# Verification of the Results of Psychosemantic Survey by Eyes-Gaze-Tracking

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## Abstract

Registration and visualization of thoughts and accompanying thoughts of the subject during his perception of any information is correctly carried out by the method of psychosocial testing. Verification of the sincerity of the test person's answers to the test tasks is available by eyes-gaze-tracking. In such a combination of different methods of collecting biopsychometric information, a synergistic effect is achieved: subjectivity of human psyche is verified through objective monitoring. This paper presents the experience of using the model of the software-hardware complex, which incorporates the psycho(color)semantic technique "Tsvetomer" and eyes-gaze-tracking, used for examination of practically healthy people in conditions of perception of visual information from the computer monitor.

## 1. Introduction

Modern information society is characterized by the intensification and increase in the diversity of types of communication processes in the social environment, implemented by technical means and related, sometimes, to diametrically opposite types of interaction.

A separate class of such information impacts are destructive phenomena, expressed in familiarization of users of modern telecommunication systems with potentially harmful multimedia objects of different nature (text, graphics, sound, multimedia). These threats lead to the need to ensure a "healthy" information environment. Psychological protection of the population from psychotraumatic information is an important component of the national security of the Russian Federation.

In this context, it is quite predictable that there is a need to develop new and improve existing systems for monitoring and protecting users from negative content - their intellectualization, which allows to effectively and timely combat threats, especially in the conditions of active actions of violators of information and psychological security-sources of destructive multimedia Internet content.

The principle is to determine the criteria for the objective attribution of a particular content to the class of potentially harmful or dangerous for the user of modern computer technology.

## 2 Purpose, Tools and Design of the Study

One of the most promising directions of psychometric instrumentation improvement is integration into a single measuring complex of psychosocial techniques [Pet2017, Sem2009] and biometric video analytics [Oli2017, Iva2015].

Such a combination of techniques allows to explore cognitive filling of the subject's psyche with the necessary flexibility and detail, and on the other hand - to obtain objective data associated with thoughts and experiences of the person [Pes2004].

The purpose of the study was to develop a tool that allows to verify by objective method subjective reactions -

responses to test tasks - of a person who perceives the information presented on the display.

A review and analysis of the informativeness and ergonomicity of a number of psychometric techniques [Ana2009] showed that in order to achieve the goal, the psychosemantic differential method proposed by C. Osgood is the optimal option [Yar2017].

This is because, in the computer embodiment, the techniques of the psychosemantic differential combine such characteristics as:

1) cognitive ergonomics - anyone simply understands the task and perform it without being tired;
2) flexibility in giving incentives - the possibility to set any sequence of presentation of different-format incentives;
3) possibility to take into account in a formal way expressive: shape, colour tones, mutual orientation of objects on the image, etc., as well as semantic characteristics of visual content presented on the display;
4) the possibility of taking into account the temporal characteristics of the test tasks performed by the subjects, i.e. the possibility of taking into account the parameters of sensomotor reactions in the method [Mak2017];
5) the presence of a "common semantic denominator" for the ability to compare different concepts on a similar basis.

As a method of objective control of psychophysiological reactions associated with cognitive-affective and vegetative-behavioral reactions of subjects performing test tasks, the method of eye-gaze-tracking was used [Bar2016].

Experiments have shown that the classical method of the psychosemantic differential can be improved. The improvements were that when expressing his attitude to the content presented on the display, the subject used color marks rather than a set of words. This variant of the method of the psychosemantic differential is called the color-semantic differential [Yan2006].

The implementation of the color-psychosemantic differential method in the performed studies was presented by the method "Tsvetomer" implemented in the form of a software application [Iva2014].

Analogues of this technique are: "Color Test of Relations" by E.F.Bazhin and A.M.Edkind [Bazhin1983], "Color Analyzer of the World" by A.M. Parachev [Par1985], "Method of Mutual Color Assessment" by P.B.Yanshin " [Yan2000].

By combining the properties of projective and formalized tests in one technique, psychometric information about a person 's thoughts, experiences and relationships to the material presented becomes available both for expert analysis of color-stimulation associations and for machine statistical analysis.

The difference between the method "Tsvetomer" and analogues is that associations "stimulus" - "color marks," tested makes not one, but two colors (color-pair). For each color pair, empirical studies have determined a numerical value - color-pair index [Yan2006].

Design of a research. On the basis of voluntary informed consent, the study was attended by 50 respondents (15 young men and 35 girls), aged 18-25, practically healthy, Russian-speaking (Russian as a native language), who were students of a humanitarian university.

The test job consisted of viewing various visual content on the computer display. Such a task simulated the viewing of photos on specialized resources on the Internet (social networks).

