR	MS2L	MS1L	MOS	MKNN	MONT
MKOP	1.00												
MOZ	.06	1.00											
MSDU	.07	.05	1.00										
MPOL	-.03	.02	-.06	1.00									
MS3L	.07	.12	.01	-.06	1.00								
MPP	-.10	-.01	-.19	.22	.09	1.00							
MVKL	.52	.38	-.15	.09	.05	.15	1.00						
MVSR	.36	.30	-.15	.33	.08	.18	.74	1.00					
MS2L	.13	-.03	.11	.43	-.06	-.16	.29	.29	1.00				
MS1L	.14	-.02	.20	.54	-.10	-.31	.15	.29	.68	1.00			
MOS	-.10	-.02	.16	.20	-.20	-.15	.08	.19	.44	.40	1.00		
MKNN	.12	-.00	.19	.51	-.14	-.19	.31	.38	.75	.81	.44	1.00	
MONT	.20	-.08	.28	.26	.02	-.11	.32	.31	.65	.65	.44	.71	1.00

Correlations are significant at $p<0.05$, 0.05 = 0.278

The greatest correlative connection was achieved by the variables for agility evaluation. Values are from middle .44 (MOS-MKNN, MONT) to almost high .71 (MKNN-MONT). Variables used for evaluation of extremity coordination achieved considerable connection, that is legs coordination from middle .40 (MS1L-MOS) to high .81 (MS1L-MKNN), hands coordination and the variable of dynamic stereotype reorganization proving ground backwards (MPOL). Variables defining other subspaces of coordination did not achieve some more significant connections.

Table 3. Factor Loadings Principial components

	F1	F2	F3	F4	h2
KOP	.04	.71	.27	-.01	77
MOZ	-.08	.50	-.02	.23	60
MSDU	.26	-.13	.58	.37	65
MPOL	.62	-.06	-.56	.06	76
MS3L	-.10	.12	-.06	.87	90
MPP	-.17	.03	-.77	.19	65
MVKL	.19	.90	-.17	-.05	84
MVSR	.33	.74	-.35	-.01	70
MS2L	.84	.12	.02	-.03	82
MS1L	.88	.05	.11	-.02	86
MOS	.60	-.06	.09	-.25	55
MKNN	.91	.15	.02	-.06	91
MONT	.80	.18	.16	.11	77
Expl.Var	3.94	2.23	1.52	1.08	
Prp.Totl	.30	.17	.12	.08	

Table 4. Extraction: Principial components

Factor	Eigen	% Var.	Cum E	Cum. %
1	4.19	32.25	4.19	32.25
2	2.15	16.53	6.34	48.79
3	1.39	10.72	7.73	59.52
4	1.03	7.96	8.77	67.46

Table 5. Correlation factors

Factor	1	2	3	4
1	1.00			
2	.24	1.00		
3	.25	-.14	1.00	
4	-.14	.17	.02	1.00

The set of 13 variables, by which we defined the coordination space, obtained about 67 % of mutual variance. Four factors have been identified along this process (table 4). Low connection among isolated factors have been achieved.

Table 6. Factors Loadings Extraction: Principial axis

	F1	F 2	h2
MKOP	.12	.42	65
MOZ	-.05	.35	50
MSDU	.23	-.19	58
MPOL	.47	.12	68
MS3L	-.13	.14	65
MPP	-.22	.22	61
MVKL	.20	.94	57
MVSR	.31	.77	88
MS2L	.81	.09	84
MS1L	.89	-.00	89
MOS	.52	-.05	84
MKNN	.93	.12	64
MONT	.76	.13	90
Expl.Var	3.630	1.958	79
Prp.Totl	.279	.150	

Table 7. Eigenvalues Principal axis

Factor	Eigen	% Var	Cum.E.	Cum. %
1	3.86	29.67	3.857	29.67
2	1.73	13.31	5.588	42.98

Table 8. Correlation factors

Factors	1	2
1	1.00	
2	.18	1.00

P.A.F analysis showed different latent structure of coordination (table 6). Two mutual factors have been extracted with total 43 % explaining the mutual system variance. Factors correlation (table 8) showed that there were no more significant connection in the mentioned space (.18), which confirms the relative factors independence in manifesting different dynamic stereotype structures.

