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BIOMEDICAL AND BEHAVIORAL SCIENCES  
(FOUO 2/80)

1 OF 2

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# USSR Report

LIFE SCIENCES

BIOMEDICAL AND BEHAVIORAL SCIENCES

(FOUO 2/80)



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USSR REPORT  
LIFE SCIENCES  
BIOMEDICAL AND BEHAVIORAL SCIENCES  
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ADVANCED BIOTECHNOLOGY

UDC 599.536/.537:591.3/.31

CHEMORECEPTION IN BLACK SEA DOLPHINS: BOTTLENOSED DOLPHIN (*Tursiops truncatus* Mont.), COMMON DOLPHIN (*Delphinus delphis* L.), AND PORPOISE (*Phocoena phocoena* L.)

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249, No 6, 1979  
pp 1498-1500

[Article by V. B. Kuznetsov, Moscow State University]

[Text] The ancestors of toothed whales had a well-developed sense of smell. An investigation of intracranial otlivy [lit. refluxes, return flows] of zeuglodon<sup>(1)</sup> showed that olfaction was gradually reduced in these fossil whales in the course of evolution. Recent toothed whales, dolphins in particular, do not have olfactory epithelium or functioning olfactory bulbs<sup>(2)</sup> and, consequently, the typical sense of smell is lacking. For a long time it was impossible to find taste buds in the tongue of dolphins<sup>(2,3)</sup>. A. V. Yablokov conjectured that the organs of chemical perception are situated in fossae arranged in the tongue of toothed whales<sup>(4)</sup>. Taste buds were subsequently found in fossae arranged in the root of the tongue in the common dolphin<sup>(5)</sup>. Research was recently resumed on the receptor apparatus in the tongue of bottlenosed dolphins<sup>(6)</sup>. The authors did not report finding taste buds in specimens of tongues from 19 bottlenosed dolphins. Our earlier experiments showed that dolphins possess well-developed chemoreception and are therefore capable of chemically communicating and transmitting information on chemical stimuli<sup>(3,7)</sup>. The purpose of the present study was to determine the sensitivity and peculiarities of chemoreception in dolphins.

We ran experiments in which we recorded the galvanic skin response to chemical stimuli in porpoises and common dolphins and the rapid constituents of the galvanic skin response, electrocardiogram, and respiration in bottlenosed dolphins. The animals were fixed in a tank with seawater in such a way that their head remained above the water. A constant current of seawater passed through a tube secured in the mouth at the rate of 7 to 10 ml/sec bathed the root of the tongue. 5 to 10 ml of a given chemical stimulus was introduced into the current at 3- to 5-minute intervals or the same amount of seawater was used as a control. In several of the experimnts with the porpoises and bottlenosed dolphins, a

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conditioned reflex was formed between the chemical stimulus and stimulation by an electric current. Nine porpoises (6 females and 3 males), 2 common dolphins (a male and a female), and 3 bottlenosed dolphins (2 females and 1 male) were presented with chemical stimuli 680, 67, and 230 times, respectively.

The experiments showed that the porpoises reacted to trimethylamine solution at concentrations of  $8.5 \times 10^{-6}$  M ( $P < 0.001$ ) and  $8.5 \times 10^{-7}$  M ( $P < 0.05$ ), skatole solution at a concentration of  $1.7 \times 10^{-6}$  M ( $P < 0.01$ ), and camphor solution at a concentration of  $3 \times 10^{-6}$  M ( $P < 0.01$ ). The male common dolphin sensed a feces solution from another male in a  $1:10^7$  dilution ( $P < 0.001$ ). The bottlenosed dolphins reacted to chemical stimuli at the following concentrations: hydrochloric acid 0.15 M ( $P < 0.01$ ), valerianic acid  $1 \times 10^{-4}$  M ( $P < 0.001$ ), quinine hydrochloride  $1 \times 10^{-4}$  M ( $P < 0.005$ ), and urine solution from a male bottlenosed porpoise  $1:10^2$  ( $P < 0.05$ ). The results of these experiments show that all 3 species of Black Sea dolphins possess relatively high sensitivity to chemical stimuli. Their ability to perceive trimethylamine, a constituent of fish odor, as well as their sensitivity to a feces solution suggest that dolphins are capable of chemically tracking fish schools and animals like themselves.

In the next stage of the work, conditioned reflexes were formed to chemical stimuli in unrestrained bottlenosed dolphins. The same method was used to train the dolphins and although a reflex was formed, it was not stable. After experiments in which they made correct decisions, the dolphins were shifted to random decisions. It was only when the animals were trained with 3 different methods in succession that a stable conditioned reflex was formed to chemical stimuli. After the female Elsa and male Philip were trained, a different technique, described in an earlier report (7), was used on the males Bogdan and Dar'yal. These bottlenosed dolphins were taught to stand while thrusting their head out of the water and opening their mouth into which chemical agents were placed. Each dolphin received a fish for touching a metal lever after the presentation of water, but if it touched the lever after presentation of the chemical tested, it received an electric shock.

The bottlenosed dolphins Philip and Elsa were taught to distinguish the solutions of chemicals in seawater from seawater. Both dolphins sensed caproic acid at concentrations of  $1 \times 10^{-3}$  M ( $P < 0.005$ ) and  $1 \times 10^{-4}$  M ( $P < 0.05$ ). However, Elsa was able to distinguish citric acid from seawater only at a concentration of 0.2 M ( $P < 0.01$ ). When the concentration was decreased to 0.05 M, neither dolphin was able to solve the problem, making only 34 correct decisions after 71 presentations. However, the 0.05 M citric acid solution in freshwater was distinguished by Elsa from freshwater ( $P < 0.05$ ). Sensitivity to bitter stimuli was studied in Philip. The dolphin sensed picric acid at a concentration of  $4.3 \times 10^{-5}$  M ( $P < 0.05$ ). Both dolphins distinguished freshwater from seawater ( $P < 0.05$ ), but they were unable to distinguish seawater half diluted with distilled water,

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from seawater. Sucrose solutions in seawater were presented to both dolphins at concentrations of 0.6 M, 0.3 M, 0.15 M, and 0.07 M. A total of 150 presentations were made in 10 experiments. The number of correct decisions fluctuated at the 50% level in all the experiments.

The bottlenosed dolphins Bogdan and Dar'yal were presented solutions of chemicals in seawater and in freshwater. The results of these experiments are shown in Table 1.

Table 1. Sensitivity of Dolphins to Chemical Substances

Key:

- |  |                           |
|--|---------------------------|
| 1. Solution of the substance in freshwater | 9. Oxalic acid            |
| 2. Concentration, M                        | 10. Hydrochloric acid     |
| 3. Bogdan                                  | 11. Quinine hydrochloride |
| 4. Dar'yal                                 | 12. Picric acid           |
| 5. Indole                                  | 13. Sodium chloride       |
| 6. Valerianic acid                         | 14. Sucrose               |
| 7. Caproic acid                            | 15. Glucose               |
| 8. Citric acid                             | 16. No sensitivity        |

The results of our experiments show that among the chemical stimuli ordinarily used to study taste perception in mammals, bottlenosed dolphins possess well-developed sensitivity only to bitter stimuli. They most likely do not sense sugar and their perception of salinity appears to be poorly developed, but this cannot be said with certainty because seawater entered the dolphin's mouth after each presentation of the stimulus, making it difficult for the animal to respond correctly. The sensitivity of bottlenosed dolphins to citric, oxalic, and hydrochloric acids is much lower while that to fatty acids is 100 times higher than taste sensitivity in the mammals already studied and in human beings, although the threshold concentrations of taste perception of hydrochloric and citric acids in mammals are usually lower than the concentrations of fatty acids.<sup>(8)</sup> Moreover, bottlenosed dolphins sensed valerianic and caproic acids in seawater at a concentration of  $1 \times 10^{-4}$  M, despite the fact that the pH of these solutions was the same as the pH of seawater owing to the buffer properties of the latter. Dolphins have obviously developed an unusual form of chemoreception.

It is reasonable to assume that dolphins perceive chemical stimuli by trigeminal nerve chemoreceptors. Olfactory stimulation in vertebrates provokes activity in branches of the trigeminal nerve<sup>(9,10)</sup> whose chemoreceptors possess relatively high sensitivity<sup>(10)</sup> with interacting olfactory and trigeminal systems<sup>(11)</sup>. The perception of chemical substances by these receptors definitely compensates for the loss of the sense of smell<sup>(12,13)</sup>.

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In the course of evolution, the reduction of olfaction in fossil whales was accompanied by development of the trigeminal nerve apparatus<sup>(1)</sup>. The chemoreceptor function of this nerve evidently developed at the same time to replace the loss of olfaction. The chemoreceptors of the nasal cavity were initially able to do so because seawater enters dolphins in the nasopharyngeal region<sup>(14)</sup>. In recent dolphins, however, it appears that receptors situated in the root of the tongue perform the main chemoreceptor function. The trigeminal nerve innervates this region in bottlenosed dolphins<sup>(15)</sup>. Structures of the rhinencephalon may be centers for analyzing information from the trigeminal nerve chemoreceptors. This assumption is supported by data concerning the effect of responses from the trigeminal nerve chemoreceptors on the olfactory centers<sup>(11)</sup>.

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THE AUDITORY SYSTEM OF MAMMALS

Moscow SLUKHOVAYA SISTEMA MLEKOPITAYUSHCHIKH (The Auditory System of Mammals) in Russian 1979 signed to press 3 Aug 79 pp 2, 3-4, 239.

[Annotation, introduction and table of contents from book by L. S. Bogoslovskaya and G. N. Solntseva. Institute of Developmental Biology imeni N. K. Kol'tsov and Institute of Evolutionary Morphology and Ecology of Animals imeni A. N. Severtsov, USSR Academy of Sciences. Izdatel'stvo "Nauka", 1979, 250 pages]

[Text] A survey is given of the basic characteristics of the structure of the central and peripheral sections of the auditory analyser of land, amphibious and aquatic mammals: predators, rodents, pinnipeds, cetaceans and chiroptera. Adaptation features are examined in detail in the structure of the auditory analyser of aquatic mammals. A morpho-functional analysis is presented of the structure of the auditory analyser in sea and land mammals.

The book is intended for zoologists, anatomists and specialists working in the field of bionics.

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Foreword

The study of sensory systems of vertebrates has a long history during which the views of researchers and their approaches to the material have changed, but conceivably one thing has remained constant--a perfectly singular interest toward the organ of vision, which has always attracted the most qualified specialists. This interest, explained by the dominant position of vision among man's analysors, has indirectly hindered the development of researches on other systems of reception and only in the '40s-'50s of our century has progress in a number of fields of science and technology sharply changed the situation existent in this field of biology.

The significant achievements of the two last decades in the study of the auditory system connected with the appearance of essentially new acoustical apparatus have led to a radical reexamination of traditional ideas on the means and significance of sound signalization in the world of animals. Works in the field of bioacoustics of mammals have demonstrated the extraordinary importance of hearing for spatial orientation and communication of all representatives of this class. Its role is especially great in small animals, such as mouselike rodents and insect eaters, among whom hearing is considered as the most far-reaching of all the sensory organs.

Study at the present level of the acoustical system of mammals that have become acclimated to the aquatic and air medium of habitation showed that hearing in them is dominant among the distance analysors, while a number of forms (toothed whales, bats) possess a special method of acoustical orientation which Griffin has defined by means of the term "echolocation." Echolocation makes it possible for aquatic and air animals to make maximal use of the special features of the medium they inhabit and successfully compete in it with other groups of vertebrates (fishes, birds).

Among the highest primates and especially in man, the main purpose of the auditory analyzor, aside from participation in different orienting reactions is the organization of specific intercourse among individuals.

The very wide range of adaptive possibilities of the auditory system of representatives of the class of mammals attests to the existence of significant variations of its structure and function. But the majority of data on the physiology and morphology of auditory formations has been basically obtained from laboratory animals and is completely inadequate for the creation of a complete and undivided picture of the interaction of all parts of this system. It is now becoming clearer that the customary experimental researches on a limited selection of species cannot answer the many very important questions on the organization of the auditory analyzor. Only comparative research is capable of showing the scope of evolutionary and adaptive transformations of any sensory system, particularly the auditory, which has traversed a complex path of development and isolation from other systems in the evolution of terrestrial vertebrates.

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The proffered book is an attempt by two researchers, who have worked independently for a long time, to bring together data on the structure of acoustical formations in mammals with different functional directivity of hearing. The peripheral sections and inceptive elements of the central auditory pathway were the most interesting for the authors. These parts in any sensory system most markedly and fully react to the impact of factors of the external environment. It is perfectly natural that gaps are to be found in the book, since, on the one hand, many groups of mammals have as yet not been studied morphologically, while, on the other hand, not all auditory formations have been studied to an equal degree.

In the monograph chapters I-IV were written by G.N. Solntseva, chapter V by Ye.Ye. Anisimov and L.S. Bogoslovskaya and chapters VI-VIII by L.S. Bogoslovskaya, but all sections of the book were considered jointly by the authors and express their common point of view.

For their cooperation in the work, the authors express sincere gratitude to all those with whom they for many years have been gathering and processing morphological material, especially N.V. Lipatov, A.A. Lemberg, T.S. Klyuyeva and V.F. Semenova.

