

IRSTI 14.23.17

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The Impact of Neurogames on the Development of Creative Skills Among Preschool Group Children

Abstract

Introduction. This article provides a comprehensive examination of the impact of neurogames on the development of creative skills in children of the preschool preparatory group. Based on the interconnection between cognitive, emotional, and sensorimotor systems in children aged 5–6, the authors present neurogames as a scientifically grounded tool for activating creative potential. In the context of growing interest in preschool education methods that stimulate brain activity, enhance sensorimotor coordination, and develop imaginative thinking, the implementation of neurogames is viewed as a relevant pedagogical task. **Methodology and Methods.** The research was conducted in preschool institutions by adapting neurogames to organized educational activities such as “Speech Development”, “Children’s Literature”, “Fundamentals of Mathematics,” and “Introduction to the Surrounding World”. The study applied various methods, including sensory integration, imagination and creative thinking exercises, the “Neuromatryoshka” method, the method for assessing emotional response, as well as correlation and regression analysis to evaluate the effectiveness of the neurogames. **Results.** The authors empirically confirmed the effectiveness of neurogames in expanding children’s vocabulary, enhancing emotional responsiveness, and stimulating imagination and figurative thinking, achieving positive outcomes. Comparative and quantitative analyses demonstrated that neurogames have a comprehensive positive influence on the development of cognitive, sensorimotor, emotional-volitional, and creative components of activity. **Scientific novelty.** The results suggest that stimulating brain activity through neurogames is an effective means of fostering creative skills in preschool-aged children. **Practical Significance.** The presented research is a scientific-practical work aimed at modernizing the content of preschool education and integrating innovative neuropedagogical approaches into educational practice.

Keywords: neurogames, creative skills, preschool children, sensory integration, emotional regulation, figurative thinking, neuropedagogy.

Introduction. In response to societal demands, the intensification of interdisciplinary integration and socio-cultural changes are imposing new requirements on the modern education system. Particularly, from the preschool education stage, the development of children’s creative potential has become one of the strategic priorities in the global educational landscape. In recent years, the potential of neuroscience, specifically neuropsychology, neurophysiology, neurobiology, cognitive neuroscience, neurolinguistics, neuro-education, and neurotechnologies, has garnered particular attention in the development of children’s creative skills, with a focus on the application of neurogames. As a result of the convergence of neuroscience, brain function, learning and memory processes, emotional-volitional processes, and behavioral mechanisms are being studied in greater depth, leading to the

introduction of new scientific foundations into preschool education and upbringing practices. In this context, alongside traditional pedagogical approaches, there is a high potential for prioritizing neuroscience-based methods, including neurogames grounded in neurodidactics, in the process of developing preschool children's intellectual, emotional, and creative potential. The creative development of children aged 5-6 is characterized by the rapid growth of imagination, figurative thinking, and the ability to generate original ideas. At this stage, children actively explore their environment and can creatively recreate their experiences through play, drawing, sculpting, and dramatization. Neurogames, as tools that activate brain function, stimulate cognitive processes, and facilitate learning, have proven effective, with significant contributions from both classical and contemporary foreign and domestic scholars.

The Model Curriculum for Preschool Education and Training states that "The development of children's creative skills and research activities is carried out daily, taking into account their individual characteristics, through play, as well as activities such as drawing, sculpting, collage-making, construction, and music-based organized activities". In the Model Curriculum, the development of children's creative skills in the educational and upbringing process is implemented through neurogames, based on individual characteristics, such as finger exercises, visual-spatial tasks, and activities that involve imagining artistic images.

In his Address to the People, President K.K. Tokayev emphasized the need for special attention to the education sector, highlighting the importance of preschool education and the need to focus on the direction of children's learning and upbringing (Tokayev, 2024). This is because preschool education is considered a crucial area that contributes to the further development of the state. The Address clearly outlines the necessity of creating conditions for quality education and upbringing from an early age. Therefore, the content of teaching and upbringing in preschool institutions in our country requires the introduction of new effective innovations aimed at enhancing the harmonious

development of children and improving the quality of their cognitive, communicative, and creative skills. One of the innovations actively entering the current preschool education process is neurogames.

Neurogames are exercises and game forms designed to coordinate cognitive, sensory, and motor systems, enhancing brain activity. In this regard, the aim of our research is to empirically determine the effectiveness of neurogames in developing preschool children's creative skills. The objective of the study is to assess the impact of the systematic use of neurogames on the development of creative skills in preschool children. Children's creativity began to be studied scientifically as a subject of psychological and pedagogical research in the early 20th century. One of the pioneers, Vygotsky (2004), in his work "Imagination and Creativity in Childhood", demonstrated that children's creative activity develops in a fundamentally different way from that of adults, with imagination, emotional responses, and the ability to imitate real life being its underlying foundations. Supporting Vygotsky's (2004) ideas, Piaget (2003) demonstrated in his work, *Play, Dreams, and Imitation in Childhood*, that creative thinking is closely related to the stages of children's cognitive development.

