Mnemonic Abilities of Internet — Active Adolescents[*]

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Abstract: The article describes the specific effects of influence of long-term and systematic resources on the Internet using mnemonic abilities of adolescents aged 15–16. The article presents the results of the study of functional and operational sides of adolescents' memory with the experience of online teens — activity until 1.5 year, and from 1.5 to 3 years, and over three years using the methods of diagnosis of mnemonic abilities. There is shown the specificity of mnemonic techniques used by teenagers with different online experience — activity stage, in memorizing of simple and sophisticated non-verbal nonsense material. The presented data was obtained with co-author A. V. Kuznetsova, are attesting about changes in the structure of mnemonic abilities of teenagers during Internet activity process.

Key words: mnemonic abilities, functional mechanisms, operational mechanisms, regulation mechanisms, internet-activity's influence

1. Introduction

Currently, there is reason to believe that virtual reality, or rather, the activity in it, is a factor not only affecting the cognitive processes and personality of the subject, but also is shaping them. This is demonstrated by our works (Cheremoshkina, 2006; 2008; 2010; Cheremoshkina, Nikishina, 2009; Cheremoshkina, 2011; Cheremoshkina et al., 2008; 2012), as well as studies by other authors (in particular Young K. S., 1996).

What kind of laws (already known to science or otherwise) is the formation of the cognitive abilities of the subject of Internet activity (cyber-activity), it remains to be seen, but it is already clear That the main issue in this regard is as follows. How cognitive abilities formed in virtual reality will be Implemented in the real world:

- with what productivity;

- with some quality features;

- with what reliability, in other words, the probability of obtaining the particular necessary for a professional result.

Abilities as a weapon (instrumental performance) cognitive activity are understood by us as stereotyped mental activity, which confirmed phylogenetically, but may develop during ontogenesis as mental properties. Stereotyping mental process is due, on the one hand, the nature of human interaction with the environment. On the other hand, the features of brain structures, including both structural and morphological properties of the brain, as well as indicators of its reflex activity. The increasing possibilities of using online resources replace the need to interact with the real world. It is clear that a long stay in the cyber environment creates the conditions for fixing

new (other) algorithms behavior, in other words, leads to stereotyping of new (other) mental activity.

This means that new systematic using of information technology, in particular, online resources, can lead to the emergence of new or transformed specific abilities.

Earlier (Cheremoshkina, 2008; Cheremoshkina et al, 2009) we provided data on the changes in sensorimotor performances of gamers (students aged 19-20, playing the computer games for at least 6 hours a day for the past 6 years). Increase reaction time was reported gamers to visual, tactile and auditory signals in a state of relative rest and under mental stress. This may indicate a decrease in speed of information processing of active cyber players at the stage of perception already.

Along with the absolute performance speed of response to signals that level of reflect the activity of the nervous system, we analyzed magnitude of the change of reaction time — activation of sensory areas in mental workload. In particular, we fixed lower than in other groups (users and developers) functionality possibilities of the left hemisphere sensory areas with increasing mental workload. In addition, the nature of the activation of sensory areas of gamers was less adequate to the proposed experimental material than in the control groups. It was found with the new hotel active cyber gamers pronounced inhibition is observed on the second presentation of the signal of the same modality. This indicates a change of the structural organization of functional systems to realize the cognitive abilities of gamers. These results suggest that active cyber gamers experienced changes in micro-genesis of functional systems, in other words, the nature of the cognitive process, in particular mnemonic.

Micro-genesis of functional system that implements a particular mental property is the process of building the interaction of different psychophysiological mechanisms to achieve a specific result. In this regard, it is clear that the ability as cannon base of cognitive activity, caused by the genesis of specific functional systems, by the maturity of the brain structures, in particular, sensory areas, as well as mechanisms for "reprogramming" (according to Luria) the cortical activity will vary depending on a number of conditions. In addition, for the "launch" of the formation of a specific functional system there certain external influence is needed. Newly emerging external stimulus stimulates the emergence of new bonds, new feature of the system, the structural organization of which can be fixed by generalizing and stereotyping of the activity conditions of it, as S. Rubinstein wrote at his time.