Study of the auditory system of pinnipeds and cetaceans was made possible through the amiable assistance of colleagues of the All-Union Scientific-Research Institute of Sea Fisheries and Oceanography, Northern Polar Scientific-Research Institute of Sea Fisheries and Oceanography imeni N.M. Knipovich, Pacific Ocean Scientific-Research Institute of Fisheries and Oceanography, Azov-Black Sea Scientific-Research Institute of Fisheries and Oceanography and Caspian Scientific-Research Institute of Fisheries and Oceanography.

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ADVANCED MEDICAL TECHNOLOGY

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MANAGEMENT OF BURN PATIENTS DURING THE STAGES OF MEDICAL EVACUATION

Moscow RUKOVODSTVO PO OBOZHZHENNYKH NA ETAPAKH MEDITSINSKOY EVAKUATSII (Guidelines on Burn Patients During the Stages of Medical Evacuation) in Russian 1979 signed to press 2 Mar 79 pp 2, 3 - 4, 192

[Annotation, introduction and table of contents from book by V. N. Zhizhin, D. Ye. Pekarskiy, N. E. Povstyanoy, S. A. Polishchuk, V. K. Sologub; edited by V. K. Sologuba, "Meditsina", 50,000 copies, 192 pages]

[Text] This handbook explains the basic questions of the clinical aspects and diagnosis of burns and burn disease, the making of prognoses and the medical classification of burn patients although the primary focus is on specific practical advice for the stage-by-stage treatment of casualties. Measures to render first aid to burn patients at the accident site or the focus of attack are explained. A great deal of attention in the handbook is devoted to the organization, volume and sequence for carrying out all first aid measures as well as primary medical and specialized care of burn patients in the setting of operations at the focus of a mass attack.

The handbook is intended for surgeons and physicians specializing in trauma.

Introduction

Soviet and foreign publications have been quite extensive on the problem of thermal injuries: during the past 20 years alone, more than 40 monographs have been published and the number of publications each year is approaching a thousand.

At the same time, up until now, there has been no concise specific guide to the treatment of burns. Published findings are, at times, conflicting, practical recommendations are not feasible at times or, when selected for clinical trial, do not always achieve the anticipated results. However, the progress in experimental and clinical burn sciences which is characterized not by just its tremendous theoretical importance but by direct results in practice as well is undisputed. This effect would be even more tangible if the recommendations of modern burn science were to become the property of a broad mass of surgeons. Unfortunately, many findings are concentrated in specialized publications, articles, collections and theses from reports and, for this reason, are virtually inaccessible. An urgent need to incorporate them into a handbook

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has arisen. This is all the more necessary for physicians in the civil defense medical service. However, a handbook of this type could become a multi-volume work.

The authors have decided not to present information on all aspects of thermal pathology but rather, to condense only proven concrete recommendations on the diagnosis and treatment of burns, burn disease and its complications into a single text.

The handbook reflects not only the authors' many years of experience and the collectives they have supervised but published findings as well.

This has determined the form and style of the presentation. The authors have refrained from the academic enumeration of numerous controversial hypotheses and often tempting but, as yet, insufficiently proven proposals and published references. In addition, a number of questions on the clinical aspects and diagnosis of burns and burn disease, its stages, complications, prognosis and the like have found brief reflection consistent with the capacity of aid during the stages of medical evaluation.

Insofar as the return of victims to employment and social functioning is an objective of the Civil Defense medical service, the authors have felt it necessary to explain the problems of rehabilitation and restorative surgery for burns.

This brief handbook is designed for physicians without a great deal of specific experience in the treatment of burn patients. Of course, the recommendations that are offered can be utilized in the practice of the stage-by-stage treatments of burn patients.

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PROGRAMMED HEMODIALYSIS AND KIDNEY TRANSPLANTATION

Riga PROGRAMMNY GEMODIALIZ I TRANSPLANTACIYA POCHKI in Russian 1978  
by G.N. Andreyev et al., pp 3-4, 141-142

[Foreword and Table of Contents]

[Text] Foreword

The treatment of patients with chronic renal insufficiency in the terminal stage has become part of the practice of many of our country's therapeutic institutions. At the same time, the problem of organ and tissue transplantation and consequently the specific problem of kidney transplantation are still far from a complete solution. Clinical transplantology is now going through a period of accumulation of experience; an effort is in progress at kidney transplantation centers to improve the near and remote results of this operation. Specialists of a new type--transplantologists--are being created before our very eyes.

The collection of scientific works, consisting basically of articles by colleagues of the Latvian Center for Kidney Transplantation, constitutes in essence a first effort at a comprehensive assessment of the possibilities of a peripheral transplantation center. This then determines the content of the book: both scientific-practical and organizational aspects of clinical kidney transplantation are examined in it. Attention is directed to a new form of organization of such a center: the LTsTP [Latvian Center for Kidney Transplantation] is an educational-therapeutic-scientific association in which therapeutic work is organically combined with scientific research and single-minded training of physicians-transplantologists. This form of structure for a center, including a chair and a scientific subdivision of a VUZ and also a department in a large hospital, is, in our view, optimal for such a type of institution.

It is known that successful treatment of patients with chronic renal insufficiency is unthinkable without a well-established programmed hemodialysis. In Latvian SSR in the last four years about 8,000 hemodialysis treatment sessions have been carried out, 2,000 of which were on an outpatient basis. This has made it possible to increase the throughput capacity of the LTsTP with simultaneous reduction of outlays for treatment of patients.

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The number of kidney transplantations has been growing at this center--as of October 1977, there had been performed here 75 such operations.

Articles included in the collection describing certain ways of preserving the functional viability of transplants and emphasizing the possibility of making a program of its prognosis deserve serious attention.

Significant facets of the problem of transplantation include the procurement of a sufficient number of viable donor organs and their proper selection. It should be noted that the Latvian Center is actively involved in a program of kidney exchanges and is successfully developing a method of typing them according to antigens of histo-compatibility.

An important feature of the researches presented in the collection is their practical bent. Colleagues of the LTsTP in cooperation with a number of chairs and laboratories of the Riga Medical Institute; with other scientific-research institutes of the country they are working on practically all the urgent problems of clinical transplantology: improvement of results of transplantation of a dead person's kidney, increasing efficiency of hemodialysis, problems of transplantation immunology, donorship, prognosis and diagnosis of rejection crises and so on. At the same time, modern methods of research are used on cellular, subcellular and molecular levels. Although some of the results obtained are of a preliminary character, these researches are undoubtedly promising, since they will permit in the future working out concrete recommendations for the clinic.

The rapid development of clinical transplantology is evidenced by the copious Soviet and foreign literature dealing with these questions. It is clear that the collection of "Programmnyy gemodializ i transplantatsiya pochki" [Programmed Hemodialysis and Kidney Transplantation] makes a definite contribution to the study of these problems. We believe that it will be of use to physicians of all specialties interested in the problem of organ and tissue transplantation.

Prof V.I. Shumakov,  
director of the Institute of Organ  
and Tissue Transplantation, USSR  
Ministry of Health

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ENVIRONMENTAL HAZARDS

NORMAL AUTOANTIBODIES AS RADIATION RESISTANT FACTORS

Moscow NORMAL'NYYE AUTOANTITELA KAK RADIOZASHCHITNYYE FAKTORY (Normal Autoantibodies as Radiation Resistant Factors) in Russian 1978 signed to press 11 September 1977 p 2, 3-4, 133-135

[Annotation, introduction and table of contents from book by N.N. Klemparskaya and G.A. Shal'nova, Moscow, "Automizdat", 1010 copies, 136 pages]

[Text] The wide range of literature, published in different native and foreign journals, on normal radiation resistant antibodies--autoantibodies--is analyzed and reviewed comprehensively for the first time in this book. The nature and physiological function of autoantibodies are examined. Their role in radiation resistance, in the processes of aging and in the phenomena of organ sensitivity to the development of malignancy is also reviewed.

Experimental data collected by the authors on how to prepare samples of normal autoantibodies from animal and human blood for clinical therapeutic application are presented. Methods for timely supplementation of the donor blood with protective autoantibodies are described. The significance of autoantibodies in the processes of infection and the formation of the immune reaction to allogenic antigens is examined.

The book is of interest not only for research-oriented radiobiologists but also for physician-therapists, infectious disease specialists, hygienists and oncologists.

There are 14 figures, 16 tables and 422 references cited.

Introduction

A remarkable mechanism exists in the living organism for repair of damage inflicted on cells, tissues and organs. Various processes participate in this mechanism: removal of the

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aggressive agent from the cells and organism, timely elimination of the causative defect by means of coagulation of proteins, regeneration of lost structures or rearrangement of complexes found in connective tissue.

The biological effect of radiation trauma has many similarities to injuries caused by other factors but is unique in its mechanism of action on the cellular structures and the rate of onset of clinical manifestations. If the result of mechanical or thermal trauma appears immediately, then the effect of radiant energy, with the exception of very large doses, leads to disease after several hours (sun light, ultraviolet rays) or in the course of many days (ionizing radiation). Of note is the fact that there is no correlation between quantity of radiation exposure and its biological effect which can be manifested in the development of serious disease, and in a number of cases even death. A characteristic of radiation trauma is the early clinical reaction exhibited in the first minutes or hours after irradiation.

The protective activity of phagocytes, both circulating in the blood and fixed in the tissues, is well known. These cells are responsible for eliminating from the blood stream allo-genic microbes and dead particles and fragments of tissue. The methods for binding proteins which circulate in plasma and in lymph tissue to absorb and remove products of cellular destruction have not been studied in depth. Only in recent years has the attention of some scientists been focused on the possibility of neutralizing these products, always present in the blood in small numbers, by radiation resistant antibodies. Such antibodies have been given the name of natural or normal autoantibodies (50, 177, 178, 277).

Cells can appear in the tissues of different organs and in the blood and then form the autoantibody, hemolysin (109, 131, 232, 234). In man, the normal level of these cells is 1-3 percent of the number of leucocytes circulating in the blood.

The function of any antibody is related to an antigen--the substance which activates the antibody. Given different biological states, mainly the presence of a small number of cellular products circulating in the blood or lymph system, the radiation resistant natural autoantibodies bind with these tissue substances to form a circulating or non-circulating complex. Phagocytic cells of the reticuloendothelial system engulf these complexes and interrupt the harmful effect of the circulating products of cell metabolism.

Until recently, very little was known about the functional

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characteristics of this important immune system. In the field of radiobiology, this study of such a system has both theoretical and practical interest. Normal radiation resistant auto-antibodies neutralize the effect of circulating products of cell breakdown. Thus, this process may have significance in neutralizing the products formed as a result of irradiation and may have an impact on the subsequent development of pathologic autoimmune reactions with an allergic component.

The protective effect of this normal factor, evidently can be enhanced by means of the stimulating effect of introducing homogenates of homologous tissues and grafts of microbial vaccines.

Included in our discussion are experimental data and data found in the literature in order to adequately examine the question of the biological role of normal radiation resistant antibodies and the possibility of timely stimulation of this factor to increase the radiation resistance of an organism. In addition, we attempt to evaluate how the protective role of natural radiation resistant antibodies is manifest given different forms of irradiation.

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RADIATION AND THE BLOOD SYSTEM

Moscow RADIATSIYA I SISTEMA KROVI (RADIATION AND THE BLOOD SYSTEM) in Russian 1979 signed to press 29 Feb 78 pp 2, 3-5, 126

[Annotation, Introduction and Table of Contents from book by O. I. Belousova, P. D. Gorizontov and M. I. Fedotova, Moscow, Atomizdat, 1700 copies, 128 pages]

[Text] Annotation

A picture of the effect of radiation upon the blood system is developed based on the authors' experimental studies carried out under conditions of a one-time and chronic external irradiation. Results are presented of studies carried out on rats, guinea pigs, rabbits and dogs. The dynamics of post-irradiation changes in hemopoiesis are presented, based on a quantitative evaluation of hematological indices, and this permits a determination of the radiosensitivity of the various cellular elements of the hemopoetic organs in the different species of animals. The authors have succeeded in producing, for the first time, data on the importance of the lymphoid tissue in post-irradiation recovery of hemopoiesis.

The results of many years of research by the authors in the field of radiobiology, in particular, radiation changes of the blood system, are of undoubted interest for all specialists who are interested in the action of radiation on the body of animals.

Figures--43, tables--29, literature citations--236.

Introduction

Much research has been devoted to study of changes in the blood system under the action of ionizing radiation. This is explained, primarily, by the fact that the hemopoetic organs are among the most radiosensitive and the changes in the blood system can serve as one of the objective indices of the condition of the irradiated body.

It must be taken into account, however, that despite the great amount of research, the topic problem, radiation hematology, is as unlimited as any other problem of radiobiology. For example, the question was posed long ago of the

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importance of the blood system in the total radiosensitivity of the body. Great attention has been paid to the sensitivity of the hemopoetic cells of the bone marrow, the role of the initial cellular pool which in some degree or other predetermines the amount of preserved cells after an irradiation, the degree of radiation damage, and so on. Facts of a similar nature are very important. But, all the completed research does not exhaustively reveal the role of the blood system in the radiosensitivity of the body. In this plan, in our opinion, it could be important to study comparative data on the response of the hemopoetic system to irradiation, under standard conditions, in animals with different natural radiosensitivity data which has been obtained with the use of quantitative methods. Meanwhile, the available, experimental hematological material has been obtained, basically, from tests on mice and rats. It has been assumed that they will be the same, too, for other mammalian species. However, the dose and time parameters of injury and recovery of blood cells cannot be identical because analysis of dosage dependencies of the destruction of mammals [146] has revealed substantial species differences, especially in the range of doses which evoke the so-called bone-marrow form of death of the animals. In this connection, we have decided to generalize the material collected by us on the quantitative characteristics of the injury and the recovery of hemopoiesis in animals with different radiosensitivity. We have not projected, here, an exhaustive generalization of data in the literature and have tried to devote more attention to our own personal observations and views. Our experiments were carried out, basically, on rats, guinea pigs and rabbits subjected to a one-time total irradiation in doses of 100-900 R and to extended daily irradiation with a total dose of 150-9000 R.

