Effects of schooling on level of cognitive functioning and analogical reasoning modifiability

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Abstract

Examination of cognitive development of children has centered on performance testing. Less attention has been paid to learning potential measurements. In this paper we will present two studies focusing on relationship between chronological age, schooling and analogical reasoning.The aim of Study 1 was the delimitation of the effect of a year of schooling on the increase of analogical reasoning operation level from the effects of chronological age. In the specialty literature written on this topic there are contradictory data regarding schooling effects on performance in tests that measure the psychometric g. The aim of study 2 was to check the role of schooling, level of schooling and chronological age in determining the modifiability of analogical reasoning. The results show a major effect of schooling on metacognitive planning and a medium effect on analogical reasoning operational and functional level.

Keywords

Analogical reasoning, schooling, modifiability, metacognitive strategies, children 7-11 year

In the research of the relationship between the brain's biological maturity and learning there is a major dilemma regarding the role these factors play in cognitive development (Piaget, 1947/2001, Vygotsky, 1978). According to Piaget (1947/2001) the cognitive development of cognitive processes is the result of biological maturization. In Vygotsky's point of view cognitive development is primarily determined by social interactions. Feuerstein represents a third force in this debate with his cognitive modiafiability theory. He was involved in the psychological assessment of immigrant children in Israel and found that children from different cultures perform very low on classic psychomet-

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ric tests. Influenced by Piaget and Vygotsky's work Feuerstein reformulated the traditional view of intelligence and began to develop a more dynamic approach to evaluating children's cognitive functioning. The central concept of Feuerstein's theory is structural cognitive modifiability (Feuerstein, 1979, 1980) which "describes the unique propensity of human beings to change or modify the structure of their cognitive functioning to adapt to changing demands of life situations"(Feuerstein, Feuerstein snd Falik, 2008, p. 2).

This determination transposed into the topic of research of reasoning and analogical transfer can be formulated as follows: they are developed according to the age of children or are related to formal education, i.e. to participation in an act of formal education. A second question refers to the modifiability of functioning level of analogical reasoning after a "mini period of schooling" according to Feuerstein's Structural Cognitive Modifiability theory.

Comparative studies of schooled and unschooled children show major differences between the two groups as far as their cognitive performance shown in the solution of tasks of analogical reasoning is concerned. The mechanisms which explain these differences are different and often of qualitative nature (Tulviste, 1991, Vygotskij, 1971, 1972).

A number of researches (Ceci, 1991; Winship and Korenman, 1997; Hansen, Heckman and Mullen, 2003) demonstrate that performance of children in psychometric tests show a linear increase with the levels of schooling. This linear correlation does not answer the question whether the age or the effect of schooling result in an increase of performance on the tests of intelligence, as the age of children also increases linearly with the level of schooling.

For the purpose of delimiting age effects from schooling effects, Cahan and Cohen (1989) have separated the two variables and demonstrated that schooling has an effect almost double as compared to age. This result has subsequently been confirmed by other studies (Crone, Whitehurst, 1999; Stelzl, Merz, Ehlers, Remer, 1995).

Several studies assess the actual consequences of schooling, by comparing the effects of chronological age and educational level. Brouwers, Mishra and Van der Vijver (2006) show that the operational level of intelligence in children increases by the acquisition of operations (e.g. grouping, conservation, etc.), by manipulating objects and symbols. The difference between schooled and unschooled children can also be explained by the general operational level, i.e. the psychometric g. (Case, Demetriou, Platsidou, Kazi, 2001).

Knowledge acquired in school results in a qualitative leap in the operational level of children (Vygotsky, 1971, 1972); although daily experiences contribute to the accumulation of cognitive operations, they cannot compensate for the effects of schooling. Schooling helps children develop skills in applying cognitive operations via the learning of some strategies and the use of certain cognitive tools which amplify transfer performance.

The role of formal education in the development of problem solving strategies has formerly been demonstrated (e.g., Posner, 1982) but their limits of applicability are not well outlined. Schooling creates its own domain of strategic knowledge (Lave, 1997), but this knowledge has an applicability limit. For example, Liberian adults, who have attended school, performed more weakly in navigation tasks based on numeric abilities than unschooled Liberians, which means that school develops strategies which do not induce transfer to tasks belonging to different fields.

