Contents

Interrogation Using Polygraph and its Scientific Basis 1
Yuri Kholodny

A Case Study of a Polygraph Examination on an Examinee
with an Implanted Defibrillator
Nathan Gordon and William Fleisher

Effects of Audiovisual Presentations of Test
Questions During Relevant-Irrelevant Polygraph
Examinations and New Measures
John Kircher, Dan Woltz, Brian Bell, and Paul Bernhardt

Comparison of Evidentiary and Investigative Decision Rules:
A Replication
Donald Krapohl and Barry Cushman

Instructions to Authors

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Interrogation Using Polygraph and its Scientific Basis

Yuri Kholodny

After many decades of negative attitude to the option of polygraph application for prevention, detection and investigation of crimes, this psychophysiological “lie detection” method used in the device has been “legalized” in the country in 1993. One year later the interrogation using polygraph (IUP) have been incorporated in the national criminalistics (science of crime detection).

A huge work on introduction of the method into the Russian law enforcement practice have been carried out throughout the ten years elapsed. The polygraph interrogation assessment from the positions of criminalistic science methodology have enabled us to prove that it is one of the particular methods of criminalistics diagnostics. Entering of polygraph interrogation into contemporary criminology has given rise to a principally new direction in criminalistic science which has obtained the name of “criminalistic polygraphology”.

The thesis that the methods recommended to be applied for prevention, detection and investigation of crimes shall meet the number of requirements where scientific justification is one of them is a steady stable one for the national criminalistics.

The specialists throughout over centennial history of practical application of “lie detection” psychophysiological method using polygraph have kept trying to offer scientific explanation and theoretical justification for those complicated processes going on with human mind and body and permitting to reveal from them the concealed information at polygraph interrogation.

It should be acknowledged that natural scientific explanation of the mechanisms forming the ground for polygraph interrogation is one of the most crucial scientific and applied research issues faced by global community of scientists and specialists engaged in the field.

Understanding of the nature of the processes going on in human psyche at polygraph interrogation apparently raises not only scientific, theoretical interest but it is as well of principal importance from practical point of view as it allows giving “transparency” to the method, increasing effectiveness and setting out scientifically grounded limits for its application.

The issues of polygraph interrogation technique theory are not properly treated in Russian scientific and special literature. The authors of small number of native publications on polygraph interrogation issue being aware of complexity of natural scientific justification of “lie detection” psychophysiological method using polygraph either avoid referring to this issue or offer vulgarized presentation of some theoretical concepts borrowed mainly from foreign scientific literature.

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1. This article was reprinted with permission of the publishing house “Spark” and the editors of “Vestnik kriminalistiki” (“Bulletin of Science of Crime Detection”).
The present article shall continue the work initiated by us to present theoretical aspects of polygraph interrogation: it is devoted to analysis of various approaches to resolution of this problem suggested by foreign and native scientists.

I.

By early 90s of the XX century there have been formed several theoretical approaches abroad (mainly in the US) trying to explain with different levels of success how lie of a human proves to be detected during IUP.

These theoretical approaches can be classified into two major classes: (a) theories that emphasize motivational and emotional factors as the important determinants of psychophysiological differentiation (e.g., feelings associated with deception, fear of the consequences of the polygraph test’s results, motivation to deceive) and (b) theories that are based on cognitive factors (e.g., knowledge and awareness of certain information, attentional mechanisms that operate while processing the questions).

According to the opinion of the US Congress experts carried out special study of the set of issues related to use of the polygraph tests—the most commonly accepted theory is that, when the person being examined fears detection, that fear produces a measurable physiological reaction when the person responds deceptively. This theory was named threat-of-punishment theory and it refers to the first one of the classes mentioned above.

With a view of opening the essence of this theoretical concept to a greater extend, Lynn P. Marcy wrote: “The basic theory of polygraphy is that under certain circumstances, questions the truth of which may have grave consequences for the subject will stimulate the sympathetic division of autonomic nervous system and cause physiological changes which can be measured, recorded, and analyzed. For this reason, the verbal answer which is articulated by the subject may not necessarily affect the physiological responses which is demonstrated by the instrument. That is to say, if the subject is asked the question, “Did you kill X?” and he is at that time aware that he did kill X, a physiological response would likely result even if he admitted his guilt and answered in the affirmative...

If, in response to this question the subject were to untruthfully deny his complicity, the fear of discovery of the truth as he knows it will cause changes in the function of each of the systems measured and recorded by the polygraph and permit the examiner to view a visible physiological response which both in theory and as demonstrated empirically by hundreds of thousands of polygraph tests can be correlated with deception.

If the subject were truthfully denying involvement in the crime, no crisis would be present and the question would not stimulate the sympathetic nervous system into action... The absence of the responses must mean that the subject is telling the truth, whereas the presence of responses means and means only that he is withholding information which he believes to be relevant to the question put to him.

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Somewhat different interpretation of threat-of-punishment theory was offered by Davis R., according to whom "lying is an avoidance reaction with considerably less than 100 % chance of success, but the only one with any chance of success at all. The physiologic reaction would be the consequence of an avoidance reaction which has a low probability of reinforcement, but not too low. If the theory has any validity at all it must be supported that the physiologic reaction is associated with a state of uncertainty. It does seem that a lie told with a complete certainty of its acceptance would be unlikely produce much reaction; and on the other hand we have the experimental evidence ... that a lie told with no prospect of success whatever is also poorly detected".