The one-time irradiation of the animals was carried out in a gamma-apparatus, EGO-2  $^{60}\text{Co}$  (1.25 MeV, with a capacity of dose 380-250 R/min (unevenness of the dose field did not exceed  $\pm 5$  percent) [52, 134], while the extended daily irradiation was, done in a gamma-apparatus ETsU-100  $^{137}\text{Cs}$  (0.66 MeV) a capacity of dose 0.041 R/min. Both instruments were constructed by staff personnel of the Institute of Biophysics, V. G. Khrushchev, Ye. S. Strashnenko, V.K. Mostinskaya and others.

The dosimeter studies in air and on phantoms were carried out by V. S. Grammatikati, with different methods: ionization, chemical and thermoluminescent. Error in measurement did not exceed 5-10 percent.

Along with study of the morphological indices of the peripheral blood, determination was made in the killed animals of the number of cells in the bone marrow in the femoral bone of the rats and guinea pigs and in the eleventh rib of the rabbits, using a modification of Mantz' method [208], and, also, of the number of cells in the spleen and thymus [18]. Calculation of the myelo-, splenocyto- and thymograms permitted determination of the number of cells of separate generations in the hemopoetic organs. Simultaneous, morphological and quantitative study of the cellular makeup of the bone marrow and lymphoid organs permitted fuller characterization of the changes taking place in the blood system.

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In tests on 15 dogs, which were carried out jointly with M. N. Trushina [17], quantitative data on changes in the separate cell populations of the bone marrow under irradiation at a dose of 150 R ( $LD_{0/45}$ ), 250 R ( $LD_{20/45}$ ) and 380 R ( $LD_{100/45}$ ), were obtained with the rib-puncture method. Assay of the absolute quantity of bone marrow cells in 1 ml of punctate agreed with the calculation of the myelograms. This permitted computation of the number of cells of the separate generations in 1 ml of bone marrow.

Results of the control tests run on intact animals showed that the methods used give completely reliable results in determination of the cellular composition of the hemopoetic organs.

The devastation of bone marrow after the action of ionizing radiation occurs as the consequence of a number of causes; for this reason, the studies were carried out with this in mind so as to obtain information about the features of the injury of the separate cell populations of the hemopoetic organs in the various animal species at different periods after the irradiation. Basic attention was devoted to a quantitative evaluation of the radiosensitivity of the various hemopoetic cells under a one-time gamma-irradiation of the different animal species (rats, rabbits, guinea pigs, dogs). Study was made in detail of the dose-effect dependency for the various cell populations of the bone marrow and lymphoid organs in the period of interphasic death and in the period of maximal cellular devastation when reproduction loss of the cells is manifested. In addition to this, study was made of the time-effect dependency.

The indirect or intermediary influence of radiation in the pathogenesis of development of radiation sickness of the whole body has long been known. However, discussion has been going on up to the present on the role of the intermediary influences in cell loss after irradiation. In experiments on a model of non-uniform irradiation we attempted a quantitative estimation of the contribution of the intermediary influence on the magnitude of the interphasic destruction of cells. In experiments on adrenal- and splenectomized animals, a study was made of the role of the adrenals and spleen in this action.

Great attention has also been allotted to clarification of the role of lymphoid tissues in the processes of post-radiation regeneration of hemopoesis. For this, intact animals were exposed to local irradiation, animals with a deficiency of lymphoid tissue were subjected to total irradiation; and, also, transplantation of lymphoid cells to irradiated animals was carried out.

In order to obtain a fuller concept about the reparative potential of the blood system, studies were run under conditions of chronic irradiation of the different animal species.

We feel that the results of our experiments answer some questions about species radiosensitivity of the separate cell populations of the hemopoetic organs, the reparative potential of the blood system, the role of the lymphoid

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tissue in these processes and the possible importance of the cited factors in the general radiosensitivity of the body. It must be emphasized that the possibilities of the laboratory and, in a number of cases, its current development of experimental hematology, have not allowed us to accomplish research on a number of the problems which face radiation hematologists. Thus, while doing work on such animals as rats, rabbits, guinea pigs and dogs, we have not been able to get comparative species data on post-radiation changes of stem hemopoetic cells.

Understanding full well that our labor is far from complete, and not devoid of inadequacies, we will always be grateful for critical remarks in connection with the presented data and their treatment.

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THE DISTRIBUTION OF IONIZING RADIATION IN THE AIR

Moscow RASPROSTRANENIYE IONIZIRUYUSHCHIKH IZLUCHENIY V VOZDUKHE  
(Distribution of Ionizing Radiation in the Air) in Russian 1979 signed  
to press 26 Mar 79 p 2, 3-6, 213

[Annotation, introduction and table of contents from book by V. I.  
Kukhtevich and V. P. Mashkovich, Atomizdat, 1800 copies, 213 pp]

[Text] The book contains estimated and experimental information on differential and integral characteristics of the field of gamma-, neutron and secondary gamma-radiation in the terrestrial atmosphere near the air-ground interface and beyond the air-vacuum interface. The physical patterns of the formation of the radiation field are analyzed. The authors examine the sources of neutrons with energy of from 0.025 eV to 14 MeV and sources of gamma-radiation with energy in the range of 0.03-10 MeV. The distance between the source and the detector and also the height of elevation of the source and the detector above the level of the terrestrial surface or the atmosphere are varied over a wide range.

A physical analysis of the dependency of the time distributions for brief, pulsed sources and pulsed sources with a finite period of the neutron and gamma-quanta pulses on measurement conditions is given. Most of the authors' material is being published for the first time in this book.

The book is intended for engineers, graduate students, students and scientific and technical workers specializing in problems of dosimetry, protection against ionizing radiation and in different related fields connected with the use of sources of radiation in science, technology and agriculture.

102 figures, 65 tables, 171 references.

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## Introduction

The interest in the problem of the distribution of radiation in the air is explained by the fact that knowledge of the field characteristics of radiation in the atmosphere or close to the interface of the atmosphere with the Earth, another dense environment or a vacuum is necessary in solving many problems of practical importance.

These problems acquire special significance when sources of strongly penetrating radiation are used, a fact which determined the selection of sources of gamma-quanta and neutrons for examination in the present book.

The specific nature of the problem of the distribution of gamma-quanta and neutrons in the air is connected with the fact that the length of radiation relaxation for such sources is as much as hundreds of meters, while the length of relaxation in dense media (for example, in protective materials) is several centimeters or tens of centimeters. This property of the distribution of radiation in the air is connected with the fact that the density of air ( $\rho = 0.001293 \text{ g/cm}^3$ ) is 1000-10,000-fold smaller than the density of solids ( $\rho \approx 1 \cdot 10 \text{ g/cm}^3$ ).

The noted pattern means that the geometric factor of radiation relaxation is beginning to play an important role for the atmosphere in comparison with denser media. For example, for an isotropic point source of gamma-quanta with an energy of 1 MeV in an infinite medium at a distance of 10 free path lengths (fpl) the relation of geometric relaxation of the radiation dose to relaxation caused by the interaction of the gamma-quanta with the material of the medium is  $2.8 \cdot 10^0$  for air;  $3.1 \cdot 10^3$  for water;  $3.6 \cdot 10^{-6}$  for lead.

The presence of the air-ground and vacuum-air interfaces significantly complicates the methods of solution and significantly increases the volume of information required.

As an example let us take problems A.1-A.9, the solutions of which are connected with estimation of the field of radiation in the air close to the air-ground interface (fig A). The typical trajectories of the scattered neutrons or gamma-quanta of the source S are conventionally indicated by arrows.

The field of radiation in the air at the location of the detector D close to the air-ground interface must be determined, for example, from the sources of ionizing radiation on the open area, from sources of steady-state and pulsed radiation which are used to measure the parameters of movement in aviation and cosmic technology (see fig A, a); from sources of activated soil elements following nuclear explosions (see fig A, b); from radiation fall-out on the surface of the Earth; from radioactive contamination of the site as the result of nuclear energy installation accidents (see fig A, c); from shielded, partially shielded

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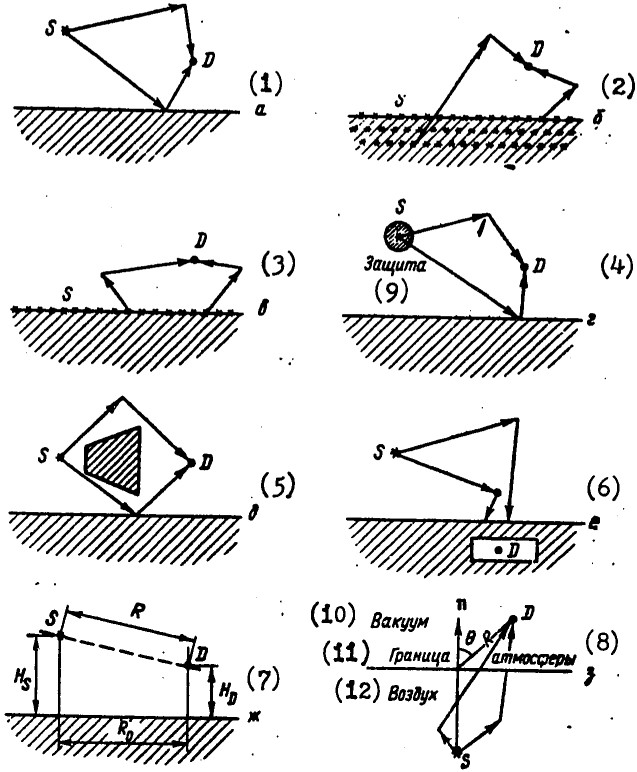


Figure A.1. The Geometry of the Most Wide-Spread Problems In Determination of the Field of Ionizing Radiation

Key:

- |      |                            |
|------|----------------------------|
| 1. a | 8. h                       |
| 2. b | 9. shield                  |
| 3. c | 10. vacuum                 |
| 4. d | 11. boundary of atmosphere |
| 5. e | 12. air                    |
| 6. f |                            |
| 7. g |                            |

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and unshielded reactors, accelerators and other sources of radiation at a great distance from them in the air, including pulsed roentgen apparatuses used for defectoscopy (see fig A, d); from sources behind shadow shielding (see fig A, e). The spectral-angular distribution of the radiation field in the air on the external surface of the shield is also initial information for rating protective structures for the radiation of powerful sources located in the air (see fig A, f).

In the above cited problems the source and the detector may be separated from the interface by a great distance. In this case it is possible to disregard the influence of the ground and examine the problem for an infinite medium of air.

Direct use of the data on the distribution of radiation in an infinite medium of air is more limited than close to the air-ground boundary. In view of the great number of variants of relative positioning of the source and the detector relative to each other and the interface, however, the results of investigations for an infinite medium of air may have wide application in practical problems and for predicting the fields of ionizing radiation close to the air-ground interface when the corresponding correction coefficients are inserted. Thus, in solving the indicated problems we arrive at the geometry of fig A, g; in this case for an infinite medium the height of the positioning of the source  $H_g$  and the detector  $H_d$  is so great that it is possible to disregard the influence of the ground on the distribution of radiation. Of scientific and practical interest is the geometry depicted in fig A, h, where the point source of radiation is located in air of variable density and the observation point is in the vacuum.

The present book examines the problem of the distribution of gamma-quanta and neutrons in the atmosphere and close to the air-ground and air-vacuum boundaries.

O. I. Leypunskiy, P. A. Yampol'skiy, A. S. Strelkov, V. G. Zolotukhin, I. V. Goryachev, N. A. Kondurushkin and many other researchers have made a great contribution to the solution of the problem of the distribution of radiation in the atmosphere.

Analysis of data published in 1968 indicated the necessity of additional research on this problem. The authors of the book conducted this research in the following basic directions:

1. Development of new modifications of the Monte Carlo method for estimating fields of ionizing radiation at great distances from the source taking into account the air-ground and air-vacuum boundaries.
2. Obtaining differential and integral characteristics of the steady-state field of neutrons and gamma-quanta in an infinite medium.

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medium of air and close to the air-ground interface. In this case sources of neutrons and gamma-quanta were examined for a wide range of energies. Energies of from 30 keV to 10 MeV were examined for gamma-quanta; from 0.025 eV to 14 MeV for neutrons.

3. Investigation of the time characteristics of radiation fields from pulsed sources.

4. Investigation of the physical mechanisms of the formation of radiation fields for the cases under consideration.

Thus the aim of the present book is analysis of the methods developed by the authors and the results of estimates together with the systemization and analysis of the information available in the literature.

The authors considered it advisable on the whole not to examine ionizing radiation fields at a small distance from the source (as much as approximately one free path length in air), since these data have been adequately covered and analyzed in the literature (see, e.g., study V.4).

The majority of the data obtained by the authors is being published for the first time. In part the results of the investigations are presented in articles V.10 to V.23.

