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CHANGES IN THE LATENT STRUCTURE OF MOTOR SPACE OF BOYS DURING PUBERTY

SPREMEMBE V LATENTNI STRUKTURI MOTORIČNEGA PROSTORA DECKOV V OBDOBJU PUBERTETE

Abstract

We analysed the latent structure of the motor space of boys at the ages of 11, 13, 15 and 17. The transversal study was carried out on a representative sample of 517 participants within the larger research work of Strel et al. (1996). Motor abilities were assessed on the basis of 26 tests covering all hypothetical motor dimensions. The latent structure was studied using the classic procedures of factor analysis. We found differences in the latent structure of motor space in different age periods. In the case of younger individuals who were tested, achievements depended on the simultaneous impact of various functional mechanisms and therefore the structure of latent space is less precisely defined. Motor abilities gradually differentiate as the age increases. At the age of 15 a repercussion of movement patterns is noticeable. The sensitivity of that age period demands that sports teachers take a closer look at the physical and motor development of young people and tailor exercises to personal development.

Key words: motor abilities, latent structure, adolescence, boys

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Izvleček

Analizirali smo latentno strukturo motoričnega prostora dečkov, starih 11, 13, 15 in 17 let. Transverzalna študija je bila opravljena na reprezentativnem vzorcu 517 merjencev v okviru obsežnejše raziskave Strela in sodelavcev (1996). Za oceno motoričnih sposobnosti smo izbrali zbirko 26 testov, ki dobro pokrivajo vse podprostore motorike. Latentno strukturo smo analizirali s klasičnimi postopki faktorske analize. Ugotavljamo razlike v latentni strukturi motoričnega prostora v posameznih starostnih obdobjih. Pri mlajših merjencih so dosežki odvisni od hkratnega delovanja različnih funkcionalnih mehanizmov, zato je struktura latentnega prostora slabše opredeljena. S starostjo se motorične sposobnosti postopoma diferencirajo. V petnajstem letu je vidno rušenje ustaljenih gibalnih vzorcev. Občutljivost tega obdobja zato zahteva od športnih pedagogov, da pozorno spremljajo telesni in gibalni razvoj otrok ter posameznikovemu razvoju primerno individualizirajo vadbo.

Ključne besede: motorične sposobnosti, latentna struktura, adolescenca, dečki

INTRODUCTION

A several-year survey revealed big changes in the morphological characteristics and motor potentials of Slovenian children and young people (Kondrič, & Šajber Pincolič, 1997; Strel, Kovač, Leskošek, Jurak, & Starc, 2002; Strel, Šturm, Ambrožič, Mesarič, Leskošek, Štihec, & Kondrič, 1994; Šturm, & Strel, 1985). An improvement of results was noted in the variables that measure the information component of movement, while stagnation was recorded in variables which represent the energy component of movement. Today's physical education has a special place in modern society by virtue of the changed morphological characteristics and motor abilities of young people, their different motivation structure, society's new attitudes to sports and healthy lifestyles, the increased threat of negative trends in society and the population's changing economic and social position. It is therefore very important to be acquainted with the development characteristics of young people, their abilities, needs and motivations, so as to provide for an appropriate choice of the goals, contents and methods of work in the process of physical education.

We sought to discover how the latent structure of motor abilities of boys during puberty changes in relation to the period when, due to great hormonal structure changes, young people face major changes in physical and motor development (Kondrič, & Šajber Pincolič, 1997; Strel et al., 1994, 2002; Tanner, 1991; Šturm, & Strel, 1985). A study of such sample has not yet been conducted in Slovenia. We can reduce the influence of unpredictable and unwanted effects of elements affecting children's development by using suitable didactic approaches based on our understanding of young people's development.

METHOD

Participants

The transversal study was carried out on a sample of 517 boys aged 11, 13, 15 and 17. The sample was stratified by region, while within the regions it was chosen randomly. It is representative of Slovenia, since the selected primary schools are situated in big and small towns and different types of schools were selected among secondary schools. The data were collected in more extensive research carried out by Strel, Šturm, Štihec, Kovač, Tušak, Ambrožič, & Leskošek (1996) entitled "The Analysis of Developmental Trends of Motor Abilities and Morphological Characteristics and the Relations of both of them with Psychological and Sociological Dimensions of Slovenian Children and Youth between the Ages of 7 and 18 in the Period 1970-1983-1993". The sample of this research includes participants who were not excused from PE classes due to health problems and whose parents had provided written consent for their children to be included in the research.

