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Cognitive resources of older preschool children in developmental and educational contexts caused by bilingualism in a multinational state

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Abstract

Introduction. The article presents the results of a study of the cognitive domain of older preschool children as a function of sociocultural conditions shaped by bilingualism, primarily in the cases of coincidence, non-coincidence or partial coincidence of the language(s) of communication in the family with the language(s) of upbringing and education in a preschool general education organization. The research focuses on basic cognitive functions and those indicators of cognitive functioning that are associated with comprehension, analysis and use of language in interaction with the outside world. **Methods.** The sample included 818 preschool children aged 5.3 to 7.5 years old (mean age 6.4 years) from 8 subjects of the Russian Federation (54.3% girls). Of the study participants, 71.5% communicated at home in one language, while 28.5% used two languages—Russian as the state language and their native language from among the languages of the peoples of Russia. All children attended preschool educational organizations: 64.1% were enrolled in preparatory groups, where upbringing and education were conducted exclusively in the state Russian language, and 35.9% were enrolled in classes, which implemented regional educational component in the native language alongside the state language. **Results.** The findings revealed specific features of the cognitive domain of older preschool children depending on the coincidence, non-coincidence, or partial coincidence of the language(s) of communication in the family and preschool education, which leads to change in the capacity of the cognitive resource when performing everyday and learning-related tasks. Intergroup differences were determined not only in the level of development of individual cognitive functions, but also the structure of

the relationships among all elements of the cognitive domain. This made it possible to assess the cognitive resources of older preschool children as a function of sociocultural conditions of development and education influenced by bilingualism in a multinational state. **Discussion.** The obtained results are interpreted in the context of the methodology of the theories of cognitive resource (Druzhinin, 2007) and language control (Green & Abutalebi, 2023).

Keywords

information processing speed, visuospatial working memory, mental operations, state Russian language, native languages of the languages of the peoples of the Russian Federation, cognitive resource, language control, older preschool age

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Introduction

The cognitive domain and the efficiency of its functioning constitute a prerequisite for constructive interaction between the individual and the outside world, representing a key personal resource for the successful acquisition of new knowledge and skills throughout the lifespan, including under conditions of atypical development (Tikhomirova, 2021). According to cognitive resource theory, the level of development and the degree of interconnectedness of individual components of the cognitive domain—including, among others, information processing speed, working memory, and basic thinking operations—make it possible to operationally describe individual capacities in the process of solving tasks of varying levels of complexity (Druzhinin, 2007). As a general characteristic of cognitive resources, the concept of cognitive system complexity is employed; it is equated with the degree of differentiation and is measured, among other things, by the number of interrelations among individual indicators of cognitive development (Druzhinin, 2007; Goryunova & Druzhinin, 2000).

At the same time, the development of the cognitive domain is characterized by heterogeneity, with more pronounced positive dynamics in some components (in particular, information processing speed; Tikhomirova et al., 2023) and less substantial changes in others (for example, perception of sets of objects; Kuzmina et al., 2020) over a given time interval. Such uneven development—and, consequently, individual differences in specific cognitive indicators—is especially pronounced during the preschool period, which constitutes the first level of the general education system. Previous studies indicate that it is precisely at this age stage that cognitive development is most sensitive to sociocultural conditions, primarily those of the family and the educational organization in which the child is raised and educated (Tikhomirova & Malykh, 2021; Von Stumm & Plomin, 2015).

Sociocultural conditions of development and learning associated with bilingualism

Among the sociocultural conditions that can exert a significant influence on cognitive development—and, accordingly, “modify the capacity of cognitive resources” (Druzhinin, 2007, pp. 166–167)—in preschool children is bilingualism among children who are citizens of a multinational state (Verbitskaya et al., 2017; Ortiz & Rodríguez, 2025; Ali, 2023; Bialystok, 2017). According to data from the 2020 Russian Population Census, the national composition of the Russian Federation comprises 194 ethnic groups that, to varying degrees, command the state language and/or a native language (Federal State Statistics Service, https://rosstat.gov.ru/vpn/2020/Tom5_Nacionalnyj_sostav_i_vladienie_yazykami). At the same time, only a portion of preschool educational organizations (hereinafter, kindergartens) have introduced a regional component into their educational programs in a native language from among the languages of the peoples of the Russian Federation. This component provides for the study and active use of the native language alongside the state Russian language.

