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## VERIFICATION OF PSYCHOMETRY RESULTS BY COMBINING OF TEMPOMETRY AND VIDEO EYE-TRACKING METHODS

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**Abstract.** One of the applied purposes of psychometry is measuring of human characteristics, hidden from the naked eye, while person is regarded as a carrier of meanings, and also as an assemble of these meanings in behavior. This kind of knowledge allows us to understand the motives of human behavior and forecast reactions to cascades of stimuli. The modern arsenal of psychometric methods is so large, that they allow to describe with assigned detailing not only a psychoprofile of any person, but also to forecast his or her behavior in different environments. However, this statement works, only if a person does test tasks sincerely, that means, if his or her reaction-answers are truthful. But if the subject intends to disturb a researcher, then there is a possibility, that the trained testee realizes his or her intention without being condemned for falsification. Practice shows, that “scales of lies”, provided in the standard test methods, are often not able to locate an intended falsification of trained testees. Within the classical psychometry approach this problem – the scale of assesment of authentithity (truthfulness) of the results of performing the test tasks during the active testee’s counteraction – doesn’t find a sitisfying solution. However, the solution of this task is very important for provision of high quality and productivity of the forecasting activity of psychologists. Verification of truthfulness of the results of the performed psychological tests by a testee is suggested through unification of computer psychometry with video eye-tracking checking.

**Key words:** psychometry, verification, behavior, eye-tracking, “Videotsvetomer”.

Modern psychometry, if under the condition of adequacy of a selection of methods to performed task within a researching troop, is able to describe minutely and informatively enough a psychoprofile of a person or a group of people, being investigated, and also to provide forecasting information about them [2; 3; 5; 12; 23; 24]. In this clear description of the unclear, hidden in the human mental life and/or in the collective unconscious (have not been realized), and also in the probabilistic prediction (forecasting) of the future of the behavior of researching object(s)’s under the given circumstances – that is one of the leading purposes of applied psychometry.

However, the leaving objects, instead of the objects of lifeless environment, in particular – thinking creatures with free declaration of will, are characterized by high variability of possible reactions. In connection with this issue, psychometry results can be informative only in those cases, when an absolutely well testee, being in his/her own usual cognitive-affective psychophysical condition, performs the test tasks sincerely and gives truthful answers, when he/she doesn’t try to disturb a

researcher by intended distortion in the performance of the test tasks [27].

If a testee has motivation to give socially approved answers, intentionally falsifying his/her own truthful attitude towards a checked topic, then, usually, he/she gives those answers, which being consciously regarded as correct ones, but not those, that he/she suggests to be acceptable (profitable) in the distinct situation, being investigated [7; 18; 19; 26].

In the century of ubiquitous "Internetization" no one has difficulty in getting access to any formalized and restricted by standard acts test psychometry procedure. Such an easy access allows any interested person to train to perform test tasks in a proper way beforehand, so, to get according to the results of processing of his/her primary answers a mark, that one needs, regardless of what a character is psychologically in reality [22].

It was historically formed, that to assess psychological characteristics of the subject, "answer-question" questionnaires are used the most often. The answers for the test tasks are the easiest to falsify. However, if the one wants to falsify his/her answers to the test tasks, a testee can do it in any test situation, performing test tasks of any procedure [25]. Even if it firstly seems, during a sensory-motor testing, that doesn't obviously tackle personal human structures (his/her world view, self-esteem and so on), and so it is supposed not to provoke intended falsification of answer-reactions, in particular cases there is a possibility for not only intended, but also for not intended, not being distinctly realized distortions by an investigated object. To accelerate the time of sensory-motor reactions above his/her own psychophysiological possibilities is practically impossible. In this way, falsification is not regarded as something possible. But everyone, having a desire, can make his/her speed of sensory-motor reactions slower [4; 8; 9; 20].

Lies, falsification and intended distortions are very largely and often used by people in the process of communication, to leave this sphere without control during the complex assessment of a person [29].

In this way, to regard psychometrical information as truthful, during the procedure of examination one should have mechanisms and indicators of presence/absence of trying of testees to distort results intentionally.

