A COMPARATIVE ANALYSIS OF THE RELATIONS BETWEEN THE MOTOR DIMENSIONS AND COGNITIVE ABILITY OF PRE-SCHOOL GIRLS AND BOYS

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Abstract:

The main aim of the study was to establish the relations between the motor and cognitive abilities of boys and girls aged 5.5 and explain any possible differences between the genders. The sample of children tested consisted of 189 girls and 203 boys. The assessment of the cognitive abilities was carried out using the RAZKOL test (Praper, 1981). The children were given 28 tests to measure their motor abilities (Rajtmajer and Proje, 1990). The results show that the coefficient of the multiple correlation attains relatively low values, with the value of the coefficient for the boys being a little higher than that for the girls. In both genders the motor factors that show the strongest connection with the cognitive variable are those which have the characteristics of coordinated movement and the speed of movement. In addition to these, in boys it was also the factor of balance that had a significant correlation with the cognitive variable, while in girls this was the factor of explosive power.

Key words: motor abilities, cognitive abilities, relation, pre-school children

EINE KOMPARATIVANALYSE DER BEZIEHUNGEN ZWISCHEN MOTORISCHEN DIMENSIONEN UND KOGNITIVEN FÄHIGKEITEN DER MÄDCHEN UND JUNGEN IM VORSCHULSALTER

Zusammenfassung:

Das Hauptziel dieser Studie war es, die Beziehungen zwischen motorischen und kognitiven Fähigkeiten der 5,5-jährigen Jungen und Mädchen festzusetzen und die möglichen Unterschiede zwichen Geschlechtern zu erklären. Die Stichprobe umfasste 189 Mädchen und 203 Jungen. Kognitive Fähigkeiten wurden mittels des RAZKOL Tests (Praper, 1981) bewertet. Die Kinder untergangen 28 Teste zum Messen ihrer motorischen Fähigkeiten (Rajtmajer and Proje, 1990). Die Ergebnisse zeigten, dass der Koeffizient der multiplen Korrelation relativ niedrige Werte behielt, wobei der Wert des Koeffizientes für die Jungen etwas höher war als für die Mädchen. Die mit der kognitiven Variable am engsten gebundenen motorischen Faktoren sind in beiden Geschlechtern die Faktoren der Koordination und Geschwindigkeit der Bewegung. Ausserdem korrelieren auch der Faktor des Gleichgewichts bei den Jungen und der Faktor der Explosivkraft bei den Mädchen bedeutend mit der kognitiven Variable.

Schlüsselwörter: motorische Fähigkeiten, kognitive Fähigkeiten, Beziehung, Vorschulkinder

Introduction

The functioning of the entire human psychosomatic system, as well as the individual dimensions of this system, is to a great extent connected with relations between these dimensions. Motor abilities are shown in interaction with other psychosomatic dimensions, so they can be correctly interpreted only on the basis of the knowledge about such connections. Therefore, a better insight into the regulation of human movement and human efficiency in general can be achieved by a detailed examination of the relations between motor abilities and cognitive abilities.

A more detailed analysis of the relations between motor and cognitive abilities is relevant in particular with regard to younger children who are in the phase of dynamic development, since its results enable a better explanation of complex developmental processes and some basic laws of a child's development. A better understanding of laws of the motor development requires the study of motor dimensions and their connection with other psychosomatic dimensions in different age groups, since in the course of the development changes occur in individual dimensions as well as in the relations between them.

The main aim of the study was to establish the relations between the motor and cognitive abilities of boys and girls aged 5.5 and to explain any possible differences between the genders. This kind of research on a sample of pre-school children has been carried out by a relatively small number of researchers so far.

Leithwood (1971) established in his research carried out on a sample of children aged 4 - 5 that the implementation of complex motor tasks involves cognitive functioning, the influence of which increases together with the complexity of the motor task. According to Leithwood the process of learning a complex motor task, in other words the integration of different individual elements into a sensible motor unity, is essentially an intellectual process. Eggert and Schuck (1978) established on a sample of children aged 6 - 8 that there is a closer connection between intellectual and motor abilities at a lower intellectual level, and at an earlier age. Dickes (1978) obtained similar results from a sample of children aged 5 - 9 and Zimmer (1981) from a sample of children aged 4 - 6. The results of their research studies show that there is a close connection between motor abilities and intelligence. It is medium high in the pre-school period and decreases in older children. They equally show that it is the variables of the coordinated movement of the entire body that are connected the most with intelligence. Madić (1986) concluded on a sample of children aged 6 that the highest correlation with intelligence was shown in the standing long jump, 10 and 20 meter runs and foot tapping. Planinšec (1995) established on a sample of children aged 5 that the motor tasks, which are the most important for the connection with cognitive abilities, are those which have the characteristics of the speed of simple movements, coordinated movement and explosive power.