Herrnstein and Murray (1994) after reviewing the literature showed that the differences between schooled and unschooled children cannot be explained exclusively by variations in intellectual factors. They suggests that IQ level increases with one point in each school year. An increase in the level of intelligence has been demonstrated by other studies as well. Winship and Korenman (1997) have reviewed these data and have obtained an effect estimated at 2.7 point IQ for each year of schooling. In conclusion, all studies in this domain indicate an increase between 1 and 4 IQ points/ school year.

In more recent studies effects of chronological age, educational level and socio-economic status on performance shown in formal tests or tests that contain items derived from real life situations are calculated both separately and in interaction (Christian et al., 2001; Sternberg et al., 1993). Brouwers, Mishra, Van de Vijver (2006) have assessed the role of these factors in a series of experiments with children from India.

They examined schooled and unschooled children with ages ranging between 6 and 9 years, using formal tests as well as tests containing items related to everyday tasks. No significant differences have been demonstrated between schooled and unschooled children in the administred tests. Their conclusion is that the level of education is not more predicitive than chronological age concerning individual differences.

Children have had significantly better results in tests containing real life situations than in formal tests and discrepancy between schooled and unschooled children has been significantly smaller in situational tests than in

formal tests. Further on, they have demonstrated a significant and powerful relationship between chronological age and the g factor, but the level of schooling does not correlate with psychometric *g*. The combining of effects of factor g, of schooling level and socio-economic status had a predictive value of 81% in the variance of crystallised intelligence.

With the use of covariance analysis, the authors have demonstrated a significant effect of chronological age on test results, rather than on Raven analogical reasoning test. Calculating the size of effect for each variable they reached the conclusion that chronological age had an effect almost double as compared to the effect of educational age.

Contradictory results have been obtained by Cliffordson and Gustafsson (2008). By using the method of regression analysis to delimit the schooling effect from chronological age effects on intellectual performance, they have examined a large number of participants with tests which affect Fluid Intelligence (GF), Crystallized Intelligence (GC) and General Visualization (GV). The results have highlighted a lesser effect of chronological age in comparison with that of educational level. These results are in accordance with the results of Winship and Korenman (1997) and demonstrate that both chronological age and the level of education increase intellectual performance, with the exception of tests that measure fluid intelligence (GF) for which the age has an inverse effect.

Other studies (e.g. Helms-Lorentz, van de Vijver, Poortinga, 2003, Van de Vijer, Brouwers, 2009) have examined the relationship between chronological age, educational age and schooling, and their effect on the processing speed of information. Performances have been measured by using a computerized test batteries and the Raven test. Chronological age and educational age represented a significant predictive value for all the tests. Thus, the two indicators of age have shown the same relation with cognitive tests but interaction between them did not result in a significant correlation. The conclusion that can be drawn based on these results is that schooling does not have a stronger impact on solving speed and results than natural environment. This can be explained by the nature of tests that use a "culture-free" content, i.e. independent of culture. These results being inconsistent with most previous research, the authors are trying to explain such discrepancies by the quality of education in the region participants originate from.

Returning to the questions at the beginning of the study, we formulated the following objectives. The aim was the delimitation of the effect of a year

of schooling on the increase of analogical reasoning operation level from the effects of chronological age. In the literature written on this topic there are contradictory data regarding schooling effects on performance in tests that measure the psychometric *g*.

If performance in culture-free analogies tests does not increase linearly with educational age, it means that schooling has a more metacognitive rather than cognitive effect, more precisely children learn strategies for planning, approach and relationing of problems.

Study I

Hypothesis

Schooling (the integration in a system of formal education) has a greater effect on the efficiency of analogical problem solving than the level of education.

Participants

In order to avoid methodological mistakes we have used severe selection criteria in the selection of participants: all participants to originate from the same country, to be of the same age, presence of children who do not attend school at all, inclusion of children with regular as well as occasional attendance. Testing took place in May so as to avoid decrease in performance due to the long holidays.