Instruments

Based on a hypothetical model by Kurelić, Momirović, Stojanović, Šturm, Radojević, & Viskić-Štalec (1975) and studies conducted by Šturm (1970, 1977) and Strel and Šturm (1981), a group of 26 tests were carried out on a sample of the Slovenian population and chosen to evaluate the motor abilities of the studied sample.

Table 1: Selected tests and their denominations

Selected test	Legend	Selected test	Legend
plate tapping 20 seconds	MTAP20*	hand drumming	MHDRUMM*
plate tapping 25 cycles	MTAP30*	hand and feet drumming	MHFDRUMM*
"1–foot tapping"	M1FTAP*	back arm twist	MBAT
standing long jump	MSLJ	bend forward on the bench	MBF
medicine ball put	MMBP	sit and reach	MSR
60-m run	MR60*	stand on a low beam	MSLB
arm pull dynamometer	MDYNAM	flamingo balance	MFLAMIN
polygon backwards	MPBACK	sit-ups 20 seconds	MSU20*
climbing and descending	MCD	sit-ups 30 seconds	MSU30*
match juggling	MMJ*	sit-ups 60 seconds	MSU60*
figure of eight with low obstacle	M8OBS	bent arm hang	MBAHMAX*
running, rolling, crawling	MRRC	accelerated run	MACR*
running round three stands	MR3S	600-m run	MR600*

** tests which participants performed only once*

Procedure

Due to the complexity and extent of the measurements, participants twice carried out the tests which were less demanding in terms of energy. In data processing, the result of the second performance of the test was taken into consideration. Tests that were more demanding in terms of energy were only carried out once.
The latent structure of motor space was determined by the component model of factor analysis. The important principal components were determined by the use of the Kaiser-Guttman criterion. To provide for a simpler determination of factors as regards the contents, the rotation with the oblimin method was used.

RESULTS

Table 2: Number of principal components, % of common variance and % of variance explained by the first principal component in different age periods

Age	No. of participants	No. of factors	% of common variance	% of first principal component
11	141	7	66.893	33.205
13	122	7	67.321	32.124
15	126	8	68.844	25.710
17	128	9	69.621	22.180

An overview of the latent structure of motor space formation through different age periods confirms our knowledge of the greater and clearer differentiation of motor abilities in later stages of life (Kovač, 1999; Planinšec, 1999; Strel, & Šturm, 1981; Videmšek, 1996). As one gets older, the amount of information which can be explained by isolated latent dimensions in the system of manifest variables grows. At the same time, the amount of information carried by the first principal component (see Table 2) decreases, as does the size of correlation among oblimin factors (see Tables 4, 6, 8 and 10).

Table 3: Pattern loadings of variables on oblimin factors - age 11

	Component						
Variable	1	2	3	4	5	6	7
MTAP20	-0.070	0.779	-0.108	0.138	0.059	0.028	0.012
MTAP30	-0.065	-0.803	0.012	-0.034	-0.035	-0.104	0.041
MTAN	0.167	0.630	0.044	0.035	-0.010	-0.037	0.330
MSDM2	0.454	0.078	-0.088	0.142	0.358	-0.044	0.148
MSTZ2	0.086	0.083	0.035	0.086	0.766	-0.090	-0.114
MDT60	0.287	-0.207	-0.729	0.051	0.000	0.195	-0.068
MPON2	-0.683	0.091	0.174	-0.119	0.076	-0.027	-0.104
MVZS2	-0.577	-0.134	-0.001	0.027	-0.143	-0.104	-0.182
MOSP2	-0.682	-0.066	-0.016	-0.094	-0.097	-0.073	-0.087
MTVP2	-0.506	-0.357	-0.144	0.164	0.015	-0.161	-0.101
MT3S2	-0.427	-0.161	0.045	-0.045	-0.202	-0.028	-0.257
MPRK2	-0.053	0.094	0.038	0.948	-0.019	-0.006	0.047
MT60	-0.553	-0.061	0.149	-0.078	-0.318	0.060	0.005
MDINAM2	-0.133	-0.087	-0.051	-0.085	0.859	0.115	0.063
MBOB	-0.116	0.319	-0.272	0.205	-0.028	0.541	-0.157
MBNR	0.025	0.169	-0.129	-0.085	0.122	0.779	-0.099
MVZI2	-0.260	-0.194	0.222	-0.133	0.003	0.392	0.233
MPRKS2	-0.028	-0.015	0.025	0.957	0.022	-0.049	0.009
MNIG2	0.003	0.071	0.011	0.097	0.067	-0.057	0.732
MFLAMIN2	-0.244	0.057	0.010	-0.221	0.030	-0.286	-0.383
MDT20	-0.062	0.165	-0.882	-0.030	0.051	-0.017	0.159
MDT30	0.009	0.055	-0.888	-0.030	0.059	-0.019	0.159
MVZGMAX	0.021	0.030	-0.243	-0.029	-0.051	-0.062	0.687
MZON	0.417	-0.113	0.126	0.247	0.088	0.409	0.096
MSTOP	0.761	0.082	-0.081	0.022	-0.102	-0.031	-0.044
M600M	-0.830	0.036	0.084	0.024	-0.042	0.157	0.054