Respondents expressed their attitude to the material presented on the display - photos with different story, building a link between the photos and one of 64 possible combinations of color marks, focusing on their "internal sense of correctness" of such a link (Figure 1).

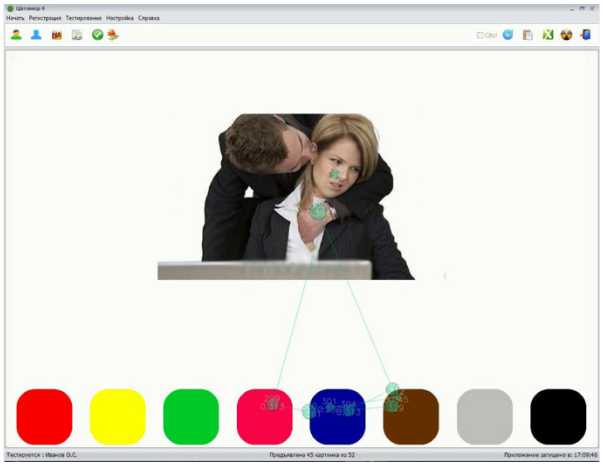

Figure 1: The main window "Tsvetomer" with the presented graphic stimulus and superimposition on the image of the "eye behavior"

The content displayed by the subjects was ranked in advance by categories: "neutral", "positive", "negative."

The content is represented by photographs with different meaning content, expressive expressiveness, and thus realized emocyogenic properties. The photographs were taken from the international base of emotional photographs (The Geneva affective picture database - GAPED DB) [Eli2011].

During the whole duration of the test tasks (from 5 to 12 minutes) eye-gaze-tracking was performed, which contains peculiarities of the "eye behavior" of the respondent in connection with his perception of the presented content.

The hardware and software complex "Gazepoint GP3 HD" to be used [Raz2018, Che2019].

During the survey, the following parameters were recorded on the temporal scale:

— the ratio of the examined to each instance of the presented photostimulas expressed through color association and a color-pair-equivalent color-pair index;

— time of complex sensomotor reaction (in milliseconds);

— the complex visualmotor response consisted of the following steps: (1) visual perception of the presented image, (2) awareness, to some degree of clarity, of the own attitude to the presented image, (3) selection of the color-pair more suitable for expressing its attitude to the content (4) and performance of this association;

— recorded eye-gaze-tracking (1) of the view fixation area on the image elements, (2) the temporal characteristics of the view fixation and its movement, and (3) the configuration of the view movements (amplitude, speed and movement path).

Thus, the use of eye-gaze-tracking to monitor the "eye behavior" of a person when they perceive visual content from a monitor enables objective control of subjective processes, as well as to obtain biometric information such as:

1) areas of view fixation on certain content elements that have made the greatest interest for this subject;
2) the duration (ms) of the view fixation in each of the areas of interest;
3) path of focus transition from one area to another;
4) an algorithm for selecting color marks for color associations to be tested.

In addition, video documentary provides biometric information on (1) dynamics of the respondent's blinking frequency when they perceive different content, as well as (2) dynamics of the diameter of his pupils.

In accordance with the design of the experiment, eye-gaze-tracking was performed in the background without distracting the subject from the perception of the presented information.

Prior to the presentation of graphic incentives, which were examined, each respondent was given specially selected verbal incentives.

These verbal incentives in the method "Tsvetomer" are represented by ten pairs of word antonyms (Table 1), which by definition have semantic differences, ideally - by 100 % [L'v2002] and are well known and understood by the Russian-speaking audience.

Table 1 : Antonim pairs used in the standard example substem color-associative tasks of "Tsvetomer" method

| № | Word-concept | Semantics | Antonimical word-concept | Semantics |
|---|---|---|---|---|
| 1 | Light | Usually and legally, the given of words in practically healthy Russian-speaking persons with undisturbed color representation has positive estimates, friendly, false attitude; And associations with color tones such as "yellow", "red-orange", "green" in their different pair combinations | Darkness | Usually and normative given group of words in practically healthy Russian-speaking persons with normal color reception has negative estimates, negative attitude; And associations with color tones such as "black", "brown", "grey", "dark blue" in their different pairings |
| 2 | Joy | | Grief | |
| 3 | Good | | Evil | |
| 4 | Positive | | Negative | |
| 5 | Victory | | Defeat | |
| 6 | Health | | Disease | |
| 7 | Warm | | Cold | |
| 8 | Peace | | War | |
| 9 | Love | | Hate | |
| 10 | Well | | Badly | |

The application value and meaning content of the subtest of the standard example of test tasks (SETT) in the method "Tsvetomer" is as follows.

For the vast majority of mentally and physically healthy adult Russian-speaking audiences, these word-concepts have understandable, easy, and therefore quickly detectable meaning.

