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Original Article

Development of cognitive and neurodynamic function of 6-year-old children using the integrated application of the game of Go and exercise of game character

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Abstract
The purpose of the work is to identify the features of the dynamics of cognitive and neurodynamic functions of children 6 years old when using the game of Go in combination with physical exercises of a playful nature. Material and methods. The study involved 30 children of the first classes, age 6 years. The children were divided into 3 groups of 10 people each. Two groups became experimental, one group - control. In the first experimental group, the children were engaged in the game of Go, in the second - the game of Go in combination with physical exercises, in the control group - according to the usual program of the extended day. Children of experimental groups were engaged in playing Guo twice a week for a month. Before and after the experiment, tests were carried out according to the Schulte method, and according to the method of Ermakov (computer program "Button Choice"). The experimental groups were engaged according to the developed methods, the children of the control group were engaged according to the standard program of the extended day group. Results. The use of the game of Guo has a positive effect on mental performance and on neurodynamic functions, while the effect on the neurodynamic functions is enhanced by the use of the game of Go in combination with physical exercises. It shows a significant influence of the nature of group lessons (the game of Go; the Game of Go in combination with physical exercises; the usual classes of the extended day program) on the cognitive and neurodynamic functions of children 6 years of age. Significant influence was found by Schulte's tests (work time on the first table and work efficiency) at $p < 0.001$ and according to Ermakov's test to determine the speed of the selection reaction when changing the position of an object in the space of three attempts, $p < 0.001$. Findings. The results of the research indicate that the use of the game of Guo has a positive effect on the indicators of cognitive functions and neurodynamic properties of 6-year-old children. Occupations only by the game of Go most affect mental performance, and occupations by playing Go, in combination with physical exercises, improves neurodynamic indicators most pronouncedly associated with the need to switch attention, the speed of choice reaction to objects whose position changes in space.
Keywords: game of Go; children; cognition; neural dynamics; Exercise.

Introduction

At present, harmonious, that is, both the physical and intellectual development of the child, is becoming more important. Diversified development of the child is provided by various sports, visiting out-of-school institutions with musical, artistic education, technical modeling and the like. Special attention harmonious development of the child gets in 6-7 years. This is due to the age periods of the development of the child's body, as well as the fact that during this period children begin to go to children's schools, start to engage in various sports, and based on such emotions as "like" and "I get", for a long time remain in the chosen sport. For children, the period of the first class and kindergarten is accompanied by the first significant stress, because the child must get up early every day and go to school, do everything according to a painted schedule, and also perform various tasks without his will and desire. In such an environment, the child is very difficult, because the child is used to the following: to comprehend the world around her when she is interested; listen to useful information as much as he needs; learn the world through gameplay; make friends by interests; thinking is inherent in her - "mine is yours"; make decisions based on emotions - "like or dislike".

But in a children's school, a child faces such difficulties: the whole day passes according to a schedule; the child must communicate with the children who are present there, and not with whom she would be more interested; gameplay is much less than before; the child must complete the required tasks; the child is prescribed for breaking the rules, etc.

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Of course, children's educational institutions, given the shortcomings, cultivate in the child very necessary qualities, such as, for example: discipline; pedantry; the concept of "need" is more important than "I want"; motivation; communication skills, etc.

But the stress of the child does not disappear. Of course, various creative activities in the educational process contribute to reducing stress, but not eliminating it as a whole. And one more factor of stress: children find it difficult to know the world, where they are limited in everything, because it is more interesting to learn the Universe by playing and competing with each other. Most often, children in the first grades find it difficult to concentrate and study new topics at the end of the learning process, they become capricious and often do such unexpected things, even parents are surprised by the actions of their child. All this is the result of the influence of accumulated stress and the psychological fatigue of children during the nine months of study.

All these factors hinder the development of the child. But children do not understand the difference between physical exertion and intellectual work. The solution was found by philosophers and military commanders more than three thousand years ago, using Go in combination with physical exercises.

Unfortunately, there are no documents indicating the creation of the game of Guo, but all the popular history and historical documents from China have a common feature: the game of Go was created in order to raise the intellect of the future emperor to the necessary level of government, because, unfortunately, The child's intellectual level was well below average. After this game was created, all the emperors of the East had played go for thousands of years, since it became an indispensable subject for study.

In modern scientific literature there is also a lot of research devoted to the study of various aspects related to the game of Go.

Scientific research connected with the game of Go is carried out in several directions:

1. The game of Go as a reflection of the development of various systems in animate and inanimate nature, including the following components:

- the application of the laws of the game of Go in programming and the creation of artificial intelligence,
- the application of the laws of the Go game in biology and medicine;

2. Features of tactics in the game of Go from the point of view of science,

3. Modern views on the game of Go as a system in terms of ethics, culture, spirituality and in various scientific fields.

The Go game is the strongest game in the world with the highest option in the game. An incredible number of possible options for the development of moves, and the ability to choose from the same-value moves attracts programmers and those people who study human intelligence. In the game of Go, people act differently in different cases, and the Guo masters, who play more than half a century, say that the game of Guo is very similar to situations in life, and in the game of Guo, as in ordinary life, some decisions are very difficult. Leaning on the work of Lee, Park, Jung, Kim, Oh, Choi,..... Kwon (2004), it can be argued that the Game of Guo is a difficult game on planet Earth, and it is a good "simulator" for the mind of a person who mankind invented over the past five thousand years. This is not only indicated by the great social position of east of the Eurasian continent, but also scientific studies whose articles are considered in this paper.

That is why a lot of scientific articles and materials on programming and computer science are directed to work with this game, they can be found in various prestigious publications. That is why the strongest programming masters challenged the Masters of humanity in the Go game, creating a computer for three years, which in 2017 overcame the strongest person on the Go game planet of that time. They made a number of important discoveries in the direction of a number of programs that can engage in self-development, even if only in the game of Go. The concept of "Neural networks" was created and developed, which by their properties resemble the work of the human brain.