In this regard, there is evidence to suggest that different types of online activities create conditions for the formation of specific and appears to be limited in their potential of functional systems. Our studies carried out in the period from 2004 to 2012 confirm these assumptions. Cognitive, communicative, play online activities and use of the Internet-resources for professional purposes affects the cognitive abilities of the subject (Cheremoshkina, 2010, Cheremoshkina, 2011 and others). Experimental studies of mnemonic, cognitive and attention abilities of online-active students aged 10–12, 14–16, 18–20, and of adult users aged 25–40 do show that long-term and systematic use of the network has not only developing but also distorting influence on their cognitive abilities (Cheremoshkina, 2008; Cheremoshkina et al., 2009a, 2009b; Kuznecova, 2010, 2011; Cheremoshkina et al., 2010; Cheremoshkina, 2011).

In order to explain the identified patterns, it needs to conceptualize the idea of the nature, structure, development, and procedural, effective characteristics of abilities. As already mentioned, the abilities of tool are based on cognitive activity, are stereotyped mental activity, which can be realized by different mechanisms, and that is reflected in the performance and qualitative uniqueness of a particular function (volume, speed, accuracy, probability of correct results) (Cheremoshkina, 2009B; Cheremoshkina, 2010). Developed abilities implemented by multilevel mechanisms: functional, operational, and regulation (Cheremoshkina, 2000; Cheremoshkina,

2009B). Functional mechanisms as genotype and innate abilities due to the foundation are trained to the extent of any involvement of the analyzing system. Cognitive, communicative and game activities in the network are implemented using mainly visual perception. Therefore, with big confidence it is safe to assume the productivity growth of the visual perceptual and mnemonic abilities in relation to the visibility of the material presented by the development of their functional mechanisms.

Operating mechanisms of cognitive abilities are ways of processing information, in analysis and interpretation. They are multifunctional and are formed by the maturation of the brain structures and brain activity development of the subject. Nature and conditions of work, the type of information being processed lay impact on qualitative features (complexity, diversity, flexibility in use, and so on) of the operating side of human cognitive processes (Cheremoshkina, 2009b). Development of operational mechanisms of specific cognitive ability is due to the formation of the most complex mental activities aimed at organizing a holistic cognitive act on the orientation to the anticipation of the possible outcome. Thus, in the present work mnemonic abilities are understand by us as the organization implements of new incoming information to what lies ahead. In other words, as an instrument or means of memorizing, preserving, forgetting and reproduction, realized with different implemented various measures of success of specific functional systems.

Active use of the internet-resources can, on the one hand, lead to new ways of processing information and, therefore, to change the structure of cognitive abilities. On the other hand, the virtual nature of space-time and social interaction creates a principally different environment for the formation and development of not only functional, but also operational, and regulation mechanisms of cognitive abilities.

2. Subjects and Research Method

Aim of the present work in this regard was the continued research about influence of internet-activity on mnemonic power user. User of internet resources, to our knowledge, refers to the network as well as for professional and informative, so for communication and gaming purposes. In this case, online resources appear to the user as a condition, in which it takes place every-day and professional activity, as compared to those for whom the creation of information technologies is consciously chosen goal or motive of having only the embodiment of the cyber-space. Length of stage and duration of daily web-spending time were considered by us as the index of internet-activity.

Previously identified patterns of development and functioning of memory of schoolchildren, teenagers, students and adults (Cheremoshkina, 2000; Cheremoshkina, and others, 2009b; Cheremoshkina, 2010), led to the selection of three experimental groups of adolescents 15–16 years of experience online-activity till 1.5 year, from 1.5 to 3 years and more than three years. The selection of the subjects for control group and for experimental group was based on the results of the questionnaire in which information was obtained   on the experience of the network-activity stage. Additionally we were checked the duration of daily network usage, and the type of internet-activity. There were created out three experimental groups and one control group. Sample of size was 210 people (The study was conducted at schools of Moscow region in 2010–2011).