It is easy to note that threat-of-punishment theory and both its interpretations above are rather vulnerable. First, the threat-of-punishment theory generates skeptical attitude among the critics who believe, that "in this theory, the polygraph instrument is measuring the fear of detection rather than deception per se". Second, one can hardly unconditionally agree with the opinion on the single determinative role of sympathetic nervous system in development of polyphysiologic reactions in course of the polygraph tests. It is known that by no means all changes in a body happening on psychophysiological level are caused by effect of this very element of vegetative nervous system: for example, the decrease of heart rate, happening in response to presenting significant questions to the interrogated person which is frequently observed in course of the polygraph tests, is determined not by sympathetic but by parasympathetic nervous system. Third, the threat-of-punishment theory creates serious complexities in explaining high effectiveness of experimental researches – for example those carried out in the circumstances of guessing selected figure or card tests – where the threat of "ruinous consequences" for lie to experimentalist is excluded completely. Fourth, it follows from the theory under consideration that expressiveness of physiological reaction to that or other question in the course of "lie detection" process is the function of "threat-of-punishment avoidance reaction" And "if the subject were unaware that his autonomic responses were being monitored, detection rate would be minimal". However the experimental research undertaken demonstrated invalidity of this assumption: in the cases when it proved to be possible to persuade the examinees that polygraph was switched off (the reactions were registered telemetrically by the removed unit) it was established that there was observed no significant aggravation of physiological reactions expressiveness.

At the same time it is noteworthy to mention that threat-of-punishment theory discovers some experimental and solid practical confirmation: as evidenced by the US Congress experts likelihood of discovering the concealed information using polygraph interrogation method is typically higher in real-life conditions rather than in laboratory environment.

Apart from the threat-of-punishment theory the concept whose essence was formed by Luria A.R. ideas sounded in early 20s by the same is also referred to this class of "polygraph theories".

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7Scientific validity of polygraph testing: .... P. 97.
Let us recall, that Luria A.R. while studying affect state of criminals and having summarized huge experimental material established the following: “the acute state of the trauma, complicated by the necessity of the concealing it, bound in by the fear of expressing itself, creates in the criminal a state of exceedingly acute affective tension; this tension is very probably exaggerated because the subject is under the fear of disclosing his crime; the more serious the crime, the more marked the affect, and the greater the danger of disclosing it, the more this complex is suppressed... Such a tension is undoubtedly one of the most serious factors for the criminal in the recognition of the guilt. By confession the criminal has the means to avoid the affective traces, to find an exit for the tension, to discharge that affective torus which created within him an unbearable conflict. Conflict can eliminate this conflict and restore the personality in a certain degree to a normal state, and this is its psychophysiological significance16.

The Luria’s ideas have been transformed into conflict theory, which established “that a large physiological disturbance would occur when two incompatible reaction tendencies are aroused simultaneously, such as a tendency to tell the truth and the tendency to lie about the specific incident”17. The conflict theory in general stands together with the experimental data and assertion of Davis R., that detection would be easier to carry out, the more the examinees tries to conceal their lie, have been confirmed in the studies of the number of scientists. In particular improvement of concealed stimuli discrimination when the examinees seek to “deceive the device”, i.e. at intensification of “conflict”18 has been demonstrated in laboratory environment.

Certain researchers stating their support of this theory point out that excitement at lie caused by conflict may be characterized as an inhibitive one related to parasympathetic nervous system19 activation. The experimental data on change of heart rate and T-waive amplitude during lie action20 are quoted to confirm the above.

However most of the specialists recognize that conflict theory is rather weak and caution from far-reaching conclusions. According to Davis R. if conflict stands as a ground or reason for intensive reactions which mean lie then there exists a certain danger of being misled due to more intensive reactions connected with personal emotive problems. Furthermore, from the conflict theory point of view the well known fact of arising of intensive reactions at presentation of psychically significant stimuli, when no answers are required from an examinee (so called silent test) and likelihood of “contesting tendencies conflict”21 arising is practically excluded, defies explanation.

The conditioned response theory grounded by the principles discovered by Pavlov I.P. at studying highest nervous activity is the last one within the “motivational emotional theories” class. This theory rests on the assumption that the relevant question ... produce differential physiological responsibility because they were conditioned to the subject’s past experience (e.g., crime). According to this account, the more serious the crime, the stronger the reactions that would be evoked by the relevant questions22.

11Barland G. H., Rasten D. C. Detection of deception... P. 446.
16Ben-Shakhar G., Furedy J. Theories and applications ..., P. 102.
With all external simplicity and seeming obviousness this theoretical concept is presumably even more vulnerable than conflict theory. If one agrees to this theory it would not be possible to offer acceptable explanation for psychophysiological reactions to lie in course of laboratory experiments where the detection percentage is rather high (for example in course of the experiments of identification of a card chosen by an examinee).

The major problem of the theories that emphasize motivational and emotional factors is the difficulty in accounting for significant detection rates under mild conditions, when subjects are not specifically motivated to avoid detection, when subjects are not attempting to conceal the relevant information, and even when subjects are unaware of the fact that their responses are monitored by polygraph"23.

The theories whose grounds are formed by "cognitive factors" related to perception and processing of stimuli presented to an examinee at polygraph test try to a certain extent to eliminate the imperfection mentioned above.

So, the fourth polygraph theory is the so-called arousal theory: "this theory avoids use of emotions such as fear or guilt. It states that detection occurs because of the differential arousal value of the various stimuli"24.

The definition of "guilty knowledge" is utilized for experimental substantiation of this theory. The essence of this definition lies in the fact that the sign of crime "for the guilty subject only, the "correct" alternative will have a special significance, an added "signal value" which will tend to produce a stronger orienting reflex than that subject will show to other alternatives"25.