In his work, Luria (1966), who studied the connection between creativity and the brain, demonstrated that the coordinated interaction between the brain's motor areas and language centers directly influences children's cognitive abilities, including creative thinking. He emphasized the importance of fine motor skill exercises and rhythmic games, which involve bilateral hand movements, in enhancing these abilities. In his research, Elkonin (1999) examined the relationship between creativity and play, demonstrating that children represent real-life situations during role-playing activities. Through the construction of imaginative scenarios, freedom and imagination are cultivated, indicating that play involves active engagement in activities that contribute to developmental processes.

Research by scholars reveals that the development of children's creative skills is based

on the interconnectedness of their cognitive, emotional, and motor systems. Creative skills are developed through imagination, visualization, and role-playing, allowing the child to freely represent life experiences. Neurogames enhance this process by activating the brain's motor and language areas through neuro-exercises and rhythmic games. Thus, neurogames can be used as an effective neuroeducational tool for developing creative skills in preschool children. Sherry & Dibble (2009) studied the impact of games on brain development in early childhood education and demonstrated their role in promoting the renewal of neural connections. The authors stated that playing activities and specially organized cognitive tasks strengthen synaptic connections and contribute to the development of the biological foundations of children's creative thinking. Karabulut (2013) theoretically and practically concluded that children's cognitive abilities develop during the preschool period as a result of sensory, motor, and emotional experiences.

In the work of Alotaibi (2024), it was demonstrated that the effectiveness of play-based learning in preschool education is assessed through systematic reviews and meta-analysis methods. The study also proves that neurogames have a significant impact on cognitive development, social development, emotional development, motivation, and activity levels. Parker et al. (2022) explored the importance of incorporating play into children's learning. The concept of "learning through play" demonstrates its contribution to the development of children's cognitive, social, emotional, creative, and physical competencies. From the key characteristics of teaching provided by the authors, the principles considered in neurogames can be identified:

- joyful: the learning process should bring joy and pleasure to the child;
- meaningful: education must be connected to the child's life experience;
- interactive: children should engage in collaborative activities with both their peers and the educator;
- active: the child must actively participate in the learning process and not just be a passive observer;

- repetitive: the child should learn by correcting mistakes through repetition and trying again.

In the works of Ayres (2018), exercises based on sensory integration are identified as playing a crucial role in the development of children's cognitive and motor systems. Sensory experiences are characterized as «food for the brain», and the incorporation of movement and rhythmic elements into the learning process is advocated. This approach has been applied in neurogames designed to enhance children's attention, memory, and motor coordination. Satova et al. (2021) developed a set of tasks aimed at fostering children's creative thinking and proposed specific methodologies for stimulating imagination, fantasy, and figurative thinking. The methods suggested by the authors served as the foundation for designing neurogames aimed at enhancing children's creative skills. The «Neuro-Matryoshka» method proposed by Zapodoynikova (2023) demonstrates positive results in the impact of neurogames aimed at developing a child's fine motor skills, creativity, and figurative thinking. Through symmetrical imagery, movement repetition, and mirror exercises, the method promotes the harmonious development of both brain hemispheres, showing its effectiveness in enhancing these cognitive abilities.

In the research of Dabyltayeva (2024), effective ways of developing preschool children's creative skills through various forms of visual arts, music, and theatrical games are clearly described. According to the author, when such art-pedagogical approaches and play technologies that enhance children's imagination, figurative thinking, and emotional intelligence are harmoniously applied, they enable the child to actively participate in the learning process, increase motivation, and create conditions for creative activity. Semago & Semago (2004) proposed methods for assessing emotional intelligence and social adaptation, establishing pedagogical mechanisms for developing children's abilities to recognize, understand, and regulate emotions. The methods used in the study were employed as essential tools in developing a child's emotional-volitional stability, self-

regulation, and confidence. In this regard, it is important to note that when a child's creative activity is combined with physical movement in the learning process, different areas of the brain are activated simultaneously. This strengthens neural connections, and the development of creative skills enters an active process. Thus, neurogames enhance the neurophysiological and cognitive effectiveness of traditional methods,

positively influencing the development of children's creative skills. Based on the scientific works analyzed above, the possibilities of neurogames have been identified as a means to strengthen the interconnection between children's cognitive, motor, and personal traits, and to effectively influence the development of their creative skills, in conjunction with traditional teaching methods (Table 1).