The first experimental group of students with the experience of internet activity till 1.5 year is 31% of the total number of subjects, including: 50% — 16 years old, and 50% — 15 years old. This group can be called the "newcomers" as duration of daily use of the internet-resources are varying within an hour. Representatives of this group in 67% of cases are turning to the internet in teaching aims, 26% — in the communication-cognitive aims,

and in 17% of cases — just for the communication. Finding information they carry with Google and Yandex, communicate via Skype and social networks (Vkontakte, Facebook). Among them weren't found possessing any special knowledge of programming.

The second experimental group with the experience stage from 1.5 year to 3 years (30% of total participants) included 44% — 16 years old, 56% 15 years old. They use online resources from 1 to 3 and more than 3 hours per day. Internet activity of this group of teenagers comes communicative and cognitive activity (in 31% of cases), games (31%), cognitive (15%), communication (15%). Representatives of this group are using social networks (Vkontakte, Odnoklassniki) and ICQ. Games and communicative-play types of activity are realized through the Counter-Strike and World of Warcraft. There was noticed that they use appropriate vocabulary and have enough skills for creating homepages.

The third experimental group with internet-activity stage up from three years is 15% of the total sample, including: 53% — 16 years old, 47% — 15 years old. The duration of the range of daily spend network surfing from 1 to 3 hours (50%) and more than 3 hours (50%). Their online-activity is more diverse than of the representatives of the previous groups. They turn to the internet-resources for cognitive aims (13%), communication (13%), communicative and cognitive (24%), communication-gaming (13%), gaming (13%), cognitive-gaming (24%). They often use role games like MUD.

The control group consisted of students without experience in dealing with internet resources and experienced till six months (24% of the total number of subjects, including the 16 years old — 44%, 15 years old — 56%).

To assess symptoms of mnemonic abilities there was used diagnostic method of mnemonic abilities, developed on the basis of the deployment of mnemonic activity (Shadrikov, Cheremoshkina, 1990; Cheremoshkina, 2000; Cheremoshkina, 2009b).

This method is aimed for studying the effectiveness of memory, level of its development, as well as the qualitative uniqueness of mnemonic techniques and methods of their regulation. Deployment method of mnemonic activity is carried out using 10 cards with images of figures of increasing complexity, which are composed of straight intersecting lines.

Time of presentation of each card as follows: from the 1st to the 10th presentation — 1 second, from 11th to 20th — 2 seconds, from 21th to 30th — 3 seconds etc. Nonverbal mindless material and the above procedure for the presentation allow to "deploy" the mnemonic activity and to isolate productivity implementing its mechanisms: functional, operational, and regulation.

In this study, by using the method of diagnostics of mnemonic abilities there were assessed four indicators:

(1) memorizing productivity based on the functional mechanisms (total time memorizing figure number 2), see Figure 1;

(2) the effectiveness of memorizing thanks to the functional and operational mechanisms (total time remembering figure number 3 and the results of the questionnaire);

(3) types of used operational mechanisms;

(4) the rate of incorporation of operation mechanisms in the memorizing process (memorizing time of figure number 3 and the results of the questionnaire).

Details of the method are shown elsewhere (Shadrikov, Cheremoshkina, 1990; Cheremoshkina, 2009B).
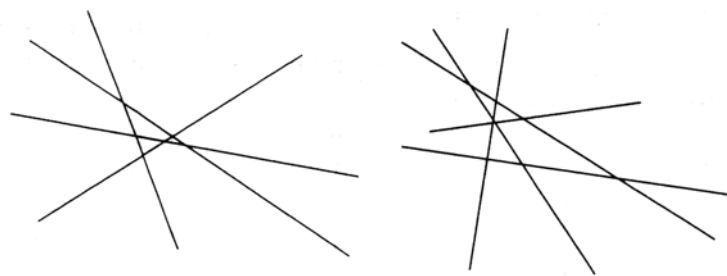
Figture 1   Cards №2 And №3

For obtaining more information there was used questionnaire of 30 questions recommended in diagnostic method of mnemonic abilities (Cheremoshkina, 2009B). Questioning of researched subject after memorizing of various complexity materials allow draw the conclusions about:

- presence or absence of mnemonic devices;
- its number and variety;
- rate of incorporation of mnemonic techniques in the memorizing process;

3. Results and Discussion

The results of memorizing the simple and sophisticated non-verbal nonsense material are presented in Figure 2. Speed of memorizing of simple material in the process of increasing experience's stage of using internet resources is growing: from 16.04 sec to 8.5 sec in schoolchildren having the experience of 1.5 year and more than 3 years. With that the time of remembering the figure №2 in control group was 22.23 sec. Indicators of memorizing figure №2 by schoolchildren with varying internet-activity's stage have statistically significant differences (to H-criterion of Kruskal-Wallis test, $p \leq 0.1$). This indicates that the productivity of the natural memory, in other words of functional mechanisms of mnemonic abilities during development of the network-activity and with increasing length of user activity's stage is increasing. The productivity of natural memory at the phenomenological level is seen in the processes of recording, individual measure's severity of which can be viewed as an indicator of the effectiveness of elementary mnemonic abilities. It can be assumed that the systematic perceptual processing of visual represented material has a "training" influence of the functional mechanisms of mnemonic abilities, which is reflected in the significant differences in the speed of memorizing simply non-verbal nonsense material.
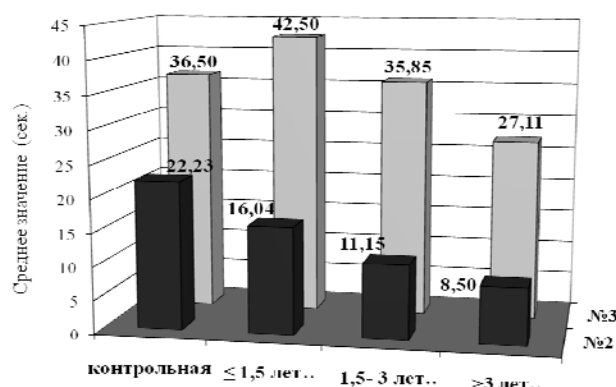

Figure 2   Average Indexes of Mnemonic Abilities' Efficiency of Schoolchildren With Various Internet-Activity's Stage (Experience) (Explanation Of Words In Picture: Среднее Значение = Average Index; Контрольная = Control; Лет = Years)

Data on the speed of memorizing complicated non-verbal nonsense material shows a different trend, see Figure 2. At the stage of development of internet resources (the experience till 1.5 year) the effectiveness of memorizing thanks to the functional and operational mechanisms decreases, in other words, the time of memorizing the complicated non-verbal nonsense material increases to 42.5 seconds, against 36.5 s. in the control group.

The effectiveness of memorizing thanks to the functional and operational mechanisms in the group of children with the experience from 1.5 to 3 years, in corporation with the "newcomers" increases, but is almost identical to the results of the control group (35.85 sec. and 36.5 seconds accordingly). Maximal speed of memorizing complicated material showed in members with network-stage up from 3 years — 27.11 sec. Reduced efficiency of memory during the period of learning the online activity is due, most likely, by adaptation of the operation aspect of the memory to the new conditions, or developing new, more appropriate specificity of presenting information in the network, methods of its processing. Stage (period) of formation is accompanied by in-depth analysis of the material and a reflection of their own behavior, as it is known, requires additional time. The results of our previous studies (Cheremoshkina, 2009B) show that cognitive stylistic originality of user's perceptual activity changes in the process of increasing length of stay in the internet (cyber) environment. We recorded a trend towards predominance of analyticity not only by programmers (professional developer of computer programs) with the experience of the activity of more than 20 years, but also for ordinary users with the experience of about 10 years (Cheremoshkina, 2008). In all probability, internet activity determines ("forcing") analytic perceptual activity to the detriment of the synthetic-analyticity balance. It finds concrete expression in increasing the rate of memorizing non-verbal nonsense material in off-net activities, as stipulated in the method of diagnostics of mnemonic abilities: in direct contact with the experimenter in the process of imaging shapes on paper with a pencil or pen. It should be noted that the analysts in the memorizing of that material are showed the worse results in comparison with the holders of the synthetic-analytical balance (Cheremoshkina, 2000; 2008; 2009B). The observed tendency is easily explained by the nature of that studying procedure, and the longer use of internet resources increases the prevalence of analyticity in the active user.