When commenting the concept of guilty knowledge, G. Ben-Shakhar and J. Furedy pointed out that "clearly, for subjects who do not possess the guilty knowledge, all items are equivalent and evoke regular orienting reactions that will habituate with repetitions"26. Exactly this determines a "cognitive" element of arousal theory: "the emphasis here is on the fact that an individual know something, rather than on the individual's emotions, fears, conditioned responses, or deception"27.

In general, this theory closely matches the results of many laboratory researches carried out in the field. In particular, application of arousal theory facilitates understanding of reasons for existence of significant differences in effectiveness of psychically significant stimuli discrimination in the circumstances of different levels of motivation28. (It should be mentioned herewith, that the results of experimental researches designated to confirm arousal theory have been based usually on registration of galvanic skin reflex /GSR/ - the only physiological indicator towards which the objective quantitative evaluation of the observed reactions could have been applied by foreign researchers).

The arousal theory has not gained wide recognition among the polygraphologists. Reid G. and Inbau F., the leading American polygraphologists of the 40-70s XX century, "suggest that the arousal theory may be predominant in laboratory experimentation, but that in the field situation the fear of punishment overrides the effect of alertness and attention found in the laboratory. This distinction is used by these workers and other field examiners to explain the effectiveness of electrodermal activity in the laboratory but not in the field"29.

26Ben-Shakhar G., Furedy J. Theories and applications ..., P. 107.
27Ben-Shakhar G., Furedy J. Theories and applications ..., P. 108.
29Barland G.H., Raskin D.C. Detection of deception..., P. 447.
The Israeli psychophysicists when carrying out neutral and significant stimuli reactions research experiments have empirically30 established, that “psychophysiological detection depends on the relative frequency of the relevant stimuli in the stimulus set presented to the subject”31 in course of the polygraph test.

The researchers offered dichotomization theory: “according to the theory, persons who choose certain (relevant) stimuli will manifest independent habituation processes to the two types of stimuli (relevant and neutral)”32 to explain the empirical rule discovered.

The founders of this theory (Lieblich I., Ben-Shakhar G. et al.) hoped that methodical principles developed on its basis would allow separating in future the complex sets of stimuli in the groups and establish their subjective significance33 determining consistent pattern of a subject addiction to each of the groups. However the researchers faced certain contradictions throughout their experiments while relying on dichotomization theory postulates.

First, “a strict dichotomization theory predicts that in a situation where the relevant and neutral categories are equiprobable (e.g., .50), it would not be possible to differentiate between them using a psychophysiological measure. However, in most studies using such base rate conditions, the skin conductance response (SCR) evoked by a relevant stimulus was greater than the SCR to a neutral stimulus”34. Second, it was revealed that the presented stimuli rarely caused more expressive SCR reaction than the neutral stimuli presented in the same circumstances. The dichotomization theory is in general rather far from real-life polygraph tests and is applicable only for a limited set of laboratory tasks. As its founders assert “further research is needed to understand the mechanism of habituation of differential autonomic responsivity”35.

At the turn of the 80s-90s the attempts of foreign scientists to form solid theoretical ground for “lie detection” psychophysiological method using polygraph have not been exhausted with the five “polygraph theories” examined above. Heslegrave R. pointed out for example: “four theories were postulated to explain the increased arousal during deception. The Amount of Information theory states that the greater arousal during deception is because more information (honest and deceptive) receives attention and pressing during deception. The Retrieval Difficulty theory states that deceptive information is more difficult to retrieve then honest information and this enhances arousal. The Novelty theory states that the enhanced arousal is because of the novel association of the unfamiliar deceptive response with the question”36. The Canadian scientist finally came to the conclusion that, according to his point of view the most fruitful is the conflict theory, as namely “conflict plays the primary role during the act of deception”37. However certain pro- and contra- within this “polygraph theory” have been already mentioned above.

31Ben-Shakhar G., Furedy J. Theories and applications ..., P. 111.
32Ben-Shakhar G., Lieblich I. The dichotomization theory ..., P. 277.
34Ben-Shakhar G., Lieblich I. The dichotomization theory ..., P. 277.
35Ben-Shakhar G., Lieblich I. The dichotomization theory ..., P. 281.
36Heslegrave R. An examination of the psychological mechanisms..., P. 323.
37Heslegrave R. An examination of the psychological mechanisms..., P. 323.
Thus by the early 90s of XX century some thirteen theories have been proposed to explain why people react when they are deceptive, although none can yet account for all of the facts.38

The leading Israeli and Canadian specialists came to the similar conclusion: Ben-Shakhar G., Furedy J. stated, that “no single theory or single theoretical approach is capable of providing a full account for the data”39, observed in the course of polygraph tests carried out in real-life and experimental conditions.

II.

In the early XXI century the problem of natural scientific basis for lie detection psychophysiological method using polygraph has become especially vital in the USA. The attention to this problem was conditioned by the fact that Ministry of Energy which is responsible for nuclear power stations operation has taken the decision of applying polygraph screen tests so as to ensure security when working with human resources.

As per the ministry request and under the auspices of the National Academy of Science the Committee to Review the Scientific Evidence on the Polygraph (hereinafter – the Committee) has been formed; its name reflected the task assigned to the same.

After 19 months of work the Committee consisted of several dozens of scientists, who were not engaged in polygraph researches before, elaborated an extensive review of applicative and theoretical aspects of the modern technique of polygraph application in law enforcement practice. Inter alia this review paid great attention to “polygraph theories” and examination of contemporary approaches to the nature of processes in human psyche and body which enable detecting their lie.

Within the review the Committee specialists examined and analyzed the conflict theory, conditioned response theory, threat-punishment theory, arousal theory, dichotomization theory at the same time having combined the three last theories in an integrated group of the mental attitude theories.