Table 1

Creative skills and their development through art pedagogy, games, and neurogames

Creative Skills	Art Pedagogy	Games	Neurogames
Imagination and Visualization	Visual Arts and Music	Role-playing Games	Visual-Spatial Exercises - Enhance spatial thinking and the ability to visualize.
Cognitive Functions	Content Visualization	Plot Logic	Attention, Memory, Comparison - Develop the ability to concentrate attention, short-term memory, and establish logical connections.
Movement and Motor Skills	Physical Movement, Theater	Dramatic Play	Simultaneous Bilateral Hand Coordination - Integrates the right and left hemispheres of the brain, improving motor coordination.
Emotional Perception	Musical Influence, Emotions	Role-playing Activities	Emotional Imitation (Facial Expressions, Voice) - Enhances the recognition and expression of emotions, fostering creativity.

The development of creative skills is closely linked to the active functioning of the child's brain structures. The table illustrates that the neurogames presented have a comprehensive impact on the key components of preschool children's creative skills, including imagination and visualization, cognitive interest, movement and motor skills, and emotional perception processes. According to research, these processes are carried out through the activity of the brain's structural and functional regions (Vygotsky, 2004; Piaget, 2003; Luria, 1966). Specifically, the frontal lobe is responsible for thinking, decision-making, behavior, and movement; the parietal lobe is involved in bodily sensations and spatial orientation; the temporal lobe handles hearing, speech comprehension, and memory; and the occipital lobe is responsible for vision, imagination, and visual imagery. Neurogames enhance cerebellar activity, coordinating children's movements, promoting balance, and developing fine motor skills.

The parts of the midbrain, the thalamus (which processes sensory information), and the hypothalamus (which regulates emotions) are activated through neurogames, contributing to the development of skills in the emotional-volitional domain (Ayres, 2018; Semago & Semago, 2004). The conclusions of scholars indicate that the comprehensive activation of various brain regions simultaneously promotes the development of a child's imagination and logical thinking, motor skills and emotions, attention, and language abilities, allowing for the full realization of their creative potential in the preschool period. Thus, neurogames, as a system of functional neuro-exercises, enhance the interconnection between different areas of the child's brain and contribute to the comprehensive activation of the neural system. Neurogames are distinguished as both an innovative approach to developing creative skills and a modern neuroeducational tool that revitalizes traditional methods. In this regard, we have attempted to highlight the

scholars who have outlined the key components and characteristics of developing preschool children's creative skills through neurogames in their research (Table 2).

Table 2

Scholars who have scientifically grounded the components and characteristics of developing preschool children's creative skills through neurogames

Component	Description	Scholars
Cognitive (Cognitive Basis)	Attention, memory, thinking, imagination, information processing	Vygotsky (2004), Piaget (2023), Ayres (2018), Karabulut (2013), Alotaibi (2024)
Sensory-Motor (Finger, Hand, Body Movements)	Coordination of movements, fine motor skills, and body flexibility	Luria (1966), Ayres (2018), Zapodoynikova (2023)
Emotional-Volitional		
Creative-Activity	Understanding and regulating emotions, self-regulation, and confidence Imagination, figurative thinking, unique ideas, creative freedom	Semago & Semago (2004), Alotaibi (2024) Vygotsky (2004), Piaget (2023), Elkonin (1999), Satova, et al., (2021), Parker, et al., (2022)

Table 2 systematizes the impact of neurogames on the development of preschool children's creative skills across four key components (cognitive-cognitive foundation, sensorimotor, emotional-volitional, and creative-activity) and correlates each component with the works of leading domestic and foreign scholars who have conducted research in this field. Unlike traditional didactic games, neurogames are specifically designed to stimulate the functional activity of the brain. They are implemented through the integration of sensorimotor coordination, bilateral movements, attention regulation, emotional activation, and cognitive interaction. While didactic games are mainly aimed at knowledge acquisition and skill reinforcement, neurogames are based on neuropsychological and neuropedagogical principles that promote interhemispheric interaction, neuroplasticity, and cognitive-emotional development.

The purpose of this study is to empirically determine the effectiveness of neurogames in developing the creative skills of preschool preparatory group children aged 5–6. The study is aimed at investigating how systematically organized neurogame-based activities influence children's cognitive functions, imagination, emotional regulation, sensorimotor coordination, and creative activity within preschool educational settings. Furthermore, the

research seeks to identify the relationship between neurogames and the enhancement of preschool children's creative potential through neuropedagogical approaches.