Thus, the mnemonic abilities of "newcomers" are characterized by minimum efficiency of operated size of the memory not only as compared with the internet-active schoolchildren but also the results of the control group. But for teens with the experience from 1.5 year to 3 years and more than three years the trend of growth of memorizing thanks to the functional efficiency of functional and operational mechanisms repeats the tendency to increase the productivity of memorizing with reliance on the functional mechanisms of memory.

Special attention should be given to the qualitative composition used online-active teenagers ways of memorizing the material. As seen from the Table 1, the composition of the operation mechanisms of adolescents with internet-activity up from 3 years is less varied than of members in other groups. Firstly they did not use the re-encoding, differently speaking, didn't try to name a figure or verbalize the memorizing process of the presented material. Secondly only 75% of teenagers with the stage up from 3 years have noted the using of the structuring as an activity of selecting the elements and their relationships. But memorizing of complicated material (figure №3) without the using of structuring is quite difficult.

One may assume that users with stage do develop individual techniques of cognitive mnemonic activity that with increasing duration of its using are no longer being reflected. In other words, individual ways of memorizing and of reproduction the information created by active users is in the closest interaction with the functional mechanisms and therefore may not be realized. This has been confirmed in the following stages of the study,

which will be discussed below. It should be noted that for adolescents with experience up from three years there is characterized the decreasing of frequency in using of all operation mechanisms, the study of which is putted to the questionnaire. However, the rate of memorizing by them the complicated material is higher than in the other groups. The shown trend may certificate about fundamental change in the structure of their memorizing. There are forming up new techniques, oriented for studying the connections between the lines and intersections in which the mechanical repetition is unnecessary. Only 25% of adolescents with the experience up from 3 years noticed the use of repetition without treatment, in comparison with 67% of the control group and 47% and 35% of adolescents in groups with experience till 1.5 year and from 1.5 to 3 years respectively. Qualitative features of mnemonic abilities of internet-active schoolchildren, thus expressed in a smaller variety of used operation mechanisms. In contrast to the control group, adolescents with the experience till 1.5 year reduced the frequency of use in the processing of this material: associations (from 50% to 25%), analogies (from 75% to 56%), and reconstructing material (from 58% to 41%). At the same time, the role of operational mechanisms in memorizing process is increasing, which are directed for the establishment of the internal connections of memorized material by structuring (from 75% to 88%).

Table 1   Operation Mechanisms Of Mnemonic Abilities Of Researched Children With Different Internet-Activity Stage

Groups	Kinds of operational mechanisms and frequency of their use %								
	re-encoding	analogy	schematization	structuring	reconstruction of material	grouping	stronghold point	association	repeating
≤ 1.5 years	31	56	83	88	41	69	94	25	47
1.5–3 years	20	35	90	90	30	70	95	40	35
>3 years	0	25	75	75	38	63	75	38	25
Control	33	75	91	75	58	66	91	50	67

Changing the list of used operation mechanisms by internet-active schoolchildren with stage is accompanied by acceleration of their inclusion in the process of memorizing.

Mnemonic abilities of "newcomers" of the internet are characterized by the minimal turn-on speed of operation mechanisms in the memorizing process. This group has fixed the highest number of participants who noted the use of mnemonic techniques for the final stages of memorizing the figures №2 (31%) and №3 (54%). Adolescents with network-activity's stage up from 1.5 year noticed the higher speed of inclusion of operation mechanisms in memorizing process, than that of the control group. 35% and 38% of subjects in the groups with the experience from 1.5 year to 3 years and up from 3 years reported on the use of certain separate methods of treatment already at the stage of implementation of the test set. Data on the rate of incorporation of the operation mechanisms in the memorizing process are presented in Table 2.