The book consists of five chapters. The first is devoted to the parameters of the atmosphere and to the determination of the radiation field characteristics and units of measurement used in the book. The second and third chapters examine quantitative information and the basic mechanisms of the formation of the field of gamma-quanta (ch 2), neutrons and secondary gamma-radiation (ch 3) in an infinite medium of air and near the air-ground boundary. The fourth and fifth chapters are devoted to investigation of the field characteristics of gamma-quanta (ch 4), neutrons and secondary gamma-radiation (ch 5) for a source located in the terrestrial atmosphere when the detector is located in the vacuum at different distances from the boundary of the atmosphere.

The authors consider it inadvisable to examine in detail the Monte Carlo method, which has been well described in the literature (V.24-V.27) and have limited themselves to only a short presentation of the modifications of this method developed by them.

Chs 1-3 were written by V. A. Klimanov, V. A. Kochanov, A. I. Ksenofontov, V. P. Mashkovich, B. N. Meshcherin, A. M. Panchenko, A. M. Chernyayev, and A. K. Shtoff; chs 4 and 5, by S. A. Konovalov, V. I. Kukhtevich, A. K. Sukhoruchkin and A. I. Trubnikov. The new, original materials for sources of neutrons and high-energy gamma-quanta in chs 2 and 3 were obtained by V. A. Klimanov, V. A. Kochanov, V. P. Mashkovich,

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and B. N. Meshcherin; for sources of low-energy gamma-quanta, by A. I. Ksenofontov, A. M. Panchenko, A. M. Chernyayev and A. K. Shtoff.

The authors wish to express their deep appreciation to all their fellow workers with whom they discussed the problems examined in the book, particularly V. G. Zolotukhin, V. K. Tikhonov, A. S. Makhon'kov, A. I. Ilyushkin, and A. M. Stepanov, for valuable advice and remarks.

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PATHOGENESIS OF NOISE SICKNESS

Moscow GIGIYENA TRUDA I PROFESSIONAL'NYYE ZABOLEVANIYA in Russian No 12, 1974 pp 13-16

[Article by Yu. V. Krylov (Moscow), submitted 15 Aug 73]

[Text] Control of the deleterious consequences of exposure of man to noise has been transformed into one of the most important biomedical problems. In recent years, a ponderable contribution has been made to our knowledge about the pathogenesis of noise sickness (Ye. Ts. Andreyeva-Galanina et al.; I. K. Razumov, and others). The share and significance of disorders referable to the central nervous, cardiovascular and other systems to the overall symptom complex of the body's reactions to noise have been defined (T. A. Orlova; A. B. Strakhov; N. N. Shatalov; L. N. Shkarinov and others). These studies were based on the same conception of pathophysiological mechanisms of noise sickness: primary reception of acoustic stimuli occurs in sensitive cells of the organ of Corti, while the entire subsequent and diverse set of reactions occurs by virtue of the close links between the auditory system and numerous nerve centers on the most varied levels, ranging from the axonal reflex to the link with stem centers, reticular formation, limbic system, cerebellum, sympathetic and parasympathetic centers and, finally, cortical representation.

In this report we submit our opinions about three scientific facts, which expand conceptions of certain aspects of the pathogenesis of noise sickness, and which enable us to outline measures to protect man against the deleterious effects of high volume aircraft noise.

The first factor pertains the effect on man of aircraft noise at volumes in excess of 125 dB in the octave range of frequencies, with geometric mean levels of 250, 500 and 1000 Hz. Noise with these characteristics is capable of inducing total vibration [shaking], when it comes in contact with the human body. We call this type of stimulus "air vibrations," in distinction from the contact vibrations known heretofore. We then established substantial differences in body reactions to such noise with the use of personal protective gear. In this case, there was an increase in role and significance of bone conduction of sound to the

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organ of Corti. Helmets with a soft cover were found not to be fully effective, in spite of the good noise-proof qualities of the ear plugs. On the basis of the obtained data, it was concluded that it is not enough to protect only the ear and the parotid region at noise levels in excess of 125 dB in the octave frequency range. With their ears and skull protected, the subjects still complained of a general unpleasant effect of noise. It was established that, under such conditions, the most distinct changes occur in thresholds of sensitivity of the skin to vibration, related to overstimulation of mechanoreceptors, against the background of insignificant changes in thresholds of pain and temperature sensibility of the skin. We know from the literature that adverse reactions occur in the cardiovascular and central nervous systems, gastrointestinal tract and other systems of the body as a result of overstimulation of mechanoreceptors situated on the skin and viscera (V. V. Parin et al.; P. K. Isakov; A. M. Ugolev and V. M. Khayutin; V. N. Chernigovskiy; O. B. Il'inskiy; Ye. I. Yesakov and T. M. Dmitriyeva; Lowenstein). Already on the basis of such a comparison, we could assume that there is a causative link between elevation of thresholds of vibration sensibility of the skin under the influence of extremely loud noise and worsening of the subjects' well-being with the ears protected. However, in order to properly comprehend the principles involved in developing protective gear against noise, it was important to determine whether the mechanoreceptor reactions were independent in this case, unrelated to the auditory system, or whether they were of a reflex nature.

In a series of analogous experiments, but involving deaf subjects (no auditory receptor), reliable changes were obtained in thresholds of vibration sensitivity of the skin and deterioration of general condition. This confirmed the independent significance of the extracochlear pathway in formation of pathophysiological reactions of the body to noise (Ye. M. Yuganov et al., 1969; Yu. V. Krylov). The obtained data expand, to some extent, our conceptions of the pathogenesis of noise sickness. They define the levels of acoustic energy at which previously used gear and means of protection against noise are no longer entirely effective. On the basis of the obtained experimental data, the authors formulated the principle of total protection of the body against high-intensity acoustic energy. This principle has been applied in the practical design of specific gear that was found to be rather effective when tested.

The question of levels of pulsed noise, with which the idea of total protection of the body against high-power acoustic energy could be used to prevent the deleterious effects of noise, is of some theoretical and important practical significance.

It was experimentally demonstrated that, in spite of effective protection of the ear, adverse reactions were recorded (electrocardiographic findings, performance indices and others) to exposure of pulsed noise lasting about 1000 ms at volumes exceeding 160 dB. On the basis of the

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obtained data, it was concluded that the acoustic impulse has a direct effect on organs and systems, leading to the necessity of total acoustical shielding of the body by means of special devices (Ye. M. Yuganov et al., 1972).

The specific pathophysiological mechanisms that caused functional changes in a number of systems of the body with exposure to acoustical impulses exceeding 160 dB are not yet completely clear. Perhaps, the EKG changes were due to mechanical displacement of the heart. However, we cannot rule out involvement of reflex mechanisms (involuntary breath holding) in interpreting this fact. It would be quite important to work on identification of such mechanisms, since this would permit more distinct formulation of specifications for more adequate protective gear. However, in this case also, we should refer to primary extracochlear mechanisms of reactions when the body is exposed to ultrahigh acoustical impulses.

The next group of questions is related to determination of the share and significance of extracochlear mechanisms in forming the reaction of the auditory system to a powerful acoustical impulse. V. I. Voyachek believed that one must make a distinction between the trigeminal (nociceptive) and acoustical (hearing thresholds) components in the complex effect of a powerful sound on the ear. This hypothesis has not been verified experimentally. We demonstrated that there is a reliable 10-15 dB elevation of hearing threshold when the intact ear is exposed to an acoustic impulse of 149-151 dB. Under the same conditions, but with the tympanum anesthetized with T. I. Gordyshevskiy's fluid (i.e., with exclusion of trigeminal reception), the thresholds of hearing did not differ from base levels. The results obtained confirm the opinion that the reaction of the auditory system to loud sounds should be interpreted as a complicated and complex process, which depends not only on the volume of the sound, but level of excitability of the central nervous system that alters lability and the level of excitability of the auditory analyzer (I. Ye. Komendantov; S. A. Vinnik and L. I. Yakub). It is quite important to take into consideration these mechanisms in the pathogenesis of an acoustic lesion. It makes it possible to predict the basic possibility of pharmacological prevention of overstimulation of the auditory system in the ranges of intensity of sound where a change in hearing thresholds is not due to the traumatizing effect of sound on sensory cells of the organ of Corti, but to a change in excitability of the auditory system as a result of various central influences, including sensitization of hearing (L. A. Orbeli). It is a pressing task to define more precisely the ranges of sound within which such an effect can occur.

According to the theses listed above and in view of the continued growth of intensity of noises to which man is exposed, it is imperative to take into consideration the data we have submitted here on the pathogenesis of noise sickness when elaborating a set of measures for effective protection against noise.

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PHOTOBIOLOGY OF THE ANIMAL CELL

Leningrad FOTOBIOLOGIYA ZHIVOTNOY KLETKI (Photobiology of the Animal Cell) in Russian 1979 signed to press 27 Jul 79 p 2, 3-4. 265-268

[Annotation, foreword and table of contents from book by A. S. Troshin, N. F. Gamaleya, S. V. Konev, N. F. Krauzova, K. Ye. Kruglyakova, V. L. Levin and K. A. Samoylova, Izdatel'stvo "Nauka", 1850 copies, 268 pp]

[Text] This collection continues the series of Soviet publications on the action of UV radiation on living subjects. The book presents studies devoted to the cellular and molecular mechanisms of the joint and individual action of different components of solar radiation on oil-synthesizing organisms. The authors give an analysis of the action of ecological types of solar radiation--long-wave UV rays and visible light, and also the effects of laser radiation. Twelve surveys and 14 experimental studies are devoted to these problems. The collection is of interest to biologists working in the fields of photo- and radiobiology, cytology, molecular biology, genetics, experimental oncology, biophysics and for physicians and agricultural specialists using optic radiation for sanitation and therapeutic purposes. Eighty-three illustrations, 34 tables.

Foreword

The First All-Union Symposium on "The Photobiology of the Living Cell" was held in Leningrad in November 1977. It was devoted to one of the current trends of modern biology--investigation of the mechanisms of the action of solar radiation on humans, animals, microorganisms and viruses. The present collection consists of reviews and also of selected section reports from the symposium. It may rightfully be classified with the traditional series of collections on the biological action of UV radiation, which has been periodically published in our country for more than 20 years. It differs from them in that it examines almost exclusively the cellular and molecular aspects of the problem, and only for oil-synthesizing subjects. In this we observe the trend, which has grown stronger in recent years, to the formation of an independent

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division of biological science--animal photobiology--along with the division of plant photobiology, which long ago became autonomous.

The collection presents studies on the effects not only of UV radiation but also of other types of solar radiation for the first time in Soviet literature. For the first time in world literature thorough analysis of the action on biomolecules, cells and tissues of ecological types of solar radiation--long-wave UV radiation and visible light--are given. This is very timely in connection with the enormous interest in the problems of "Man and His Environment" and "The Sun and the Biosphere". Probably it is for precisely this reason that photobiologists are now turning with increasing frequency to the study of purely ecological situations, in which not one but several types of optic radiation (UV, visible light, infrared)--as well as such factors as ionizing radiation, high or low temperatures, various chemical substances--act simultaneously or in succession on the biological subject. The chemical substances, often in negligible quantities, are capable of initiating, intensifying or attenuating photobiological reactions. Substances with such properties are distributed extremely widely: they are part of food, pharmacological remedies, chemical preparations for domestic uses; they may accompany man's industrial activity, etc. This is why great attention has been devoted to the problems of photosensitization and photoinitiation in this collection.

The rapid introduction of laser technology has made it necessary for biologists to study the effects of laser radiation. Investigation of their properties and mechanism will undoubtedly be based on knowledge of the nature of the biological action of ordinary (non-coherent) light. This circumstance dictated the inclusion of in the collection of a number of articles devoted to the action of laser radiation on biomolecules and cells. Extensive comparison of the effects of coherent and noncoherent light is performed for the first time in the world literature.

The collection contains 12 survey articles (they occupy half its volume) and 44 experimental ones. All the material is divided into three sections which correspond to the basic trends in modern cellular and molecular photobiology: the action of light on protein and biological membranes; light injury to nucleic acids and the reparative processes; the action of light on the cell: the morphological, cytogenetic, physiological and biochemical aspects. Each section opens with survey articles: there are 3 of them in chapter 1; 6 in chapter 2, and 3 in chapter 3. The collection crowns the experimental studies of a trend new to our country which is connected with investigation of the action on humans of optic radiation from industrial sources (the articles of L. A. Gvozdenko et al., I. S. Alekseyeva et al.). In addition to those named, other articles contain material of an applied nature (the studies of L. V. Potashov et al., L. M. Gakh, L. M. Tsareva, V. N. Zalesskiy et al.). It would be no exaggeration to say that the entire

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collection has a practical aspect, inasmuch as the mechanisms of the biological action of light of different wave-lengths--a most important factor of the environment and an agent widely employed in medicine and agriculture--are examined in it.

