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BIOMEDICAL AND BEHAVIORAL SCIENCES

(FOUO 15/81)

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BIOCHEMISTRY

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JOURNAL OUTLINES MEDICAL INDUSTRY'S GOALS FOR 1ST YEAR OF 11TH FIVE-YEAR PLAN

Moscow KHIMIKO-FARMATSEVTICHESKIY ZHURNAL in Russian Vol 15, No 3, Mar 81 pp 5-7

[Article by editorial staff]

[Text] The 26th Congress of the USSR Communist Party has just concluded. It marks a historic new frontier in the development of Soviet society en route to Communism. The resolutions of the Congress clearly reflected the Party's genuinely citizen-oriented policy, one that embodies the ideas of Lenin and the October Revolution and is permeated with revolutionary spirit and a bold approach to the solution of pressing problems.

Workers in the medical industry, like all Soviet citizens, unanimously approve and support the decisions of the 26th CPSU Congress and the positions and conclusions set forth in the report made to the Congress by L.I. Brezhnev, the General Secretary of the CPSU Central Committee, and have taken it upon themselves to implement them through steadfast effort.

In conformity with the document entitled "Principal directions to be taken in the economic and social development of the USSR in 1981-1985 and the period up to 1990," workers in the medical industry must solve critical problems pertaining to the further expansion of this branch, in order better to provide the populace and public-health institutions with drugs, the tools of medical technology, and other products intended for use in medicine.

Discussion of the draft of this document by the personnel of enterprises and organizations produced a new elevation of political and occupational morale. Workers in the medical industry made many valuable proposals directed at improvement of work in their individual sections and at enterprises, associations, and facilities serving the entire industry, as well as at elimination of existing shortcomings and deficiencies. New socialist obligations have been adopted for 1981.

Having accomplished the planned tasks for 1980 and the 10th Five-Year Plan as a whole, workers in the public-health industry, inspired by the resolutions

of the 26th CPSU Congress, are filled with resolve to implement the Party's sweeping plans and to make a worthy contribution to further improvement of health care for Soviet citizens.

The most important socialist obligations taken on by the personnel of a number of industrial associations and enterprises in the chemical-pharmaceutical industry for 1981 are described below.

"Akrikhin" Order of the Red Banner of Labor Chemical-Pharmaceutical Plant

To fulfill the annual production plan ahead of schedule (by 30 Dec 81) and produce goods with a value of 300,000 rubles over and above the planned level. To increase production (in comparison with 1980) of hydrocortisone acetate and diprasine by a factor of 2, of potassium orotate by 20%, of carbocholine by 38%, of nitroxoline by 60%, of sulfapyridazine by 25%, of 6-mercaptopurine by 58%, of amidopyrine by 60%, of prednisone acetate by 25%, and of progesterone by 25%. To effect the entire increase in output without enlarging the workforce. To save 300,000 rubles in raw-material costs, 1 million kW-h of electricity, 500 Gcal of thermal energy, and 1000 tons of conventional fuel. To obtain savings totalling 2.5 million rubles from introduction of 480 inventions and innovators' suggestions and no less than 65,000 rubles from implementation of measures for scientific organization of labor. To save 700,000 rubles as a result of introduction of the latest scientific and technical developments. To have engineering and technical personnel draw up no fewer than 430 personal working plans directed at improving production efficiency. To render supervisory assistance to the Noginskiy Sovkhoz.

"Oktyabr'" Leningrad Order of the Badge of Honor Industrial Chemical-Pharmaceutical Association

To fulfill the annual production plan ahead of schedule and, in conformity with the contingency plan, to produce additional medical goods with a total value of 200,000 rubles. To provide the entire increase in production through improved labor productivity. To put into production and submit for clinical testing five new drugs.

"Biostimulyator" Odessa Industrial Chemical-Pharmaceutical Association

To fulfill the annual production plan ahead of schedule and to increase output by 6.6% over the 1980 level, 84% of the increment coming from improved labor productivity. To exceed the production quota for medical goods by 200,000 rubles, with consumer goods accounting for 130,000 rubles of this total. To save (in comparison with the specified levels) 161,000 kW-h of electricity, 2180 Gcal of thermal energy, and 5000 rubles in raw materials and semifinished goods. To obtain a savings amounting to 200,000 rubles as a result of introduction of new technology. In attempting to contribute to the social development of personnel, to take an appropriate part in the remodelling of the Ogonek youth camp. To organize an

auxiliary farm for vegetable production at the subsidiary Kolkhoz imeni S.M. Kirov. To improve the skills of 540 workers and engineering-technical and maintenance personnel.

"Sintez" Kurgan Plant for Drugs and Medical Goods

To increase standard net output by 5.4%. To produce consumer goods with a total value of no less than 600,000 rubles. To introduce six new high-efficiency technological processes. To begin serial production of four new types of products. To fabricate pilot models of three new types of products. To obtain a nominal annual savings of 300,000 rubles by implementation of organizational and technical measures and 95,000 rubles from implementation of measures for scientific organization of labor. Provisionally to free 55 workers through technically progressive measures. To make use of 490 suggestions and inventions for a savings of 850,000 rubles. To save 6.1 million kW-h of electricity and 17.5 Gcal of thermal energy. To reduce the cost of goods produced by 70,000 rubles. To provide 6.2 million rubles of capital investments. To put into operation new production facilities with an area of 2604 m^2. To train 300 new professional workers, improve the skills of 560 workers and 45 engineering-technical personnel, and train 120 individuals in allied professions. To assist the sovkhozes and kolkhozes of the region in sowing and harvesting.

"Mosmedpreparaty" Order of the Red Banner of Labor Industrial Association

To fulfill the annual production plan for the most important types of goods ahead of schedule, by 30 Dec 1981. To produce and market goods with a value of 150,000 rubles in excess of quota. To overfulfill the plan for improvement of labor productivity by 2.9%. To reduce the cost of finished goods by 50,000 rubles, with savings on raw and semifinished materials providing 30,000 rubles of this total. To save 2.1 million kW-h of electricity, 1350 tons of conventional fuel, and 10,000 Gcal of thermal energy. To obtain profits of 75,000 rubles in excess of quota. To put into practice 500 innovators' suggestions and obtain a nominal savings of 500,000 rubles. In conformity with the social-development plan, to improve the educational level of the association's workers with no loss of productivity, sending 77 individuals to specialized middle and higher educational institutions and 39 to schools for working youth. To provide all types of instruction, including economics courses for administrators and 1500 workers and engineering-technical personnel. To obtain a savings of 250,000 rubles through introduction of new technology and automation and mechanization of production. To assist the subsidiary sovkhoz in improving agricultural efficiency.

"Farmakon" Leningrad Industrial Chemical-Pharmaceutical Association

To fulfill the approved annual production plan ahead of schedule, by 29 Dec 81. To produce goods with a value of 100,000 rubles in excess of quota. To market products with a total value of 70,000 rubles in excess of quota. To improve labor efficiency by 3% in comparison with 1980.

To provide the entire increase in output by improving labor productivity. To reduce the cost of finished goods by 30,000 rubles. To obtain a profit of 30,000 rubles in excess of quota. To begin commercial production of five new drugs. To obtain a savings of 192,000 rubles as a result of implementation of progressive scientific and technical measures. To save raw materials with a value of 25,000 rubles, 800,000 kW-h of electricity, 730 tons of conventional fuel, and 5500 Gcal of thermal energy. To obtain a savings of 150,000 rubles through implementation of suggestions from innovators and inventors. To train 25 individuals in second professions and improve the skills of 240 workers through advanced training. To take an active part in rendering supervisory assistance to agriculture, the plant school and kindergarden, and other allied facilities. To continue socialist competition with the Akrikhin Chemical-Pharmaceutical Plant.

These socialist obligations have been adopted at meetings of enterprise and association personnel with leading production workers, members of party, union, and YCL organizations, and representatives of economic administration.

2478
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BIONICS

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GOALS OF AND PROSPECTS FOR DEVELOPMENT OF NEURONAL TECHNOLOGY

Kiev OTBOR I PEREDACHA INFORMATSII in Russian No 62, 1980 (manuscript received 17 May 79) pp 49-55

[Article by V.L. Kuznetsova, V.L. Kuz'menko and I.M. Tsygel'nyy, L'vov]

[Text] The progress being made in contemporary computer technology is due to a combination of work in two areas, i.e., improvement of components through utilization of the latest achievements in physics and technology and intensificiaion of the search for new theoretical principles upon which to base computer devices, including multivalent [17] and neuronal [5] logic. Attempts by researchers to combine the advantages of these two major trends have led to intensive study of the mechanisms of information processing by the human nervous system and to efforts to use these mechanisms in computer design. It can be assumed that some computers will be constructed in conformity with the principles underlying the processing and storage of information in the human brain, utilizing components that simulate the behavior of neurons and neuronal networks. Modern computers are generally intended for solution of formalized problems. One advantage of devices based on neuronal networks is the fact that they will permit solution of nonformalized problems, such as those associated with image recognition or with the control of complex behavior in an environment varying in a probabilistic and stochastic manner. The main distinctive feature of such computers will be their capacity for self-organization and self-programming, possibly conjoined with an ability to make nonlogical decisions, i.e., to decide among equiprobable alternatives. It is expedient to use data on the evolution of biological structures in designing them. What we have in mind here is naturally not rote duplication of the arrangement of neural networks. On the contrary, the evolutionary pathways for colloidal systems are extremely limited and our task is to go beyond biological evolution, i.e., models of cerebral systems may contain types of neurons that do not occur in nature (if they are needed for the creation of better computer systems) or have not as yet been discovered.

Many neuronal models have now been devised in the USSR and abroad and are suitable for use in the construction of neural-network models applicable to computer technology, automatic control systems, information transmission and processing systems, image-recognition systems, etc. Since many of them

are not sufficiently effective from the standpoint of information processing in the neuron, it is necessary to establish more precise general criteria for the optimum design of circuits utilizing nerve-like components, which will make it possible to characterize the ways currently being developed for simulation of neurons.

The design of nerve-like components has necessitated solution of two problems. The first is the creation of high-speed electronic models of the nervous system, in order that its behavior can be studied in cases where the capabilities of ordinary electrophysiological methods are limited (e.g., in studying networks that process sensory information, in attempting to determine the mechanisms of real-time memory, in constructing models of nervous-system pathology for diagnostic purposes, etc.). The solution of these problems will of itself justify expending effort in the creation of a wide range of neuronal models, although far from exhausting their possible applications.

The second problem is that of the use of nerve-like components and networks composed of such components in technology.

In accordance with these goals, two approaches have been employed in working out the principles for construction of nerve-like components and networks. The first and historically earlier approach is a product of attempts to copy natural analogs as closely as possible [2, 20, 24], duplicating both the information-carrying and physiological properties of neurons. The second approach consists in simulating the components of a neural network as an information-processing system [12, 15]. We are justified in speaking of neuronal technology in this instance.

The term "neuronal technology" refers to the use of the principles of information processing in neurons and neuronal networks in the design of electronic devices. In contrast to neurocybernetics, a science that is predominantly theoretical, neuronal technology is concerned with practical problems and, without obliging itself to duplicate a biological analog exactly, attempts to solve problems pertaining to the use of such an analog for purely technical purposes.

The need to divide the approaches employed into "modelling of neurons" and "neuronal technology" is a conseqence of the fact that they belong to different scientific disciplines, the former to biology and physiology and the latter to bionics, i.e., neuronal technology is that branch of bionics which utilizes the principles of information processing in neurons to create technical devices.

There are at present several major trends in the development of neuronal technology. One of them entails the creation of general-purpose nerve-like components that would permit the construction of networks with any desired degree of complexity, the only restrictions being those imposed by the models themselves [12, 15]. This is obviously a promising direction to take, since it is most feasible in technological terms and gives the components and circuits of neuronal technology general applicability.

Another area of concentration entails the introduction into neuronal networks of components different from the basic structural unit, i.e., the nerve-like component. Thus, Pak [12] describes a model of a neuronal network containing a random-number generator, a control unit, a triggering unit, and a clock-pulse generator. It must be noted at this point that, as in the design of any complex measuring and information-processing system, uniformity and regularity of structure are of great importance in the design of ultracomplex neuronal networks. These requirements are especially significant in making the transition to microelectronic technology. It would therefore seem that the most effective approach is not introduction of additional units into the network but implementation of the necessary functions of such units by the set of neurons employed.