Materials and Methods. This study employed a quasi-experimental research design with control and experimental groups. The research was conducted over 24 months during the 2023–2025 academic years in preschool educational institutions located in Almaty, Kazakhstan. The quasi-experimental design was selected because the preschool groups were formed according to the existing institutional structure, and random individual assignment was not possible due to ethical and organizational considerations. The study consisted of three main stages: diagnostic stage, formative stage, and monitoring and evaluation stage. During the diagnostic stage, the initial level of preschool children's creative skills, cognitive functions, emotional stability, imagination, and motor coordination was assessed. In the formative stage, neurogames were systematically integrated into organized educational activities. Finally, during the monitoring stage, repeated diagnostic assessments were conducted to evaluate the effectiveness of the implemented neurogames.

Participants. The participants of the study included 103 preschool preparatory group

children aged 5-6 years from preschool institutions in Almaty city. Among them, 51 children participated in the experimental group; 52 children participated in the control group. The experimental group participated in organized educational activities integrated with neurogames, while the control group continued traditional preschool educational practices without neurogame intervention. All participants were involved with the informed consent of their parents and under the supervision of preschool administrators, psychologists, and educators in accordance with the ethical standards of the Ministry of Education and Science of the Republic of Kazakhstan.

Research Environment and Intervention Process. The neurogame-based intervention was integrated into organized preschool learning activities, including speech development, children's literature, fundamentals of mathematics, and introduction to the surrounding world. Neurogames were conducted three times per week, and each session lasted approximately 25 - 30 minutes. The intervention program was implemented systematically throughout the entire research period. The neurogames included: mirror exercises; rhythm coordination activities; bilateral hand coordination tasks; symmetrical drawing; visual-spatial exercises; emotional recognition games; sensory integration exercises. These activities were designed to stimulate cognitive, emotional, sensory-motor, and creative processes simultaneously.

Several scientifically grounded methods and diagnostic tools were used during the study:

1. Sensory Integration Method - The sensory integration approach developed by Ayres (2018) was used to improve children's visual-motor coordination, rhythm perception, attention, and motor activity. Exercises involving movement, rhythm, and ball coordination were integrated into neurogames.

2. "Neuro-Matryoshka" Method - The "Neuro-Matryoshka" method proposed by Zapodoynikova (2023) was used to develop bilateral coordination, fine motor skills, imagination, and figurative thinking through mirror activities and symmetrical visualization exercises.

3. Emotional Intelligence and Social Adaptation Assessment - The methodology developed by Semago & Semago (2004) was applied to assess emotional-volitional stability, emotional recognition, emotional regulation, and social adaptation skills among preschool children.

4. Creative Thinking and Imagination Tasks - A set of creative tasks developed by Satova et al. (2021) was used to evaluate children's imagination, figurative thinking, originality, and creative activity.

5. Observation and Questionnaires - Observation methods and questionnaires for teachers and parents were additionally used to assess behavioral changes, communication skills, and children's participation in creative activities during the intervention process.

Neurogames Applied in the Study. The following neurogames were systematically implemented during organized educational activities: "memory grid", "counting with the ball", "mirror exercise", "drawing with hands", "depicting emotions". Each neurogame targeted specific developmental indicators such as attention, memory, emotional regulation, creativity, movement coordination, and imaginative thinking. The collected data were analyzed using both descriptive and inferential statistical methods.

Data Analysis. The collected data were processed using descriptive and mathematical-statistical methods: percentage indicators, mean values, and standard deviation were calculated. Comparative Analysis. The initial and final results of the experimental and control groups were compared in order to determine the dynamics of the development of creative skills. Correlation Analysis. Correlation analysis was used to identify the relationship between neurogames and the cognitive, emotional, sensorimotor, and creative development components of children. Regression Analysis. Multiple regression analysis was applied to determine the impact of neurogames on cognitive development. Cognitive development indicators were taken as dependent variables, while the above-mentioned neurogames were considered independent variables. Student's t-test was used to determine the statistical significance of the differences between the

results of the experimental and control groups. As a result, the indicator $t = 5.45$, $p = 0.0016$ was obtained, which statistically confirmed the effectiveness of neurogames. The structure of the neurogames was developed based on the above-mentioned scientifically grounded methodological guidelines. The neurogames

were designed to stimulate children's physical activity, visual-motor coordination, imagination, and creative thinking. The methods used to assess the level of children's creative skills, as well as indicators of cognitive and personal development and the effects of neurogames, are fully described (Table 3).