The combination of sociocultural conditions associated with bilingualism in older preschool children may lead to specific features of the cognitive domain and, accordingly, to changes in the capacity of children’s cognitive resources, primarily among those who command two languages. Indeed, in a bilingual environment, one of three possible language-use contexts is activated: a monolingual context (e.g., one language used exclusively at home and the other exclusively in kindergarten), a bilingual context (both languages used in different educational activities in kindergarten when a regional educational component in the native language is implemented), or a “mixed” context (both languages used within a single utterance in cases of unequal proficiency or use of the native and state languages). Each of these contexts engages fundamentally different cognitive resources (Gallo & Abutalebi, 2024; Green, 2024; Green & Abutalebi, 2023; Frederiksen & Kroll, 2022; Calabria et al., 2018). According to language control theory, across all three contexts, the mechanisms that ensure successful switching between two

languages are gradually refined: at the initial stages of acquiring one of the languages, a maximum of cognitive resources is “absorbed,” whereas subsequently the cognitive load decreases, leading to the “release” of resources for more efficient performance of current tasks (Green & Abutalebi, 2023; Bialystok & Craik, 2022).

Cognitive development in sociocultural bilingual conditions: meta-analyses and systematic reviews

Meta-analyses and systematic reviews of studies examining the cognitive domain of children who command one or two languages (as a rule, a state language and a native language) often yield diametrically opposite results (Bialystok, 2017).

On the one hand, changes in the level of manifestation of certain cognitive functions are reported in children who command two or more languages compared with their monolingual peers. For example, preschool children from families where two languages are used demonstrate higher performance only on measures of cognitive control, but not working memory (a meta-analysis involving 18,200 children aged 5 to 7 years; Hartanto & Toh, 2019). A small but statistically significant advantage of bilingual children has also been documented in tasks assessing attentional switching, planning, and information processing speed (a systematic review of 143 studies involving children aged 1.5 to 14.5 years; Gunnerud et al., 2020; or a systematic review of 58 studies employing 125 cognitive tasks; Planckaert, Duyck, & Woumans, 2023). On the other hand, some authors conclude that there are no reliable group differences between preschool children who command one or two languages. Thus, no cognitive advantages of bilingualism were identified in analyses of cognitive control, reaction time, working memory, fluid intelligence, or vocabulary size (a meta-analysis involving 4,524 children aged 9 to 10 years; Dick et al., 2019).

Such discrepancies in findings may be attributable, among other factors, to approaches that examine children’s bilingualism exclusively in the context of family communication— one or two languages—without considering the language of instruction in educational organizations, or, conversely, that focus solely on the language of instruction—native or non-native—without accounting for the number of languages used in the family. As a result, a substantial group of children for whom there is a partial coincidence between the language(s) of family communication and the language(s) of instruction in educational organizations is often overlooked. At the same time, this situation is widespread among Russian children. For instance, children who use both a native language and the state Russian language in the family may attend educational organizations where instruction is provided exclusively in Russian, while children of other nationalities from among the peoples of Russia who speak only the state Russian language at home may attend kindergartens with a regional educational component and receive instruction in two languages. Including a group of preschool children with a partial coincidence of the language(s) of family communication and the language(s) of instruction in preschool

educational organizations makes it possible to obtain new data on the specific features of the cognitive domain of older preschool children in differing sociocultural conditions of development, upbringing, and education.

Overall, greater “sensitivity” to sociocultural conditions associated with bilingualism was reported for basic cognitive indicators—particularly information processing speed and visuospatial working memory—as well as for indicators of cognitive functioning associated with understanding, analyzing, and using language, such as vocabulary, classification and generalization, and the ability to draw inferences based on given logical relations (Zinchenko et al., 2022; Tikhomirova & Malykh, 2021; Ortiz & Rodríguez, 2025; Ali, 2023; Han et al., 2022; Gunnerud et al., 2020; Oppenheim et al., 2020).

It should be noted that when analyzing the cognitive domain depending on the child’s ability to command one or two languages, researchers typically consider only the level of development of a given cognitive characteristic. However, within the framework of cognitive resource theory, alongside the level of development of individual components of the cognitive domain, its structural organization is of fundamental importance (Druzhinin, 2007). Specifically, a smaller number of interrelations and lower correlation coefficients among individual cognitive functions indicate a higher degree of differentiation of the cognitive domain and, consequently, a greater capacity of cognitive resources in the performance of everyday and learning-related tasks (Goryunova & Druzhinin, 2000). A cross-sectional analysis of the level of development and the degree of differentiation of the cognitive domain makes it possible to assess the capacity of the cognitive resources of older preschool children in developmental and educational contexts shaped by bilingualism, including their readiness for successful knowledge acquisition, particularly during the age-relevant formation of reading skills.