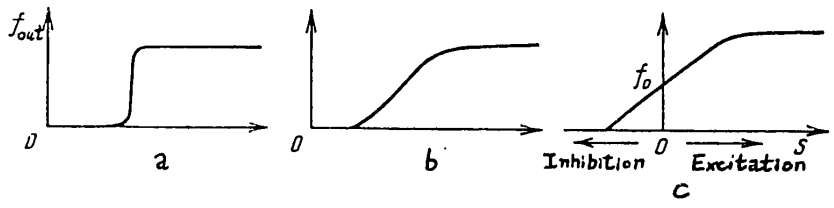
In devising neuronal models, researchers quite often attempt to reproduce the maximum number of properties inherent in the neuron in a single model. The model frequently includes components carrying out functions that appear at first glance to be uncecessary (e.g., nonlinear frequency enhancement of the processed signal to provide a clearer response to changes in the input signals [12], attenuation of the input signals, etc.) and these complicate both the model and the character of the transformations to which the information is subjected. However, such circuitry can considerably increase the effectiveness with which a neuronal network functions in solving nonformalized problems.

Another trend that merits attention is that of the development of nerve-like components based on a minimum number of elements. The components described by Ivashchenko and Donov [4] and by Nagumo et al. [25] fall into this category. The history of work in this field illustrates the convoluted manner in which neuronal technology has developed. The first nerve-like components [19, 22] had a simplified form, a consequence of the relatively unsophisticated nature of the technology and electronics of the time. Increasingly more complicated and cumbersome models were subsequently created in order to reproduce more exactly the information-carrying properties of neurons [20]. These could not be utilized to construct complex networks. The next stage in the development of neuronal technology involved a reduction in the number of elements needed to create a nerve-like component. This "simplification" resulted from the use of components embodying more extensive information-carrying properties; their effectiveness was a product not of their circuit design but of their internal physical processes (the avalanche transistor, thyristor [4], tunnel diode [25], multigate transistor, liquid crystal, etc.). Modern integrated-circuit technology can be used to create such nerve-like elements. The "simplification" of nerve-like components can, in our opinion, be of particular value as we move toward their use as the basis for molecular and supermolecular cybernetics. Combined utilization of contemporary achievements in the physics of supermolecular structures and neuronal technology can lead to the creation of dynamic self-propagating cybernetic systems.

The creation of integrated circuits composed of nerve-like elements and based on an optimum array of circuit components is also a pressing matter.

However, the underlying goal of the development of neuronal technology is not the construction of nerve-like components but the creation of devices that can be used in the national economy. It is natural and expedient to employ not neuronal models but neuronal-network models constructed from them for the development of such devices. In designing neuronal-network models, the researcher must take into consideration the fact that, in addition to the rigid steric structure of the neuron-neuron connections dictated by morphogenesis [16], operative neuronal networks are formed randomly [7, 16] and specific networks are formed for the accomplishment of definite tasks. Here each neuron can function in several networks at different times. Hence it follows that qualitatively new components or modifications of existing neuronal models are required for creation of a dynamic neuronal-network structure. One achievement in this area is the network model proposed by Pak [12], which consists of nerve-like components with inputs capable of undergoing a change of function, thus making possible to obtain a stochastic organization for the string of signals in the network.

However, the number of types of nerve-like elements qualitatively specialized for performance of complex functions is not yet sufficient for construction of complex neuronal networks. The nervous system contains more than 1000 different types of neurons [13] that have been shown to exhibit morphological differences (this does not preclude functional differences). In this connection, we must seek new functional designs for nerve-like components. The list of neuronal models that can provide the requisite diversity might include models of recognitive neurons, distributive neurons, annunciator neurons, comparison neurons, and other special types whose development would facilitate the construction of complex networks.



We feel that one promising approach to this problem is the use of the organizational principles of multivalent components and structures [9, 17] for the creation of nerve-like components and networks. It has been shown [6, 10, 23] that a neuron can be described not only as an analog element but also as a discrete threshold-type element. Proceeding from our investigations, it should be noted that the processes by which information is transformed in existing nerve-like components can be described by one of the three functions f(S) shown in Fig. 1a, b, and c, where

$$S=\sum_{i=1}^{n} a_i f_{exc} - \sum_{j=1}^{m} b_j f_{inh};$$

here f_{out} is the frequency of the pulse train at the output from the nerve-like component, f_{exc} and f_{inh} are the frequencies of the pulse trains at the excitatory and inhibitory inputs respectively, f_0 is the spontaneous-activity frequency, a_i are the weights on the excitatory inputs, and b_j are the weights on the inhibitory inputs. The characteristic curve in Fig. 1a describes a threshold-type logic element that operates on the "all or nothing" principle. Figure 1b shows the characteristic curve for a similar element possessing infinite-value logic with upper and lower thresholds, while Fig. 1c represents an element of the same type with spontaneous activity, which increases its sensitivity and extends its capabilities.

When the circuit of a nerve-like component includes certain additional features, e.g., quantization of the working frequency range, it is possible to construct neuronal networks with a rearrangeable information structure, whose operation can be described with the aid of multivalued logic. The neuron has a multiplicity of excitatory and inhibitory inputs with weights ω_i and a single output. With appropriate normalization, the input parameters x and output parameters y vary within the limits $0 \leqslant x \leqslant 1$ and $0 \leqslant y \leqslant 1$. These parameters simulate neuronal signals (pulse frequencies) and do not change sign. Moreover, the neuron has upper and lower excitation thresholds. Its operation can consequently be described by the expression [5]:

$$y = \sum_{i=1}^{n} \omega_i x_i - \theta,$$

where θ is the threshold; in arithmetic representation [18], this gives

$$y(x_1, x_2, \ldots, x_n) = (\theta + 1) \& \sum_{i=1}^{n} \omega_i x_i - \theta \& \sum_{i=1}^{n} \omega_i x_i$$

and an analogous arithmetic representation of the multivalued logical function [18]. Attempts have been made to construct such models [9, 21].

The logic of development of modern electronics also dictates the creation of nerve-like elements based on digital technology, which can specifically provide a considerable improvement in the precision with which information can be transformed and an increase in operating speed. Attempts have been made to move in this direction [3, 14], but achievement of significant results will require more intensive efforts, which will make it possible to construct complex neuronal networks that are no longer intermediate stages in information processing of the perceptron type [11] but self-organizing systems capable of making independent decisions even when there is an information deficit, i.e., under conditions of quite substantial indeterminacy.

At this point, we must set forth the basic principles of the structural organization and self-organization of such systems.

The first principle is that the system must include a sufficiently large set of components. This multiplicity is necessary in order to permit signal fluctuations. While fluctuations are undesirable in a system operating in conformity with a rigid program, they are necessary in an ultracomplex system capable of unforeseen actions. This is a consequence of well-known rules of information theory [1].

The second principle is that the network must be capable of self-formation of feedback circuits. It should be noted that two types of neuronal feedback circuits are distinguished, i.e., homeostatic and heterostatic; these are apparently interconvertible. The purpose of homeostatic circuits (neuronal networks linked by negative feedback) is maintenance of equilibrium within a given program. In all probability, heterostatic circuits (neuronal networks with negative and positive feedback exhibiting aperiodic fluctuational activity) play a considerable role. The functional rhythm of the neurons in a heterostatic circuit depends on many factors. Depending on the manner in which the primary circuits (homeostatic and heterostatic) are connected to form second- and third-order circuits, the system-rhythm pulsations can acquire a wholly individual character. In this case, the exogenous action of receptor models can have an organizing influence on the rhythmic operation of an ultracomplex network.

It also is important to provide the system with an initial program. The existence of an initial program is dictated by the need to compare newly arriving information with it. The initial program must obviously be similar to a genetic program or instinct in a biological system and is determined by the system properties, although it can be introduced from without.

In order to create conditions for self-organization, it is also necessary to simulate the system's intrinsic requirements, its "attitude" toward external factors, since a system lacking such properties cannot develop. For example, a system can require homeostatic balancing under full-load conditions.

The goals of neuronal technology as a branch of bionics are thus extremely interesting and far-reaching. The most important objective is the creation of a wide variety of initial components (neurons and general-purpose network subunits), followed by the development of subcircuits of increasing complexity and hierarchic systems.

It will be possible for neuronal technology to solve these fundamental problems in the near future. As for the subsequent development of organizational principles for complex and ultracomplex networks, it will obviously follow upon the establishment of a basis for an integrated-circuit technology for neuronal-network elements comprising large numbers of nerve-like components linked into subcircuits. Utilization of the internal

information-manipulating properties of materials is considerably more promising in those cases where they are to some extent identical to those of neuronal structures. Such properties are displayed, for example, by the hierarchic system of supermolecular compounds in polymers.

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2478
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BIOTECHNOLOGY

UDC 612.825.5:612.882

MECHANISMS OF INTERACTION OF INTERNAL AND EXTERNAL ANALYZERS

Leningrad MEKHANIZMY VZAIMODEYSTVIYA VNUTRENNIKHH I VNESHNIKH ANALIZATOROV in Russian 1980 (signed to press 8 Aug 80) pp 2, 132-142, 149

[Annotation, bibliography and table of contents from book "Mechanisms of Interaction of Internal and External Analyzers", by Professor Vladimir Semenovich Raytses, Institute of Physiology imeni I. P. Pavlov, Izdatel'stvo "Nauka", 1350 copies, 150 pages]

[Text] The monograph correlates data from the literature and the author's own materials from electrophysiological investigation of the functional organization of the central sections of the internal (visceral) analyzers and the mechanisms of the interaction of visceral afferent signals with sensory streams entering the nervous system from somatic, vestibular and visual receptors. Current data is reported on the participation of the hypothalamolimbic structures of the brain in the central control of sensory processes and in the mechanisms of the interaction of intero- and exteroceptive signalling. The book examines the significance of visceral signalling to the formation and realization of certain forms of emotional reactions and purposeful behavior, as well as to disturbances in the emotional sphere under conditions of visceral pathology. Bibliography: 449 titles; 50 figures; 5 tables.

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PHYSIOLOGY

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DIRECT TRANSFER OF CONDITIONED-REFLEX GUSTATORY AVERSION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 259, No 5, 1981 (manuscript received 6 Mar 81) pp 1265-1267

[Article by G.A. Vartanyan and T.M. Makarova, Scientific-Research Institute of Experimental Medicine, USSR Academy of Medical Sciences, Leningrad]

[Text] The first experiments on duplication of habits of the conditioned-reflex type by administration of a cerebral extract from irradiated donor animals to unirradiated animals were carried out in 1965 [1, 2]. They produced many contradictory opinions, with some authors totally denying that this phenomenon could exist [3]. However, many data have now been amassed that basically confirm the existence of the "transfer" phenomenon in vertebrates [4-6]. Analysis of the literature showed that the success of "transfer" depends in large measure on the model selected. Attempts to "transfer" complex reactions have generally been unsuccessful. It can be assumed that "transfer" of complex forms of conditioned-reflex activity is naturally hampered by the multistage, multilevel organization and functional lability of the nervous mechanisms responsible for complex adaptive behavior. It is therefore best to use reactions characterized by rapid induction, stability, and simplicity of expression, since the functional systems responsible for such reactions are at least to some extent genetically predetermined.

The gustatory-aversion reaction developed in 1955 [7] provides one such model. These researchers induced aversion to a saccharin solution by conjoining its ingestion with irradiation of the experimental animals with large doses of ionizing radiation. The gustatory-aversion reaction was subsequently subjected to extensive study in order to find different methods for evoking it and to establish the mechanisms of its central organization [8]. It was found that the processes underlying the formation and expression of the gustatory-aversion reaction are most probably functions of the phylogenetically ancient gustatory visceral system and require only minimum support from other cerebral centers. A number of data, however, indicate that higher levels of the central nervous system participate in this reaction [9]. The great biological significance of the gustatory-aversion

reaction and its high induction rate (1-3 joint presentations of the conditioned stimulus and unconditioned reinforcement are adequate for 100% fixation of the reaction) enable us to regard it as a phenomenon similar in its mechanisms to natural conditioned reflexes and enhance its value as a model for "transfer." A number of researchers [10, 11] have "transferred" gustatory-aversion reactions by administering homogenized cerebral tissue from donor rats to intact animals. The gustatory-aversion reaction was induced in the donors by conjoining ingestion of saccharin with exposure to ionizing radiation.

The present investigation was conducted to determine whether it is possible to "transfer" a gustatory-aversion reaction induced pharmacologically by the cerebrospinal-fluid method, which is physiologically the most adequate technique and corresponds to a natural pathway for neuropeptide transport in the central nervous system [12, 13].

