EXPERIMENTAL TEST OF THE POSSIBILITY OF DEVELOPING AND USING A SEMANTIC DRIVER

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It is well known that many correlations have been discovered between the memory processes and the behavioral, physiological, and neurochemical processes. Researchers can be largely divided into three camps: advocates of the neurochemical concepts of memory (data on the post-translational protein modification during the memory consolidation and on the participation of epidindimine and other brain-specific proteins in this process are presented in review [41]); advocates of the psychological [2] and physiological [21] approaches who study memory as a "black box" based on the stimulus-response principle; and synthesizers who are attempting to combine these two dominant methodologies. In the latter's opinion, "...matter and brain on the one side and the abstract and thought on the other relate to each other by means of functional (physiological-biochemical) reorderings of this matter)" [4, p. 881].

"The behavioral specifics of the engram are undoubtedly transchemical and can be adequately explained, e.g., by the spatial organization of the neuroglial complex formed during the learning process" [7, p. 985]. These words can explain the low efficiency of the attempts to construct a conceptual model of memory on the basis of local actions on individual brain segments or introduction of various arbitrary chemical substances. Such approaches to memory research are inevitably limited to describing individual phenomena rather than the entire system as a whole. This is best illustrated by the absence of acceptance methods of memory modification, except for the methods related to learning.

If memory is understood as a set of all behavioral, physiological, and genetic programs, the need for an integrated information approach to the study of living systems becomes obvious. In this case, it becomes necessary to develop the means of affecting the entire system as a whole rather than its individual subsystems. In practice, however, medicine has accumulated a vast quantity of methods and means of correcting violations either in subsystems or in their individual elements yet there are still no sufficient possibilities for employing the autocorrection capabilities explicitly present in the organism. Available methods of increasing the general adaptation properties of the organism--medicinal and non-medicinal adaptogens, various psychotechnics, etc.--are good yet it is often necessary also to use local stimulation. For example, gastrectomy is often performed in the case of stomach ulcer yet the psychological discomfort accompanying this disease inevitably leads to the appearance of other psychosomatic disorders after such treatment. The spiral coils are sown into people suffering with chronic alcoholism and, for the time being, they stop drinking yet often continue to suffer either from an undetected or untreated affective complex. And there are many more such examples.

Under the conditions of today's information stress and a rising volume of psychosocial dissonances, the need has arisen in being able accurately to stimulate the autocorrection capabilities available in the organism. In most cases, it would be preferable not to resort to any exogenic (chemical and physical) factors for this purpose in addition to the customary natural factors so as to avoid the habitual iatrogeny, addiction, side effects, etc. Access to higher control system hierarchies--the psychic sphere--always meets these conditions but calls for an individually oriented and unique activity on the part of the physician which, in a perfect case, should be similar to the creative inspiration in art.

In order to see common features in known yet disjointed facts and understand the relationship between them and thus employ these and new facts deliberately rather than randomly and thus optimally, it is necessary to introduce logic into the existing agglomeration of knowledge about mental activity.

Let us consider a simple memory organization model. To this end, let us represent man as a complex transient self-organizing system capable of procreating and possessing the maximum possible number of degrees of freedom in his functions in living nature. The most important among these functions are the capability of self-programming and adaptive reprogramming as well as the ability to organize interfaces for the data input and output and to connect peripheral devices (tools and auxiliary input/output devices). This system cannot be fully described by the totality of its component subsystems which are partially known, primarily due to the fact that it is open, i.e., constantly interacts with the environment and cannot be considered separately from it. For the description convenience, cybernetic models [25] are often used although we should note that the approaches used in this case differ in the extreme. Thus, the processes of forming conscious acts are likened to the quantum mechanical behavior of electrons in a solid, and brain is considered as a sum of complex networks with a variable degree of internal relationships [57] or, conversely, the validity of similarities between the human brain and the computer is being sternly refuted [56]. In our opinion, since computers are a product of human creative activity, it is permissible to treat them as a model of personality with limited functions. It will become evident from the subsequent presentation that the goals formulated in this article also make it possible to make a reverse--generalized--description of the structure of personality with the help of cybernetic constructions and computer technology.

A version of a system which illustrates at least a three-dimensional model of the personality structure is shown in Fig. 1. It is clear that there is an infinite diversity of models yet there is no need for a more complicated model for this study. The decision-making device (the processor) is a random access memory consisting of the monitor memory and buffer memory. The processor has either direct or mediated connections to other modules and contains data and programs of the most likely behavior and emergency life support as well as a system of programs for the orientation and research activity. There is a periodic exchange with the read-only memory (long-term memory) in which data files are formatted with the help of the burner and programs are formed. The priority generator which has a counter for the number of incidents of behavior consistent with a situation where a certain routine is being executed, allowing for the *a priori* probability, assigns the highest priority to the routines which ensure the maximum adaptation to the changing environment. When the value of the program priority comprised of the number of its realizations with successful or unsuccessful outcomes exceeds a certain critical number, this routine is rewritten into the data bank for permanent storage and is not subject to correction. Access to this memory area under intact conditions is impossible. Only the routines which are at the stage of exchange between the buffer memory in the processor and the long-term memory are subject to correction. It is assumed that this occurs as block-by-block rewriting from the long-term memory into RAM during the slow-wave sleep [8] and, conversely, with a program correction during the paradoxical sleep [19]. Programs whose realization is enabled are stored in the RAM buffer which, togeth-