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PHYSIOLOGY

UDC 612.081

SLOW NON-ELECTRICAL RHYTHMS OF THE HUMAN BRAIN

Leningrad MEDLENNYYE NEELEKTRICHESKIYE RITMY GOLOVNOGO MOZGA CHELOVEKA (Slow Non-electrical Rhythms of the Human Brain) in Russian 1979 signed to press 12 Mar 79 pp 2-5, 126-127

[Annotation, table of contents and foreword from book by Valentin Borisovich Grechin and Yuriy Dmitriyevich Kropotov, Izdatel'stvo "Nauka," 1,400 copies, 127 pages]

[Text] Annotation

The monograph presents contemporary data on the dynamics of slow non-electrical processes: the oxygen tension, the electrical resistance, temperature, the concentration of some ions and a number of other processes registered in the tissues of the human brain both in the state of peaceful awakening and during the fulfilment of various functional tests. Distinctive features of the registration of those processes in the human brain. Literature data and the results of the authors' investigations conducted on patients with implanted electrodes. By means of an original method of analysis of fluctuations of slow non-electrical processes their participation in assuring the motor and intellectual-mestic activity of man. A distinctive feature of the monograph is examination of the connections between fluctuations of the oxygen tension, electrical resistance and local temperature of brain tissue and their correlations with the pulsed and slow-wave forms of the electrical activity of neural cells. On the basis of those investigations, and also of the data obtained by mathematical modeling a hypothesis is expressed that metabolic processes modeling the activity of the neuron-glia populations of the human brain are reflected in the slow non-electrical processes.

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## Foreword

The successes of the biological sciences in the cognition of living matter and its highest form, the brain, are connected to a considerable degree with the improvement of old and the creation of new methods of research. In the course of 50 years electrophysiological methods, which assure the possibility of studying in the living the neurodynamics of the brain of animals and man in all the variety of the spectrum of bioelectrical manifestations, have been and remain some of the principal, if not the only method of investigating the state of the brain in the normal and pathology. At the same time, from the first steps of clinical electroencephalography the neurophysiologists have attempted to assimilate methods of evaluating the properties of matter borrowed from physics and chemistry. Thus, in the 1920's appeared clinical publications devoted to the use of the method of measuring the electrical conductivity of materials to establish the boundaries of a brain tumor [132].

Successes of physical chemistry in the creation of ion-selective glass led to the investigation of the dynamics of the hydrogen ion concentration in the surface layers of the cerebral cortex [92, 110]. To the 1930's date first attempts to investigate distinctive features of the hemodynamics of the human brain under conditions of natural sleep and epileptic seizure [97, 155].

Even a simple listing makes it possible to turn the reader's attention toward one important fact--the brain blood flow, the hydrogen radical concentration (pH) and the complex resistance of the tissue are not electrophysiological phenomena and reflect events in the neural tissue elementary in comparison with the polymorphous and complex in the interpretation of the EEG picture. The first researchers turned attention toward the high

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informativeness of those parameters for studying the physiology and pathophysiology of the central nervous system. In spite of the sparseness of the technical realization, those investigations were a result of a direction new for neurophysiology--the study in the living of processes directly reflecting the metabolism of the human brain.

Contemporary successes in the study of the physiology and pathophysiology of the human brain have resulted from the introduction into the clinic of electronic equipment, analyzing devices, an arsenal of neurotropic devices and chemical methods of investigation biological liquids and tissues, that is, by the development of clinical-physiological, -biophysical, -biochemical, etc, symbiosis. The progress of recent decades in the study of the physiology of the human brain is also connected with successes of the stereotaxic neurosurgery and above all with the application of methods of long-range intracerebral electrodes for the purpose of diagnosis and treatment [5]. They have permitted, under the conditions of long and multi-point contact with the brain of the patient, investigating a broad spectrum of physiological processes characterizing the functional state of separate subcortical nuclei and cerebral cortices [4, 6, 13, 22]. Characteristic of the clinical neurophysiology of recent years is the use in the process of neurosurgical operations and diagnostic procedures of the methods of investigation in the living of the metabolism of neural tissue by methods borrowed from biophysics and physical chemistry that have undergone preliminary testing under experimental conditions on animals [41].

The present work has the purpose of acquainting the reader with still-little-known methods of studying physiological mechanisms of the brain of man and animals and methods of investigating slow non-electrical processes: polarographic registration of the oxygen tension (the tissue  $pO_2$ ), impedancometry, methods of determining the total, regional and local brain blood flow, the concentration of various ions, the method of fluorometry and oxi-redoximetry of the living, etc. Each of those parameters characterizes different aspects of the vital activity of neural tissue and in that respect supplements the others to a considerable degree. Registered by means of extracellularly arranged electrodes, those processes characterize effects that develop in the brain space near the electrode, that is, extracellular, and only in that way reflect the state of cells of neural tissue. The most general feature of those processes is that none of them can be defined as electrophysiological--their registration requires transformations of some physical (or chemical) contents of tissues into electrical signals of the measurement system. This fact does not diminish the importance of studying those processes to find out the physiology of the brain, but on the contrary emphasizes their role in the generation and modulation of electrophysiological phenomena and in the survival of brain cells.

Slow non-electrical processes represent a complex system of processes reflecting different planes of the functional state of one and the same neuron-gilal population of the brain. Different slow non-electrical processes differ in particular features, informativeness and place in the organization of neural tissue. In the last 20 years considerable factual

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material characterizing the possibilities of slow non-electrical processes in studying the physiology of the brain has been accumulated. However, the development of knowledge of different slow non-electrical processes is irregular. Thus, extensive material reflects the present state of the phenomenology of slow non-electrical processes of the brain of animals and the pathophysiology of the general hemodynamics of the human brain. Comprehensive investigations of local slow non-electrical processes became a reality only in the last decade mainly in connection with successes of stereotaxic neurosurgery. The creative adaptation of some of those methods to the conditions and possibilities of stereotaxic neurosurgery, which constitute an element of a complex approach in the study of the physiology of the human brain [4] made the present work, done in the Department of Neurophysiology of the Scientific Research Institute of Epidemiology and Microbiology imeni Louis Pasteur, USSR Academy of Medical Sciences, under the leadership of N. P. Bekhtereva, corresponding member of the USSR Academy of Sciences and academician of the USSR Academy of Medical Sciences, a reality.  
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MEMORY AND ADAPTATION

Novosibirsk PAMYAT' I ADAPTATSIYA (Memory and Adaptation) in Russian  
1979 signed to press May 23 1979 pp 2, 3-5 192

[Annotation, introduction, and table of contents from book by R. Yu.  
Il'yuchenok, Izdatel'stvo "Nauka" (Siberian Division) 192 pages, 4,500  
copies]

[Text] In the monograph the physiological mechanisms of adaptation are analyzed as a function of the effectiveness of work of the central regulatory systems and memory. An analysis of the data obtained during the adaptation of man to various climatic-geographical conditions (Pamiro-Alay, Altay, Kuril Islands) allowed us to separate three phases of the adaptational process, at the base of which lie various physiological mechanisms. Particular attention has been devoted to processes of memory and the functional assymetry of the brain in different phases of adaptation.

The book is designed for physiologists, psychologists, psychiatrists, neurologists, and therapists as well as students of universities and medical institutes.

Introduction

Up to the present time we have amassed extensive data about changes in different systems of the organism, basically during adaptation to extreme and near-extreme conditions. All this rich factual data has promoted an understanding of many particular mechanisms characteristic for concrete types of adaptation to defined conditions of the climatic-geographical and production environment. However on the basis of the material we have it is difficult to give on interpretation of the universal general mechanisms of individual adaptation.

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Three expeditions (1975-1977) carried out by the Department of Central Regulatory Mechanisms of the Institute of Physiology, Siberian Branch of the Academy of Medical Sciences USSR with analogous programs of research into the adaptation of man to contrasting climatic-geographical conditions allowed us to compare the dynamics of a large number of reactions occurring in parallel and to show up those of them which were present both during adaptation to mountainous conditions with different climatic regimes and during a time shift after transmeridional flight, that is, allowed us to show up those reactions of the organism which are probably universal for the process of adaptation.

The investigations were carried out in mountainous conditions of Central Asia and Siberia (Pamiro-Alay, Altay) in points located roughly at an identical elevation, but differing in climate, and in conditions of a shift of the time zone by four hours (Southern Kuril Islands).

The expedition of 1975 on Pamiro-Alay (settlement of Konchech, elevation 2500 m above sea level, a hot and dry climate) pursued the goal of clarifying adaptation to mountainous conditions with a elevated temperature.

In 1977 in Altay (the Aktash mine, at an elevation of 2600 m above sea level with a markedly continental climate, similar in characteristics to the climate of Novosibirsk) "purer" adaptation to mountainous conditions was studied since inhabitants of the Academy City (Novosibirsk) and adjacent places comprised the group of experimental subjects. On the Kunashir Island (a Southern Kuril settlement, time shift of four hours, a monsoon climate) in 1966 scientists observed a predominance of desynchronization elicited by the transmeridional displacement, and adaptation in conditions of a monsoon climate.

The choice of geographical places with subextreme climatic conditions was dictated on the one hand by a desire to follow the clear cut process of adaptation but without the superimposition of pathological syndromes and on the other hand by a desire to compare the shifts of different functions in contrasting conditions while attempting to show up the presence of several common changes. Although the main problem of the investigations was a study of memory processes during adaptation, a series of other psychological and psychophysiological tests were carried out paralleling this study. These investigations allowed us not only to evaluate the background on which one or the other process of memory took place, but also to follow the course of the process of adaptation through many parameters, and as was clarified later, to follow its phaselike quality with the physiological mechanisms intrinsic to each phase.

Therefore it seems expedient before examining the memory processes to give a description of the adaptational restructuring of the neurological status of the vestibular, statokinetic, psychological, and psychophysiological reactions; then one can show the significance of memory during adaptation, with the help of whose regulation one may predetermine the paths of intervention in the process of adaptation.

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The first successful efforts to change the course of memory trace formation and reproduction by pharmacological substances introduce the hope that this path will furnish real approaches to the control of memory. Undoubtedly even by the end of this book the role of memory in different phases of the adaptational process will not be revealed because of an insufficiency of data. However, if we succeed in informing the reader that memory in its widest sense takes part in the process of adaptation and can compose the basis of the formation of adaptive programs which allow the organism to adjust its activity to the changing conditions of the environment, if we can succeed in informing the reader that memory is the foundation of physiological mechanisms providing for the individual adaptation of the organism, then we may consider that we attained our goal.

The collective of coworkers of the Department of Central Regulatory Mechanisms of the Institute of Physiology, Siberian Branch of the Academy of Medical Sciences USSR took part in the work. V. P. Leutin, I. V. Vol'f, S. B. Tsvetovskiy, and E. I. Nikolayeva investigated the change of bio-electrical activity of the brain and vegetative shifts in people during the formation and reproduction of the memory trace. L. A. Konstantinovskaya and N. I. Dubrovina carried out psychological examinations of memory, attention, and functional state (in the first expedition N. K. Kiyashchenko and S. R. Chaplygina examined these). M. A. Gilinskiy, I. A. Korsakov, and V. L. Plyashkevich investigated the activity of the human operator during the adaptation of man to mountainous conditions (Pamiro-Alay, Altay) and on Kunashir. The head of the faculty of the Belorussian Institute of Advanced Medical Studies, professor, doctor of medical sciences L. S. Gitkina and the head of the laboratory of the Institute of Neurology, Physiotherapy, and Neurosurgery of the Ministry of Public Health of the Belorussian SSR, professor, doctor of medical sciences I. A. Sklyut took part in the expedition. L. S. Gitkina carried out the neurological status examination and I. A. Sklyut carried out the examinations of static and dynamic coordination and vestibular reactions.

In experimental investigations L. V. Loskutova, I. M. Vinnitskiy, N. V. Vol'f, and S. B. Tsvetovskiy studied the role of different structures of the brain in the mechanisms of one session learning, N. I. Dubrovina studied the neuronal mechanisms of the interaction of these structures, and M. A. Gilinskiy, G. V. Abuladze, V. I. Masycheva, and I. A. Pukhov studied the significance of various structures of the brain in the mechanisms of regulation of memory tract formation and reproduction. The author expresses gratitude to all coworkers of the department and participants of the expeditions who took an active part in the research which lies at the basis of this book.

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PROTECTIVE EFFECT OF ANTICHOLINESTERASE AGENTS ON PROTEIN AND RNA CONTENT OF THE SUPRAOPTIC NUCLEUS OF THE BRAIN DURING DEPRIVATION OF PARADOXICAL STAGE OF SLEEP

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 245, No 2, 1979 pp 477-479

[Article by N. N. Demin and N. L. Rubinskaya (presented by Academician Ye. M. Kreps on 5 Oct 78), Institute of Physiology imeni I. P. Pavlov, USSR Academy of Sciences, Leningrad, submitted 24 Oct 78]

[Text] It was previously [1] demonstrated in our laboratory that depriving rats of the paradoxical stage of sleep (PS) by keeping them on small platforms above water [2,3] is associated with significant decline in protein and RNA content of neurons, as well as glial proteins, and in particular those of the supraoptic nucleus. These changes reach a maximum in about 24 h after the start of the experiment [4]; thereafter, there was some attenuation of the protein and RNA deficiency in these structures.

Since the major role of cholinergic structures of the brain in development of PS was recently demonstrated [5, 6], on the one hand, and stimulation thereof attenuates the effects of deleterious factors [7, 8], on the other hand, we conducted a series of experiments involving 24-h deprivation of PS of rats against a background of elevation of endogenous acetylcholine as a result of administration of anticholinesterase agents (antiCE) [9]. We gave the experimental animals hypodermic injections of armine (0.4 mg/kg weight) as an agent that penetrates the blood-brain barrier and preparation Gd-42 (in a dosage of 0.02 mg/kg), which does not penetrate this barrier. It was established that, under these conditions, there was slight but reliable decrease in protein (by about 15%) and RNA (by 20-24%) content of neurons of the supraoptic nucleus in waking rats as well. However, 24-h PS deprivation with both antiCE used virtually failed to increase this deficiency, whereas in intact animals [4] PS deprivation of the same duration was associated with approximately 45% decrease in neuronal protein content and 40% decrease in RNA. PS deprivation failed to induce any changes whatsoever in protein and RNA content of gliocytes of rats given armine or Gd-42, whereas protein content dropped by about 15 to 20% in intact animals.