At this rate, a smart program was created today, which can not only win against world champions, but also learn from its own game (Silver, Schrittwieser, Simonyan, Antonoglou, et.al., 2017). The long-term goal of artificial intelligence is an algorithm that teaches tabula rasa, superhuman skill in difficult areas. AlphaGo has recently become the first program to defeat the world champion in the game Go. AlphaGo tree search evaluates positions and selected movements using deep neural networks. These neural networks were trained in supervised learning on human experiments, as well as by enhancing learning from self-directed play. Here we introduce an algorithm based solely on reinforcement training, without data about a person, a guide, or knowledge of a domain outside the rules of the game. AlphaGo becomes his own teacher: the neural network learns how to predict AlphaGo's own choices, as well as the winner of AlphaGo games. This neural network improves the strength of the search tree, which leads to a better choice of movement and stronger self-reproduction at the next iteration. Starting with tabula rasa, our new AlphaGo Zero program achieved superhuman performance, winning 100–0 against the previously published one, which defeats the champion AlphaGo. The same team a year earlier published their work in the work entitled "Mastering the Game Go through deep neural networks and search for trees. The authors introduced a new approach to the Go computer, which uses "value networks" to evaluate positions on the board and "policy networks" to select moves. These deep neural networks are learning a new combination of supervised learning from human expert games and enhancing learning in self-play games. Without any search work, neural networks play go at the level of the most advanced Monte Carlo search

programs that mimic thousands of casual games for independent play. They also introduced a new search algorithm that combines Monte Carlo simulations with value and political networks. Using this search algorithm, the AlphaGo program reached 99.8% of the winning rate compared to other Go programs and won the world champion in European standards, taking five games out of five possible. This is the first time that a computer program has defeated a professional player, although it was believed that the pace of development of our civilization will bring this moment closer in ten years.

This achievement was promoted by the discovery of 2006, by the same team of programmers (Silver, Sutton, Muller, 2007). The authors studied the addition to the Go game, which reinforces the learning approach based on the linear evaluation function and a large number of life-long functions. This strategy has proven effective in game programs and other reinforcement learning applications. The team applied this strategy to Go, creating more than a million functions based on templates for small pieces of the board, and then using time-consuming, versatile training and independent play. This method identifies hundreds of low-level forms with recognizable value for experienced go players and provides quantitative estimates of their values.

Many do not undertake such a large work, but study it in separate arrays, for example Audouard, Chaslot, Hoock, Perez, Rimmel, & Teytaud (2009). The authors indicated the successful use of parallel (grid) coevolution, which is used to create the book-opener (013) in 9x9. The statements about the Go game are well-known by the algorithm, and the resulting program was also able to reliably comment on the discovery in professional Go games on a 9x9 board.

Other authors study the "Tree of Possible Options", which are incredibly advanced, for example, Chan, Churchill (1996) for a long period studied various trends in the game of Go. The presented algorithm of the genetic algorithm for searching for trees of variants in the game of Go. The method is compared with the traditional alpha-beta MTDf search method in a series of tests and results.

The problem of learning and developing a program that could develop on its own in Grae-go, self-complacent is one of the strongest motivations of programmers. One of the methods of developing programs and approaching artificial intelligence was done by Liang, and Chen (2014). In this article, the authors propose a method that reduces the complexity of the Go game by studying and extracting patterns from game records. This method is more effective than the base method, which studies the odds in a baseline situation. Saving information processing and energy consumption by 20% more than in the base case. A similar issue was addressed by Srisuphab, Seewald, Song (2012).

For several parties, older masters can assess the skill of the player, his strength and skills. With the estimated capabilities of Moudrik, Baudis, Neruda, Ieee (2015), using machine learning algorithms, they show that the estimates can be used to predict various relevant target changes. They applied this methodology with good accuracy, predicting the player's strength and style of play (for example, the territoriality or aggressiveness of the game). The authors proposed a number of possible applications, including assistance in researching the game of Go, identifying the ranks of real players of Internet players, or setting up Go-play programs for piercing the activities of players of the same style of play. The same problem reveals Wang, but in this case the program is able to study and copy the style and directions of development of the game from the masters of the game of Go.

Lee (2012) also took up the assessment of the skill of the game. The adaptive Monte-Carlo tree search (MCTS) estimates the number of simulations corresponding to the strength of the opponents of the player we are studying. Further, an adaptive T2FS-based language assessment system affects a person's performance and presents results using a linguistic description. Experimental results show that the proposed approach is applied to apply to the adaptive linguistic evaluation of the effectiveness of the human player Go.

Thanks to the System of computing options trees, programs have been developed that, by the principle of operation, resemble different areas of intelligence work. This is indeed an important step towards the development of Artificial Intelligence in science: Coulom (2007), Fernando, & Muller (2014), Huang, Coulom, Lin, & Soc (2010) Oshima, Yamada, & Endo (2013), Yee, & Alvarado (2012).

Cognitive neuroscience has also been used by December Guo. Chen, Chen, Zhang, Zhang, Li, Meng, He, & Hu (2003) In order to study the neural basis of the Go game, functional magnetic resonance imaging (fMRI) was used for measuring brain activity of subjects involved in the game of go. Enhanced activation was observed in many areas of the cortex, such as the dorsal, prefrontal, parietal, occipital, posterior, temporary and primary somatosensory and motor areas. Quantitative analysis showed a moderate degree of stronger activation in the right parietal region than in the left. This type of lateralization of the right hemisphere differs from the weak laterality of the left hemisphere, which is observed during a game of chess.

Neuroscience began to be studied from different sides of those parties. So Moudrik, & Neruda, (2016) devoted their own words to the definition of Player's skills in Go compared to deep neural networks. Go has become a riotous subject for research in the field of artificial intelligence, mainly due to the successes in Go software. Here, researchers have developed an application of deep neural networks, the purpose of which is to improve the experience of people playing the game of Go online. The following experiment was conducted by Schumann, A. (2015), where he imitated the movements of the Physicum polycephalum plasmodium while playing Go. Then he focused only on the Go game, where the location of black and white stones imitate syllogistic considerations, in particular considerations of the Aristotelian syllogism and reasoning of the

performative syllogism. For the first type of reasoning, he used a special form of coalition games. For the second kind of reasoning, he turned to ordinary antagonistic games. Then Schumann, & Pancerz (2016) used the Physarum machine, which is a biological computing device implemented in the plasmodium Physarum polycephalum and / or Badhamia utricularis, which are single-core organisms capable of building complex networks for solving various computational problems.