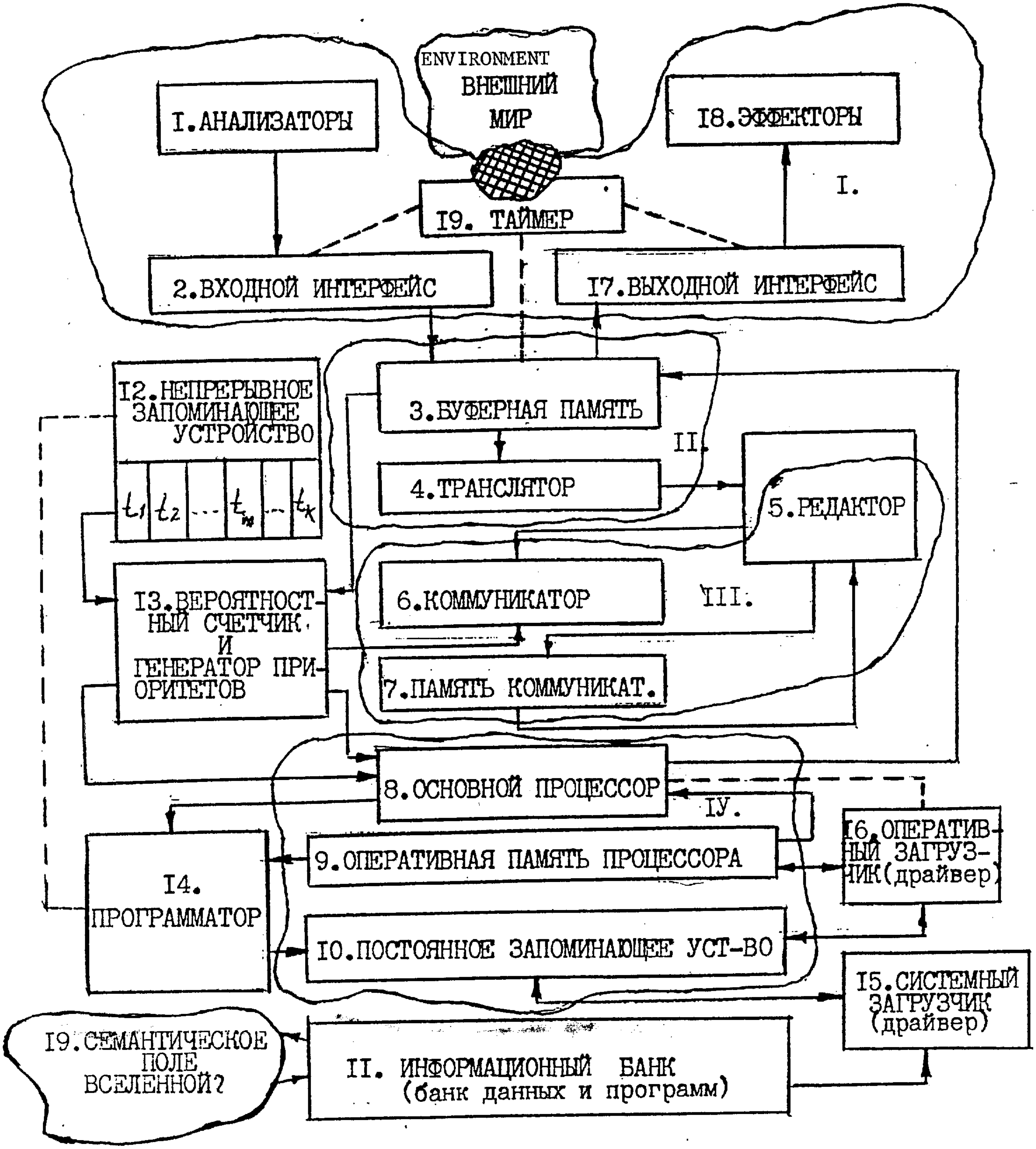

Fig. 1. Conceptual Cybernetic Model of Functional Human Memory Device. Key: I--Iconic memory; II--Short-term memory; III--Conscious; IV--Subconscious; 1--Analyzer; 2--Input interface; 3--Buffer storage; 4--Translator; 5--Editor; 6--Communicator; 7--Communicator memory; 8--Central processor; 9--Processor RAM; 10--ROM; 11--Data bank (data and program bank); 12--Contiguous storage device; 13--Probability counter and priority generator; 14--PROM burner; 15--System loader (driver); 16--On-line loader (driver); 17--Output interface; 18--Effectors; 19--Timer [top center]; 19--Semantic field of the universe [bottom left].

er with the long-term memory and the data bank, assists in the sphere of subconscious mental activity. A part of the processor (the monitor memory) and the monitor itself as a communication device make up the consciousness sphere. In addition, the system contains the input/output devices with semantic interfaces a part of whose structure is combined with a part of the short-term memory (input and output register) into the iconic memory. Among other structures necessary for describing the model, we should note the editor which is intended for analyzing the semantic codes to see whether they correspond to those permitted for input/output, a contiguous memory which stores the nonformatted information increases in time layer by layer, and the driver which performs the functions of loading data and standard (corrected) programs into the data bank.

Even without a detailed description of the functioning of its individual structures, this model makes it possible to illustrate how memory is transferred from a short-term stack to RAM by means of successive learning, i.e., multiple execution of the memory engram (program) with subsequent transfer to long-term storage and eventually, to absolute standard memory (data bank). The latter also contains all genetic life support programs.

It is obvious that disruptions in the state and behavior (diseases) may be a result of incorrect operation of any of the structures (except for certain infectious diseases or damage due to an injury). In this case, a search for the means of correcting the control systems rather than the local manifestations of these violations is justified. If we extend the use of the information approach to describing the personality structure, such facilities should then be exceptionally informative, i.e., being effective not only due to and not so much by means of its physical origin as due to its semantic organization. Under natural conditions, one can encounter several layers of semantic organization: from the simplest, in the form of, e.g., a certain combination of geoelectromagnetic field parameters which indicate an impending natural catastrophe [26] to the most complicated verbal signals. The presence of the decoder (the editor code which identifies the signal and assigns to it a corresponding number--is common to complex-organized signals of any physical nature, making it possible to refer to them as semantic, after which the semantic signal translated into autocodes is forwarded for processing and incorporated in associative processes. It is obvious that the semantic nature of any random signal, e.g., an arbitrary set of phonemes, is formed only when it is presented more than once (except for the instinctive behavior signals whose corresponding autocodes are genetically determined). Consequently, in order to impart meaning to any sequence of signals, no matter how complex, it is necessary to present it for the second time in combination with the context data (learning). As the long-term storage area is being filled during the development of an individual, his ability for learning decreases. Then, engram consolidation calls either for a greater number of signal presentations or for imparting greater significance in the context information, i.e., enhancing the emotional resonance. Here, emotions play the role of the communicative monitor signals which indicate the significance level of the signal or the engram being reaized for the individual and as an accounting parameter for the counter which determines the information or program priority number.

any of a small set of basic units of sound, different for each language, by which utterances are represented

Thus, an extended program correction or generation process is necessary for modifying the behavior or state under natural conditions; Ebbinghaus devoted his efforts to early studies of this process. In the case of a pathological condition, correction of the control system disruptions also calls for an equally long process if it is possible altogether. Given a single signal presentation, orientation-research activity programs are activated depending on the degree of its

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novelty and the semantic driver is organized after subsequent presentations; this driver loads the program already formed in the long-term memory into the data bank. As we have already mentioned, the speed of this process changes substantially depending on the priority. If the program is formed and its standard is available in the data bank, its source code present in the random access memory is periodically compared to its matrix stored in the long-term memory which enables constant autocorrection of the program due to the influx of sensory data on the program realization outcome. A review of experimental studies [54] provides extensive information indicating that after intensive learning, the number of paradoxical sleep events and the duration of each such event increase substantially even after several hours following the learning process and decrease gradually during many days. Paradoxical sleep deprivation causes a considerable delay in the habit formation speed. Based on these facts, many authors maintain that transition of new information from the short-term to the long-term memory actually occurs during the paradoxical sleep [31] although one can find experimental proof that this conclusion is incorrect [54]. We know with certainty only that paradoxical sleep is vitally necessary and its deprivation leads to a catastrophe [52]. The relationship between the sleep deficit or disorder and the development of chronic mental disorders is well known [27]. A factor analysis of the patients' reports about their dreams demonstrates that the possibility of even conscious autocorrection of information during the controlled dreaming is realistic [45]. In the opinion of Yu.S. Borodkin and P.D. Shabanov, "consolidation of the persistence of memory [imprint] as a process of transition from short-term memory to the long-term memory presupposes transformation of the neurodynamic changes (possibly, circulation of nerve pulses in closed nerve circles) into stable neurochemical reorderings of the synaptic apparatus involving the neuron genome. One of the most important properties of consolidation is postulation of a certain end time interval during which data are transferred from short-term to long-term memory. It depends on the learning method and varies from seconds to hours and even weeks. Individual periods of the consolidation process are probably not equivalent. The most important (and, consequently, the most vulnerable) are the initial triggering stages which are carried out during the very learning procedure while the least significant (least vulnerable) are the end processes (translation of specific proteins, their exchange, etc." [9, p. 10]. It is generally assumed that any stimulation of the engram during the consolidation which damages [9] or interferes with it [9] leads to an irreversible change in the engram. Obviously, there can be many such actions: semantic interference, concussion, powerful stresses, etc., and if it had not been for the possibility of constant autocorrection of the program, the life of the individual would terminate.

