THE RELATION BETWEEN INTELLIGENCE AND LATENT MOTOR SPACE

Marjeta Kovač
Janko Strel

POVEZANOST MED INTELIGENTNOSTJO IN LATENTNIM MOTORIČNIM PROSTOROM

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Abstract

The study analyses the relations between latent motor space and fluid intelligence of 1859 girls, aged 10 to 18. To evaluate their motor abilities 26 tests were selected and the latent structure of motor abilities was studied by classical procedures of factor analysis. Test TN-20 was selected to assess fluid intelligence. The relations between the latent motor dimensions and fluid intelligence for each age group were studied by the multiple regression analysis.

The relations between the fluid intelligence indicators and agility, coordination of motion in rhythm, the speed of simple motor tasks, and mobility are low, but statistically significant for younger subjects. The tasks with complicated motion structure, being new to the subjects, and supposedly to be successfully solved in the shortest possible time or in the optimum rhythm, demand a certain level of fluid intelligence. The capacity of the central nervous system to receive, supervise, harmonise and elaborate different information is in the foreground.

The connections with the energy variables at the age of 17 and 18 are surprising and can be explained by a rational use of techniques, requiring the involvement of mechanism for tonus regulation. The subjects control and correct motion performance on the basis of feedback information, comparing the data from the long term memory.

Key words: latent structure of motor abilities, intelligence, girls from 10 to 18 years of age

Izvleček

V študiji so analizirane povezave med latentnim motoričnim prostorom in fluidno inteligentnostjo 1859 deklet, starih 10 do 18 let. Za oceno motoričnih sposobnosti smo izbrali 26 testov, ki pokrivajo vse podprostore motorike, latentno strukturo motoričnega prostora pa smo preučevali s klasičnimi postopki faktorske analize. Za oceno fluidne inteligentnosti smo izbrali test TN-20. Povezave med latentnimi motoričnimi dimenzijami in fluidno inteligentnostjo smo za vsako starostno skupino preučevali z multiplo regresijsko analizo.

Povezave med fluidno inteligentnostjo in agilnostjo, koordinacijo gibanja v ritmu, hitrostjo izvajanja enostavnih gibov in gibljivostjo so nizke, a statistično značilne predvsem pri mlajših merjenkah. Sklepamo lahko, da naloge z zapleteno gibalno strukturo, ki so za merjenke nove in jih morajo učinkovito rešiti v čim krajšem času oziroma v optimalnem ritmu, zahtevajo odrejeno raven fluidne inteligentnosti. V ospredju je sposobnost centralnega živčnega sistema, da sprejema, nadzoruje, usklajuje in predeluje različne informacije.

Povezanost s spremenljivkami energijskega tipa pri sedemnajstih in osemnajstih letih je presenetljiva, pojasnjujemo pa jo z racionalno uporabo tehnike, ki zahteva vključevanje mehanizma za tonusno regulacijo. Izvedbo gibanja merjenke hkrati nadzorujejo in popravljajo na podlagi povratnih informacij s primerjanjem podatkov iz dolgoročnega spomina.

Ključne besede: latentna struktura, motorične sposobnosti, inteligentnost, dekleta, starost 10 do 18 let

University of Ljubljana, Faculty of Sport, Ljubljana, Slovenia

Contact address
Marjeta Kovač
Univerza v Ljubljani - Fakulteta za šport, Gortanova 22,
SI-1000 Ljubljana, Slovenia
Tel: +386 1 540-10-77
Fax: +386 1 540-22-33
E-mail: Marjeta.Kovac@guest.arnes.si

INTRODUCTION

Children's and youngsters' development follows certain successive levels defined by quantitative as well as qualitative changes. Certain areas of development are correlated, as they are parallel or interconnected. The altered morphological characteristics and motion abilities of the young, different structure of motivation and different attitude of the society towards sport and healthy living, and at the same time an increased danger of negative trends and a changing economic and social picture of the citizens, give a special place to physical education in the society. It is therefore very important to understand the development characteristics of the young, their abilities and motivation. It enables us to select adequate goals, contents and working methods in the process of physical education.

