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**RELATIONSHIP BETWEEN MOTOR
ABILITIES AND SCHOOL READINESS
IN PRESCHOOL CHILDREN**

**ODNOS MED MOTORIČNIMI
SPOSOBNOSTMI PREDŠOLSKIH OTROK
IN NJIHOVO PRIPRAVLJENOSTJO ZA ŠOLO**

Abstract

On the sample of 660 preschool children (333 boys and 327 girls) upon joining the first grade, the battery of 16 motor tests was applied to analyse the relations between motor abilities and school readiness of children. The analyses were done separately for boys and girls, using the statistical program for the canonical correlation analysis in Mahalanobis space. The established relation showed that the general motor ability of both boys and girls positively correlates with their general school readiness. Due to statistical significance and positive correlation between the set of motor variables and the set of school-readiness variables, it must be pointed out that motor exercising in preschool age is of utmost importance.

Key words: preschool children, motor abilities, school readiness

Izveček

Na vzorcu 660 predšolskih otrok (333 dečkov in 327 deklic) pred vpisom v prvi razred smo uporabili baterijo 16 motoričnih testov, s katerimi smo analizirali povezavo med motoričnimi sposobnostmi otrok in njihovo pripravljenostjo za šolo. Analize smo opravili ločeno za dečke in deklice, pri čemer smo uporabili statistični program za kanonično korelacijsko analizo v Mahalanobisovi razdalji. Ugotovljena povezava je pokazala, da so tako pri dečkih kot deklicah splošne motorične sposobnosti v pozitivni korelaciji z njihovo splošno pripravljenostjo za šolo. Zaradi statistične značilnosti in pozitivne korelacije med naborom motoričnih spremenljivk in naborom spremenljivk pripravljenosti za šolo, je treba poudariti, da je motorična vadba v predšolskem obdobju izredno pomembna.

Ključne besede: predšolski otroci, motorične sposobnosti, pripravljenost za šolo

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Introduction

Development of children is the result of a complex interaction between heredity, growth, maturation and environmental impacts, and has a biological and behavioural context. Biological development is characterised by differentiation of cells which enables the cells to perform specialized functions or to refine functions that already exist. Behavioural development relates to the evolution of intellectual, psychological, and sociological attributes. Motor development of children could be defined in terms of progressive changes in motor performance, resulting from growth, maturation as well as biological and behavioural development. It is known that mental, social, educational, and emotional maturity are positively related, and personality traits are related to academic and physical achievement (Dolenec, 2001; Dolenec, Karacsony, Burnik, 2004; Dolenec, Pistotnik & Pinter, 2002; Etnier, Salazar, Landers, Petruzzello, Han & Nowell, 1997; Eunicke-Morell, 1989; Ismail & Gruber, 1971; Pistotnik, Dolenec & Pinter, 2002; Vernon & Mori, 1992). Performance of a preschool child is associated with certain factors closely related to the total motor, emotional, social, and intellectual development (organismic age theory by Olson, according to Ismail and Gruber, 1971).

The associations of motor and cognitive abilities in both boys and girls are positive and significant (Planinšec, 2002). In both sexes, motor dimensions that are most strongly associated with the cognitive abilities are those of coordination and speed of movement. Despite some differences between boys and girls, they still have a lot in common since the most important latent motor dimensions prevailing in the connection between motor and cognitive dimensions are similar. Cognitive abilities are responsible for the processes of foresight, planning, decision making as well as comparison and processing of information with the use of long-term memory in solving problem situations. Motor tests of coordination also consist of problem situations that need to be solved efficiently (Dolenec, 2001). Paper-and-pencil tests assess neuromuscular development, fine motor skills, hand-eye coordination, and attention span. Owing to this, children write their names, copy geometric figures, write numbers, complete a drawing, recognize shapes, and discriminate among prepositions.

Some researches showed that longer attendance of nursery school (kindergarten) had significantly better impact on the pre-school children's results in school-readiness tests upon enrolment in elementary school (Sabo, 2004). The same conclusion applies to motor abilities, especially in the fields of coordination, flexibility and balance (Sabo, 2003). The aim of this paper is to analyse and determine relation between motor abilities and school readiness in preschool children, after leaving kindergartens.

Method

Participants

The sample of subjects was drawn from the population of children in the city of Novi Sad (Vojvodina, Serbia & Montenegro) upon joining the first grade. This research was performed on a sample of 660 preschool children (333 boys and 327 girls) at average age of 6.5 years ($SD=0.17$ years). All children attended kindergarten for at least one year.

Instruments

The battery of 16 motor tests used in this research was selected on the basis of previous experience with adults, and some of the tests were modified to suit children (Bala, 1999a, 1999b, 2002). The tests (for adults) assess the effectiveness of the following functional mechanisms: movement structuring, tonus and synergetic regulation, regulation of excitation intensity and regulation of excitation duration (Gredelj, Metikoš, Hošek, & Momirović, 1975; Kurelić, Momirović, Stojanović, Šturm, Radojević, Viskić-Štalec, 1975).

