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Cognitive Predictors of Success in Learning Russian Among Native Speakers of High School Age in Different Educational Systems

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Background. The search for cognitive predictors of success in language learning is associated both with basic cognitive characteristics (processing speed and spatial working memory) and with general characteristics (intelligence). However, the ratio between cognitive functioning and success in language learning can change during the period of school education and depends on the socioeconomic level of the society and the effectiveness of the national educational system.

Objective. To analyze the cognitive predictors of Russian language learning samples of Russian-speaking 11th graders from Russia, Kyrgyzstan, and Moldova, three countries with a similar organization of the educational system, but differing in the functional effectiveness of that educational system and in their socioeconomic levels.

Design. The sample comprised 545 Russian-speaking 11th graders (average age = 17.42 + 0.59; 36.1% male) studying Russian throughout their public-school education in Russia, Kyrgyzstan, and Moldova. The statistical methods of one-way analysis of variance, correlation, and multiple regression analysis were used.

Results. Among the indicators of cognitive development we analyzed, the functioning of the national educational system is the one most associated with the development of fluid intelligence of 11th graders, which is directly proportional to the quality of education in the country; to a lesser extent, it is associated with the development of working memory. In Kyrgyzstan (average level of socioeconomic development) and Moldovian (low level of socioeconomical development), only fluid intelligence was associated with the score on the state exam on the Russian language. In Russia, which has a very high level of socioeconomic development, spatial working memory becomes important, along with fluid intelligence.

Conclusion. Differences in the relationship between cognitive functioning and success in Russian-language learning are associated both with the objectives of the state exam (identification of pupils ready to attend university versus testing of what was learned in school), and, in conditions of low educational effectiveness, with a greater cognitive load during the exam.

Keywords: processing speed; spatial working memory; fluid intelligence; success in learning Russian; native speakers; state final examination; teacher's assessment

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Introduction

Modern studies of the cognitive mechanisms of academic achievement initially focused on achievements in mathematics, given its importance in modern technological society (e.g., Rodic et al., 2015; Taub, Keith, Floyd, & McGrew, 2008; Tikhomirova & Malykh, 2017). These studies demonstrated that cross-cultural differences in the relationship between indicators of cognitive development and mathematical achievement are also associated with the students' particular native language (Rodic et al., 2015). However, much less research has been devoted to the analysis of success in native language learning; moreover, these studies were mainly related to the English language, with samples of schoolchildren from English-speaking countries (e.g., Alloway & Alloway, 2010; Botting, 2005; Gathercole & Baddeley, 2014).

Studying the success of Russian language learning is limited by the linguistic context, since Russian is used as one of the main languages in an educational system only in a number of countries of the former USSR. There are only a handful of studies of the cognitive foundations of individual differences in the success of learning Russian (Verbitskaya, Malykh, & Tikhomirova, 2017; Verbitskaya, Malykh, Zinchenko, & Tikhomirova, 2017; Verbitskaya, Malykh, Zinchenko, & Tikhomirova, 2015). One of these studies evaluated samples of pupils who were educated in the Russian language throughout their schooling in Russia and Kyrgyzstan – two countries with similar educational systems but different socioeconomic levels (Verbitskaya et al., 2017).

In these national educational systems, a student's knowledge is assessed using the teachers' grades and standardized state exams. Analysis of academic success based on each of these indicators has its advantages and disadvantages. In particular, the teacher's assessment is subjective (even within the same school) and officially varies from 2 to 5, but in reality it varies from 3 to 5, which becomes a limitation in research when conducting statistical analysis of data. At the same time, it is the teacher's assessment that is the indicator of success in learning that can be used throughout the entire period of education – from primary school to high school. On the other hand, the results of state exams are standardized (for example, the Unified State Exam in Russia), but can only be used in studies involving respondents in the final year of their secondary education. According to available data, the relationship between the teacher's assessment of a student's Russian-language learning and the result of the national state exam can vary in cross-cultural terms more than 2.5-fold, and depends, inter alia, on the purpose and content of the national state exam (Verbitskaya, Malykh, Zinchenko, & Tikhomirova, 2017).