The present study

The aim of the present study is to examine the characteristics of the cognitive domain in older preschool age as a function of sociocultural conditions of development and education, primarily in situations of coincidence, non-coincidence, or partial coincidence between the language(s) of family communication and the language(s) of instruction in preschool educational organizations. The research focuses on basic cognitive functions as well as on those indicators of cognitive functioning that are associated with understanding, analyzing, and using language in interaction with the surrounding world. Within the framework of cognitive resource theory, the complexity of the organization of the cognitive domain—and, accordingly, the capacity of children’s cognitive resources—will be assessed under conditions of family upbringing and preschool education associated with bilingualism in a multinational state.

This aim can be achieved only in a study involving older preschool children who use, within their families, two languages—Russian as the state language and a native language—and who also attend preschool educational organizations that include preparatory groups

implementing a regional component of the educational program in a native language from among the languages of the peoples of the Russian Federation.

Methods

Sample and research procedure

The study sample comprised 818 preschool children aged 5.3 to 7.5 years (mean age 6.4 years), of whom 54.3% were girls. The study included children from 8 subjects of the Russian Federation, including the Republic of Tatarstan (Tatars – 71.2%; Russians – 28.8%), the Kabardino-Balkarian Republic (Kabardins – 60.8%; Balkars – 26.1%; Russians – 8.7%; Dargins – 4.4%), the Chechen Republic (Chechens – 100%), the Republic of North Ossetia-Alania (Ossetians – 91.1%; Russians – 8.9%), the Republic of Bashkortostan (Bashkirs – 65.9%; Tatars – 20.9%; Russians – 13.2%), the Chuvash Republic (Chuvash – 87.1%; Russians – 12.9%), the Sakha (Yakutia) Republic (Yakuts – 96.2%; Russians – 3.8%) and the Moscow Region (Russians – 93.6%; Tatars – 4.4%; Ukrainians – 2%).

Among the study participants, 584 children (71.5%) communicated at home in one language, and 234 children (28.5%) in two languages—both Russian as the state language and a native language from among the languages of the peoples of the Russian Federation. The study involved preschool children whose families used, among others, Russian, Tatar, Ossetian, Chechen, Bashkir, Kabardian, Balkar, Chuvash and Yakut languages in communication with the child.

All children attended preschool educational organizations that included preparatory groups implementing a regional component in the educational program in a native language from among the languages of the peoples of the Russian Federation. Among the participants, 524 children attended preparatory groups where upbringing and education were conducted exclusively in Russian (64.1%), and 294 children (35.9%) were enrolled in preparatory groups with a bilingual model of preschool education.

Data collection was carried out individually with the direct participation of a member of the research team and a psychologist or other specialist working in the preschool educational organization, strictly according with the developed protocol. The parents of the study participants provided information about the child's nationality, the child's level of proficiency in Russian, as well as the language(s) used for communication with the child in the family.

Each participant completed the tasks on a computer under an individual login in a separate room of the kindergarten. The greeting and task instructions in Russian were read by a member of the research team to each participant, regardless of the child's ability to read the text on the computer screen independently. For children who did not fully understand the instructions for the tasks in Russian (2.3% of the total number of participants), part of the instruction was read aloud in the child's native language, which

was recorded in the study protocol. In tasks that required pressing keys or a key on the computer keyboard, the participant in the study performed these actions independently.

Measures

“Choice reaction time” task, information processing speed

The numbers 1, 2, 3, and 4 appear on the screen 40 times in a random order with an interstimulus interval ranging between 1 and 3 seconds (Tikhomirova, Kuzmina, Malykh, 2020). The participant’s task is to quickly and accurately press the key that corresponds to the number displayed on the screen. The measure used in the study was reaction time for correct responses only, recorded in milliseconds. Higher values corresponded to lower processing speed.

“Corsi Block-tapping” task, visuospatial working memory

In the task, sequences of cubes are presented on the screen one after another, each cube lights up in yellow for 1-second with a 1-second interval between stimuli (Tikhomirova, Malykh, Malykh, 2020). The participant was required to reproduce the entire sequence in the same order by clicking on the corresponding cubes with the mouse. The total number of correctly reproduced sequences was recorded.

“General knowledge and vocabulary” task, vocabulary and the ability to differentiate essential from non-essential object features

The task instruction requires the child to choose one word that correctly completes the sentence. For example, the child was read the beginning of the sentence “A boot always has...” and was presented with a list of words from which to select the single correct option: “buttons, straps, sole, buckle, lace” (Zambatsyavichene, 1984). The total number of correctly completed sentences was recorded.

“Classification and generalization” task, ability to group objects based on given criteria and to unite them on the basis of common features

The task instruction required the participant to choose one “odd” word that did not fit with the other words. For example, the child was read a list of words—“tulip, lily, bean, daisy, violet”—and was asked to think and name the word that did not belong with the others in the series (Zambatsyavichene, 1984). The total number of correct responses was recorded.