Motor abilities of preschool children were assessed by the following motor test batteries:

- **functional coordination:**
 - coordination by baton (CCOORB),
 - obstacle course backwards (COBSTA),
 - slalom (running) with 3 medicine balls (CSLA3M),
 - 15-metre dash (DASH15)
- **frequency of simple movements:**
 - arm plate tapping (SARTAP),
 - foot tapping (SFOOTT);
- **flexibility:**
 - forward bend and touch on a bench (FFOBEN),
 - straddle split (FSTRASP);
- **balance:**
 - standing on two legs on a narrow balance beam, across, eyes open (BAC2LE),
 - standing on one leg on a narrow balance beam, along, eyes open (BAL1LE);
- **power (explosive strength):**
 - standing broad jump (EJUMP),
 - hand grip (EHANGR);
- **muscular endurance (isometric strength):**
 - bent-arm hang (IMHANG),
 - holding legs on a vaulting box (IMHOLE);
- **muscular endurance (isotonic strength):**
 - leg-lifting, lying on the back (ITLELI) and
 - sit-ups (ITSITU).

School-readiness of preschool children was evaluated by means of School readiness test battery (Preizkus pripravljenosti otrok za šolo, POŠ, Toličič, 1986), consisting of four subtests:

- understanding messages, demands, orders, as well as identification and understanding sentences, words and syntax: speech comprehension (SPEECH);
- ability to conclude and use experience: reasoning (REASON);
- fine hand coordination, as well as ability to copy different figures as a whole and their parts: graphomotor ability (GRAPFO);
- perceptiveness: understanding the amounts (AMOUNT).

Procedure

Relations between motor abilities and school-readiness of children were computed by the statistical program for the canonical correlation analysis in Mahalanobis space with additional identification structures and reliability estimates of factors significant at 0.05 under Bartlett's significance tests CANCANBT (Momirović, 1999). The analyses were made separately for boys and girls.

Results

On the basis of intercorrelations of motor and school-readiness variables (see Table 1) it is not possible to notice any tendency of relation neither in boys nor in girls. It is really difficult to do this based solely on all of the analysed manifest variables, with only a few of them bearing statistical significance (these are highlighted). Table 1 is given because it was the initial matrix for the canonical correlation analysis (see Tables 2, 3 and 4).

Table 1: Cross correlations of Mahalanobis motor and school-readiness variables

VARIABLE	SPEECH		REASON		GRAPFO		AMOUNT	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
CCOORB	-.058	-.060	-.043	-.035	-.106	.002	.027	-.178
COBSTA	-.189	-.109	.022	-.116	-.092	-.071	-.153	-.089
CSLA3M	-.040	-.070	-.091	-.235	-.074	-.187	.031	.042
CDASH15	-.108	-.038	-.099	-.141	-.168	-.084	-.074	-.155
SARTAP	.062	.120	.113	-.017	.224	.117	.045	.096
SFOOTT	.114	.009	.033	.024	.113	.026	.021	-.020
FFOBEN	.063	-.011	-.031	-.031	.081	.153	.056	.137
FSTRASP	.084	.207	.040	.026	.056	.117	.057	.195
BAC2LE	-.052	-.067	.041	.019	.098	.030	.007	.053
BAL1LE	.116	-.065	.082	.011	.055	.047	-.010	-.124
EJUMP	.141	.061	.033	-.028	.048	.062	.034	.141
EHANGR	-.010	.078	.067	.061	.129	-.029	.025	-.001
IMHANG	.009	-.013	-.032	.107	.019	.084	-.016	-.062
IMHOLE	.060	-.002	.089	-.008	-.033	.068	.019	.000
ITLELI	.035	-.004	.154	.036	-.029	-.042	.066	.005
ITSITU	-.012	.061	-.067	-.024	-.002	.100	-.018	-.098

Legend (for Tables 1, 3 and 4:

CCOORB coordination by baton
 COBSTA obstacle course backwards
 CSLA3M slalom (running) with 3 medicine balls
 DASH15 15-metre dash
 SARTAP arm plate tapping
 SFOOTT foot tapping
 FFOBEN forward bend and touch on a bench
 FSTRASP straddle split
 BAC2LE standing on two legs on a narrow balance beam, across, eyes open
 BAL1LE standing on one leg on a narrow balance beam, along, eyes open

EJUMP standing broad jump
 EHANGR hand grip
 IMHANG bent-arm hang
 IMHOLE holding legs on a vaulting box
 ITLELI leg-lifting, lying on the back
 ITSITU sit-ups
 SPEECH speech comprehension
 REASON reasoning
 GRAPFO graphomotor ability
 AMOUNT understanding the amounts

Bartlett's significance tests for evaluation of canonical correlations between corresponding pairs of canonical factors show that, in boys, only the first pair is statistically significant in explaining the relation between the sets of analysed variables ($\rho = .535$ in Table 2). This relation accounts for 29% of common variances of these two sets of variables. In girls, the first two pairs of canonical factors are statistically significant, the first pair explaining about 30% and the second only about 13% of common variances of the corresponding canonical relations.

