RESEARCH ARTICLE

Arbitrariness of Speech in Adult Active Internet Users: Types and Intensity of Deformations

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Abstract

Objectives

Testing the hypothesis about the presence of a long-term negative effect of Internet practices on the arbitrariness of speech in adults.

Methods

The study is based on a retrospective approach, which is a combination of an *ex post facto* research and a cross section. The participants in the control group were adults (n = 50; 20 men, 30 women; age 46.9±6.14) who keep the habit of traditional print reading. The experimental group consisted of individuals (n = 50; 20 men, 30 women; age 45.1±6.16) who abandoned this habit in favor of Internet practices. The evaluation of arbitrariness of speech was carried out using the method of "Opposites" (Susanna Rubinstein). Groups for the cross-sectional study were, on the one hand, a "pre-digital" person (rate of implementation of the method by healthy adults until 2000); on the other hand, modern young people (n=50; 20 young men, 39 young women; age 19.58±0.94).

Results

The cross section allowed to determine the following hierarchy in order of the arbitrariness deterioration: 1) pre-digital person; 2) modern adult reader; 3) modern active Internet users of different ages. The *ex post facto* research found significant reductions in the indicators of arbitrariness of speech in the experimental group, which are presented in two types of deformations: "weakening of control" (deformation coefficient – two) and "weakness of control in combination with lexical deficit" (deformation coefficient – seven).

Conclusion

The results obtained do not contradict the hypothesis about the deformation of cognitive functions in adults as a long-term effect of the Internet use. The idea of cognitive unloading mechanism, which explains the appearance of cognitive deformations through the specifics of Internet information coding, is expressed.

Keywords: cognitive function, print reading, Internet practices, cognitive deformation, deformation coefficient.

Introduction

The rise of the Internet and its rapid evolution within just a quarter of a century divided the history of mankind into two eras – "pre-digital" and "digital". Monitoring of studies on interaction between user and the Internet shows that the main subjects of study are new and diverse forms of deviant behavior (from various cyber addictions to disruptive online communications). The undoubted significance of these problems and their increasing relevance determine the focus of research interests, which can be easily verified by the statistical analysis of the subjects of publications in academic portals, such as Google Scholar. However, at the same time, an ordinary, relatively speaking "regular" user does not actually come into the view of scientists. The ongoing studies are mainly focused on adolescents and young adults (as members of generation Z who are about the same age as the Internet). This also applies to studies on cognitive processes in Internet practices, which mainly assess short-term effects. Thus, there is an obvious lack of scientific data on the possible changes in the cognitive processes of the average

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adult Internet user and on the long-term effects of technology on their cognitive functions.

A rather limited amount of scientific evidence reveals the widest range for constructing hypotheses. In this range, assumptions about the presence of some negative or deforming effect have their place. Such a pessimistic view has a rationale from various perspectives. From the point of view of the average person, direct life factology, including educational one, does not demonstrate a massive increase in cognitive abilities among active Internet users, regardless of their age. These everyday observations are also confirmed by the results of studies of the cognitive functions of young Internet users, which do not reveal any cognitive advantages in them compared to their "pre-digital" peers and adults, but rather the opposite [9; 15 and others]. And finally, the very essence of the Internet, which is constantly improving towards greater accessibility for users and facilitating their efforts, can be considered the generalized philosophical position that determines the pessimistic view. Some scientists, continuing Marshall McLuhan's [12] metaphor about technology as a continuation of a human which expands his functions, believe that digital technologies have a completely different nature, "replacing or substituting" the cognitive functions of their user [17, p. 46]. The validity of such a view of the Internet, in particular, can be considered proven concerning memory in studies of the Google effect, which consists in changing the semantics of memorization from the information content to the place of its storage in the network [8; 16; 19; 20]. This effect proves that the capabilities of the technology actually invite the user to externalize their functions, which leads to their gradual digital replacement.

The subject of this study is speech as one of the higher mental functions. Empirical study of the long-term consequences of Internet use is based on the logic of common sense, namely: it is possible to assess the impact of the new by comparing it with the old, traditional one. The practice of print reading can be considered the traditional one, since it is the "reading person" that is the highest cultural achievement of the pre-digital era [12]. The new, respectively, is the diverse experience of Internet practices.

Objectives

Testing the hypothesis about the presence of a long-term negative effect of Internet practices on the arbitrariness of adult speech.