We employed the procedure described by Reinis [1] for induction of the aversion reaction. The donor rats were deprived of drinking water for 3 days; they were permitted access to water for only 15 min per day, in special cages equipped with graduated waterers. On the fourth day, the animals were presented with 0.1% saccharin solution instead of water (also for 15 min) and, after 30 min, they were injected intraperitoneally with a 0.5 M LiCl solution in an amount equivalent to 2% of body weight. A similar procedure was carried out on the sixth and ninth days. The aversion reaction thus induced was found to have been retained when the donor rats were tested 1.5 months after its induction. The recipient rats were also deprived of drinking water. These animals were daily presented with their choice of two graduated waterers containing water and saccharin solution (for 15 min). The amount of liquid drunk was precisely determined and only those animals that preferred the saccharin solution were selected. "Transfer" of cerebrospinal fluid from the donors to the recipients was carried out 9 days after induction of the aversion reaction in the donors, since this represented the optimum interval after 100% fixation of the reaction in the donors [15]. For this purpose, 0.1 ml of cerebrospinal fluid drawn from the suboccipital cisterna was injected into the suboccipital cisternae of the recipients. The operation was carried out under shallow ether anesthesia. The recipients were then tested daily for 6 days.

The rats in the two control groups were subjected to the same conditions as the recipient animals. After a stable saccharin-consumption background was established for the first group of animals, the intact rats were injected suboccipitally with cerebrospinal fluid and the amount of liquid ingested was observed for 6 days. The rats in the second control group were not interfered with at all and we merely observed their saccharin and water consumption levels for 12 days. This period was divided into two 6-day intervals and the saccharin-consumption levels for the first and second intervals were compared.

The experimental group consisted of 80 animals, 40 of which were donors and 40 recipients. The first control group consisted of 20 animals (ten

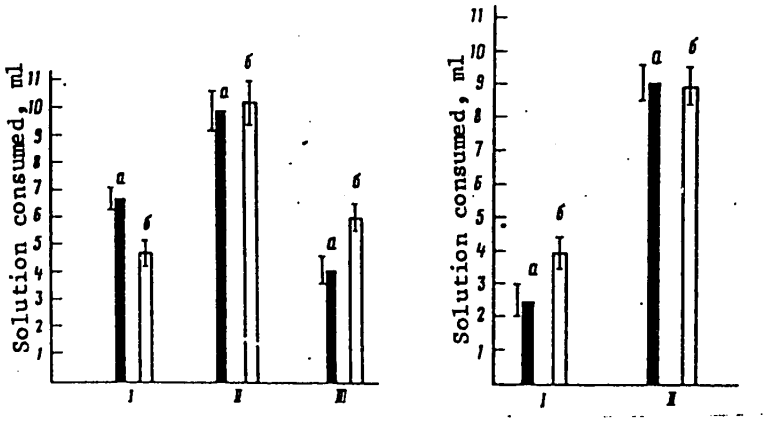

Fig. 1. Consumption of saccharin solution (0.1%) in experimental and control groups. I) Experimental group, recipients (n = 40) receiving subdural injection of cerebrospinal fluid (0.1 ml) from aversion-conditioned donors; II) first control group, recipients (n = 10) receiving subdural injection of cerebrospinal fluid from normal, non-aversion-conditioned rats; III) second control group, animals (n = 15) not given injection of cerebrospinal fluid; a) average amount of saccharin solution consumed over 6 days prior to injection of donor cerebrospinal fluid (before "transfer") (I), injection of cerebrospinal fluid from normal animals (II), and midpoint of observation period (over first 6 days) (III); b) average amount of same solution consumed after administration of donor cerebrospinal fluid (after "transfer") (I), administration of cerebrospinal fluid from normal animals (II), and midpoint of observation period (over second 6 days) (III).

Fig. 2. Water consumption and total liquid consumption for animals in experimental group before (a) and after (b) subdural injection of cerebrospinal fluid (0.1 ml) from aversion-conditioned donors. I) Average water consumption (over 6 days) by recipients (n = 40); II) aver[illegible] total fluid (water + saccharin solution) consumption (over 6 days) by r[illegible]ipients (n = 40).

intact donors and ten recipients. The second control group consisted of 15 recipients. In addition to evaluating the amounts of saccharin consumed by the recipients before and after "transfer" of cerebrospinal fluid, we determined the amount of water drunk and the total amount of liquid ingested.

It can be seen from Fig. 1 that the recipients exhibited a reliable reduction in saccharin consumption ($p < 0.05$) as a result of administration of cerebrospinal fluid taken from a donor in which the aversion reaction had been induced. The control recipients that received cerebrospinal fluid from intact donors not only failed to display any decrease in saccharin consumption but even exhibited a slight rise. Saccharin consumption by

the recipients in the second control group, which reflected the "spontaneous" fluctuations over the 12-day test period, rose toward the end of this period. Water consumption clearly increased after the recipients were given cerebrospinal fluid from donors with a pronounced aversion reaction ($p < 0.05$), while the total amount of liquid consumed was not altered as a consequence of "transfer" (Fig. 2).

The data obtained enable us to draw the following conclusions. First of all, the reliable reduction in saccharin consumption by the recipients after administration of cerebrospinal fluid from donors with a gustatory-aversion reaction proved the existence of direct "transfer" of gustatory-aversion reactions in rats. Secondly, the results of our investigation confirmed earlier data on the role of the cerebrospinal fluid as the most important pathway for neuropeptide transport in the central nervous system [12, 13].

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2478
CSO: 1840/335

ELECTROPHYSIOLOGICAL CORRELATES OF PERCEPTION AND COGNITION

Prague STUDIA PSYCHOLOGICA in Russian Vol 21, No 3, 1979 (manuscript received 9 Apr 79) pp 162-166

[Article by J. Radilova and T. Radil, Institute of Physiology, Czechoslovak Academy of Sciences, Prague]

[Text] This work is concerned with the study in man of evoked potentials, in particular of P 300 waves, in response to visual stimuli. A technique was applied which allowed us to sort into two groups and to average separately the evoked potentials in relation to how the stimulus was interpreted; subjectively, correctly or incorrectly, with certainty or uncertainty, although the subject was incorrect objectively. The results point to the fact that given a correct response with subject certainty, the amplitude of the P300 wave was greater in the majority of cases.

Uncovering the nerve mechanisms involved in psychological processes and understanding their conscious components is an important but extremely difficult task. It can be accomplished only by experimentation on human subjects. Modern electrophysiological, computing and experimental psychological approaches have openedup new possibilities mainly in the field of objective analysis of mechanisms for perception and cognition (Radil et al., 1979). However, in spite of the complex nature of the nerve processes involved, we should consider the impact of the stimulus effect. With this in mind, we can define accurately the temporal parameters of nerve processes which are the basis for perception and cognition. Therefore, we can detect the relationship between the processes, physiological correlates of which can be recorded using electrophysiological and other methods, and the psychic components about which it is possible to obtain information using experimental psychological methods. Based on natural scientific and philosophical points of view, is the premise that, despite all qualitative differences, we are not dealing with two parallel processes. Building on principles of dialectic-materialistic monism, we consider that the "neurophysiological" and "psychological" levels of phenomena are only two aspects of complex activity in the neuronal networks, responsible for the entire complex process of perception and cognition. Therefore, we can suggest positively the causal relationships between simultaneously occurring physiological and psychic events during perception and cognition, despite the fact that these very methods of analysis provide us only with correlates for a certain temporal congruence of processes.

A psychophysiological approach to the study of information intake is considerably more complex than a neurophysiological one which deals only with the neuronal mechanisms for coding and decoding and sometimes with motor reactions in response to stimuli. For analysis of information intake by man, it is necessary to bear in mind that during the process of indentification of a stimulus, results of perceptive and cognitive learning, the imprints of which are retained in memory, have a significant influence on a perception test. Moreover, identification depends on a specific perceptive-cognitive program which was created previously and also retained in memory. Thus, cognition depends to a significant degree on the nature of the perceptive-cognitive task presented to the subject by the investigator and formulated with related psychological instructions. Without doubt, even in the case of physically identical stimuli, the quality of which in all likelihood is coded and decoded by identical neuronal mechanisms, this very identification can be altered fundamentally in relation to a change in the program for perception and cognition. It stands to reason that there is no place in this scheme for any kind of indeterminate phenomenon; reflection of the stimulus in the brain results from a complicated interaction between codification and decodification mechanisms "proposed" and retained in different parts of memory. Using this approach, we can show the effect of "internal dynamic functional structures" of perception and cognition on the basis of which cognition occurs. Undoubtedly, a similar structure has its own neuronal basis which can be studied successfully using objective approaches even though an important component of it is the conscious-subjective process.

This study is concerned with objective examination of perceptive and cognitive processes related to consciousness. From the methodologic point of view, it is advantageous to construct an experimental situation, during which peripheral codification and decodification mechanisms, given repeating stimulation, are not altered. The sensory systems are usually studied in this way to analyze the differences in responses given the effect of different stimuli. With this approach, it is suggested that the internal state of the system does not change. However, this theory is not only without foundation, but also changes in the internal state are the object of a special study. Therefore, it is important to maintain a constant quality of stimuli in any study on the nature of information intake. Furthermore, it is advantageous to create an experimental situation during which the quantity of internal states of the interpreting system is wholely circumscribed. A final approach is the use of only two perceptive-cognitive states. This approach was used in our tests, described in this report.

Given the presence of two internal perceptive-cognitive states, the possibility arises for classification of evoked electroencephalographic responses into two groups in relation to which perceptive-cognitive programs for the stimulus are perceived. It is important to note here that the stimulus is retained from the point of view of its own basic qualities. The evoked electroencephalographic responses are averaged into two unrelated groups; at the end of the test it is possible to compare the form of both evoked potentials.

For this analysis, we used the technical apparatus shown in figure 1. It consisted of an LAB 8 computer and units of an SUP programmed apparatus. Each separate evoked potential was retained in the computor memory in a nonaveraged form prior to activation of the sorting program which transmitted it to one of the two parts of the computor memory where a procedure for sorting was carried out within the framework of one or another group of evoked responses which corresponds to one or another perceptive-

cognitive state of the subject. This system allowed us to overcome the problem of the latent period of the evoked potential which is significantly shorter than the latent period of the psychic process of cognition.

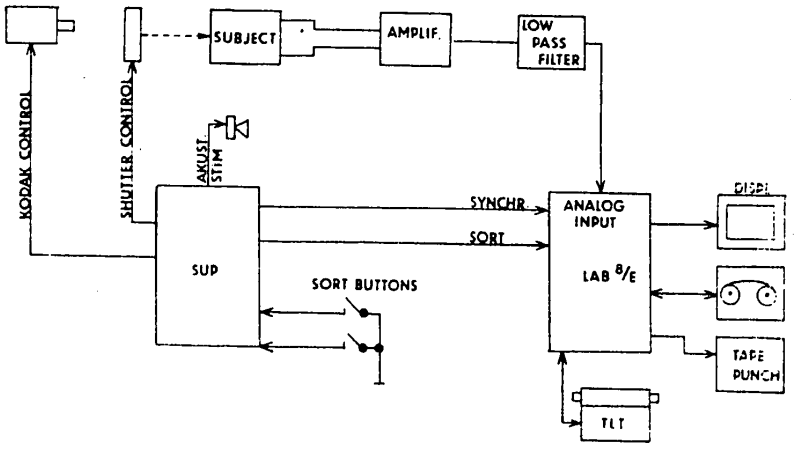

Рис. 1. Техническое устройство, которое состоит из вычислительной машины ЛАБ 8, и блоков программируемого устройства СУП и проекционного [illegible].

Figure 1. Technical Apparatus which Consists of an LAB 8 Computer and Units of an SUP Programmed Apparatus and Projection Equipment

In the above mentioned tests, both internal perceptive-cognitive states corresponded to which stimuli were correctly or incorrect recognized (Radilova et al., 1979). This test represents a variant of a solution to the problem referred to in experimental psychology by the name "7±2" (Miller, 1956). The essence of this problem consists of how much information can be absorbed in a parallel fashion by an individual. In figure 2, a sample stimulus is shown. Using a projection tachistoscope, randomly dis-

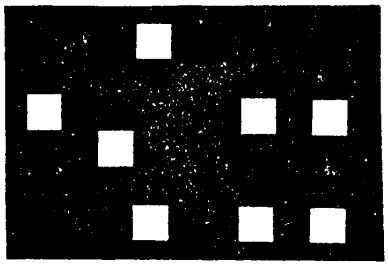

Рис. 2. Пример стимулов.