The search for cognitive predictors of success in language learning is associated with both basic cognitive characteristics (processing speed and spatial working memory) and general characteristics (fluid intelligence) (Tikhomirova & Malykh, 2017; Verbitskaya, Malykh, & Tikhomirova, 2017; Verbitskaya et al., 2015). In particular, intelligence is considered as one of the most significant predictors of individual language learning outcomes at various ages and in different sociocultural samples (e.g., Brouwers, Van de Vijver, & Van Hemert, 2009; Deary, Strand, Smith, & Fernandez, 2007; Taub et al., 2008; Verbitskaya, Malykh, Zinchenko,

& Tikhomirova, 2017; etc.). According to these studies, spatial working memory plays an important role in successful learning at school; however, it has been shown that this cognitive characteristic is associated with a variety of academic and language skills to various extents – from reading technique and vocabulary to grammar (e.g., Cain, Oakhill, & Bryant, 2004; Gathercole & Baddeley, 2014; Verbitskaya et al., 2015). Processing speed is the cognitive indicator for which direct correlations with success in native language learning are obtained, and their absence at certain school ages is being discussed (e.g., Sheppard & Vernon, 2008; Tikhomirova, Voronin, Misozhnikova, & Malykh, 2015; Verbitskaya, Malykh, & Tikhomirova, 2017). It is also reported that the predictive power of each of these cognitive indicators may vary throughout the educational process. Working memory, measured at the beginning of school, is a more powerful predictor of reading and writing skills during the next six years of schooling than is intelligence, for example (Alloway & Alloway, 2010).

A number of studies found that indicators of cognitive functioning, as well as the relationship of these indicators to success in learning, including language, may vary depending on the sociocultural environment (Tikhomirova & Malykh, 2017; Tucker-Drob & Bates, 2016). According to a meta-analysis involving more than 240,000 respondents from 45 countries, such cross-cultural differences are usually associated with the socioeconomic level of the countries ($r = 0.16$; $p < 0.001$) and the characteristics of the national educational systems ($r = 0.25$; $p < 0.001$) (Brouwers et al., 2009). It was also reported that given a higher socioeconomic level, there is more intensive development of cognitive functions, especially intelligence (von Stumm & Plomin, 2015).

Numerous studies have shown that the quality of national education is one of the most significant sociocultural factors leading to changes in the relationship between cognitive functioning and learning success (e.g., DeNavas-Walt & Proctor, 2014; Nisbett et al., 2012; Schneeweis, Skirbekk, & Winter-Ebmer, 2014). In particular, it has been shown that cognitive resources play a greater role in the success of school education in a less heterogeneous and more effective educational environment (Tikhomirova & Malykh, 2017; Tucker-Drob & Bates, 2016). A subject-based orientation of the national educational system towards, for example, mathematics, can affect the achievement of students in this discipline (Paik et al., 2011). Specifically, it was shown that various cognitive factors have different effects on the student's development, depending on the educational environment. And, according to a number of studies, fluid intelligence is considered the most "sensitive" to the quality of the national educational system (e.g., Nisbett et al., 2012; Tikhomirova & Malykh, 2017). These results can lead to cross-cultural cognitive predictors of success in learning Russian in native speakers of high school age in different educational systems.

The effective functioning of the national educational system is derived from various predictors related to both economic indicators (government spending on education; gross enrollment ratio of people older than 15 years of primary, secondary, and higher education; average duration of education in the population; satisfaction of the population with the quality of education; proportion of the population with secondary education or higher; proportion of primary school teachers with teacher training), and to educational achievements (reading literacy, math, science,

and computer literacy). These socioeconomic and educational indicators are taken into account when deriving the Human Development Index (HDI), yielding scores from which the categories (groups) of countries are formed.

In the present study, the analysis of cognitive predictors of success in learning Russian is was performed on samples of Russian-speaking 11th graders from Russia, Kyrgyzstan, and Moldova, three countries with a similar organization of the educational system, but differing in the functional effectiveness of that educational system and in their socioeconomic level.

According to the 2016 international rating of the United Nations Development Programme, based on the achievements of a country in three areas of development – health, education, and living conditions – Russia is included in the group with a very high level of human development (49th place), Moldova in the group of countries with a high level (112th place), and Kyrgyzstan in the group with a medium level (122th place). It should be emphasized that in Moldova the present study was conducted in schools in Tiraspol, in the unrecognized Transnistrian Moldavian Republic, characterized by a very low socioeconomic level and, as a consequence, low effectiveness of the national educational system.