A population of 70 children aged between 7-11 years (M=8.32, sd=2.59) participated in the study). The children were divided into 3 groups on the basis of their schooling experience: 6 unschooled children, 30 children schooled on occasional basis and 34 children schooled on regular basis. Groups were balanced according to the criteria of age and sex. (Table 1).

Group of unschooled children. It contained a number of 6 children, who live in the suburbs of Cluj known as Pata RÂt. These children live near the garbage dump of Cluj in very difficult conditions. Some of them are enrolled in schools but do not attend classes. Some of the children did not know their last name or their age. Data regarding their age have been obtained from

their parents. In some cases not even the parents could give a precise answer to this question.

Group of participants schooled occasionally Children in this group are helped by the Caritas Foundation in Cluj; although they are engaged in formal education they do not regularly attend school.

Group of participants schooled regularly. They come from primary schools in Cluj-Napoca. Their socio-economic status is very varied.

Table 1.
Demographic data of participants *

	Age				
Schooling	*7-8*	*8-9*	*9-10*	*10-11*	Total
Unschooled	2	2	2	----------	6
	(1, 1)	(0, 2)	(1, 1)		(2, 4)
Occasional	8	7	7	8	30
schooling	(3, 5)	(3, 4)	(3, 4)	(3, 5)	(12, 18)
Regular	10	8	8	8	34
schooling	(6, 4)	(5, 3)	(4, 4)	(4, 4)	(19, 15)
Total	22	17	18	16	70
	(10, 10)	(8, 9)	(8, 9)	(7, 9)	(33, 37)

* Number of boys and girls appears in parenthesis

Instruments

In this study we used the Matrix Analogy Test (MAT) by J. A. Naglieri

The test is used to assess nonverbal intelligence and inferential reasoning in pupils aged between 5 and 17 years. Test items are grouped according to four factors which build up nonverbal intelligence: Completion of Patterns, Analogical Reasoning, Serial Reasoning and Spatial Visualization.

Procedure

The test has been administered individually and lasted approximately 30-50 minutes for each participant. Assesments have taken place during the month of May, 2013. Tests have been administered by 3 experienced assessors.

Results

Results are presented in two stages. In the first stage we present descriptive statistics; in the second stage, the results concerning differences between groups and the effect of chronological age, educational age and that of schooling on the results obtained by the participants in MAT subtests. (Table 2.).

Table 2.
Descriptive statistics of participants

Variable	N	Min.	Max.	M	SD
Pattern Completion	70	,00	16,00	10,00	4,94
Analogical Reasoning	70	,00	15,00	7,25	4,63
Serial Reasoning	70	,00	16,00	8,37	5,45
Spatial Visualization	70	,00	14,00	3,85	4,02

From results shown in Table 2, it is apparent that there were participants who have resolved none of the items of the MAT test and there are children who have solved all the items. For a result in greater detail see Table 3.

Table 3.
Averages and standard deviations of the 3 groups

	Schooling	N	M	SD
Pattern Completion	1	6	2,50	2,42
	2	30	7,40	4,15
	3	34	13,61	2,26
Analogical Reasoning	1	6	2,00	2,28
	2	30	4,73	3,93
	3	34	10,41	3,06
Serial Reasoning	1	6	,50	,836
	2	30	6,16	4,79
	3	34	11,70	3,84
Spatial Visualization	1	6	1,50	1,64
	2	30	1,60	2,19
	3	34	6,26	4,19

1 = Unschooled; 2 = Ocasionally schooled; 3 = Regularly schooled

In every subtest schooled children obtained the best results, followed by children with occasional schooling while the poorest results were obtained by unschooled children.

In order to delimit the effect of each variable taken into account (schooling, chronological age, educational age), in a second stage of data processing the multiple regression method was used (Table 4). Chronological age, educational age, and schooling explain 66.7 % of result variancy on the Pattern Completion subtest, 47.2 % of result variancy on the Serial Reasoning subtest, 46.1 % for the Analogical Reasoning subtest and only 26.8 % for the Spatial Visualization subtest.