Figure 2. Sample of stimulus

tributed squares with surface dimensions of 3 x 3 cm were presented on a 48 x 31 cm screen. Similar pictures were used with 6, 7, 8, 9 and 10 elements. The randomness of their distribution was limited by the fact that they could not be placed in the center of the screen, that is in the area of eye fixation and that the squares were never

arranged in a row. The task of the subject who received related instructions was to determine the number of squares which appeared on the screen. The results were communicated to the investigator who then pressed one of two buttons connecting the electrical charge of the evoked potential to one of two groups for averaging. After an acoustical stimulus of a 20 ms duration, the shutter of the projection tachistoscope was turned on. This length of projection time was adequate for completing of the task, but inadequate for scanning of the stimulus with saccaduc eye movement. Stimuli consisting of different distribution in space and number of squares were alternated in a random order. After classification of evoked potentials by the investigator, slides were alternated automatically in the projection tachistoscope.

In one experimental series, 30 tests were conducted. The most constant components of evoked potentials were the primary positive component, the primary negative component and the latent positive component, manifested with a latent period of approximately 300 ms (P 300 wave) (figure 3). We also found that the amplitude of the latent positive component was frequently higher when the task was completed correctly, that is, when the subject evaluated correctly the number of squares in the stimulus presented (in 70 percent of the tests). In 20 percent, no difference was detected, in 10 percent a difference in the reverse direction was detected. As the criterion for the difference in amplitude, we selected a difference exceeding 20 percent.

In the second series of experiments, the criterion for classification was certainty or uncertainty of the subject as to whether he recognized correctly the number of squares in the stimuli. In this experiment, it was not important to determine whether or not the subject accomplished the task correctly. In other words, given certainty by the subject, the correct and incorrect responses were classified in the same group of evoked potentials and vice versa. The results were similar to those found in preceding tests. Given subject certainty, the amplitude of the latent positive component (P 300) of averaged evoked responses was greater in the majority of cases.

Similar results were found in experiments conducted in our laboratory (Grabowska et al., 1979) where subjects were given the task of identifying a very weakly illuminated series of 10 letters (A, B, C, E, F, L, O, P, T, Z). Only one letter was shown on the screen for a period of 20 ms and the letters were alternated in random order. The criterion for classification was correctness of recognition. The form of the evoked response was distinct from the previous tests because threshold stimuli were used. Regardless of this, in the majority of cases, the amplitude of the latent positive component was greater given correct cognition.

Although interpretation of different components of evoked potentials is extremely complicated from the neurophysiological point of view, it is clear that different waves, including the latent positive wave (P 300) represent the summarized electrical phenomena originating in large numbers in neuronal elements in time and in space. The increase in wave amplitude in the summarized evoked responses signifies an increase in the quantity of neurons participating in a given phase of the process of perception and cognition. Increase in the amplitude given correct cognition and cognition with certainty of the subject about correctness of the solution could possibly be interpreted as a consequence of the fact that, in the process of perception, a large quantity of nerve elements are involved. The variation in number of

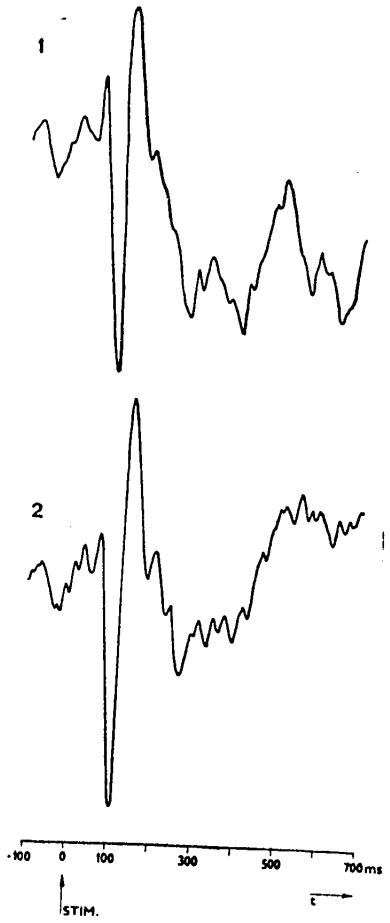

Рис. 3 Устраненные потенциалы затылочной области. Амплитуда волны П 300 выше при правильном опознании (на верху) идентичных стимулов.

Figure 3. Evoked Potentials from the Occiput Region. Amplitude of the P 300 Wave was Greater given Correct Cognition (shown on top) of Identical Stimuli

activated neurons in the course of the experiment is probably the cause (that is, the neurophysiological basis) for variation in the level of stimulation--vigilance or attention.

These tests showed that the latent component of evoked electroencephalographic

potentals is the correlate of the psychic process related to cognition of visual stimuli. Similar types of tests can aid in uncovering the mechanism for activity of the nerve substrata in complex psychic processes involved in perception and cognition.

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UDC 621.391.19

ABSTRACTS FROM THE BOOK 'DESCRIPTION AND RECOGNITION OF OBJECTS IN ARTIFICIAL INTELLECT SYSTEMS'

Moscow OPISANIYE I RASPOZNAVANIYE OB"YEKTOV V SISTEMAKH ISKUSSTVENNOGO INTELLEKTA in Russian 1980 (signed to press 30 Jun 80) pp 2-4, 135-137

[Annotation, foreword and abstracts from book "Description and Recognition of Objects in Artificial Intellect Systems", edited by Doctor of Medical Sciences V. S. Gurfinkel' and Candidate of Technical Sciences V. S. Fayn, Institute of Problems of Information Transmission, USSR Academy of Sciences, Izdatel'stvo "Nauka", 2300 copies, 137 pages]

[Text] This collection includes articles that refer to the following three problems: mathematical modeling of variability in a number of objects which are of pratical importance (speech process, certain types of images, etc.), use of mathematical methods in medicine, and certain aspects of voice control of a computer in man-machine systems.

It is designed for specialists in the field of artificial intellect, pattern recognition and in related fields.

Foreword

Time has made noticeable corrections in the interpretation of the problem of pattern recognition, and in the understanding of its essence and place in modern scientific and technical knowledge.

One of the primary manifestations of this development is the clearer realization that the task of strict recognition is secondary in a certain sense in relation to another task, namely, detection and description of the essence of variability in the recognized object. In all those cases where the essence of variability has been well studied, organization of the recognition process on its basis has already been sufficiently investigated. Construction of a description of variability also has value independent of recognition, since this affords a solution to another problem in the field of artificial intellect, namely, artificial generation of changes in the object (design, speech synthesis, automatic multiplication, etc.). All of this has resulted in the appearance in recent years of a large number of works on mathematical modeling of the laws governing a certain variable phenomenon or object. This trend also appears in this collection: the articles of Ye. F. Yurkov and V. S. Nagornov, A. S. Omel'chenko and V. S. Fayn, Ye. P. Ponomarev

and Yu. N. Prokhorov, V. N. Sorokin,and A. P. Vaynshtok treat a search for descriptions of the laws which characterize the variability of objects in diverse, practically important tasks.

Detection of the essence of variability or its ties to externally observed characteristics of an object is unfortunately a very difficult problem, which cannot always be resolved even today. A classic example of this type is the problem of seismic prediction or zoning. The tasks of medical diagnosis which are also exceptionally difficult are no less urgent. However, the urgent need for their resolution is a powerful stimulus for the application of new efforts. In this collection, these tasks are covered by the articles of A. M. Alekeseyevskaya and V. S. Pereverzyev-Orlov, P. Ye. Kunin and V. P. Karp, and Yu. B. Fogel'son.

Yet another problem of artificial intellect which is covered in the collection is organization of dialogue in the man-machine system. One of the methods of satisfying the requirement for maximum comfort and natural functioning of man in this system is to give the machine the capability of understanding commands given by voice. Studies which have already been made in this area for a number of years are represented by the articles of S. N. Krinov, V. P. Savel'yev, G. I. Tsemel', as well as A. V. Vasil'yev, S. S. Raksheyev and V. M. Chizhkov, and S. M. Shevenko.

The originality of the suggested methods and urgency of the topics raised will be of undoubted interest to specialists in the field of pattern recognition and prediction.

UDC 621.391

FINDING THE EMPIRICAL RELATIONSHIP USING ONE-DIMENSIONAL FUNCTIONS

[Abstract of article by Yurkov, Ye. F. and Nagornov, V. S.]

[Text] A method is described for finding the relationship between quantities from experimental data using one-dimensional functions. An algorithm is presented for discovering one-dimensional functions and results of an experimental verification of the method.

Three illustrations, eight bibliographic entries.

UDC 621.391.19

METHOD OF TRANFORMING FLAT CURVES BASED ON MOVING REFERENCE POINT METHOD

[Abstract of article by Omel'chenko, A. S. and Fayn, V. S.]

[Text] A new method is analytically worked out for transforming flat curves. It simulates the local interactions between the points of the curve. It is based on the theory of differentiated varieties. The method is applied to solving one of the problems of correcting charts of the ice situation.

Three illustrations, six bibliographic entries.

UDC 621.391.19

LOCAL EVALUATION OF INFORMATION CONTENT OF FLAT CURVE

[Abstract of article by Omel'chenko, A. S.]

[Text] A possible approach is examined for evaluating the complexity of tabulating a curve for the particular case which is widespread in practice where it is necessary to have not only a global, but also a local estimate when the complexity of the curve (evaluated by a traditional plan) significantly varies on different sections. An algorithm is presented which makes the local evaluation of complexity. The algorithm is applied in one of the problems of correcting charts of the ice situation.

Three illustrations, three bibliographic entries.

UDC 534.42

ADAPTIVE LINEAR FILTERING OF SPEECH SIGNALS

[Abstract of article by Ponomarev, Ye. P. and Prokhorov, Yu. N.]

[Text] An examination is made of recurrent algorithms for adaptive linear filtering of a speech signal from a mixture with additive white noise. The presented algorithm contains a block of recurrent evaluation of the parameters for the speech signal model, and a block for isolating the signal from the noises. The relative independence of these blocks results in a comparatively simple procedure for processing the signal. The algorithms of recurrent evaluation of the parameters make it possible to construct both an evaluation of the autoregression parameters, and the parameters of a multiple-stage model. Conditions for the validity of the evaluations are presented. Results of digital modeling done on a real signal are given.

Three illustrations, eight bibliographic entries.

UDC 621.391.192.2

MECHANICS OF TONGUE MOVEMENTS

[Abstract of article by Sorokin, V. N.]

[Text] A description is made of the movements of the tongue as a solid body under the influence of shifting of its root and turning of the lower jaw, as well as a model for elastic deformations of the lingual surface. Results are given from approximating the x-rays of the vocal tract by natural functions of elastic fluctuations. The experiment used speech material in the form of x-rays of all vowel sounds of Swedish pronounced in a drawn-out manner, and x-ray film frames of the basic forms of articulation of Russian pronounced at a rapid rate both in isolation and in syllables. The experiments made it possible to pinpoint the type of boundary conditions for the tongue root. The average error of approximation on the anterior portion of the tongue was about 6% with five employed natural functions.

Three tables, seven illustrations, 13 bibliographic entries.

UDC 621.391.144

ASSESSMENT OF INTERFERENCE-RESISTANCE OF SPEECH REJECTOR ANALYSIS

[Abstract of article by Vaynshtok, A. P.]

[Text] The interference-resistance of speech rejector analysis is discussed. Results are given of computer experiments to evaluate the parameters of the formant fluctuations in an artificial three-formant signal distorted by noise.

One table, one illustration, five bibliographic entries.

UDC 621.391

PROBLEM OF 'TWO PHYSICIANS' IN PATTERN RECOGNITION

[Abstract of article by Alekseyevskaya, M. A. and Pereverzyev-Orlov, V. S.]

[Text] Different physicians describing one patient in terms of general vocabulary give the terms a different meaning, and consequently speak in different languages. It is noted that it is possible to reduce formalisms of the decisive and prognostic rules type obtained with one physician to the languages of other physicians.

UDC 621.391.19

METHOD OF RETROSPECTIVE RANDOMIZATION TO COMPARE EFFECTIVENESS OF ALTERNATIVE TREATMENT VARIANTS

[Abstract of article by Kunin, P. Ye. and Karp, V. P.]

[Text] One of the possible approaches is examined for comparing the effectiveness of alternative treatment variants where retrospective data are used in contrast to "blind sampling" in the comparison of comparable groups of patients.

One table, two bibliographic entries.

UDC 621.391

REDUCING RESELECTION IN CONSTRUCTING DIVIDING SIGNS

[Abstract of article by Fogel'son, Yu. B.]

[Text] A reselection algorithm is examined in teaching programs of object recognition. An iteration process is suggested which searches for the combinations of parameters that form good divisions of the objects of classes presented for training. This process is based on the concept of gradual "pulling" of the necessary parameters by those that were selected in the previous iteration. The convenience of using the algorithm for tasks of medical diagnostics is shown.

