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Preschoolers' executive function: effect of the duration of preschool attendance and quality of teacher-child interactions

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The aim of this study was to determine the role of duration of preschool attendance and the quality of teacher-child interactions in the executive functions development of preschoolers. The study involved 947 children (51% girls) age 4–7 years ($M = 70.3$ months; $SD = 4.3$). The number of children attending kindergarten for less than 1 year was 144; 268 children (28.3%) had attended for 1 to 2 years; and 535 children (56.5%) had attended for more than 2 years. The results showed that the children who attended a group with a high quality of teacher-child interaction for one or more years had better results on verbal work memory, and cognitive and physical inhibitory control than those who attended the same group over a shorter period.

KEYWORDS

executive functions, cognitive development, teacher-child interactions, kindergarten attendance, preschool children

1 Introduction

Executive functions (EF) are a group of cognitive processes that provide the ability to adapt to new situations and exert behavioral control (Diamond, 2013; Morosanova et al., 2022; Silva et al., 2022). These processes include three core components: working memory (retaining and using information, both visual and verbal); cognitive flexibility (the ability to switch between rules, tasks, and stimuli), and inhibitory control (resisting habits, temptations, or distractions; Miyake et al., 2000). EF development is most active during the preschool years and becomes crucial to a child's later performance (Anderson, 2001; Zelazo and Müller, 2002).

There is a large amount of research-based evidence demonstrating the positive impact of EF on children's school adjustment and academic skills such as reading performance, language comprehension, math performance, and problem solving (Bull et al., 2008; Clements et al., 2016; Cortés Pascual et al., 2019; Oshchepkova and Shatskaya, 2023). Studies confirm that children with higher levels of EF are more successful in school compared to less EF- developed children (Cortés Pascual et al., 2019). The high importance of EF for academic success, starting in early childhood, increases interest in understanding the factors that contribute to their development.

One of the most important factors determining cognitive development in children is their social environment. In accordance with this, kindergarten attendance becomes one of the significant variables of EF. Research findings have associated this with the fact that the kindergarten environment provides opportunities for communication with peers,

interaction with different tools, and role-playing behavior (Vandell et al., 2010; Ghardashi et al., 2013; Hall et al., 2013; Sylva et al., 2014; Dean and Jayachandran, 2019). Furthermore, in modern kindergarten, children learn foreign languages, take music and dance classes, and practice sports (Veraksa et al., 2019). A growing body of evidence shows that these activities improve working memory, inhibitory control, and flexibility, the main components of EF (Howard et al., 2018; Chichinina et al., 2022; Dolgikh et al., 2022; Furlley et al., 2023).

Among the most important factors that can influence children's cognitive development in kindergarten is the quality of teacher-child interactions. According to Hamre and Pianta (2007), the main dimensions of teacher-child interaction include emotional support, classroom organization and instructional support. The results of longitudinal and cross-sectional studies have shown that this factor has a long-term impact on EF in preschoolers (Williford et al., 2013, 2016; Veraksa A. N. et al., 2020). According to the cultural-historical approach, this is since the teacher is a bearer of social rules, and an example of volitional actions (Vygotsky, 1982; Veresov, 2012). Thus, a child's ability to develop cognitive skills (including EF) depends on the opportunities provided by the adult during joint interaction (Pianta et al., 2008).

However, it is important to note that the data on the role of duration of preschool attendance and the quality of teacher-child interaction in children's cognitive development are contradictory and not always empirically supported (Burchinal et al., 2010; Weiland et al., 2013; Hill et al., 2015; Gong et al., 2016). Moreover, there are practically no studies that examine the joint effect of these indicators on the EF in preschool children.

2 Current study

This study was aimed to explore the role of duration of preschool attendance and quality of teacher-child interactions in EF development of preschoolers. It is important to note that attending kindergarten is not obligatory for children in Russia. This makes the question of the role of kindergarten attendance in children's cognitive development especially relevant.

The study covered the following research questions: (1) How does the duration of preschool attendance impact EF? and (2) What relationships between the quality of teacher-child interaction and duration of preschool attendance is most effective for building of EF skills?