Table 4.
Effects of schooling, chronological age and educational level on MAT performance

Subtests	Factors	*B*	p
Pattern completion			
	Schooling	0,712	,000
	Level of schooling	0,175	,155
	Age	0,174	,129
Analogical reasoning			
	Schooling	0,585	0,000
	Level of schooling	0,216	0,169
	Age	-0,025	0,086
Serial reasoning			
	Schooling	0,536	0,000
	Level of schooling	0,305	0,051
	Age	-0,054	0,706
Spatial visualization			
	Schooling	0,602	0,000
	Level of schooling	-0,159	0,384
	Age	0,047	0,779

Schooling variable (Table 4.) has a significant effect on the results of analogical reasoning subtests. There are no significant effects of age and schooling level on the results of the 4 subtests.

To highlight the effects of schooling level on test performance a multivariate ANOVA analysis was conducted. We found significant differences between groups delimited by the level of schooling (CP, $F(3, 66)=17.32$, $p=0.000$, RA $F(3, 66)=8.82$, $p=0.000$, RS $F(3, 66)=13.32$, $p=0.000$, VS $F(3, 66)=3,43$, $p=0.022$).

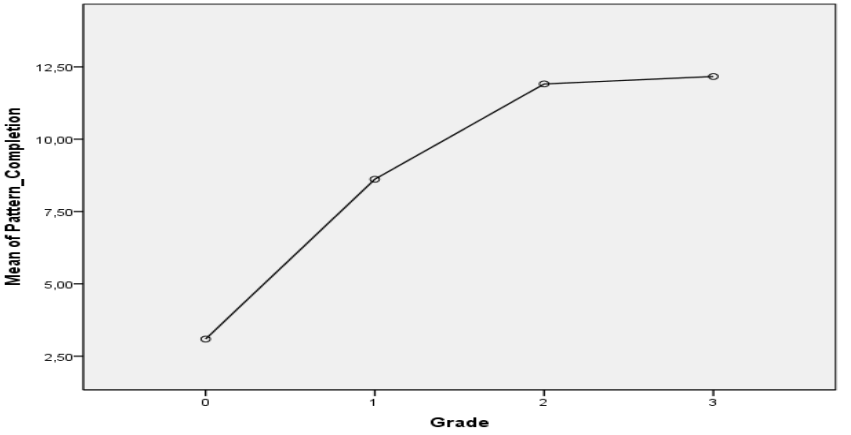

Figure 1. The effect of schooling level variable in the Pattern Completion subtest

In CP and RA subtests children's performance increases linearly with the level of schooling (Figure 1 and 2). In pattern completion one may notice a considerable increase in performance of unschooled children up to second grade. There is no indication of such a significant increase between second graders and third graders.

In the analogical reasoning subtest the greatest difference can be found between unschooled children and first graders. After this leap, no significant developments were recorded in relation to educational level.

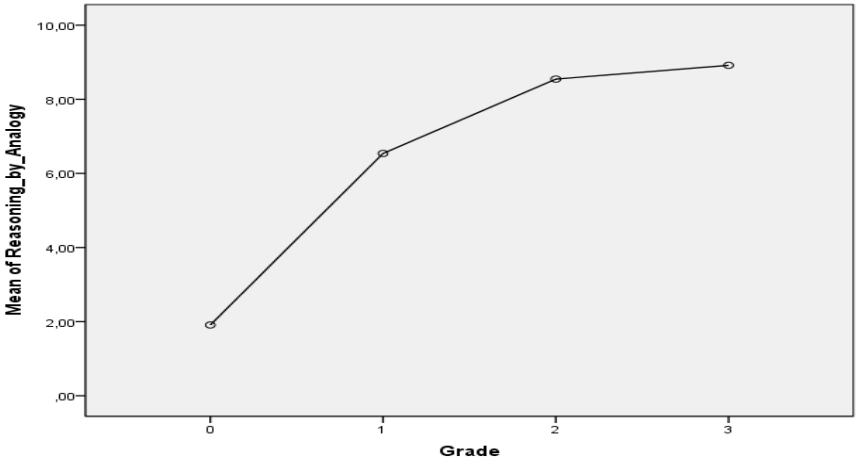

Figure 2. The effect of education level variable on Analogical reasoning subtest

In the Serial Reasoning subtest there is a tendency of performance increase in unschooled children up to second grade, but between second and third grades a tendency of decrease is to be noticed (Figure 3).

