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**FEATURES OF EXECUTIVE FUNCTIONS DEVELOPMENT IN**  
**MOSCOW AND KAZAN PRESCHOOLERS**

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***Abstract***

The purpose of this study was to compare the development level of various executive function components – working memory, cognitive flexibility and inhibition – in older preschool children belonging to two widespread cultures that exist on the territory of the Russian Federation – Russian culture and Tatar culture. Differences were found to exist in the performance of tasks on executive functions in preschool children from Moscow and Kazan. In addition, we analysed the differences that existed between boys and girls from these different cultures, and also within each of the cultures. The analysis of the differences between boys and girls in Moscow and Kazan showed that the development level of various EF components is generally very close in respect to Moscow girls and boys whereas numerous differences were obtained among the Kazan children. The outcomes of the analysis showed that Kazan girls were ahead of not only the Kazan boys but also of their Moscow counterparts in their development. Notwithstanding the fact, the Kazan boys were found to be behind in their development. One can explain these variations by differences in the traditions (gender stereotypes and cultural behavioural models) used in bringing up boys and girls in the two cultures. The results make us think about the influence of cultural factors on the development of not only inhibitory control but also cognitive flexibility and working memory in children.

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**Keywords:** Preschool age, culture, inhibition, working memory, cognitive flexibility.



## 1. Introduction

Of particular importance in the preschool years is the development of executive functions (EF) that form the basis of mastering one's own behaviour and provide for purposeful problem-solving and successful adaptation to new situations, so indispensable at a stage when a child is making a transition from kindergarten to school (Diamond & Lee, 2011; Miyake et al., 2000). At the same time, as classics of world psychology show, children's abilities to control their behavior form in the course of their interaction with adults who through speech transmit to the child cultural patterns and means needed to master their mental processes (Vygotsky, 2005; Luria, 1961). In addition to being educated in a certain cultural environment, every child assimilates behavioral models, norms, patterns and values that have gained acceptance in its milieu. (Vygotsky, 2005; Veraksa, 2000; Luria, 1973; Kotik-Friedgut, 2006; Schwarz, 2008; Triandis, 2007). That is why cross-cultural studies present great interest to developmental psychology as they make it possible to evaluate and compare how various environmental factors resulting from specific features of cultures under investigation, on the one hand, and individual differences, on the other, influence the formation of executive functions. Given the obvious significance and usefulness of such studies many scientists have to note that there has been insufficient empirical research in investigating cultural differences in children's performance of cognitive regulation tasks (Byrd et al., 2008; Han et al., 2013). As a result, the present study was devoted to the examination of the developmental features of executive functions in preschool children belonging to two most wide-spread cultures – Russian and Tatar – present on the territory of the Russian Federation, and, in particular, in its largest centres (Moscow and Kazan).

### 1.1. Comparison of Russian and Tatar cultural traditions

Within a relatively small area of what present-day Tatarstan occupies today, the Russians and the Tatars have lived in close proximity to each other for centuries: in terms of their historical, geographical, climatic and socio-economic conditions of development, the Tatar and Russian ethnic groups are identical (Lopukhova & Gulova, 2001). Having for centuries been in close contact with each other, both the Russians and the Tatars have nevertheless preserved ethnic characteristics of their culture manifest in language, religion, customs, rituals and holidays, family way of life and traditions of upbringing (Musina, 1990; Urazmanova, 2001). Notwithstanding all their vastly similar socio-economic development, more and more studies point to significant differences that exist in the values and accepted behavioral models based on their respective individual cultural traditions (Bayanova, 2013; Lopukhova & Gulova, 2001; Lopukhova, 2007).

It is important to note that unlike many other cities and towns in the Republic of Tatarstan the city of Kazan remains a multiethnic environment in which these two cultures exist side by side. As was shown in Bayanova's study (2013), the accepted behavioral norms of Tatars living in the capital of the republic differ from those residing in monoethnic (mostly rural) towns. Nevertheless, even in large cities, the influence of traditional models has a great impact on the molding and development of personality in modern Tatars. As Lopukhova shows (2001) in her paper, "the influence of ethno-cultural traditions is already felt unconsciously in early childhood, through family education and imitation of the gender patterns of their parents and family members which results in the formation of nuclear structures in the mental make-up of the personality". In another study Lopukhova (2007) analyzed gender behavioral patterns based on the

material of Russian and Tatar folk tales, which showed that there are significant differences between their male and female characters in terms of behavior and relationships. Whereas the Russian fairy tales depict a female character as occupying a subordinate and dependent position in relation to a male one, the Tatar tales show both of them to be equally active, cooperative and, at the same time, very independent.