Each of categories of these verbal incentives represents semantic space with "good", "positive", "pleasant" semantics and, respectively, with "bad", "negative", "disgusting" semantics.

In the course of the psychophysiological examination, color-liberal associations are always presented for execution at its first stage. This is a calibration step: the subject, first, in the course of performing the SETT in practice, clarifies how to perform subsequent color stimulation associations; Secondly, since at this stage the respondent does not have the need and intention to falsify the results, he performs these color-liberal associations with the temporal and affective characteristics that he is comfortable with. And he does as sincerely as he can be sincere. Thus, at the first stage - the stage of training, statistical characteristics of "sincere" sensomotor reactions and parameters of "eye behavior" in the test situation are collected without significant cognitive loads.

## 3 Results and discussion

In particular, Figure 1 shows a good example from a psychophysiological survey. The situation of the so-called harassment when a male superior petting a female subordinate. She tries to remove herself, but has a fear of doing so actively. (This is an example of a formalized description of the semantic content of a given visual content.)

For the proposed stimulus (photography), the subject performed a color association: "dark blue" and "brown". The color-pair indices (*IC*) for a given color concentration is 0.46. This value belongs to an empirical defined range

(its lower bound) of neutral relation to the form and content of the stimulus.

However, as can be seen by the oculogram superimposed on the elements (objects) of Figure 1, the examined though performed the color association "dark blue" + "brown", but also he considered for associations the option of choosing color labels: "magento" and "dark blue". And this chromaticity has an *IC* of 0.73 - "positive relation". But the subject refused to implement this option.

In a comprehensive way, considering the whole series of color-stimulation associations of this subject in this session, it is highly likely that this respondent actually estimates the situation of male harassment of a woman in the workplace not as unacceptable and outrageous, which requires generally accepted norms of behavior, but as quite normal and even good. However, he understood that such attitudes towards such situations were not welcome by society and therefore opted for a more socially acceptable option to demonstrate their attitudes to the form and content of the stimulus.

Thus, the described example also demonstrates the possibilities of verification not only explicit, intends to demonstrate the responses demonstrated by the respondent to incentives, but also those reactions that the examined person tried to hide.

The ability to visualize hidden psychometric information makes the developed method of psychophysiological examination also suitable for solving applications of instrumental verification of broadcast messages.

The use of hierarchical clustering methods in relation to the test results of the subjects allowed to build a dendrogram and determine the ranges of *IC* values (Figure 2). Each of the three identified classes can be conditionally associated with *"positive"* $IC \in [0.64; 1.0]$, *"negative"* $IC \in [0.08; 0.51]$ and *"neutral"* $IC \in [0.52; 0.63]$ graphic content [Iva2019].

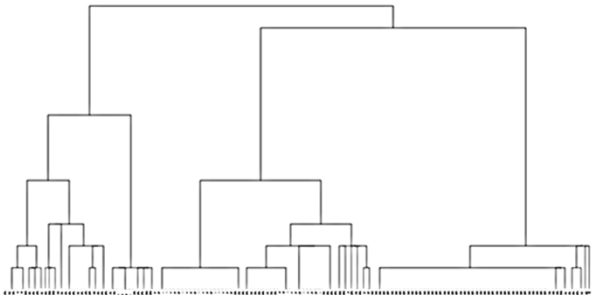

Figure 2: Dendrogram, obtained from calibration data

Figure 3 shows the dynamics of cognitive-affective relationship developing in examined persons when presented with visual content.

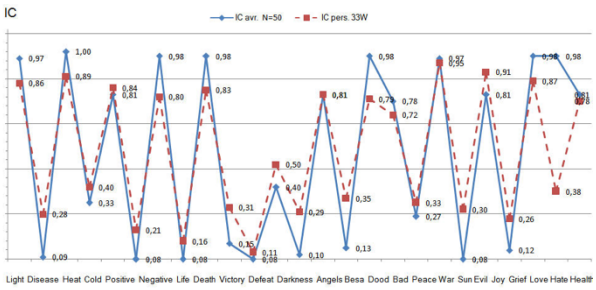


Figure 3: Color-osmantic differential on SETT antonyms: a characteristic graph of average *IC* values for a group of 50 people

In addition to color-osmantic associations for the presentation of antonyms, the graph (Figure 4) shows the ratio of reaction time required for the performance of associations.