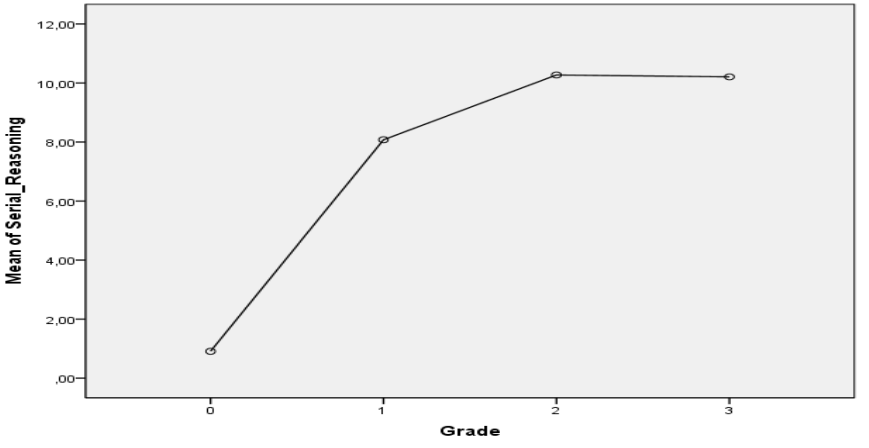

Figure 3. The effect of education level variable at the Serial Reasoning subtest

In the Spatial Visualization subtest an even more pronounced decrease is observed, third graders had a significantly poorer performance than participants from the second grade. (Figure 4).

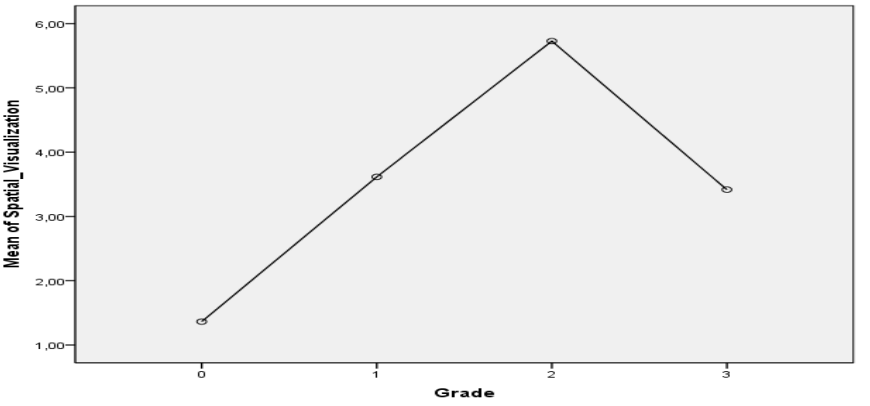

Figure 4. The effect of schooling level variable in the Spatial Visualization subtest

Discussions

This study tried to delimit the influence of schooling and schooling level on performance in tasks based on analogical reasoning. By identifying these factors, the aim was to clarify the role of schooling in analogical reasoning performance and by this, to elucidate the role that metacognitive components play in solving analogies.

In previous studies (Helms-Lorenz, van de Vijver, Poortinga, 2003, van de Vijver, Willemse, 1991) only a minimal influence of schooling on cognitive performance measured with psychometric tests has been demonstrated. According to our results, the fact that a child attends school regularly, occasionally or does not participate at all in formal education creates significant differences on the level of analogical reasoning. Schooling effect is more powerful than the effect of age or level of schooling. The results are in accordance with the results obtained by Fuller and Clarke (1994) and Brouwers et al. (2006).

As expected, our findings confirm previous experimental data (Cahan, Cohen, 1989; Stelzl, Merz, Ehlers and Remer, 1995, Crone, Whitehurst, 1999) having a new methodological characteristic: the participants in the experiment come from the same locality and their age is balanced. Also, there have been found children aged 10-11, who have not yet participated in a formal system of education.