See Table 1 for Legend

Table 4: Correlation matrix of the factors - age 11

Component	1	2	3	4	5	6	7
1	1.000	0.315	-0.290	0.313	0.270	0.091	0.309
2	0.315	1.000	-0.243	0.222	0.203	0.139	0.145
3	-0.290	-0.243	1.000	-0.219	-0.162	-0.050	-0.086
4	0.313	0.222	-0.219	1.000	0.171	0.119	0.142
5	0.270	0.203	-0.162	0.171	1.000	0.147	0.149
6	0.091	0.139	-0.050	0.119	0.147	1.000	0.167
7	0.309	0.145	-0.086	0.142	0.149	0.167	1.000

Table 5: Pattern loadings of variables on oblimin factors - age 13

	Component						
Variable	1	2	3	4	5	6	7
MTAP20	-0.202	0.141	-0.068	0.182	0.159	0.210	-0.557
MTAP30	0.045	-0.356	0.014	-0.008	0.242	-0.107	0.590
MTAN	0.050	-0.100	0.092	-0.049	0.098	-0.082	-0.804
MSDM2	0.370	0.411	0.179	0.311	0.065	0.224	0.021
MSTZ2	0.129	0.685	0.003	0.268	0.070	-0.084	-0.088
MDT60	-0.028	0.177	0.605	0.137	0.076	0.127	0.071
MPON2	-0.361	-0.086	-0.153	-0.357	0.023	-0.268	-0.036
MVZS2	-0.240	0.057	-0.173	-0.298	0.181	-0.353	0.179
MOSP2	-0.805	-0.093	-0.011	-0.115	-0.130	-0.029	-0.081
MTVP2	-0.288	-0.047	-0.071	-0.219	-0.243	0.173	0.393
MT3S2	-0.617	-0.088	-0.154	0.117	-0.123	-0.310	0.130
MPRK2	-0.013	-0.002	0.033	0.957	-0.013	-0.061	-0.005
MT60	-0.433	-0.447	-0.115	-0.069	-0.014	-0.207	-0.012
MDINAM2	-0.046	0.707	-0.019	-0.053	0.145	0.014	-0.171
MBOB	0.052	0.001	0.029	-0.035	0.729	0.139	-0.014
MBNR	0.016	0.108	0.052	-0.063	0.840	-0.134	-0.031
MVZI2	-0.534	0.350	0.015	-0.196	0.087	0.113	0.272
MPRKS2	-0.028	-0.005	0.026	0.964	-0.056	-0.016	-0.001
MNIG2	-0.004	-0.441	0.024	0.184	0.362	0.361	-0.031
MFLAMIN2	-0.035	0.360	-0.121	-0.042	-0.023	-0.509	0.162
MDT20	-0.005	-0.084	1.015	-0.026	0.002	-0.125	-0.009
MDT30	-0.024	-0.113	1.008	-0.012	0.022	-0.105	-0.017
MVZGMAX	-0.035	0.033	-0.099	0.093	0.125	0.829	0.027
MZON	-0.376	0.244	0.327	0.171	0.069	0.212	-0.095
MSTOP	0.401	0.079	0.189	-0.104	-0.060	0.541	-0.095
M600M	-0.333	-0.113	-0.265	0.112	0.095	-0.539	0.080