These differences also manifest themselves in the existing rituals and traditional patterns of gender-role interaction in the family, characteristic of Russian and Tatar cultures (Lopukhova & Gulova, 2001). As shown in the study by Lopukhova (2001), there were pronounced differences in traditional and ritual forms of communication between men and women among Tatars and Russians, which is reflected in the specific notions about men's and women's individual qualities and behavioral norms. While Russian men and women could freely and constantly engage in communication and interaction with one another, the spheres of life for Tatar men and women did not overlap: unlike in Russian households, the Tatar home was traditionally divided into "men's" and "women's" parts. They participated in festivals and various rituals separately from one another, and sometimes they did so on different days, leisure activities took place, as a rule, in gender-homogenous companies. The social division of the spheres of life activity was also manifest in the fact that the household was considered a women's domain in the family whereas the man of the house acted, to describe it in terms of Russian cultural ideas, as a guest rather than the master of the house. Based on this tradition, modern Tatar families also follow a specific pattern of the husband and wife relationship. The husband is treated with honor and respect in the house, his every wish is watched and fulfilled with utmost care, but at the same time, he cannot "intrude" into any sphere of the household life by criticizing, remonstrating and attempting to control family life or domineer in any other way. Meanwhile Russian culture simply lacked such traditions because any ritual forms habitually less regulated communication between men and women, and the man, as a rule, bossed the show in every sphere of joint activity. Wedding ceremonies in Tatar culture, too, provided women with a more independent socio-economic position, compared with that of the wife being very dependent on her husband in Russian culture.

These cultural traditions and customs have influenced the education of boys and girls by imparting to them proper personal qualities and rules of social behavior in various situations. The traditional Tatar social division of the sexes and a well-developed system of ritual forms of regulating social interaction between representatives of one sex and those of the opposite sexes demanded that the members of these groups should display a whole gamut of psychological qualities ranging from domination to dependence, from initiative to subordination, from firmness to softness of character and so forth. That is the reason why this culture does not hold images of masculinity and femininity in too high esteem. Conversely, Russian culture should involve different psychological mechanisms for regulating social interaction when it allows closer social contacts between men and women that are almost unregulated by the ritual forms of communication.

Traditional upbringing aimed to inculcate in men and women mutually complementary personal psychological qualities to ensure the effectiveness of joint activities and to reduce the likelihood of interpersonal conflicts. In this regard, the ideal psychological images of masculinity and femininity will vary much in Russian culture.

Thus, the researchers' analysis showed significant differences to exist in the sex-role norms of the two cultures, which can have a substantial effect on the characteristics in the upbringing of girls and boys

in Tatar and Russian families. It can be assumed that the cultural features identified will influence the development of executive functions in boys and girls of the two cultures.

### **1.2. Cross-cultural studies of executive functions**

In conformity with the Miyake model (Miyake et al., 2000), executive functions are divided into the following three main components: 1) working memory; 2) flexibility of attention or shifting; 3) inhibitory control or inhibition.

Inhibitory control is an ability to resist internal or external distracters in accordance with the requirements of a task or a situation (Diamond, 2013). Cross-cultural studies have shown that children from Korea or China demonstrate a higher level of inhibition development compared to that of North American preschool children, which can be explained by educational practices and increased parental control in collectivist cultures (Lan et al., 2011; Oh & Lewis, 2008; Sabbagh et al., 2006). The study by A. Chasiotis and colleagues (2006) revealed that German and Costa Rican preschoolers from coped with inhibition tasks significantly better than Cameroonian children did. However, despite the revealed differences in the inhibition level many scientists are still inclined to believe the parameters of this EF component development to be similar in different cultures since its development has a neuropsychological basis (Friedman et al, 2008) and a universal evolutionary value (Ardila, 2008).

The cross-cultural study of Russian and Romanian preschool children conducted by L. Cheie and colleagues (2014) found no significant differences to exist in inhibitory control development; however, they obtained some data according to which Russian preschool children had a higher level of anxiety than their Romanian peers did. Moreover, this study showed that children's anxiety and age were the only predictors considered to be of significance for the successful performance of tasks on inhibition and cognitive flexibility.