The paper described the implementation of the game Go on the machines Physarum. A special version of the game is presented, where payouts are estimated using a measurement determined on the basis of a rough theory. The theoretical foundations provided in the article are complemented by a description of a specialized software tool developed, among other things, to simulate the described gri. The aftertreatment of the influence of the Go game on the mental state of children was considered Kim, Han, Lee, Kim, Cheong, & Han (2014). The authors investigated the objective symptoms of attention deficit disorder with increased activity (ADHD) associated with a deficit of executive functions. The Go game includes many aspects of cognitive function, and it has been suggested that this will be effective for children with ADHD. The study involved seventeen primary school children with ARVD and seventeen subjects. Participants played under the guidance of a teacher for 2:00 a day, 5 days a week. Before and at the end of the treatment period, clinical symptoms, cognitive functions and brain EEG were assessed using the ADHD Dupauls scale (ARS), a child's depression inventory (CDI), a space in numbers, a children's color trace test (CCTT) and an 8 channel QEEG system (LXE3208 , Laxtha Inc., Daejeon, Korea). The researchers determined that the game is effective for children with ADHD, because it activates the hypo-aural prefrontal function and improves the executive function of the main brain.

According to the above, it can be concluded that the Go game can be effectively used in the modern educational process. Since the nature of children is a need for movement, physical exercise, along with the game of Go, one should also use physical exercises, outdoor games. In our opinion, this coincides with the experience of the eastern emperors, and can be successfully applied in the modern extracurricular educational process for children of 6 years. In this study, a hypothesis was put: the use of the game of Go in combination with physical exercises will positively affect the cognitive and neurodynamic functions of children 6 years of age.

The purpose of the work – to identify the features of the dynamics of cognitive and neurodynamic functions of children 6 years old when using the game of Go in combination with physical exercises of a game character.

Material and methods

Participants

The study involved 30 children of the first classes, age 6 years. The children were divided into 3 groups of 10 people each. Two groups became experimental, one group - control. Before the start of the experiment, the groups did not significantly differ in all indicators of testing.

Table 1

Indicators of cognitive and neurodynamic functions of children 6 years of control (V, n=10) and experimental (A, n=10 and B, n=10) groups to conduct the experiment

The name of the tests	Group	Statistical Indicators				
		$\bar{x}$	S	m	t	p
Schulte test, work time on the first table, S	A	700,80	61,78	19,54	-0,45^{a-b}	0,661^{a-b}
	B	711,40	42,69	13,50	0,87^{b-v}	0,398^{b-v}
	V	694,00	47,08	14,89	0,28^{a-v}	0,785^{a-v}
Schulte test, work efficiency, S	A	128,00	16,33	5,16	-0,27^{a-b}	0,790^{a-b}
	B	129,80	13,24	4,19	0,40^{b-v}	0,695^{b-v}
	V	127,40	13,68	4,33	0,09^{a-v}	0,930^{a-v}
Schulte test, the degree of efficiency at the beginning of work, c.u.	A	0,93	0,08	0,03	0,73^{a-b}	0,476^{a-b}
	B	0,91	0,08	0,02	-1,19^{b-v}	0,248^{b-v}
	V	0,95	0,09	0,03	-0,51^{a-v}	0,618^{a-v}
Test Schulte, mental performance, c.u.	A	0,91	0,08	0,02	-1,27^{a-b}	0,221^{a-b}
	B	0,96	0,09	0,03	-0,47^{b-v}	0,647^{b-v}
	V	0,99	0,17	0,05	-1,30^{a-v}	0,211^{a-v}
Ermakov Test, the first attempt, the amount	A	7,40	1,07	0,34	2,14^{a-b}	0,06^{a-b}
	B	6,90	1,52	0,48	-1,73^{b-v}	0,101^{b-v}
	V	8,30	2,06	0,65	0,14^{a-v}	0,893^{a-v}
Ermakov Test, the second attempt, the	A	11,40	2,50	0,79	1,70^{a-b}	0,107^{a-b}
	B	10,80	1,62	0,51	-2,21^{b-v}	0,06^{b-v}

amount	V	12,10	2,33	0,74	-0,65 $^{a-v}$	0,526^{a-v}
Ermakov Test, the third attempt, the amount	A	14,00	2,11	0,67	1,81^{a-b}	0,087^{a-b}
	B	12,00	2,79	0,88	-1,83^{b-v}	0,084^{b-v}
	V	14,10	2,33	0,74	-0,10^{a-v}	0,921^{a-v}

Note:
A - class A, the first experimental group
B - class B, second experimental group
V - class B, control group
a-b - comparison of groups of children in classes A and B
b-v - comparison of groups of children in classes B and V
a-v - comparison of groups of children of classes A and V

Research organization

The study involved 30 children of the first classes, age 6 years. The children were divided into 3 groups of 10 people each. Two groups became experimental, one group - control. In the first experimental group, the children were engaged in the game of Go, in the second - the game of Go in combination with physical exercises, in the control group - according to the usual program of the extended day. Children of experimental groups were engaged in playing Guo twice a week for a month. Before and after the experiment, tests were carried out according to the Schulte method, and according to the method of Ermakov (computer program "Button Choice"). The experimental groups were engaged according to the developed methods, the children of the control group were engaged according to the standard program of the extended day group.

Description of classes in the experimental and control groups

Group A (first experimental)

This is a group of 10 children from the first "A" class. The children did 10 lessons of 50 minutes each. Days of the week and dates are shown in from table 1.

Schedule of one lesson:

1-10 min. - the children themselves choose simple tasks for the Go game. From 8 to 18 Lessons from the book “Game Go. From acquaintance to 20 Kyu ”, 16 tasks for each lesson.

10-45 min. - children play between themselves three games for about 10 minutes, each game they change color. The coach monitors the discipline, the observance of the rules of the game, judges the parties of athletes if necessary, helps children to understand in difficult situations.

45 -50 min. - disciplinary wishes are held for children, and an incentive club rating is put in by the games.