Three bibliographic entries.

UDC 621.391.199

SIGNIFICANCE OF FREQUENCY CHANGES IN MAIN TONE FOR AUTOMATIC SPEECH RECOGNITION

[Abstract of article by Krinov, S. N., Savel'yev, V. P. and Tsemel', G. I.]

[Text] The expediency of using the dynamics of the main tone for segmentation of the speech signal is examined, in particular, combinations of vowel-voiced consonant which comprise a part of coherent pronunciation. The temporal position of the frequency maximum of the main tone and its relative increment depending on the context and speaker are studied.

One table, two illustrations, six bibliographic entries.

UDC 621.391.199

WORD GROUPING BY SIGNS OF REFERENCE SOUNDS AND SOUND COMBINATIONS

[Abstract of article by Krinov, S. N.]

[Text] An examination is made of a grouping algorithm (divisions into groups) of any set of words according to the signs of the reference sounds and sound combinations. The code (number) of the group is a sequence of numbers which code the types of sound combinations between neighboring vowels of complete formation. The algorithm of word recognition which uses the grouping algorithm is described.

One illustration, six bibliographic entries.

UDC 621.391.199

AUTONOMOUS PRODUCTION OF WORD SIGNS

[Abstract of article by Vasil'yev, A. V., Raksheyev, S. S. and Chizhkov, V. M.]

[Text] A system for obtaining the original description of pronunciations lasting to 1.6 s is examined. In order to form a temporal sequence of signs, a device is used to isolate signs and a display which is connected to a writing machine. The use of this system made it possible to abandon the use of a computer to obtain statistical material necessary for working out a word recognition algorithm.

Three illustrations, five bibliographic entries.

UDC 621.391.19

MACHINE 'UNDERSTANDING' OF TEXTS IN NATURAL LANGUAGES

[Abstract of article by Shevenko, S. M.]

[Text] The ideas and formalisms used in active and theoretical systems for understanding natural language are examined. A critical approach to modern linguistic concepts of machine "understanding" is suggested from the viewpoint of systems linguistics mainly presented in the works of Soviet scientists.

44 bibliographic entries

9035
CSO: 1840/356

UDC 591.513.5:51

MATHEMATICAL SIMULATION OF ELEMENTARY REASONING

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 259, No 2, 1981 (manuscript received 16 Oct 80) pp 509-512

[Article by V.N. Kozlov, Moscow State University imeni M.V. Lomonosov]

[Text] The purpose of the present investigation was to construct a model of the functional mechanisms of the animal nervous system that provide the basis for the purposive behavior observed, for example, in L.V. Krushinskiy's well-known experiments performed to study elementary reasoning [1]. It also proved possible to interpret the conditioned reflex within the framework of the model obtained; a somewhat simplified version of the model can be applied to the problem of image recognition [2, 3].

The most characteristic property of elementary reasoning in animals is their ability to distinguish certain very simple environmental patterns and utilize them in devising behavioral programs. It is significant that behavior based on elementary reasoning can (in contrast to learned behavior) be carried out when an animal first encounters an unusual situation in its habitat. One example of the manifestation of elementary reasoning in animals is their capacity for extrapolation of the movement of a stimulus, i.e., their ability to predict the future position of a moving stimulus and to act in conformity with this prediction [1].

The model is based on the following action schema. A given environmental situation is used as the basis for selection of one of the set of situations stored in the animal's memory as an environmental model. Having a knowledge of the properties of this model, the animal can then assume that the same properties are present in the environmental situation and select purposive behavior on this basis.

In structural terms, the model to be described can be represented in the form of a system that interacts with the environment and consists of the following subsystems (Fig. 1).

Subsystem CS is the encoding system. The result of its operation is S, i.e., the code for the environmental situation. The situation code consists

of a pair of sets $\langle M,T \rangle$. If, for example, a situation involves a number of objects arrayed in a certain manner, then M is the set of objects and T characterizes their relative positions and is the set of all numbers having the form r(a,b)/r(c,d), where a, b, c, and d are arbitrary objects belonging to set M and r(a,b) and r(c,d) are the distances between the corresponding objects. If the situation is temporal, i.e., involves a sequence of events taking place over a period of time, M is the set of events and T is the set of all numbers having the form t(A,B)/t(C,D), where A, B, C, and D are arbitrary events belonging to set M and t(A,B) and t(C,D) are the time intervals between the corresponding events.

The model memory is the set of codes for certain situations, to the elements of sets M and T for which weights reflecting the importance (significance) of the elements in the situation have been assigned. During the course of the animal's interaction with the environment, the weights on the elements of the situation codes in the memory are reassigned from low-significance elements to more significant elements. The basis for this reassignment mechanism was the hypothesis that the most characteristic elements of a definite situation are those that are most frequently encountered.

The "operator" subsystem implements a certain procedure utilized to work with the information contained in the memory and is governed by the "guide to action" for a given enviromental situation. The "implementation" subsystem comprises effector organs and organizes purposive behavior in the environment on the basis of the information contained in the "guide to action."

The "operator" subsystem functions in the following manner. The concept of similarity between situations is introduced. When a given environmental situation arises, the most similar situation is sought in the memory and the situation found is termed the guide to action. The objects involved in the environmental situation and the guide to action are subjected to a definite type of comparison when they are found to be similar, a process that makes it possible to utilize the information contained in the guide to action to organize behavior in the environmental situation in question.

For example, let the guide to action be situation A (Fig. 2), where a, b, c, and d are objects present in the animal's surroundings, e.g., tables, chairs, instrument control panels, etc., while m is a feeder containing food. Let the environmental situation be situation B, which differs from situation A only in the absence of object m, i.e., the feeder. The absence of the feeder in situation B may mean that it has been hidden behind something and is therefore not visible. Objects a, b, c, and d in situation B are compared with objects a, b, c, and d in situation A in determining the similarity of the two situations. By using situation A and the known location of feeder m with respect to objects a, b, c, and d in this situation, it is possible to determine the presumed location of the hidden feeder in situation B.

Now let the guide to action be temporal situation $\mathcal{H}_1$ (Fig. 3) and the environmental situation be temporal situation $\mathcal{H}_2$. In situations $\mathcal{H}_1$ and $\mathcal{H}_2$, points H_1, H_2, etc. represent certain events taking place at discrete instants, while the intervals between points correspond to the times separating these events. Temporal situations can reflect the unfolding of certain events with time, e.g., the movement of a stimulus. It is readily seen that the guide to action $\mathcal{H}_1$ for environmental situation $\mathcal{H}_2$ makes it possible to assume that events H_4 and H_5 will take place in the future and to organize behavior in conformity with this prediction.

It should be noted that the environmental situation was represented as a "fragment" of some situation in the memory solely for the sake of greater clarity in the above examples. In order to make a prediction, it is in no way obligatory that the memory contain precisely that situation a "fragment" of which is perceived in the environment. The environmental situation can lack some elements of the situation in the memory, can contain new elements not in the memory, can have altered relative element positions, etc., so that the prediction in some sense utilizes and analogy of the situation.

If the distance separating the environmental situation and the guide to action is small, actions taken on the basis of the guide can be interpreted as resulting from learning by the animal. In actuality, if the guide to action, i.e., the situation stored in the memory, is the same as or very similar to the environmental situation, this means that the animal has already encountered the same sort of environmental situation, is familiar with it, and acts on the basis of its knowledge of the situation.

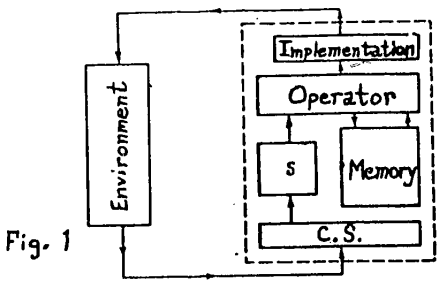

Fig. 1

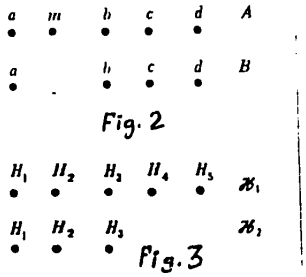

Fig. 2

Fig. 3

Fig. 1. Block diagram of model.

Fig. 2. Situation in memory and environmental situation in determination of location of hidden feeder.

Fig. 3. Situation in memory and environmental situation during prediction process.

If the distance between the environmental situation and the guide to action is sufficiently great, one can consider a rather high degree of "abstraction" to be required, since any action is undertaken on the basis of a situation in the memory that differs quite substantially from the environmental situation. In this case, the animal does not have information on either the specific environmental situation or situations rather similar to it. This obviously corresponds to what Krushinskiy called the first presentation of a situation and we are therefore dealing with the case that he described as requiring elementary reasoning.

In this interpretation, actions based on learning and those requiring reasoning appear to be the antipodes of the same functional mechanism. Actions based on learning can be regarded as a special and, in a certain sense, primitive case of the operation of the mechanism responsible for actions requiring reasoning.

Let us now consider how a conditioned reflex is represented in the model. Let a temporal situation ABX_1X_2C be stored in the memory, where AB designates the conditioned stimulus and element C involves reinforcement. Those elements that can vary from situation to situation are designated as X_1X_2. The induction of a conditioned reflex consists in presentation of a conditioned stimulus AB n times, followed by reinforcement. Within our conceptual framework, this is nothing other than repetition of situation ABX_1X_2C n times. There is an increase in the weights on the corresponding situation elements in the memory. Figure 4 provides a partial illustration of the process: an increase in the weight on an element represented by a letter is reflected in an increase in its size. If the memory contains some situation that also starts with AB (e.g., ABF_1F_2N), the "guide to action" when AB appears in the environment is not this situation but situation ABX_1X_2C. The prediction is consequently of stimulus C, with appropriate behavioral sequelae.

If conditioned stimulus AB is presented but reinforcement C is not given, the weights on the corresponding elements are reduced. Ultimately, situation ABX_1X_2C ceases to dominate when AB is presented (the conditioned reflex fades away).

Similarity between situations is introduced in the following manner. We are given the situations $A = \langle M_A, T_A \rangle$ and $B = \langle M_B, T_B \rangle$ with $\|M_A\| = n$, $\|M_B\| = m$, and $n \geqslant m$ ($\|M_A\|$ and $\|M_B\|$ are the sizes of sets M_A and M_B). We will consider some transformation ψ: $M_B \to M_A$. Proceeding from considerations of meaningfulness, we can introduce some class $\mathcal{P}$ of situation-similarity functions, each of which takes into account given characteristics of situations in evaluation of their similarity. We assume that, for each i, some number $\xi_i(x)$ is assigned to each element x of the code for any situation,

this being the weight on the element in similarity evaluation at level i. Over and above class $\mathfrak{P}$, we can then introduce some "integral" similarity function that takes into account in unified form the properties described by the individual functions belonging to this class. We assume class $\mathfrak{P}$ to consist of three functions (p_1, p_2, and p_3). Function p_1 evaluates the number and significance of the elements of sets M_B and M_A that are compared with one another for a given representation ψ. Function p_2 evaluates the number of identical elements of sets M_A and M_B compared. Function p_3 evaluates the similarity of the relative positions of the objects comprising situations A and B.

Each of the functions p_1, p_2, and p_3 is defined by a system of axioms. These axioms are derived from considerations of meaningfulness related to behavioral analysis. The overall similarity P(A,B) between situations is defined as $P(A,B) = \max(p_1 + p_2 + p_3)$, where the maximum is taken over all possible representations $\psi: M_B \to M_A$.

In investigating this model, we came up with a number of statements characterizing its properties. In this article, we will limit ourselves to an interpretation of the significance of the analytic results.

Environmental situation	Situation in memory
ABK_1K_2C	ABX_1X_2C
ABL_1L_2C	ABX_1X_2C
ABD_1D_2C	ABX_1X_2C

Fig. 4. Increase in weights on elements of situation stored in memory during induction of conditioned reflex.

It was shown that the situation code remains unchanged when there is a shift, slewing, similarity transformation, or symmetry transformation of the situation as a whole, i.e., the model "ignores" these situation transformations. In can in a definite sense be assumed that it evaluates the situation objectively, i.e., appraises nothing but the situation. The aforementioned transformations can be perceived only if there are frames of reference external to the situation. In this case, however, it must be considered that one is no longer dealing merely with the situation at hand but with something more extensive, since the frame of reference is "tied" to objects that do not enter into the situation.

It was shown that functions p_1, p_2, and p_3 can only be monotonic functions of a certain special form of argument. The sense of the corresponding hypotheses is that, within the framework of the assumptions made in constructing the model, the form of the functions that can be used in determining the similarity of situations is not arbitrary but quite clearly predetermined.

