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Evaluating the Meaning of the Information Message and Speech-Mental Activity of a Person

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ABSTRACT

We would like to offer to the attention of the readers a scientific report as a statement of the author's hypothesis, which is experimentally tested, but requires an additional verification. The report addresses the trends outlined in the course of the scientific research on identification of regular patterns that describe the influence of information on people. The content of this scientific report relates to the field of interdisciplinary scientific research at the junction of the information theory and cognitive psychology. The article describes the criteria for evaluating the meaning of an information message and a speech-mental activity of a person. Subject to an appropriate follow-on development, the results obtained can be applied in cognitive psychology, psychiatry and in the domain of artificial intellect.

KEYWORDS

Information; Entropy; Cognitive Psychology; Galvanic Skin Response; Delirium.

INTRODUCTION

We continue publishing the findings of the scientific research on the topic of information influence on people. This scientific report addresses the findings of the research, the beginning of which was described in our article [1]. In this research we tried to identify the criteria for evaluating the meaning of an information message and speech-mental activity of a person. While the work has been performed, healthy people have been involved as test subjects. But, it would be useful and interesting to conduct a series of experiments under clinical conditions, because in terms of emotions, a healthy individual and a person suffering from a mental disorder can perceive the meaning of the same information message in dissimilar ways.

The sphere of our scientific interest includes the elements of information theory and cognitive psychology. Characterizing cognitive psychology as a new scientific trend in psychology, W. Naisser noted in his book that tracing the movement of the information flow within the "system" (i.e. in the brain) is a top-priority objective in this new field of knowledge [2]. The goal set by one of the founders of cognitive psychology is identical to the goal of our scientific work. This implies that the object of our study is cognitive psychology, which we research using the method of information theory.

A person conveys or receives information in the process of speech-mental activity. This is a conscious or unconscious intellectual activity of a person, in which information is used in the form of speech. For presentation of information, an alphabet of the relevant natural language is used. One of the derivatives of the speech-mental activity of a person is a textual information message (text), to which a person attaches some meaning. A textual information message with a sense attached to it is the subject of our research.

The speech-mental activity plays an important role in the process of interaction between people. One of the reasons why conflicts occur between people could be a misinterpreted information message. In other words, misinterpretation of the sense of the information message. This question is also relevant in psychiatry for evaluation of the speech-mental activity of a person in a disturbed state of mind (delirium).

MATERIALS AND METHODS

From our point of view, the meaning of information message is the human thought encoded by means of certain linguistic signs and represented in oral or written form. In order to establish the criteria for evaluation of the sense of an informational (textual) message and speech-mental activity, we have used one of the basic concepts of information theory – entropy. The studies show that the entropy of a textual informational message is able to influence the emotional state of a person and can be used as one of the factors for correction of the addictive behaviour [3, 4]. According to C. Shannon "The entropy is a statistical parameter which measures, in a certain sense, how much information is produced on the average for each letter of a text in the language" [5].

What kind of relationship is there between entropy, meaning and emotional state of a person? To answer this question, we have conducted a comparative statistical analysis of two types of text messages and evaluated their influence on the emotional state of a person. These types of texts include:

1. An ordinary text, for example, an excerpt from a scientific article.

2. A probabilistic text – that same ordinary text, but with a random distribution of words.

This implies that the first type is the text containing meaning, while the second one is an analog of the speech-mental activity of a person in a state of delirium.

For each type of text, the difference of entropies of two adjacent words was calculated (Δ_H), characterizing coherence of words in the textual information message. For this coherence of words variance was calculated as a random value, and correlated with the evaluative parameters of the galvanic skin response (GSR).

If we suppose that letters in a text sequence are independent, then entropy and, therefore, the quantity of information can be calculated according to the formula [6]:

$$H = -\sum_{i=1}^{n} p_i log_2 p_i ,$$

Where H is entropy of a multitude of probabilities p_i, bits per symbol; p_i – probability of occurrence of a letter in the text message.

A test subject was offered to read both types of text messages. In doing so, his emotional state was evaluated using the GSR parameters. In our research, the following GSR parameters were used as evaluative ones:

• GSR-activity *TA*, $_cN_p/min$. The GSR-activity value is obtained as the average of amplitudes of single phase GSR signals over the test time expressed in centiNapiers (cNp) per one reaction.

• Time of activation phase t_i, sec. It characterizes the instantaneous speed of the GSR signal in the activation phase.