Table 3

Neurogames, methods, and their effects are used to develop preschool children's creative skills

Indicators of Creative Skill Development		Applied Methods	Applied Neurogames and Their Effects
Cognitive (attention, thinking, imagination)	Functions (memory, memory)	Sensory integration method – visual-motor coordination, rhythm exercises, ball activities	“Memory Grid”, “Counting with the Ball” – develop concentration and memory.
Sensorimotor Development (movement coordination, fine motor skills)		Sensory integration method – visual-motor coordination, rhythm exercises, ball activities	“Drawing with Hands” – develops motor skills and movement coordination.
Emotional-Volitional Domain (emotional stability, self-confidence)		Emotion recognition and regulation method – recognizing and regulating emotions through play and sensory experience	“Depicting Emotions” – enhances emotional regulation and self-confidence.
Creative Activity (imagination, figurative thinking, creative engagement)		Symmetrical visualization method – creative tasks for figurative thinking and symmetrical drawing	“Mirror”, “Drawing Similar Images” – develop creative imagination and figurative thinking

At the end of the experiment, a repeated diagnostic assessment was conducted. The initial and final results were compared, and the impact of neurogames on the development of children's creative skills was identified. The indicators presented in this table facilitate a comprehensive evaluation of the child's developmental level and provide a systematic framework for monitoring the specific developmental domains influenced by neurogames.

Results. The research experiment was conducted within the framework of a flexible curriculum for preschool children, implemented through organized learning activities. Specifically, the development of children's creative skills was targeted through neurogames adapted to the types of organized learning activities, including “Speech Development”, “Literature”, “Basic Mathematical Concepts”, and “Introduction to the Environment”. In each type of organized learning activity, neuro-exercises and game elements were introduced to enhance children's cognitive, motor,

emotional, and creative activity. For example, in the “Speech Development” section, exercises coordinated with movements were used to activate vocabulary; in the “Literature” activity, visual depictions were recreated to strengthen emotional impact; and in the “Mathematics” lesson, games involving rhythm, counting, and logical thinking development were applied. During the “Introduction to the Environment” activity, exercises aimed at enhancing children's observational skills and imaginative visualization were carried out. The integrated approach within the flexible curriculum significantly strengthened the children's learning activity, creative imagination, and attention stability in the experimental group.

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activity, visual depictions were recreated to strengthen emotional impact; and in the “Mathematics” lesson, games involving rhythm, counting, and logical thinking development were applied. During the “Introduction to the Environment” activity, exercises aimed at enhancing children’s observational skills and imaginative visualization were carried out. The neurogames not only developed the children’s

creative skills but also increased their interest, creating a positive emotional atmosphere for the learning and upbringing process. The integrated approach within the flexible curriculum significantly strengthened the children’s learning activity, creative imagination, and attention stability in the experimental group. Figure 1 visually presents the integration of neurogames into organized learning activities.

Figure 1

Neurogames used in organized learning activities for developing preschool children’s creative skills and their effects



Figure 1 demonstrates the integration of neurogames into different types of organized learning activities for preschool children. The use of neurogames in speech development, literature, mathematics, and environmental education contributed to the activation of children’s attention, imagination, motor coordination, and emotional development. The presented scheme illustrates the comprehensive impact of neurogames on preschool children’s cognitive

and creative activity. The systematic integration of neurogames into organized learning activities contributed to positive changes in preschool children’s creative development. Based on the implemented neurogame activities presented in Figure 1, comparative statistical indicators of the control and experimental groups were obtained. Results of Preschool Children’s Creative Skills Development Dynamics (Table 4).

Table 4

Comparative results of the impact of neurogames on preschool children’s creative skills development and the growth dynamics of the experimental group indicators

Indicators	Initial Control Group (n=52)	Final Control Group (n=52)	Initial Experimental Group (n=51)	Final Experimental Group (n=51)	Growth Dynamics (Experimental)
Cognitive (Cognitive Basis) Functions	49%	57%	47%	65%	+18%
Sensory-Motor (Finger, Hand, Body Movements)	51%	59%	51%	67%	+16%
Emotional-Volitional, Orderliness	43%	57%	41%	66%	+25%
Creative Activity (Potential)	65%	78%	63%	87%	+24%

The table demonstrates that neurogames positively influenced all indicators of preschool children's creative development. An increase was observed in: cognitive functions; sensory-motor coordination; emotional-volitional stability; creative activity. The experimental group showed significantly higher growth dynamics compared to the control group. To further investigate the impact of neurogames on

preschool children's creative skills, regression modeling was applied. Cognitive development (attention, memory, thinking, imagination) was considered the dependent variable, while the following neurogames were examined as independent variables: "memory grid"; "mirror"; "drawing with hands"; "counting with the ball"; "depicting emotions". Results of the Regression Analysis (Table 5).