It is not always necessary to know the exact degree of similarity between situations: it is sometimes sufficient to have only an estimate, i.e., the range of similarity values. The limits of this range depend on certain characteristics of the situation and may be valid for entire classes of situations having these characteristics. Some estimates of this type were obtained for the model.

Calculation of similarity represents a certain procedure. The concept of the complexity of calculation of the similarity between situations is introduced and can be interpreted as the difficulty of determining similarity, which reflects the actual difficulty in operating with situations. Complexity estimates have been made. The degree of complexity is rather high in the general case. However, one can limit the class of situations to be considered to those that are in a definite sense "reasonably" organized in relation to one another (a strict definition can be given of "reasonable" organization). Complexity is significantly reduced in this case.

A modification of the model that is applicable to the image-recognition problem has been constructed in the form of a computer program with which experiments have been conducted.

The author wishes to express his deep gratitude to L.V. Krushinskiy and V.B. Kudryavtsev for their assistance.

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2478
CSO: 1840/349

RADIATION BIOLOGY

UDC: 621.039.55

GAMMA-INSTALLATIONS FOR RESEARCH AND RADIATION BIOLOGY

Moscow GAMMA-USTANOVKI DLYA RADIOBIOLOGICHESKIKH ISSLEDOVANIY in Russian 1981 (signed to press 20 Feb 81) pp 2-4, 60

[Annotation, foreword and table of contents from book "Gamma Installations for Research and Radiation Biology", by Aleksandr Nikolayevich Gladilkin, Igor' Vasil'yevich Ignatov, Rostislav Aleksandrovich Kuzin et al., Energoizdat, 810 copies, 60 pages]

[Text] Annotation

This is a presenation of problems in creation of gamma devices intended primarily for carrying out radiobiological studies to ensure radiation safety and, especially, radiation safety for space flights. The devices can be used to solve a wide group of problems in general radiobiology, radiation hygiene, radiation resistance of components in electronic equipment and in some areas of agriculture and public health.

The book is intended for specialists working in the area of modeling radiation effects using gamma radiation while conducting experimental research on radiobiology, radiation resistance, etc. It is also helpful for engineering and technical workers involved in the development of gamma-radiating devices. 10 tables, 24 illustrations, 57 bibliographic references.

Foreword

The past 10 years have been marked by intensive growth in research on near-earth space using artificial, unpiloted, earth satellites.

A logical extension of the process of space research was to be the process of mastering space, wherein a man is obliged to remain aboard a piloted spacecraft for extended periods. This stay in space involves hazardous radiation factors of effects on the cosmonaut such as galactic and solar cosmic radiation.

The requirement for ensuring spaceflight safety called forth the broad formulation of radiobiological experiments to study the radiation effect of the emanations of cosmic space.

Based on requirements for devices to model the radiation effects of space emanations, a unique system of 52 "Lyustra" gamma devices, for modeling the chronic effect of galactic space radiation on large laboratory animals, and a "Kobal't" gamma device, for modeling the acute effects of solar burst emanations, have been developed and implemented. The "Lyustra" gamma devices have made it possible, for the first time, not only in the USSR but, also, in the world, to conduct an experiment over the course of six years in which 246 dogs have been chronically irradiated with doses ranging from 25 to 150 rads per year*. The radiobiological findings contribute to the solution not only of radiation safety of space flights, but, also, of standardizing radiation effects for individuals working with ionizing radiation sources.

The "Yenot-1" and "Yenot-2" gamma devices are intended to model chronic and acute radiation effects on small laboratory animals over a wide range of dosages. These achieve a radiation effect of a various temperal character (acute, fractionated, chronic and combined effects) in order, primarily, to answer questions of effective doses. The devices make it possible to conduct a large number of experiments with variations of chronic and acute irradiation of animals.

The "Svet" gamma device is intended for experimentation to determine the coefficients of relative biological effectiveness of heavy charged particles. This device has the same range of dosage powers which is available in accelerators of protons and heavy ions with various energies.

The "Start" gamma device was created and used for ground processing of different versions of on-board experiments in which animals are irradiated aboard a spacecraft; it has also been used for a long time to irradiate components of electronic and other equipment.

The "Integral" and OU-3 gamma devices were created for experiments in radiobiology under natural conditions--on mountains and aboard spacecraft under flight conditions. The "Integral" device is small and light in weight, and can be carried by any type of transport. The OU-3 responds to the requirements imposed on space technology; it has successfully passed a group of ground tests and has been used to conduct an experiment in radiobiology with small laboratory animals aboard the "Kosmos-690" satellite.

The book presents some findings of research in radiobiology obtained using all of these devices.

The design features of the gamma devices were determined by their function and the use of ^{60}Co and ^{137}Cs gamma radiation point sources. The radiation and physical

*Extra-systemic units (rad, ber, roentgen, curie) are used here and below. These are easily converted to SI units, as follows: 1 rad = 0.01 Gy; 1 ber = 0.01 J/kg; 1 R = $2.58 \cdot 10^{-4}$ C/kg; 1 Ci = $3.7 \cdot 10^{10}$ Bq.

parameters of the devices were obtained through calculation, and then thoroughly studied experimentally.

These devices can be used, and are being used, not only for research in space radiobiology, but also to solve a wide group of problems of general radiobiology, radiation hygiene and radiation resistance.

The authors are deeply grateful to N. A. Tufitulova for her help in preparing the manuscript for publication.

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CSO: 1840/309

HUMAN FACTORS

UDC: 681.51:007.5

JOINT WORK OF MACHINE AND HUMAN OPERATOR IN SEARCH SITUATION

Kiev OTBOR I PEREDACHA INFORMATSII in Russian No 61, 1980 (manuscript received 7 May 79) pp 14-19

[Article by B. P. Gazdayka, T. N. Lunik, V. V. Rudenko, A. N. Svenson and N. T. Tynnaya, L'vov, from collection "Information Screening and Transmission" edited by L. Ya. Mizyuk (chief editor) et al., an interagency Ukrainian collection, founded in 1965, Izdatel'stvo "Naukova dumka"]

[Text] Current systems of mass screening [selection] of information, such as aerial photography, taking photos of earth from artificial satellites, photographic and television studies of the ocean floor and others yield an enormous amount of visual information amounting to hundreds of thousands of frames within a relatively short period of time. Of this volume of information, only a small part is of real interest in each specific case. This part must be retrieved from the overall array of spatial signals that one generally calls the background. As a rule, such retrieval [searching] work is done by a human operator with professional skill in recognizing objects under changing retrieval conditions. In this case, the operator's visual system is considered to be ideal [1], considerably superior to the capabilities of modern automatic systems with regard to adaptability, universality and imperviousness to interference [noise].

However, there are both physical and psychological limitations inherent in a human operator, which have a substantial influence on the efficiency of his work. These limitations include, first of all, fatigability that leads to decline of reliability of operator performance as a function of time.

In operator retrieval systems, monotony related to visual perception and processing of a large quantity of patterns, a significant part of which contains no useful information, is an important factor that causes fatigue.

In order to determine the effect of operator fatigue on efficiency of performance, a study was made on a unit specially developed for this purpose, which simulates rather completely the psychophysical conditions of retrieval system operator work, where the presented image is in the form of a television frame.

This device made it possible to deliver to the operator images with different types of backgrounds, configurations, dimensions and contrast of objects. The operator's task included continuous tracking during a specific work session of the image in a tested background on the screen of a videomonitoring device and determining

his opinion as to the presence on the screen of the sought object, with specified dimensions and shape, by means of controls.

During the experiment, smooth rectangular objects of a constant brightness with a 4:1 ratio between the sides and relative contrast of 0.15 to 0.75 in relation to average background brightness were displayed to the operator. Such presentation of the retrieval object conforms to a broad range of tasks, since most sought objects, which are products of civilization, have rectilinear elements in their structure, unlike objects of natural origin around them which usually have arbitrary outlines. The dimensions of the object of retrieval were in the range of 0.1 to 0.5 of the length of a line. The sharpness of the image displayed to the operator changed from 500 to 50 lines. The image was changed from a contrasted to "diffuse" one. Operators who had previously undergone a course of instruction and training participated in the experiment.

The experimental studies of operator retrieval work with consideration of fatigability were conducted with increasing duration of sessions of continuous work up to 4 h, with a work load that was uniformly distributed in time.

The experimental results, which were recorded after every hour of work, were evaluated on the basis of the average cost of decision making or degree of risk, determined by the following equation [3]:

$$R = C_m P_m + C_{fa} P_{fa} \qquad (1)$$

where $P_m = n_m/n$ and is the probability that the operator will miss [or skip] an object; $P_{fa} = n_{fa}/n_f$, probability of false alarm; n_m is the number of objects skipped by the operator; n is the total number of objects presented to the operator; n_{fa} is the number of frames in which the operator gave false alarm; n_f is the number of elementary frames viewed by the operator; C_m, C_{fa} are the cost of mistakes referable to missing objects and false alarm, respectively (first and second type of mistakes) determining the cost of these errors under concrete retrieval conditions.

Figure 1 illustrates the values of risk R as a function of operator working time T with varying sharpness of image $m_1 > m_2 > m_3$ and $C_m = C_{fa} = 0.5$.

Analysis of these functions $R = f(T)$ shows that the results of operator retrieval work at the first moment of time are determined primarily by objective factors of the retrieval operation (sharpness of image, dimensions and contrast of the sought object, etc.).

The relative increase in risk ΔR (difference between values of R at the start and end of the work period related to 1 h of work) with increase in duration of the session remained virtually constant and could serve as the quantitative estimate of fatigability of the operator.

The functions illustrated in Figure 1 are similar to the results of studies of attention reported in [5, 6]. They demonstrated that concentration of attention diminishes from the 15th min of observation on, then stabilizes at a certain level (25-30% unnoticed signals) and, starting in the 45th min of work no stimuli (moral or material), no improvement of working conditions for purely operator retrieval led to improvement of attention for the next 30 min. Only frequent

breaks (3-5 min every 30 min of work) made it possible to retain reliability of retrieval at the initial level, which is determined by the retrieval conditions and organization of the work place.

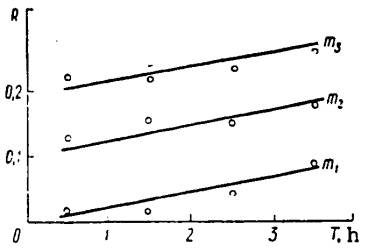

Figure 1.

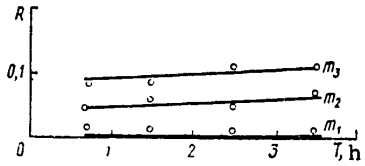

Figure 2.

On this basis, we can recommend a session of 20-30 min with brief (5-15 min) breaks between sessions for practical organization of operator retrieval. However, if it is necessary to provide for continuous retrieval, such organization requires an increase in number of operators.

In theory, it is possible to try to automate the entire process of retrieval and recognition by classical methods, but this is unlikely to lead to results that could be applied to practice: examination of each segment of a frame to find a specified pattern in it (for example, building of a specific type, part of a road, submerged weight [cargo?] in the case of underwater photography, etc.) requires the use of rather complex algorithms [2], as a result of which the entire process of automatic retrieval of useful information turns out to be considerably longer than manual retrieval. This is attributable chiefly to the fact that an automatic system would meticulously examine parts of a frame known to be empty for the purpose of detecting in it all isomorphic variants of the specified pattern, whereas an operator would discard the frame at first glance.

The situation could be significantly improved if the task of retrieving useful information is reduced to the task of retrieving simple patterns [images), which refers to the typical details of a geometric structure of the sought image, the number of isomorphic variants of which is rather small, for example, segments of straight lines.

Experience has shown that straight lines, as examples of simple patterns, are rather widespread and, on their basis, one can solve the problem of automatic preselection of signals.

However, the drastic restriction of tags [signs, features] of the sought pattern, i.e., reduction of volume of useful information about the object with partial automation of the retrieval process, would result in singling out, along with useful objects, some false ones containing some of the tags inherent in useful objects.

One can reduce the quantity of false alarms at the second stage, the stage of identification of patterns on each of all the preselected informative frames by the operator. In this case, the operator's duties include making the final decision as to the presence or absence of the sought object in the presented frame.

Thus, the operator is relieved of the obligation to constantly monitor the presented image and thereby also of processing a large amount of monotonous information, which is equivalent to reducing the duration of an operator work session. In this case, it is proposed to organize the joint work of a machine and operator. Then the task of the automatic unit includes preprocessing of the image and issuing a warning signal about the presence of the object on a frame at the time this frame is shown to the operator; the operator's task is to analyze the image after the machine's signal and make the final decision as to whether the object discovered by the machine is referable to the category of sought or false objects.