In addition to those mentioned the review examined the orienting theory suggested by the Israeli researcher Kleiner M. as the general theoretical justification for polygraph testing. The Sokolov E.N. studies of orienting response, published in foreign scientific literature in the 60s last century41 have been put as the ground for orienting theory. Basing upon the definitions of “stimulus novelty” and “orienting response” Kleiner M. tried to explain difference between human response to control and test questions in the course of their testing using polygraph.

The significant achievement of the concept suggested by the Israeli scientist proved to be the fact that it introduced the definition of “significance of the stimulus” into theoretical constructions. This originality resulted in shift at test results evaluation from the definitions of “deception indicated” and “no deception indicated” to the definitions of “significant responding” and “no significant responding”.

39Ben-Shakhar G., Furedy J. Theories and applications ..., P. 113.
Meanwhile the Committee specialists did not agree to Kleiner M.\textsuperscript{43} opinion that orienting theory may serve as comprehensive natural scientific justification for polygraph tests technique.

First of all they paid attention to the fact that "the practice of previewing questions with examinees is problematic under orienting theory."\textsuperscript{43}

Second, proceeding from orienting theory the comparison questions should have been constructed in absolutely different manner: "instead of designing them to induce reactions in nondeceptive subjects, they would probably be designed to be nonnoevocative, as they are in the relevant-irrelevant technique."\textsuperscript{44} The Committee specialists in generally "do not take very seriously the argument that ... polygraph examination procedures based on comparison question technique can be justified in terms of orienting theory."\textsuperscript{45}

It is noteworthy to mention that carrying out review of "polygraph theories" the Committee specialists analyzed not all theoretical concepts available nowadays within global practice. In particular a very interesting theoretical concept of Polish polygraphologists which was named by its authors as \textit{memory traces identification} concept proved to be out of the Committee focus.

The Polish researchers basing upon the accumulated experience of polygraph tests came to the conclusion over twenty years ago, "that the American theory of detection of deception did not provide sufficient explanation for the physiological phenomena registered during the tests."\textsuperscript{46}

Throughout the next years the Polish researchers developed their own theoretical concept of human testing using polygraph. From their point of view such test "consists of four basic elements: 1. The character of this examination is to reproduce memory traces; 2. Examination procedure takes account of the principles used in psychological experiments; 3. The examination is a method of criminological identification; 4. The examination is aimed at retrieving information needed by law enforcement agencies. The above concept is based on the assumption of revealing memory traces of criminal offences."\textsuperscript{47}

Although this theoretical concept proceeding form the article published can not claim to be exhaustive one in nature, it is nevertheless noteworthy to point out the most important achievement by Polish researchers, as per our opinion, which was made by them by the opening of XXI century: it was for the first time directly stated in the foreign scientific literature on the issue of lie detection psychophysiological method that polygraph test carries out human memory examination aimed at revealing existence (or absence) of traces of events having criminal relevant meaning.

However let us come back to the review elaborated by the Committee specialists.

The analysis done by the Committee specialists lead them to the same conclusion Davis R.\textsuperscript{48} came to over 40 years ago: "it is possible that different theories are applicable in different situation. The dichotomization


\textsuperscript{44}The Polygraph and Lie Detection..., P. 77.

\textsuperscript{45}The Polygraph and Lie Detection..., P. 77.

\textsuperscript{46}The Polygraph and Lie Detection..., P. 77.

\textsuperscript{47}Krzyczak A. The Debate Over Polygraph in Poland // Polygraph. 2000. V. 29. № 3. P. 227.

\textsuperscript{48}Krzyczak A. The Debate Over Polygraph in Poland..., P. 227.

\textsuperscript{49}Davis R.C. Physiological responses...
and orienting theories, for instance, may be more applicable to tests in which the signal value of the stimulation is more pertinent than the threat of severe consequences of detection: for example, when an investigation is aimed at identifying witnesses with knowledge about an incident even if they are innocent. The conflict, set, punishment, and arousal theories, in contrast, may be more applicable for identifying individuals guilty of serious crimes or those hiding dangerous plans or associations. In 1973 Barland G. and Raskin D. stated "it is unfortunately that so little theoretically oriented research has been conducted during the past half century that the polygraph has been used as a "lie detector". Fortunately, this situation seems to be changing." In 1983, the experts, when performing under the US Congress assignment the analysis of situation in the field of polygraph application in various spheres of life of American society, came to the conclusion that in order to build the comprehensive "polygraph theory" it is necessary that "basic polygraph research should consider the latest research from the field of psychology, physiology, psychiatry, neuroscience and medicine."

20 years later - in 2003 - the Committee specialists had been also forced to state that "a solid theoretical base is necessary to have confidence in tests for the psychophysiological detection of deception... For the most part, polygraph research has focused on a few physiological responses for which measures have been available since at least the 1920s and tried to make the best of them by testing variations of them in practice, without doing nothing much to develop the underlying science... There has been no systematic effort to identify the best potential physiological indicators on theoretical grounds or to update theory on the basis of emerging knowledge in psychology or physiology."

The Committee to Review the Scientific Evidence on the Polygraph finally came to the conclusion that "the theoretical rationale for the polygraph is quite weak."

III.

The theoretical aspects of psychophysiological method of "lie detection" with use of polygraph draw attention of the scientists in the USSR for the first time in late 60s. Analysis of scientific and other information from overseas lead to the conclusion, that the "polygraph theories" existent at that period did not offer sufficient explanation of the nature of the phenomena observed in real and laboratory environment. In the light of the above it was proposed to examine the polygraph test process from the positions of informational theory of emotions proposed by the Academician Simonov P.V. in 1965.