Table 2: Canonical correlations and Bartlett's significance tests

	rho	lambda	hi2	df	p
boys					
f1	.535	.625	151.125	64	.000
f2	.251	.875	42.757	45	.567
f3	.220	.934	21.830	28	.789
f4	.134	.982	5.859	13	.951
girls					
f1	.547	.553	186.430	64	.000
f2	.364	.788	74.762	45	.003
f3	.229	.909	30.010	28	.363
f4	.202	.959	13.126	13	.438

Legend:

f	pair of canonical factors	df	degree of freedom
rho	canonical correlation coefficient	p	significant level of rho
hi2	hi square test		

Table 3 shows the structure of the first motor canonical factor of boys, as well as the structures of both factors of girls. Table 4 shows the structures of school-readiness canonical factors of boys and girls.

Table 3: Structure of the first canonical factors

VARIABLE	Boys		Girls	
	f1		f1	f2
CCOORB	-.211		-.278	.264
COBSTA	-.379		-.336	-.114
CSLA3M	-.185		-.329	-.692
CDASH15	-.435		-.376	-.063
SARTAP	.453		.315	-.071
SFOOTT	.297		.023	.107
FFOBEN	.176		.271	-.112
FSTRASP	.219		.533	-.183
BAC2LE	.103		.041	-.020
BAL1LE	.246		-.149	.302
EJUMP	.250		.257	-.232
EHANGR	.215		.078	.062
IMHANG	.001		.060	.396
IMHOLE	.096		.056	.068
ITLELI	.148		-.014	.004
ITSITU	-.074		.019	.248

Table 4: Structure of the second canonical factors

VARIABLE	Boys	Girls	
	f1	f1	f2
SPEECH	.557	.485	-.038
REASON	.389	.333	.623
GRAPFO	.676	.505	.436
AMOUNT	.286	.632	-.648

The first motor canonical factor is the general motor factor without significant involvement of the energetic component (manifestation of strength) in boys and girls. In the structure of the second motor canonical factor of girls there is certain specificity, showing in good coordination, balance, and isometric contraction of arm muscles.

The first school-readiness canonical factor is of a general type in both boys and girls. The specificity of the second factor is rather illogical, because of the tendency that girls with good reasoning have lower ability to understand the amounts. Due to really great specificity of both second motor and school-readiness canonical factors in girls, the authors consider that the appearance of significance of the second pair of canonical factor was coincidental. That was the reason that the authors did not take this pair of canonical factors into consideration when discussing the research results. Contribution to such conclusion was also found in the reliability coefficients beta1 and beta2 in Table 5. The same table also shows the values of redundancies (red1 and red2) for both sets of variables in boys and girls.

Table 5: Redundancies (red) and reliabilities (beta) of motor and school-readiness factors

Boys			Girls		
	red1	beta1		red1	beta1
motor factors					
f1	.063	.655	f1	.045	.484
			f2	.019	.166
school-readiness factors					
f1	.244	.668	f1	.275	.644
			f2	.062	-.055

Discussion

The results of canonical correlation analyses pointed to a tendency of general motor and cognitive development in preschool children just about to enrol in the first grade, i.e. the development of abilities which define readiness for school. That tendency is present in boys as well in girls. It is also evident that there are some differences, though not that significant, in the structure of these general abilities. Representativeness of the boys' structure of general motor factor was mostly accounted for by performance of fast simple motions, maintaining of balance and motions

requiring energetic components. In girls, the generality of the motor factor was obtained mostly in performance motor tasks in the domain of coordination and flexibility.

In the structure of the general school-readiness factor in boys the most important role is that of graphomotor abilities and speech, and to a lesser extent reasoning and understanding the amounts. In girls, this general factor was manifested mostly with understanding the amounts and graphomotor abilities, then with speech and reasoning. It is obvious that graphomotor abilities in preschool children are very important, as indicated by some other complex researches in that field (e.g. Del Giudice, Grossi, Angelini, Crisanti, Latte, Fragassi, & Trojano, 2000).

The established relation showed that in both boys and girls the general motor ability is in positive correlation with the general school readiness. This conclusion is concordant with the researches mentioned before (Dolenec, Pistotnik, & Pinter, 2002; Pistotnik, Dolenec, & Pinter, 2002; Planinšec, 2002) which pointed to positive and significant associations of motor and cognitive abilities for boys and girls alike. According to the same results, motor dimensions that are most strongly associated with the cognitive abilities are those of coordination and speed of movement. Of course, all this points to importance and need for development of motor ability in the comprehensive development of preschool children. Children with better motor abilities can better adapt to different problem situations, activities, and tasks at the beginning and during their schooling.

On the basis of redundancy values it could be concluded that general school readiness has more important role than general motor ability in explaining of common variance of two variable sets. This means that the beginning of schooling can be predicted with general motor ability, but better prediction is achieved by means of the POŠ test battery. Due to the statistical significance and positive correlation between the set of motor variables and the set of school-readiness variables, the authors suggest giving more attention to motor exercising in preschool age as well as putting the children in the situation where they have to solve different motor problems. In such a way small children will develop their motor and cognitive components of motor behaviour, which will contribute to their readiness for school and later for the entire schooling.

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