See Table 1 for Legend

Table 6: Correlation matrix of the factors - age 13

Component	1	2	3	4	5	6	7
1	1.000	0.020	0.258	0.242	0.047	0.240	-0.198
2	0.020	1.000	0.124	0.117	0.049	0.108	-0.150
3	0.258	0.124	1.000	0.346	0.206	0.368	-0.256
4	0.242	0.117	0.346	1.000	0.166	0.266	-0.344
5	0.047	0.049	0.206	0.166	1.000	0.174	-0.150
6	0.240	0.108	0.368	0.266	0.174	1.000	-0.229
7	-0.198	-0.150	-0.256	-0.344	-0.150	-0.229	1.000

Table 7: Pattern loadings of variables on oblimin factors - age 15

	Component							
Variable	1	2	3	4	5	6	7	8
MTAP20	0.040	0.801	0.206	-0.052	0.009	0.177	-0.042	0.049
MTAP30	0.018	-0.739	-0.065	-0.011	-0.059	-0.240	0.005	0.079
MTAN	0.002	0.678	-0.033	0.174	-0.062	-0.058	-0.010	-0.129
MSDM2	0.480	-0.101	0.404	0.057	0.064	0.018	0.015	-0.328
MSTZ2	-0.003	0.221	0.807	-0.028	0.122	-0.045	-0.212	-0.047
MDT60	0.186	0.314	0.173	0.234	-0.184	-0.222	0.068	-0.244
MPON2	-0.251	0.004	-0.104	-0.163	-0.083	0.198	0.096	0.541
MVZS2	-0.032	-0.237	0.105	-0.084	-0.081	0.034	0.073	0.649
MOSP2	-0.081	-0.068	0.121	-0.538	-0.106	0.165	0.309	0.189
MTVP2	0.161	-0.103	-0.174	0.033	0.004	-0.102	-0.035	0.766
MT3S2	-0.101	-0.180	0.111	-0.252	0.016	0.227	0.569	0.236
MPRK2	0.096	-0.016	0.197	0.113	0.878	-0.014	0.096	0.041
MT60	-0.367	0.367	-0.403	-0.181	0.111	-0.054	0.017	0.456
MDINAM2	-0.114	0.066	0.746	-0.013	0.268	0.030	0.180	-0.094
MBOB	0.139	0.240	0.008	-0.004	-0.051	0.738	0.032	-0.071
MBNR	-0.049	0.054	-0.046	0.251	0.019	0.844	-0.069	-0.002
MVZI2	0.128	0.021	0.317	0.138	-0.521	-0.085	0.277	0.383
MPRKS2	0.142	-0.002	0.244	0.117	0.842	-0.062	0.057	0.060
MNIG2	0.444	0.302	-0.193	0.032	0.200	-0.269	0.070	-0.048
MFLAMIN2	-0.335	-0.092	0.292	0.011	-0.050	-0.109	-0.550	0.418
MDT20	-0.051	0.028	0.045	0.931	0.074	0.096	0.005	0.130
MDT30	0.000	0.038	-0.069	0.907	0.023	0.160	0.069	-0.046
MVZGMAX	0.728	0.203	-0.097	-0.221	0.118	0.021	-0.032	0.065
MZON	0.272	0.011	0.012	-0.076	-0.047	0.282	-0.627	-0.022
MSTOP	0.680	-0.046	0.059	0.165	-0.077	0.107	-0.162	-0.059
M600M	-0.643	0.072	0.008	-0.212	-0.141	0.032	0.019	-0.072

See Table 1 for Legend

Table 8: Correlation matrix of the factors - age 15

Component	1	2	3	4	5	6	7	8
1	1.000	0.186	0.061	0.279	0.163	-0.034	-0.081	-0.323
2	0.186	1.000	0.012	0.141	0.137	0.118	-0.056	-0.271
3	0.061	0.012	1.000	0.158	0.059	0.042	0.038	-0.098
4	0.279	0.141	0.158	1.000	0.058	-0.038	-0.113	-0.273
5	0.163	0.137	0.059	0.058	1.000	-0.048	-0.041	-0.178
6	-0.034	0.118	0.042	-0.038	-0.048	1.000	-0.048	-0.007
7	-0.081	-0.056	0.038	-0.113	-0.041	-0.048	1.000	0.097
8	-0.323	-0.271	-0.098	-0.273	-0.178	-0.007	0.097	1.000