According to informational theory of emotions there exist stable dependence of the psychic tension grade upon demand ratio and difference between required and available information. At the same time the emotion itself acts as "reflection by the human brain... of any actual demand (its quality and ratio) and probability (possibility) for its satisfaction evaluated by the brain basing upon... previously acquired individual experience."

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59 The Polygraph and Lie Detection..., P. 77.
60 Barland G.H., Raskin D.C. Detection of deception..., P. 471.
61 Scientific validity of polygraph testing..., P. 106.
62 The Polygraph and Lie Detection..., P. 92.
63 The Polygraph and Lie Detection..., P. 213.
Proceeding from the aforementioned point Simonov P.V. deduced the rule of emotions emerging which was expressed by the following structural formula:

\[ E = f [ - P, (I_n - I_0), ... ] \]

where: \( E \) - emotions, their grade, quality and sign;
\( P \) - power and quality of actual demand;
\( (I_n - I_0) \) - evaluation of probability (possibility) for satisfaction of the demand basing upon acquired experience;
\( I_n \) - information on the means which are predictively necessary to satisfy the demand;
\( I_0 \) - information on the means available with the subject at the moment\(^{57}\).

Simonov P.V. and Zanicheva A.A. formulated the first native concept of interrogation using polygraph by 1970\(^{58}\).

According to the concept, the need to conceal the information known to the person under examination and not to manifest their selective attitude to a particular fact or event (be it a criminal offense or the card chosen in the course of game/stimulating test) is the direct goal of the person being examined.

It was presumed thereat that the person under examination was not confident in their opportunities and did not know what happened to their physiological measures evaluated by the polygrapher when registering reactions. This causes deficit of pragmatic information for the person examined and leads to emerging of spontaneous emotional reactions accompanied by changes in physiological functions dynamics.

Basing on demand category the theoretical concept gave rather sufficient psychological explanation of human opportunities with use of polygraph, first of all in the field and laboratory environment and secondly in the cases when the verbal replies were not required from the examined person.

Progressiveness of the aforementioned concept lied in the fact that informational theory of emotions being its fundament was first to point out principally new - neurophysiological - approach to studying “lie detection” method psychophysiological mechanisms and named basic brain structures (neocortex, hippocampus, amygdale) that participate in genesis of the reactions registered in the course of interrogation using polygraph.

The theoretical concept proposed by Simonov P.V. and Zanicheva A.A. along with the advantages mentioned above was not recognized as comprehensive as it was not in a position to give explanation to the number of the facts observed during IUP. It is particularly difficult to explain existence with the same person of virtually same physiological reactions at presenting test questions in the course of real or game like examination (when a card is to be guessed), although the needs of the examined person to conceal their awareness of these facts – signs of criminal act or the card chosen – would be definitely different.

After the specialized laboratory for IUP had been established in summer 1975 in the USSR the natural science grounding of permissibility to use the device for the purposes of detecting from the human the information concealed by them has gained its relevance as well.

The scientists and specialists pointed their attention to the fact that “polygraph theories” being formed by the early 80-s of the last century had the notional, descriptive nature and thus were not able to serve as the solid basis for fundamental scientific studies of the phenomenology of obtaining information from a human with use of polygraph.

The analysis of foreign “polygraph theories” and Simonov-Zanicheva concept demonstrated that their formation would follow basically the same scheme: first a thesis, formulated on the basis of empiric observations (threatening punishment theory,
as an example) or scientifically established statements (conditioned reflex theory, as an example), was declared and then to confirm the thesis the facts from real or experimental (laboratory) practice of "lie detection" psychophysiological method application were selected.

Finally there was made a conclusion that such an approach was deadlock: it was not possible to offer theoretical grounding for psychophysiological method which is a polygraph interrogation method, by selecting one or another hypothesis basing upon the physiology data available without summarizing huge number of experimental data accumulated by psychophysiology and neurophysiology. It is possible to form the integrated theory capable of explaining set of facts stably observed at IUP of a human only in consequence to research of psychological phenomena in their correlation to the brain neurophysiologic activity mechanisms.

Emotions - the special class of mental processes and statuses, related to demands and motives, reflecting in the form of direct experiences the significance of particular situations for a human providing influence on the same in the course of their vital activity - are the psychological "center" of the threatening punishment theory\(^\text{39}\) and starting point for Simonov-Zanicheva theoretical concept.

Psychological science has established long ago that emotions reflect human's evaluative attitude to the situations, being formed or being possible, to their activity and/or to their expressions\(^\text{50}\) in these situations.

Carrying out IUP of a person with the purpose of revealing concealed information from them takes place always at certain psychological tension. As per the opinion of the persons both committed criminal act and groundlessly suspected, the IUP procedure proved for them to be always subjectively significant and emotionally saturated. Exactly this forced researchers to adhere the determining role to emotions at forming "polygraph theories".

Without any sign of denying existence of emotional component in the current state of a human exposed to polygraph interrogation Russian specialists approached to analysis of what is going on from somewhat different positions back a quarter of a century ago.

At explanation of the essence of polygraph interrogation the foreign specialists would provide more or less detailed description of the procedure and there could be given a number of examples to this effect. However it could have not been possible to get formalized definition of the phenomenon forming the ground of the method in any foreign study of polygraph issue. At the same time the clear definition of the phenomenon forming the fundament being the basis of polygraph interrogation technique and which, according to the American scientists "is probably a fundamental paradigm for psychophysiology"\(^\text{61}\), is obviously necessary from the theoretical, methodical and particularly practical point of view.