## **2. Problem Statement**

Thus, there is data available on the issue of cross-cultural differences in the development of such an EF component as inhibitory control in preschoolers, but so far, there has been little comparative research into executive functions in Russian children compared with their peers from other cultures. Primarily, this is because EF development has only recently become the object of psychological research in Russia, which is a multicultural country. Thus to enable the study of these cognitive abilities it is necessary to take into account cultural specifics of various peoples inhabiting our country.

## **3. Research Questions**

In this study we wanted to address several problems:

- First, to analyze the similarities and differences in EF development in preschoolers from two different cultures. This particular age period is the most sensitive to EF development, so identification of the most significant factors that have a bearing on their formation is a major challenge to age psychology.

- Secondly, proceeding from the cultural features revealed and associated with inculcating certain behavioral patterns and personal qualities in boys and girls, we sought to analyze gender differences in the specifics of EF emergence in children from these two different cultures.

#### **4. Purpose of the Study**

The purpose of this study was to compare the development level of various executive function components (working memory, cognitive flexibility and inhibition) in older preschool children belonging to Russian and Tatar cultures.

#### **5. Research Methods**

##### **5.1. Sample**

The study involved 250 children from senior kindergartens groups in Moscow and Kazan (125 from Moscow, 125 from Kazan). Of these, 55.6% (139) were boys and 44.4% (111) were girls.

##### **5.2. Materials and Procedure**

Children were tested in two separate sessions in the middle of the school year. The first session included the assessment of verbal working memory, cognitive flexibility and anxiety. The second session included the assessment of visuospatial working memory and inhibition.

Executive functions were evaluated using three subtests from the standardized neuropsychological battery NEPSY-II (Korkman et al., 2007). NEPSY-II is based on designed to evaluate cognitive development in children between 3 and 16 years of age. The stimuli and instructions have been translated into Russian and used in prior research with Russian-speaking pre-schoolers (Almazova et al., 2017; Sobkin et al., 2016).

- To assess verbal working memory, we used the Sentence Repetition subtest. The stimuli included 17 sentences of increasing length and complexity. The child was read one sentence at a time and asked to repeat it. When the child recalled the sentence correctly, the response was scored as 2; when there was one or two mistakes, the response was scored as 1; when there were more than two mistakes, the response was scored as 0. If the child received 0 points on three consecutive trials, the procedure was stopped. The accuracy score was calculated by dividing the total number of points by the maximum possible score of 34.
- To assess visuospatial working memory, we used the Memory for Designs subtest. This task included four trials. On each trial, the child was shown a grid with four to eight designs. The grid was displayed for 10 seconds and then removed from view. Next, the child was provided with a blank grid and a set of cards, some of which depicted the same designs that were presented before. The child's task was to select the appropriate designs and place them on a grid in the same location as previously shown. For each trial points are scored separately for the four parameters:
  - 1) the Content score assesses the child's ability to recall which designs were shown for each trial;
  - 2) the Spatial Score assesses the child's ability to recall where a design was shown for the trial;

- 3) the Bonus Score reflects the child's ability to recall which designs were in which locations for that trial;
- 4) the Total Score for each trial is the sum of the Content, Spatial and Bonus Scores.

The maximum number of points varied across trials, reflecting the difference in the number of designs that had to be reproduced. The final score was calculated by dividing the total number of points earned by the maximum possible score of 120.

- To assess inhibition we used the Inhibition subtest. The stimuli included two pages depicting black and white squares and circles, alternating without any regularity. One page, used for practice, displayed 8 figures arranged in a line; the other page, used for test trials, displayed 40 figures arranged in 5 lines. The first task is Naming: the child is asked to name the shape of figures on the page as soon as possible. At the second task (Inhibition), the child is required to name figures in opposite to those which were actually pictured (say "circle" instead of "square" and vice versa). The researcher calculates three indicators in each task: 1) the number of Self-corrected Errors which has occurred when the child provides an uncorrected response or skip a shape, but correct the incorrect or skipped response; 2) the number of Uncorrected Errors which has occurred when the child does not correct the mistakes; 3) the completion time to each task.
- To assess cognitive flexibility we used the Dimensional Change Card Sort (DCCS) (Zelazo, 2006). Children are required to sort a series of bivalent test cards (with pictures of red rabbits and blue boats), first according to one dimension (color) and then according to another (shape). At the third try a child has to sort cards according to the more complicated rule with the additional factor (cards with/without borders). We computed the accuracy score for each try (maximum is 24 points).