Table 9: Pattern loadings of variables on oblimin factors - age 17

	Component								
Variable	1	2	3	4	5	6	7	8	9
MTAP20	0.068	0.866	-0.011	-0.026	0.015	-0.013	0.082	-0.050	0.003
MTAP30	-0.024	-0.835	0.086	-0.138	0.007	-0.121	0.071	-0.036	0.012
MTAN	0.064	0.543	-0.240	0.179	0.283	0.100	-0.093	0.031	0.163
MSDM2	0.625	0.100	0.425	-0.053	-0.048	0.052	0.068	-0.051	0.062
MSTZ2	0.169	0.145	0.760	-0.051	0.004	0.000	0.049	-0.062	-0.071
MDT60	0.098	0.040	-0.017	0.410	0.039	0.282	0.278	-0.321	-0.039
MPON2	-0.684	0.006	0.007	-0.141	-0.261	0.195	0.109	-0.031	-0.122
MVZS2	-0.731	-0.123	0.026	0.060	-0.155	0.219	0.011	0.096	0.137
MOSP2	0.046	-0.168	0.057	0.123	-0.020	0.121	0.089	0.701	-0.011
MTVP2	-0.250	0.122	0.166	-0.140	-0.098	-0.036	0.659	0.209	-0.291
MT3S2	-0.166	-0.183	0.024	-0.006	-0.037	0.095	0.120	0.530	-0.152
MPRK2	0.072	-0.010	0.042	-0.009	0.955	0.062	0.082	0.017	-0.002
MT60	-0.245	0.022	-0.224	0.032	-0.043	-0.065	0.334	0.430	-0.208
MDINAM2	-0.070	-0.259	0.779	0.102	0.142	0.020	-0.072	0.007	0.033
MBOB	0.016	0.527	0.414	0.094	-0.066	-0.105	0.103	-0.055	0.012
MBNR	-0.373	0.400	0.193	-0.042	0.004	-0.267	-0.130	-0.151	0.442
MVZI2	0.177	-0.052	0.003	0.075	-0.404	0.494	0.169	0.190	0.408
MPRKS2	0.034	0.016	0.077	-0.012	0.958	0.047	0.045	0.046	0.021
MNIG2	0.087	-0.080	0.145	0.139	0.006	-0.750	0.097	0.141	0.171
MFLAMIN2	-0.226	0.013	0.211	-0.114	0.103	0.624	-0.051	0.173	0.024
MDT20	-0.052	0.053	0.081	0.950	0.006	-0.090	-0.060	0.015	-0.020
MDT30	-0.029	0.075	-0.004	0.954	-0.036	-0.107	-0.077	0.070	-0.035
MVZGMAX	0.118	-0.068	-0.064	-0.008	0.172	-0.095	0.709	-0.119	0.305
MZON	-0.027	0.031	-0.045	-0.036	0.030	-0.051	0.069	-0.028	0.797
MSTOP	-0.023	0.033	-0.048	0.304	0.089	-0.047	0.308	-0.576	0.033
M600M	-0.008	0.142	-0.093	-0.033	0.030	-0.089	-0.047	0.734	0.028

See Table 1 for Legen

Table 10: Correlation matrix of the factors - age 17

Component	1	2	3	4	5	6	7	8	9
1	1.000	0.063	0.085	0.166	0.224	-0.077	0.013	-0.278	0.165
2	0.063	1.000	0.024	0.195	0.118	-0.141	-0.031	-0.201	0.174
3	0.085	0.024	1.000	-0.026	0.023	-0.028	0.043	-0.084	0.057
4	0.166	0.195	-0.026	1.000	0.130	-0.061	0.131	-0.192	0.126
5	0.224	0.118	0.023	0.130	1.000	-0.165	-0.054	-0.209	0.071
6	-0.077	-0.141	-0.028	-0.061	-0.165	1.000	0.062	0.130	-0.068
7	0.013	-0.031	0.043	0.131	-0.054	0.062	1.000	0.016	-0.014
8	-0.278	-0.201	-0.084	-0.192	-0.209	0.130	0.016	1.000	-0.199
9	0.165	0.174	0.057	0.126	0.071	-0.068	-0.014	-0.199	1.000

The latent structure of motor space of boys aged between eleven and seventeen changes with age, as only three similar structured factors appear in all age groups (see Tables 3, 5, 7 and 9).

DISCUSSION

The structure of the first oblimin factor changes with age. Typically, in younger participants the most important was the factor where the latent dimension was composed of the variables of energy regulations and movement structuring. The structure of this factor is very complex, since it is affected most by the variables of endurance, agility, explosive strength and co-ordination of movement. With increased age, the formation of the first factor is mainly influenced by the variables of agility and of co-ordination of the whole body movement, while the number of variables effecting the stated factor is falling. Similar findings on the complexity of the first isolated latent dimension were already reported by Strel and Šturm (1981) and, within the same umbrella research as the one reported here, also by Kovač (1999) on a sample of girls aged ten to eighteen, and by Planinšec (1999) on a sample of boys aged ten, twelve and fourteen.