The analysis of concealed information technique test (that is guilty knowledge test and peak of tension test) approaches undertaken by the Russian specialists in the late 70s - early 80s allowed suggesting hypothesis on existence of a certain unified phenomenon being the basis of this and other polygraph testing techniques. The conditional


\(^{50}\)Great attention is paid to emotions studies in contemporary psychological science. Detailed examination of various emotions psychology aspects stays beyond the subject of this study. Only thoroughly studied and experimentally grounded statements and only to the extend necessary for research of polygraph examination analysis technique will be used for further presentation of the material and discussing the particular issues of emotions psychology, psychological processes, statuses and functions.

working name “psychophysiological phenomenon” was given to this phenomenon for its convenient application in future.

**Psychophysiological Phenomenon** - if described from the point of view of IUP technology - consists in the fact that external stimuli (a word, a thing, a photo, and so forth) bearing for a human significant information, in particular situation, on the event infixed in their memory, stably generates the physiologic reaction exceeding reaction towards associated (homogeneous) stimuli presented under the same conditions but not related to the aforementioned event and bearing no significant information for the human.

The suggested definition of Psychophysiological Phenomenon proved to be practically useful and productive from the methodological point of view. However appearance of this definition gave rise to at least two questions.

First - could this definition be considered as universal one?

Second - does this definition grasp in full the phenomenon it is meant to describe?

In order to reply the aforementioned questions the analysis of studies in the filed of experimental and applied psychophysiology was undertaken which allowed establishing that Psychophysiological Phenomenon in the way it was formulated was not a “private property” of IUP and was observed not only in course of testing a human with polygraph, but under some other methodical conditions as well.

First, Psychophysiological Phenomenon is stably observed in course of operator profession persons activity (flight dispatchers, radar station operators and so forth) at fulfilling the tasks on detection, identification and classification of targets, objects, etc. Psychophysiological Phenomenon, realized in such conditions, is rather thoroughly studied in engineering psychology and the researches outcomes have been provided in the studies of the scientists of the Institute of Psychology of Russian Academy of Science. It may be noted in general that Psychophysiological Phenomenon functioning in the course of human testing using polygraph does not differ much methodically from its (Psychophysiological Phenomenon) manifestations in the conditions of operator work.

Second, Psychophysiological Phenomenon may be observed in the conditions of subliminal perception when human’s psyche is being tested by subjectively significant for them but unconscious stimuli.

The researches have shown that “subliminal effect of emotional word consists in the fact that change of vegetative functions ... has been registered before the person tested could read the same” The essence of this phenomenon consisted in the fact that “weak sensor stimuli may generate activation of

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62 Mitrichev V.S. and Khodolny Yu.I. Polygraph as a tool...

63 The concept of “psychophysiological phenomenon” was suggested by Azayov Yu.K. in the 80s last century and at first the Psychophysiological Phenomenon definition mentioned “the events, infixed in human consciousness”. However theoretical analysis of Psychophysiological Phenomenon functioning in different methodical conditions, brief presentation of which will be provided below, has given the ground for the author of this article to introduce clarification into the definition of Psychophysiological Phenomenon: it shall be referred to “events infixed in human memory”.

64 Methods of Psychic Statuses Diagnostics and of Human Activities Analysis / Under general editorship of Dikaya L.G. M: IP RAN (Institute of Psychology, RAS), 1994. 206 p.; etc

65 Coconscious perception is the “form of direct psychic reflection of reality, conditioned by the stimulants on whose influence a subject may not report to themselves” (Psychology. Dictionary. M.: Publishing House for Political Literature, 1990 P. 388-389), or whose influence they do not realize.

cortical neurons (which render control signal for occurrence of changes in vegetative functions — Yu.Kh.), but space-temporal parameters of this excitement are not enough for a stimuli to be created"67. The examples of multi-channel registration of Psychological Phenomenon in such conditions are widely presented in the studies performed in the 70s-80s of the XX century under the guidance of Kostandov E.A.68.

In the late 70s the phenomenon of coconscious perception was studied by Russian specialists from the “lie detection” psychophysiological method position. Particularly guilty knowledge test was realized at subliminal level using tachistoscope69 in the experimental study (in which the author of this article participated). The experiments demonstrated that the tested person selected one of 5-6 double-digit figures in the number sequence suggested and concealing this figure from the examiner as per the instruction received did not manage to view any of them on the screen. This was confirmed with interrogation of the tested person after the experiment was over. At the same time the physiologic reactions registered using polygraph allowed to observe rather stably in the course of the experiment the figure the tested person was concealing within the sequence examined.

However of greatest interest with respect to research of the mechanisms being the ground for detection of the concealed information from a human in the course of its testing using polygraph is the form of Psychophysiological Phenomenon realization in conditions of sleeping70. Over forty years ago American researchers stated that “it clearly demonstrated that sleeping subjects can make complex discrimination between repetitive auditory stimuli. They can for instance discriminate between meaningful words” and “if the stimuli are personally significant, corticofugal signals to the brainstem may evoke, in turn, arousal signs which may be electro-encephalographic, autonomic, or behavioral”71.

In the late 70s the phenomenon of coconscious perception under conditions of sleeping was modeled by the specialists engaged in studies of polygraph interrogation psychophysiological mechanisms. In course of the experimental study (in which the author of this article participated) the tested person being in the second stage of slow wave sleep was presented with the stimuli being of higher significance for this subject in wakeful state along with the neutral stimuli (as per polygraph interrogation technique). Thereat all demonstrations of “excitement” described by the American researches were observed, including Psychophysiological Phenomenon which was being registered rather stably. It was quite impressive to observe the way the tested person was sleeping and was not realizing the words or word combinations played from a tape-recorder (and it was confirmed with interrogation of the tested person upon their waking up), when the changes in dynamics of breathing and in cardiovascular system signaled subjective significance for the sleeping subject of the certain semantic stimulus perceived by their brain. In particular any sleeping human at this stage of sleep manifests reactions to their own name or to the name of any event, fact that are quite significant in the current timespan of their life.