Materials and Method

The study designs

Verification of the suggested hypothesis is extremely difficult in terms of methodology. An exact answer to the question posed could be obtained in a longitudinal study or in a true experiment, but their organization is virtually impossible for objective reasons. There remains scope for implementing a retrospective approach to research, in particular, an *ex post facto* quasi-experiment [4, p. 99–124]. Unlike other types of experiments in which the researcher fixes the results by manipulating the conditions, in this case the logic is directly opposite: from the result (in this study, this is the arbitrariness of speech) to the conditions (traditional reading and Internet practices).

The study participants were selected according to the following criteria:

- completion of the main stages of cognitive development in the pre-digital era and belonging to middle adulthood (from 40 to 60 years);

- higher education;

- work in the field of intellectual professions (teachers, managers, accountants, engineers, librarians).

These criteria allow us to assume a certain identical and fairly high level of cognitive development among the study participants prior to their experience as an Internet user.

The selection of participants in the control and experimental groups was questionnaire-based. The control group (CG) was formed by adults who keep the practice of print reading in their life, while the experimental group (EG) was formed by persons who actually abandoned it in favor of the Internet. It should be emphasized that in the current conditions of mixed reality, all participants in the study are Internet users. The main content of their Internet activity, according to self-reports, is the search of professional or personal information, which, as a rule, is also supplemented by watching the news for men, and by communication in instant messengers for women. The habit of traditional print reading was fundamental for selecting the control group. It is expected that in the sample of intellectual professions there is also a certain number of those who enjoy new reading formats (hypertexts, audio books, etc.), which were excluded from further research due to the specificity of such cases of Internet practices.

Considering weak *ex post facto* control (in particular, the impossibility of conducting preliminary testing of participants, etc.), the method of cross sections defined by two poles was added. On the one hand, a "pre-digital" person and, therefore, having zero

experience in handling digital technologies, and on the other, a modern young person formed under conditions of ever-increasing digitalization. The indicated poles are guidelines for the intergroup comparison of the speech condition in adults forming the CG and the EG.

Study sample

Participation in the study was voluntary, anonymous and free of charge in the following samples.

"Pre-digital" adult is a hypothetical group represented by diagnostic indicators of the speech condition in a healthy adult obtained before 2000.

A modern adult is an empirical sample for *ex post facto*, consisting of two groups that differ in their preferences for the sign system of information coding: printed (CG: n = 50; 20 men, 30 women; age 46.9 ± 6.14) or digital (EG: n = 50; 20 men, 30 women; age 45.1±6.16). In the following discussion, they will be referred to as readers and active adult Internet users, respectively.

A modern young person is an empirical sample consisting of members of about the same age as the Internet and who are its active users (students of various faculties of Brest State A.S. Pushkin University, n=50; 20 young men, 39 young women; age 19.58±0.94).

It should be noted that the minimum number of samples required for comparative analysis is due to the difficulties of compiling a control group, that is, finding those who do not abandon the practice of print reading.

Method

The speech condition of the study participants was diagnosed using the method of "Opposites" [14, p. 138-141]. Stimulus material contains 46 words, to which it is suggested to choose a word with the opposite meaning. Such an option of a directed associative experiment allows to assess not only the arbitrariness of speech activity, but also the resilience thinking. In addition, the method of "Opposites" makes it possible to determine the attention fatigue by the increase in errors by the end of the experiment. Data processing consisted in calculating the errors made, which were considered: 1) disturbance in the course of associations, checked through dictionaries of antonyms; 2) lack of associations.

The assessment of the speech condition was conducted in a group form: in the classes for advanced training in case with adults; in lectures with students. Multimedia and other digital technologies (including mobile phones) were not used in the classes.

Statistical analysis

The processing of data obtained in different designs is aimed at solving a number of particular research problems presented in Table 1.

Table 1. Mathematical and statistical technologies for solving empirical tasks in different study designs

№	Empirical task	Solving technology
	Cross section method	
1	Building group error profiles	Descriptive statistics measures
2	Selecting methods of secondary mathematical and statistical processing	Verifying the results for the normal distribution (Kolmogorov–Smirnov test)
3	Estimating the differences between the four samples	Kruskal–Wallis H test
4	Estimating the differences between the two groups	Mann–Whitney U test
	Quasi-experiment *ex post facto*	
1	Estimating the possibility of extrapolation of the obtained data	The "splitting the sample in half" technique (Mann–Whitney U test)
2	Defining the types of deformation	Cluster analysis (hierarchical and k-means)
3	Calculating the deformation coefficient reflecting the degree of its intensity	Correlating the number of errors averaged for the sample with the "pre-digital" data of the implementation of the method. If the coefficient is close to one, then it indicates the identity of the measured indicators. Accordingly, the higher it is, the higher the degree of deformation.
4	Excluding the involution factor from explanations as an additional variable	Correlation test (Spearman in R) of the number of errors with the age of the study participants

All statistical calculations were carried out using the SPSS v.19 program.

