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FEATURES OF COGNITIVE PROCESSES IN CHILDREN WITH DIFFERENT INTERNET ACTIVITY

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Abstract

The paper presents the results of studying the peculiarities of cognitive processes in children with different durations of using digital devices per day. The sample consists of 5-7-year-oldpreschoolers (N=50) and 7-11-year-old junior schoolchildren (N=50) with the experience of using digital devices, as well as their parents (N=100), living in Moscow. The sample of children is balanced by sex and age. The research methods are selected, developed and corrected with the results of approbation, including neuropsychological tests by Akhutina T.V., and a socio-psychological questionnaire for each age group. All the respondents are divided into the groups according to age (preschool/schoolchildren) and user activity. Judging by the results of the study, there are differences in the state of cognitive processes in preschoolers and schoolchildren, depending on the duration that the children spend on average with digital devices. The main differences are obtained in the group of the schoolchildren. The preschoolers show the following regularity: the higher the user activity is, the worse the function of the serial organization of movements, switching and efficiency in the graphical test are. The schoolchildren with medium user activity are the most effective in performing neuropsychological tests. The results suggest that the moderate use of digital technologies and the Internet (the medium user activity level) can be effective in the cognitive development of primary schoolchildren and proper planning of study time and rest time.

Keywords: Digital technologies, neuropsychological diagnostics, cognitive processes, Internet activity.

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1. Introduction

Infocommunication technologies take an increasingly important place in the way of life of both adults and children. Infocommunication technologies become a significant cultural tool, mediating the personal, emotional, behavioural and cognitive development of children and adolescents. The use of infocommunication technology provides new opportunities for learning, developing, creating and communicating. Along with the enumerated possibilities, the use of infocommunication technology by children incurs a number of significant and yet unexplored risks associated with an excessive enthusiasm for digital devices, facing information inappropriate for age and the formation of unhealthy relationships in the family.

2. Problem Statement

The question of the impact of infocommunication technologies on the development of higher mental functions of children remains insufficiently studied and controversial. There are two fundamentally opposite points of view about the impact of infocommunication technologies on higher mental functions: positive (Small & Vorgan, 2008) and negative (Spitzer, 2014). However, now there is an increasing number of studies proving that digital technologies provide the younger generation with more advantages than disadvantages.

So A. Fish and colleagues show that children using home digital devices have higher cognitive development rates than children who have no computer at home (Fish, Li, McCarrick& Partridge, 2008). Similar results are obtained by another group of researchers (Jackson, Witt, Games et al., 2012) who show that children using the Internet have higher academic performance than children who do not use the Internet. During the last decade, research has emerged that proves the positive impact of digital technologies on the development of visual intelligence: the ability to control several visual stimuli simultaneously, visualization of spatial relationships (DeBell& Chapman, 2006), pattern recognition, development of visual memory (Van Deventer &White, 2002), metacognitive processesof planning, search strategies and evaluation of information (Tarpley, 2001).

Given the inevitability of the introduction of new technologies into everyday life, most researchers are increasingly using the unbiased approach - studying and ascertaining the changes in the cognitive processes of children and adolescents under the influence of infocommunication technologies, rather than treating infocommunication technologies as something bad or good (Agosto, 2002; Barr, Pennycook, Stolz&Fugelsang, 2015; George, Odgers & 2015; Mills, 2016, etc.).

Despite the growing urgency of this issue, up to the present time, there is a lack of systematic studies of the influence of infocommunication technologies on the development of higher mental functions (memory, attention and thinking) of children.

3. Research Questions

The present study aims to explore the influence of user activity (duration and frequency of use of digital devices) on the development of cognitive processes in preschoolers and primary schoolchildren.

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4. Purpose of the Study

The main research tasks of the study include:

1) exploring the characteristics of user activity – the frequency and duration of Internet use by children;

2) examining the state of higher mental functions in children with different user activity using a battery of neuropsychological tests.

5. Research Methods

5.1. Samples

The study involved children of two age groups: 5-7-year-old preschoolers (N = 50) and 7-11-year-old junior schoolchildren (N = 50) with experience of using digital devices, as well as their parents (N = 100 people) living in Moscow. The sample of children was balanced by sex and age.