The autocorrection process is very slow and it sometimes lags far behind available needs for adaptation. The facilities available in medicine are stochastic in orientation and hit the target far from always even if it is known precisely.

The simplified model of memory structure presented here makes it possible to hypothesize about the possibility of developing an artificial semantic driver whose functions are reduced to supplying the correcting information directly to the damaged information area. Under natural conditions, there is such a possibility (imprinting); furthermore, it is employed spontaneously, albeit in a fragmentary nature, in some psychotherapy procedures (catharsis).

Imprinting as a phenomenon of imprinting information after its single presentation was identified for the first time by Lorenz as an individual special psychic act; to this end, he examined known information about the movement of chicks just hatched from eggs after any moving object. We can assume that the possibility of imprinting decreases rapidly with the development of the organism [33] which is due to the biological necessity of concentrating the learning ability during those organism development periods when the role of the acquired habit is optimal [47]. Ethological-physiological-biochemical studies make it possible to speculate that the nervous mechanisms of imprinting are due to the right intermediate area of the ventral hyperstriatum whereas the contralateral area performs the function of translating the imprinting information into a certain unidentified brain structure [43]. It has been established that a significant difference in the distribution character of synaptosomic proteins in the forebrain from that under conventional conditioned reflex learning is observed during imprinting [23]. The reality of quick formation of fixed neurochemical memory codes during imprinting has confirmed the possibility of reproducing imprinting in recipient chicks during the intra-abdominal injection of homogenates of donor chick brain [34]. This is possible only during the first three weeks of development since during this period, macromolecules can penetrate the brain even through the not-yet-formed hematoencephalic barrier. The authors stress that imprinting can be realized only during the sensitive period which for chicks, is equal to 32-36 h after hatching and can be easily traced by the low pitch sound emitted by the chicks. At the end of this period, an avoidance reaction develops which is accompanied by distress tones, i.e., the sounds of displeasure. It is thought that the amygdaloid complex plays an important role in forming the persistence of memory during single-session learning [22] and it is stressed that the engram activation largely depends on the contextual (emotionally tinted) information available during the presentation of the stimulus being imprinted. It is important to note the difficulty of studying such engrams since they may modify insignificantly yet very stably in time the behavioral patterns of humans and animals and have no crude noticeable manifestations in individual programs [55]. The latter can be attributed to the fact that the researchers do not have an adequate logic approach to the imprinting research methodology.

An analysis of available data shows that the following is necessary for realizing the imprinting:

- a relative sensory deprivation of the individual (in the literal sense, the chick's stay in the egg);

- a high semantic information gradient (i.e., the degree of its novelty relative to the preceding experiment information which for the chick is literally reduced to the medium volume bounded by nontransparent walls); and

- a high degree of stress (which is probably characterized by being similar to a daze after information shock).

One can clearly see that simple mixing of these factors will by no means facilitate the imprinting of information, so these are identified only for didactic purposes for the sake of understanding subsequent text. In addition to this factor, the absence of any kind of external information editing at the moment of imprinting is extremely important since the system for comparing the memory codes to the external information codes has not yet been formed. As the memory is being loaded, the correspondence codes will form in the editor and will play the role of identifying the external stimulus and, according to the previous experience, initiate various behavioral programs. Any new stimulus which does not have the corresponding codes (i.e., for which there is no similar image in the memory)

does he bypass the reticular formation?

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initiates programs of the orientation-research activity as the result of whose actions the identifying codes form in the editor.

In humans, eyeball movement following the moving object is observed during the early days of their lives yet the rapidly forming editor soon makes it possible to perform selective orientation of the information input/output systems for perceiving the stimulus with the maximum novelty gradient relative to the context. At the same time, the extensively developing associative relationship system attributes any new stimulus to a constantly increasing number of memory cells, and it is classified as being partially known. As the personality develops, this leads to a gradual decrease in the ability to learn. We can speculate that the early arrays of information entering the brain subsequently serve as a peculiar reference point and format all subsequent information so that it only complements the internal model of the world on the same scale rather than alters it. Attempts to teach social skills to Amal, Camal, *et al.* have been virtually unsuccessful due to the fact that the proposed information was so inconsistent with the image of the world stored in the memory that the editor could not transmit it for organizing new memory cells, while a large number of information presentations in combination with various biological reinforcements would be necessary both for organizing new memory cells and the corresponding codes. This has been partially studied in animals yet only humans have such a highly developed associative system which ensures the highest ability to learn in the animal world. Yet the editor orients any semantic information, including verbal, toward those memory areas where only gradual program correction (learning) is possible, rather than an instantaneous program change (imprinting). The latter is also impossible due to the fact that all arbitrarily changing random access and long-term memory programs do not change the standard matrices stored in the bank which are not subject to correction. While the learning process has been rather well described and is well known even for humans without the cortex [42] and in lower forms of life, the imprinting phenomenon remains unclear.

One can speculate that imprinting is a process where new standard matrices are formed as a result of which the long-term memory is allowed to form and correct their working analogues to whose cells the editor addresses the new external information.

In N.P. Bekhtereva's opinion [5], imprinting is possible under direct electric stimulation of brain segments; she cites references to studies demonstrating that imprinting is possible not only at early ontogenesis stages. In an experiment on humans, V.M. Smirnov *et al.* [35] demonstrated that direct electric stimulation of the motor areas of the brain which destabilizes the muscular tension leads to the formation of artificial stable functional links (ASFS) when combined with rhythmic sensory stimulation and exposed to the effect of nonspecific connectors (ethymizol). The authors classify the ASFS as imprinting by placing it between conditioned and unconditioned reflexes. The ASFS formed between two brain zones is used for treating, e.g., the Parkinson disease. In this case, the light which is blinking at the same frequency as during imprinting is shown to the patient, and a decrease in the muscular hypertension is attained the same way as it happens when current pulses are applied to the motor zone through invasive electrodes [36]. Today, the ASFS are formed in patients for therapeutic and diagnostic purposes and in healthy individuals, for the purpose of optimizing their mental condition [37]. Versions of forming the ASFS without inserting electrodes into the brain are possible yet this has been described in considerably lesser detail [37].