One of the most ergonomic, informative and that's why effective ways of dealing with this problem of defining a degree of sincerity of a testee during the performance of the test tasks is combining of several methods, embodying different principals during one procedure of psychometric examination. For example, questionnaires are aimed at measuring psychometric characteristics of the part of personality of the subject, that understands meanings; projective tests, to an increasing degree, open pithy characteristics of unconscious sphere of human mental life; sensory-motor methods characterize "bioenergetics" resources of material substratum - neuro-sensory muscle complex, through that cognitive-affective activity of the subject arises through his/her behavior in distinct circumstances of physical and social environment, instantly adapting to this environment [9; 20; 21].

In this way of logic, questionnaires are connected with realized meanings by the consciousness of the subject; projective tests are connected with the unrealized by subject's consciousness part of mental life; sensory-motor reactions are connected with characteristics of neuronc substratum, through that mental life is shown in the physiological world of behavioral activity of the subject. But all these items are

characteristics of different levels of one and the same object – human.

The mostly valid research of this complex is possible, when in the procedure of research parameters of all parts of this complex are registered at the same time.

Of course, realization of such unification of methods in one procedure is possible only in compute-based performance. There is no established architecture of such software-hardware complexes (SHC). But a steady trend is represented by unification of different psychological, socially-psychological and psychophysiological methods under one program casing, complemented with tools of impersonal biometrical monitoring of physiological and also sensory-motor reactions [17; 30].

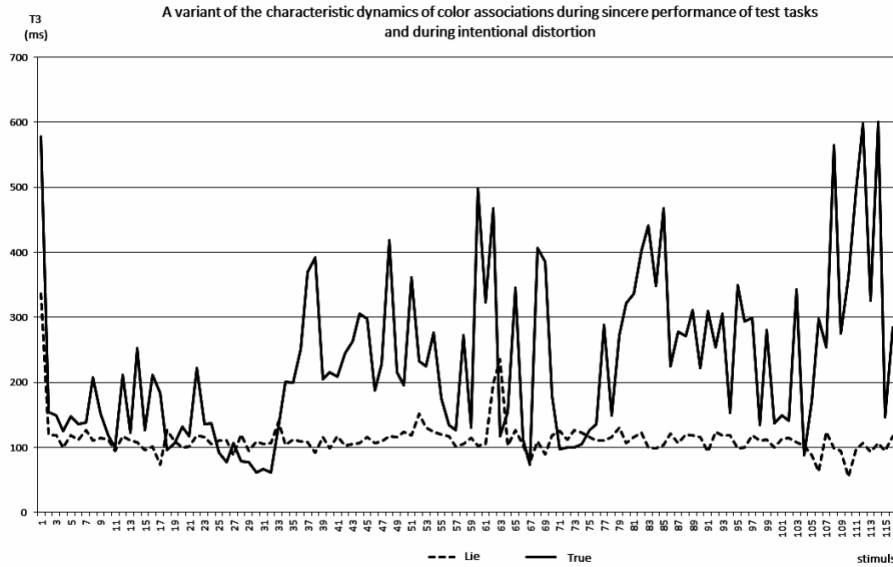
In the succession of carried researches (2015 – 2020) the authors used the described method during creation of psychometrical tool – (SHC) “Videotsvetomer” [9-11]. “Videotsvetomer” consists of the authorial method ©“Tsvetomer” [10], unified with a side hardware-software (HSC) for video eye-tracking (eye-gaze tracking) “Gaze Point H3” [32]. In the carried out researches these two methods were unified into one synchronously functioning psychometric system.

The tool, created in this way - (SHC “Videotsvetomer”) allows at the same time in the unified time scale to measure:

- 1) “semantic” part of human mental life, notional filling of the conscious and thinking of the subject during his/her perception and comprehension of stimuli, and also to assess his/her attitude to the meanings, built in the stimuli being demonstrated (for this purpose an indicatory parameter was created – color pair index (IC));
- 2) unrealized characteristics of human mental life – through color stimulating associations; meanings, contained in one stimuli of groups of them, – become impossible to be connected with meanings, built in other stimuli and groups of them. What is more, very often the subject is unable to explain rationally presence of the semantic link between color associations connected concepts. However the “feeling” of presence of such linking is often proved.
- 3) and also to measure parameters of the accompanying behavioral reactions – sensory-motor (the speed of color-stimulating associations – T1, T2, T3), and also eye-gaze tracking parameters (duration of eye focusing (ms) on the stimulus, the speed (ms), quantity (one item per time unit) and the amplitude (pxl.) of saccades, dynamics of eye-apple diameter (pxl.)).