“Analogical reasoning” task, the ability to draw inferences by analogy based on given logical relationships between concepts

In this task, the instruction was read aloud from the screen: “The words ‘forest–trees’ are related in the same way as the words in the second pair. Choose the word that matches the word from the second pair: ‘library’ is related to what?” A list of response options was then read aloud: “garden, yard, city, theater, books” (Zambatsyavichene, 1984). The total number of correct responses was recorded.

Results

The statistical analysis included indicators of the development of the cognitive domain in older preschool children—information processing speed, visuospatial working memory, as well as general knowledge and vocabulary, the ability to classify and generalize concepts, and the ability to draw inferences by analogy based on given logical relations between concepts. The number of languages used for communication with the child in the family and for instruction in kindergarten was considered as an indicator of sociocultural conditions of development and education affected by bilingualism in a multinational state.

Descriptive statistics

Table 1 presents the means and standard deviations (in parentheses) for information processing speed (“Choice reaction time” task), visuospatial working memory (“Corsi Block-tapping” task), as well as indicators related to understanding, analyzing, and using language (“General knowledge and vocabulary”, “Classification and generalization”, and “Analogical reasoning” tasks), including their variation depending on the number of languages used for communication in the family and instruction in the preschool educational organization.

In Table 1, for the “Choice reaction time” task, the mean reaction time for correct responses is presented in milliseconds; for all other tasks, the number of correct responses is reported, ranging from 0 to 12 for the “Corsi Block-tapping” task and from 0 to 10 for the “General knowledge and vocabulary”, “Classification and generalization”, and “Analogical reasoning” tasks.

Table 1

Descriptive statistics of cognitive domain indicators in older preschool children depending on conditions of development and education associated with bilingualism

Indicator	General sample (n=818)	Communication in the family		Education and training in kindergarten	
		One language (n=584)	Two languages (n=234)	One language (n=524)	Two languages (n=294)
"Choice reaction time"	1425.16 (333.1)	1423.89 (324.7)	1435.01 (395.5)	1407.34 (312.5)	1471.97 (459.2)
"Corsi Block-tapping"	1.51 (1.3)	1.46 (1.3)	1.61 (1.6)	1.46 (1.3)	1.59 (1.3)
"General knowledge and vocabulary"	6.11 (2.1)	6.21 (1.9)	5.78 (2.7)	6.19 (2.1)	5.29 (2.1)
"Classification and generalization"	5.24 (2.3)	5.26 (2.2)	5.07 (2.7)	5.34 (2.2)	4.86 (2.0)
"Analogical reasoning"	5.44 (2.6)	5.50 (2.5)	4.84 (2.5)	5.35 (2.6)	6.16 (2.1)

According to the descriptive statistics, only minor differences in mean values across all cognitive indicators are observed between groups of children with one and two languages of communication both in the family and in kindergarten. Thus, with respect to basic cognitive indicators, children who command two languages were, on average, slightly slower but demonstrated somewhat higher levels of working memory. On the verbal tasks, the group of preschool children with two languages showed slightly lower performance in vocabulary size and the ability to classify and generalize, but outperformed their peers who were educated in one language in the ability to construct analogical inferences based on given logical relations.

Analysis of group differences in the level of development of cognitive domain indicators

To assess the statistical significance of differences between groups of preschool children with different sociocultural conditions shaped by bilingualism, as well as the effect size of these differences on cognitive domain indicators, a one-way analysis of variance was conducted. As a categorical factor, the following groupings were considered sequentially: groups with one or two languages of family communication, groups with one or two languages of instruction in kindergarten, and the coincidence, partial coincidence, or non-coincidence of the language(s) of family communication with the language(s) of education. The dependent variables included information processing speed, visuospatial working memory, general knowledge and vocabulary, the ability to classify and generalize, and the ability to draw inferences. Assessment of the distributions of all dependent variables for the compared groups using Levene's test indicated equality of variances ($p > 0.05$).

The results of the analysis of variance showed no differences across all cognitive domain indicators between groups of older preschool children who were communicated with at home in one or two languages ($p > 0.05$), as well as between preschool children attending preparatory groups in kindergartens where upbringing and education were conducted exclusively in the state language or using both the state and native languages ($p > 0.05$).

At the same time, the results of the analysis of variance in which the categorical factor was the coincidence, non-coincidence, or partial coincidence of the language(s) of family communication with the child and the language(s) of instruction and upbringing in kindergarten revealed statistically significant differences between groups of preschool children on certain cognitive domain indicators. Groups of older preschool children were formed on the basis of data on the language(s) of communication in the family and education in kindergarten.