3 Materials and methods

3.1 Procedure

Data were collected between March and May 2023, while the children were attending senior groups of municipal kindergarten in Moscow, Kazan, and Sochi. All the EF tests were performed during three individual meetings with each child (each lasting 20–25 min) in a quiet room in the kindergartens. The interval between meetings was 1 or 2 weeks. Classroom observations of teacher-child interactions were conducted in live situations during the spring of 2023 by one certified specialist in the CLASS method.

The study was approved by the Ethics Committee of the Faculty of Psychology at Lomonosov Moscow State University (approval No: 2023/8).

3.2 Participants

The study involved 947 children (51% girls) age 4–7 years ($M = 70.3$ months; $SD = 4.3$). The children attended kindergartens in Moscow (73.9%), Kazan (13.5%), and Sochi (12.6%). The children's kindergarten attendance periods ranged from 2 to 56 months ($M_{\text{age}} = 27.3$; $SD_{\text{age}} = 11.8$). All the kindergartens were public and education in them was free. In all studied groups there were approximately the same number of children (about 30) and 1 or 2 teachers. All kindergartens adhered to the same educational program, "From Birth to School." This programme is implemented in the context of different types of children's activities: play, communication, project activities, creative activities (drawing, music, reading; Veraksa et al., 2019). All children attended the senior kindergarten group. All parents were informed about the aims of the study and gave written consent for their children's involvement in the research.

3.3 Measures

3.3.1 EF skills measures

To assess the development of the children's EF, subtests of the NEPSY-II (Korkman et al., 2008) were used. The reliability of the tools used to assess EF has been tested on more than 1,300 preschoolers from Russia (Veraksa A. et al., 2020).

3.3.1.1 Verbal working memory

To study verbal working memory, the "Sentences Repetition" (SR) subtest of the NEPSY-II was used. The subtest consists of 17 sentences, which are presented in gradually increasing difficulty (in the length and grammatical) with the task to remember and repeat them. The instructor pronounces them at a calm pace. The child has to repeat the sentence after the instructor. For each correctly repeated sentence, a child receives 2 points; if he/she made 1–2 mistakes while repeating (e.g., such as skipping, replacing, or adding words, changing the order of words), he/she gets 1 point; if, however, a child makes 3 or more mistakes or does not answer at all, then he/she is awarded 0 points.

3.3.1.2 Visual working memory

To study the children's visual working memory and visual-spatial orientation, the NEPSY-II "Memory for Designs" (MfD) subtest was used. In this the child is presented with images with pictures located on the field for 10 s, after which the image is removed from the field of vision, and the child is asked to choose from the proposed cards (including tractor cards) those that he/she has seen before and place them in the part of the field (cell) where they were on the sample. The technique includes four samples, in which the number of cards increases from 4 to 8 on one field. At the end of the test the child receives points for content (for each correctly chosen card), location (for any card placed in the same cell as on the sample), and bonus points (for a correctly chosen card placed in the same cell as on the sample). The total score of visual working memory is the sum of the scores of the listed indicators.

3.3.1.3 Reactive cognitive flexibility

The Dimensional Change Card Sort (DCCS; Zelazo, 2006) was used to assess the children's reactive cognitive flexibility. The DCCS includes three tasks for sorting cards. In the first task the child has to sort the cards by color; in the second, by shape, and then follow a complex rule: if a card has a black border, he/she has to sort it by color, and if there is no border, by shape. In each type of sorting, there are differences between the cards being sorted and the basis for sorting (e.g., when cards are sorted by color, the shape does not match, and vice versa). For each correctly sorted card, the child is awarded 1 point. At the end, the total number of points for each task and then the total score for all tasks is calculated.

3.3.1.4 Cognitive inhibition

The "Inhibition" subtest of the NEPSY-II was used for assessment of cognitive inhibition. The subtest consists of two blocks: a series of white and black figures (circles and squares) and a series of arrows with different directions (up and down). Two tasks are carried out with each series of pictures: the task of naming figures (in this case a child simply has to name the figures that s/he sees as quickly as possible) and the task for inhibition (in this case a child is supposed to say the opposite of what they see; for example, if she/he sees a square, she/he has to say "circle," etc.). Each task is scored by the number of errors the child makes, the number of errors corrected or uncorrected, and the amount of time the child spends on the task. Based on the results obtained in each series, as well as the exact age of the children in months, integrated scores for information processing speed and cognitive inhibitory control are calculated.