## 6. Findings

### 6.1. The results of comparing Moscow and Kazan preschoolers

Visual working memory. In general, Moscow's preschoolers were much better at remembering the spatial location of objects (on the spatial score) than those from Kazan (for comparison: 17.62 and 16.28 points,  $t = 1.938$ ,  $p = 0.054$ ). If we are to talk about differences between the Moscow and Kazan boys, it was found that the Moscow boys scored significantly higher points than their Kazan peers in all the aspects of visual memory, except for the bonus (see Table 1). This suggests that the Moscow boys are better at remembering the location of objects on the field, and at distinguishing more easily the right images from distracters, compared with their Kazan counterparts. With girls, things are different: the scores obtained by girls from Moscow for the bonus are significantly lower than in those girls from Kazan got (for comparison: 12.49 and 17.45 points,  $t = -2.384$ ,  $p = 0.018$ ). Thus, the ability of boys from different cities to accurately reproduce an image, i.e., to put the right pictures in the right places, is developed equally, while the Moscow girls' ability is significantly less developed than that of the Kazan girls.

Verbal working memory. In terms of a trend, the verbal memory of preschoolers from Moscow is higher than that of Kazan preschoolers (for comparison: 19.57 and 18.21 points,  $t = 1.938$ ,  $p = 0.054$ ). At the same time, this trend can be traced for boys (for comparison: 19.60 and 18.68 points,  $t = 1.927$ ,  $p = 0.056$ ), but it is untraceable for girls.

**Table 01.** Differences in visual and verbal working memory scores in pre-school children in Moscow and Kazan

Working Memory	All sample Kazan/Moscow		Boys Kazan/Moscow		Girls Kazan/Moscow	
	t	p	t	p	t	p
Visual Memory, Content			1,969	0,050		
Visual Memory, Spatial	2,036	0,043	3,074	0,003		
Visual Memory, Bonus					-2,384	0,018
Visual Memory, Total Score			2,165	0,032		
Verbal Memory	1,938	0,054	1,927	0,056		

Cognitive flexibility. No significant differences were found to exist between preschoolers from Moscow and Kazan in the performance according to The Dimensional Change Card Sort methodology (DCCS).

Inhibition. The time it took the Moscow girls to name figures was significantly greater than that required by the Kazan girls (for comparison: 49.08 and 44.26 sec,  $t = -2.613$ ,  $p = 0.041$ ). This suggests that the latter have a better-developed cognitive flexibility and a higher speed of information processing. In addition, the number of mistakes corrected in the inhibition test for Moscow boys is significantly lower than in the one for Kazan boys (for comparison: 1.87 and 2.82 errors on average,  $t = 1.938$ ,  $p = 0.054$ ). Since no differences were observed in other indicators for this test, it can be assumed that the Moscow boys make fewer mistakes, which indicates that their ability for inhibition is developed better than that of the Kazan boys.

**Table 02.** Differences in assessments of inhibitory control in preschoolers from Moscow and Kazan

Inhibition	All sample Kazan/Moscow		Boys Kazan/Moscow		Girls Kazan/Moscow	
	t	p	t	p	t	p
Naming, time					1,982	0,050
Inhibition, Corrected Errors			-2,064	0,041		

An analysis of the connections between the EF components also made it possible to identify differences between children from Moscow and Kazan. Moscow preschoolers' performance according to the visual working memory method was associated with the number of mistakes made by children doing the inhibition task. One can assume that it is the well-developed ability to self-check and the high level of inhibition that help children to cope more successfully with choosing the right cards among the distracters and correctly position them on the field. Whereas the Kazan preschoolers' successful performances on the visual working memory assignment was more closely related to cognitive flexibility, i.e., an ability to follow instructions and to adapt to new task conditions (the DCCS technique).

## 6.2. Analysis of the differences between boys and girls in Moscow and Kazan

Visual working memory. Overall, the sample shows no differences in the visual working memory scores among boys and girls (Table 3). However, the Kazan girls' scores were higher in all parameters of visual memory, except for spatial location scores than those obtained by the Moscow girls (Table 3). At the same time, the Moscow boys' spatial memory scores are significantly higher than those shown by the girls (for comparison: 18.59 and 16.59 points,  $t = -2.613$ ,  $p = 0.041$ ). Thus, visual working memory is generally better developed in Kazan girls than it is in Kazan boys, but they equally well remember the spatial location of objects but this particular feature of working memory distinguishes boys from girls in Moscow.

Verbal working memory. There were no significant differences obtained in the scores of auditory working memory among all boys and girls and between boys and girls in each of the cities.