Table 2   The Distribution of The Researched Subjects Depended on the Period of Inclusion of Operational Mechanisms of Mnemonic Abilities in Memorizing Process

Period of inclusion of operational mechanisms in memorizing process	Number of researched subjects in the groups with different internet-activity's stage, %			
	≤ 1.5 year	1.5–3 years	> 3 years	control
trial task	14	35	38	25
figure №2	31	40	23	17
figure №3	54	25	39	58

Analysis of character of memorizing the non-verbal material by schoolchildren of different groups do certificate, that decline in the rate of incorporation of operation mechanisms during mastering of internet-activity is followed by a gradual, deployed control and by a reflection of their own actions. More experienced network-users quickly and selectively applies the most effective ways to memorizing, due to a large degree view of their network activities (for example, to use an analogy with the cards, letters and other symbols, etc.). Operational mechanisms, which were used by them, were congruent for nonverbal meaningless material. The basis of successful treatment was the grouping, i.e., selection of 2 or 3 lines as the basis of a figure on which then stages of memory elements were "strung". It can be assumed that the nature of remembering the material, which is different in complexity and meaning, by users with different experience of stay in the network will vary significantly. Thus, these results suggest a kind of "impoverishment" of the operation part of memory during the immersion of the subject in virtual reality. While adolescents with network-experience are using the less diversity of the mnemonic techniques more successfully.

The obtained results determined the next stage of the research of specifics of mnemonic abilities network-active teenagers — correlation analysis of time of memorizing the simple and complex material. This is revealed to identify the specifics of the changes of relationship of functional and operational mechanisms of mnemonic abilities in the internet-activity stage's increasing (see Figure 3).
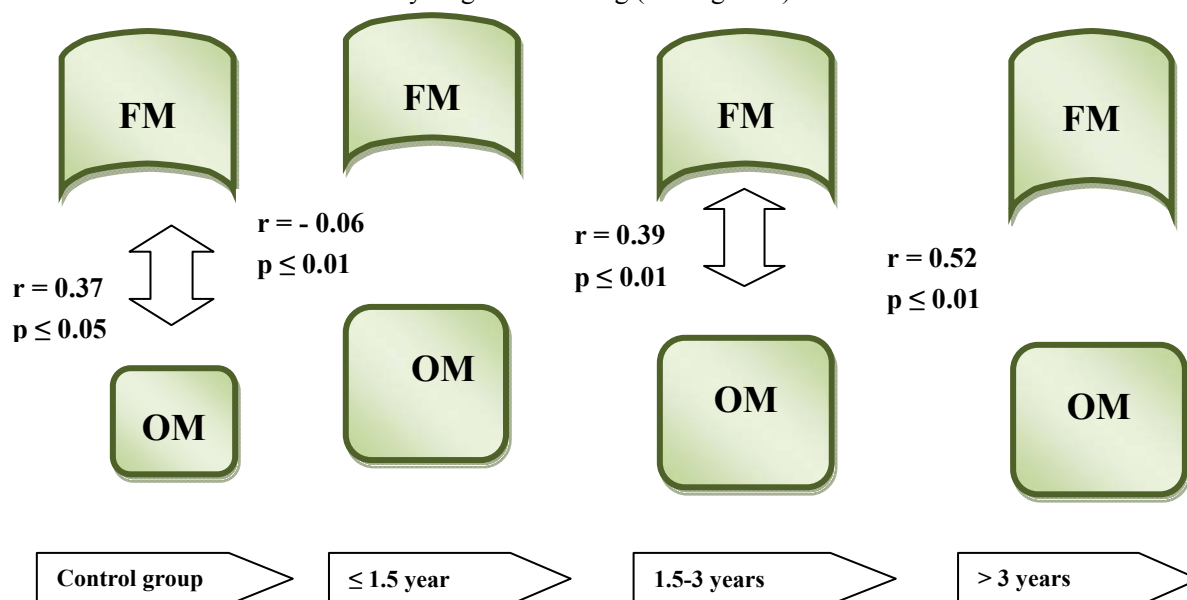

Figure 3   Changes of Functional System of Mnemonic Abilities of Adolescents during the Process of Internet-Activity Stage's Increasing (Explanation: FM = Functional Mechanisms, OM = Operational Mechanisms)

Low efficiency of memorizing the complicated nonverbal material of "newcomers" of the internet is the result of absence of relationship of functional and operational mechanisms their mnemonic abilities (Spearman's coefficient of range correlation is -0.06). The negative nature of the relationship confirms inversely dependent identified productivity growth of functional mechanisms and reduce the effectiveness of operational mechanisms of mnemonic abilities. Differently speaking, Intensive increasing of productivity of memorizing with support by functional mechanisms is accompanied by a temporary decrease of efficiency of memorizing due to the interactional system of functional and operational mechanisms.