The objective of this research was to determine the relations between latent motor space and general intelligence of schoolgirls aged 10 to 18 years. The research was based on the motor model of Kurelić and colleagues (1975) and the Cattell-Horn theory of fluid and crystallised intelligence (Pogačnik, 1995). We assessed the content and the level of correlation for each age group, and we studied at the same time the changes in the correlation in the process of growing up.

The research work in the area of motor behaviour in Slovenia is based on the model of Kurelić and colleagues (1975). The Model of Kurelić and colleagues (1975) is hierarchic and based on functional mechanisms responsible for latent motor abilities. There are four dimensions at the lower level: the mechanism for movement structuring, the mechanism for synergy automation and the regulation of tonus, the mechanism for regulation of excitation intensivity, and the mechanism for regulation of the duration of excitation. There are two dimensions at the higher level: the mechanism for central regulation of movement and the mechanism for energy regulation. At the highest level the mechanism for regulation of movement is called the general factor of motorics. The findings of different authors (Šturm, 1977; Strel, 1981; Pavlović, 1982) have confirmed that the structure of motor abilities is organised hierarchically, and that it is primarily determined by two dimensions of wide range regulation. The processes of structuring, control and regulation of motor activities prevail in the first one, therefore it is supposed to depend on the mechanism of reception, analysis and implementation of information, and the energy regulation of movement prevails in the second one.

The Catell-Horn theory (Cattell 1963, 1971, Horn 1985; according to Pogačnik, 1995) claims that the primary mental abilities reflect basic psychological structures and processes. They represent those sources of differences among people which are subjected to the basic modules of intellect. All the abilities are correlated positively among themselves and are assembled into a wide range of abilities. At the highest level the neuro-physiological ability of information analysis, by Cattell called fluid intelligence Gf, and the experiences, called crystallised intelligence Gc, are substantial. To study the relations of motor abilities we have selected the fluid intelligence, which is relatively independent of upbringing and experiences and serves as a basis for numerous intellectual activities. It is reflected in the fast and effective resolving of mental problems and is highly correlated with the learning of new areas.

Both the fluid intelligence and the crystallised intelligence develop very fast from the time of an individual's birth to the age of maturity. However, the fluid intelligence develops as a consequence of biological growth of central nervous system, and the crystallised intelligence as a consequence of investment impact of Gf and the social environment on the education of a person. Gf is supposed to reach its peak at the age of 16, and starts to decline after the age of 30. Gc ends its development a bit later and it does not decline with age, in certain cases of primary mental abilities it even grows until later age (Pogačnik, 1995:74).

The performance of the complex motor exercises and the intelligence tests depend on the highest functions, which are decisively affected by the same mechanisms (Ismail, 1976). When performing those exercises and solving the intellectual problems the most important is the functioning of central nervous system to receive, to control, to harmonise, and to elaborate numerous and various information. The performance of such exercises demand a certain level of intellectual potentials (fluid intelligence).

While the development of intelligence is relatively permanent (Pogačnik, 1995), the physical and motor status of children have changed significantly in the last 20 years (Šturm and Strel, 1985; Malina, 1991; Tanner, 1991; Przeweda, 1995; Conger and Galambos, 1997; Kondrič and Šajber Pincolič, 1997). We have assessed the content and the level of correlation for each age group, and we have, at the same time, studied the changes in the correlation in the process of growing up.

Because of the difference in the morphological and motor development, and the differences in the correlation between intelligence and motor abilities according to gender (Mohan and Bhatia, 1989; Strel and Žagar, 1993) we have taken only girls as the sample of the research work.

METHODS

Subjects

The sample of 1859 schoolgirls of primary and secondary schools was stratified according to the regions, and selected ad hoc within the regions. The sample is representative for Slovenia, since the schools were selected from both bigger and smaller centres, and among the secondary schools we have selected those which can be classified as schools with various types of education. Our research sample covers girls of primary schools who were at the age of 10, 11, 12, 13 and 14 years in the interval of +/– six months from 1 October 1993, and the girls of secondary schools who were at the age of 15, 16, 17 and 18 years in the interval of +/– six months from 1 October 1994, and were not excused from participating in the physical education for health reasons. Prior to that their parents had given a written consent to their participation in the research work.