Table 5

Multiple regression analysis of neurogames' impact on cognitive development

Variables	β	Std. Error	t	p
Memory Grid	0.52	0.11	4.72	0.001
Counting with the Ball	0.48	0.10	4.35	0.002
Mirror Exercise	0.31	0.09	3.11	0.004
Drawing with Hands	0.29	0.08	2.94	0.006
Depicting Emotions	0.27	0.07	2.75	0.009

$$R^2 = 0.64$$

$$\text{Adjusted } R^2 = 0.61$$

$$F = 18.45$$

$$p < 0.001$$

The regression model demonstrated that the neurogames "Memory Grid" and "Counting with the Ball" had the strongest influence on the development of preschool children's cognitive functions. All predictors showed statistically significant effects ($p < 0.05$).

The results of the multiple regression model, the neurogames "Memory Grid" and "Counting with the Ball", which are aimed at improving

attention concentration and memory, had the highest impact on developing cognitive functions (with a high β -coefficient, $p < 0.05$). Below, the research presents a correlation map that describes the effect of neurogames on preschool children's creative skills, shown through a diagram. Figure 2 presents the correlation map between neurogames and creative skill components

Figure 2

Correlation map describing the effect of neurogames on preschool children's creative skills

Memory networks	0,65	-0,33	0,45	0,56
Counting objects	0,12	-0,21	0,33	0,15
Mirror exercises	0,23	0,14	0,45	0,32
Drawing with hands	0,32	-0,21	0,33	0,47
Expressing emotions	0,43	0,11	0,33	0,34
	Sensory-motor skills	Emotional regulation	Creative development	Cognitive development

The diagram shows the correlation between the impact of neurogames (Memory Grid, Counting with the Ball, Mirror Exercise, Drawing with Hands, Depicting Emotions) and the key components of preschool children's creative skills (cognitive development, motor skills, emotional stability, and creative development):

- in the development of cognitive functions, the "Memory Grid" and "Counting with the Ball" games were found to have a significant impact on activating children's attention and memory processes;

- high correlation values in the development of sensory-motor skills and creative thinking were observed through the "Drawing with Hands" and "Mirror" games;

- the increase in emotional regulation levels was facilitated by the "Depicting Emotions" game, which contributed to enhancing the clarity of children's creative thinking and boosting their artistic freedom.

The intensity of the colors in the diagram and the correlation coefficients represent the level of interconnection between the neurogames and each component. Through the correlation map, it is evident that the systematic use of neurogames is effective in the comprehensive development of children's creative skills. As demonstrated above, the systematic use of neurogames led to positive changes in the development of preschool children's creative skills. However, to determine the specific impact of each type of neurogame on particular components, regression modeling was conducted. The analysis results presented below quantify this impact. The table shows that the neurogames had a positive impact on the development of preschool children across all indicators. The growth dynamics in the experimental group were identified based on the following indicators.

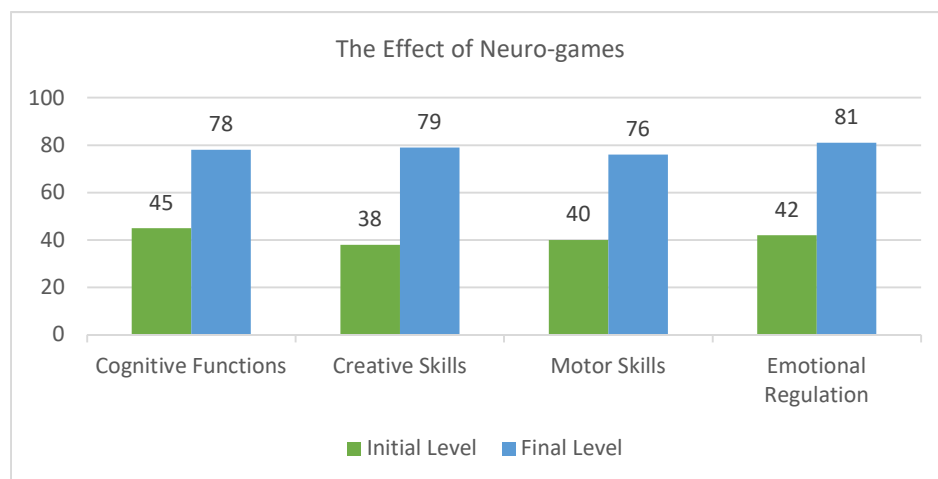
An 11% increase was observed in cognitive functions, which corresponds to the results of approximately 6 children out of 51. A 10% increase was recorded in sensory-motor skills, indicating an improvement in the development of approximately 6 children. There was also a 10% increase in emotional-volitional

stability, which corresponds to 6 children. The highest growth was observed in creative potential, with a 16% increase, indicating a rise in the creative activity of approximately 9 children. In the control group, the learning and upbringing process conducted using traditional methods resulted in the following development indicators. An 8% increase was observed in cognitive functions, which corresponds to the results of approximately 4 children out of 52. An 8% increase was noted in sensory-motor skills, affecting approximately 4 children. A 14% increase was recorded in emotional-volitional stability, with the development of approximately 8 children improving. There was a 13% increase in creative activities, reflecting a rise in the number of creative activities of approximately 7 children.