Starting from these findings, several conclusions can be drawn in what concerns the components of analogical reasoning. In the first place, the importance of metacognitive strategies involved in solving analogies may be emphasized. The learning of these strategies is linked to formal education and may not be compensated for by children's daily experiences.

School helps children in acquiring higher level thinking strategies, these acting on a metacognitive level - since the level of education did not have a significant effect. If there is a general level of efficiency linked to maturization of the cognitive system, then age should also have had a significant effect on solving tasks of analogy.

The obtained data show that children's performance in tests that contain tasks of analogy does not increase linearly with chronological age. In the case of certain tasks of analogy even a decrease of performance was noted. These results lead to the idea that cognitive maturization in itself does not guarantee good performance in recognizing and solving analogies, unless they are regulated by metacognitive factors. We do not want to deny the existence of analogical thinking in unschooled children, we have even noticed in the interactions before and after tests that they use analogies to explain certain events, but not as a systematic approach to the problems, a strategy constantly used by schooled chilren.

The combined effect of schooling, age and level of schooling on different types of problems proved to be different. In the case of easier tasks based on analogical reasoning, like pattern completion, schooling proved to have had the largest influence. In tasks based on serial thinking and spatial visualization we found the smallest influence. The ability to discover the order in which items appear in a matrix and the ability to imagine what a figure will look like when two or more components are combined is more accessible to children with a low level of education, i.e. children from first or second grade.

In accordance with Ceci (1991) and Christian et al. (2001) schooled children do better in tests of basic intelligence and it could seem to us that those with lack of schooling are less intelligent. These differences, however, are not

based on a different functional level but on the lack of metacognitive strategic knowledge.

Results presented here have several limits. The greatest shortcoming is the very small number of unschooled children. Unfortunately from the viewpoint of scientific results, but fortunately for the Cluj Napoca society, it is very difficult to find children who totally lack schooling. Another limitation of the research is the inadequate conditions in which the tests were given.

For a more accurate delimitation of the influence of schooling, age and educational level we conducted another experiment.

Study II

The findings of Study I made it necessary to check the role of the variables level of schooling, schooling and chronological age in determining reasoning modifiability. The test used in this study is much more practical and in this way, resembles the tests with integrated content in everyday tasks (Brovers, Mishra and van de Vijer, 2006). Previous studies failed to show significant differences between schooled and unschooled children in these conditions. The Children Analogical Thinking Modifiability Test (CATM) has several advantages over other analogical tests: first, it allows the manipulation of objects, and as such, may be included in the category of the paradigm "learning by doing". Another advantage of the test is given by the structure of the item: it allows the measuring of current operation level of analogical reasoning as well as the measuring of the size of analogical transfer made between the learning and the post-test phase.

Returning to the initial question about the modifiability of functioning level of analogical reasoning after a “mini period of schooling” according to Feuerstein’s Structural Cognitive Modifiability theory we administrated the Children Analogical Modifiability test for a more accurate radiography of metacognitive strategies involved in solving analogies.

Hypothesis

As far as tests aimed at solving analogies are concerned, after a period of training/learning schooling effect does not occur on a significantly high level as in the case of formal tasks, but it is a positive predictor of the transfer coefficient.

Participants

Table 5.
*Number of participants/age and schooling**

Schooling	*7*	*8*	Total
Unschooled	4	8	12
	(1,3)	(4, 4)	(5,7)
Regularly schooled	10	13	23
	(6, 4)	(7,6)	(13, 10)
Total	14	21	35
	(7, 7)	(11, 10)	(18, 17)

* Number of boys and girls appears in parenthesis

Instruments

We used the Children`s Analogical Thinking Modifiability Test elaborated by D. Tzuriel and P. Klein (1985).

The primary objective of the Analogical Reasoning Modifiability test is to assess the ability of training and using of abstract concepts and cognitive processes which operate on the abstract relations between them within the framework of analogical reasoning and transfer. The test contains three sets of logically isomorphic non-verbal analogies. Each set contains 14 analogies applied during three stages: pre-learning, formative learning and post-learning stages.