The group of preschool children in whom the language(s) of family communication coincided with the language(s) of instruction and upbringing in kindergarten included 431 children (52.7% of the total sample). This group comprised preschool children who (a) communicated in their families in Russian (as a state or native language) and received education in kindergarten in Russian, and (b) communicated in their families in two languages (the state Russian language and a native language) and were educated in kindergarten in two languages as well (Russian and a native language).

The group of preschool children in whom the language(s) of family communication did not coincide with the language(s) of instruction in kindergarten included 153 children (18.8%). This group comprised children who were communicated with in the family exclusively in a native language from among the languages of the peoples of the Russian Federation, while attending kindergartens whose educational programs did not include a regional component in the native language.

The group with a partial coincidence between the language(s) of family communication and instruction in kindergarten included 234 children (28.5%). This group comprised children who (a) communicated in their families in two languages (the state Russian language and a native language) and were educated in kindergarten exclusively in Russian, and (b) communicated in their families exclusively in Russian (as a rule, as the state language) or exclusively in native language and were educated in kindergarten in two languages (the state Russian language and a native language) through the implementation of a regional educational component in a native language from among the languages of the peoples of the Russian Federation.

Table 2 presents the descriptive statistics of cognitive domain indicators in older preschool children depending on the degree of coincidence between the language(s) used in the family and those used in kindergarten.

Table 2

Descriptive statistics of the level of development of cognitive domain indicators in older preschool children depending on the degree of coincidence between the language(s) used in the family and in kindergarten

	Coincides (n = 431) 52.7%	Doesn't coincide (n =153) 18.8%	Partially coincides (n=234) 28.5%
"Choice reaction time"	1394.2 (309.1)	1614.4 (360.1)	1410.8 (395.5)
"Corsi Block-tapping"	1.46 (1.2)	1.45 (1.3)	1.53 (1.6)
"General knowledge and vocabulary"	6.39 (1.8)	5.04 (1.8)	5.97 (2.7)
"Classification and generalization"	5.51 (2.1)	3.70 (2.1)	5.26 (2.7)
"Analogical reasoning"	5.48 (2.3)	5.53 (2.2)	4.94 (2.7)

According to Table 2, the analysis of mean values revealed significant group differences in information processing speed, as well as in general knowledge and vocabulary, classification and generalization. Specifically, an advantage on these cognitive indicators was observed in the group of older preschool children in whom the language(s) of family communication fully coincided with the language(s) of instruction in kindergarten. At the same time, test results in the groups of preschool children with full coincidence and partial coincidence of the language(s) of family communication and kindergarten

instruction differed slightly; in particular, on the “Classification and Generalization” task the mean values were 5.51 and 5.26, respectively.

Notably, a wide range of variability across all analyzed cognitive domain indicators was observed in older preschool children in whom the language(s) of family communication and kindergarten instruction only partially coincided.

The results of the analysis of variance of group differences among older preschool children depending on the coincidence, non-coincidence, or partial coincidence of the language(s) of family communication and education in kindergarten are presented in Table 3.

Table 3

Results of the analysis of group differences in cognitive domain indicators

Indicator	Sum of squares (SS)	F statistic (F)	Significance level (p)	Effect size (η^2)
“Choice reaction time”	1977539.6	10.89	0.000	0.05
“Corsi Block-tapping”	7.39	2.17	0.115	0.01
“General knowledge and vocabulary”	80.88	10.76	0.000	0.05
“Classification and generalization”	133.45	14.31	0.000	0.07
“Analogical reasoning”	31.16	2.49	0.084	0.01

According to Table 3, statistically significant differences between the analyzed groups of older preschool children were identified for three cognitive domain indicators—information processing speed, vocabulary and general knowledge, and the ability to classify concepts and generalize them on the basis of common features ($p = 0.000$). Specifically, group differences with an effect size of 5% were found for the “Choice reaction time” and “General knowledge and vocabulary” tasks, and with an effect size of 7% for the “Classification and generalization” task.

Multiple comparisons with Bonferroni correction revealed task-specific patterns of group differences. In particular, with regard to information processing speed, all three groups of preschool children—those with full coincidence, non-coincidence, and partial coincidence between the language(s) of family communication and the language(s) of education in kindergarten—differed from one another ($p < 0.05$). For the tasks related to vocabulary, classification of concepts, and their generalization, statistically significant differences were identified only between two groups—preschool children with full coincidence and those with non-coincidence of the languages used in the family and in kindergarten ($p < 0.001$).

Analysis of the structural organization of the cognitive domain

To assess the structure of the cognitive domain in older preschool children depending on sociocultural conditions of development and education influenced by bilingualism, a correlation analysis was conducted.