Such technical solution supplied a psychologist with a possibility of carrying out researches of semantic content of the conscious and subconscious of the subject through the method, being traditional for psychology. But at the same time it also gave a possibility to carry out impersonal monitoring of behavioral reactions synchronically with psychometry.

For example, Fig.1 demonstrates a temporal sensory-motor profile of color-stimulating associations of one testee, who performed color associating tasks in identical test circumstances. Temporal profile with sincere answers – continuous graph; with intended distortions – the dashed one.



**Fig. 1.** Temporal profiles of a separate testee due to measurements of complex sensory-motor reaction during the performance of color-verbal associations.

Temporal parameters of behavioral reactions – sensory-motor and eye-gaze tracking, when we speak of millisecond measuring scale, even a trained person will find it really difficult or even impossible to forge, without giving oneself out by such trying: either through characteristic changes of temporal profile, or through color-semantic associations.

Alternative approach to identification of truth degree of the messages is embodied in contact polygraphometry. But, this is more likely, an expert method, with characteristic possibilities and restrictions for such methods [1; 16].

Any practicing psychophysiological-polygraphologist is, as a rule, an attentive supervisor (and thinker). Usage of sensory organs and rational thinking for discourse and correct conclusions is known as method of profiling and verification [9; 10; 20] – not impersonal, but an expert method, being to no less degree art, than science (however, this method is very informative).

Drawbacks of this approach are recourse intensity of getting psychometric information, length of the procedure of examination and binding data of outcoming data and target conclusion to a distinct expert [3; 20; 24].

Psychological tests are so widespread, because they turned out to be optimal according to a series of indications during as individual, as group surveys. But, as it was mentioned above, and is mentioned by several authors, in case when questionnaires are used, a lot of other problems arise [2; 22].

Thus, authors of this publication aimed at the development of algorithms to assess a degree of sincerity of testees' answers to verbal and/or graphically given test tasks. This algorithm is based on unification and systematic assessment of semantic and sensory-motor parameters of testee's reactions in circumstances of formalized or half-formalized testing.

To reach the declared aim in 2017-2020 a scientific research, cipher “Tsvetomer” was carried out. On basis of voluntary conversant agreement 50 people of both sexes aged from 18 to 25 have taken part in the research, being practically healthy (in medical aspect), not complaining about their health, activity and mood during the examination, being students of Russian speaking higher education Institute of art profile.

Design of the survey. Every testee was sat in front of the computer monitor in such a way, that usually sits a person, looking through web-pages. Stimuli were sent to the monitor in the beforehand prepared succession: with distinct form of expression, distinct content, distinct notional filling and identified emotionality. You can watch a typical session, following this link:

<https://drive.google.com/open?id=1MyCVtXe7V5dVju8pWsmVNdgAOxJ8OkVW>

As verbal stimuli there were taken words, that were antonymous pairs, building up the standard example of test (color-associating) tasks (SETT). As graphical stimuli images were taken: 1) photos with ranked [28] and 2) with unknown (examined) emotionality and semantics.

A testee had to look at the monitor with a displayed stimulus (word, phrase or picture), and, on basis of his/her own inner feeling of “correctness” perform association of the stimulus with two out of eight available color assessment marks (or with one and the same color mark twice), as it is provided in the method “Tsvetomer” [10].

During the whole session with the length of  $10 \pm 4$  minutes, being carried out at the same time as the performance of test color-associating tasks, Videotvetomer (eye-gazed tracking) of eye behavior of the testee was carried out [20; 28; 32].

As a result, units of primary data on every testee were formed.