Discussion and conclusion

Using the method of Principal Components in range of factors analysis, 4 factors have been obtained, which defined demonstrating space of coordination. The first main component takes about 32 % of variability in explanation of the whole variance system. 6 variables participate in the structure of the first component, that is, two for evaluation of legs coordination: slalom with legs with two balls (MS2L=.84), dribbling with weaker leg (MS1L=.88), variables for agility evaluation; eight with bending (MOS=.60), forward-backward roll with running (MKNN=.91), agility on the ground (MONT=.80) and the variable for evaluation of dynamic stereotype reorganization: proving ground backwards (MPOL=.62), with somewhat less variability, but they gave contribution in explaining the first component. Communalities of the mentioned variables are from .76 (MPOL) to .91 (MKNN). The other principal component with strong vectors participated with about 17 % of variability in explaining of the mutual variance. The structure of this component defined four variables, two for evaluation of hands coordination: dribbling of basketball ball (MVKL=.90) and variable dribbling with weaker hand (MVSR=.74) as well as two variables for evaluation of body coordination: stick coordination (MKOP=.71) as well as variable agility in air (MOZ=.50). Communalities of mentioned variables are from .60 (MOZ) to .84 (MVKL), which presents extremely good defining of variables in the observed space. The third principal component explains 11 % of variability of the whole system variance with three defined variables used for evaluation of coordination of fast complex tasks permeating: jumping over (MPP=.77), variable for evaluation of dynamic stereotype reorganization: jump backwards (MSDU=.58) and once again variable (MPOL=-.57). The last fourth principal component obtained only 8 % of variance of the rest of the system with one variable which is: dribbling three balls (MS3L= -.87). Communalities of mentioned variables are from .55 (MSDU) to .90 (MS3L). It´s obvious that heterogenuousity of the extracted structural components of latent space by applying principal component in the transformation of space is used by the method of principal axis, which gave more different, homogenuous and better defined survey of space with less number of isolated factors. After applied Varimax rotation, two principal factors have been isolated with total of 43 % explaining the mutual variance (table 7). By using this method (P.A.F) in defining the leading latent dimension, now goes about 30 % of variability in explanation of total variance, while other factor is defined with somewhat more than 13 % variability. In the first isolated factor, the variable with large vectors length has been extracted, which are variables for legs coordination evaluation. Those are: slalom with legs with 2 balls (MS2L=.80), slalom with weaker leg (MS1L=.89), agility variables: forward-backwards roll with running (MKNN=.93), agility on ground (MONT=.76) and variable eight (MOS=.51) with somewhat less variability. Communalities of the mentioned variables are from high .79 (MONT) to very high .90 (MKNN). In the structure of the other factor variables used for evaluation of hands coordination, the following have been extracted: dribbling of basketball ball (MVKL=.94), dribbling with weaker hand (MVSR=.71). Communalities are from .84 (MVSR) to .88 (MVKL). Using the P.A.F. method didn’t confirm the assumption of high structure coordination level but the reduction of demonstrating variables on less number of factors (latent dimensions) has been enabled, which defined the students coordination space.

The first factor is responsible for agility and legs coordination whereas hands coordination variable is responsible for isolation of the second factor. Low connection of the obtained factors (table 8) to latent space of coordination can be justified by different functions of CNS during performance of a certain task, which confirms Bernstein´s theory of motion structure on four levels, where one level is leading in one motion and the auxiliary level in the other. This research has been conducted on PE students with the goal to determine the structure coordination level and its complexity. After determining the connection of demonstrating space variables, further procedure of processing data has been applied using factors analysis (Principal Components). Concerning the fact that this method didn´t give homogenous structure of space coordination, further procedure of processing data have been applied using P.A.F. (Principal Axis Factoring), which gave better defined, more homogenuous structure of research space. Two principal factors have been extracted, which explain the total variability of 43 % mutual variance. The first component takes about 30 % of variability in explaining of total variance, while the other takes somewhat more than 13 % of mutual variability. Through individual factors of extracted components, after performed rotation, it can be seen that the first principal component has been explained with 4 variables. Two variables for agility evaluation: forward-backwards roll (MKNN) and agility on ground (MONT); two variables for legs coordination evaluation: dribbling two balls with leg (MS2L) and dribbling one ball with weaker leg (MS1L). On extraction of the first factor, the contribution was also given by the variable for agility evaluation: eight with bending (MOS=.52). The second principal component is explained with two variables used for hands coordination evaluation: dribbling basketball ball (MVKL), dribbling basketball ball with weaker hand (MVSR).

Analysing the complex space of coordination, in range of the first factor, we have variables that evaluate agility and legs coordination, while in other factor we have isolated variables, used for hands coordination. The stated facts haven´t confirmed the assumption of relatively high level of the structure of students coordination. This explains the fact that the students achieved the best results in those variables for coordination evaluation which they met during different physical activities and above all sports games (basketball, football, handball) and some other activities, where it has been necessary to solve tasks in the shortest possible time (for example proving ground) and weaker results in those activities they first time met in the form of applied variables.

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STRUKTURA KOORDINACIJE STUDENATA

Sažetak

Za koordinaciju se kaže da je oblik motoričke intelignecije, kao i da predstavlja jednu od najsloženijih motoričkih dimenzija. Gledano sa fiziološkog aspekta to se potvrđuje, zato što je kvaliteta koordinacije utemeljena na sposobnosti Središnjeg Živčanog Sustava (CNS). Kao motorička dimenzija, sudjeluje, manje-više u svim kretnim oblicima i aktivnostima. Zahvaljujući multidimenzionalnosti koordinacije i njenoj složenosti, veoma je važno definirati faktore koji mogu biti univerzalni za ovu temeljnu motoričku sposobnost. Međutim, razne dimenzije koordinacije ovise o više čimbenika: faktora kognitivnog razvoja, emocionalnog stanja, koncentracije, motivacije, prethodnih motoričkih iskustava… Za utvrđivanje koordinacije u ovom radu primjenjeno je 13 testova. Testirani uzorak je uključivao 160 redovitih studenata muškog spola, uzrasta 20-21 godinu (± 6 mjeseci). Temeljni cilj istraživanja je bio utvrđivanje strukture koordinacije na temelju primjenjenih manifestnih varijabli. Za svrhe redukcije dimenzionalnosti prostora razapetog varijablama, upotrebljena je faktorska analiza. Pretpostavka o relativno visokoj razini strukture koordinacije studenata nije potvrđena.

***Ključne riječi**: koordinacija, faktorska analiza, manifestne varijable, latentne dimenzije*

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Correspondence to:
Assoc.Prof. Ratko Pavlović, Ph.D.
University of East Sarajevo
Faculty of Physical Education and Sport
East Sarajevo, 71000 Sarajevo, BiH

E-mail: pavlovicratko@yahoo.com