Variables

Motor Abilities Tests and Latent Variables

On the basis of the hypothetical model of Kurelić and colleagues (1975), the research works of Šturm (1970, 1977), and Strel and Šturm (1981) we selected 26 tests to assess the motor abilities of the sample to be measured. The tests are described in the project research work of Strel and colleagues (1992).

Because of the complexity and the extensiveness of measurements the tested girls performed two repetitions of energy less consuming tests. When elaborating the data, the second repetition was taken into consideration. The subjects performed energy more demanding tests only once.

Table 2: Number of main components, percentage of explained variance and proportion of first principal component of various age periods

age	n	number of factors	percentage of explained variance	proportion of first principal component
10	223	7	64.61	31.84
11	207	7	64.28	27.37
12	221	7	64.83	28.68
13	216	9	68.25	25.11
14	205	8	64.01	23.85
15	174	7	63.93	28.47
16	201	8	66.85	27.87
17	212	8	68.31	30.94
18	200	7	60.50	22.02

The correlation of manifest variables was explained with the small number of latent variables by the component model of factor analysis. Their proper values and their proper vectors were isolated with the Kaiser-Guttman criteria.

Intelligence Test

We used the test of the set TN-20 (Pogačnik, 1994), which in the first place measures fluid intelligence. It contains also a bit of perceptive and spatial component. It consists of 45 sets of special tasks increasing in difficulty. The available time is limited to 20 minutes; therefore the result is determined also by mental quickness. The test achieved satisfying measurement characteristics; it is practical for use, and relatively free of cultural influence (Pogačnik, 1994, 1995). Due to its measurement attributes the selected measuring

Table 1: Selected tests and their codes

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

* tests where subjects performed only one repetition

Table 3: Structure of isolated factors in different age periods

age	FACOBL1	FACOBL2	FACOBL3	FACOBL4	FACOBL5	FACOBL6	FACOBL7	FACOBL8	FACOBL9
10	Energy component	Speed of simple motor tasks	Mobility of hip joint	Repetitive strength of abdominal muscles	Coordination of movement in rhythm	Mobility of shoulder girdle	Balance		
11	Energy component	Mobility of hip joint	Speed of simple motor tasks	Repetitive strength of abdominal muscles	Coordination of movement in rhythm	Mobility of shoulder girdle	Balance		
12	Co-ordination and energy component	Explosive strength	Mobility of hip joint	Repetitive strength of abdominal muscles	Speed of simple motor tasks	Rhythmic performance of motor tasks with hands and legs	Coordination of hands movement		
13	Co-ordination and energy component	Repetitive strength of abdominal muscles	Speed of simple motor tasks	Mobility of hip joint	Balance	Explosive strength	Mobility of shoulder girdle	Unnamed factor 1	Unnamed factor 2
14	Energy component	Speed of simple motor tasks	Repetitive strength of abdominal muscles	Explosive strength	Mobility of hip joint	Coordination of movement in rhythm	Tonus regulation	Coordination of hands movement	
15	Agility	Mobility of hip joint	Speed of simple motor tasks	Explosive strength of hands muscles	Repetitive strength of abdominal muscles	Coordination of movement in rhythm	Aerobic endurance		
16	Agility	Repetitive power of abdominal muscles	Mobility of hip joint	Explosive power of hands muscles	Balance	Coordination of movement in rhythm	Speed of simple motor tasks	Aerobic endurance	
17	Agility	Repetitive strength of abdominals muscle	Mobility of hip joint	Aerobic endurance	Speed of simple motor tasks in given rhythm	Coordination hand – eye	Explosive strength of hands muscles	Balance	
18	Agility	Mobility of hip joint	Unnamed factor 1	Explosive strength of hands muscles	Repetitive strength of abdominal muscles	Speed of simple motor tasks	Aerobic endurance		

procedure enables us to give quite reliable assessment of fluid intelligence, and it is suitable to be used on the sample of school children in Slovenia.