We should also mention a study by Mejovšek (1977), which examines adults, but has no equal, in terms of the size of the sample, number of tests and complexity of data processing. In his study Mejovšek established that there are two factors, which are important for the connections between motor and cognitive abilities. When a motor task does not contain problem situations, the connection can be explained by the speed of the flow of information in the nervous system. On the other hand, when a motor task does present a problem, the connection can be explained by the influence of cognitive activities during the solving of a motor problem.

All the above-mentioned studies establish the existence of a positive correlation between motor and cognitive abilities; however, they also differ significantly with regard to the samples and methods they use, which makes a comparison of their results virtually impossible. There are differences in the age of the tested persons, with the age difference sometimes spanning over several years. In pre-school period there are significant differences in the structure of motor abilities even between the groups that are only half a year apart (Rajtmajer, 1993a). Different studies differ with regard to the number of children included in a sample, which is often very low. They are also different in that they use different tests for the assessment of motor abilities, using only a small number of tests, which often cover only a part of the area of motor abilities. A significant difference is in the fact that motor variables are treated mostly only in the manifest space, and not in the latent space, which in our opinion would be more appropriate, since the latent dimensions have a wider scope of functioning and are on a higher level than the manifest variables. Furthermore, the previous studies are also different with regard to their widely differing methods of data processing and consequently the interpretation of the results obtained.

In our opinion, a relatively big problem with children aged 5.5 is in the implementation of testing, which causes more complications at this age than with older subjects. Problems are caused by the selection and number of motor tests to be used and the number of repetitions of each task to be tested. We believe that the number of selected tests in our study is still acceptable. However, we assume that any further increase of the number of tests would only result in overloading the children, which could have a negative effect on the test results. In addition, children of this age make a relatively large number of mistakes in the implementation of test tasks, which is particularly true for more demanding motor tasks. It can be concluded that certain problems connected with the implementation of test tasks by pre-school children simply cannot be avoided, which has also been established by other authors (Zimmer, 1981).

Problems which are caused by the collection of data on the motor abilities of pre-school children and which certainly have a direct effect on the test results, demand that the results should be treated with a degree of caution. Despite all this, the measuring characteristics of most of the selected tests for measuring the motor abilities of younger children are appropriate, which has been confirmed by several studies (Strel and Šturm, 1981; Rajtmajer and Proje, 1990; Videmšek and Cemič, 1991; Planinšec, 1995). The test we have used for the assessment of cognitive abilities (Praper, 1981) also possesses good measuring characteristics.

The tested children were mainly treated separately according to gender, since there is a great probability that girls and boys differ in motor efficiency already at this age. These differences are probably not large, which has been established by some previous studies (Thomas and French, 1985; Rajtmajer, 1993b; Pišot, 1997). However, separate treatment according to gender as early as at this age enables comparisons with other studies including mostly older subjects, where there are significant differences between the genders.

Methods

All the tests have been implemented within the framework of the research project entitled "The structure of and the relations between psychomotor and cognitive abilities and social and morphological characteristics of pre-school children", which is conducted by Dr. Rajtmajer and has been implemented for several years as a cooperation between the Faculty of Education of Maribor and the Health Clinic in Maribor (Slovenia).

The sample of tested children consisted of 189 girls and 203 boys aged 5.5, +/- 14 days, from the city of Maribor and its surroundings. The sample was very limited according to age with a very small deviation span, since even in preschool period there are differences between samples that differ according to age (Rajtmajer, 1993a). Such a precise age limitation of the sample will enable good comparisons and a further search for differences between the different age groups.

The assessment of cognitive abilities was carried out with the RAZKOL test, whose author was Praper (1981) and which was standardized on a Slovenian population of pre-school children. The test consisted of verbal and non-verbal tasks, and the results of the test depend on the relation between the mental and chronological age of the individual. The test gives a general assessment on the cognitive development of the individual, since according to Praper (1981) specific cognitive abilities are still not differentiated at this age. In view of the fact that some studies (Mejovšek, 1977; Momirović, Gredelj and Hošek, 1980; Momirović and Horga, 1982) point out that it is mainly the general cognitive ability that is significant for the connection with motor abilities, the test used in this study is an appropriate choice.