Evidently, the range of practical organization of the retrieval operation in a machine--operator system is determined primarily by the probability characteristics of the automatic retrieving device. Since, with such organization of retrieval, the operator evaluates and identifies only the objects fixed on by the machine, the automatic retrieval device must have zero or close to zero probability of skipping an object P_{mA}. This is associated with an increased probability of false alarm by the machine P_{faA}, and, as will be shown in the following, under specific conditions of retrieval this cannot serve as an obstacle to the practical use of the proposed system, since the operator is able to "correct" the machine's mistakes [4].

Statistical experimental studies were conducted using the proposed scheme of organization of retrieval.

The experimental methods and testing conditions did not differ from those described above. To simulate the operation of an automatic retrieval device, each operator work place was equipped with individual audio signalization, the use of which was attributable to the fact that the channels for perception of visual information are loaded. The audio signal reporting presence of an object (sought or false) on a frame was delivered from the instructor's console just prior to delivery of this frame to the operator.

The results of the experimental studies of joint machine and operator work are illustrated in Figure 2 in the form of magnitude of risk R as a function of duration of session T with probability of false alarms by the machine $P_{faA} = 0.01$ and with $P_{mA} = 0$ for different sharpness of image m and $C_m = C_{fa} = 0.5$.

A comparison of the results of the operator's independent work (Figure 1) and operator work with the machine (Figure 2) shows that the use of the machine--operator system lowers the value of R to almonst one-half, both during the first hour of work and the entire work session.

With the use of machine--operator system, the degree of operator fatigability decreases to more than one-third ($\Delta R = 0.01$), as compared to retrieval by the operator (Figure 1, $\Delta R = 0.025$). Under particularly favorable conditions ($m_1 = 500$ lines), the operator virtually fails to get tired and retrieval reliability is close to the possible maximum throughout the work session.

Let us single out three different schemes of organizing television retrieval systems: automatic, operator and combined machine--operator.

Figure 3 illustrates the experimental (by the method described previously) mean cost of risk R_Σ of the machine--operator scheme as a function of the machine's

probability characteristics with m_1 = 500 lines (solid line in Figure) and m_2 = 50 lines (dash line), various correlations between costs of first and second type of mistakes C_m, C_{fa}, and various values of probability of machine skips P_{mA}, namely: curves 1 and 1'--P_{mA} = 0.1; 2 and 2'--P_{mA}= 0.05; 3 and 3'--P_{mA} = 0.

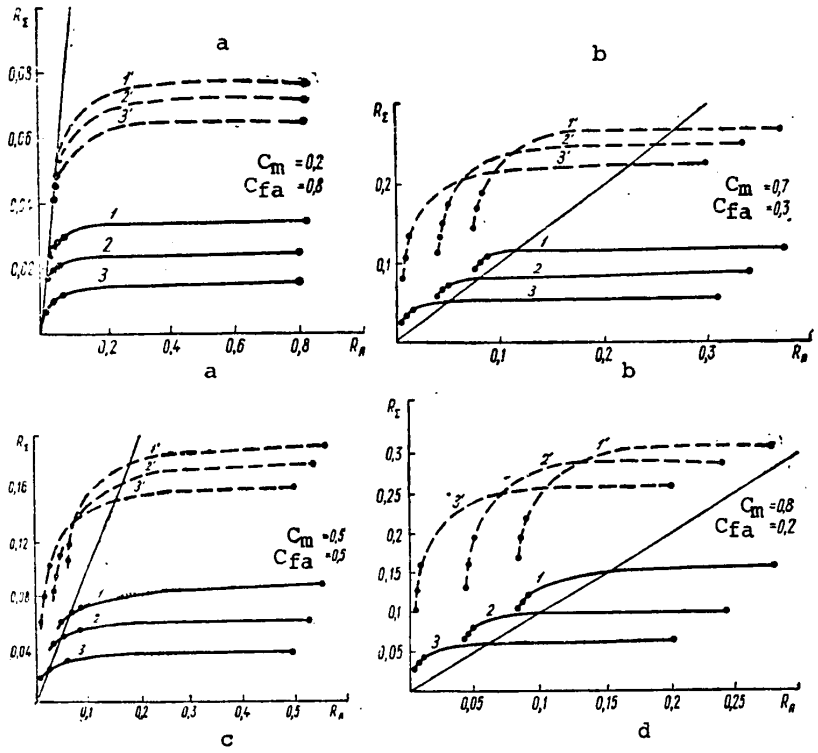

Figure 3.

Analysis of the illustrated functions $R_\Sigma = f(R_A)$ shows that when the risk is low for the automatic device, ratio $R_A/\frac{C_m}{C_{fa}}$ does not exceed 0.8-1.0, with m_1 = 500 lines and 0.01-0.015 with m_2 = 50, maximum efficiency can be obtained with automatic retrieval (Figure 3, b, c, d). With increase in $R_A/\frac{C_m}{C_{fa}}$ and P_{mA} = 0, it is more efficient to use the combined machine--operator scheme (Figure 3a). If the probability characteristics of the machine become worse, it is more efficient to use operator retrieval. With decrease in sharpness of the image, the range of application of automatic retrieval broadens.

A better idea about the choice of organizational retrieval scheme can be gained by examining Figure 4, which illustrates the range of effective use of one of three (under curves a, b, c) possible organizational retrieval schemes as a function of probability characteristics of the machine P_{mA} and correlation between cost of mistakes of the first and second type, C_m/C_{fa}, m_1 = 500 lines (Figure 4a) and m_2 = 50 lines (Figure 4b); with P_{mA} = 0, the areas are marked by solid lines and with $P_{mA}>0$ the areas are marked by dash lines.

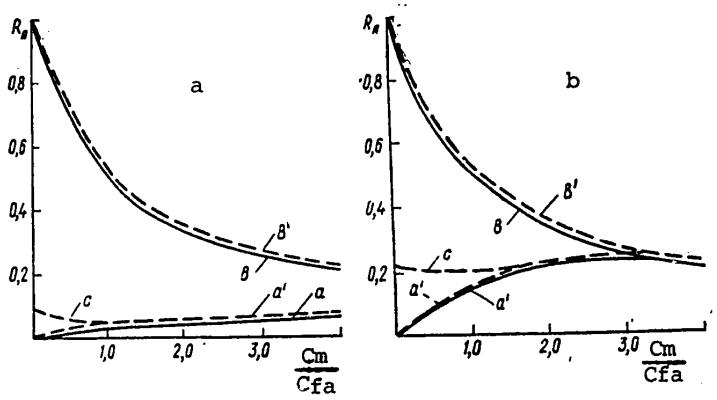

Figure 4.

Thus, with $P_{mA} = 0$, there are only two areas in which there is minimal risk: 1) automatic retrieval (area under curve *a*); 2) use of machine--operator scheme (area between curves *a* and *b*).

The area above curve *b* is the area of impossible levels of machine risk with specified cost of mistakes C_m and C_{fa} and probability of machine skips P_{mA}.

With $P_{mA}>0$, the area of operator retrieval appears. Thus, with $P_{mA} = 0.025$ the area of operator retrieval is between curves *a*, *b*, *c* (see Figure 4, a and b). Further increase of P_{mA} leads to disappearance of the area of the machine--operator scheme and only two areas remain--automatic and operator retrieval.

On this basis, it can be concluded that it is desirable to use the combined machine--operator scheme only if the machine has P_{mA} equal or close to zero. In this case, the risk involved in such a retrieval system would be lower or equal to the risk in operator retrieval. The condition of equality is met only if the automatic device has the maximum possible risk, i.e., when the probability of false alarm P_{faA} tends to one.

There is analogous decrease in area of the machine--operator system with decrease in sharpness of the image (see Figure 4b). In this case, automatic retrieval acquires much weight (the area of automatic retrieval becomes wider).

The findings we have obtained, which are qualitative rather than quantitative, indicate that there are three areas, in each of which one of three possible organizational schemes for constructing the retrieval system is the most efficient. For this reason, it is necessary to conduct in the future some quantitative studies of the efficiency of possible methods of constructing retrieval systems as related to specific retrieval conditions, including the type and statistical characteristics of the background, shape, dimensions and contrast of the object, parameters of ash [?] media, probability characteristics of the automatic device, cost [price] of mistakes of the first and second type.

The results of such studies would make it possible to define the optimum scheme for constructing a retrieval system assuring minimal risk, depending on objective retrieval conditions.

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METHOD FOR COMPREHENSIVE EVALUATION OF TRAINING OF OPERATORS OF PERIPHERAL COMPUTER UNITS AND ITS TECHNICAL REALIZATION

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[Article by R. S. Grayfer, engineer]

[Text] The proposed method and its technical realization concern the solution of one of the major tasks of ergonomics--the creation of technical devices for instruction and training of operators (1).

"Remote" and "on-site" peripheral computer terminals (user stations, data recorders, data preparation devices, etc.), through which the user interacts with the computer, are widely used in data processing systems (DPS) and ACS [automated control systems]. Both "professional" operators (DDPPT [Devices for data preparation on punched tape], DDPC [Devices for data preparation on cards] and DDPMT [Devices for data preparation on magnetic tape] operators) and operators combining production and operator functions (foreman, warehouseman, TCD [technical control department] controller, etc.) may work with different peripheral terminals (PT). Compared with the professional operators' functions, the indicated specific nature of the "nonprofessional" operators' work is responsible for increasing the reliability of system functioning: the "nonprofessional" operator's functions have an additional internal justification owing to deliberate prediction of the consequences of errors made. This makes possible an increase in the human operator's reliability as the result of the feature of "self monitoring" of performances (2). The efficiency and accuracy of data file editing is increased, because it is possible, for example, for an error made in calculating the movement of a material and detected during data verification to be compared at the warehouseman's workplace with the actual stock of the material; the operator's self monitoring is improved, since he develops and reinforces associations between items (or events) and their numerical expression.

To a significant extent, the indices of the quality of the functioning of DPS's and ACS's are a function of the level of the operators' training and experience. This relationship is primarily expressed in a decrease in the number of repeat calculations of tasks on the computer thanks to the increased reliability (absence of errors) of the collection and preparation of rapid information.

It is advisable to employ special training programs and devices in order to develop skills and work experience on computer PT's in the operator. The economic effect of using such programs and equipment may be substantial, inasmuch as it is

the result of the action of such factors as reduction of the time necessary to introduce DPS's and ACS's to a project, i.e., acceleration of entry into industrial operation; increase in the operators' training and experience level; reduction of physical wear on the data preparing devices in the HC [hardware complex], and reduction of the number of labor-intensive hand operations by the human instructor.

Up to the present, industry has not produced PT operator training devices. This unsatisfactory situation may be explained by the fact that, first, the necessity of the described devices has not been fully realized, second, sound technical requirements taking into account both the general information model of training systems (3) and the specific conditions for operating PT's, have not been developed for the construction of their structures. PT operator training devices belong to the class of "training equipment" for developing stable skills and experience in specific functions in operators.

Analysis of known training equipment which might be used as analogs for PT operator training devices showed that along with the typical nature of the functional-logical structure, this training equipment has specific shortcomings. The basic ones relate both to the method of task presention as well as to the method of evaluating the level of the operator's training: the work rate is compulsorily imposed upon the operator. This rate is synchronized with the read-out rate of the coded task by the tape-transport mechanism, although in practice an independent data input rate is more practicable; the level of the operator's training is evaluated according to the dynamics of indices, either productivity or absence of errors. The self monitoring index is not taken into consideration here; the operator's training is evaluated ineffectively owing to the delay in statistical processing of the recorded elements of the task and the operator's response actions.

As the analysis presented suggests, in training equipment analogs the criterion for evaluating the operator's training is one of two personal indices of his activity computed: absence of errors or productivity. The indicated criterion, however, is inadequate for evaluating PT operators' training, inasmuch as the quality of their activity directed at developing or modifying data arrays on DPS's or ACS's is determined by the aggregate of their absence of errors, self monitoring, and productivity indices (4).

The study (5) substantiates an inferred criterion for evaluating the operator's experience in work on closed control systems, taking into consideration not only the activity indices but also the indices of the operator's physiological condition, measured by special methods. Full use of the integrated method (5) in order to construct PT operator training devices is not rational, since in this case the structure of the operator training device (or system) itself becomes complicated; this is undesirable.