**Table 1.** Stimuli, united into the sense-containing units.

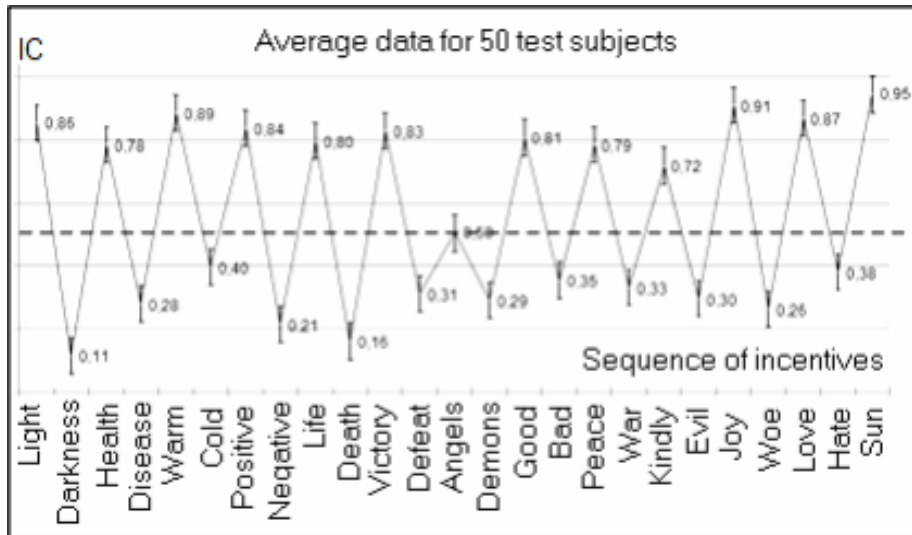
№	Primary parameters of processing	Remarks
1	Words with positive semantics	10 words
2	Words with negative semantics	10 words
3	Photos with “neutral” emotionality	14 items
4	Photos with “negative” emotionality	25 items
5	Photos with “positive” emotionality	22 items
6	Photos with unknown (examined) emotionality	29 items
7	Color pair index for definite stimulus/ Index of assessment	From 1, 00 - “excellent” Over 0,50 $\pm$ 0,05 “neutral” up to 0,01 - “disgusting”
8	Total time of reaction of choice/associating, needed for assessment of stimulus with marks (T3)	(ms)
9	Body of data with parameters of oculogram (separate example)	<a href="https://drive.google.com/file/d/1ytbYEPKXsBx7JNmdyB7qjZYNsKgG-y-e/view">https://drive.google.com/file/d/1ytbYEPKXsBx7JNmdyB7qjZYNsKgG-y-e/view</a>

The procedure of the performance of test tasks was organized in the following way.

Verbal stimuli in quantity of 20 words were given to a testee in a succession. These

words were antonymous pairs, well-known to the Russian-speaking audience from their birth, so that meanings of these words were understandable enough for the members of the research, and they didn't need any mental work [13; 14].

The succession of presentation of the verbal stimuli (SETT) for every testee (on the abscissa) is represented in Fig.2.



**Fig.2.** Calibrating verbal stimuli SETT: a succession of their presentation and characteristic meanings of color-pair indexes

Also Fig. 2 shows on the ordinate axis cognitive-emotional testees' attitudes to the meanings, put up into the words during the language evolution by the culture, and, accordingly, meanings, found by testees in this words-stimuli in the process of examination.

Analysis of the results shown in picture 2 proves, that colour-semantic differentiation of words-stimuli is neatly implemented depending on the notional filling of the stimulus. In this regard, coloursemantic differential is identical with psychosemantic differential [11; 14].

Unit test task (unit colour-stimulus reaction) is represented by the following phases: 1) presentation of a successive stimulus for perception → 2) sensory perception of the stimulus → 3) actualization in the focus of meanings in his/her conscious, so to say, meanings, existing in the individual world-image An important moment – the world-image → 4) association of the stimulus (and of meanings, connected with it) with two colour evaluative marks.

The evaluative marks were represented by the following colour tints: (left to right): 1\_red-orange, 2\_lemon-yellow, 3\_grass-green, 4\_crimson, 5\_dark blue, 6\_brown, 7\_asphalt grey, 8\_black (not to mistake for colour stimuli of the short variant of Lüscher color test. Similarity is minimal!; requirements for colour marks in Lüscher method and "Tsvetomer" are different).

All possible pairwise combinations of colour marks are given empirically tucked up numerical values: <https://yadi.sk/i/b52qejDkdZf9pw>.

To perform every simple colour stimulus associating task a testee spent some time, that characterized his/her psychophysiology for a period of the session. A typical variant of a result of simple test tasks completed by testees is shown in Table 2.