Group B (second experimental)

This is a group of 10 children from the first "B" class. The children did 10 lessons of 45 minutes each. Days of the week and dates are shown in the summary table.

Schedule of one lesson:

1-10 min. - the children themselves choose simple tasks for the Go game. From 8 to 18 Lessons from the book “Game Go. From acquaintance to 20 Kyu ”, 16 tasks for each lesson.

10-25 min. - children play one game between each other, approximately 15 minutes. The coach monitors the discipline, the observance of the rules of the game, judges the parties of athletes if necessary, helps children to understand in difficult situations.

25-30 min. - children do physical exercises for 5 minutes (outdoor games, relay races, a set of exercises in verses (Kozina, Z., Kozin, V., 1998), Kozina, Z., Kozin, V., 2009, Kozina, Zh.L ., & Kozin, V.Yu. 2009, Lahno, O., Hanjukova, O., Cherniavska, O., 2015)

30 - 45 min. - children play one game between each other, approximately 15 minutes. The coach monitors the discipline, the observance of the rules of the game, judges the parties of athletes if necessary, helps children to understand in difficult situations.

45 -50 min. - disciplinary wishes are held for children, and an incentive club rating is put in by the games.

Group V (control)

This is a group of 10 children from the first "B" class. They didn’t play Go, it’s a control group. During classes, the children were engaged in a regular day-care group.

Research methods

The study of mental health according to the method of "Schulte table" (Kozina, Z., et.al., 2011, 2014, 2016, 2017).

The purpose of the test is to determine the stability of attention and the dynamics of efficiency. Used for examination of people of different ages. The subject is alternately offered five tables, in which the numbers from 1 to 25 are arranged in random order. The subject searches, shows, and names the numbers in the order of their increase. The sample is repeated with five different tables.

The main indicator is lead time. According to the results of the implementation of each table, an exhaustion curve (fatigue) can be constructed, which reflects the stability of attention and performance in dynamics.

With this test, you can also calculate such indicators as work efficiency (ER - average work time on 5 tables), degree of work (the ratio of work time on the first table in work efficiency), mental performance (mental health) (ratio work time on the fifth table to work efficiency), proposed by A. Yu. Kozyrev. The result is less than 1.0 - an indicator of good working in, respectively, the higher this indicator is, the more the subject needs time to prepare for the main work. The result indicator (PU) of less than 1.0 indicates a good mental stability and, accordingly, the higher this indicator, the worse the mental stability of the subject to perform the specified work. After completion of the test results are automatically recorded in the database.

Diagnostics of the psychophysiological state of a person according to the program Ermakova SS measuring the reaction time of a point selection in space: "Button selection"

Registration of the psychophysiological state of a person by simulating the reaction time of choosing a point in space. The response time of a point selection in space is measured, which includes carrying out one series or several test series, according to the algorithm consists of a sequence of actions:

• an image of an object is displayed on the touch screen of an electronic device for response, while the object is displayed every time in a new place, the time interval between appearances of the object is not constant,

• response to the appearance of an object on the screen is carried out by touching the image of the object,

• conclude the number of appearances of the object in each series, the number of correct touches and the number of series.

Computer program "The reaction of the choice of a point of space" ("Button selection")

Characteristic. The computer program "The reaction of the choice of a point in space" is designed to determine one of the types of complex sensorimotor reaction - the selection reaction. A complex signal is a stimulus with several distinctive features or a set of incentives that differ in any attribute. In this case, the complications of the stimulus are carried out by changing the point of space to which it is necessary to respond.

Work with the program.

1. Open the file: Reakcja-wyboru.html

2. In the “Rounds” column (Fig. 1) set the required number of execution runs (by default, 1); in the “On (sec)” column, specify the required operation time; in the column "Off (sec)" set the duration of pauses of rest between the series (in the case of one series in this column - 0)

3. Start the execution by touching the “GO” button; the point you want to touch is highlighted in color or in any other way

4. At the end of the work in the window, click "Ok"

5. To fix (record) the number of touches, which is displayed in the column "sum". If you run several test series, then you need to record the number of touches at the end of each series.

6. Reset with the “Reset” button.

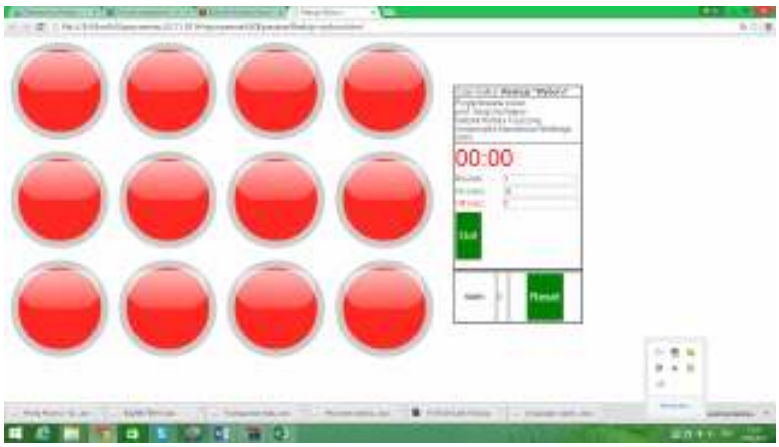

Fig. 1. The program window "Reaction point selection space":

Parameters are logged:

Total test run time;

The total number of correct answers;

number of mistakes

Statistical analysis

The digital material obtained during the research was processed using traditional methods of mathematical statistics. For each indicator, the arithmetic mean value of X, the standard deviation S (standard deviation), the assessment of the significance of differences between the parameters of the initial and final

results, as well as between the control and experimental groups by the Student t-test with the corresponding significance level (p) were determined. A multidimensional dispersion analysis of test indicators was also carried out to determine the effect of various classes on the indicators of the cognitive and neurodynamic functions of children 6 years of age.

Mathematical data processing was carried out with the help of Microsoft Excel Analysis Data Analysis Software, SPSS. Differences were considered significant at a significance level of $p < 0.05$.