We can speculate that imprinting moments appear during the process of intact vital activity when information slides into the data bank area. In this case, it turns into a standard compared to which all service programs are formed (the life support and behavior systems). If this information is a fully and correctly corrected program (i.e., consistent with the corresponding tasks), there will be no noticeable crude personality changes: a motor skill (automatism) develops in a musician as a result of goal-oriented learning, a man acquires conversational language in a foreign language environment under latent learning, etc. If an inadequate program is imprinted, a disease develops, i.e., a stable pathological state of the brain [10], a somatic disruption, etc. No matter what they are aimed at, in this case the therapeutic facilities are not pathogenetic since they by no means eliminate the cause of the disease, i.e., the fixed standard engram. In the cases where the symptomatic treatment works, one can suspect that there is an imprinting phenomenon when "correct" information about the state and behavior of the system due to this treatment slides into the data bank and forms a new standard. Such standard may exist in the memory simultaneously with the first one (inadequate) yet when the source codes of service programs are compared to them, priority is given to the correct one as being more capable of adapting, so commands equivalent to the situation also appear on the input/output systems, including behavioral, somatic, and vegetative. The possibility of substitution of the standard program or its part cannot be ruled out.

All of the foregoing has been generally well known and is merely an outcome of using a certain conceptual tool for ensuring the possibility of formulating new premises. To this end, let us again examine Fig. 1 and try to establish how the memory zones should differ.

The iconic memory retains information from milliseconds to tens of seconds. It is physically localized predominantly along the periphery of the analyzers (e.g., in the retina of the eye) and in their central sections. From the information viewpoint, it is an analyzer (1), a semantic interface (2) which interprets the serial code of the external stimulus as a parallel code of the neuronal pulse, and a short-term memory input (3). In its functions, it is similar to the computer analog-to-digital converter and has the same properties: a controllable sampling rate (space-time discrimination thresholds) and the dynamic amplification range (perception thresholds). It plays the role of a delay line in ensuring adaptive tuning of other elements of the perception system to a discrete stimulus. In an off-line mode, it continuously directs streams of information to the short-term and contiguous memory. From the information viewpoint, iconic input and output memories are identical and form a single autonomous system with feedback.

The short-term memory retains information from hundreds of milliseconds to several hours. Its capacity is much higher than the iconic memory capacity yet it is a stack memory, i.e., when a new register is filled, the contents of the old register are erased, which is manifested as a semantic interference phenomenon (the effect of new data during the consolidation of the short-term engram leads to its partial or complete erasure). It contains a translator (5) which translates the neuronal autocodes (spatially organized neuronal constellations) into the information display monitor codes (images, thoughts, feelings, and visualizations). It integrates information from the iconic memory into the system in the domain of time which is manifested by the possibility of recalling the context of recently presented stimulus; many violations of this ability are known, e.g., "tunnel" vision as a result of intoxication with hallucinogenic drugs when only a point of fixation is perceived while the context of the present moment is irreproducible. It is physically located largely in the cortex of the brain. It is similar to the input/output register in the computer.

The consciousness stores information until the monitor memory is turned off, which occurs most often upon falling asleep. It is intended for exchanging information with the environment and displaying information about the internal environment (partially). It comprises a communicator monitor (6) for orienting the input/output device, an emotional resonator (18) (a statistical counter which checks the correspondence of the commands to the outcomes), and monitor memory (8) which is similar to the computer graphics display. The consciousness system may exist for a certain time autonomously both when external information is blocked (sensory deprivation) and when exchange with the processor is blocked (endogenic depression). It is similar to the computer random access memory. It can be easily turned off or modified by external stimuli but is easily restored upon an exchange with the processor. The monitor memory is controlled by both perceived and unperceived commands and contains a agglomeration of external information and activated engrams of the processor buffer memory.

The subconsciousness stores information indefinitely long yet it can be corrected (forgotten) or completely erased (lacunar or total amnesia after concussion, retrograde amnesia after electroconvulsive shock, etc.). In order to increase the information storage reliability, it invariably contains identical information blocks: a data base (10) and a buffer memory (9). The latter has a combinatorial apparatus for making the command decision which is *a priori* most statistically optimal with respect to behavior and condition (motivation, will, desire, needs, etc.). This information may be partially perceived yet the degree of perception depends on numerous factors and almost never is controlled randomly. The subconsciousness is similar to the computer processor since the principal behavior and state strategies are being generated there. The affective complexes (programs with high priority) which in healthy people are preformed as passions, impulsive actions, etc., form there. In sick people, they have already slipped through into the data bank and inevitably transform any correct program forming in the long-term memory until it matches an incorrect standard. For this reason, various types of suggestions, rational psychotherapy, and other methods employing learning are rather inefficient.

The continuous storage device (12) stores information during the lifetime. It differs from other types of memory in that information is not stored in formats and is not organized into files or blocks but is accumulated permanently. It is impossible to access it; randomly selected information is used by the PROM burner (14) as a substrate for making the program blocks. Cases where fragments of such information enter random access memory are known (dreams, sudden recollections of things allegedly never seen before, conversations in a foreign language, etc., which is especially frequent as a symptom of mental disorder). Judging from available data, it indeed contains absolutely all--even contextual--information ever received (including unperceived). Cases of phenomenal absolute memory which are used most often as a circus act are known.

The data bank (11) stores some information during the lifetime of the biological object and some during the life span of the progeny of given species (genetic programs). This information is standard and is not subject to correction. Direct access to it is impossible and is gained only through the somatic driver (15) which is organized exclusively when the biological object is in special states (imprinting) and relocates this or another information from the bank to the long-term memory or vice versa.

The semantic field of the universe (19) *per se* is information. It is the most hypothetical of all aforementioned formations. There are many hypotheses of its existence (the world of Plato ideas, Young's archetypes, etc.), yet the most up-to-date interpretation was given by V.V. Nalimov and Zh.A. Drogalina [30] which, however, elicited justified criticism [3]. To a certain extent, it corresponds to P.V. Simonov's "superconsciousness" category. It is related to the concept of public consciousness and metaphysical categories of Ygregor, Atman (in Buddhism), *et al.*

Without further dwelling on describing the components of the proposed model of the personality structure, we should reiterate that it does not claim to be in absolute correspondence with any currently known reality but serves merely as a scheme for explaining the proposed approach to developing new nonmedicinal methods of correcting the state and modifying the biological object behavior.

Based on the goal thus formulated, we shall assume that at any personality stage, any disruption of information or the systems retaining it (memory) may lead to a consolidation of the incorrect standard engram during the imprinting. Consequently, virtually all diseases (except for injuries and certain infectious diseases) call for a certain critical time for treatment which exceeds the time between two imprintings. In other words, in order to re-record or duplicate a standard entry in the data bank for the purpose of treating the patient (eliminating or suppressing the incorrect standard), it is actually necessary to enter the correct program into the bank block which stores the preceding standard of the same program (the incorrect one). This requires a lot of time during which the correcting information will be constantly, or sufficiently often, presented (drugs, suggestion, etc.) and during which the highest priority will be assigned to the program being formed in the long-term matrix (i.e., the already formed adequate control program with a positive outcome of its realization must be available at the very moment of imprinting in the long-term memory). This program's priority must exceed the priority of the standard present in the bank, and only then will the new program, having become a standard, receive predominance in copying the service programs. As we can see, too many conditions are necessary for truly pathogenic treatment. For this very reason, the arsenal of the stimulus facilities in today's medicine is continuing to increase yet neither one of them is a panacea, and there is no end in sight.