**Table 2.** Parameters of result of the performance of simple test task

	Stimulus	IC	Time of reaction T3 (ms)	Remarks
21	“Happiness”	0,9 8	259	T3 = T1 + T2, where T1 is the time of stimulus emerging to the click on the first chosen colour mark, and T2 is the time period between the clicks on the first and the second marks

Thereby, every simple test task completed by a testee content biopsychometrical information about:

- Emotional attitude expressed through colour associations
- Time, that a testee needed to perform difficult visual motor reaction (PVMR) of colour stimulating association;
- Semantic polarity of the presented stimulus.

The same thought is encoded through numbers in Table 3.

**Table 3.** Conjugation of parameters of emotional attitude towards stimulus (color index) and time (T3) needed to carry out this ratio

№	IC ↓ T3→	Quickly	Middling	Slowly
		1	2	3
1	Positive	<i>11</i>	<i>12</i>	<i>13</i>
2	Neutral	<i>21</i>	<i>22</i>	<i>23</i>
3	Negative	<i>31</i>	<i>32</i>	<i>33</i>

In general form complex parameter “IC - T3” characterizes:

- A) subjective cognitive strain connected with implementation of colour-verbal associating choice and  
B) individual style of reaction.

For example, colour-verbal association for a verbal stimulus “Happiness” (Table 2) shows, that separate testee connects this word with concepts from semantic field, that includes a lot of positive meanings (IC = 0,98); in this case the testee needed 259 ms to grasp and express his/her own attitude towards “Happiness”.

Provided that IC of “Happiness” among the Russian-speaking population usually equals  $0,90 \pm 0,01$  (picture 2) and time to implement this attitude through activity is usually  $270 \pm 50$  ms (picture 1), then a conclusion can be made, that this testee has got an adequate (for this populace) positive attitude towards the word with positive content. Meanwhile, the testee didn’t have any difficulty to understand and to express attitude towards the meaning of the word quickly enough. In this case the code of “complex parameter” IC T3 will be “*11*”.

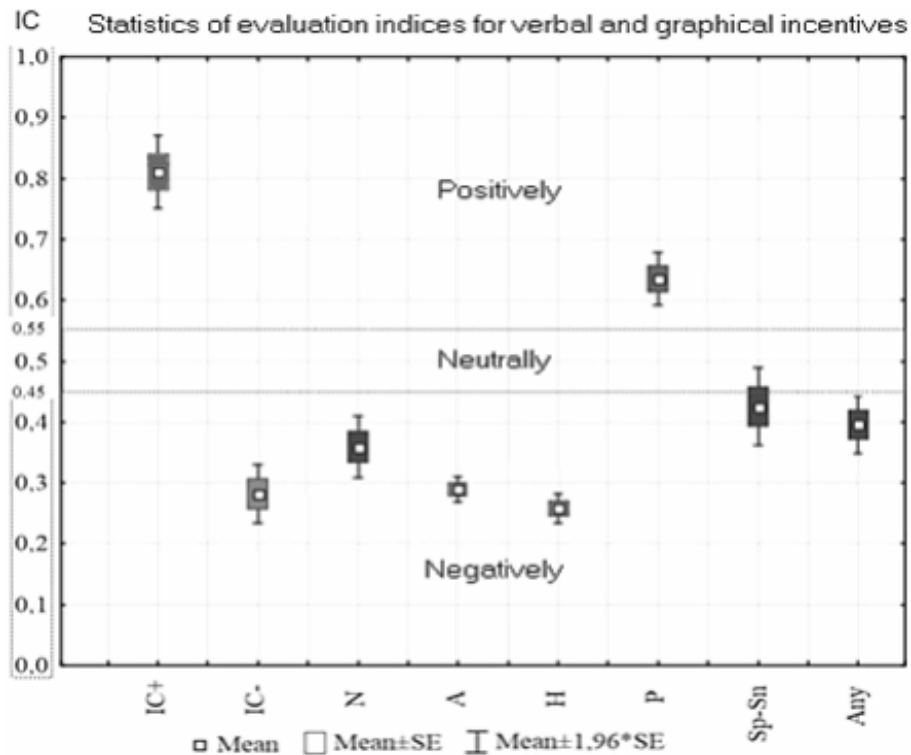
As it was shown above, graphical stimuli were used in the research together with the verbal ones. You can see grouped represented graphic stimuli in table 4.