5.2. Methods

The research methods were selected, developed and corrected with the results of approbation including 1) neuropsychological tests; 2) a socio-psychological questionnaire for each age group that included several units of questions. The examination was conducted at home in families in the form of an individual interview with each child. The parents filled out a socio-psychological questionnaire.

The neuropsychological examination for the both age groups of children included the following methods (Akhutina, 2016): 1) dynamic praxis; 2) auditory memory (memorizing the two groups of three words in each); 3) arithmetic operations; 4) the deferred reproduction of words; 5) visual-spatial memory (the reproduction of four hard-to-verbalize figures from memory); 6) generating a story on a series of plot pictures; 7) the graphical test "Fence"; 8) the test «Dots» (on the computer); 9) the deferred reproduction of figures (from a trial to test visual-spatial memory). The neuropsychological tests were used to diagnose the following neuropsychological indices (Akhutina, 2016): 1) programming (executive functions) and control; 2) the serial organization of movements; 3) auditory information processing; 4) visual-spatial information processing; 5) left-hemisphere functions; 6) right-hemisphere functions; 7) the functions of the first functional unit of the brain (tonus, fatigability, hyperactivity).

The results were processed using the statistical program IBM SPSS Statistics 22. Correlation and one-way analysis of variance (ANOVA) was conducted to find cognitive differences in the groups of the children with various user activities.

6. Findings

In this paper, we compared the effectiveness of the performance of neuropsychological tests by the children with different durations of the use of digital devices per day. All the respondents were divided into groups according to age and user activity. At preschool age, 44% (22 of the 50 children) rarely used the Internet and digital devices, 48% of the children used the Internet and digital devices 1 to 3 hours a day, and only 8% of the children used digital devices 1 to 3 hours on weekdays and more than 3 hours at the weekend (Table 01). At the primary school age, the picture of user activity changed. Only 14% of the

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children rarely used digital devices; 66% (33 of the 50 children) used the Internet and digital devices from 1 hour to 3 hours a day (medium user activity); 20% of the children used digital devices for more than 3 hours a day (high user activity).

Table 01. Preschool and primary school children with different user activity

Age groups	Low user activity (using the Internet for less than 1 hour on weekdays and weekends)	Medium user activity (using the Internet 1-3 hours on weekdays and weekends)	High user activity (using the Internet 1-3 hours on weekdays and more than 3 hours on weekends)
Preschoolers (5-7 years) N = 50	22 (44%)	24 (48%)	4 (8%)
Younger schoolchildren (7-10 years old) N = 50	7 (14%)	33 (66%)	10 (20%)

The obtained statistical distribution of the children by user activity reflected the real social situation of the frequency and duration of use of digital devices by preschoolers and primary schoolchildren in Moscow (Soldatova & Shlyapnikov, 2015; Soldatova et al., 2014).

The peculiarities of development of cognitive processes in children with different enthusiasm for digital devices and the Internet turned out to be different in the group of the preschool children (5-7 years) and in the group of junior schoolchildren (7-10 years).

In the group of the preschool children, there were fewer differences in the performance of neuropsychological tests depending on the user activity than in the group of primary schoolchildren. Significant differences were observed only in the index of the functions of the serial organization of movements and at the level of the trend in indices of auditory information processing and the right hemisphere functions. The following regularity was observed: the higher the user activity in preschool children was, the worse they performed neuropsychological tests on average. The children who spent more time in the Internet demonstrated the worst performance of the graphical test "Fence" (mean = 3.25, $p < 0.01$). They found the tendencies to expand the programme, detachment of the hand from a sheet of paper, the presence of "planes" and simplification of the program in dynamic praxis. The children with low user activity performed the best graphical test (mean = 1.36). The children with medium activity showed average results. The children with high user activity at the level of the trend were worse than the other children at repeating the words aurally (with the first presentation) and at retaining the words in memory during involuntary memorization (the first series). Also, at the level of the trend, differences were obtained in the composition of a story on a series of pictures. The children with medium and high user activity on the average had more errors in the composition of a story due to the weakness of the right hemisphere functions. That is, they allowed a low-realistic interpretation of the events depicted in the picture, with the ignoring of several components of the picture. Significant differences in other neuropsychological indices between the groups of the children with different user activities at preschool age were not found.