Results

The study convincingly showed the effectiveness of the Games of Go for the improvement of cognitive and neurodynamic processes in children 6 years of age. It was found that the use of the Game by itself, as well as in combination with physical exercises, has a positive effect on the level of mental performance according to Schulte's test (Table 2, Fig. 1, 2). The speed of work on the first table, as well as the efficiency of work on this test, is most pronounced in the first experimental group (group A). In group A, the improvement in the performance indicator in the Schulte test was significantly at $p < 0.05$ and $p < 0.01$ compared group B and group V; also significant differences in terms of working time in the Schulte test on the first table in group A compared with group V (Table 2). In group B, an increase in mental awareness of Schulte's test was also observed, but the most pronounced improvement was in the results of switching attention and the speed of neurodynamic processes with Ermakov's "Choice of Button" test (Table 2, Figs. 3, 4). In the third attempt of this test, the improvement in the results in group B was significant at $p < 0.05$ compared group A with group V, and in the first attempt compared with group V (Table 2).

The findings suggest that the use of the game of Go with both exercise and without exercise has a positive effect on the mental performance of children. But the neurodynamic properties are more significantly improved with the use of the game of Go in combination with exercise.

Table 2

Indicators of cognitive and neurodynamic functions of children 6 years experimental (A, n=10 and B, n=10) and control (V, n=10) groups after the experiment

The name of the tests	Group	Statistical Indicators				
		$\bar{x}$	S	m	t	p
Schulte test, work time on the first table, S	A	581,90	57,58	18,21	$1,39^{a-b}$	$0,180^{a-b}$
	B	614,50	46,40	14,67	$1,21^{b-v}$	$0,24^{b-v}$
	V	638,70	42,98	13,59	$2,50^{a-v}$	$0,02^{a-v}$
Schulte test, work efficiency, S	A	79,90	12,72	4,02	$3,04^{a-b}$	$0,007^{a-b}$
	B	94,40	8,07	2,55	$1,61^{b-v}$	$0,13^{b-v}$
	V	103,80	16,62	5,26	$3,61^{a-v}$	$0,00^{a-v}$
Schulte test, the degree of efficiency at the beginning of work, c.u.	A	0,95	0,07	0,02	$1,53^{a-b}$	$0,143^{a-b}$
	B	0,92	0,04	0,01	$1,52^{b-v}$	$0,15^{b-v}$
	V	0,96	0,05	0,02	$0,22^{a-v}$	$0,83^{a-v}$
Test Schulte, mental performance, c.u.	A	0,91	0,08	0,03	$0,10^{a-b}$	$0,92^{a-v}$
	B	0,94	0,05	0,02	$0,20^{b-v}$	$0,84^{b-v}$
	V	0,98	0,06	0,02	$0,06^{a-v}$	$0,95^{a-v}$
Ermakov Test, the first attempt, the amount	A	9,70	1,42	0,45	$0,91^{a-b}$	$0,374^{a-b}$
	B	10,10	1,52	0,48	$2,68^{b-v}$	$0,06^{b-v}$
	V	9,90	1,79	0,57	$0,28^{a-v}$	$0,79^{a-v}$
Ermakov Test, the second attempt, the amount	A	13,10	1,29	0,41	$0,15^{a-b}$	$0,881^{a-b}$
	B	14,00	1,63	0,52	$2,65^{b-v}$	$0,06^{b-v}$
	V	13,90	1,85	0,59	$1,12^{a-v}$	$0,28^{a-v}$
Ermakov Test, the third attempt, the amount	A	16,90	1,45	0,46	$2,60^{a-b}$	$0,018^{a-b}$
	B	17,20	1,48	0,47	$2,71^{b-v}$	$0,013^{b-v}$
	V	15,10	2,47	0,78	$1,99^{a-v}$	$0,06^{a-v}$

Note:
A - class A, the first experimental group
B - class B, second experimental group
V - class V, control group
a-b - comparison of groups of children in classes A and B

b-v - comparison of groups of children in classes B and V
a-v - comparison of groups of children of classes A and V

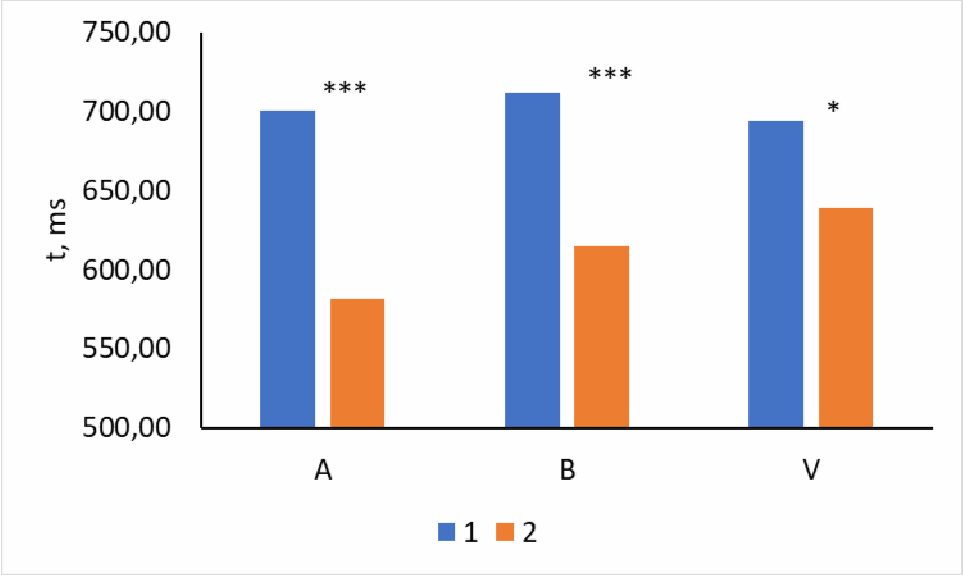

Fig. 1. The results of the Schulte test (total work time) by the children of the experimental and control groups before and after the experiment:
1 - Before the experiment; 2 - After the experiment
A - class "A", the first experimental group
B - class "B", the second experimental group
V - class “V”, control group
t - work time