3.3.1.5 Physical inhibition: statue

The "Statue" subtest of the NEPSY-II is aimed at measuring inhibition and self-control of bodily movements. In this task, a child needs to stand motionless in a certain position for 75 s, without being distracted by external sound stimuli. For each 5-s interval three types of mistakes are recorded (i.e., movements, the opening of the eyes, and vocalizations). The child receives points from 0 to 2 for the successful completion of the task (maximum 30 points); 2 points if he/she does not make a mistake during a 5-s interval; 1 point if child makes one type of mistake; and 0 points if the child makes 2 or more types of mistakes.

3.3.2 Teacher-child interaction

The quality of teacher-child interaction in kindergarten was measured using the Classroom Assessment Scoring System (CLASS, Pre-K; Pianta et al., 2008; Bukhalenkova and Almazova, 2022). This method requires at least four 30-min cycles of observation of the children in a group (total duration = 120 min/class). The CLASS method assesses classroom experience in three domains: Emotional Support (Cronbach's $\alpha = 0,755$), Classroom Organization (Cronbach's $\alpha = 0,674$), and Instructional Support (Cronbach's $\alpha = 0,855$). Emotional support is a composite measure of four dimensions: positive and negative climate, teacher sensitivity, and regard for students' perspectives. Classroom Organization includes measures of three dimensions: behavior management, productivity, and instructional learning formats. Instructional Support includes three dimensions: concept development, quality of feedback, and language modeling.

All the dimensions are evaluated using a 7-point Likert scale. From the points received in each dimension, three domain scores are calculated.

3.3.3 Duration of preschool attendance

Duration of preschool attendance of each child was recorded in months. The data were collected according to the register of children's stay in preschool. The teacher did not change during the child's attendance in the kindergarten. In the framework of this study, we assumed that the kindergarten environment had not changed.

4 Results

The distribution in the sample was mixed (Shapiro-Wilk test). The results of diagnostics of children's EF corresponded to the age norms defined earlier on the basis of a study of older Russian preschoolers (Veraksa A. et al., 2020).

4.1 Duration of preschool attendance and EF skills

In the first step of statistical analysis, the following three groups were identified: 144 children (15.2% of the sample) had attended kindergartens for less than 1 year; 268 children (28.3%) for 1 to 2 years; and 535 children (56.5%) for more than 2 years.

Then the ANOVA was used to examine the role of duration of preschool attendance in the children's EF (Welch criterion). As a result, significant differences in the level of development of verbal working memory ($F = 9.055, p < 0.001$) and physical inhibitory control ($F = 4.9, p = 0.008$) were revealed depending on the children's kindergarten attendance period. There was no significant difference for the reactive cognitive flexibility. The analysis of *a posteriori* differences (Gaims-Howell criterion) revealed that:

- verbal working memory levels were significantly lower in children who attended kindergarten for less than 1 year compared to children with longer attendance periods;
- physical inhibitory control was also significantly lower in children who attended kindergarten for less than 1 year compared to children with longer attendance periods.

4.2 The quality of teacher-child interaction and of duration of preschool attendance

An ANOVA was conducted to test the hypothesis that the children's EF development would be influenced not only by the quality of teacher-child interaction itself, but by the period of time the child spent in that environment.

At first, a cluster analysis of the results in the CLASS assessment was carried out (using the K-means method). It allowed us to identify three groups with low, medium, and high levels of teacher-child interaction (Table 1). The groups all had significant differences in all CLASS domains (the Welch criterion, $p \leq 0.001$).

The first group included children ($N=363$) with low indicators of emotional support, classroom organization, and instrumental support in the group. The indicators of emotional support and classroom organization according to the norms of the methodology were at an average level. The second group of children ($N=460$) was characterized by average indicators of teacher-child interaction in the group relative to the sample. Here all indicators corresponded to the average level according to the norms of the methodology. The third group ($N=180$) included children in whose groups the interaction between teacher and children was at a high level. The indicators of emotional support and classroom organization here corresponded to a high level according to the norms of the methodology, but instrumental support was at an average level.

At the next stage, using the clusters obtained previously, we used bifactorial ANOVA to analyze the joint effect of kindergarten attendance period with the teacher-child interaction on the level of EF (Table 2). It is important to note that there were no significant differences in EF development depending on the quality of teacher-child interaction alone.