Consideration of differences in the socioeconomic situation of these countries, including the effectiveness of the educational system, makes it possible to assess the impact of public education on the correlation ratio between the cognitive development of the students and their success in learning Russian as a native language.

Methods

Participants

The sample comprised 545 Russian-speaking students in 11th grade (average age = 17.42 + 0.59; 36.1% male) studying the Russian language for the duration of their public-school education in Russia, Kyrgyzstan, and Moldova.

The sample in Russia includes 231 students (average age 17.7 years, standard deviation 0.39; 41.6% male), the Kyrgyz sample consists of 165 students (average age 17.6 years, standard deviation 0.55; 33.3% male), and the Moldovan sample includes 149 students (average age 17.3 years, standard deviation 0.55; 30.9% male).

Public schools from Russia, Kyrgyzstan, and Moldova were selected for participation in the study according to the following criteria:

1. State status (departmental affiliation, number of teachers per student, etc.);
2. Qualifications and structure of the teaching staff (ratio of teachers with higher education to the total number of teachers, age group with the largest number of teachers, etc.);
3. Similar educational programs in the Russian language;
4. Quality of students' education (ratio of the average grade for the final state exam on the Russian language to the grade for the region).

Eleventh graders from one Russian school (Moscow Region), one Kyrgyz school (Bishkek), and two Moldovan schools (Tiraspol), equalized with respect to ranking position in the region, took part in the study.

Procedure

Assessment of Cognitive Development

For assessment of *processing speed,* the computerized "Choice Reaction Time" test was used (Tikhomirova & Malykh, 2017; Tosto et al., 2013). In this test, the numbers 1, 2, 3, 4 appear 40 times in random order at intervals of 1 to 3 seconds. Participants are asked to press the key corresponding to the number that appears on the screen as quickly and accurately as possible. The response time is limited to 8 seconds. The number of correct answers and the average value of the reaction time are recorded. Statistical analysis uses a measure of reaction time only for the correct answers.

For assessment of *spatial working memory,* the computerized "Corsi Block" test was used (Tikhomirova & Malykh, 2017; Tosto et al., 2013). The screen shows a sequence of "igniting" cubes one after another. The test begins with a sequence of four cubes; the maximum possible number of elements in the sequence is nine. During presentation, the cubes "ignite" for 1 second with an interval of 1 second. Participants are asked to reproduce the entire sequence of "igniting" the cubes by clicking on the desired cubes with a computer mouse. The task was automatically interrupted if the student incorrectly performed all the sequences of the same level. Statistical analysis uses an indicator of the number of correct answers.

For *fluid intelligence* assessment, the "paper-pencil" version of the "Standard Progressive Matrices" test was used. Tasks are grouped into five series, each of which consists of 12 tasks. Participants are asked to choose the missing element of the matrix task from six or eight proposed options. Statistical analysis uses an indicator of the total number of correct decisions.

Success in Learning Russian

As indicators of success in learning, we used (a) the average score of semi-annual assessments in the Russian language on samples of Russian, Kyrgyz, and Moldavian students and (b) test scores on state exams: the Unified State Exam (Russian students), National Testing (Kyrgyz students), and the Unified State Exam (Moldovan students).

The semi-annual assessment is made by the teacher of the Russian language when assessing students' the Russian language and varies from 2 (unsatisfactory) to 5 (excellent).

The Unified State Exam in Russia is a set of tasks in a standardized form, the successful completion of which establishes that the student meets the federal state educational standard of Russia in academic subjects. The exam on the Russian language is compulsory for all graduates of Russian schools and is taken upon completion of the last, 11th, year of schooling.

National Testing in Kyrgyzstan is a set of tasks in a standardized form aimed at identifying the high school students most ready for further study at a university. In the present study, the score for the main test is used for statistical analysis; it is taken at the end of the last, 11th, year of schooling.

The Unified State Exam in Moldova, in Tiraspol, as well as in Russia, is the main form of state certification of school graduates and constitutes a set of standardized tests aimed at determining whether the results of the basic educational programs

completed by students meet the state educational standard. The Unified State Exam in one's native language (optionally Russian, Moldavian, or Ukrainian) is compulsory for all graduates of Tiraspol schools and is taken upon completion of the last year of study at general academic schools.