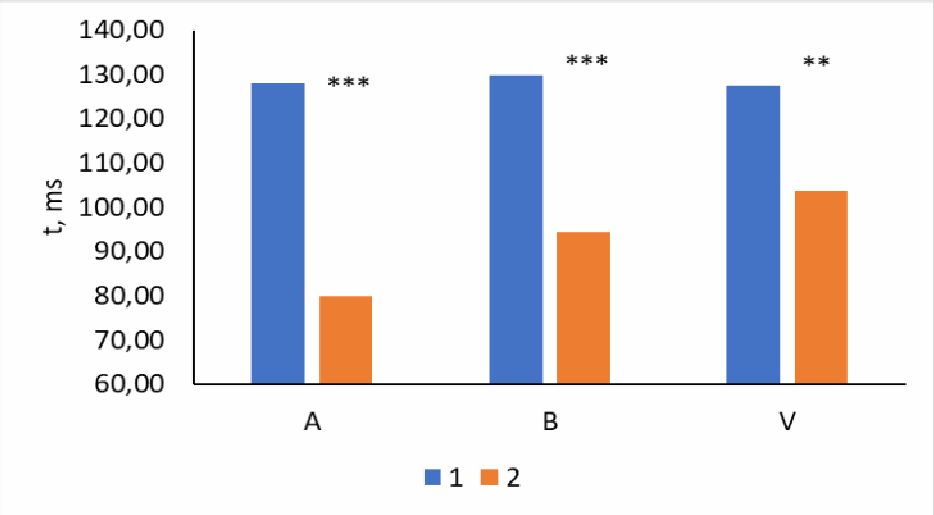

Fig. 2. The results of the Schulte test (work efficiency) by the children of the experimental and control groups before and after the experiment:
1 - Before the experiment; 2 - After the experiment
A - class "A", the first experimental group
B - class "B", the second experimental group
V - class “V”, control group
t - work time

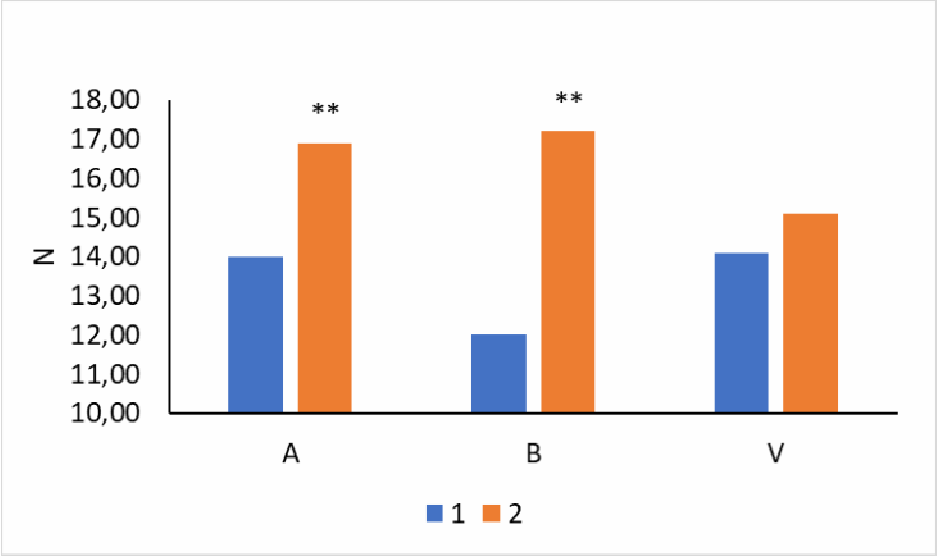

Fig. 3. Results of the Ermakov test ("Select a button") (3rd attempt) by experimental and control group children before and after the experiment:
1 - Before the experiment; 2 - After the experiment
A - class "A", the first experimental group
B - class "B", the second experimental group
V - class “V”, control group
N – number of elements

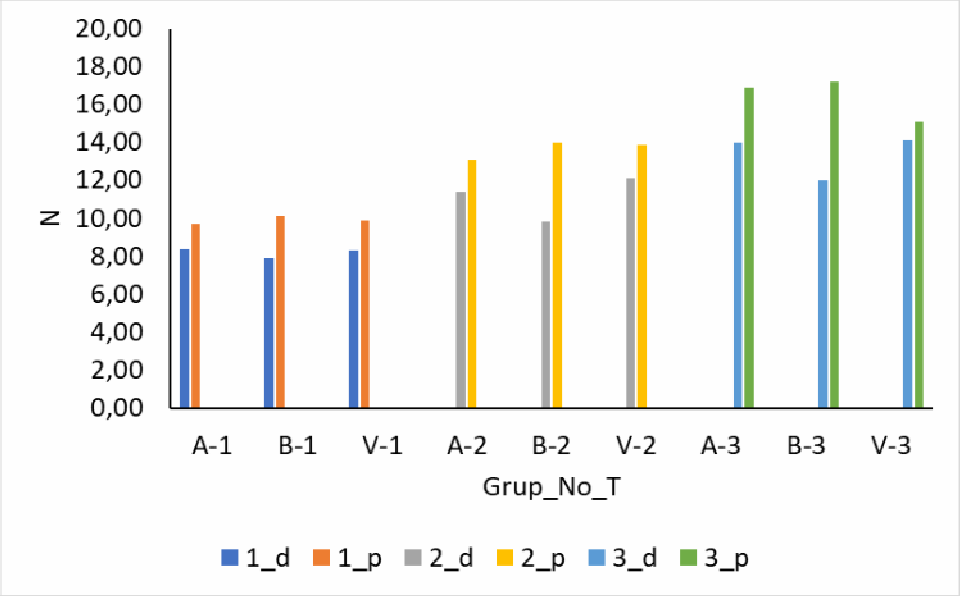

Fig. 4. Results of the Ermakov test (“Choice of a button”) (1-3 attempts) by children of experimental and control groups before and after the experiment:
d - To experiment; p - After the experiment
A - class "A", the first experimental group
B - class "B", the second experimental group
V - class “V”, control group
1 - first attempt
2 - second attempt
3 - the third attempt
N - number of elements
Grup_No_Tests - groups and testing period

The results of multidimensional two-factor analysis of variance also showed a significant effect of the nature of group exercises (Go game; Play Go in combination with physical exercises; usual extended-day classes) on the cognitive and neurodynamic functions of children 6 years old (Table 3). Significant influence was

found by Schulte's tests (work time on the first table and work efficiency) at p <0.001 and according to Ermakov's test to determine the speed of the selection reaction when changing the position of an object in the space of three attempts p <0.001 (Table 3).