A significant joint effect of duration of preschool attendance, and the quality of teacher-child interaction on the development of verbal working memory, and cognitive and physical inhibitory control, was found. There was no significant difference for the reactive cognitive flexibility. The analysis of a post-hoc comparisons (Games-Howell criterion) found pairwise differences for a number of indicators. Children in groups with a high level of teacher-child interaction with a longer kindergarten attendance period demonstrated higher indicators of a verbal working memory, and cognitive and physical inhibitory control relative to the children in groups with a high level of teacher-child interaction, but a shorter period of kindergarten attendance.

5 Discussion

5.1 Duration of preschool attendance and EF

The first research question of the present study was to determine the role of duration of preschool attendance on the EF development of preschoolers.

The analysis revealed significant differences in the level of development of verbal working memory and physical inhibitory control depending on the children's kindergarten attendance period. The results showed that children with less than a year of kindergarten attendance period performed more poorly on verbal working memory than children attending kindergarten for a year or more. Such results can be explained by the fact that for the interaction with peers and teachers, children need to memorize important information and use it in the future; thus their capacity of verbal working memory increases. Moreover, activities that a child attending kindergarten is involved in may also contribute to the development of verbal memory. For example, singing, reading, or learning a foreign language lead a child to use more of his/her verbal working memory to successfully learn the material (Weiland et al., 2013; Shoghi Javan and Ghonsooly, 2017; Frolli et al., 2022).

Our study also showed differences in physical inhibitory control depending on the kindergarten attendance period. Children who had attended kindergarten for more than a year were better able to control their behavioral impulses and to restrain them if the situation required it. This is due to the fact that the kindergarten environment is oriented towards the child's socialization and promotes the internalization of behavioral norms (Vygotsky, 1982). Learning the norms implies understanding the appropriateness of one's actions in

TABLE 1 Results of CLASS domains and dimensions assessment.

CLASS domains	Low level		Medium level		High level		Significance of differences (Welch criterion, p)	
	M	SD	M	SD	M	SD		
Emotional support	4.74	0.57	5.66	0.44	6.45	0.25	1,260	<0.001
Classroom organization	4.14	0.49	5.37	0.36	6.51	0.33	2,214	<0.001
Instructional support	1.88	0.46	2.68	0.5	3.79	0.76	595	<0.001
N	363		460		180			

TABLE 2 Joint effect of the kindergarten attendance period and teacher-child interaction quality on the level of EF.

EF parameters	Kindergarten attendance * teacher-child interaction (joint effect)	Post hoc comparisons: kindergarten attendance * teacher-child interaction (joint effect)
Verbal working memory	$F=4.536$ $p=0.001$	low level of teacher-child interaction * less than 1 year kindergarten attendance < high level of teacher-child interaction * more than 2 years kindergarten attendance * high level of teacher-child interaction * less than 1 year kindergarten attendance < high level of teacher-child interaction * for one to 2 years high level of teacher-child interaction * less than 1 year kindergarten attendance < high level of teacher-child interaction * more than 2 years
Cognitive inhibitory control	$F=2.98$ $p=0.001$	high level of teacher-child interaction * for one to 2 years kindergarten attendance > medium level of teacher-child interaction * for one to 2 years kindergarten attendance
Physical inhibitory control	$F=2.45$ $p=0.004$	high level of teacher-child interaction * less than 1 year kindergarten attendance < high level of teacher-child interaction * for one to 2 years kindergarten attendance

specific situations and the need to suppress impulsive desires and urges. In addition, interaction with peers in kindergarten often takes place in play. Through the playful reproduction of everyday life actions (e.g., role-playing situations at the store, in the family, at school, etc.), preschoolers learn the behavioral rules for different situations, which implies control of one's behavior (Pinto et al., 2013; Hamre et al., 2014; Yudina, 2022).

5.2 The joint effect of the quality of teacher-child interactions and duration of preschool attendance in the EF

The second research question was to determine the most effective relationship between the quality of teacher-child interactions and kindergarten attendance period for EF.

The study revealed the joint effect of kindergarten attendance period and teacher-child interaction quality on the development of verbal working memory, and cognitive and physical inhibitory control. It was shown that children who attended a group with a higher quality of teacher-child interaction for more than a year had better results on verbal working memory and physical inhibitory control measures than those who attended a similar group for less than a year. In addition, children who attended the group with high teacher-child interaction quality for 1 to 2 years showed better results in cognitive inhibitory control test than those who attended the group with medium teacher-child interaction quality over the same attendance period.