The results of the correlation analysis revealed no differences in the structure of the cognitive domain between older preschool children attending preschool educational organizations where instruction was provided exclusively in the state Russian language and their peers from kindergartens implementing both the state Russian language and a native language within the framework of a regional educational component in a native language from among the languages of the peoples of the Russian Federation ($0.22 < r < 0.53$ at $p < 0.05$ in kindergartens with one language; $0.20 < r < 0.54$ at $p < 0.05$ in kindergartens with two languages).

The correlation analysis also revealed no differences in the structure of the cognitive domain between older preschool children who communicated in their families exclusively in one language and their peers from families where two languages were used ($0.14 < r < 0.53$ at $p < 0.05$ in one-language families; $0.18 < r < 0.58$ at $p < 0.05$ in two-language families).

In contrast, the correlation analysis identified differences in the structure of the cognitive domain among three groups of older preschool children for whom the language(s) of family communication and the language(s) of instruction in kindergarten coincided, did not coincide, or partially coincided. Table 4 presents Spearman's correlation coefficients for the three analyzed groups of older preschool children (* $p < 0.05$; ** $p < 0.01$).

Table 4

Results of the analysis of the structure of the cognitive domain in older preschool children depending on the degree of coincidence between the language(s) of family communication and instruction in kindergarten

Indicator		1	2	3	4	5
"Choice reaction time" (1)	Coincides					
	Doesn't coincide					
	Partially coincides	1				
"Corsi Block-tapping" (2)	Coincides	-0.18**				
	Doesn't coincide	-0.36**				
	Partially coincides	-0.47**	1			
"General knowledge and vocabulary" (3)	Coincides	-0.15*	0.19**			
	Doesn't Coincide	-0.21*	0.24**			
	Partially coincides	-0.35**	0.36**	1		
"Classification and generalization" (4)	Coincides	-0.17*	0.04	0.48**		
	Doesn't coincide	-0.22**	0.25**	0.39**		
	Partially coincides	-0.41**	0.36**	0.49**	1	
"Analogical reasoning" (5)	Coincides	-0.02	0.17**	0.40**	0.46**	
	Doesn't coincide	-0.19**	0.20**	0.42**	0.39**	
	Partially coincides	-0.27**	0.29**	0.45**	0.47**	1

As shown in Table 4, the correlation coefficients between the analyzed cognitive indicators range from $|0.15|$ to $|0.49|$, indicating statistically significant relationships of varying strength—from weak to moderate. The correlation analysis revealed two main patterns.

The first pattern was observed in the analysis of the relationships between basic cognitive functions (“Choice reaction time” and “Corsi Block-tapping” tasks) and cognitive indicators characterizing language comprehension and use (“General knowledge and vocabulary”, “Classification and generalization”, and “Analogical reasoning” tasks). Specifically, differences were identified in both the number and strength of interrelations across groups of older preschool children in whom the language(s) of family communication and kindergarten instruction coincided, did not coincide, or partially coincided. The cognitive domain of the group of preschool children with full coincidence of the languages used in the family and kindergarten was characterized by a smaller number of interrelations (5 out of 7 possible) compared with the other groups (7 out of 7 possible). At the same time, the strongest relationships were observed in the group with partial coincidence of the languages used in the family and kindergarten ($0.27 < r < 0.47$ at $p < 0.05$), whereas the weakest relationships were found in the group with full coincidence of the languages used in the family and kindergarten ($0.15 < r < 0.19$ at $p < 0.05$).

The second pattern was observed in the analysis of relationships exclusively among cognitive indicators characterizing language comprehension and use in interaction with the surrounding world (“General knowledge and vocabulary”, “Classification and generalization”, and “Analogical reasoning” tasks). In this case, similarity was observed across all three groups of preschool children—with coincidence, non-coincidence, and partial coincidence of the language(s) of family communication and kindergarten instruction. Specifically, in all groups of preschool children, the coefficients between test indicators reflecting the level of development of mental operations ranged from 0.39 to 0.49 at $p < 0.01$.

Discussion

In the present study, conducted on a sample of older preschool children from eight subjects of the Russian Federation, characteristics of cognitive functioning were analyzed depending on sociocultural conditions influenced by bilingualism. The analysis addressed not only the level of development of individual cognitive functions but also the structure of their interrelations in groups of older preschool children under conditions of full coincidence, non-coincidence, or partial coincidence between the language(s) of family communication and the language(s) of instruction in preschool educational organizations. This research approach made it possible to assess the capacity of cognitive resources in older preschool children across differing family and educational conditions associated with bilingualism in a multinational state.