Informed consent of participants' parents and representatives of the school administration was obtained. Data was collected in the computer science office of a general educational institution, strictly according to the developed protocol and under the supervision of a researcher. Data analysis was carried out on the anonymized personal data.

Statistical Approach

In the first step of statistical analysis, differences in the indicators of cognitive development were assessed using the method of univariate analysis of variance. It is assumed that the differences between Russian-speaking high school students who study throughout their schooling in Russia, Kyrgyzstan, or Moldova can be explained, first of all, by differences in the effectiveness of the national educational systems.

In the second step, we investigated the indicators of cognitive development (processing speed, working memory, and fluid intelligence) and of success in learning Russian (both annual grade and state exam score) in each group of participants by correlation analysis. Spearman correlation coefficients were calculated.

In the third step, significant cognitive predictors of success in Russian language learning (grade and state exam score) in each group of participants were determined by multiple regression analysis.

Results

The indicators of processing speed, spatial working memory, and fluid intelligence were analyzed as cognitive predictors, and the results of the state exam on the Russian language and the teacher's assessment were analyzed as indicators of the success of learning Russian.

Table 1 presents the average values and standard deviations (in parentheses) for the indicators of cognitive development and success in teaching the Russian language for native speakers from Russia, Kyrgyzstan, and Moldova. For processing speed, Table 1 gives the average response time in seconds to the correct answers for all tasks of the "Choice Reaction Time" test. For spatial working memory and fluid intelligence, the total numbers of correct answers for the "Corsi Block" and "Standard Progressive Matrices" tests, respectively, are presented. The minimum and maximum possible values for spatial working memory are from 0 to 12; for fluid intelligence from 0 to 60.

Table 1 shows that the best values for all the indicators of cognitive development are found in the sample of students in Russia: large values for spatial working memory and fluid intelligence, lower values for processing speed. The average processing speed is the same for students from Kyrgyzstan and Moldova. In terms of spatial working memory, Moldovan students are ahead of their Kyrgyz peers (5.30 versus 4.73), and inferior to them in fluid intelligence (47.02 versus 48.67).

Table 1

Descriptive statistics of indicators of cognitive functioning and success in learning Russian

	Russian speakers from Russia	**Russian speakers from Kyrgyzstan**	**Russian speakers from Moldova**
Processing speed	0.71 (0.2)	0.74 (0.2)	0.74 (0.2)
Spatial working memory	5.43 (2.0)	4.73 (2.3)	5.30 (1.9)
Fluid intelligence	52.17 (4.9)	48.67 (6.1)	47.02 (6.8)
Grade	4.04 (0.6)	3.76 (0.6)	4.15 (0.7)
State Exam	72.1 (12.0)	173.3 (26.7)	38.3 (9.9)

The success in Russian language learning in this study is represented by two indicators: the average score of semi-annual assessments and the score on the state exam. The minimum and maximum possible values are: for the teacher's grade, from 2 to 5; for the Unified State Exam in Russia, from 0 to 100; for National Testing in Kyrgyzstan, from 0 to 231; for the Unified State Exam in Moldova, from 15 to 57.

Although the grading system is identical in the three countries, a cross-cultural comparison of academic success on the basis of grades is impossible due to the high degree of subjectivity of school grades and their dependence on the educational achievements of a particular school group (class, school, etc.). At the same time, within the population samples, teacher assessment is acceptable to consider as one of the indicators of academic achievement in the Russian language, along with the results of the state exam.

Differences in Cognitive Development

Using univariate analysis of variance, we estimated differences in processing speed, working memory, and fluid intelligence among the three groups of high school students.

Table 2 summarizes the results of analysis of variance for cognitive indicators. As a categorical factor, the students belonged to the group "Russian speakers from Russia", "Russian speakers from Kyrgyzstan", or "Russian speakers from Moldova".

According to the values of the Levene's variance equality criterion ($p > 0.05$), all distributions of the cognitive variables for the compared groups have the same variances.