• Time of relaxation phase t_i, sec. It characterizes the instantaneous speed of the GSR signal in the relaxation phase.

• Activation amplitude a_i, $_cN_p$. Increment of activation in i-th reaction.

• Relaxation amplitude -a_i, $_cN_p$. Decrement of activation after relaxation in i-th reaction.

• Average activation speed V_i, cNp/min. It characterizes the "strength" of response in i-th reaction.

• Average relaxation speed -V_i, cNp/min. It characterizes the intensity of reduction processes in the skin.

The works of Sukhodoev can be referred to for a more detailed description of the listed parameters [7, 8].

For registration of GSR and measurement of evaluation parameters, two-channel hardware and software complex "DIANEL 11S-iON" was used, its description being available in [9].

RESULTS AND DISCUSSION

A series of tests on healthy people was conducted according to the described methodology. The results of one of the tests are given in the Table 1. The rest of the tests had similar results.

Table 1: Results of test.

Evaluative parameter of GSR	Ordinary text		Probabilistic text	
	Left channel	Right channel	Left channel	Right channel
GSR-activity TA, cNp/min	48,89	41,69	14,03	11,30
Activation time t_i, sec	2,28	2,70	1,26	1,27
Relaxation time t_i, sec	19,13	18,62	17,53	15,07
Activation amplitude a_i, $_cN_p$	18,09	15,43	4,72	3,26
Relaxation amplitude -a_i, $_cN_p$	20,30	17,47	15,35	11,80
Activation speed V_i, $_cN_p$/min	7,80	5,53	3,35	2,57
Relaxation speed -V_i, $_cN_p$/min	1,29	2,26	1,55	1,04

According to the tabulated data and readings of the hardware and software suite "Dianel 11S-iON", the emotional state of a person in testing with the use of the first type of texts was evaluated as an activity of an average intensity. In tests with the use of the second type of texts the activity was intensified. It is obvious that the increased emotional activity is connected with the fact that the test subject was trying to grasp the meaning of the textual information message in the senseless set of words.

When calculating the variance of words' coherence in terms of entropy Var(Δ_H) for the first and second types of texts, the variance was equal respectively to:

1. Var $(\Delta_H)_1$= 0,794643 (bits per symbol)^2;

2. Var $(\Delta_H)_2$= 0,698014 (bits per symbol)^2.

Having compared the results obtained after calculation of variance with the content of the respective texts, we arrived at the conclusion that variance of the words' coherence in terms of entropy may serve as a criterion for evaluating the meaning of the textual information message (M):

$M = Var (\Delta_H)$.

For the reason that the text with a lesser variance value affects the emotional state of a person more strongly, for the qualitative evaluation of the speech-mental activity, a criterion equal to the inverse value of the word coherence variance in terms of entropy is offered (M^{-1}):

$M^{-1} = Var (\Delta_H)^{-1}$.

A probabilistic assessment of the information message in the process of speech-mental activity of an individual can be performed by way of the following comparisons:

1) if $M_i \geq \bar{M}$, then the information message relates to the first type;

2) if $M_i < \bar{M}$, then the information message relates to the second type.

In inequalities 1) and 2) the following symbolic notations are used:

M_i – a criterion for assessing the meaning of the textual information message of an individual;

$\bar{M}$ – an average statistical value of the same criterion for healthy people.

Let us assume that the variance of the words' coherence in terms of entropy for an individual is less than an average statistical value of this criterion for healthy people. Then, most probably, this information message is a result of a speech-mental activity of a person being in the state of delirium.

CONCLUSIONS

Thus, the following conclusion can be drawn: the less the text of an information message is ordered in terms of probabilistic distribution of words, the greater is the variance of coherence, and vice versa. The revealed pattern allows to use the variance of the words' coherence in terms of entropy for qualitative assessment of the meaning of the textual information message, i.e., the greater the variance, the greater is the meaning, and vice versa. However, there is an inverse relationship between the meaning of the information message and the emotional state of a healthy person. In other words, the simpler the information message is formulated, the more it is understandable to another person and does not provoke in him strong emotional reactions. This conclusion corresponds to a well-known phrase «The one, who thinks clearly, expresses one's thoughts clearly». This is a kind of a qualitative criterion for evaluation of the speech-mental activity of a person.

After an appropriate follow-on development the results obtained can be used in cognitive psychology, psychiatry and in the field of artificial intellect.

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