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In view of these results, we conducted a similar experiment but using one-fifth the previous dosage of antiCE.

As before, these experiments were conducted in albino Wistar rats weighing 170-200 g. The rats were divided into 3 groups: 1) intact control animals; 2) experimental rats given hypodermic injections of armine in a dosage of 0.08 mg/kg weight 2 h prior to the experiment; 3) rats also given Gd-42 in a dosage of 0.004 mg/kg. We submitted 5-6 rats from each experimental group to PS deprivation; 5-6 animals from each group were kept in individual cages. After the animals had spent 24 h on small platforms over water (PS deprivation), control and all experimental rats were decapitated: a) those in cages--some in a waking state and relatively calm and some who slept naturally; b) those deprived of PS.

In all of the groups, we determined absolute protein and RNA content of different neurons and surrounding glial cells of the supraoptic nucleus. The samples to be examined were fixed in cooled Brodskiy fixing agent then imbedded in paraffin. After deparaffination of sections 6-8  $\mu$ m in thickness, the RNA was stained with gallocyanin-chrome alum [10]. The absolute RNA content per cell was determined cytospectrophotometrically using a scanning, integrating SIM-1 microspectrophotometer, according to optical density of the scanned area of neurons and gliocytes on sections for a beam with a wavelength of 585 nm. The proteins on the sections were stained with amido black 10B [11], and absolute level thereof per cell was determined on the basis of optical density at 620 nm by means of a probing two-beam MUT-5 cytospectrophotometer and the corresponding cell volumes.

The results we obtained in this series of tests are listed in Table 1, as percentages of deviation from levels demonstrated in intact waking rats. For the sake of comparison, data previously obtained [9] with the use of the same antiCE but in 5 times larger doses are also listed in this table.

These data indicate that administration of both armine and Gd-42 in small doses (0.08 and 0.004 mg/kg, respectively) prevented entirely the decline of protein and RNA levels in supraoptic nucleus cells, at which intact animals are deprived of PS (which is particularly marked expressly 24 h after the start of the experiment. We see that there was no decrease in protein and RNA content, which did occur in waking rats given a large dose of antiCE.

At the same time, we cannot fail to observe that, even in a small dose, antiCE prevented the minor accumulation (about 15%) of proteins and RNA in the glia of the supraoptic nucleus, usually observed during natural sleep [1,4].

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Table 1. Changes in protein and RNA content of neurons and glia of the supra-optic nucleus of the rat brain in different functional states against the background of administration of antiCE--armine (large dose, 0.4 mg/kg; small dose, 0.08 mg/kg) and Gd-42 (large dose, 0.02 mg/kg; small dose, 0.004 mg/kg)\*

Physiological state	Protein		RNA	
	large dose	small dose	large dose	small dose
Neurons				
Sleep without antiCE	+7	-7	+1	+3
Waking, with armine	-15**	-9	-20**	+2
Waking, with Gd-42	-14**	-2	-24**	-1
Sleep, with armine	-6	+5	-22**	-2
Sleep, with Gd-42	+9	-4	-13**	+2
PS deprivation, with armine	-15**	+6	-17**	+2
PS deprivation, with Gd-42	-11**	±0	-19**	+3
Glia				
Sleep without antiCe	+15**	+11**	+17**	+11**
Waking, with armine	-2	-4	-7	-1
Waking, with Gd-42	+11**	+3	-2	-1
Sleep, with armine	+7	-4	+2	-8
Sleep, with Gd-42	+8	-6	-9	-2
PS deprivation, with armine	+1	-10	-2	+2
PS deprivation, with Gd-42	+4	-5	-7	-5

\*Percent deviation from levels in intact waking rats.

\*\*Statistically reliable deviation; data referable to large doses according to [9].

Thus, it can be assumed that excitation within a certain range of cholinergic receptors, both central and peripheral, or only peripheral, may provide substantial protection of brain structures against the catabolic effects of prolonged PS deprivation.

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CURRENT PROBLEMS IN THE PHYSIOLOGY OF HIGHER NERVOUS ACTIVITY

Moscow SOVREMENNYYE PROBLEMY RIZIOLOGII VYSSHEY VERVNOY DEYATEL'NOSTI in Russian, 1979 signed to press 16 Apr 79 pp 2, 223-224

[Annotation and table of contents by N. P. Bekhtereva, Editor, Moscow, Meditsina, 2723 copies, 224 pages]

Annotation, p 2

[Text] The book consists of 7 reviews of the literature and draws upon the experimental data obtained by the review authors, who are 13 research scientists with various specialties: they are neurophysiologists and include clinicians, neuropharmacologists, morphologists and histologists who deal with urgent problems of current physiology of the higher nervous activity--conditioned reflex activity and memory.

The articles present data on the morphological (including subcellular) substrate of human and animal higher nervous activity. They examine the neurophysiological, pharmacological aspects of higher nervous activity, original concepts on systemic mechanisms of the activity of neurons and intracortical interaction and the features of subcortical provision of short-term memory in man. Materials are presented on the structural-functional dynamics of the processes in the brain which guarantee optimal conditions for realization of memory and conditioned reflex activity. These articles will attract the attention of a very wide circle of medical-biological specialists. The book contains 32 figures and 460 bibliographic references.

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HUMAN FACTORS

THE FACTOR IN THE COMBAT READINESS OF FLARE SIGNALLERS

Moscow FAKTOR BOYEGOTOVNOСТИ RAKETCHIKOV (The Factor of the Combat Readiness of Flare Signallers) in Russian 1979 signed to press 12 Mar 79 p 2, 3-4, 255-256

[Annotation, introduction and table of contents from book by K. A. Alekseyevskiy and P. I. Yedemskiy, Voenizdat, 20,000 copies, 256 pages]

[Text] The book examines current issues concerning the moral, political and psychological training of strategic flare-signalling troops. The authors shed light on features of the process of molding the personalities of flare signallers, the role of ideological and political education in this process, the forms and methods of ideological work on moral, political and psychological training of personnel, the ways and means of increasing the effectiveness of work on molding the necessary moral and fighting qualities in soldiers during combat training and performance of service.

The book is intended for commanders, political workers, party and active Komsomol members of units and subdivisions and also for the students and pupils of military educational institutions.

Introduction

On the basis of penetrating marxist-leninist analysis of the current international situation, the 25th CPSU Congress demonstrated that the foreign policy of the imperialist states is still giving new evidence of the changelessness of the reactionary, aggressive nature of imperialism. Despite the people's yearning for peace, the forces of imperialist reaction are continuing the arms race and the forging of aggressive blocks and are threatening mankind with a new world war.

Under these conditions the Communist Party and the Soviet government are displaying unflinching concern for the strengthening of the economic and military might of the Soviet state and for increasing the combat readiness of the Soviet Armed Forces. "Our party," the summary report of the CPSU Central Committee to the 25th Party Congress indicates, "will leave no stone unturned in order that in the future the glorious Armed Forces of



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the Soviet Union may also have all necessary means for fulfilling their primary task--to be the guardian of the peaceful labor of the Soviet people and the bulwark of universal peace."\* The responsibility of the state bodies, social organizations, officials and citizens to safeguard the country's security and strengthen its defense capacity has been confirmed in the new USSR Constitution, which proclaims the defense of the socialist Fatherland one of the most important functions of the state and the affair of the entire people.

The questions of enhancing the moral potential of the Soviet state and building up the spiritual power of the people and the soldiers of the Armed Forces occupy an important place among the numerous tasks of preparing the country for defense under present conditions. In this, the CPSU Central Committee and the Soviet government are being guided by the leninist tenet of the role of the moral factor in war and V. I. Lenin's indication that the masses' revolutionar resoluteness, their consciousness, steadfastness and readiness for self-sacrifice are "a decisive and prevailing factor."\*\*

Modern warfare, if the imperialists succeed in unleashing it, will make unprecedentedly severe demands on soldiers' spiritual powers. In order to gain the victory over the enemy they must be politically mature, ideologically staunch, well trained, stable and fearless, capable of withstanding any ordeals. The significance of these qualities is also great in peacetime. The performance of combat duty and the maintenance of weaponry and combat technology in constant combat readiness requires from soldiers great exertion of moral and physical powers and the capacity to endure great moral and psychological burdens.

All of this immeasurably increases the role and significance of the moral, political and psychological training of personnel. In this connection, at the scientific-practical conference of leading political workers of the army and navy, which took place in 1976, it was emphasized that such a situation must be achieved that in organizing the training and education of personnel each commander and political worker distinctly understands what new moral, physical and psychological trials our soldiers will run into and with what reserves of strength--combat and moral--the defenders of the Motherland must be prepared today.

This book examines issues in the moral, political and psychological training of flare-signallers. With no pretension to giving an exhaustive treatment of this process, the authors have set themselves the goal of shedding light on some of its features on the basis of experience gained in the training and education of the personnel of flare-signalling subdivisions.

\* Materials of the 25th CPSU Congress, Moscow 1976, p 83.

\*\* V. I. Lenin, "Poln. Sobr. soch." [Complete Works], Vol 40, p 249.

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SIMULATION OF THE PHYSIOLOGICAL EFFECTS OF WEIGHTLESSNESS. SOVIET-AMERICAN EXPERIMENTS

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 2, 1980 pp 71-75

[Article by Academician O. G. Gzenko and A. I. Grigor'yev, Candidate of Medicine]

[Text] The results of research conducted in connection with the preparation for and execution of manned spaceflights in the USSR and United States indicate that weightlessness is the most important of the extreme factors that adversely effect humans. Therefore, one of the urgent tasks now confronting space biology and medicine is to make a thorough study of the functional characteristics of the human body under the unusual conditions of weightlessness. Such a study is making it possible to conduct research at virtually all levels of biological organization of living systems using the most up-to-date methods. The creation of adequate experimental models capable of duplicating the various physiological effects characteristic of weightlessness has become one of the major goals of scientific work in the field of space medicine and biology.

The main pathogenetic factor responsible for functional changes in human beings upon exposure to weightlessness is the absence of the hydrostatic pressure of blood and its resulting redistribution: blood flows from the lower half of the body to the upper half. The intensified flow of blood to the heart increases its intrathoracic volume, triggering a process that leads to a loss of plasma and reduction in the volume of circulating blood. A decrease in the output of antidiuretic hormone and aldosterone plays an important part in the process by decreasing the reabsorption of water and sodium in the kidneys and increasing their elimination from the kidneys. The sensation of thirst diminishes at the same time and the water balance in the body becomes negative. The loss of fluid is one of the causes of the weight loss that almost invariably occurs after a spaceflight. The decrease in hydrostatic pressure can also alter venous tone and elasticity. The prolonged absence of hydrostatic pressure of the blood results in a deterioration of the cardiovascular reaction to change in body position in space, a phenomenon that is clearly revealed

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by the orthostatic test. If preventive measures are not taken, all these changes may give rise to serious disturbances. Hence a thorough study of the mechanisms of their origin is essential. Unfortunately, the effect of gravity-induced redistribution of blood on the activity of the various functional systems of the body is still largely unknown, despite the intensive study given the problem to date.

Another important factor responsible for functional changes in some physiological systems in weightlessness is the removal of the weight load from the locomotor apparatus. Movements become uncoordinated in the absence of support and an insufficient load on the bones and muscles results in a decrease in both muscle size, especially in the legs, and density of bony tissue, change in protein metabolism (decrease in protein resynthesis, development of a negative nitrogen balance), and in increased excretion of calcium and potassium by the kidneys. These disorders can be prevented from arising during spaceflight by using a variety of prophylactic measures, chiefly regular physical exercise.

The two factors described can be duplicated in ground experiments and they can serve as a basis for simulating the physiological effects of weightlessness. Two experimental models - immersion in a liquid and strict bed regime - are now widely used for this purpose.

The first systematic efforts in this field were undertaken in the USSR and United States in the early 1960's, at first with mainly the bed regime used in the USSR and immersion in the United States. Later on both countries made extensive use of the two models and conducted virtually similar research.

In a comparatively short period of time, Soviet and American scientists performed numerous experiments of varying complexity and duration (bed regime for 80 to 36 weeks and immersion for up to 56 days) aimed largely at studying these phenomena and determining their causes and underlying mechanisms in order to be able to forecast the health of cosmonauts and to devise and evaluate the efficacy of various prophylactic and rehabilitation measures.

The results of medical examinations of cosmonauts and astronauts during and after spaceflights convincingly show that the prognoses based on ground studies were accurate, particularly with respect to decrease in orthostatic stability and physical fitness, deterioration in the regulation of the vertical position of the body and coordination of movements while walking, decrease in strength of the antigravity musculature, and disturbance of several metabolic processes, specifically, the water-salt balance. They demonstrated the soundness of the efforts to simulate several physiological effects of weightlessness by means of a bed regime or immersion.

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Because the redistribution of fluids in the body is an important factor in the functional disorders that arise in weightlessness, experiments in the USSR were recently supplemented by a qualitatively new element - an antiorthostatic position of the subjects during the bed regime when the head of the bed is lowered below the horizontal level. The subjects experienced a sensation of blood rushing to the head, a characteristic of weightlessness, that gradually subsided. Hyperemia and slight pastiness of the face, swelling of the nasopharynx, and in some cases illusion of turning upside down were some of the other effects observed.