The results of the research indicate that the use of the game of Guo has a positive effect on the indicators of cognitive functions and neurodynamic properties of 6-year-old children. Occupations only by the game of Go most affect mental performance, and occupations by playing Go, in combination with physical exercises, improves neurodynamic indicators most pronouncedly associated with the need to switch attention, the speed of choice reaction to objects whose position changes in space.

Table 3

The results of analysis of variance (two-factor multidimensional) indicators of cognitive and neurodynamic processes in children of the experimental and control groups as a result of double testing

Source	Dependent Variable	Tests of intergroup and externally group Effects					
		Type III Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Corrected Total	Schulte test, work time on the first table, s	140278,683a	5	28055,74	11,095	0,000	0,507
	Schulte test, work efficiency, s	22047,950b	5	4409,59	23,366	0,000	0,684
	Schulte test, the degree of efficiency at the beginning of work, c.u.	,039c	5	0,008	1,532	0,195	0,124
	Test Schulte, mental performance, c.u.	,032d	5	0,006	0,701	0,625	0,061
	Ermakov Test, the first attempt, the amount	60,883e	5	12,177	4,789	0,001	0,307
	Ermakov Test, the second attempt, the amount	107,483f	5	21,497	5,842	0,000	0,351
	Ermakov Test, the third attempt, the amount	132,550g	5	26,51	5,674	0,000	0,344
Intercept	Schulte test, work time on the first table, s	2,59E+07	1	2,59E+07	10238,68	0,000	0,995
	Schulte test, work efficiency, s	733278,2	1	733278,2	3885,527	0,000	0,986
	Schulte test, the degree of efficiency at the beginning of work, c.u.	53,96	1	53,96	10554,37	0,000	0,995
	Test Schulte, mental performance, c.u.	53,79	1	53,79	5857,425	0,000	0,991
	Ermakov Test, the first attempt, the amount	4558,817	1	4558,817	1792,98	0,000	0,971
	Ermakov Test, the second attempt, the amount	8954,817	1	8954,817	2433,619	0,000	0,978
	Ermakov Test, the third attempt, the amount	12702,15	1	12702,15	2718,653	0,000	0,981
Group*Test Period	Schulte test, work time on the first table, s	140278,7	5	28055,74	11,095	0,000	0,507
	Schulte test, work efficiency, s	22047,95	5	4409,59	23,366	0,000	0,684
	Schulte test, the degree of efficiency at the beginning of work, c.u.	0,039	5	0,008	1,532	0,195	0,124
	Test Schulte, mental performance, c.u.	0,032	5	0,006	0,701	0,625	0,061
	Ermakov Test, the first attempt, the amount	60,883	5	12,177	4,789	0,001	0,307
	Ermakov Test, the second attempt, the amount	107,483	5	21,497	5,842	0,000	0,351
	Ermakov Test, the third attempt, the amount	132,55	5	26,51	5,674	0,000	0,344
Error	Schulte test, work time on the first table, s	136545,5	54	2528,62			
	Schulte test, work efficiency, s	10190,9	54	188,72			
	Schulte test, the degree of efficiency at the beginning of work, c.u.	0,276	54	0,005			
	Test Schulte, mental performance, c.u.	0,496	54	0,009			
	Ermakov Test, the first attempt, the amount	137,3	54	2,543			
	Ermakov Test, the second attempt, the amount	198,7	54	3,68			

	Ermakov Test, the third attempt, the amount	252,3	54	4,672			
Total	Schulte test, work time on the first table, s	2,62E+07	60				
	Schulte test, work efficiency, s	765517	60				
	Schulte test, the degree of efficiency at the beginning of work, c.u.	54,275	60				
	Test Schulte, mental performance, c.u.	54,318	60				
	Ermakov Test, the first attempt, the amount	4757	60				
	Ermakov Test, the second attempt, the amount	9261	60				
	Ermakov Test, the third attempt, the amount	13087	60				
Corrected Total	Schulte test, work time on the first table, s	276824,2	59				
	Schulte test, work efficiency, s	32238,85	59				
	Schulte test, the degree of efficiency at the beginning of work, c.u.	0,315	59				
	Test Schulte, mental performance, c.u.	0,528	59				
	Ermakov Test, the first attempt, the amount	198,183	59				
	Ermakov Test, the second attempt, the amount	306,183	59				
	Ermakov Test, the third attempt, the amount	384,85	59				

a. R^2 = ,507 (corrected R^2= ,461)
b. R^2 = ,684 (corrected R^2= ,655)
c. R^2 = ,124 (corrected R^2= ,043)
d. R^2 = ,061 (corrected R^2= -,026)
e. R^2 = ,307 (corrected R^2= ,243)
f. R^2 = ,351 (corrected R^2= ,291)
g. R^2 = ,344 (corrected R^2= ,284)

After the experiment, in April and May, in conversations with the class leaders of group A and group B, it was observed that the children involved with the Go game performed homework and tasks at full-time assignments and completed additional tasks. Many of the children of the same classes who did not go to Go, felt bad and were sick, many of whom were harder to get a job, and rarely did any additional tasks. Group B, that is, the class in which the children did not play Go, in April, half were ill, and many in May simply did not go to school for various reasons. Teachers of the junior high school, sharing their observations, marked the formation of a more stable psyche and intellectual endurance of children who had been attending lessons from the Go throughout the school year. Children who did not play Go, at the end of the year were psychologically exhausted and difficult to concentrate on tasks.

Discussion

The study has expanded the modern views of scientists on the game of Go as a system in terms of ethics, culture, spirituality and in various scientific fields. The obtained data on the positive influence of the Go game on the cognitive and neurodynamic functions of 6-year-old children confirm the results of modern research on the positive influence of the Go game on the intellectual level of children and the executive functions of the brain.