For this reason, the search for means of controlled imprinting is justified since it will make it possible deliberately to correct defective information and will form a completely new trend in medicine.

Based on the proposed conceptual model of the personality structure and an analysis of the vast knowledge about imprinting, ASFS, amnesial actions, and cases of self-therapy for various diseases and successful therapy by most diverse methods, we are proposing the following principle of semantic driver organization for altering the behavior and state. The following is necessary for realizing it:

1. To identify the most significant affective information at a given moment and in a given state.

2. Block or eliminate the editor.

3. Develop a semantic resonance with the help of the most significant affective information.

4. Assign the highest priority to the correct program being formed by initiating or simulating its successful operation.

5. Supply the new program with the highest semantic gradient against the background of relative sensory deprivation.

6. Consolidate the engram.

The methods existing in psychology for determining the maximum significant affective information are hardly suitable. With respect to the problem formulation, the closest are the psychoanalytical methods yet they call for very high outlays of time and are fraught with subjectivism in interpreting the outcome. The most acceptable is the A.R. Luriya's principle [28] whereby verbal stimuli are presented to the subject under test and his speech responses (as is done during the associative experiment) and ideomotor reactions accompanying the motor act of pushing the button when giving a verbal answer are recorded. The related motor-associative technique opens up new possibilities: "...the diagnostics of affective imprints is entering the path of considerably higher accuracy and objectivity; it becomes possible to observe the mechanisms underlying the identified verbal reaction and estimate the degree of stress, excitation, and disruption and, consequently, the degree of affectivity of the process occurring in front of us" [28, p. 92]. Later, Razran and Riz and then O.S. Vinogradova *et al.* suggested a method of assessing the semantic fields of affective formations where the key stimulus is specially formed by developing a negative conditioned reflex while the response to the testing stimuli is traced by the directional spread of the changes in the finger and forehead plethysmogram. By using this technique, we were able to prove that it was extremely labor-consuming and called for considerable time outlays, but its principal shortcoming was the inevitability of subjective interpretation of the results even at the stage of identifying the response against the background of noise. While completely reproducing the procedure in [15] in recording the electroplethysmogram of the finger and forehead, we obtained curves which were dithered with noise as much as those cited in the procedure description. In other words, the confidence of response against the background of noise was extremely low. To standardize the response identification and the entire procedure, a controlled hardware system on the basis of the Iskra-1256 microcomputer with real-time analog data analysis was developed. The computer presented verbal stimuli on the display or from an analog tape recorder, controlled the electric stimulator, generated the conditioned reflex, and carried out the testing procedure with analysis of electroplethysmogram and oscillogram over two channels (N.V. Gavrilov and A.N. Zhuravlëv's procedure) and the galvanic skin reflex according to Féré. The computer version of the procedure turned out to be sufficiently reliable yet the procedure of learning with subsequent testing of one presumed affective formation required approximately one and a half hour. Furthermore, negative reinforcement with the help of electric shocks was unacceptable in certain instances. The source code is cited in Appendix 1 and a sample protocol is presented in Appendix 2. For practical purposes, the above computer procedure is inconvenient yet it is suitable for studying the dynamics of affective formations in psychopathology for scientific and research purposes. Missing

There have been many other attempts to define the physiological or behavioral responses to semantic stimuli: from the infamous "lie detector" (an individually targeted polygraph system in a general case) to complex methods of analyzing the elicited semantic potentials in the brain [49, 32], including those recorded by the electrodes implanted in the human brain [39]. Yet all these methods are fraught with a significant defect: the editor may, depending on its tuning and even the testee's desire, pass or not pass all external information in the personality structure or direct it to the memory zones which are totally different from those necessary. The cognitive processes developing in this case will reflect the associations which are very far from the truth. In order to eliminate the artificial effect of consciousness, the editor is either blocked by initiating changes in the state of consciousness in order to eliminate critiquing [38] or the test information is presented above the perception threshold yet below the comprehension threshold. In the latter case, the same parameters are used for assessing the response to the stimulus as in the case where comprehended stimuli are presented: the galvanic skin reflex [18], changes in the encephalogram [17], changes in the generated potential [24], etc. It is assumed that virtually all stimuli within the subsensory range (6-12 dB for sound) may be transferred to a number of comprehended stimuli which cause a random response reaction [20] by means of consciously changing the analyzer thresholds. In the opinion of other researchers, the reactions to perceived or unperceived semantic stimuli differ in principle [16]. All procedures for analyzing the behavioral and physiological responses to perceived or nonperceived stimuli known in published sources can be used only for scientific and research purposes and are not therefore used for the purpose of practical diagnostics of affective formations.

We developed a research algorithm, a computer routine, and the corresponding hardware system which record the time of complex visual and motor response of discrimination and semantic stimuli and the averaged generated potentials to these stimuli. The algorithm (Fig. 2) [figure is not reproduced] is simple: a person is shown randomly alternating words on a display with the task of pushing the button as quickly as possible when the word having a meaning appears and pushing it no sooner than 3 s and no later than 5 s later when a meaningless word presented upon the command of another pseudorandom number generator appears. Such an operator activity calls for a high level of stress during the entire procedure since the number of errors is taken into account, and information about each error is displayed on the display screen. Naturally, these words are perceived and are not only a substrate of the operator activity but also serve as masking devices for the unperceived information. The latter is presented in the form of a closed infinite cycle of words whereby the supposedly significant words alternate with neutral. The luminous intensity was not changed while the time of presentation of noncomprehended stimuli was set within a 5.0-40.0 ms range so that they would not be comprehended in any situation. According to an expert estimate, 200 people, both healthy and sick, could not comprehend the meaning of the test words under masking conditions although after receiving corresponding instructions, many (especially the schizophrenics with a high perceptive accuracy) noted that "something else was blinking under the words." Masking was also facilitated by various forms of glare on the display screen [46]. The validity of the method was confirmed by testing two lists of neutral words without meaningful words as well as by the fact that in practically healthy people, there were no reliable differences in parameters during the testing of any conjecturally meaningful stimuli (money, exams, career, prestige, jeans, Zhiguli [car], food, sex, etc.). The latter can be attributed to the natural absence of affective complexes in healthy people. Under single conditions of obtaining confident results from healthy individuals, deeply concealed affective formations were identified; no comprehensible information could be derived about them yet this was possible to do only by using specially oriented additional procedures. Statistically significant parameter deviations of the response to conjecturally affective and neutral stimuli were always discovered in the patients which made it possible to determine not only the descriptor of the affective formation but also its structure. The minimum procedure duration is 30 min. Parametric parameter averaging criteria using two variational series--affective and neutral--and for each stimulus separately were used for real-time processing. Appendix 3 contains the source codes, Appendix 4 presents the introductory instruction, and Appendix 5 contains the research protocol (see Fig. 3).

We should note that the experimental results do not bear out the hypothesis that in the case where a significant stimulus is presented, which is a part of the affective semantic field structure, a large number of associative connections is involved in its cognitive analysis, so both the response time and the character of the induced potentials change likewise. The cases where the response time is shortened and changes in the form and latent periods of the generated potentials do not correspond to known concepts are also observed, albeit to a lesser extent. The most frequently occurring pattern of averaged (600 averagings) generated potentials in the tap from the vertex is shown in Fig. 4.