The longer a child had attended a group with high level of teacher-child interaction quality, the better the child's voluntary control of his or her own activities. According to previous findings, regular positive feedback and emotional support from the teacher contribute to a child's EF (Duval et al., 2016; Bukhalenkova et al., 2022). In addition, the classroom organization and daily routine arrangement contribute to the result that the children adapt to the kindergarten environment and learn to control their own behavior.

It is interesting to note that our study did not find significant differences in the level of development of EF in children who attended kindergarten for less than a year depending on the level of teacher-child interaction quality. We assumed that this was due to the fact that not only the environment itself is important for the child's cognitive development, but also the child's readiness to perceive the environmental conditions. Before teacher-child interaction begins to play a role in children's cognitive development, the child has to have adapted to the kindergarten environment and teachers.

Finally, a number of important limitations need to be considered. Our study did not consider family factors: socioeconomic status, the quality of parent-child interactions, and the quality of the home environment. These can all potentially influence EF. In addition, it seems important to trace the extracurricular activities of the children in future studies.

6 Conclusion

This study set out to determine the importance of duration of preschool attendance and the quality of teacher-child interactions in the EF development of preschoolers. The

significance of the kindergarten attendance period in the development of working memory and physical inhibitory control, both key components of EF, was underscored. The second major finding was that the children who attended a group with a high level of teacher-child interaction for more than a year had higher scores on EF. Thus, it was not only the kindergarten environment itself which was relevant, but also the duration of the preschoolers' stay there. For further research, it would be interesting to assess the longitudinal effects of kindergarten attendance period and the quality of teacher-child interactions on the EF of preschoolers.

The results are of practical significance for teachers and parents. For parents, the results can help them to make a decision to enrol their child in kindergartens, especially in Russia, where this period is not obligatory for children. For teachers they demonstrate the necessity of better professional preparation of teachers in kindergartens.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study was approved by the Ethics Committee of the Faculty of Psychology at Lomonosov Moscow State University (approval no: 2023/8). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

MG: Formal analysis, Writing – original draft, Writing – review & editing. AK: Methodology, Resources, Writing – review & editing. OS: Conceptualization, Methodology, Writing – review & editing. AV: Conceptualization, Funding acquisition, Project administration, Supervision, Writing – review & editing. AY: Formal analysis, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