For the assessment of motor abilities 28 tests have been used, which have already been standardized on a Slovenian population and are thus appropriate for the chosen sample of subjects (Rajtmajer and Proje, 1990). The motor tests belong to the following hypothetical dimensions:

- coordinated movement of the entire body (KKOTZO - rolling the ball around a hoop, KLILEN - walking backwards by stepping on each rung of a horizontally placed ladder, KHOONA - walking through hoops backwards, KPOLNA - polygon backward, KPLAKL - crawling under a bench, KPLAZO - crawling with a ball, KTEKOT - crawl-and-run)
- hand coordination (KROZOT - circling the ball around the body, KKOTZS - rolling the ball around the feet, KUDARZ - bouncing the ball off the

Table 1: The highest and most important values of the projections of the motor variables on oblimin factors and the names of the factors for boys

OBLIMIN FACTOR	VARIABLE	VALUES FROM PATTERN MATRIX	VALUES FROM STRUCTURE MATRIX	NAMES OF THE FACTORS
1. FACTOR	KOCLM8	.754	.762	coordinated movement in space and time limitation
	KOCPV7	.730	.749	
	KOCKVO	.627	.643	
	KPOLNA	.604	.688	
	KHOONA	.598	.674	
2. FACTOR	HITAR1	.843	.850	speed of simple movements
	HITTAN	.730	.742	
	HITAR2	.603	.686	
	KUDARZ	.360	.457	
3.FACTOR	EXMSD3	.862	.828	explosive power
	EXMSDZ	.802	.840	
	EXMSVI	.334	.435	
4.FACTOR	RSLKVP	.789	.777	balance
	RSLKVV	.744	.742	
	RSPKVA	.642	.655	
5.FACTOR	VDMKLO	.665	.697	speed of movement
	KKOTZS	.654	.627	
	KROZOT	.643	.729	
	KKOTZO	.499	.620	
	KTEKCC	.454	.514	
6.FACTOR	KTEKSS	.804	.779	agility
	KBOTEK	.764	.765	
7.FACTOR	VDMBPO	.664	.716	repetitive power
	VDMBPR	.533	.612	
	KUDRZO	.385	.459	
	EXMSVI	.376	.410	
8.FACTOR	KPLAZO	.768	.773	solving complex motor tasks
	KTEKOT	.674	.687	

floor with two hands in a standing position, KOCPV7 - building a tower of big foam rubber cubes, KOCKVO - building with hollow cubes, KOCLM8 - building a tower of small wooden cubes),

- agility (KBOTEK - stepping sideways, KTEKSS - agility run (running back and forth over a 3m-distance four times), KTEKCC - zigzag running (back and forth over a 5m-distance),

- explosive power (EXMSDZ - standing long jump, EXMSD3 - standing triple jump, EXMSVI - standing high jump),

- repetitive power (VDMKLO - stepping on a bench, VDMBPO - sideways jumps, VDMBPR - sideways jumps with hand support),

- speed of simple movements (HITARI - hand tapping - two fields, HITTAN - foot tapping, HITAR2 - hand tapping - 4 fields),

- balance (RSLKVV - standing on a block longitudinally, RSLKVP - standing on a block crosswise, RSPKVA - standing on a vertical block).

The children carried out three repetitions of each motor test.

The data were processed separately for girls and boys. The factor analysis was used for establishing the latent space of the motor dimensions. In this, the number of the principal components was determined with the use of the Kaiser-Guttman criterion, according to which the important principal components are those whose eigenvalue is equal or greater than 1, and the principal

Table 2: The highest and most important values of the projections of the motor variables on oblimin factors and the names of the factors for girls