Organisation and the Course of Measurements

The measuring of motor abilities and intelligence was carried out in the project "The analysis of development trends of motor abilities and morphological characteristics, and the relations of both with the psychological and sociological dimensions of Slovenian children and youth from 7 to 18 years of age in the Period from 1970 - 1983 - 1993" (by Strel and colleagues, 1992, 1996).

Data Analysis

We analysed the relations between fluid intelligence and latent motor variables, the latter being mostly responsible for relations at each age group, by means of the multiple regression analysis. The predictor system was represented by motor dimensions, expressed in latent space, and the criterion variable was represented by the result of measuring the intelligence in its manifest form.

RESULTS

The lowest correlation with the used system of predictors was detected at the age of 10, where the isolated latent dimensions explain 8.3 % of the variance of criteria variable. It is evident that there are two latent dimensions having statistically significant projection on the variable, which we denominated *coordination of movement in rhythm and balance*. A relative effect of certain variables on the common variance indicates that *coordination of movement in rhythm* contributes the most to its explanation.

The system of predictors is statistically very high significantly related to the criteria variable at the age of 11 and 12. The proportion of variance of criteria variable, explained by the system of predictor variables, is with 26 % at the age of 16 substantially higher than at the age of 10 years. The relations with latent dimensions defined as *coordination of movement in rhythm, speed of simple motion and balance* are al-

Table 4: The relation of fluid intelligence variable with the latent motor variables of subjects aged from 10 to 18 years

10 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.288	.083	2.523	.017		
predictors	**BETA**	**CORR**	**PARTIAL**	**T**	**SIGN T**	**P**
factor 5 (coordination of movement in rhythm)	.211	.203	.203	2.906	.004	4.283
factor 7 (balance)	.145	.131	.139	1.967	.051	1.899
11 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.510	.260	9.133	.000		
predictors	**BETA**	**CORR**	**PARTIAL**	**T**	**SIGN T**	**P**
factor 5 (coordination of movement in rhythm)	.307	.368	.326	4.652	.000	11.297
factor 3 (speed of simple motion)	.226	.271	.240	3.332	.001	6.124
factor 7 (balance)	.200	.285	.216	2.982	.003	5.700
12 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.342	.117	3.179	.003		
predictors	**BETA**	**CORR**	**PARTIAL**	**T**	**SIGN T**	**P**
faktor4 (repetitive strength of abdominal muscles)	.211	.200	.199	2.628	.009	4.220
factor 5 (speed of simple motion)	.197	.216	.188	2.485	.014	4.255
factor 1* (coordination and energy component)	–.197	–.034	–.184	–2.423	.016	0.669
13 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.288	.083	1.736	.084		
predictors	**BETA**	**CORR**	**PARTIAL**	**T**	**SIGN T**	**P**
factor 9 (non-denominated factor)	.183	.209	.184	2.459	.015	3.824
14 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.383	.147	3.639	.001		
predictors	**BETA**	**CORR**	**PARTIAL**	**T**	**SIGN T**	**P**
factor 6 (coordination of movement in rhythm)	.194	.255	.200	2.650	.009	4.947
factor 4* (explosive strength)	–.193	–.255	–.196	–2.597	.010	4.921
15 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.315	.099	1.230	.296		
16 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.383	.147	1.590	.142		
predictors	**BETA**	**CORR**	**PARTIAL**	**T**	**SIGN T**	**P**
factor 3 (mobility of hip joint)	.290	.311	.279	2.503	.015	9.019
17 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.435	.189	2.712	.010		
predictors	**BETA**	**CORR**	**PARTIAL**	**T**	**SIGN T**	**P**
factor 1 (agility)	.310	.366	.287	3.123	.005	11.346
18 years						
criterion v.	**RO**	**DELTA**	**F**	**SIGN F**		
TN-20	.382	.146	3.545	.002		
predictors	**BETA**	**CORR**	**PARTIAL**	**T**	**SIGN T**	**P**
factor 2* (mobility of hip joint)	–.233	–.259	–.239	–2.970	.003	6.034

*negative sign at factor 1 at the age of 12 years is a consequence of the fact that lower score means a better result when compared to factors 4 and 5

*negative sign at factors 4 and 7 at the age of 14 years is a consequence of the fact that higher score means a better result when compared to factor 6

*negative sign at factor 2 at the age of 18 years is a consequence of the fact that higher score means a better result when compared to other factors so statistically significant. Three latent dimensions *(repetitive strength of abdominal muscles, speed of simple motion and coordination in energy component)* have at the age of 12 statistically significant projections on the criteria variable.