**Table 4.** Graphic stimuli, that have certain expressive demonstration and semantic filling, being shown to testees in the research.

Class of graphic stimuli	Quantity and title of the file
Photos with “neutral” emotionality	In total 19 items
Photos with positive emotional polarity	In total 22 items
Photos with negative emotionality:	
• Killed and suffering animals	14 items
• Human sufferings	15 items
• Snakes and spiders	18 items
	In total 47 items

The colour-graphic associations were performed in a way, parallel to colour-verbal associations. Fig. 3 demonstrates results of assessments of stimuli, presented in the research (for selection N=50)



**Fig. 3.** IC statistics for different incentives

Analysis of the information, displayed in picture 3, allows us to make the following conclusions.

The unit «IC+» contains statistics of verbal stimuli with positive semantics.

The unit «IC-» reflects assessment of verbal stimuli with negative semantics.

A smaller dispersion of statistics for stimuli with negative semantics is in general

characteristic for the general aggregate of testees.

Probably, it is connected with the fact, that all the bad is identified in the personal world views more distinctly and univalent.

The unit «N» contains statistics, that characterize the attitude of testees to, so to say, not emotive, emotionally neutral (according to the authors – implementations of these standardized stimuli – DB GAPED (Geneva's university)), graphic stimuli.

However, according to the steady impressions of the authors of the implemented examination, when a person is given the task to reflect his/her attitude towards stimulus in a rational way (using words as assessment), then it activates work of the mind, and then a testee assesses usual well-known household objects (an electric bulb, a lamp, an so on), as the positive ones. And it is correct from the rational point of view. But when a person is proposed to express his/her attitude towards the form and the content of a graphic stimulus, then mostly the irrational channel (colour marks) is used, and then the emotional part of mental life works, and it is demonstrated through this, that externally inexpressive images without any emotive content are assessed not as neutral, but as the neutral-negative ones. This phenomenon demonstrates, that the result to get in the performed test depends on the type of assessment marks (a maxima for comparison: “what is the question, that is the answer”).

Units «A » and «H» demonstrate the anticipated testees' attitude towards the form as content of stimuli with suffering animals and suffering people. Assessments are explicitly negative. What is more, dispersions of statistics in this case are minimal.

In unit «P» results were anticipated: as the photos with positive content were demonstrated, these photos were assessed positively.

In unit «Sp-Sn» photos of snakes and spiders were demonstrated. According to the plan of the authors of DB GAPED, perception of insects and reptiles must cause disgust-abruption. However emotional experiences from these stimuli were not univocal for the testees. Students-psychologists do not treat pictures of snakes and spiders as something unambiguously disgusting.

Interpretation of the results reflected in the unit «Any» presents special interest.

At this stage of the research it can be affirmed, that in the whole statical advertising is assessed moderately negatively by our compatriots.

Unification of these assessments into one massif is very exponential. However, one should observe, the assessment of an advertising banner by a specific testee, because this phase is especially interesting due to the ability to show reaction of a specific person to a specific stimulus.

During the process of treatment of the experimental data the parameters of videooculography were overlapped on all the results, got with the help of the method “Videotsvetomer”.

Preliminary data testify complex interrelations between the parameters of sight and the parameters performance of colour-stimulig associations towards the stimuli of different form and content.

Nevertheless, numerical parameters of the videooculogram allow to control unambiguously the fact, that a testee perceives stimuli and tries to implement the test tasks correctly. During face-to-face examination this function was performed by specialists. But the usage of video oculography in this way allows to carry out the examination distantly, without losing any important forecasting information.

Hereby, it has been demonstrated, that unification of “Videotvetomer” with biometrical videomonitoring is a perspective solution from the point of view of provision of automatical verification of the results of psychometrical testing.

The authors suggest, that SHCs with the described above functionality are correct to regard as a new subclass of “sincerity detectors”. Such tool is able to realise the maxima of psychometrics: “You can’t show anything unexisting and you can’t hide anything, that exists”. This subclass of SHC can be called “videopolygraph”, and a particular variant of implementation of this subclass of psychometrical tools can be called “Videotsvetomer”.

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