Pre-learning phase has several objectives. The main objective is the assessment of participants' basic level of cognitive functioning by examining their ability to recognize, elaborate and use non-verbal analogies. Pre-

learning stage also aims at familiarizing participants with elements of tasks included in the terms of analogies (shape, colour, size), as well as practising modalities of correct answer elaboration within the first tasks.

Procedure

The 3 series of analog isomorphic problems have been individually administered. Administering pretest lasted for approximately 15 minutes for each participant. Learning phase took much longer in unschooled children (approximately 1 hour and 20 minutes), schooled children assimilated solving strategies in 15-20 minutes. The posttest took place immediately after the learning phase and lasted on average (regardless of group) 10-20 minutes. Having to take into account the criteria imposed by us, testing took place during May and June (so as not to be applied after a long holiday).

Three experienced pscychologists collected data, each of them having a more than three-year experience in administering formative tasks.

Results

In the first phase, we calculated averages and standard deviations for each group and each test phase (pre- and posttest). (Table 6).

Table 6.
Averages and standard deviations obtained by the two experimental groups in the CATM test

	Pretest								Posttest							
	Schooled				Unschooled				Schooled				Unschooled			
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max
Rez. CATM	9.7	3	4	13	5.6	1.8	3	9	13	0.8	11	14	7.8	3.3	3	14

We also calculated the transfer coefficient using the formula: xmax-xpost/xpost-xpre where xmax means maximum achievable points in the test (14 points in this case), while xpre and xpost scores obtained by participant in the pretest and posttest phase.

Table 7.
Averages and standard deviations of transfer coefficient

	Transfer Coefficient			
	Schooled (N=12)		Unschooled (N=23)	
	M	SD	M	SD
CATM	0.31	0.30	0.68	0.29

In order to test the hypotheses we used the multiple regression method in which we introduced age, level of schooling and schooling as independent variables, and performance in pre- and posttest and transfer coefficient as dependent variables. (Table 7)

Table 8.
Regression analysis

Variable	Pretest			Posttest			Transfer		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Schooling	2.31	1.88	1.12	5.76	1.50	0.87*	0.73	0.21	1.01**
Level of schooling	0.96	1.18	0.24	-0.50	0.94	-0.13	-0.25	0.13	-0.59
Age	1.43	0.89	0.24	0.55	0.71	0.09	0.03	0.10	0.06
Schooling x Level of Schooling x age									
R^2			0.45			.62			.34
F			8.78**			17.26**			5.41**

*p < .05. **p < .01.

In the pretest phase the minimum score obtained by participants from the unschooled group was 3 points and 4 points in the experimental group of "schooled" children. In the group of unschooled children no participant obtained maximum score in the pretest stage. Participants from the "schooled" group who obtained maximum score in the pretest phase were excluded from the experiment because they do not show progress after the learning phase.

With respect to the coefficient of transfer only one child out of those unschooled obtained 0 points, i.e. score did not increase in posttest phase as compared to the prettest. In the group of schooled children 3 children had transfer coefficient 0.

After processing the data, interesting results were obtained. Variation in the current operation level of analogical reasoning (pretest), measured with practical tests is explained in 45% by the cumulative effect of schooling, level

of schooling and age. We found that the influence of variables included in the experiment was the greatest in the posttest phase (after the learning phase). At this stage of analogies solving, 62% of result variancy can be explained by the factors of schooling, level of education and age. The transfer coefficient is influenced in 34% by the cumulative effects of schooling, level of schooling and age.

The highest scores in both pretest and post-test phase were obtained by schooled children ($F(2, 32) = 8.78$, $p<0,001$ pretest phase, respectively $F(2, 32) = 17.26$, $p<0,001$ in post-test phase). The transfer coefficient of schooled children was significantly higher than that of unschooled children ($F(2, 32) = 5.41$, $p<0,001$.