69Intensity and length of double-digit figures demonstration by tachistoscope on the screen were gradually diminished and selected in the way the tested person was unable to identify the value of the figures although they have seen some flare on the screen.


13 Polygraph, 2006, 35(1)
The above listed four variants of Psychophysiological Phenomenon realization in different methodological conditions (IUP, operator activity, subliminal perception and subliminal perception in the state of sleep) demonstrated that the definition of this phenomenon suggested above was true and allowed stating at least three important conclusions.

First, indeed the universal neurophysiologic mechanism forms the ground of Psychophysiological Phenomenon and stably functions regardless substantially different methodical conditions and modality of the stimuli perceived. In the light of this the position of P. Davis was recognized as prospectless (which was supported in particular by the specialists of the Committee for studying scientific relevance of polygraph in the early XXI) according to which various theories were applicable in various situations. Psychophysiological Phenomenon is an objective reality, "fundamental mechanism of psychophysiology" of humans. And Psychophysiological Phenomenon therefore shall have the single theoretical justification and explanation of its mechanisms may not be dependent upon one or another technique applied during IUP.

Second, Psychophysiological Phenomenon realization at unconscious perception (both in the state of sleep and wakeful state) proves that its neurophysiologic mechanism does not depend upon human consciousness, it operates autonomously, aside from will and desire of a human being. The second conclusion lead to the important inference: if Psychophysiological Phenomenon gives rise to a stronger physiologic reaction towards one of the stimuli under the conditions of unconscious perception then some specific feature is inherent to this stimulus. Significance of the stimuli is such feature which in the 70s-80s of the last century did not attract due attention: it determines relevance of the information contained in the stimuli to the sense of the task decided by a human in particular situation.

External stimuli are ranged by the level of their subjective significance for each human. It happens supraliminally in wakeful state. A human reacts unconsciously towards the stimuli significant for them at subliminal perception or during sleep. Such reaction proves that when there happens no realization of stimuli, psyche keeps classifying the stimuli perceived externally according to their subjective significance (for the current moment in the human life).

Finally, third, Psychophysiological Phenomenon realization under the conditions of unconscious perception in the wakeful or sleep state (that is when the perceived stimuli are not recognized) lead to a thought that the decisive role in the mechanism of its realization may be played not by human emotions (which can not arise under the conditions mentioned above in principle) but by their memory.

Indeed, in the circumstances mentioned some stimuli bear information on some event which is of subjective significance for a human: such stimuli would certainly be perceived and evaluated by human psyche aside from their desire and will. This process will be accompanied by expressive physiological reactions of the body which will be observable during IUP. If the stimulus perceived in the same conditions is subjectively insignificant for a human the reaction to such stimuli will not have stable and expressive character. Concealed information technique is based, in particular, on the principle specified.

The important advantage of concealed information technique is the fact that it serves as "incorporate an extremely effective safeguard against false positive errors - the innocent person cannot determine which question is the critical question (that is a relevant question - Yu.Kh.), and therefore cannot consistently react to it regardless of how nervous or fearful he is".

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72 Davis R.C. Physiological responses...

Basing upon the own experimental researches described above, the data on identified by that period brain structures, involved in genesis of emotional statuses and memory and results of the studies in the field of neurophysiology, obtained by the mid 80s, the author of the present article attempted for the first time in the Russian science to explore neurophysiologic mechanisms of Psychophysiological Phenomenon realization.

The researches conducted those years demonstrated that “if in the previous experience of the system the stimuli concerned (or same one) coincided with a certain biologically important activity, there happened activation of memory traces with transfer of excitement to the subcortical centers of emotions and motivations correspondent to the activity concerned. All these stages of stimuli information processing seem to be obvious... The association cortex, secondary and tertiary areas of this analyzer and hippocampus structures take part in it”. When studying possible neurophysiologic mechanisms of Psychophysiological Phenomenon the attention was paid to the fact that amygdale is closely tied with hippocampus and these two structures participate together in organization of various forms of emotional behavior.

The researches allowed to get to the hypothesis that amygdale plays specific role in Psychophysiological Phenomenon realization under the conditions of testing human during IUP. Scientific data demonstrated in particular that “amygdale plays an important if not a major role in evaluating such feature of signals as emotiveness. Marking the coming signals on the basis of the past experience the amygdale forms hierarchic relations in the signals flow... Participation of amygdaloid complex in the memory processes may consist in regulation of the flow of the signals forwarded for fixation and preservation... The comprehensive signal formed with its participation proves to be significantly more resistant to interfering influence of the similar ones because it possesses additional parameter – significance realized in neuron signals”. Thus, proceeding from the outcomes of the theoretical and experimental researches conducted, the author of this article suggested in 1987 the theoretical concept of purposeful memory examination, which gave explanation to the mechanisms forming the ground of revealing information from human in the course of IUP.

IV.

Memory plays fundamental role in the mechanisms of “lie detection” psychophysiological method, and many facts point to this. Starting from the first described experiment of “lie detection” with use of laboratory devices, performed by C. Lombroso in the late XIX century, polygraph test practice pushed the researchers to the analysis of the role the memory plays in this psychophysiological method technique. However instead of this, the researchers would focus on emotional tension state of a human when he was in the situation of polygraph testing. Such an approach would bring up emotions of the tested person as the most important psychophysiological component, pushing their memory aside.