Table 2

Results of analysis of variance for indicators of cognitive development

	SS	**F**	***p*-value**	η^2
Processing speed	0.08	0.89	0.41	0.01
Spatial working memory	48.52	5.13	0.01	0.02
Fluid intelligence	2201.3	31.05	0.00	0.12

Table 2 shows that the effect of belonging to the group "Russian speakers from Russia", "Russian speakers from Kyrgyzstan", or "Russian speakers from Moldova" is statistically significant for fluid intelligence and spatial working memory. At the same time, the effect size for the spatial working memory indicator turned out to be insignificant (2%, respectively, at $p < 0.05$). The results of multiple comparisons with the Bonferroni correction revealed differences in spatial working memory only between the students from Russia and those from Kyrgyzstan, in favor of the former (5.43 versus 4.73).

The effect size for fluid intelligence reaches a value of 12% ($p < 0.001$). Multiple comparisons with the Bonferroni correction demonstrated differences between the students from Russia and their peers from Moldova and Kyrgyzstan. Moreover, the best results in the "Standard Progressive Matrices" test are shown by the students in Russia (the average value of the fluid intelligence is 52.17 versus 47.02 and 48.67, respectively). The students from Moldova and Kyrgyzstan differ only at the level of $p = 0.046$, with a slight advantage for Kyrgyz students. The average values of fluid intelligence are presented in Table 1.

Processing speed does not differ among the students studying in Russia, Moldova, or Kyrgyzstan ($p = 0.41$).

Relationships Between Cognitive Development and Success in Learning Russian

Correlation analysis was used to estimate the relationships between cognitive development indicators – processing speed, spatial working memory, and fluid intelligence – and success in learning Russian as measured by the state exams and grades in Russian-language class.Table 3 shows the Spearman correlation coefficients between indicators of cognitive development and success in learning Russian.

Table 3

Results of the correlation analysis of the relationship between indicators of cognitive development and success in learning Russian

	Processing speed	**Working memory**	**Fluid intelligence**
State exam	–0.08	0.22**	0.25**
	0.02	0.09	0.33**
	–0.02	0.09	0.19*
Grade	–0.01	0.09	0.30**
	–0.02	0.09	0.15*
	–0.04	0.06	0.03

Note. Upper row – "Russian speakers from Russia", middle row – "Russian speakers from Kyrgyzstan", bottom row – "Russian speakers from Moldova". * $p < 0.05$; ** $p < 0.01$.

Table 3 shows that in the group from Russia, one of the indicators of the success in learning Russian – the state exam score – is moderately correlated with fluid intelligence and spatial working memory. The correlation coefficients between state

exam score and fluid intelligence ($r = 0.25$ at $p < 0.01$) reach large values. The teacher's assessment correlates only with fluid intelligence ($r = 0.30$; $p < 0.01$). It should be noted that in the students studying in Russia, none of the success indicators in learning the Russian correlated with processing speed ($p > 0.05$).

In the group of students studying in Kyrgyzstan, both measures of the success in learning Russian – state exam score and grade – are moderately correlated with fluid intelligence. Moreover, the score on the state exam is more closely related to fluid intelligence than the annual grade (0.33; $p < 0.01$ vs. 0.15; $p < 0.05$). In the sample from Kyrgyzstan, as in the students from Russia, none of the success indicators is statistically significantly related to processing speed ($p > 0.05$).

In the group of students in Moldova, among all the indicators of cognitive development and success in learning Russian, only one weak but statistically significant association was found, that between the state exam score and fluid intelligence ($r = 0.19$; $p < 0.05$).

The relationships between the grade and the state exam score showed that these two indicators are more closely related in the students from Russia ($r = 0.68$; $p < 0.01$) than in those from Moldova ($r = 0.20$; $p < 0.05$). In the students from Kyrgyzstan, the correlation coefficient between the state exam score and fluid intelligence is 0.33 ($p < 0.01$).

The moderate correlation among cognitive development indicators – processing speed, spatial working memory, and fluid intelligence – were observed in all three students samples ($|0.19| > r > |0.32|$ with $p < 0.05$).

The Role of Cognitive Characteristics in Success in Learning Russian

In order to investigate the role of the indicators of cognitive development – the processing speed, spatial working memory, and fluid intelligence – in the success in learning Russian, a multiple regression analysis was performed for the three groups of students. The scores on the state exam and the teacher's assessments were used as dependent variables.