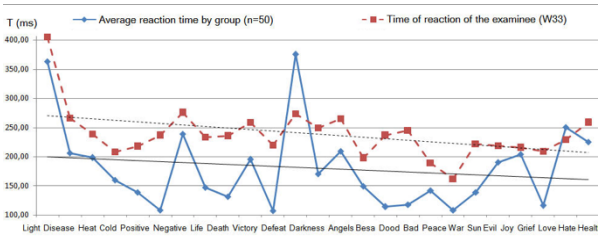


Figure 4: Color-osmantic differential on SETT antonyms: a characteristic graph of average *IC* values for a group of 50 people

Despite the predominance of the same evaluation judgments of respondents regarding each stimulus image, however, a unanimous assessment was not obtained for any of the 146 images. In this regard, the authors have developed an algorithm for obtaining an integral assessment of content (*F*), taking into account both the power of the analyzed sample and the degree of consistency of expert opinions (*K*). A graph illustrating the degree of convergence of the results of the algorithm depending on the number of respondents is presented in the Figure 5.

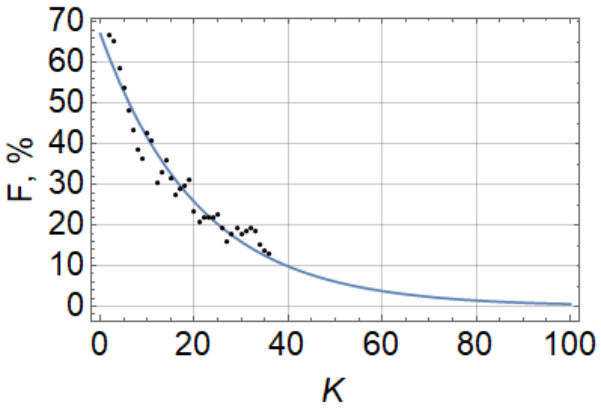


Figure 5: The algorithm for obtaining integral evaluation of the content

Visual analysis of Figure 6 suggests that, at a minimum, there is a tendency that the more negative meaning is contained in the word stimulus, the less time it takes the test person to perform a color-ferral association.

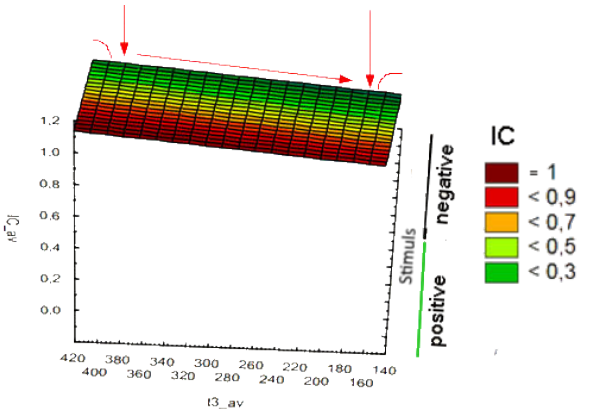


Figure 6: Graphic representation of the relation of the subjects to content depending on their categorical affiliation: "neutral," positive, "negative"

There is nothing new about this conclusion yet. A well-known phenomenon in psychology - bad people react more clearly and faster - is also found in this data.

However, setting this pattern on special incentives presented at the calibration stage, when there is no motive to falsify their responses, allows further, at the targeted testing stages, to use the data obtained in this way as a comparison array when assessing the sincerity of execution of test tasks.

It is expected that the values of the color-pair indices for verbal stimulus from the SETT for semantically positive words have values from 0.74 and higher; For semantically negative - from 0.46 and lower.

The concept of "Angels" received *IC* = 0.55, which makes it possible to suggest that in the paintings of the world of modern young people, the concept of "Angel" is not, unquestionably positive, as was the case with the generations of the mid-20th century.

Also expected is the value of the *IC* for images from GAPPED DB with letters *"A"*, *"Sp"*, *"H"* (pictures causing negative emotions) received the *IC* 0.34, 0.32, 0.29 respectively. And images with index *"P"* received group value of *IC* - 0.68. Thus, the expert assessment of the emotions of GAPPED DB photographs fully coincides with the associative reactions to these photographs of the subjects.

The results not previously met include the fact that the ratio to neutral pictures - *"N"* - GAPPED DB was estimated by the group as a whole - at 0.38 (moderately negative). This is probably due to the tendency of modern youth to negatively assess little emotional content.

As a certain finding was that on the images of snakes - the letter *"Sp"* GAPPED DB, the *IC* of the group made 0.57 - neutral-positive attitude. Perhaps it will correctly interpret that there is a tendency to transform the image of snakes in the consciousness of modern young men and girls from negative to positive. It is also possible that the result reflects the personality features of the examined contingent.

## 4 Summary

The software developed on the basis of the described methods and algorithms can be installed both on the side of the Internet access service provider and on the automated workplaces of users, which will allow timely detection and, if necessary, blocking of potentially dangerous multimedia objects.

### 4.1 Acknowledgements

The reported study was funded by RFBR according to the research project number 18-29-22064\18.

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