The correlation of the whole predictor system and criteria variable at the age of 13 is not statistically significant. And at the age of 14 the correlation of both spaces, the motor and the cognitive space, is again statistically significant. We can explain 14.7 % of variance by using the system of predictor variables, which is demonstrated mostly by the influence of latent dimensions, denominated *coordination of movement in rhythm* and *explosive strength*. The influence of factor of tonus regulation is also evident but it is statistically insignificant.

At the age of 15 there is no statistically significant correlation between the whole scope of latent motor dimensions and criteria variables. The predictor system is then at the age of 17 again high statistically significantly correlated with the criteria variable. The proportion of the explained variance is 18.9 % at the age of 17 and 14.6 % at the age of 18. From a thorough examination of its constitution it is evident that at the age of 17 years it is statistically significantly effected only by the projection of the factor denominated *agility,* and at the age of 18 years by the *mobility of hip joint*. The influence of agility is also evident but it is not statistically significant.

DISCUSSION

We have found out that the system of latent motor dimensions is statistically significantly correlated to the criteria variable at the ages of 10, 11, 12, 14, 17, and 18 (at the level of 0.05). Those findings are surprising as the majority of researchers consider that the correlation exists primarily at younger generations.

There are no relations in the puberty period, and after considerable biological changes the correlation is reinstated. Although the development of fluid intelligence reaches its peak at the age of 16, the motor development does not seem to be accomplished yet, which enables correlation above all in the areas, where the functioning depends on the speed of information transfer and on a harmonious functioning of agonists and antagonists.

The correlation of intelligence and the agility with mobility at the age of 17 and 18 may be a result of fluid as well as crystallised intelligence. With the experience and with the richness of stored motor programmes the central nervous system becomes more capable for data elaboration. The speed of the impulse flow increases as a consequence of experience, of the use of higher number of possible strategies, and the integrated operation of various subsystems (Luria, 1983).

A small proportion of explained variance at the age of 10, which is contrary to expectations, can be explained with the finding, that while performing the motion exercises, where coordination of the whole body movement and the agility prevail, and where the correlation should be the most explicit, other mechanisms most probably prevail, above all the mechanism for energy regulation. We can see from the analysis of the latent dimensions, that the factors are more complex, that the independent factor of the entire body movement and the agility has not been isolated, and that the variables of explosive strength and endurance prevail at the projections on the first factor.

Statistically significant relations appear mostly with those latent dimensions, which belong to the area of informational components of movement (coordination of movement in rhythm at the age of 10, 11 and 14, balance at the age of 10 and 11, the speed of simple motion at the age of 11 and 12, mobility of hip joint at the age of 16 and 18, and agility at the age of 17 years). At the age of 12 and 13 we noticed the correlation between latent dimensions determined by the manifest variables of informational as well as energy type (coordination and energy components and an unnamed factor 2). At the age of 12 the highest projection was shown at the factor which can be classified as energy component of movement (repetitive strength of abdominal muscles).

On the basis of the detailed analysis of certain projections of latent motor dimensions (predictors) on fluid intelligence (criteria) we can find out the following:

The projections of factors *coordination of movement in rhythm* at the age of 10, 11 and 14, and *agility* at the age of 17, on the criteria variable confirm the findings of certain authors about the correlation between intelligence and the performance of the motor abilities, characterised by the informational complexity, rhythmic unity and extraordinary movements, and also the simultaneous activity of dominant and non dominant side of the body (Ismail, Kephart and Cowell, 1963; Ismail and Gruber, 1965; Kirkendall, 1968; Ismail and Kirkendall, 1968; Dotson, 1968; Leithwood, 1971; Ismail, 1976; Ismail, Kane and Kirkendall, 1976; Klojčnik, 1977; Mejovšek, 1977; Momirović in Horga, 1982; Pavlović 1982, 1986; Vauhnik, 1984; Momirović and colleagues, 1987; Hotz, 1990, 1991; Strel and Žagar, 1993; Planinšec, 1995).