Table 4 summarizes the results of a regression analysis for the state exam score. Regression coefficients are given only for statistically significant predictors of the success of the state exam in the three analyzed groups.

Table 4

Results of the regression analysis of the state exam scores in the analyzed groups of students

Group of Russian-speaking students	**adjusted R^2**	**Significant predictors**	**β**	**B (standard error B)**	***t***	***p***
From Russia	0.08	Fluid intelligence	0.20	0.44 (0.18)	2.30	0.02
From Kyrgyzstan	0.12	Fluid intelligence	0.36	1.56 (0.36)	4.34	0.00
From Moldova	n/s	n/s	n/s	n/s	n/s	n/s

Note. n/s – non-significant

Table 4 shows that a regression analysis revealed differences in the percentage of the explained variance of scores on the state exam in the students from Russia (adjusted $R^2 = 0.08$; $F = 3.00$; $p = 0.02$) and Kyrgyzstan (adjusted $R^2 = 0.12$; $F = 6.87$; $p = 0.000$). It is also noteworthy that there is a lack of significant results of the multiple regression analysis on the sample of students from Moldova ($p > 0.05$).

In the students studying in both Russia and Kyrgyzstan, fluid intelligence is the only cognitive predictor of the state exam result. In particular, in the group of students in Russia, the standardized regression coefficient reaches 0.20 ($p < 0.05$); in the group of students in Kyrgyzstan it reaches 0.36 ($p = 0.000$).

For the assessment of success in learning Russian based on teacher assessment, different results of multiple regression analysis were obtained for the students studying in Russia, Kyrgyzstan, and Moldova. Only in the students from Russia was the variance significant, with 8% of the variance of the scores explained by fluid intelligence (model characteristics: adjusted $R^2 = 0.08$; $F = 4.94$; $p = 0.003$), whereas in the students from Kyrgyzstan and Moldova, the results of multiple regression were statistically insignificant ($p > 0.05$).

Discussion

In the present study, we investigated the cognitive predictors of the success in learning Russian as a native language in various educational environments. The study involved Russian-speaking 11th graders studying throughout their entire period of schooling in Russia, Kyrgyzstan, or Moldova – countries with a similar organization of the educational system, but with different levels of effectiveness in its functioning.

With the analysis of variance, differences in the indicators of cognitive development – information-processing speed, spatial working memory, and fluid intelligence – were studied in the three groups. The greatest cross-cultural differences were obtained for fluid intelligence, with the best values for the students in Russia. The results of multiple comparisons with the Bonferroni correction showed the differences between those in Russia and their peers in both Moldova and Kyrgyzstan. The students from Moldova and Kyrgyzstan differ from each other only at the level of $p = 0.046$, with a slight advantage for students from Kyrgyzstan. These results are consistent with data reported in the literature (e.g., Nisbett et al., 2012), in that they indicate a more significant effect of the quality of the educational process on fluid intelligence, measured by the "Standard Progressive Matrices" test, in comparison with the other indicators of cognitive development. It was also reported that cross-cultural differences in fluid intelligence reach their maximum at primary school age, which is explained by large differences in the availability and quality of preschool education, and at the full level of general education, when children are selected to continue their schooling (Tikhomirova & Malykh, 2017).

The smallest, but statistically significant, cross-cultural differences were found for spatial working memory. Multiple comparisons showed differences in working memory only between the students from Russia and Kyrgyzstan, in favor of the former. This result contradicts the data on the absence of significant differences in spatial working memory in a sample of Russian and Kyrgyz high school students (Grades 10–11; $p = 0.07$; Tikhomirova & Malykh, 2017), which can be explained by

the slightly different age characteristics of the sample in the present study (only students in Grade 11). At the same time, in a number of studies of Russian schoolchildren, cross-cultural differences are reported for indicators of visual-spatial working memory (e.g., Tikhomirova, Malykh, Tosto, & Kovas, 2014).

Thus, the fluid intelligence of 11th graders, which is directly proportional to the quality of education in the country, is most closely related to the effectiveness of the national educational system; to a lesser extent, it is related to the development of spatial working memory. Processing speed does not differ among the 11th graders in national educational systems with different levels of effectiveness: those of Russia, Kyrgyzstan, and Moldova.