The method described in the article for evaluating the level of PT operators' training proposes an integrated index $R(t) = \dot{R}[\beta^{o}(t), K^{o\delta}(t), \Pi(t), K^{1o}(t)]$, the components of which are the characteristics of the work and self-monitoring operations, which vary in time: $\beta^{o}(t)$ = the probability of the operator's making mistakes; K^{oo} = the probability of his detecting errors actually made; $\Pi(t)$ = the

operator's productivity in symbols per second; $K^{00}(t)$ = the probability of the operator's "detecting" a error actually not made (a false error).

The advisability of such a selection of components for the integrated index is substantiated by the fact that, first, the named characteristics are mutually independent and, second, the characteristics may be used as arguments in mathematical modeling of an operator-device system under the assumptions of the "structural method" of evaluating the reliability of a man-equipment system (6).

It is advisable to subordinate the selection of the structure of the integrated index $R(t)$ to the requirement of simplification of the technical realization of the training device. Hence a mathematical linear form of representation is suggested:

$$R(t) = a_1\theta_1[\beta^0(t)] + a_2\theta_2[K^{00}(t)] + a_3\theta_3[\Pi(t)] + a_4\theta_4[K^{10}(t)]. \quad (1)$$

where $\theta_i\ (i = \overline{1,4})$ and $a_i\ (i = \overline{1,4})$ are, respectively, the relative ratings and the weighted coefficients of the characteristics.

The magnitude of the value R (t) varies within the range of $0 < R(t) < 1$ when the following combination of conditions is fulfilled:

$$0 < \theta_i\ (i = \overline{1,4}) < 1; \quad \sum_{i=1}^{4} a_i = 1; \quad a_i\ (i = \overline{1,4}) > 0.$$

The necessity of using the relative ratings of the characteristics is dictated by the differences in the size and relative magnitude of their values. Relative ratings may be written in the form:

$$\theta_1[\beta^0(t)] = \frac{\bar{\beta}^0}{\beta^0(t)}; \quad \theta_2[K^{00}(t)] = \frac{K^{00}(t)}{\bar{K}^{00}};$$

$$\theta_3[\Pi(t)] = \frac{\Pi(t)}{\bar{\Pi}}; \quad \theta_4[K^{10}(t)] = \frac{\bar{K}^{10}}{K^{10}(t)},$$

where $\bar{\beta}^0$, $\bar{K}^{00}$, $\bar{\Pi}$, $\bar{K}^{10}$ are the standardized values of the characteristics.

It is advisable to select the standardized values of the characteristics with the guidance of the following assumptions: the standardized value of the value must be maximally or minimally attainable (the principle of optimizing the benchmark). In order for the index R (t) to maintain a monotonic relationship, characteristics, increase in the values of which results in an increase in the values of the index R (t), must be standardized at maximum, and, in the opposite case, at minimum, values. On the basis of the indicated assumptions, we may write: $\bar{\beta}^0 = \min \beta^0(t)$; $\bar{K}^{00} = \max K^{00}(t)$; $\bar{\Pi} = \max \Pi(t)$; $\bar{K}^{10} = \min K^{10}(t)$.

The experiments conducted (4) made it possible to determine the extreme levels of the averaged (by group of operators) values of the characteristics after completion of training: $\min \beta^0(t) = 5 \cdot 10^{-3}$ (per symbol); $\max K^{00}(t) = 0.99$; $\max \Pi(t) = 2$ symbols/s; $\min K^{10}(t) = 0.03$. Based on the interrelation of the weighted

coefficients and taking into consideration the different degree of the influence of variation of each of the characteristics on the indices of the quality of functioning of the DPS and ACS (greatest influence $\Delta\beta^0$, least ΔK^{10}) the following expert evalutions were made: $a_1 = 0.6$; $a_2 = 0.3$; $a_3 = 0.06$; $a_4 = 0.04$.

The method described may be realized on an autonomous device (7) the flow-chart of which is presented in the figure. Tasks in the form of brief alphabetic and numerical sequences enter from the output of the mass storage unit MSU through the standard storage unit SSU to the display unit DU and to the input of the response comparison unit RCU. The operator being trained perceives the task visually and performs it using the response input unit RIU. Performance of the task generally includes 1) symbols--error correction indices and "beginning and end of task" indices--selected by the unit for determining the error correction index UDECI and the unit for determining the "beginning and end of question" index UDBEQI, respectively; and 2) alphabetical and numerical symbols, entering the other input of the RCU unit through the response storage unit RSU. In the RCU unit the tasks received are compared with the results of their performance. When the compared values coincide, a signal appears at the output of the "absence of error" signal former AESF. In the opposite case, the signal enters the output of the error-signal former ESF. Both signals reach the counter unit CU, which is controlled by signals from the outputs of the UDECI unit such that when error correction indexes are present, recording is permitted in the counter for actual errors detected by the operator and in the counter for false errors "detected" by the operator. In the opposite case, recording is permitted in the counter for errors undetected by the operator and in the counter for symbols completed without errors. Via the signal from the UDBEQI unit output, the content of the CU unit enters the unit for computing the operator's "professional" characteristics UCOPC, which receives data at other inputs from the counters for the number of presentations CNP and the duration of the question CDQ and computes the characteristics according to the formulas:

$$\beta^0 = \frac{n_r}{N}; \quad K^{00} = \frac{n^{00}}{n_r}; \quad K^{10} = \frac{n^{10}}{N - n_r}; \quad \Pi = \frac{N}{T}. \tag{2}$$

Here n_r is the number of errors made (generated) by the operator; N is the number of completed symbols of the task; n^{00} is the number of errors actually made and detected by the operator; n^{10} is the number of errors not actually made but "detected" by the operator (false errors); T is time spent on completion of the task.

On the basis of data from the output of the unit for setting standardized coefficients USSC and the enumerated "professional" characteristics, the integrated index R (t) is determined in the training index computing unit TICU according to formula (1). In an analogous manner, on the basis of data from the outputs of the USSC unit and of the unit for setting the operator's "professional" characteristics USOPC, the required value of index R_{tr} is computed in the unit for setting the training index USTI. The $R(t)_{meas}$ measured and the required R_{tr} of the value of the indices are compared in the unit for comparing the operator's training indices UCOTI, and the result of comparison is depicted by the display unit DU. Achievement of the relation $R(t)_{meas} \geq R_{tr}$ is the condition for ending training.

The time intervals necessary for the operation of the devices are produced by a

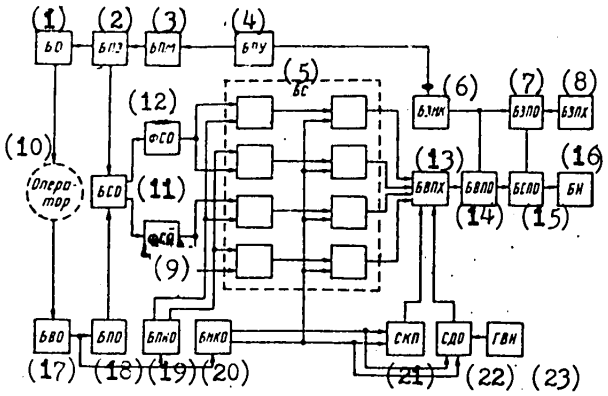

Figure.

Key:

1. DU [display unit]
2. SSU [standard storage unit]
3. MSU [mass storage unit]
4. PCU [programmed control unit]
5. CU [counter unit]
6. USSC [unit for computing standardized coefficients]
7. USTI [unit for setting the training index]
8. USOPC [unit for setting operator's "professional" characteristics]
9. AESF ["absence of error" signal former]
10. Operator
11. RCU [response comparison unit]
12. ESF [error-signal former]
13. USOPC [unit for setting operator's "professional" characteristics
14. TICU [training index computing unit]
15. UCOTI [unit for comparing operator's training indices]
16. DU [display unit]
17. RIU [response input unit]
18. RSU [response storage unit]
19. UDECI [unit for determining error correction index]
20. UDBEQI [unit for determing the "beginning and end of question" index]
21. CNP [counters for number of presentations]
22. CDQ [counters for duration of question]
23. TIG [time interval generator]

time interval generator TIG. The performances of the devices and the task presentation rate are determined by the programmed control unit PCU. Here both the independent rate, which is dependent only on the time for completion of task mastery by the operator, and the compulsory rate, which is assigned by the PCU unit, are possible.

With "nontime-sharing" DPS's and ACS's, it is advisable to include the described autonomous device in the system of technical devices. With advanced time sharing systems, a centralized method of training operators (a training class) at the timesharing computer center, for example, using terminals connected with a common mini-processor, is more economical.

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PSYCHOLOGY

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RESEARCH METHODS IN ENGINEERING PSYCHOLOGY AND INDUSTRIAL PSYCHOLOGY

Leningrad METODOLOGIYA ISSLEDOVANIY PO INZHENERNOY PSIKHOLOGII I PSIKHOLOGII TRUDA: CHAST' 2 in Russian 1975 (signed to press 22 Oct 75) pp 2-4, 158-160

[Annotation, foreword, bibliography and table of contents from book "Methods of Research in Engineering Psychology and Industrial Psychology", edited by A. A. Krylov, doctor of psychological sciences, Izdatel'stvo Leningradskogo universiteta, 5260 copies, 160 pages]

[Text] Part 2 of this collective monograph (the first part was published in 1974) considers information processing by operators, basic methods for studying information processing interactions between man and technological devices and also certain questions related to engineering psychology design and standardization.

This book is intended for specialists working in the areas of engineering psychology, industrial psychology and ergonomics. Nine tables, 26 figures, 38 bibliographic citations.

Editor's Foreword

(Text) The creation of automated systems of control, in which a person performs control functions, are most typical of the new forms of organization of manufacturing processes. For this reason, every day more and more of the activities people perform on the job have taken on characteristics typical of operators' and the number of kinds of jobs where people function "purely" as operators is continually growing.

The particulars of an operator's work have posed new problems for psychologists. Solution of these problems has required the development of new methods of research, of theoretical concepts and of ways to implement scientific data in practice. In a relatively short period of time, it has been possible from timid attempts to match individual functional psychophysiological mechanisms with technological devices to move to the development of hypotheses about the organizations of the activity of the brain as an information processing system; from individual suggestions for rationalizing certain types of industrial activity

to complex methods of engineering psychology design and assessment of operators' tasks.

Methodological problems in the area of engineering psychology and industrial psychology have currently also taken on special significance because of the fact that questions involving optimizing the individual's on-the-job activity are becoming more and more complex and the fact that qualitative changes in the nature of an activity necessitate new approaches to its study. The principles of a systems approach and quantitative analysis turn out to be absolutely essential for transition from taking account of separate human characteristics in constructing equipment to the engineering psychology systems design of an activity.

This, however, should not be understood as a renunciation of substantive psychological research and qualitative analysis. Soviet engineering psychology and industrial psychology must solve problems which are significantly broader than merely making it possible for people to perform job tasks and operations quickly and accurately. Technology and also the conditions and organization of work must, furthermore, fully meet demands for well-rounded human development and human improvement in a socialist society. Meeting these demands in practice necessitates in-depth study of the work activity of a person and of the person himself as performer of the work. The information processing aspect of psychological research takes on special significance in connection with the creation of automated systems of control and engineering psychology design.

This book, the second part of the collective monograph "Methodology for Research in Engineering Psychology and Industrial Psychology", examines questions related to information processing and operators' activities, the fundamental methods for studying information processing interaction between people and technological devices and also certain questions related to psychological engineering and standardization.

The book develops several ideas for a systems approach to the study of the organization of information processing in the brain system (the concept of "switching"). A number of methodological principles for research are considered, not only in general form, but concretely as applied to typical problems in engineering psychology. This is especially relevant to the study and evaluation of devices for displaying information, instrument panels and panels of control units. Certain methodological problems, for example, from those related to evaluation of the characteristics of information flow in signals, to the study of principles and methods of composition and questions of standardization are, basically, only formulated.

Chapter I, Nos. 1 and 2 were written by A. A. Krylov, No. 3 by V. M. Vodlozerov and V. G. Naberezhnyy; Chapter II, No. 4 by A. A. Krylov, No. 5 by V. A. Ganzen and P. A. Kudin, No. 6 by T. P. Zinchenko; Chapter III, No. 7 by Yu. M. Zabrodin, No. 8 by T. P. Zinchenko, No. 9 by I. M. Lushchikhina, No. 10 by A. I. Naftul'yev; Chapter IV, No. 11 by M. M. Zibert, G. S. Nikiforov and A. A. Krylov, No. 12 by F. S. Pinskiy, No. 13 by Yu. A. Simonenko, E. P. Shaytor and I. M. Yusupov, No. 14 by G. V. Sukhodol'skiy; Chapter V, Nos. 15 and 16 by G. V. Sukhodol'skiy, and No. 17 by S. A. Mikhaylov.

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