The success of the performance of motor tasks, that should be executed by subjects in certain rhythm and in various directions in the shortest time possible, depends on the centres of cortical regulation of movement. Probably a simultaneous activation of both mechanisms is necessary, namely the mechanism for the structuring of movement, because the subject has to create individually the most optimal sequence of movements in certain rhythm or perform a prescribed exercise in a limited space, and the mechanism for synergy and tonus regulation. The latter is responsible for the involvement of antagonists and agonists, since the exercise has to be carried out as fast as possible, and considering also the importance of the accuracy of the movement.

The performance of the most complex motor exercises and the capacity of solving intelligence tests depend on the highest functions, which are decisively affected by the same mechanisms. We can assume that also the exercises with complicated motion structure, which are new to the subjects and demand a successful resolution in the shortest time possible at the optimal rhythm, demand a certain level of intellectual potentials (fluid intelligence). When performing those exercises and solving the intellectual problems the most important is the functioning of central nervous system to receive, to control, to harmonise, and to elaborate numerous and various information. The speed of transformational processes, which underline human intellectual and motor functioning, depends on the above mentioned capacities.

Among motion complex exercises we should point out also the motor learning, a process of acquisition, improvement, consolidation and the use of motor programmes. The co-ordinational variables represent a new, unknown task, and the success of its performance depends on the speed of learning. Learning of motor skills represents an intellectual task (Horga, 1993), since it depends on a series of processes of elaboration of information in the central nervous system.

While performing the exercises, the subjects compare the information kept in their memory with the actual information, coming from sensor centres, primarily the visual impulses and the impulses of muscles, sinews and joint receptors (Adams, 1976, after Horga, 1993). The movement performance can therefore be controlled on the basis of feedback information. According to the Schmidt theory of open and closed loop system (Schmidt, 1991) the most important thing to be learned about the motion task is the establishment of the scheme in the motor memory: the recall scheme and the recognition scheme enable the inclusion of the general motor programmes responsible for the whole range of movement. The recall scheme makes possible to modify according to the environment (it means an open loop – feed -forward), and the recognition scheme makes possible to recognise and estimate motor activities on the basis of their sensor consequences (closed loop- feedback).

In the neuronic network we keep the conditions which are necessary to renew the motion pattern. Any previously kept pattern can be recalled by a similar impulse from outside. It is only important that the patterns which are more often reconstructed become clearer, and that the pattern can be reproduced from only a part of the motion pattern stored in the memory.

The level of simultaneous and consecutive comparison between the information and the quantity of information about different motor tasks, kept in the memory, are those elements which can confirm the probability of relations between the agility and intelligence of the 17- year-old subjects.

We also confirmed the relation between intelligence and balance, which had already been proved by certain authors in their early research works (Guyette and colleagues, 1964; Ismail and Gruber, 1965; Ismail 1976; Ismail, Kane and Kirkendall, 1976). Balance depends on the involvement of the eyesight analyser, the size of the area, in which balance should be, statistics of endeavours with which the desired balance position is kept, or on the overcoming of the force, which tends to disturb the balanced position during motion. Reticular formation plays a key role as an integration step in the management of body posture and balance. Vestibular organ with vestibular cores, being abundantly in relation with little brain, is sensitive to the static and dynamic changes of gravity point position (Henatsch and Langer, 1985). The success of movement structures, where the formation and keeping of balance position prevail, depends mostly on the mechanism of synergy and tonus regulation, i.e. the mechanism, which has its basis in the cortex, where all the mental activities take place. The eyesight receptors should not be neglected. They transfer the information to the higher positioned centres of the central nervous system. They participate also at the solving of the test sets, since the tests themselves measure wide range visual factor (Pogačnik, 1994).