The results of the control group showed that 27.0% (13 children) developed creative skills as a result of the natural developmental process and the impact of traditional methods. In contrast, the experimental group showed 43.7% (21 children), with a 16.7% difference. The targeted work based on neurogames in the experimental group yielded higher results, confirming the effectiveness of the experimental method. Overall, the changes in the control group reflect the impact of natural development and traditional methods; however, the growth in indicators is noticeably lower compared to the experimental group. The increase in each indicator confirms that the applied methods were purposefully directed and effectively organized. The results of the experiment were interpreted using quantitative and inferential statistical methods. The mean values, standard deviations, and percentage indicators of the development of creative skills in the control and experimental groups were compared and assessed. It was observed that the indicators of developed creative skills in the experimental group were significantly higher compared to the control group. The development of preschool children's creative skills is depicted through a radial diagram. Figure 3 illustrates the growth dynamics of preschool children's creative skills before and after the intervention.

Figure 3

The comprehensive impact of neurogames on the development of preschool children's creative skills



The research results demonstrate a clear positive change in the development dynamics of the key components of preschool children's creative skills. In the two-level radial diagram, the results of the initial and final levels for cognitive functions, motor skills, emotional-volitional stability, and creative potential are visually represented, showing the outcomes of systematically using neurogames. For example, cognitive functions increased from 47% to 65%, motor skills increased from 51% to 67%, emotional-volitional stability increased from 41% to 66%, and creative activity increased from 63% to 87%. In the diagram, the indicators for each component are presented in the format "X% → Y%" to illustrate the actual growth dynamics. The visualization not only displays the results but also provides a broader understanding of the scope of the neuroeducational approach's impact. Statistical analysis was performed using Student's t-test, which allowed for the assessment of the statistical significance of the difference between the mean results of the two independent groups (control and experimental). The analysis result: $t = 5.45$, $p = 0.0016$ ($p < 0.01$).

The identified indicator demonstrates that the growth in the experimental group is not due to chance and proves the effectiveness of the methodologies based on the neurogames used. Specifically, the p-value being below 0.01 indicates the statistical significance

of the difference between the control and experimental groups. The average score for creative skills in the control group was 54.25%, with a standard deviation of 2.99, while in the experimental group, the scores were 65% and 2.58, respectively. Therefore, the results obtained demonstrate that neurogames have a comprehensive positive impact on the development of creative skills by actively engaging preschool children's cognitive, motor, emotional-volitional, and creative activities.

Discussion. The obtained results confirm the effectiveness of neurogames in developing preschool children's creative skills. The experimental group demonstrated significantly higher indicators of cognitive functions, emotional-volitional stability, sensory-motor coordination, and creative activity compared to the control group. The findings correspond with the studies of Choyak (2018), who emphasized the importance of sensory-motor and movement-based activities in stimulating brain functional activity and supporting children's cognitive and emotional development. The present study also supports neuroeducational approaches, suggesting that integrated movement and cognitive tasks positively influence preschool children's creative potential.

Neurogames contributed to the activation of cognitive, emotional, and motor processes through systematic engagement in movement-based, symmetrical, and emotionally oriented

exercises. The integration of attention regulation, emotional recognition, motor coordination, and imaginative tasks created favorable conditions for the comprehensive development of preschool children's creative skills. The correlation and regression analyses further demonstrated that neurogames had a statistically significant impact on children's cognitive and creative development. In particular, activities such as "Memory Grid" and "Counting with the Ball" showed the strongest influence on attention concentration, memory activation, and creative thinking development. Figure 1 presents a systematization of the neurogame elements used during the organized learning activities of "Speech Development", "Literature", "Basic Mathematical Concepts", and "Introduction to the Environment" in preschool groups. The exercises adapted for each organized learning activity were designed to activate children's cognitive, motor, emotional, and creative activities and to develop their creative skills.