Table 11: Denomination of factors in individual age groups

Group	FACOBL 1	FACOBL 2	FACOBL 3	FACOBL 4	FACOBL 5	FACOBL 6	FACOBL 7	FACOBL 8	FACOBL 9
11 years (N=141)	energy and co-ordination component	speed of alternative motion	repetitive strength of abdominal muscles	flexibility of body in sagittal plane	explosive strength of hands muscles	co-ordination of movement in rhythm	balance		
13 years (N=122)	agility	explosive strength of hand muscles	repetitive strength of abdominal muscles	flexibility of body in sagittal plane	co-ordination of movement in rhythm	aerobic endurance	speed of alternative motion		
15 years (N=126)	aerobic endurance	speed of alternative motion	explosive strength of hand muscles	repetitive strength of abdominal muscles	flexibility of body in sagittal plane	co-ordination of movement in rhythm	unnamed factor 1	co-ordination of whole body movement	
17 years (N=128)	co-ordination of whole body movement	speed of simple motor task in rhythm	explosive strength of hand muscles	repetitive strength of abdominal muscles	flexibility of body in sagittal plane	balance	endurance of the upper part of body	speed endurance	co-ordination of hand movement

At the age of thirteen, agility is developed as a latent dimension of the highest variance. At the age of fifteen, aerobic endurance is for the first time isolated as the most important factor. According to the structure of motor space at the age of seventeen, when the first isolated factor is co-ordination of entire body movements and endurance appears in two factors, we assume that, besides endurance, the co-ordination of movement also becomes distinct at that age (see Table 11).

Such development points to the complicated structure of movement co-ordination, particularly with younger people. This has already been identified by various authors (e.g., Kovač, 1999; Planinšec, 1999; Strel, 1981; Strel, & Novak, 1980; Strel, & Šturm, 1981; Šturm, 1970, 1977; Videmšek, 1996). Younger children are forced to activate more prime motor abilities in response to more demanding and structured movement tasks, which are less familiar or unknown to them and where the performance of well-co-ordinated movement is important. Simultaneously, regulation of tonus muscles is necessary, as are the intensity of excitation and the appropriate level of excitation duration. These findings are in line with the theory of the development of the most important functions of the central nervous system (Luria, 1983). As all structures of the central nervous system are not completely developed and physiologically still not ready when children are young, they cannot combine the various types of stimulation that enable complicated motor assignments (Ismail, 1976). Namely, they are processed at the cortical level and, in the case of the rapid activation of energy and longer performance, at the sub-cortical level.

Only the following factors appear in all age periods: flexibility of the body in the sagittal plane, repetitive strength of abdominal muscles and the explosive strength of hand muscles. The projections of motor variables for these factors are quite similar all the time. We therefore assume that these three latent motor dimensions are relatively stable in terms of structure and development.

The body's topologically conditioned factor flexibility in the sagittal plane keeps its homogenous structure. It is determined by the variables 'bend forward on a bench', and 'sit and reach'. The functional regulation of flexibility mostly depends on the functioning of the subcortically located mechanism of synergy regulation and regulation tonus, controlling the activity of agonists and antagonists (Gredelj, Metikoš, Hošek, & Momirović, 1975). In general, flexibility depends mainly on anthropometric characteristics and their changes (Agrež, 1973).

Other researchers (e.g., Agrež, 1973; Kovač, 1999; Strel, & Šturm, 1981) have also identified a similar factor. Flexibility in the area of the spine and hip (in the 'bend forward') and of the knees in hyper-extension, together with adequate muscles and binding tissue of the rear side of the body and lower limbs, identified by the tests, is also important for the successful performance of the tests of agility and co-ordination of movement. Kurelić et al. (1975) also found a correlation at the latent level. Namely, the mechanism of central movement regulation is supposed to be superior to the abovementioned latent motor dimensions.