- Anderson, V. (2001). Assessing executive functions in children: biological, psychological, and developmental considerations. *Pediatr. Rehabil.* 4, 119–136. doi: 10.1080/13638490110091347
- Bukhalenkova, D. A., and Almazova, O. V. (2022). Experience in applying the CLASS method for assessing the quality of the educational environment of a kindergarten. *Vestnik Moskovskogo Universiteta. Seriya 14. Psikhologiya* 2, 128–152. doi: 10.11621/vsp.2022.02.06
- Bukhalenkova, D., Veraksa, A., and Chursina, A. (2022). The effect of kindergarten classroom interaction quality on executive function development among 5- to 7-year-old children. *Educ. Sci.* 12:320. doi: 10.3390/educsci12050320
- Bull, R., Espy, K. A., and Wiebe, S. A. (2008). Short-term memory, working memory, and executive functioning in preschoolers: longitudinal predictors of mathematical achievement at age 7 years. *Dev. Neuropsychol.* 33, 205–228. doi: 10.1080/87565640801982312
- Burchinal, M., Vandergrift, N., Pianta, R., and Mashburn, A. (2010). Threshold analysis of association between childcare quality and child outcomes for low-income children in pre-kindergarten programs. *Early Child. Res. Q.* 25, 166–176. doi: 10.1016/j.ecresq.2009.10.004
- Chichinina, E., Bukhalenkova, D., Tvardovskaya, A., Semyonov, Y., Gavrilova, M., and Almazova, O. (2022). The relationship between executive functions and dance classes in preschool age children. *Educ. Sci.* 12:788. doi: 10.3390/educsci12110788
- Clements, D. H., Sarama, J., and Germeroth, C. (2016). Learning executive function and early mathematics: directions of causal relations. *Early Child. Res. Q.* 36, 79–90. doi: 10.1016/j.ecresq.2015.12.009
- Cortés Pascual, A., Moyano Muñoz, N., and Quílez Robres, A. (2019). The relationship between executive functions and academic performance in primary education: review and Meta-analysis. *Front. Psychol.* 10:1582. doi: 10.3389/fpsyg.2019.01582
- Dean, J. T., and Jayachandran, S. (2019). Attending kindergarten improves cognitive but not socioemotional development in India. Working paper. Available at: <https://faculty.wcas.northwestern.edu/~sjv340/kindeergarten.pdf> (Accessed March 20, 2024).
- Diamond, A. (2013). Executive functions. *Annu. Rev. Psychol.* 64, 135–168. doi: 10.1146/annurev-psych-113011-143750
- Dolgikh, A. G., Bayanova, L. F., Shatskaya, A. N., and Yakushina, A. A. (2022). The relationship between teacher evaluation of children's musical abilities and executive functions indicators in children attending music classes. *Russian Psychol. J.* 19, 80–93. doi: 10.21702/rpj.2022.4.5
- Duval, S., Bouchard, C., Pagé, P., and Hamel, C. (2016). Quality of classroom interactions in kindergarten and executive functions among five-year-old children. *Cogent Educ.* 3, 120–129. doi: 10.1080/2331186X.2016.1207909
- Frolli, A., Cerciello, F., Esposito, C., Ciotola, S., De Candia, G., Ricci, M. C., et al. (2022). Executive functions and foreign language learning. *Pediatric Rep.* 14, 450–456. doi: 10.3390/pediatric14040053
- Furley, P., Schütz, L.-M., and Wood, G. (2023). A critical review of research on executive functions in sport and exercise. *Int. Rev. Sport Exerc. Psychol.*, 1–29. doi: 10.1080/1750984X.2023.2217437
- Ghardashi, F., Rahnama, F., Akbarzadeh, R., and Stagy, Z. (2013). Relationship between kindergarten attendance and cognitive-motor development of preschool children in Sabzevar City. *Life Sci. J.* 9, 377–380.
- Gong, X., Xu, D., and Han, W. J. (2016). The effects of preschool attendance on adolescent outcomes in rural China. *Early Child. Res. Q.* 37, 140–152. doi: 10.1016/j.ecresq.2016.06.003
- Hall, J., Sylva, K., Sammons, P., Melhuish, E., Siraj Blatchford, I., and Taggart, B. (2013). Can preschool protect young children's cognitive and social development? Variation by center quality and duration of attendance. *Sch. Eff. Sch. Improv.* 24, 155–176. doi: 10.1080/09243453.2012.749793
- Hamre, B. K., Hatfield, B., Pianta, R., and Jamil, F. (2014). Evidence for general and domain-specific elements of teacher-child interactions: associations with preschool children's development. *Child Dev.* 85, 1257–1274. doi: 10.1111/cdev.12184
- Hamre, B. K., and Pianta, R. C. (2007). "Learning opportunities in preschool and early elementary classrooms" in School readiness and the transition to school. eds. R. C. Pianta, M. J. Cox and K. Snow (Baltimore, MD: Brookes), 49–84.
- Hill, C. J., Gormley, W. T., and Adelstein, S. (2015). Do the short-term effects of a high-quality preschool program persist? *Early Child. Res. Q.* 32, 60–79. doi: 10.1016/j.ecresq.2014.12.005