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Results

Cross section results

The frequency analysis of errors revealed that the correct implementation of the method in different groups of study participants differs significantly. In the group of adult readers, 30% of respondents found associations to all the proposed words correctly; in the group of adult active Internet users – 8%, and in the group of young Internet users, their number is at the chance level (2%). There are significant differences between the number of adults from different samples who selected antonyms correctly ($\varphi=2.92$, $p<0.01$). There are no such between active Internet users of different ages ($\varphi=1.45$, $p>0.05$).

Table 2 reflects the descriptive statistics data on the implementation of the method in different groups of study participants.

Table 2. Errors in the arbitrariness of associations

Statistic	Adults		Young Internet users
	Readers	Internet users	
R	0–3	0–15	0–9
∑	59	220	204
M±σ	1,18±1,02	4,4±3,5	4,08±2,00

The data in Table 2 demonstrate a significantly greater correctness in executing the instructions for the antonym's selection in the group of adult readers, compared with which the number of errors in adults and young active Internet users increases by an average of 3.5 times.

Applying the Kolmogorov–Smirnov test revealed that in all three samples the distribution deviates from the normal one.

The Kruskal–Walli's test (values 0 and 1 were introduced as "pre-digital" indicators) revealed significant differences between the compared samples: $H=59.37$, $p<0.01$.

Pairwise comparison of groups revealed highly significant differences between samples of readers and Internet users of different ages: $U=414.5$ for adults and $U=229.5$ for young people ($U_{stat}=912$ for $p<0.01$). However, there are no significant differences between adult and young active Internet users ($U=1189.5$).

The figure shows the number of errors made by respondents of different groups as the associations were selected (46 associations were divided into 3 parts), which allows to visualize the fatigue indicators of the study participants [14, p. 141].
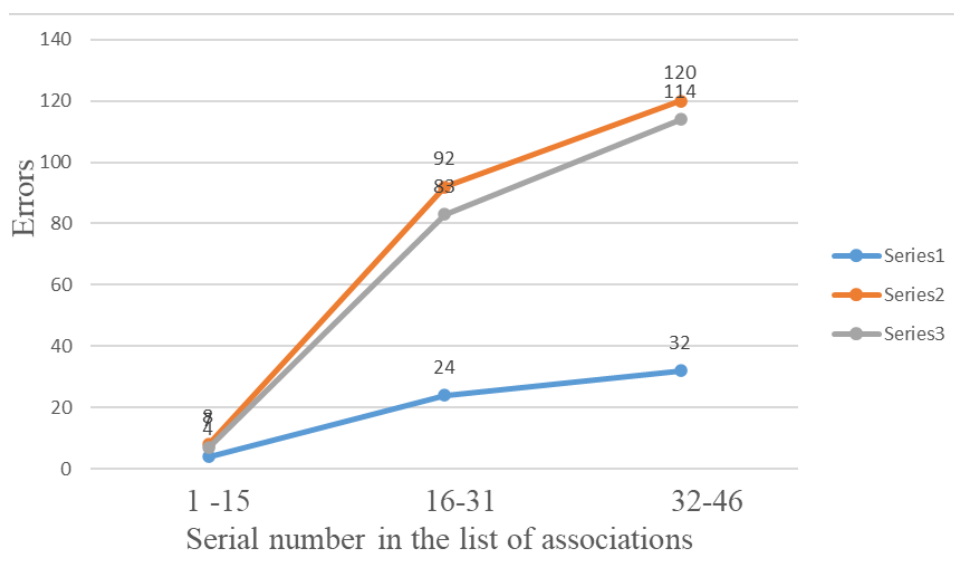

Fig 1. Fatigue dynamics in different samples

Series 1 – Adult readers

Series 2 – Adult active Internet users

Series 3 – Young active Internet users

This figure clearly demonstrates in fact the same "start" for participants in different samples. Readers have a slow and gradual increase in the number of errors. For active Internet users of different ages, this growth represents the identical "surge".