After calculating the influence of each predictive factor it was noted that only schooling had a significant effect on post-test performance and on transfer coefficient (Table 8)

In the next stage differences between schooled and unschooled children's results in pretest and post-test were tested by using the method of variance analysis in repeated measurements. The main effect of test phase is significant, Wilk's Lambda=0.45, $F(1, 34) = 39.79$, $p=0,000$. Interaction between test phase (pretest and posttest) and schooling variable was not significant Wilk's Lambda=0.95, $F(1, 34) = 1.51$, $p=0,227$. Schooling had a significant effect ($F(1, 34) = 41,60$, $p=0,000$ on pre- and post-test performance.

Following this, the difference between unschooled children's averages obtained in pre- and posttest ($t=4.73$, $p=0,001$) were calculated.

Discussions

The purpose of the study was a more accurate radiography of the metacognitive component which is an important mechanism of both analogical reasoning and analogical transfer. The CATM test was used which has several advantages over formal tests. First of all, test items are not presented to children, they can only be rebuilt by figuring out and by objects that can be easily manipulated by participants. Secondly, the test also includes a learning phase which can be regarded as an educational activity in which strategies of metacognitive approach, planning and self-monitoring are offered.

According to the findings, neither age, nor schooling and nor the level of schooling had a significant effect on solving analogies (pretest phase) meas-

ured by formative tests. This means that differences between children are not based on these factors but are determined by variables not included in our research (e.g. level of intelligence, the *g* factor, etc.) This record is an argument for inter-cultural studies in which the effect of test content on performance has been demonstrated. Taking into account children's culture, major differences in results have been reduced (Berry et al. , 2002, Irvine, 1979, van de Vijer, 2002). Manipulation of objects, which is equivalent to both schooled and unschooled children's daily experiences (Piaget, 1947/2001) is the engine of cognitive operation development and in this way these are not affected by chronological age, schooling and level of schooling as Vygotskij (1971, 1972) suggested.

The findings highlight the role of schooling which has a significant influence on transfer coefficient and posttest results. Schooled children had better results in each testing stage (pre- and posttest) than unschooled children but only the after learning phase results were influenced by schooling. These results lead us to believe, that the learning phase managed to create a "mini period" of schooling but this only takes effect if it cumulates with regular attendance of a formal educational system. Direct comparison of analogical skills emphasized the role of schooling which has substantial impact on the results of the posttest. Schooled children took more advantage from induction of metacognitive strategies. Thus, the results obtained are in accordance with Posner's (1982) findings: schooling induces the use of strategies without affecting the operational level of children.

According to Feuerstein (1979, 2008) after a short period of mediation we found changes in efficiency of analogical reasoning functionality depending of complexity of tasks. Despite the fact that no statistically significant differences were found between pre-test and post-test results of unschooled children a change in their problem approach and higher-order intellectual acts can be observed.

This result was also confirmed by comparing transfer coefficient in experimental groups. It was proved that even relatively short periods of schooling have a big impact on children's cognitive functioning (Fuller and Clarke, 1994). School broadens the field of applicability of thinking but does not create new operational processes (Brouwers et al., 2006). School's role is, therefore, not to create new intellectual structures, and it has to centre on ensuring success in transferring the knowledge children have acquired (Cole and

Bruner, 1971). Such knowledge transfers can be achieved by using metacognitive strategies such as approach, planning and self-monitoring.

Conclusions

The benefficial effect of schooling appears in the manner in which children can transfer knowledge. Analogical transfer (recognition of similarity, mapping and application of knowledge in new situations) is influenced by the metacognitive strategies learned in schools.

Chronological age and educational level do not have a significant impact on the operational level of analogical reasoning and transfer. Even a short-term schooling will result in development of metacognitive strategies which increase the operational level of analogical reasoning (Castillo, 1998). Important components of analogical reasoning and transfer are those metacognitive strategies which are taught in schools and help both in solving analogical tasks and in knowledge transfer.

Limitations of the study

A real limit of the study is the very small number of unschooled children. In study 1 we managed to include only 6 unschooled children and 12 in study 2. Due to the lack of unschooled subjects we limited the number of participants from the group of occasionally and regularly schooled children as well.

Another limitation of the study was the inadequate testing conditions encountered in the group of unschooled children mentioned above.

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