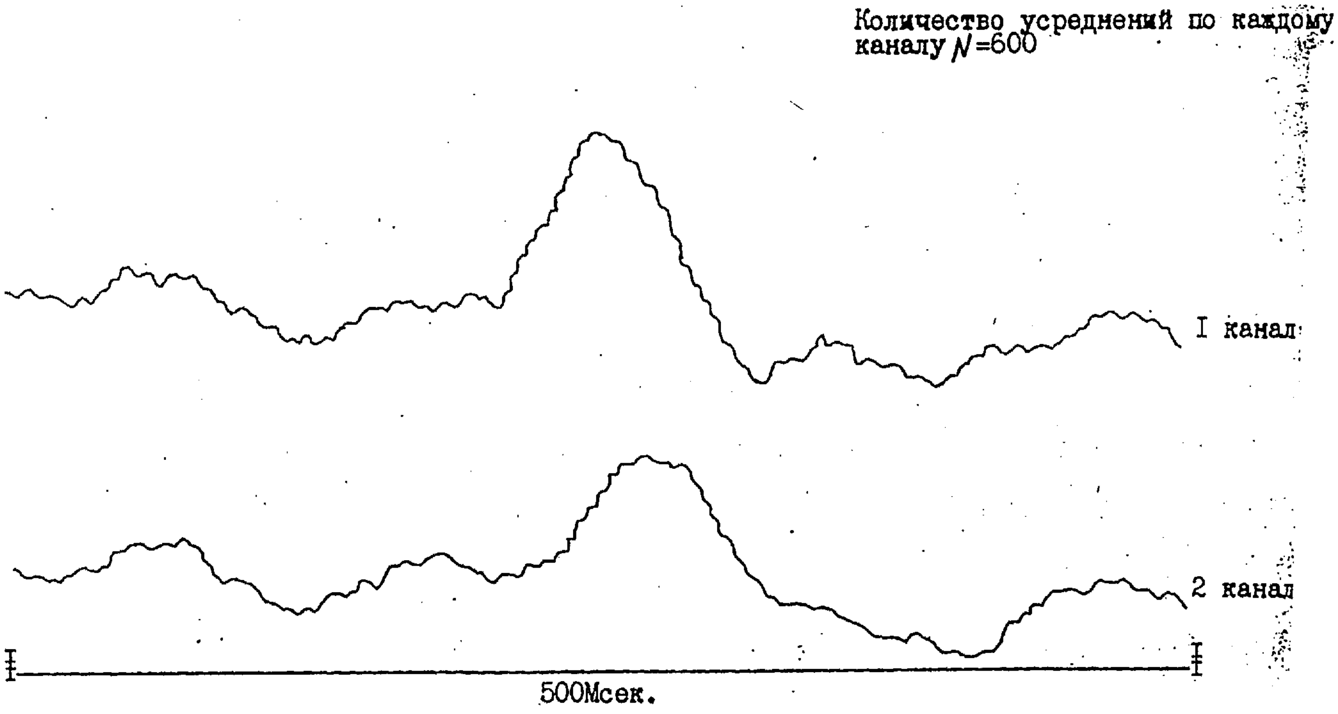


Fig. 4. Induced Potentials to Nonperceived Significant Words (Channel 1) and Nonperceived Neutral Words (Channel 2). On top: The number of averagings for each channel is N = 600.

The use of the aforementioned algorithm in the program of computer on-line psychosemantic testing (KOPS) demonstrated the high reliability (all criteria have alpha of less than 0.01) of the method for diagnosing affective formations. Thus, when the same lists of words were presented to patients with chronic alcoholism and surgery patients during the preoperative examination, statistically differing results were obtained according to the affective formation diagnosis. In other words, when three to five lists are consecutively presented to the healthy or sick persons, one can objectively diagnose latent alcoholism or hypochondriac manifestations, etc., even without knowing the medical history, without talking to the testee, and without visual acquaintance with him. This increases the method reliability since those already existing are employing the subjective physician interpretation of the results in all cases. Attempts to automate diagnostics, in particular in psychiatry, have been made before [50]; mental patients are used as computer operators [48] so as to examine the higher senses of the patients by semantic differential methods yet the unique capabilities of computers in the procedure of verbal testing have been discovered only recently [12]. Namely, these procedures enabled us to develop a practical working tool for studying the affects rather than a basic research tool which is the first component of the semantic driver design.

Yet for practically healthy people, it is necessary to carry out a considerably greater number of COPS-type procedures than for mental patients. For this reason, a verbal display testing algorithm was developed which, in a general form, represents a procedure of selecting a rhythm from the masking symbolic noise. In reality, the presented information is completely randomized in brightness and frequency, so the predictable distribution of descriptors of various semantic formations defined by the physician is present only in the testing word sequence in this cycle. Thirty words are tested during 20 min, which fully covers any conceivable sphere of human activity. The parameter is the rhythm at which the button is depressed. The character of statistical distribution of the number of depressions for individual words from the file is analyzed and the statistical significance of the maximum values of averaged reference points for neutral words is estimated. The source code is cited in Appendix 6.

The COPS and PDP programs contain the procedure of individually targeted subjective scaling—a repertory grid (V.I. Pokhilko). The results of its processing are analyzed by multivariate statistical methods (factor and variance analysis) after the computer testing procedure and, combined with the results from using the personality questionnaires, questionnaires form procedures (MMPI, Cattle, Roven, Spilberger, Lucier, *et al.*) and the medical history information, are embedded into the foundation of the semantic driver.

In other words, the first stage in organizing the driver is determining the individually targeted affective information which is dominant by the survey time.

The second stage is ensuring the maximum expressed emotional semantic resonance, first negative, then positive (something similar naturally occurs during psychedelic, psycholytic, and psychocatarthic procedures). In practice, this task is reduced to a dichotomy presentation of semantic information in the form of operator activity with acoustic commands issued into the right ear above the comprehension level, and uncomprehended information—into the left ear. The information structure is carefully and individually selected so as to ensure that the maximum discomfort related to semantic analysis of the presented information is achieved by the culmination moment. In this case, the information not related to the affective formations and representing operator activity commands, which require that phrases be repeated or uttered, earlier given sequences of numbers be recalled, etc., is presented in the conscious mode. In this case, the responses are not listened to the end while the testee's speech is interrupted, very intimate questions are posed, etc. In the unconscious mode, a dialogue which represents doubts in the possibility of treatment, skeptical statements about the testee's personality, etc., is presented. The unconscious dichotomy presentation of information makes it possible largely to bypass the editor, so the information is perceived without conscious critiquing. The state of consciousness is altered in order to eliminate the editor fully by injecting small doses of ketamine-series preparations. The drug injection time is the culmination of the procedure, so the absolutely affective information presented at this time causes a considerable emotional response which is accompanied by significant vegetative and behavioral changes.