OBLIMIN FACTOR	VARIABLE	VALUES FROM PATTERN MATRIX	VALUES FROM STRUCTURE MATRIX	NAMES OF THE FACTORS
1. FACTOR	VDMBPO	.745	.781	speed of simple movements
	HITAR2	.711	.748	
	HITTAN	.699	.663	
	VDMBPR	.690	.749	
	KROZOT	.485	.606	
2. FACTOR	RSLKVP	.858	.857	balance
	RSLKVV	.848	.842	
	RSPKVA	.674	.681	
3.FACTOR	KBOTEK	-.896	-.896	agility
	KTEKSS	-.834	-.832	
4.FACTOR	KTEKOT	.635	.621	speed of movement
	KKOTZS	.570	.580	
	VDMKLO	.423	.447	
5.FACTOR	EXMSDZ	.802	.809	explosive power
	EXMSD3	.763	.760	
	EXMSVI	.656	.663	
6.FACTOR	KOCPV7	.875	.864	eye-hand coordination
	KOCLM8	.738	.766	
7.FACTOR	KHOONA	.806	.828	coordinated movement of the entire body
	KPOLNA	.749	.806	
	KLILEN	.689	.670	
	KPLAZO	.444	.498	
	KPLAKL	.380	.545	
	KTEKCC	.301	.405	
8.FACTOR	KOCKVO	.613	.640	coordinated hand movement
	KUDARZ	.558	-.620	
	HITAR1	.464	-.475	
	KKOTZO	.439	.505	

components were transformed into the obliminal position. The obtained factors were used for the assessment of the relations between the motor and cognitive variables. The canonic correlation analysis was used. The coefficient of multiple correlation and the correlation coefficients for each motor factor and cognitive variable were calculated. The comparison of the results obtained for boys and girls was carried out on the basis of descriptive analysis.

Results

Despite the fact that it is not our aim to analyse and define the latent structures of motor space, we have, in view of the basic aim of our study, carried out a brief interpretation of the latent motor dimension.

For boys we obtained 8 latent motor dimensions, which explain 60.6 % of the common variance of the system and which are defined on the basis of the pattern matrix and structure matrix, as shown in Table 1. The first factor, which we have named *coordinated movement in space and time limitation*, has a somewhat unusual structure. It is defined mainly by variables in which coordinated hand movement and coordinated movement of the entire body prevail, demanding precise timing and implementation in exactly determined space coordinates. The second factor, which is well defined, is named *the speed of simple movements*. The third factor is equally well defined and it is named *explosive power*. The fourth factor, named *balance*, has a clear structure. The fifth factor is rather complex and is named *the speed of movement*, since the most important common characteristic of tests with the highest projections is the quick implementation of movement. The sixth factor is defined by two variables with a fairly high projection and is named *agility*. The interpretation of the seventh factor is difficult. However, it is highly probable that the main cause of the variability of this factor is repetitive power, although it also shows characteristics of the speed of movement, rhythm and partly explosive power. The eighth dimension is named *the solving of complex motor tasks* and is defined relatively well by two dimensions only.

For girls we also obtained 8 latent dimensions, which explain 60.0 % of the common variance of the system and are defined on the basis of the pattern matrix and structure matrix, as shown in Table 2. We have named the first factor *speed of simple movements*, since the common characteristic of the most important tests is the quick implementation of simple hand and foot movements. The second factor is well structured and is named *balance*. The third factor is named *agility* and has only two, yet high projections. The fourth factor is named *speed of movement*, since the common characteristic of the tests with the highest projections is mainly the quick implementation of movement. The fifth factor has a well defined structure of *explosive power*. The sixth factor is defined by two variables the characteristic of which is the precise adjustment of hand movement to visual perception, and is therefore named *eye-hand coordination*. The seventh factor has a well-defined structure and can be named *the coordinated movement of the entire body*. The eighth factor does not have a completely clear structure, but it seems that the prevailing characteristic of variables defining it is *coordinated hand movement*.

Both for girls and boys the latent structure of motor dimensions was defined by 8 factors. We have established that there were differences in the structure of the motor dimensions between boys and girls, but some dimensions were very similar. In the dimensions of *explosive power* and *agility*, the highest projections had completely equal

Table 3: *Results - boys*

RO = .467 p = .00

FACTOR	r
FAC 1	.573
FAC 2	.478
FAC 3	.092
FAC 4	.220
FAC 5	.041
FAC 6	.142
FAC 7	.074
FAC 8	.205

RO = coefficient of multiple correlation;
p = level of statistical significance of RO;
r = correlation coefficient between
a motor factor and the cognitive variable

variables. We have given the same names also to the two other dimensions, i.e. *the speed of simple movements* and the speed of movement. Thus the differences between the genders are mainly shown by the dimensions which define coordinated movement in general.

The results show that there is a positive correlation between the motor variables and the cognitive variable in both boys and girls. However, there are differences between the genders.

Table 3 shows the results for boys. Between the motor factors and the cognitive variable there is a statistically significant correlation (RO = .46) at the level of p = .00, which means that 21 % of the common variance is explained. The value of the coefficient RO is not high. As far as particular motor factors are regarded, the highest correlation coefficient with cognitive variable is attained by coordinated movement in time and space limitations, followed by the speed of simple movements, balance, the solving of complex motor tasks and agility. The remaining factors have very low values of the correlation coefficients.