**Table 03.** Differences in assessments of working memory in boys and girls

Working Memory	All sample Boys / Girls		Boys Boys / Girls		Girls Boys / Girls	
	t	p	t	p	t	p
Visual Memory, Content			1,969	0,050		
Visual Memory, Spatial	2,036	0,043	3,074	0,003		
Visual Memory, Bonus					-2,384	0,018
Visual Memory, Total Score			2,165	0,032		

Cognitive flexibility. Throughout the sample, the girls' scores for card sorting by color and shape and the total score according to the DCCS method are significantly higher than the boys' (Table 4). Simultaneously, the same differences are observed in Kazan, while in Moscow there are no significant differences in the cognitive flexibility scores. Thus, the Kazan girls have a better-developed cognitive flexibility in comparison with the boys from Kazan, whereas in the Moscow girls and boys this cognitive ability is developed equally well.

**Table 04.** Differences in cognitive flexibility scores among boys and girls

Cognitive Flexibility	All sample Boys / Girls		Boys Boys / Girls		Girls Boys / Girls	
	t	p	t	p	t	p
DCCS, color	-2,008	0,046	-1,925	0,051		
DCCS, shape	-2,204	0,028	-1,821	0,071		
DCCS, borders						
DCCS, Total Score	-2,257	0,025	-2,176	0,031		

Inhibition. The sample offers, overall, no significant differences in the inhibition scores between boys and girls. At the same time in Kazan, the number of corrected errors and the time spent on naming is higher for boys than for girls, which also suggests a lower level of cognitive flexibility development in the Kazan boys. In Moscow, the number of corrected errors in the inhibition test is greater for girls than for boys, which indicates a higher level of self-control.



**Table 05.** Differences in inhibitory control scores among boys and girls

Inhibition	All sample Boys / Girls		Boys Boys / Girls		Girls Boys / Girls	
	t	p	t	p	t	p
Naming, Corrected Errors			2,293	0,024		
Naming, time			2,395	0,018		
Inhibition, Corrected Errors					-2,235	0,027

## 7. Conclusion

In this study, we sought to analyze the differences between Moscow and Kazan preschoolers. It was found that Moscow preschool children have a higher development level of verbal working memory, as well as spatial memory that stems primarily from the differences between Moscow and Kazan boys. It turned out that the visual and verbal working memory of Kazan boys is worse than that of Moscow boys. These differences may be due to the specific features of the development of other EF components - a much lower level of development of attention and inhibitory control involved in solving tasks on working memory, in comparison with Moscow boys. At the same time, significant differences were obtained in the level of EF development in Moscow and Kazan girls: the latter conversely have a better-developed visual working memory, cognitive flexibility and speed of information processing than the Moscow girls. Thus, the Moscow boys are far ahead of their Kazan peers in the development of certain EF components whereas the situation with the girls' development is quite the opposite. The revealed differences stemmed from the specifics of child rearing in the two cultures.

The analysis of the differences between boys and girls in Moscow and Kazan showed that the development level of various EF components is generally very close in respect to Moscow girls and boys whereas numerous differences were obtained among the Kazan children. Therefore, Kazan boys have a less developed visual working memory, cognitive flexibility and attentiveness in comparison with Kazan girls. These gender differences agree very well with the comparison results of preschool children from Moscow and Kazan, and are due to the peculiarities of child rearing in the two cultures. Thus, Tatar culture offers differences in the degree of boys' and girls' participation in housework, whereas Russian culture allows for practically none of such differences. In addition, in Tatar culture, girls are traditionally brought up to be more independent than girls in Russian culture which is aimed at inculcating traditional female qualities in girls in order to complement the traditionally male ones. Such features of upbringing can contribute to a more rapid EF development among Tatar girls in comparison not only with Tatar boys, but also with Moscow girls.

Thus, the study showed a relationship between EF development in preschool children and the specificity of child rearing in Russian and Tatar cultures. These differences are most conspicuously manifest in the development level of boys and girls from different cultures, which once again underscores the impact gender stereotypes and cultural behavioral models have on the development of cognitive control in children.

The obtained results supplement the picture of EF development in the preschool age period and make us think about the influence of cultural factors on the development of not only inhibitory control but also cognitive flexibility and working memory in children.

## 7.1. Limitations

The present study did not analyze actual parenting strategies, and nor did it control the factor of whether each family belonged to a particular culture. Neither did this study take into account the influence of the quality of the educational environment of the kindergarten, which also has a great impact on child development at this age stage.

Inclusion of these factors in future analysis will make it possible to clarify the relationships identified and to confirm the effect of cultural factors on EF development in the preschool period.

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