Results of ex post facto

When splitting samples of adult readers and Internet users, differences of high and equal significance were

found for two different subgroups: U=87 and U=116.5 (p<0.01).

As a result of hierarchical clustering, two clusters were revealed in the CG, and three in the EG. Data on errors in the association selection of representatives of different clusters (established by k-means clustering) can be found in Table 3, which shows the number of observations forming it next to the cluster number.

Table 3: Clustering data in CG and EG

Statistic	Readers		Internet users		
	1 **(n=31)**	**2** **(n=19)**	**1** **(n=32)**	**2** **(n=15)**	**3** **(n=3)**
R	0–1	2–3	0–4	5–10	13–15
M±σ	0,48±0,5	2,31±0,47	2,31±1,3	6,93±1,57	14±1
Deformation coefficient	0,48	2,31	2,31	6,93	14

According to Susanna Rubinshtein, normally a person retains instructions without switching "from the directed course of associations to the free one" [14, p. 138]. To calculate the deformation coefficient in accordance with the mathematical rules of division, it was necessary to "mitigate" the indicated norm to one error, therefore, in this case, the deformation coefficient coincides with the arithmetic mean.

Correlation analysis found no relationship between the number of errors made and the age of the subjects: r=0.024 in CG and r=-0.109 in EG (p>0.05).

Interpretation of the results

The starting point in the analysis of the empirical data obtained is the indicators of the implementation of the method in the "pre-digital" era. Even in the most effective group of adult readers (Table 2), there were only a third of respondents who consciously regulate their speech and cognitive activities, which indicates the ongoing transformation of "pre-digital" norms.

The most common mistakes in the group of adult readers were the following: to order (20%), to subordinate (16%) and correction (6%). In the group of adult active Internet users, this series is repeated, but with a larger percentage: to order (60%), to subordinate (34%) and correction (32%). In the group of young users, it changes slightly: clumsy (66%), to subordinate (60%) and to order (54%). Probably, the word "clumsy" is not in the relevant vocabulary of a modern young person, which explains the largest percentage of participants who made mistakes in choosing antonyms for it. Whereas the words "to order" and "to subordinate" are not only included in such a vocabulary, but, judging by the number of slips, they have a pronounced emotional coloring, referring to the evaluative language of Belarusians.

It is fundamentally important that there are differences in the accuracy of association selection (table 2) and in indicators of attention fatigue (figure)

between adult readers and active Internet users of different ages. Thus, age-related cross section itself provides conflicting information about the direction of the changes taking place. However, cross-cultural section data, which provide an opportunity to compare the condition of arbitrariness of speech in the "pre-digital" and "digital" eras, allow us to build the following hierarchy in order of its deterioration:

"pre-digital" person;

modern adult reader;

modern adults and young active Internet users.

Cluster analysis showed that in the control group, the majority (table 3, cluster 1) performs the method in accordance with its "pre-digital" indicators, and the minority (table 3, cluster 2) is twice as bad.

In the experimental group, there was not established any subgroup in which the implementation of the method would meet the "pre-digital" standards. If, nevertheless, we assume that these subjects had a sufficiently high cognitive development level before 2000, now they show a different degree of deformation of the arbitrariness of speech (with coefficients from 2 to 14).

Qualitative analysis of errors showed that their main type among representatives of different clusters is the replacement of antonymous ones by other types of relationships, most often causal and synonymous (for example, the word stimulus "to subordinate" is followed by the answers "to execute", "to fight" or "to rule"). The answers of the representatives of the second and third clusters are characterized not only by a large number of errors, but also by the absence of associations. These characteristics allow us to designate the first type of deformation as "weakening of control" (and to consider it weak, with a coefficient of 2). Another type of speech deformation can be registered as "weakness of control in combination with lexical deficit" (and considered strong, with a

coefficient of 7).

The additional control measures taken make it possible to exclude the age factor from possible explanations of the phenomenon of cognitive deformation, as well as to extrapolate the results to the population of adults with higher education. Thus, those adults who practice print reading have a higher level of arbitrariness of speech, the indicators of which are largely compliant with those of a "pre-digital" person. However, it is necessary to note the general deterioration of arbitrary associating in modern adults compared to representatives of the pre-digital era.