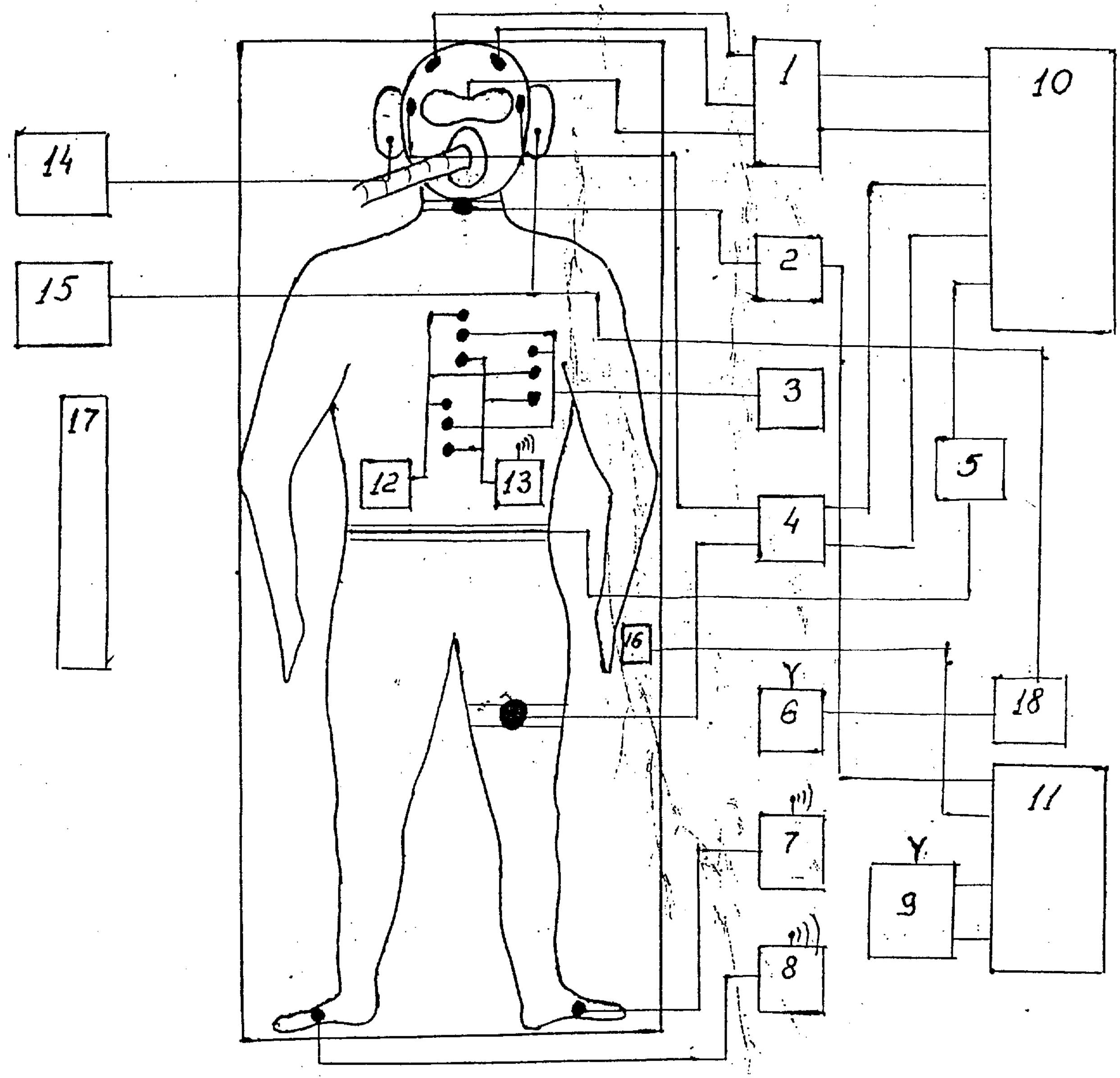
Against the backdrop of ketamine, the negative emotions which accompany the perception of the affective formation structure resemble the state of psychocatharsis. At this moment, the content of information is abruptly changed by supplying it with a positive connotation while the stimuli intensity is suddenly and abruptly increased to the maximum (110 dB) thus causing considerable stress. At the time of acoustic shock, ethymizol is injected to ensure data consolidation and thus, the need for treatment formed by an imperative suggestive method and the correct program being subconsciously formed slip through into the data bank. In order to reinforce consolidation and ensure multiple re-recording of this program with the maximum priority, a hypnotic drug is injected which puts the patient to sleep. During this time, information reflecting the success of the procedure is being continuously presented.

Ethymizol (ethylnorantiphein) was synthesized in 1962 and is a neurotropic drug from the family of antifeins has analeptic properties. Compared to other analeptic medications (corazol, bemegrid, and caffein), it potentiates the effect of analgesic and narcotic drugs while simultaneously stimulating breathing [40, 29, 1]. It is used in clinical psychiatry [1, 6]. Its principal feature is the unique property of nonspecific connection [11] which makes it possible to form temporary links between various zones of the brain. There are many contradictory data on this field yet it has been demonstrated in recent studies that only the ethymizol's ability to accelerate and reinforce the memory engram consolidation is authentic [29]. Calypsol was selected among the ketamine preparations as being one of the most popular intravenous anesthetics which causes the so-called dissociative anesthesia and has a powerful hallucinogenic effect. Introduction of even small doses of this preparation makes it possible, while maintaining consciousness, to attain a hallucinogenic effect whereby violations of the external stimuli perception in this case potentiate hallucinations resembling oneiroid. Ethamidat (radenarcon) is one of the softest hypnotics which has no side effects and contraindications and does not cause a histamine release. Various combinations of preparations are common while the preparations themselves are trivial.

Patient S.V. Kv-ts is 36 years old and is suffering from logoneurosis (stuttering), has no somatic contraindications and according to the results of psychological examinations, displays a tendency to astheno-depressive reactions, a reduced self-image, intrapunitivity (aggression directed at oneself) and sensitivity. Among his personality traits, depressive-alarmed complex is dominant due to his living situation. Computer testing demonstrated the presence of a tendency toward forming an affective formation due to stuttering.

A block diagram of a complex for audio visual stimulation and recording of physiological parameters is shown in Appendix 7. The patient was put on a couch and subjected to psychocorrection according to a program developed beforehand. The procedure proceeded completely in accordance with the program and there were no extraordinary situations. The working protocols are cited in Appendices 8-11.

As a result of this procedure, depressive tendencies were completely suppressed while maintaining the remaining character of the personality traits. The logoneurosis was cured. There were no somatic changes and a decrease in the brain cortex tonicity was detected in the electroencephalogram (an increase in alpha-indices) with a sharp increase in the beta-activity which attests to an activationof the hypothalamus-hypocampal formations. A subjective feeling of self-confidence developed and the fear of social contacts disappeared.



Appendix 7. Block Diagram of the Complex for Audio Visual Stimulation and Recording of Physiological Indicators During the "Imprinting" Procedure. Key: 1--B1 Biomedica averaging device; 2--Sound amplifier; 3--FCP-II Fukuda Denshi cardiocomputer; 4--VC-9 Nihon Kohden Biophysical oscilloscope; 5--Sanei Instr Balancing bridge; 6--DS-501 Fukuda Denshi Cardiotelemonitor; 7, 8--Biomedica Telemonitor transmitters; 9--Biomedica telemonitor; 10--Schlumbeger magnetograph; 11--HO-671 recording magnetograph; 12--Halter recorder; 13--Telecardiomonitor DS-501 transmitter; 14--Jupiter 203 tape recorder; 15--HO-67 playback tape recorder; 16--Button; 17--Transparency; 18--G6-28 generator.