The relation between the factor of *speed of simple motion* and the indicators of intellectual capabilities is also statistically significant at younger age groups. The relation was discovered by different authors (Sloan, 1951; Willson, Tunstall in Eysenk, 1971; Mejovšek, 1977; Jensen, 1980, 1982, 1987; Strel and Žagar, 1993; Planinšec, 1995). Mejovšek (1977) ascertains in his research that the relation in the tasks of simple motions can be explained by the speed of the information transfer. Probably at younger age categories the simple motion tasks, to execute simple motions as quick as possible, represent the problem challenge, and require the implementation of more complex intellectual capacities. The efficiency of solving the test sets depends also on mental speed (Pogačnik, 1994), since the task is limited in time. We can also agree with Hofman (1980), claiming that the speed of movement is only a special part of efficient functioning of the whole system of balancing and monitoring of motor issues. And because of that also the whole system, which is crucial for the regulation and monitoring of motor space, can be equalised with fluid intelligence in the area of intellectual functioning.

Repetitive strength of abdominal muscles and the *explosive strength* are the only factors of energy component of movement to have projections on the criteria variable. Although the repetitive movement is partly automated we can explain the relation by the importance of the cognitive capacities also at familiar tasks (Ferrari and colleagues, 1991, after Horga, 1993). A simultaneous use of practical and conceptual knowledge, saved in a long-term memory, enables us to better perform the already learned movements.

The energy regulation, which appears in brisk motor actions, is decisive to achieve a good result in those kinds of motion, where explosive strength is needed. The most important is the speed or rather the time spent to develop strength. The latter is determined by the coordination of muscles' group functioning. The faster the harmonisation of those processes is, the more we are successful with the fast muscle actions. Also in the cognitive processes the speed of information flow and its elaboration (Lehrl and Fischer, 1990, after Pogačnik, 1995; Tušak and Tušak, 1997) is very important. We can assume that the projection of test exercises of explosive strength of hands and legs on the criteria variable can be explained by the speed of information transfer through the synapses and by the speed of data elaboration.

The correlation of mobility and intelligence, proved so far in the research works only by Momirović and Horga (1982), can be explained by the complicated adjustment of muscles tonus. Although the performed movements of all three tests are structurally simple, it is clear that the maintenance and regulation of muscles' tonus is extremely important for the success of the carried out exercises. The tonus directly depends on the level of activation of alpha motoneuron and the relation with the cortex through the pyramid and out-of-pyramid path (Pinter, 1996).

CONCLUSIONS

The principal aim of the research work had been to find out the relations between the latent motor space and the fluid intelligence of schoolgirls aged from 10 to 18.

We have determined a significant statistical correlation between the indicators of fluid intelligence and the latent motor dimensions in girls aged from 10 to 12 and at girls aged 14, 17, and 18 years.

The proportion of explained variance is the lowest at the age of 10 years and the highest at 11 and 17 years. The results are surprising, since the majority of researchers think that in the process of growing up the relation starts to decline gradually. Although the development of fluid intelligence reaches its peak at the age of 16, the motor development is not completed yet at that age. This situation enables establishing certain relations, above all in cases where the functioning is conditioned by the speed of the information transfer and by the synchronised operation of agonists and antagonists, as well as by the involvement of the information kept in the long term memory, and finally by the rational performance of movement.

Statistically significant relations appear mostly with those latent dimensions, which belong to the area of informational component (coordination of movement in rhythm at 10, 11, and 14 years of age, balance at 10 and 11, the speed of simple motion at 11 and 12, mobility of hip joint at 16 and 18, and the agility at the age of 17). At the age of 12, 13 and 14 we can observe the relation, which are determined by the variables of the informational as well as the energy type (coordination and energy component). At the age of 12 the highest projections can be seen in the factor, which can be classified as the energy component of movement (repetitive strength of abdominal muscles), and at the age of 14 the factor of explosive strength.

Following the obtained results concerning the relation between the fluid intelligence and the latent motor variables, even after the age of 16, it would be also sensible to study the relation between motor space and the crystallised intelligence on a sample of secondary schoolgirls. That seems to be specially important because the correlation between the fluid and crystallised intelligence ranges from 0.40 to 0.60 (Pogačnik, 1995). As we have studied the relation of motor and cognitive space only on the sample of girls, it should be interesting to compare the results with a similar research carried out on a sample of boys.

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