The repetitive strength of abdominal muscles was interpreted by various researches (e.g., Gredelj et al., 1975; Kovač, 1999; Planinšec, 1999; Strel, & Šturm, 1981; Šturm, 1970). The highest projections for that factor are part of all three tests of sit-ups. The movement structure is the same in all tests, as only the position of the hands changes during sit-ups for 60 seconds. Movement is based on the repetitive activity of abdominal muscles. Successful performance of movement depends on the mechanism regulating the duration of excitation, which, in the case of long-lasting physical efforts, balances the consumption of energy potential (Kurelić et al., 1975).

The variables 'arm pull dynamometer' and 'medicine ball put' are highly projected on an individual factor in all age categories, whereas the variables '60-m run' and 'standing long jump' have an important influence on the formation of other factors, mostly involving the realisation of complex movement structures.

The principal characteristic of the explosive strength movement tasks is the activation of muscles' strength within the shortest time possible. The functional basis for those rapid, short-lasting movement reactions is the non-lactic anaerobic metabolism of energy release (Astrand, & Rodahl, 1986). The movement is demanding also from the point of view of information, since accurate determination of the movement direction and of the strength of the activity are required. However, energy regulation decisively determines the speed at which an action is performed. The production of muscle power depends not only on the sum of forces developed by different muscle groups, but also on the harmonised work of those muscle groups. The co-ordination and supervision of the speed of strong movements is provided for by the cerebellum and the mechanism for regulating excitation intensity (Kurelić et al., 1975).

Up until the age of fifteen the speed of alternative motion and the co-ordination of movement in rhythm appear as independent, structurally stable dimensions. Both were already isolated in several studies (Gredelj et al., 1975; Hošek, 1976; Kovač, 1999; Planinšec, 1999; Strel, & Novak, 1980; Strel, & Šturm, 1981; Šturm, 1970). Movement tasks consisting the factor of alternative motion speed are relatively simple and performed at maximum speed within a limited time and with permanent amplitude. As the highest possible number of repetitions is required - following each other in opposite directions - the result depends on the inter-muscle mechanism balancing the excitement and on the release of agonists and antagonists. The successful performance of movement also depends on the information provided by visual receptors and on the analysis and usage of feedback information for any possible correction of movement. The continuous performance of movement and, thereby also the achievement of better results, are determined by the rhythmic performance of a task. The dominating influence of the latter is probably also why these movement tasks, together with the tests of rhythmic performance of movement structures characterised by extremely well-structured rhythmically harmonised movement, form one dimension for seventeen-year-old people, which has been denominated the speed of simple motor tasks in rhythm.

Up until the age of seventeen, the two variables 'hand drumming', and 'hand and feet drumming' constitute their own factor. While performing both measurement procedures, it is necessary to control movement and harmonise the movement programme with the greater amount of information permanently coming back as feedback. This demands that information is linked at the cortical level. The sequence of performance is very important. Therefore, the result depends more on adequate rhythm and short-term memory than on the ability to perform rapid movement. From the functional point of view, the nerve centres of the higher levels of the central nervous system play a more important role. According to the formation of common dimensions reflected in tests of simple movement speed on senior participants, this is particularly true of the younger individuals who were tested.

Balance is also a very common isolated latent dimension, as it appears at the ages of eleven and seventeen. It is best formed by variables which hypothetically cover such motor ability, namely, 'stand on a low beam stand', 'flamingo balance' and 'bent arm hang'. A similar structure of the latent dimension or better the connection of the formerly mentioned variables with the variables of balance was also cited by other authors (e.g., Kovač, 1999; Planinšec, 1999; Strel, & Šturm, 1981). Maintaining the optimum position is necessary for all movement tasks, which is to a great extent a result of the mechanism for synergy and tonus regulation (Kurelić et al., 1975). For younger tested individuals, maintaining a certain position demands the formation of an adequate motor programme, which leads to significant connections with the co-ordination of movement (Hošek, 1976; Strel, & Šturm, 1981).

Complex movement tasks with constant jerky changes in direction which, assisted by kinesthetic and visual receptors require the activation of maximum muscle strength of different muscle groups, have important projections on variously denominated factors at all ages. However, they only create an independently denominated latent dimension at the age of thirteen. At the age of eleven variables help form a complex latent structure, covering energy as well as the information component of movement. Later, variables hypothetically covering agility play an important role in the formation of the latent dimension of realising complex movement structures, speed endurance and a certain dimension at the age of fifteen which we, due to heterogeneous structure, did not denominate.