Discussion

The results obtained in this study, which reveal various long-term effects of Internet practices on the arbitrariness of speech in adults, are quite comparable with the data of those studies on specific Internet practices that correspond to Internet experience of our subjects. For example, the analysis of screen or digital reading, from the first analytical works [7] to meta-analyses of recent years [5] quite clearly indicates a decrease in reading speed and a deterioration in comprehension. However, these deteriorations are observed not in everyone. There is a small category of "good" screen readers who are distinguished by their excellent command of print reading skills [18, p. 140]. It was experimentally established [10] that the biggest problem is not the screen itself, but reading in interrupted viewing mode, i.e., accompanied by inserts from visual images and requiring scrolling of text on the screen. It is precisely this mode that is also present in Internet search, in the study of the effectiveness of which the emphasis is placed on the metacognitive potential of Internet users, which is understood as the assessment and control of their search information activity [2; 3; 11; 21]. In other words, there is a search for those individual characteristics that lead to better/worse effectiveness of online activity. Researchers of screen reading and online search explain the dominant tendency towards the deterioration of the effectiveness by increasing cognitive load [13] in Internet practices, which causes problems of selective attention [1; 5; 6].

Since the executive functions provide any complex forms of behavior, the increase in cognitive load can be considered as a kind of universal mechanism that explains the deterioration of any purposeful activity. However, it seems that Internet practices also generate their own specific mechanisms that worsen the effectiveness of cognitive activity and the condition of cognitive processes. One of them can be

described as "cognitive unloading mechanism".

The leading characteristic of Internet communication is the change in the symbolic system of information coding. If in the traditional print culture, the word was the main unit of information coding, then in recent decades it has been gradually replaced by the image (this trend was marked back in the era of television). In modern conditions, it is more accurate to speak of a digital image as artificially created and broadcast with high speed and density. Both the word and the image are closely interconnected in the mental organization of the subject. However, as components of any cognitive function, they occupy a different place in its hierarchical structure, the highest stage of which belongs to the word (suffice it to recall the sequence of stages of development in any theory of intelligence, for example, Jean Piaget). Therefore, an increase in the share of Internet practices in the experience of an adult leads to a gradual transformation, simplification of the higher level of the cognitive function, returning it to genetically earlier, well-learned, figurative forms of implementation.

The mechanism of cognitive unloading, proposed as an explanation for the phenomenon of cognitive deformation, corresponds to the life experience that every adult has: if some complex skill is acquired in any field (cooking, music, sports, etc.), then it needs constant training, otherwise it starts to atrophy. Similarly, simplifying forms of Internet communication imperceptibly simplify the user's cognitive organization.

Limitation

An obvious limitation of the study is its population validity, which allows the results to be extrapolated only to adults engaged in intellectual-type professions. It is possible that other long-term effects of the Internet may be established in other samples.

Despite all the control measures taken, there remains the possibility of an alternative explanation of the data obtained regarding the condition of speech arbitrariness in different categories of adults. This explanation consists in the fact that it is precisely those individuals who initially did not have a very high level of cognitive development who refuse print reading in favor of the Internet. And it is not intensive Internet practices but individual deficits that determine problems in the arbitrariness of speech.

Conclusion

The condition of arbitrariness of speech in adult readers actually corresponds to the normative indicators of this function in the pre-digital era. In adult active Internet users, the measured speech

parameters are significantly worse and do not differ from the speech of young people.

There are two types of speech deformation in active adult Internet users. The "weakening control" type (coefficient two) is more common and lies in the difficulty of purposefully selecting words from one's own vocabulary. The type "weak control combined with lexical deficit" is characterized by a greater degree of deformity (coefficient seven). In addition to speech control problems, this type is characterized by an insufficiently extensive lexical vocabulary.

To explain the recorded deformation, a mechanism of cognitive unloading is proposed, which is associated with a digital image as the leading unit of Internet information coding. The digital image actualizes the genetically earlier components in the structure of the function, ignoring the most complex ones associated with the word. The low demand for the verbal component in many Internet practices gradually leads to a simplification of the cognitive function.

The data obtained, taking into account their limitations, allow us to generalize that a person certainly does not become less intelligent from print reading, while Internet practices do not make him more intelligent. In practical terms, this means the following: in order to be an intelligent and effective representative of the modern information society, one should combine his various types of Internet activity with the practices of traditional print reading.

Acknowledgements

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