- Howard, S. J., Vella, S. A., and Cliff, D. P. (2018). Children's sports participation and self-regulation: bi-directional longitudinal associations. *Early Child. Res. Q.* 42, 140–147. doi: 10.1016/j.ecresq.2017.09.006
- Korkman, M., Kirk, U., and Kemp, S. L. (2008). *NEPSY-II: Lasten Neuropsychologinen Tutkimus*. Helsinki: Psykologien Kustannus.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., and Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: a latent variable analysis. *Cogn. Psychol.* 41, 49–100. doi: 10.1006/cogp.1999.0734
- Morosanova, V. I., Bondarenko, I. N., and Fomina, T. G. (2022). Conscious self-regulation, motivational factors, and personality traits as predictors of students' academic performance: a linear empirical model. *Psychol. Russia State Art* 15, 170–187. doi: 10.11621/pir.2022.0411
- Oshchepkova, E. S., and Shatskaya, A. N. (2023). Development of narratives in children aged 6-8 years depending on the level of executive functions. *Lomonosov Psychol. J.* 46, 11–31. doi: 10.11621/LPJ-23-25
- Pianta, R., La Paro, K., and Hamre, B. (2008). *Classroom Assessment Scoring System PreK Manual*. Baltimore, MD: Brookes.
- Pinto, A. I., Pessanha, M., and Aguiar, C. (2013). Effects of home environment and center-based child care quality on children's language, communication, and literacy outcomes. *Early Child. Res. Q.* 28, 94–101. doi: 10.1016/j.ecresq.2012.07.001
- Shoghi Javan, S., and Ghonsooly, B. (2017). Learning a foreign language: a new path to enhancement of cognitive functions. *J. Psycholinguist. Res.* 47, 125–138. doi: 10.1007/s10936-017-9518-7
- Silva, C., Sousa Gomes, V., Fávero, M., Oliveira Lopes, S., Merendeiro, C. S., Oliveira, J., et al. (2022). Assessment of preschool-age executive functions: a systematic review. *Clin. Psychol. Psychother.* 29, 1374–1391. doi: 10.1002/cpp.2718
- Sylva, K., Melhuish, E., Sammons, P., Siraj, I., Taggart, B., Smees, R., et al. (2014). Effective pre-school, primary and secondary education 3–16 project (EPPSE 3–16) students' educational and developmental outcomes at age 16 department. Education research report RR354
- Vandell, D. L., Belsky, J., Burchinal, M., Steinberg, L., and Vandergrift, N. (2010). NICHD early childcare research. Do effects of early child care extend to age 15 years? Results from the NICHD study of early child care and youth development. *Child Dev.* 81, 737–756. doi: 10.1111/j.1467-8624.2010.01431.x
- Veraksa, A. N., Almazova, O. V., and Bukhalenkova, D. A. (2020). Studying executive functions in senior preschoolers. *PsyCh J.* 9, 144–146. doi: 10.1002/pchj.310
- Veraksa, A., Bukhalenkova, D., and Almazova, O. (2020). Executive functions and quality of classroom interactions in kindergarten among 5–6-year-old children. *Front. Psychol.* 11:603776. doi: 10.3389/fpsyg.2020.603776
- Veraksa, N. E., Komarova, T. S., and Dorofeeva, A. M. (eds.). (2019). From birth to school. Innovative program of preschool education. 5th ed. M.: Mozaika-Sintez, 335 p.; 6th ed. supplemented and revised. M.: Mozaika-Sintez, 366 p.
- Veresov, N. (2012). The importance of cultural-historical theory of education: reflections on learning, development, business, and creativity. *Forum Osviatowe* 1, 141–156.
- Vygotsky, L. S. (1982). Problems of general psychology. Collected works. In 6 vol.: vol. 2. Moscow: Pedagogy.
- Weiland, C., Ulvestad, K., Sachs, J., and Yoshikawa, H. (2013). Associations between classroom quality and children's vocabulary and executive function skills in an urban public prekindergarten program. *Early Child. Res. Q.* 28, 199–209. doi: 10.1016/j.ecresq.2012.12.002
- Williford, A. P., LoCasale-Crouch, J., Whittaker, J. V., DeCoster, J., Hartz, K. A., Carter, L. M., et al. (2016). Changing teacher-child dyadic interactions to improve preschool Children's externalizing behaviors. *Child Dev.* 88, 1544–1553. doi: 10.1111/cdev.12703
- Williford, A. P., Vick Whittaker, J. E., Vitiello, V. E., and Downer, J. T. (2013). Children's engagement within the preschool classroom and their development of self-regulation. *Early Educ. Dev.* 24, 162–187. doi: 10.1080/10409289.2011.628270
- Yudina, E. G. (2022). Pretend play as the territory of freedom. *Nat. Psychol. J.* 47, 13–25. doi: 10.11621/npj.2022.0303
- Zelazo, P. D. (2006). The Dimensional Change Card Sort (DCCS): a method of assessing executive function in children. *Nat. Protoc.* 1, 297–301. doi: 10.1038/nprot.2006.46
- Zelazo, P. D., and Müller, U. (2002). "Executive function in typical and atypical development" in Blackwell handbook of childhood cognitive development. ed. U. Goswami (Oxford, UK: Blackwell), 445–469.