As a result, Soviet scientists began to use antiorthostatic hypokinesia as the principal experimental model of weightlessness. Numerous investigations, including one involving 182 days of the bed regime, were carried out with this model from 1970 to 1977. These experiments tested the various prophylactic and rehabilitation measures recommended for use on the Salyut orbital space stations.

In recent years, experiments with antiorthostatic hypokinesia were also run in the United States. The results of the experiments in both countries were discussed at the International Astronautical Federation, International Academy of Aviation and Space Medicine, conferences of the Committee on Space Research (COSPAR), and international "Man in Space" symposia.

The annual meetings of the Mixed Soviet-American Working Group for Space Biology and Medicine, organized in January 1971 in accordance with the Agreement on Cooperation in Space Research Between the USSR and the United States, have played an especially important role. These meetings, held alternately in the two countries, made it possible to prepare several agreements on space biology and medicine, specifically, the combined program for research on the simulation of some physiological effects of weightlessness under conditions of hypokinesia.

At the 7th meeting of the group (Yerevan, USSR) in 1976, specialists from both countries presented detailed reports on methods of simulating weightlessness. It was decided to hold a scientific conference on the problem and relevant reports and communications were read at a special symposium held in conjunction with the 8th meeting of the group (Washington, D. C.). It was decided to perform a series of joint experiments to study the effects of hypokinesia.

It was agreed by both parties that the first such experiment would be run in order to evaluate the experimental conditions required for conducting research on hypokinesia in the USSR and the United States. For this purpose that adequate and standardized methods of investigating the functioning of various bodily systems would have to be used in both countries. Considerable work was done even earlier, at the 3rd, 4th, and 5th meetings of the Mixed Soviet-American Working Group for Space Biology and Medicine, to standardize the techniques of clinical and physiological examination of cosmonauts. It was decided to rely on the agreements

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concluded at these meetings for the experiments with hypokinesia too, especially since many of the methods used to examine cosmonauts and astronauts are virtually the same as those used in experiments on the ground.

At the 9th meeting of the group (Leningrad) in 1978, a final decision was made and a protocol signed on the conducting of joint Soviet-American experiments with hypokinesia. The main purposes of the experiments were as follows:

- (1) To evaluate antiorthostatic hypokinesia as a model of several physiological effects of weightlessness;
- (2) To compare the results obtained with the subjects in horizontal and antiorthostatic positions of the body during the bed regime;
- (3) To standardize the conditions under which the experiments with hypokinesia were to be performed;
- (4) To identify and unify the physiological and biochemical methods and tests used as well as the methods for mathematical analysis of the results.

Experiments were performed in the Institute of Biomedical Problems of the USSR Ministry of Health in May and June 1979 and in the Ames Research Center in July and August of the same year. The scientific directors of the experiments were L. I. Kakurin of the USSR and H. Sandler of the United States. The executive officers were V. M. Mikhaylov of the USSR and C. Alexander of the United States.

All the methods used in the experiments to evaluate the activity of the various bodily systems studied were not only unified but applied in the same way both in the USSR and in the United States in order to obtain comparable data. To check on observance of the agreed experimental conditions while the research was under way, two American scientists were posted to the Institute of Biomedical Problems and two Soviet scientists to the Ames Center.

Ten volunteers each, age 30 to 40 years, served as subjects in the American and Soviet experiments. They were found to be healthy after a preliminary medical examination. Based on functional stress tests run during the pre-experimental period, each group was subdivided into two equivalent groups of 5 men each. The experiment involved a week-long period of hypokinesia and two-week control and recovery periods. During the bed regime one group of subjects remained horizontal while the other was in an anti-orthostatic position with the head part of the bed lowered 6°. The bed regime was strictly maintained during the period of hypokinesia. Motor activity was kept to a minimum. All movements were prohibited except some turning of the body on its long axis during meals and performance of physiological functions.

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The subjects' health was constantly monitored throughout the experiments. The microclimate was comfortable in the wards where the subjects were kept. The normal composition of the skin microflora was maintained by special means of personal hygiene.

The subjects ate four times a day. The food consisting of natural and preserved items had an energy value of 2550 kcal during the bed regime and about 2800 kcal in the control and recovery periods. The subjects were required to eat all the food so that the quantity of individual ingredients ingested could be accurately calculated.

The cardiovascular system of the subjects was carefully studied throughout the experiment. A great many physiological parameters were recorded for this purpose both at rest and during functional stress tests. This made it possible to detect the reserve capabilities of the organism. Negative pressure applied to the lower part of the body and graduated physical exercise were used as stress tests. Physical exercise at 850 kgm/min was performed before and after the bed regime for 5 minutes with the subject "lying down" and "sitting" on a bicycle ergometer. Meanwhile the parameters of blood circulation, gas exchange, and external respiration were recorded. The subjects wore a Chibis G suit when exposed to negative pressure. The purpose was to evaluate and prevent cardiovascular changes during long flights on the Salyut orbital stations.

Special attention was paid to the heart, particularly, the bioelectrical activity and contractility of the myocardium. A variety of methods, including electrocardiography, echocardiography, occlusion plethysmography, and rheography, were used to record the parameters that characterize cardiovascular function.

As for the hemodynamics, since it cannot be studied without evaluating the hydration status of the organism, isotopes were used during the experiments to determine the volumes of the bodily fluids - total, intravascular, and extracellular water as well as the quantity of intracellular and interstitial fluids.

Metabolism was another function of great interest. The extensive program of biochemical studies made possible a comprehensive evaluation of protein, carbohydrate, fat, and water-salt metabolisms. The activity of many endocrine glands was also investigated by determining the concentrations in biological fluids of such hormones as angiotensin, aldosterone, epinephrine, norepinephrine, insulin, thyroxin, triiodothyronine, growth hormone, and parathyroid hormone.

To study water-salt metabolism adequately, an investigation was made not only of the excretion of ions but of their presence in foods and beverages so that the role of this factor in altering the excretion of water and electrolytes during hypokinesia could be assessed. Osmoregulation was evaluated from the results of a test with a 2% water load.

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In addition to the physiological methods and parameters, the methods for mathematical analysis of the resulting information were also standardized. Mathematical support of the experiments included the preparation of primary material in tabular form for entry into a machine bank and standardization of the ways of putting out reference and significant information. Programs were devised for assessing secondary information. In accordance with the agreement reached with the American specialists, the statistical processing of the data was done by the standard methods.

The joint Soviet-American experiments with hypokinesia were carried out in a spirit of mutual understanding and they proved to be useful for both sides. Soviet and American researchers are now analyzing the experimental material. There was a preliminary discussion of the results in Houston in October 1979 during the 9th meeting of the Mixed Soviet-American Working Group for Space Biology and Medicine. It was suggested that the results of the experiments be published jointly. It is to be hoped that these publications will be their worthy culmination and that they will contribute to continued fruitful cooperation between the scientists of the two countries.

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SYSTEMS ANALYSIS OF BEHAVIORAL MECHANISMS

Moscow SISTEMNYI ANALIZ MEKHAZIMOV POVEDENIYA (System Analysis of Behavioral Mechanisms) in Russian 1979 signed to press 19 Jun 1979 p 2, 358-360

[Annotation and table of contents from book by K. V. Sudakov, V. B. Shvyrkov and D. G. Shevchenko, Izdatel'stvo Nauka, 4200 copies, 360 pages]

[Text] The outlook the systemic approach to the analysis of voluntary behavior is demonstrated in an analysis of concrete, factual material. The results of using P. K. Anokhin's theory of the functional system in the study of different aspects of the voluntary behavior of animals and humans are presented. The book contains the works of leading Soviet scientists on problems of the organization of the neurophysiological mechanisms of behavior, the relation between mental and physiological processes in behavior, the systemogenesis of behavioral acts, the mechanisms of the use of memory in behavior and the role of emotion and motivation.

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EXPERIMENTAL PSYCHOLOGICAL STUDIES IN AVIATION AND SPACE TRAVEL

Moscow EKSPERIMENTAL'NO-PSIKHOLOGICHESKIYE ISSLEDOVANIYA V AVIATSII I KOSMONAVTIKE (Experimental Psychological Studies in Aviation and Space Travel) in Russian 1978 signed to press 9 June 1978 pp 3 - 6, 302 - 303.

[Introduction and table of contents from book by G. T. Beregovoy, N. D. Zavalova, B. F. Lomov, and V. A. Ponomarenko, Izdatel'stvo "Nauka" 2,700 copies, 303 pages]

[Text] Scientific and technical progress has sharply focused the problem of the interaction of man and technology. Its resolution is a critical condition for increasing the effectiveness and quality of work processes and the reliability of "man-machine systems". By its very essence, this problem requires a comprehensive investigation and cannot be solved on the basis of the technical sciences alone; a close association with the sciences involving the study of man is also necessary. At this point, it is certain that the development of a new technology inevitably demands that allowances be made for the so-called human factor, that is, the characteristics of man for who this technology has been created.

Within the system of sciences dealing with the study of man, an important position belongs to psychology, especially its branches which have been designated "engineering psychology". It investigates the processes involved in the informational interaction between man and machine.

Originating slightly more than a quarter of a century ago, this field has developed very intensively. Within a relatively short period of time, a rather large volume of information as to the function of man in guidance and control systems has been accumulated. However, a number of questions have come up in engineering psychology that are still only at the abstract level. And yet, life demands not just a determination of the general approaches and principles but a precise definition of them as well as applicable to various types of "man - machine" systems. This concept is also important for the future development of the general positions of engineering psychology.

The book brings to the attention of the readers the psychological problems of the interaction between man and technology in the most complex forms of work,

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the control of flying objects. The problems of allowance for the human factor in the development of flying equipment, the training of man for flight and the organization of flight safety are discussed in this context.

The authors have selected the professional activity of the pilot and cosmonaut as the objective of psychological study as these occupations are among the most complex and dynamic. The effect of scientific and technical progress in the activity of man and together with this, the significance of the human factor in control of a technical field is perhaps most clearly evident in aviation and space travel. The primary problems of engineering psychology stand out here as if in a concentrated form.

Aviation and space flight are by nature a critical psychological experiment (experimentus crucis) in which it is possible to discover what is veiled by habitual conditions in other forms of activity. Flight is always associated with alteration of these habitual conditions, with the unexpected and with risk. For this reason, man's abilities and his psychological "reserves" become fully evident here.

The psychological characteristics of man's actions as a function of the diverse conditions of the function of a pilot and cosmonaut, especially in conjunction with the properties of the informational atmosphere of flight are presented in the text.

The first chapter of the book discusses the theoretical questions of the functioning of the human operator. The functioning of a cosmonaut during the various stages of space flight is explored in the second chapter. A great deal of attention (in the third chapter) is devoted to the contents of instrument piloting, an important operation of man in space as well as to the problem of combining the procedures of piloting with spatial orientation while using various informational models of control.

The relationship of the processes of awareness and decision making in the non-standard situation of flight to the properties of the informational environment and man's conceptual model as well as an analysis of the conditions for psychological assurance of success in the activities of the pilot and cosmonaut during the most complex flight conditions are examined in the fourth and fifth chapters.

Chapter six illustrates the change in the functional content of piloting in conjunction with automation of control. Based on analysis of the behavior of a pilot using various systems of automatic control, guidance has been worked out for the engineering psychological design of the "man - automatic machine" system in aviation and space travel.

The concept of using the indices of the body's physiological reactions to the conditions of an activity in psychological studies is explored in chapter seven in materials from experimental flights. The problem of psychological assurance

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of flight safety is analyzed in the eighth chapter. Chapter nine provides illustrations of the practical results of psychological research in aviation and space travel.

In engineering psychology (as is also the case in its other fields), the basic mass of research is done in laboratory experiments. However, when attempts are made to use the data obtained in conditions of the actual activity, conflicts arise among the mass of problems and the need for substantive corrections.

The organization of a natural experiment (the study of man's functioning in natural conditions) is an extremely difficult matter but this is what will make it possible to study the mental processes, functions and human condition more fully and comprehensively. At the same time, the detailed analysis of certain aspects of some psychic phenomenon requires laboratory investigation. For this reason, in conducting their research, the authors of this monograph have made an effort to organically unify laboratory and natural experiments.

The combination of natural and laboratory experiments makes it possible to check the findings obtained in various situations against each other and to correct them with respect to each other which, in turn, leads to the statement of new problems and also to new generalizations.

As it appears to us, the data obtained is useful not only for specialists involved in studying the human factor, but also for those who are developing a new technological field. The authors are in complete agreement with the conclusion of General Aircraft Designer O. K. Antonov that an aircraft will be complete when we understand that it is not made for passengers or freight but for the man that will control it. This, of course, is also applicable to a space craft.

In addition, the authors are also confident that the results obtained are necessary, not just for aviation and space travel, but that they are of functional importance for the development of various "man - machine" systems.

The functioning of the pilot and cosmonaut are only examples of human activity in the operation of complex technology and a special instance of a wide range of the phenomena of modern life. Yet this is the sort of example whose analysis will make it possible to discover many of the fine mechanisms of the mental control of activity, the characteristics of receiving and processing of information by man in a setting of stress-factor influence, the dynamics of the psychic condition and more.