78When testing some Tosetti suspected in a murder of a six-year old girl C. Lombroso "adopted the plethysmograph and found a slight diminution of the pulse when Tosetti was set to do a sum; when, however, skulls and portraits of children covered with wounds were placed before him, the line registered showed no sudden variation, not even at the sight of the little victim's photograph. The results of the foregoing examination proved conclusively that Tosetti was innocent of a crime" (quoted from Travilla P. V. A history of lie detection // J. of Criminal Law and Criminology. 1939. V. 29. N. 6. P. 863).
The results of the researches by Voronin L.G. and Konовалов V.F. serve as strong argument to the fact that memory is a leading psychological function at revealing from a human using psychophysiological method the information which may be concealed; they applied elements of polygraph testing technique in the experiments when studying the mechanisms of memory functioning in the early 70s of last century.

When explaining selection of actually prohibited in that time “lie detection” method as a research tool the scientists pointed that “any technique is perspective if using the same one can manage to discover changes of vegetative and other reactions arising at emerging, preservation and interaction of affective afterimage”79 in human memory. Voronin L.G. and Konовалов V.F. came to the conclusion that “traces of stimulation discoverable through electrosensitive reactions are neurophysiologic basis of memory... For long-term memory ... [these reactions – Yu.Kh.] accompany the process of retrieval of information from memory”80. When applying ECG, EEG, galvanic skin reaction and other electrophysiological research methods for memory mechanisms examination, the scientists discovered that “if strong excitement of signal systems emerges, irradiating emotional sphere of brain activity, the same will find its reflection in electrographic components (for example, in GSR). This is especially expressively manifested if emotions along with signal systems create the specific state which is usually called concern”81.

Criminalistics science has been leading to understanding that memory plays an important role in polygraph interrogation mechanisms. It is known that criminalistics faces two classes of traces during investigations of crime - materially fixed traces and afterimages (that is “ideal traces”, “prints” of the crime event), infixed in human memory.

As mentioned above, Polish criminalists came to the same point of view after the Russian specialists and independently. The opinion that during IUP examination of events traces preserved in human memory is carried out became apparently common in polish criminalistics in the mid 90s. The Polish researchers82, having truthfully determined memory as fundamental basis of polygraph interrogation unfortunately adjoined “ideal traces” kept in memory to the emotions having thus obtained modified threat-of-punishment theory as a result.

Memory is the form of mental reflection of reality consisting in infixing, preservation and further reproduction of human experience by the same. Connecting past with the present and future, memory is the most important cognitive function of human, forming the ground for their development and education. Contemporary psychophysiological science understands totality of memory systems by the function of “memory”: long-term and short-term memory, procedural and declarative memory (where the latter is divided into episodic and semantic one), etc.

Now, nineteen years after, it is possible to admit that the suggested hypothesis on the role of amygdale in neurophysiologic mechanisms of Psychophysiological Phenomenon proved to be correct. As the further researches demonstrated, participation of namely this structure “ensures formation of stably and durably preserved traces of emotional memory” rapid and firm infixed of emotional events in memory83, due to which “emotional memory trace is not erasable and subject to amnesia”84.

80Voronin L.G. and Konovalov V.F Electrographic Trace Processes ..., P. 145.
81Same as above, P. 102.
84Amygdaloid Complex ... P. 175
Polygraph application practice confirms accuracy of the scientific data obtained: in the course of real polygraph interrogations it proved to be possible to reveal from human the afterimages of higher significance (preserved in emotional memory) events backed in past by 15-20 years.

M. Kleiner, when developing the oriented “polygraph theory” mentioned above went farther than Polish polygraphologists: he was studying correlation between emotions and memory in course of polygraph interrogation and correlation between test and control questions in particular. When examining the place of memory in polygraph interrogation technique the Israeli polygraphologist applied analysis of neuron mechanisms of the function and also discovered important role of amygdale in formation of affected memory traces. Proceeding from the different scientific positions Kleiner M. finally came to assertions close to those stated by the native scientists in late 80s.

Thus many direct and indirect data obtained by the researchers during the last 20-25 years unambiguously testify - memory is the fundamental psychic function subject to examination by “lie detection” psychophysiological method using polygraph.

The purposeful memory examination theory, developed in the Russian polygraphologist school, consists in the fact that during testing with polygraph the afterimages of events kept in memory of a human, may be intentionally actualized using the aim set and then detected through registered physiologic reactions as they arise in response to stimuli presented to them (human being) specially selected and grouped.

From the positions of task-oriented memory test theory many phenomena empirically observed in course of polygraph interrogation may be successfully explained. For example with the help of the theory the following becomes clear:

- high effectiveness of polygraph testing in laboratory environment (which was difficult to explain from the positions of threat-of-punishment theory) and intensity of registered reactions in the cases when the tested person did not know about registration carried out (which is also not explainable from the point of view of the function of “threat-of-punishment avoidance”);

- reason for intensity of reactions registered in the course of silent test (which was not understandable from the point of view of conflict theory) or in laboratory environment (where the conditioned reflex theory “stumbled”);

- nature of “activating power” of stimuli presented during polygraph testing which under the influence of the aim set examine activated afterimages of human memory (the activation theory was unable to point what and where is activated in human mind and brain);

- necessity of prior discussion of the questions with the tested person before presenting them during polygraph testing which contradicted postulates of the orientation theory and the number of other facts.

Thus the theoretical concept of task-oriented memory test theory, according to our opinion forms solid basis for sufficiently clear explanation and acceptable natural scientific grounding of mechanisms ensuring accuracy of information obtained from a human in consequence to the polygraph test of the same.

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85Kleiner M. Physiological detection of deception ..., P. 147-149.
86This assertion shall not be understood as denying the role of psychologically important components of current state of a human at IUP (emotions, attention, set, etc.). The issues of participation and influence of certain psychic processes will be examined in next articles.
References


Interrogation Using Polygraph and its Scientific Basis