The results of the present study did not reveal statistically significant differences between older preschool children who command one or two languages, either in basic cognitive functions (“Choice reaction time” and “Corsi Block-tapping” tasks) or in indicators characterizing language comprehension and use (“General knowledge and vocabulary”, “Classification and generalization”, and “Analogical reasoning” tasks). These findings are consistent with the conclusions of meta-analyses and systematic reviews, which, while acknowledging extremely small effects of bilingualism on certain cognitive functions in respondents of specific age groups, generally report an absence of cognitive advantages of bilingualism (Gunnerud et al., 2020; Dick et al., 2019; Bialystok, 2017). Moreover, in most studies where minor effects of bilingualism on cognitive development—primarily executive functions—are observed, an urgent need is emphasized to identify sociocultural conditions, particularly educational ones, that may facilitate the manifestation of differences between children who command one or two languages (Ortiz & Rodríguez, 2025; Ali, 2023; Papastergiou, Pappas, & Sanoudaki, 2021; Bialystok, 2021; Hartanto et al., 2019).

Such a sociocultural condition, characteristic not only of the Russian Federation but also of “well over half of the countries of the world” (Bialystok, 2017, p. 233), was found to be the degree of coincidence between the language(s) of family communication and the language(s) of instruction in preschool educational organizations. Intergroup differences were demonstrated in the level of development of information processing speed, with an effect size of 5%, as well as in vocabulary size (5%) and the ability to classify and generalize (7%). With regard to information processing speed, all three groups of older preschool children differed from one another, with an advantage observed in children for whom the language(s) of family communication fully coincided with the language(s) of instruction in kindergarten. For indicators related to language comprehension and use, differences were identified only between groups with full coincidence and non-coincidence of the language(s) used in the family and in kindergarten, again favoring the former. These findings are consistent with results obtained in studies involving older school-age children, which report higher processing speed in high school students educated in their native language—Russian or Kyrgyz (Verbitskaya et al., 2017), and Russian, Kyrgyz, or Moldovan (Zinchenko et al., 2022).

It should be noted that more pronounced individual differences across all cognitive indicators were observed in the group of older preschool children with partial coincidence between the language(s) used in the family and in kindergarten. This group included children who communicated in two languages in the family but attended kindergartens with instruction exclusively in the state Russian language, as well as children who communicated in only one language in the family but were educated in kindergartens using two languages. The greater individual variability observed in this group may be associated with the degree of mastery and frequency of use of each language and, consequently, with individual differences in the use of each language—whether in home

communication, kindergarten instruction, or their constant mixing (Green & Abutalebi, 2023; Frederiksen & Kroll, 2022; Calabria et al., 2018).

Analysis of the structural organization of the cognitive domain revealed specificity in interrelations depending on the degree of coincidence between the language(s) of family communication and kindergarten instruction, but only with respect to relationships between basic cognitive functions and indicators of language comprehension, analysis, and use. The smallest number and weakest strength of interrelations among individual indicators were observed in the group of older preschool children with full coincidence between the language(s) used in the family and in kindergarten. In contrast, the maximum possible number of interrelations and their highest strength were characteristic of the group with partial coincidence of the language(s) used in the family and in kindergarten. Conversely, analysis of interrelations exclusively among indicators of language comprehension, analysis, and use—vocabulary, general knowledge, ability to classify and generalize, and analogical reasoning—revealed uniformity of structure across all groups of older preschool children, namely, a maximum number of interrelations of moderate strength. This structural “division” may be related to age-specific features of development in older preschool children, particularly the uneven developmental trajectories of individual elements of the cognitive domain—basic cognitive functions with their rapid dynamics (Tikhomirova et al., 2023; Kuzmina et al., 2020) and the more gradual formation of thinking operations (Zaporozhets, Zinchenko, & Elkonin, 1964).

The structural specificity of the cognitive domain and differences in the level of development of individual indicators depending on sociocultural conditions influenced by bilingualism made it possible to assess the complexity of the cognitive domain in preschool children at different degrees of coincidence between the language(s) of family communication and kindergarten instruction. Within the framework of cognitive resource theory, it is precisely the complexity of the cognitive domain that reflects the capacity of an individual’s cognitive resources, which in turn is characterized by varying degrees of differentiation (Druzhinin, 2007; Goryunova & Druzhinin, 2000). The highest degree of differentiation, with the possibility of autonomous activation of high-level indicators of information processing speed, general knowledge and vocabulary, and the ability to classify and generalize—and, consequently, the greatest cognitive resource capacity—was characteristic of the group of older preschool children for whom the language(s) used in the family and in kindergarten fully coincided. This group included children who communicated at home exclusively in Russian (as a native or state language) and attended kindergartens with instruction exclusively in the state Russian language, as well as children who communicated at home in two languages (native and state) and attended kindergartens where, alongside the state Russian language, a regional educational component in the native language was implemented. According to language control theory, full coincidence of the language(s) used in the family and in preschool educational organizations eliminates the need for substantial cognitive “costs” associated with language switching across contexts, thereby enabling high performance in task

completion, particularly on measures of processing speed, vocabulary, classification, and generalization (Green & Abutalebi, 2023; Bialystok & Craik, 2022; Frederiksen & Kroll, 2022; Calabria et al., 2018).