We recorded the following tendency: the more internet-activity stage of schoolchildren aged 15–16, the

stronger the relationship of functional and operational mechanisms of mnemonic abilities is significant - r = 0.52 with p ≤ 0.01 in the group with the stage up from 3 years versus 0.37 at p ≤ 0.05 in control group. This suggests that the structure of mnemonic abilities of schoolchildren with stage up from 3 years is changed. There is forming out the systemic interaction of multi-level mechanisms, in other words, a new qualitative level of mnemonic abilities. The obtained results, thus, allow us to consider long-term and systematic network-activity as a factor of development of mnemonic abilities. A natural principal logical consequence of development of systemic interaction of functional and operational mechanisms is the appearance of regulation mechanisms. Exactly the regulation mechanisms, in our opinion, are the most "sensitive" for changes of the parameters of outer and inner human's life of its constituent cognitive activity.

Let us examine this point in detail. Regulation mechanisms of cognitive abilities are manifesting the systemic interaction of control, assessment, anticipatory and other operations, the manifestation of which is due to the motives, volitional, motivational and emotional processes. This interaction is specified in order for working or activity. These notified operations or purposeful activity does not take place apart from consciousness. Hence, if certain types or forms of activity lead to deformation of regulation mechanisms, this means presence of negative influence, impact on human consciousness. In this case, internet-activity's stage might be such type of factor. Using Internet-resource for obtain the information can make influence on user's consciousness, affecting his memory as a system of organization of information for future activity and attention as a process focused on the concentration of the consciousness of the subject. In the case of active using the Internet-resources subject no need to memorize large amounts of information, as it is present in constant access. Additionally in condition of virtual reality user often manifests itself as a consumer, rather than the creator, and it reduces the intensity of the process of goal-setting subjects online-activities.

It should also be noted that social interaction in virtual space attracts anonymity and opportunities for self-realization through the use of new roles. Anonymity plus frequent change of roles produces stereotyped behavioral responses with reduced conscious control and contributes to the deregulation of the mental activity. Playing activity in the network, in the cyber-environment is an important factor involved in the virtual world where the subject gradually stops to be a subject, his activity is determined not by his consciousness, but by the game, not by his own logic, but by logic of the game's creator. According to our results, the active user and "resident" of the internet over time become more and more energy-consuming to go back to the real world in which to build their own behavior, and often, as the practice shows, to correct the results of their reckless and spontaneous steps. This is evidenced by the results of the study of memory not only gamers, but ordinary users. In this regard, the matter of principle question to predict the influence of the internet on the human psyche is the duration of the use of internet resources. The obtained results about the significance of differences in the speed of both direct and indirect memorizing of adolescents shows that the "critical" period in determining patterns of development and formation of mnemonic abilities in condition of network-activity may be a period of about 1.5 year.

4. Conclusions

Mnemonic capacities of adolescents with different experience of internet-activity are vary in terms (indexes) of efficiency and of quality of originality. As the experience of network-activity increases productivity of memorizing with support on functional mechanisms (effectiveness of immediate memory). During the first 1.5

year of learning internet-resources by adolescents the efficiency of memorizing due to the functional and operational mechanisms (performance results of impact memory) is reduced. Longer network-activity (over three years) increases the efficiency of memorizing thanks to the functional and operational mechanism by increasing their systemic interaction.

The structure of mnemonic abilities of teenagers in the process of active using the network-resources is changed, what does lead to the development of mnemonic abilities. With that the methods of working out the memorized material in the process of increasing internet-activity's stage become less diverse, but more automated.

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