At the ages of thirteen and fifteen the motor space structure also comprises the latent dimension of aerobic endurance. It is principally formed by the manifest variables of the '600-metre run' and 'accelerated run'. Both runs were performed under a sub-maximal charge from two to five minutes and the result therefore reflects cardio-vascular capacities, the endurance of muscle strength and the motivation needed to overcome the associated muscle pain and increased ventilation. A similarly structured latent dimension was discovered by Kovač (1999) in girls aged fifteen, sixteen, seventeen and eighteen, whereas in our research the variables of endurance at the age of seventeen have high loadings on the factor that we called speed endurance. In early age periods they are combined with the variables of the so-called energy block. Success in testing younger individuals therefore depends not only on the mechanism of excitement duration, but also on the mechanism of movement structuring, intensity of excitement and synergy and tonus regulation. Poorer results are also connected with the morphological structure of participants: increased body weight and higher amounts of subcutaneous fat (Strel et al., 1994, 1996, 2002; Škof, Kropej, & Milić, 2002; Šturm, & Strel, 1985).

Two factors with an endurance characteristic are isolated at the age of seventeen. At this age, the tests no longer represent a big effort for boys, so both factors determine special muscle endurance. For topological reasons, we called the first one 'endurance of the upper body' and the second one 'speed endurance' due to the similar functional characteristics of the variables they comprise.

Co-ordination of the whole body movement was isolated as an independent factor at the ages of fifteen and seventeen, despite the fact that the variables forming it already significantly influence the formation of more broadly structured dimensions at earlier ages. Since at these ages all structures of the central nervous system which are very important for complex movement tasks requiring the harmonised functioning of various muscle groups have still not been definitely formed, younger children need more motor abilities to perform such assignments. This is confirmed by various authors researching the complexity of the co-ordination structure amongst younger age groups (Kovač, 1999; Planinšec, 1999; Strel, 1981; Strel, & Novak, 1980; Strel, & Šturm, 1981; Šturm, 1970, 1977; Videmšek, 1996).

At the age of fifteen a latent structure is formed, which has not been denominated. The seventh factor at the age of fifteen is mostly revealed by the tests 'match juggling' and 'running round three stands'. A common characteristic of both tests is the structuring of movement on the basis of visual perception. The formation of this factor could be explained by the repercussion of traditional movement patterns in this age period, particularly due to the rapid growth of limbs.

CONCLUSIONS

The results of research are limited by transversal characteristics of study and variable sample. Therefore conclusions should be interpreted taking the above into account. With increased age the structure of particular dimensions also becomes clearer. Ever more factors contain quite logical projections of motor variables, their intercorrelation is lower and their actual existence therefore becomes more feasible. These conclusions confirm previous findings related to higher connections between the latent dimensions of the motor space of younger participants and findings on the gradual differentiation of motor abilities (Kovac, 1999; Planinšec, 1999; Strel, & Šturm, 1981; Videmšek, 1996).

The structure of motor space in different age periods shows the important influence of body growth on motor abilities. Due to hormonal changes in the period of puberty, we notice relatively fast limb growth, an increase in body weight and subcutaneous fat, which influence established movement patterns. The result is a slightly complex structure of certain factors. In our research work this was visible at the age of fifteen. The sensitivity of this age requires a special approach by PE teachers to children. The increased body development at such time can bring about a sudden stagnation or even regression in the process of motor potential development (Conger, & Galambos, 1997; Kondrič, & Šajber Pincolič, 1997; Kovač, 1999; Strel et al., 1994, 2002; Šturm, & Strel, 1985). This process is quite natural and logical, but children have difficulties understanding it. They are often turned off sport due to their reduced motor efficiency. Sports teachers must therefore closely monitor the body and motor development of children and young people and adjust physical exercise to the development level of each individual. Given the development of their sexuality, cultural influences, value estimations and prejudices, how they create their self-image is very important. At first this only covers physical appearance and it is closely linked to motor development (Strel, & Štihec, 1993). Properly planned and carefully led sports exercises can have quite a positive influence on the motor, cognitive and social activities of young people.

It is exactly this development issue that raises questions about the reliability, validity and homogeneity of certain structurally and functionally complex tests in different development periods. Obtained data confirm the findings according to which the validity and homogeneity of measurement procedures, covering the co-ordination of movement, balance, endurance and the strength of arms and shoulder girdle (Kovač, 1999; Strel, & Šturm, 1981), differ in various age periods. Due to the interconnection of the area of psychosomatic status and its influence on motor space, the structure of certain latent motor dimensions remains complicated and sometimes incomprehensible.

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