The results for girls are shown in Table 4. The same as above, there is a statistically significant correlation between the motor factors and the cognitive variable (RO = .40) at the level of p = .00, which means that there is 16 % of the common variance. The same as above, the value of the coefficient RO is not high. Among the individual motor factors, the

Table 4: Results - girls

RO = .407 p = .00

FACTOR	r
FAC 1	.398
FAC 2	.154
FAC 3	.246
FAC 4	.576
FAC 5	.331
FAC 6	.315
FAC 7	.242
FAC 8	.211

RO = coefficient of multiple correlation;
p = level of statistical significance of RO;
r = correlation coefficient between a motor factor and the cognitive variable

highest correlation coefficient is attained by *the speed of movement*, followed by the *explosive power, eye-hand coordination, agility, coordinated movement of the entire body* and *coordinated hand movement.* The factor of balance has a very low value of the correlation coefficient.

Discussion

We can say that the obtained results are partly consistent with the expectations and with some results of the previous studies. The results show that the coefficient of the multiple correlation attains relatively low values, with the value of the coefficient for the boys being a little higher than that for the girls. In both genders, the motor factors that show the strongest connection with the cognitive variable are those which have the characteristics of coordinated movement and the speed of movement. In addition to these, in boys it was also the factor of balance that had significant correlations with the cognitive variable, while in girls this was the factor of explosive power.

On the basis of the obtained results we can explain the connection between motor abilities and cognitive abilities by the influence of different factors. These factors are mostly relevant for both genders, although there are certain differences in the structures of latent motor dimensions, as well as in the relations with cognitive ability. The results show that with regard to these relations the motor dimensions of coordinated movement are a little, yet not substantially, more important for boys, while for girls the same goes for the speed of movement.

The connection between coordinated movement and cognitive abilities has been established in pre-school children by several researchers (Leithwood, 1971; Eggert and Schuck 1978; Dickes, 1978; Zimmer, 1981; Planinšec, 1995). Latent motor dimensions which have the characteristics of coordinated movement are characteristically under the prevailing influence of the informational component of movement. Such movement is mainly regulated by the mechanisms of the central nervous system on the cortical level, which are responsible for the coordinated functioning of different areas of the motor cortex and other areas of the cortex, as well as the mechanisms which coordinate the functioning of the cortical and subcortical areas. With regard to the motor variables which have the prevailing characteristics of coordinated movement, i.e. t*he coordinated movement of the entire body, coordinated hand movement, coordinated movement in time and space limitations, the solving of complex motor tasks, eye-hand coordination* and *agility*, the connection is dependent mostly on the cognitive processes on the following:

- the recognition and the formation of a suitable strategy for the solving of motor problem situations, in particular when solving these problems involves a high informational complexity and a quick processing of information in solving these problems are important;

- the efficiency of motor learning, which is particularly relevant to the initial phase of motor learning, called by some authors (Schmidt, 1991) the cognitive phase, because of the importance of the cognitive processes to this phase. Here it should be noted that all the motor tests involved 3 repetitions, so we can expect that the efficiency of motor learning enables a quicker implementation of each of the subsequent repetitions. This is confirmed also by Adams (1981), who says that the cognitive factors are important particularly in the initial trials of the implementation of an unknown motor task, but later becomes less and less important;

- the analysis and the use of feedback information, in which an important role is played not only by the speed of information flow, but also by the efficient processing and sensible use of information in further movement;

- the integration of information from different sources in making an efficient motor response, since the integrative function of the brain enables efficient processing of information and thus ensures the planning of a suitable motor program representing a basis for the efficient implementation of a movement;

- the adjustment of precise hand movement to a visual analyser, in which the most important role is played by the simultaneous activity of the perceptual processor and hand movement;

- the efficient use of motor information from long-term memory in different new circumstances, since we know that the efficiency of the use of information from the long-term memory is highly important in the cognitive processing of information, particularly when it involves its use in unknown and new circumstances, including also the quality and the quantity of information from the long-term memory.