In contrast, the cognitive domain of older preschool children for whom the language(s) used in the family and in kindergarten did not coincide was characterized by the lowest degree of differentiation and a low level of development of individual cognitive functions, resulting in reduced cognitive resource capacity when performing test tasks. This group included children who communicated at home in a native language from among the languages of the peoples of the Russian Federation and attended kindergartens where upbringing and education were conducted exclusively in the state Russian language. The need to acquire knowledge in a non-native language activates a “mixed” context of language use, with a subsequent transition to a monolingual context involving a division between languages used “only at home” and “only in education.” At the initial stage of language acquisition, this requires maximal cognitive resources, leaving limited capacity for effective performance of learning tasks (Gallo & Abutalebi, 2024; Green & Abutalebi, 2023; Bialystok & Craik, 2022). Indeed, a number of studies have shown that mastering an educational program in a non-native language engages substantial cognitive resources even after eleven years of schooling (e.g., Zinchenko et al., 2022). Information processing speed appears to be the most “sensitive” to conditions of bilingualism and has specific importance for learning in Russian regardless of the native language group (Zinchenko et al., 2022).

Under conditions of partial coincidence between the language(s) used in the family and in kindergarten, the cognitive domain of older preschool children, according to the obtained data, is characterized by low differentiation but a high level of development of individual cognitive functions, which allows for partial compensation of limited individual resources. This group included children who communicated in two languages in the family (state Russian and a native language) and attended kindergartens with instruction exclusively in Russian, as well as children who communicated exclusively in Russian at home and attended kindergartens implementing a regional educational component in a native language. Under such sociocultural conditions, the “mixed” context of language use is also primarily activated, with maximal cognitive “costs” and a subsequent transition to monolingual or bilingual contexts (Green, 2024; Green & Abutalebi, 2023; Bialystok & Craik, 2022). However, partial coincidence of languages—knowledge of one of them—provides an opportunity to cope more effectively with task performance due to a high level of development of individual cognitive functions, primarily information processing speed, sufficient vocabulary size, and others.

Thus, the results of the present study demonstrate intergroup variation in the efficiency of cognitive functioning at the older preschool stage depending on sociocultural conditions of development and education associated with bilingualism. Scientific data on the specific features of cognitive resources in older preschool children, obtained through consideration of the “language-related” characteristics of the family and preschool

educational organization, open up opportunities for the development of psychological and pedagogical support programs for children, including those implemented within the framework of regional educational components in a multinational state environment.

Conclusions

Sociocultural conditions of development and education associated with bilingualism in a multinational state—namely, full coincidence, non-coincidence, or partial coincidence between the language(s) of family communication and the language(s) of instruction in preschool educational organizations—contribute to the manifestation of specific features of the cognitive domain in older preschool children, leading to changes in the capacity of their cognitive resources when performing everyday and learning-related tasks.

Under conditions of full coincidence between the language(s) used in the family and in kindergarten, the cognitive domain is characterized by a high degree of differentiation and high-level development of individual cognitive functions, and, consequently, by greater cognitive resource capacity in this group of older preschool children. In contrast, when the languages do not coincide, the cognitive domain is characterized by low differentiation and a low level of development of cognitive indicators, which may result in reduced cognitive resource capacity when performing relevant tasks. In situations of partial coincidence, the cognitive domain of preschool children is characterized by low differentiation but a high level of development of individual cognitive functions, which allows for compensation of limited individual resources.

Among cognitive domain indicators, information processing speed, vocabulary size, and the ability to classify and generalize are the most “sensitive” to sociocultural conditions of development and education influenced by bilingualism, with higher levels of development observed in older preschool children under conditions of full or partial coincidence between the language(s) of family communication and instruction in preschool educational organizations.

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Tatyana Nikolaevna Tikhomirova – idea, concept and methodology of the study; administration of data collection; interpretation of results; text of the article.

Artem Sergeevich Malykh – selection of methodological tools; database administration; statistical data analysis.

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Conflict of Interest Information

The authors have no conflict of interest to declare.