Correlation analysis revealed that the specific relationship between the cognitive indicators and the state exam score has a cross-cultural character. In particular, in Kyrgyzstan (average level of socioeconomic development) and Moldovan Tiraspol (low level of socioeconomic development), only fluid intelligence is correlated with the result of the state exam on the Russian language. In Russia, with a very high level of development, spatial working memory becomes important, along with fluid intelligence.

The specific goals of the state exams in Russia, Moldova, and Kyrgyzstan, and, as a consequence, their content, could explain these cross-cultural differences. Thus, the National Testing of high school students in Kyrgyzstan is aimed, first of all, at identifying the most capable students, regardless of the quality of their education in a particular school. The Unified State Exam in Russia is aimed at checking the level of knowledge acquired during the educational process, which can actualize the role of working memory. However, the result of the state exam on the Russian language in Moldova (Tiraspol, in the unrecognized Transnistrian Moldavian Republic), designed according to the model of the Russian exam, is not correlated with spatial working memory ($p > 0.01$), which may be due to the low effectiveness of the educational system in this region.

The content of state exams can apparently explain the relationships between the teacher's assessment and the score on the state exam on the Russian language in the groups studied. These two indicators of success in learning Russian are closely related in the group of students from Russia, moderately related in the students from Kyrgyzstan, and weakly related in the students from Moldova.

Regression analysis revealed differences between the percentage of the explained variance of scores on the state exam on the Russian language in the students from Russia (adjusted $R^2 = 0.08$; $F = 3.00$; $p = 0.02$) and from Kyrgyzstan (adjusted $R^2 = 0.12$; $F = 6.87$; $p = 0.000$). These differences may be related both to the content of the state exam in Russia (assessment of the level of knowledge acquired at school) and Kyrgyzstan (identification of graduates capable of university study), as well as to a greater cognitive load for the exam in conditions of low learning effectiveness. Moreover, regardless of the national socioeconomic level, fluid intelligence is a universal statistically significant predictor of students' success in the state exam on the Russian language ($0.20 < \beta < 0.36$; $p = 0.000$). The central role of intelligence for academic success has been emphasized in a number of studies performed on samples of schoolchildren from different European countries and the USA (e.g., Rinderman & Neubauer, 2004).

The lack of significant results of multiple regression analysis on the group of 11th graders studying in Moldova may be due to the specificity of the state exam and the degree to which it matches the content of Russian-language education in the city of Tiraspol.

With respect to teacher assessment, different results of multiple regression analysis were obtained for the groups in Russia, Kyrgyzstan, and Moldova. In the students from Russia, 8% of the variance in improvement as measured by the teacher's assessment was explained by fluid intelligence (model characteristics: adjusted $R^2 = 0.08$; $F = 4.94$; $p = 0.003$). In Kyrgyzstan and Moldova, the results of multiple regression were statistically insignificant ($p > 0.05$). This result indicates the possible use of a variety of cognitive and other (e.g., emotional and motivational) resources when performing various tasks, to determine success in learning.

It should be emphasized that in the analyzed samples, a small percentage of the variance of the indicators of success in language learning was explained by cognitive characteristics – from 8% to 13%. This result is consistent with evidence that greater heterogeneity and less effective educational environments result in lower contribution of the cognitive performance in the educational achievement (Tucker-Drob & Bates, 2016).

Conclusion

Among the indicators of cognitive development we analyzed, the fluid intelligence of 11th graders, which is directly proportional to the quality of education in the country, is most closely associated with the effectiveness of the national educational system; to a lesser extent, it is also associated with spatial working memory. Processing speed did not differ among the 11th graders in the three national educational systems with their different levels of functional effectiveness.

The present study showed the cross-cultural specificity of relationships of fluid intelligence, spatial working memory, processing speed, and in success in learning Russian based on the state exam grade. In more favorable educational conditions for successful completion of the state exam, working memory also plays an important role, along with fluid intelligence.

Further research may be directed to understanding the cognitive mechanisms of learning Russian as second language in national educational systems with different levels of functional effectiveness.

Limitations

The lack of statistically significant results from a regression analysis on a sample of students from Moldova confirms the need to include an additional number of Russian-speaking 11th graders studying in Russian from other regions of Moldova.

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