The connection between the motor dimensions of the speed of movement and cognitive abilities based on a sample of pre-school children has so far been established by Planinšec (1995). Some researches have reached similar conclusions on adult samples, e.g. Mejovšek (1977) and Kovač (1999). The speed of movement is obviously dependent on many different neurophysiological factors, among others also the speed of the conduction of impulses on nerve paths. The connection between the cognitive variable and the variables of the speed of simple movements, which are simple from the informational point of view, can be explained by the general speed of the transfer of impulses in the central and peripheral nervous system. This enables a quick communication between the different areas of the central nervous system, which is very important for the efficient information processing, representing the basis of cognitive processes. A quick communication system is the basis for the efficient functioning of the central nervous system, and it is also important for the connection with the peripheral areas. Our assumptions are somehow confirmed by the findings of Vernon and Mori (1992), who have established that there is a significant positive correlation between the measure of intelligence and the measure of the speed of impulse conduction in the peripheral nervous system. They have explained this correlation by the fact that the speed of information processing is dependent on the speed of impulse conduction in the nervous system. Likewise the level of intelligence is dependent on the speed of information processing. The level of intelligence and the speed of informational processes are thus connected with the speed of the conduction of impulses on nerve paths.

It is somewhat surprising that there is a connection between the factor of explosive power and cognitive variable in girls, which is probably due to the influence of different factors. The latent dimension of explosive power includes the following tests: standing long jump, standing triple jump and vertical jump. These are obviously tasks that require, among other things, motor action with a complex structure, in which leg movement is dominant. Children at this age are not used to carrying out such demanding and complex leg movements in real life situations, so they probably do not have this kind of specific experience and such movements present a kind of problem situation to them. It should be noted that similar results were obtained by Madić (1986) on a sample of children aged 6. He has established that the connection of this kind is due to the ontogenetic development. Motor programs for the legs are not formed later than those for the arms, which is why carrying out the motor tasks in which leg movement is predominant requires regulation on the cortical level. In spite of the fact that the factor of explosive power is mostly under the influence of energy factors, at the age of 5.5 the cognitive activities are probably important as well. Furthermore, in girls, the factor of explosive power has important correlations with the factor of the coordinated movement of the entire body and the factor of the speed of simple movements, which have important connections with cognitive abilities. In boys, the connection of the cognitive variable with the factor of explosive power is not statistically significant. This is probably due to the fact that in boys the factor of explosive power is under a much greater influence of energy factors and the cognitive ability does not play an important role.

It is also a little surprising that there is a connection between the factor of balance and cognitive variables in boys. Some researchers have already established the finding, but on a sample of older subjects (Ismail, Kane and Kirkendall, 1976; Kovač, 1999). As we know, balance is mostly under the influence of subcortical regulatory mechanisms, i.e. it is regulated automatically, so it is after all a little unusual that it should have a positive correlation with the cognitive variable. Perhaps at this age the influence of the mechanisms of the cortical regulation of movement is still needed for balance. In addition to this, the keeping of balance requires perceptual speed and the speed of the functioning of the afferent-efferent system, the efficiency of which is to a great extent dependent on the speed of the information flow in the nervous system and is perhaps one of the factors which has an important role in the connection with the cognitive variable. In spite of the fact that balance is mostly automatically regulated, at the age of 5.5 the cognitive activity is evidently still present.

Conclusion

Despite some differences between girls and boys, we have established that they still have a lot in common, since the most important latent motor dimensions prevailing in the connection between motor and cognitive variables are similar. The value of the coefficient of the multiple correlation for boys is a little higher than that for girls. The same has been established for older children by Strel and Žagar (1993), but the difference is not big. We can say that there is no essential difference between the genders in the relations between the motor dimensions and cognitive abilities. In children at this age we cannot really determine any specificity, although it is certainly present at an older age.

The results differ to some extent from the results obtained in similar studies with adult samples, since they are also affected by some facts involving mainly the development of certain functional structures of the central nervous system. In the ontogenetic development the most developed areas of the central nervous system are the last to reach maturity. They are not completely formed until the period between the ages of 7 and 12 (Lurija, 1983), and they are responsible for the most demanding forms of mental activity.

The results obtained from the sample of girls and boys aged 5.5 confirmed the anticipation that there exists a positive correlation between the motor dimensions and cognitive ability. The low value of the coefficients showing the correlation between the motor factors and the cognitive variable was somewhat surprising. This is in part contrary to previous assumptions that the connection between motor and cognitive abilities is relatively high in the pre-school period, but later decreases gradually. During development individual human psychosomatic dimensions, and probably also the relations between them, change, therefore further research on samples of different ages is needed in order to establish how the relations between motor and cognitive abilities change with age and what the differences are between the genders.

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