As for the use of the game of Guo in combination with physical exercises, it should be noted that no such studies have been conducted, and our work is the first from this point of view. The method of combining the game of Guo with physical exercises overlaps with the experience of the ancient Chinese emperors, who used this game in combination with the martial arts to educate their children. But an experimental scientific study of the influence of the game of Go in combination with physical exercises on the cognitive and neurodynamic functions of 6-year-old children is a new acquisition in this field.

The results obtained in our work confirm the results of studies in which it is shown that the game of Guo affects the human brain and changes its consciousness and reaction to events in life. Being aware of some aspects of life, a person does not take knowledge of them for being, as all people do. As a rule, this is an analysis error, from the point of view of psychology and science. The Go game changes the conscious perception of the world through a prism not always of the situation on the board, but at the same time obeying the same rules. In this case, a person from party to party sees that the situations in Go do not repeat, no matter how she tries to

repeat the game, but the conditions of the game are not variables. Such a situation in the game allows a person to look at his own dawn on the other hand, to reconsider his experience and, possibly, change his attitude to the world around him, thus develop and bring his sense of the universe to reality, thereby reducing the influence on his consciousness of negative life experience . This influence of the game of Guo on a person was noticed by masters long before our era and was described in more than one work. These examples were used by masters of our time.

We have received the fact that the use of the game of Guo has a positive effect on mental refreshment and on neurodynamic functions, while the influence on the neurodynamic functions is enhanced by the use of the game of Go in combination with physical exercises. These data confirm and expand the results of other researchers. Studying the effects of the Go game on the brain examined Lee, B., Park, Jung, Kim, Oh, Choi, . . . Kwon (2010), defining the effect of the Go game on brain development in professionals. Currently, one of the most difficult problems of modern neuroscience is learning-induced neural plasticity. Many researchers have discovered activation-dependent structural plasticity of the brain in sulfur and white matter. The game of Paduk (Go), as is known, requires many cognitive processes and long-term learning, and the authors have found that such processes lead to structural changes in related areas of the brain. The authors suggest that research into the mechanism underlying such changes may be useful for improving higher-order cognitive abilities, such as learning, abstract reasoning and self-control, which can contribute to education and cognitive therapy. Lee, Guesgen, Baltes, Jeo (2015) also came to similar conclusions. The authors experimentally showed that simple neuro-fuzzy reasoning is performed much better when using the game of Go, than other methods of developing intelligence, and this shows a great potential for the application of the game of Go. Playing Guo also treats Alzheimer's disease, it has been proven by Lin, Cao, & Gao (2015).

Our work also confirms the results of the research of the authors, showed the high value of the Go game in modern society. The question of what place the people play in Go society is in China, because the Chinese believe that the state does not take this game seriously, for example, Japan or Korea. Therefore, the question of the Go game was discussed in Amaro, & Kyburz (2001). Also attention to the spiritual world in the game Go considers Cobb (1997).

About serious recreation writes Lu (2017). This article combines both analytical and evocative autoetographic studies of the Go game, in order to lighten Confucian self-interunit and promote Robert Stebbin's concepts of serious rest. As an analytical auto-tune research, this article is intertwined with the author’s personal experience of reproducing the game of Guo with theoretical discussions.

The complexity of learning Go games compared to other board games is considered by Matsubara (1996). The most important difference is the complexity of the game tree, which is significantly higher than the complexity of the game tree CHESS.

The victorious principles of Go in linguistic methods were proposed by Nishino, Sugeno, & Ieee (1997). In this article, the authors offer a scripted approach to solving and analyzing complex problems. This is a variation of the processing of linguistic information. People use macroscopic methods built from an abstract data structure; mild processing and powerful prediction; to solve several complex problems. Creation and scripting is done through the processing of linguistic information. The authors identified the script as the combinational notion of a sequence and its meanings, described by linguistic labels. For adding, scripting, and analyzing in a Go game, systems are shown. December is also viewed in various scientific fields, but not so much as in the field of computer programming. In the field of physics, Cai, Ma, Hou, Cui, Jia, Zhang, . . . Wei (2017) built a discrete model for decontamination, taking into account the possibility of connecting to a cell, inspired by the game Go. An analytical solution was found for a simplified 1D model and shows good consistency with the experimental results for ZSM-12. Some abnormal pseudo-phase transition phenomena in the deactivation process and acid density are presented by modeling the deactivation of SAPO-34. This model can offer new methodologies for studying the mechanism of deactivation of a zeolite. In the field of studying the social behavior of people Beheim, B. A. draws parallels between the principles of the Go game and human behavior.

Thus, our study and the results obtained expand and complement the results of research by other scientists on the effect of the Go game on cognitive functions. A new result is the determination of the effectiveness of the use of the game of Go in combination with exercise. The developed technique allows more significant influence not only on the cognitive functions of children 6 years old, but also on the neurodynamic properties.

Conclusions

The use of the game of Go has a positive effect on mental festivity and on neurodynamic functions, while the effect on the neurodynamic functions is enhanced by the use of the game of Go in combination with physical exercises. The use of the Go game by itself and in combination with physical exercises has a positive effect on the level of mental performance according to Schulte's test at $p < 0.05$. The use of the game of Go in combination with physical exercises contributes to the improvement of the indicators of switching attention and speed of neurodynamic processes with the Ermakova test “Choice of a button”.

The results of the multidimensional two-factor analysis of variance showed a significant effect of the nature of group exercises (Go game; Play Go in combination with physical exercises; ordinary classes of the

extended day program) on the cognitive and neurodynamic functions of children 6 years of age. Significant influence was found by Schulte's tests (work time on the first table and work efficiency) at $p < 0.001$ and according to Ermakov's test to determine the speed of the selection reaction when changing the position of an object in the space of three attempts, $p < 0.001$.

The results of the conducted studies indicate that the use of the game of Guo has a positive effect on the indices of the cognitive functions and neurodynamic properties of children 6 years of age. Occupations only by the game of Go most affect mental performance, and occupations by playing Go, in combination with physical exercises, improves neurodynamic indicators most pronouncedly associated with the need to switch attention, the speed of choice reaction to objects whose position changes in space.

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Conflict of interest

The authors declare that there is no conflict of interest.

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