In the children at primary school age, there were more differences depending on user activity in comparison with preschool children. Unlike the children at an earlier age, the children with medium user

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activity (using the Internet 1-3 hours on weekdays and weekends) were the most productive when performing neuropsychological tests. These children mastered the motor programme in the trail for dynamic praxis better (mean = 0.21, $p < 0.05$); they needed less time to compose a story on the series of plot pictures (the programing and control index of voluntary activities). The productivity of the graphical test was quite high, but it took more time to complete this task in comparison with the other children. These children allowed the least "mirror-like" mistakes in the image of the figures and in the transformation of the figure into a sign in the trial for visual memory, with the same productivity for all the children (the visual-spatial information processing index).

Differences in the index of the auditory information processing concerned the reproduction of memorized words. The children with medium user activity demonstrated a better performance when memorizing words in the trial for auditory memory (mean = 5.7, $p < 0.01$). The maximum differences were found only with respect to a second reproduction, differences at the level of trends - in a first reproduction; there were no significant differences in the third and deferred reproduction. The children with medium user activity made less mistakes in the lexical designing of a story on the series of pictures. They had less fatigability and disarrangement of the hands (the tonus) when performing a trail for dynamic praxis (the index of the functions of the first functional unit of the brain). In the developmental indices of the left-hemispheric and right-hemispheric functions, these children showed average results.

The children with low user activity, compared to children with medium user activity, were worse at mastering the motor program in dynamic praxis (mean=0.57, $p < 0.05$); they needed more time to perform the computer test "Dots", especially the third series of tasks (the index of executive functions and control). But these children performed the graphical test on a sheet of paper better than the others, they needed less performance time (low user activity - 27.86 sec, medium - 46.15 seconds, high - 47.10 sec, $p<0.05$) (the index of the serial organization of movements). Given the same efficiency of visual memory in all the children studied, the children with low user activity admitted the errors of the mirror-like image and in the transformation of the figures into a sign (the index of visual-spatial information processing) more often than the others. They kept the direct line when performing the graphomotor test (the index of the functions of the first functional unit of the brain).

The children with high user activity were better than the other children at the computer tasks. In the test "Dots", they performed tasks most quickly, especially in the third, the most complex trial, which required the good concentration and attention distribution. However, they did not differ from the children from the other groups in the productivity of the computer tasks. When performing the neuropsychological tests, they showed either average results, or results below average. In the trial for dynamic praxis, they mastered the motor programme worse than the others (mean = 0.90, $p < 0.05$) (the index of programming and control). These children performed the graphical test (the index of the serial organization of movements) slower than others. When generating the story, these children allowed more lexical errors (significant differences at the level of the trend), their vocabulary was poorer, they searched for a required word and verbal replacements of the word (the index of auditory information processing). In dynamic praxis, these children exhausted faster than the others, they often had the hypertension of the hands, excessive amplitude of movements during the trial (the index of the functions of the first functional unit of

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the brain). When performing the graphomotor test, they were worse at keeping to the direct line than the others ($p < 0.05$).

The results obtained point to a positive effect of digital devices on the development of children's cognitive processes, which is consistent with the above-mentioned foreign studies. It is noteworthy that the moderate use of the Internet (the medium level of user activity) plays a positive role. The children with high user activity are less efficient in performing the procedures, as did the children with low user activity. However, the positive impact of digital devices in our study concerns the children at primary school age. In the preschool children, the increase in user activity is associated with a decline in efficiency, especially in switching within one task and from one task to another (the serial organization of movements). It is also possible that these results are associated with the uneven sampling and a small number of preschool children with high user activity.

7. Conclusion

There are differences in the state of cognitive processes in preschool children and junior schoolchildren, depending on the time that children spend on average with digital devices. The main differences are obtained in the group of the junior schoolchildren. The preschool children show the following regularity: the higher the user activity is, the worse the function of serial organization of movements, switching and productivity in graphical test are.

The children at primary school age with medium user activity are the most effective in performing the neuropsychological tests. On the average, the ability for activation during the task performance and switching from one task to another is developed better in them; they are better at controlling the execution of tasks, avoiding mistakes. During the oral composition of a story, they use a variety of vocabulary, have a lower fatigability and better arm tonus. The results obtained during the research suggest that the moderate use of digital technologies and the Internet (medium user activity) can be effective for the cognitive development of primary school children with proper planning of study time and rest time.

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