The research results demonstrated the effectiveness of neurogames in developing preschool children's creative skills. The creative skill indicators of the experimental group children showed a significant improvement compared to the control group, indicating that neurogames had a comprehensive impact on the development of cognitive, sensory-motor, emotional-volitional, and creative-activity components. The systematic use of neurogames facilitated the active development of children's attention and memory, figurative thinking, emotional regulation, and the ability to transform imagination into creative activity. Additionally, the sensory integration methods, mirror exercises, emotion recognition, and symmetrical visualization exercises applied during the study helped unlock each child's creative potential. The development of creative skills was clearly evident as a result of the systematic use and repetition of neurogames, leading to the automation of activities. The development of preschool children's creative skills was reflected in the following characteristics:

1. Activation of Imagination and Figurative Thinking: Children began to freely create

unfamiliar images and representations, inventing new roles and stories in narrative games.

2. Improvement in Sensory-Motor Coordination: Through mirror exercises and symmetrical drawing with both hands, the precision and coordination of the children's hand movements improved, demonstrating an increase in fine motor skills.

3. Establishment of Emotional Response: After exercises focused on emotion recognition, children were able to express their moods clearly through facial expressions and tone of voice. Additionally, their ability to understand the emotional states of their peers improved.

4. Strengthening of Attention and Memory Stability: During complex tasks, children were able to maintain focus, recall elements from previous exercises, and apply them independently in new situations.

5. Independence in Task Execution: As a result of repeating exercises during neurogames, children began to perform tasks independently without seeking assistance, demonstrating that the activity had become an automated skill.

The regression analysis conducted provides evidence of the impact of neurogames on the cognitive development component, demonstrating that their systematic use is an important tool in enhancing the creative potential of preschool children. To further investigate the impact of neurogames on preschool children's creative skills, regression modeling was applied. This model allows for the assessment of the effect of different types of neurogames on the level of cognitive development. Cognitive development (attention, memory, thinking, imagination) was considered the dependent variable, while the following neurogames were examined as independent variables: "Memory Grid", "Mirror", "Drawing with Hands", "Counting with the Ball", and "Depicting Emotions" games. The findings of this study demonstrate that neurogames significantly contribute to the development of preschool children's creative abilities, as reflected in improvements in cognitive functions, emotional-volitional stability, sensorimotor coordination, and creative activity. These results are consistent with the findings of Alotaibi

(2024), who reported that neurogame-based approaches positively influence children's cognitive, emotional, and social development. Similarly, the observed improvements in attention, memory, and coordination corroborate the conclusions of Ayres (2018), whose work on sensory integration highlighted the effectiveness of movement- and sensory-based activities in enhancing cognitive abilities. The gains in sensorimotor coordination found in the present study also support Luria's (1966) assertion that motor activity and cognitive development are closely interconnected and jointly contribute to higher-order thinking processes.

The findings further align with the work of Parker et al. (2022), who emphasized that effective learning occurs when activities are joyful, meaningful, interactive, active, and repetitive. The neurogames implemented in this study incorporated these characteristics, which may explain the substantial improvements observed in children's creative performance. In addition, the increase in creative activity and imaginative expression is similar to the results reported by Dabyltayeva (2024), who found that creative and engaging educational activities promote the development of children's creative potential. While previous studies primarily described the developmental benefits of neurogames and sensory-based approaches, the present study provides empirical evidence demonstrating statistically significant improvements across multiple developmental domains, thereby extending existing research on the role of neurogames in fostering preschool children's creativity.

Conclusion. The study aimed to determine the role of neurogames in the development of creative skills among preschool preparatory group children. In modern preschool education, particular attention is paid not only to children's academic readiness but also to the development of imagination, emotional stability, creative

thinking, and the ability to express themselves freely. In this context, neurogames were considered an effective pedagogical tool that stimulates brain activity, increases cognitive interest, and creates opportunities for the development of children's creative potential. The results of the conducted research proved that neurogames are an effective tool for developing creative skills in preschool children. During the experimental work, the systematic use of neurogames had a positive impact on the development of children's cognitive, sensorimotor, emotional-volitional, and creative activity components. The obtained results demonstrated improvements in preschool children's attention, memory, figurative thinking, and creative activity.

The developmental indicators of the control and experimental groups were compared and analyzed. As a result, the experimental group demonstrated significantly higher developmental dynamics. Statistical analysis confirmed the effectiveness of the experimental methodology. The level of creative skill development among children in the experimental group was higher compared to that of the control group. The findings of the study showed that the use of neurogames in the preschool education and upbringing process contributes to the development of children's creative potential, stimulates brain activity, and enhances cognitive processes. The systematic implementation of neurogames makes it possible to improve the quality of organized learning activities in preschool institutions and supports children's creative abilities from an early age. Artificial intelligence tools were used only for technical editing purposes, including grammar correction, stylistic refinement, and improving the clarity of the text. The scientific content of the study, data analysis, interpretation of the results, and conclusions were entirely carried out by the authors.

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