Patient Iv-v, 32 years of age, is suffering from logoneurosis and has no somatic contraindications and, according to the results of psychological examination, displays sufficient activity, has high self-confidence, and clearly expresed tendency toward competition and domination. His behavior is characterized by consistency and unity of purpose while control of motivation is lowered. Computer testing made it possible to identify affective formations in the subconscious memory sphere which attest to the presence of a psychotrauma in childhood. It was possible verbally to characterize the semantic field of the affect.

The working protocols which characterize the scheduled progress of the procedure are cited in Appendices 12-15. There were no extraordinary situations.

The character of the personality profile did not change after the procedure although there were certain changes on individual scales. The speech character changed: fluent speech appeared and stuttering during emotional verbal contacts disappeared. Stuttering is possible in cases of calm and slowed-down speech. The patient acquired a subjective feeling of controllability of his speech. There were no somatic changes. In principle, the changes in the electroencephalogram are similar to those of the preceding patient.

From the viewpoint of analyzing the mechanisms which ensure the effectiveness of the aforesaid procedure, we are especially interested in similar changes in the test results of both patients. Thus, according to the results of the electroencephalogram study, the cortex tonicity decreases after the procedure (an increase in the alpha-index in the Kv-ts patient and a decrease in the alpha-rhythm frequency in the Iv-v patient). At the same time, the theta-rhythm increases sharply, whereby in the Kv-ts patient, this rhythm does not dampen when stimulated with rhythmic light while in the Iv-v patient, the theta-rhythm is amplified under rhythmic light stimulation and hyperventilation. The aforementioned shifts attest to a certain reordering of the functional relationships in the cortex and subcortical formations: the activity of the hypothalamus-hypocampal structures is reinforced sharply against the background of a certain decrease in the cortex activation. We know that the hypothalamus and the hypocampal-type structures are due to motivation, emotions, and memory. Consequently, we can say that these results attest to a restructuring of the stored behavioral programs and a reordering of the emotional and conceptual factors which control behavior.

In comparing the shifts of the electroencephalogram and changes in the personality profile, one can see similar changes on individual scales in addition to the changes in profile which are specific for each patient and are determined by the presence of affective complexes (e.g., a diminution of depression after the procedure in patient Kv-ts). Thus, a decrease on the sixth scale of the MMPI test (the rigidity of the affect) was observed in both patients which, according to the aforesaid assumptions, may reflect a reordering of the emotional-motivational sphere. An increase in the results on the seventh scale attests to an increase in the emotional stress. The reordering occurring in the emotional-motivational sphere which is reflected by a change in the cortical-subcortical functional relationships and is manifested in changes in the personality profiles similar in character according to the MMPI test leads to individually specific personality changes. Thus, the theta-rhythm activation in patient Iv-v can be attributed to an increase in the values on the fourth scale and can be interpreted as an enhancement of his impulsive behavior.

Thus, a good consistency of the results of psychological and physiological testing gives reason to regard that the programs introduced for the purpose of psychocorrection are workable and that the proposed combination of stimuli corresponds to the formulated goals and makes it possible efficiently to organize a semantic driver for loading correctly organized information into the memory.

The resulting experimental data make it possible to speculate that a new trend in developing the methods of nonmedicinal stimulation of the human psyche function has been developed.

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Appendix 16

Glossary of Terms Used

Processor--a device intended for processing data stored in random access memory. It serves for executing the programs and the related elementary operations, while in so doing, it controls the information flows and connections with the input/output device.

Buffer memory--memory used by the processor for storing and accumulating intermediate data or programs during processing or while accessing the input/output devices without interrupting the processor operation at the same time.

Random access memory--memory which contains the programs to be directly used and data being employed by them as well as data entering from the input device as a result of these programs' execution.

Monitor (communicator)--a device which ensures generation of messages about the program-run results and displays data stored in the monitor memory. It makes it possible to direct the program execution process.

Read-only memory (data base and long-term memory)--serves for storing the formed programs and data files. When the program is executed, it is transferred to the buffer memory or the processor RAM.

Burner--a device which serves for developing new adaptation programs by formatting data and fragments of programs entering the random access memory as well, as the contiguous storage device.

Contiguous storage device--is the permanent memory which operates in the sequential (in time) accumulation mode. It contains all data as well as the responses of the system to various changes in the environment during the life span.

Interface--performs the functions related to organizing the data collection, switching information channels to the input-output register, and at the stage of accessing the peripheral devices (analyzers and effectors). It performs integration of sensory codes into semantic codes.

Driver--a device which ensures addressing and interchange between the data base and the bank and organizes the data bank's data structure.

Data bank--the principal storage which contains formatted programs located in a certain structure. It permanently stores all adaptation and behavioral programs and their priorities appearing during the lifetime.

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Appendix 18

Clarifications to the Block Diagram of Conceptual Cybernetic Model of the Functional Device of Human Memory

Block No.	Block Name	Block Purpose	Analogue
1.	Analyzers	Data encoding	Peripheral data processing (eyes, ears, etc.)
2.	Input interface	Image formation	Subcortical and cortical data processing (primary, secondary, and tertiary analyzer zones)
3.	Buffer memory	Image stabilization	Short-term memory
4.	Translator	Image transformation into a form accessible to consciousness	Subconscious perception of information
5.	Editor	Comparison of the formed image to the existing ones	Subconscious perception of information
6.	Communicator	Incorporation of the image prepared for comprehension in the system of existing images	Conscious perception of information
7.	Communicator memory	Image storage in the form acceptable to consciousness	Subjective experience
8.	Central processor	Constructing behavior algorithms and controlling their realization	Mechanisms of purpose formulation and meaning generation
9.	Processor RAM	Storage of programs entering for realization and information for construction of algorithms by the processor	Actual motivation
10.	Contiguous memory device	Storage of behavior and adaptation software package as well as catalog of situations	Individual experience
11.	Data bank	Storage of standard copies of the software package as well as typical adaptation subroutine packages	Philogenetic and ontogenetic experience

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Block No.	Block Name	Block Purpose	Analogue
12.	Contiguous memory device	Continuous accumulation of unprocessed data	Nonrandom memory
13.	Probability counter and priority generator	Determining the priorities of entering data, processing of priorities of realized programs, and probablistic estimate of program effectiveness	Needs, motive hierarchy formation, and learning
14.	Burner	Conversion of behavior algorithms into behavioral programs	Formation of neuronic codes in behavior control
15.	System loader	System information loading	No analogues
16.	On-line loader	Selection of priority programs and their placement in the processor RAM	Actualization of individual experience
17.	Output interface	Formation of codes for executing systems (image decoding)	Formation of a sequence of motor acts (primary, secondary, tertiary motor analyzer fields)
18.	Effectors	Execution of the output interface commands	Neuromuscular system

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