Psychological investigations into the functioning of the pilot and cosmonaut have a practical thrust in improving the safety of flight. In discovering the structure and mechanism of this activity, we have established a specific objective — optimizing the characteristics of the interaction between man and technology. We point out the three following directions for realizing results from the work being done.

The first is the development of methods in engineering-psychological experimental research into "man - flying object" systems.



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The second is the development of engineering and psychological requirements for the structure of systems to transform information aboard flying craft and for the principles of dividing the functions between man and automatic equipment in flight.

The third direction concerns proposals for the training of pilots and cosmonauts to function in emergency situations.

We feel that the results of studies presented in this book are important for the construction of general theories of engineering psychology and even moreso for the future development of a psychological theory of activity as a whole. In this context, we would like to note that a number of new facts were brought out as a result of the courage and creative initiative of the flight staff.

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#### INDUSTRIAL ERGONOMICS

Moscow PROIZVODSTVENNAYA ERGONOMIKA (Industrial Ergonomics) in Russian, 1979 signed to press 26 June 79 pp 2, 3-5, 311-312

[Annotation, introduction and table of contents from book by S.I. Gorshkov, Moscow, "Meditsina", 6700 copies, 312 pages, illustrations]

[Text] The successful development of ergonomics has been based, to a large degree, on its complex approach to the study of the "man-machine-industrial environment" system. The discipline has provided an analysis of many factors which characterize the functioning of this system. In industrial conditions, this complex investigation is directed at the elucidation of undesirable factors and at attempts to alter them in accordance with ergonomic requirements.

The book, "Industrial Ergonomics", presents the fundamental stages in the development of the interaction between man and technology, the ergonomic tasks and the methods used in ergonomic investigations. The authors analyze thoroughly the hygienic and psychophysiological criteria which are necessary to evaluate and design industrial equipment and to organize the work environment.

As distinct from other monographs concerned with ergonomic solutions to questions of purely operative forms of labor, this book focuses on the construction of industrial equipment which will correspond to the anatomical-physiological and psychological needs of man in various areas of industrial production: mechanical engineering, tube rolling production, textile production, work on conveyor lines, leather production and the organization of the labor of computer operators.

The monograph is intended for hygienists, professional pathologists, physiologists and psychologists of labor.

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There are 39 tables, 85 figures and a bibliography of 91 references in the book.

#### Introduction

Scientific-technical progress, the growth of automation and mechanization of industrial processes, which have furnished industries with new technology, have altered the nature of labor and the interaction of man and technology. As a result, ergonomic investigations directed at a complex study of the conditions of labor in attempts to improve the interaction of "man-machine-industrial environment" acquire more significance every year.

In a speech given at the 16th Congress, professor comrade L.I. Brezhnev noted that the party considers the improvement of the conditions of labor and the conversion of all industry to a safe, comfortable environment for man as central in any technological re-equipping of industry. These conditions must be guaranteed to the working man in a socialist society.

The discipline of ergonomics is concerned with creating an environment in which the social labor process occurs, or according to the words of Marx, where the smallest possible expenditure of energy (industrial) occurs and where conditions are the most suitable for human needs.

The fulfillment of this goal is possible only when technology is based on the entire system of knowledge about man or a complete analysis of his anatomical-physiological and psychological characteristics. This means that the task of ergonomics consists of optimizing the position of man in the "man-machine-industrial environment" system and humanizing technology by insuring correspondence between construction of industrial equipment and organization of the working environment and the anatomical-physiological and psychological nature of man. The principle of "correspondence", resulting from unity of subject (man) and object (nature, technology) in the process of labor is the basic concept of ergonomics.

At the present time, ergonomics in the USSR is developing primarily in three directions--technological esthetics, engineering psychology and industrial ergonomics. Technological esthetics has developed the most in our country. Its goals are artistic construction of equipment and industrial esthetics. The basic task of engineering psychology is the study of the relationship between construction of control panels of such important national economic objects (atomic, hydro- and thermal-electric stations, airports, energy-systems, etc.) and the nature of perception and processing of information by the operator. The task of industrial ergonomics is the realization of the principle of

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correspondence between construction of industrial equipment in factories, plants, mines and other enterprises and the anatomical-physiological and psychological characteristics of man.

The process of gradually transforming the industrial functions of man by means of technology has attained particular significance in the current period of the scientific technological progress. This progress has been accompanied by lightening of the burdens of labor and eliminating manual labor, but at times has disturbed the "correspondence" principle, the cause for which is the difficulty of including the anatomical-physiological and psychological needs of man in the construction of complex modern equipment. In a number of instances, this is caused by an inadequate understanding of the nature of man--his anthropometric characteristics as applied to the questions of ergonomics, his power and speed potentials, the nature of afferent synthesis, the mechanisms of perception and processing of information. To maintain many forms of equipment, workers assume uncomfortable working poses and are required to exert a great amount of energy. The volume of information which they must process has also increased. Monotony and hypokinesia occur frequently. In order to construct industrial equipment which corresponds to the characteristics of man, engineers must understand these characteristics and include "the human factor" in various aspects of design and construction.

Increased security, effectiveness and economy of industry are the main contributions of ergonomics. However, in the course of developing ergonomics other difficulties remain such as methodologic problems. These difficulties, to a large degree, are related not to anthropometric problems of organizing the work environment but to problems of the informational interaction of man with the contemporary complex technology. This topic is also discussed in the monograph.

The data, presented in the book, were collected by co-workers at the Section for the Physiology of Labor and Ergonomics of the Scientific-Investigation Institute for the Hygiene of Labor and Occupational Diseases of the USSR Academy of Medical Sciences. The investigators conducted complex physiological-ergonomic studies of related enterprises and experimental studies when the need to remodel one or another industrial situation occurred.

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HUMAN ECOLOGICAL PHYSIOLOGY

Moscow *EKOLOGICHESKAYA FIZIOLOGIYA CHELOVEKA*. Adaptatsiya Cheloveka K Ekstremal'nyim Usloviyam Sredy (Human Ecological Physiology. Human Adaptation to Extreme Conditions) in Russian 1979 signed to press 25 Jan 79 p 2, 3-4, 702-704

[Annotation, foreword and table of contents from book by O. G. Gazenko (ed.), Izdatel'stvo Nauka, 2950 copies, 222 pages]

[Text] The book presents materials reflecting the influence on humans of such extreme environmental factors as acceleration, weightlessness, noise and vibration, motion sickness, hypoxia and hyperoxia, hyper- and hypocapnia, magnetic fields and ionizing radiation. The physiological and psychological reactions of man to extreme environmental conditions are examined; a classification of extreme factors is given, and the characteristics of the process of adaptation to the influence of these factors are established.

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Foreword

There are two distinct directions in the development of research in modern human ecological physiology.

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The goal of one of them is the study of the processes of adaptation to different extreme environmental factors, and of the other--of adaptation to climatogeographical environmental conditions.

By now a large amount of materials, observations and experimental research on both trends of work has been amassed. The collected materials are compiled for publication under the title "Human Ecological Physiology" ("Human Adaptation to Extreme Environmental Conditions" and "Human Adaptation to Natural Environmental Factors").

This book concerns aspects of the first direction, which relate to the problem of human adaptation to extreme environmental conditions. Works containing the results of numerous investigations on problems of great interest for aerospace medicine, underwater and high-altitude expeditions, occupational physiology and the hygiene of modern production are being published for the first time here in the form of a handbook on physiology.

The book contains 13 chapters which present materials on the investigation of the influence on the organism of such extreme environmental factors as overload, weightlessness, motion sickness, noise and vibration, hypoxia and hyperoxia, hypercapnia and hypocapnia, magnetic and electromagnetic fields and ionizing radiation.

The chapter "Natural Gravitation and Its Influence on the Development and Vital Activity of Organisms" contains detailed information on the evolutionary genesis, structure and functioning of the organism's antigravitational physiological system. Needless to say, natural gravitation can by no means be placed in the category of extreme environmental factors. The inclusion of this chapter is the product of an attempt to facilitate the readers' understanding of the rather complex physiological patterns which determine the organism's reaction to the influence of a number of extreme mechanical environmental factors such as acceleration, weightlessness, motion sickness, vibration, etc.

The problem of the influence of extreme environmental factors has been little treated. The literature essentially contains no correlating works on the problems of adaptation to extreme environmental factors.

The book makes an attempt to examine this problem and clarify the properties of physiological and psychological reactions to the indicated environmental conditions. A classification of extreme factors is proposed and possible criteria for their evaluation are presented.

Possibly some conclusions will seem contradictory and debatable to the readers. It must be borne in mind, however, that the controversial nature of such a statement is undoubtedly caused by the novelty and insufficient previous study of the problem under investigation.

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The editorial staff of the volume did not attempt to eliminate or soften the controversial nature of some opinions and conclusions, feeling that in interpretation of the problem of adaptation, a problem on the leading edge of science, such an opinion may be a stimulating source for the emergence of new thoughts and new searches.

The present volume consists of works performed in laboratories having far from the same lines of work and different specializations. This was reflected in the features of the style of presentation of the materials and of their interpretations, in judgments on the practical significance of the works and their feasibility. The authors' goal included the observance of a strictly objective approach to the presentation of the materials of the chapters, and in our view, this task was basically solved successfully.

Works on such extreme factors as high and low temperature and chronic hypoxia which did not fit into the volume are included for publication in other volumes of the "Handbook on Physiology" that are close in type.

The editorial staff of the volume would be grateful to all who wish to express critical comments and wishes.

O. G. Gazenko and A. G. Kuznetsov

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PSYCHOLOGICAL CONDITIONING DISPLAYED BY PILOTS IN CRITICAL FLIGHT SITUATIONS

Moscow VOPROSY PSIKHOLOGII in Russian No 6, 1979 pp 114-117

[Article by A.A. Oboznov, Moscow]

[Text] Flight activity is related to certain aspects of surgery where the professional is confronted not infrequently with complicated and critical situations. The most important conditioning for the effectiveness of pilot activity in such circumstances is opportune detection of the circumstance which could create complications. Flight simulation sessions have shown that many errors of flight are related to the unanticipated occurrence of a critical situation.

In this article, we analyze such typical errors as delayed detection of the potential danger of altitude loss which can occur while attempting to extricate a plane from a difficult flight position. The most grave consequences can result from an error of this nature (3), (7).

We assert that a psychological analysis of the cause for unexpected occurrences in flight such as danger from altitude loss, must begin with an examination of the actual nature of the goal or task (5). If one assumes that the pilot formulates a concrete plan of action for the future state of the plane's flight, then this plan, in the functional sense, can be called the object-goal (4). Therefore, one can assume that the object-goal determines the sequence and order of perception by the pilot of the signals which register the state of the guided object.

According to the recommendations of several methodologists of flight training, extrication of a plane from a complicated position (CP) to horizontal flight means, above all, elimination of roll and pitch displayed on the gyrohorizon (2). With this method of training for extrication from a CP, the pilot

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is given adequately defined dimensions of the roll and pitch to use as parameters for flight. These parameters acquire special subjective significance and have a central place in the object-goal. Thus, during the process of extrication from a CP, the pilot will direct his main attention to the indices shown on the gyrohorizon and could as a result, lose sight of the altitude parameters.

According to our suggested hypothesis, timely detection of flight danger caused by any kind of position deviation depends on the fact that this parameter will occupy a place in the object-goal--underscoring the subjective significance of the parameter to the pilot.

#### Methods

The investigation was conducted in a pilot flight simulator, consisting of the cabin of a single-seat plane with an instrument panel and a steering mechanism. The pilot formulated the initial flight plan. After the plan was programmed into the instrument panel, the panel was covered with an opaque shield. Then, utilizing a control panel, the investigator and his aid programmed into the instruments a complicated flight position (the pilot could not see the changes made in the instrument dials). Then, the instrument panel was uncovered and the pilot was told to extricate the "plane" in the quickest way possible from the complicated position and return it to horizontal flight. The pilot was unaware of the nature of the complicated position and the order in which the experimental tasks would be presented to him.

For the test, the margin of altitude selected by the pilot in his initial flight plan to extricate the plane from a CP was altered.

During the experiment, the basic parameters of flight were recorded on film; steering activity of the pilot; the radio-exchanges between the pilot and the investigator (the content of the radio-exchange was recorded simultaneously on a tape-recorder); notes on the switching on and off of the camera apparatus used to record the direction of the pilot's glances on the instrument panel. An "NAS" apparatus was used to film the pilot's glances. The speed of the filming equalled eight frames per second. Data from the film recordings were processed in an "M-220" computer.

In all, 24 pilots participated in the experiment and were exposed to 312 experimental tasks for extrication from complicated flight positions.

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## Results and Discussion

Analysis of the steering movements of the pilots indicated that extrication from a complicated position begins with elimination of the roll by levelling the plane and reducing the pitch. The average time required, from uncovering the screen to the first control movement to counteract the roll and the first movement to eliminate the pitch equalled  $1.5 \pm 0.6$  seconds and  $3.0 \pm 1.3$  seconds.

These data indicate that in the time required to eliminate the position deviation caused by roll and pitch, the margin of altitude was diminished. In 40 percent of all cases, the loss of altitude exceeded 1000 meters and in 12.5 percent--2000 meters and more. During this moderately brief period of time, the safety of the flight could be threatened. These data once again point to the significance of timely calculation of altitude for a safe extrication of the plane from a complicated flight position.

What kind of attention is directed at the altimeter during the process of extrication? We examined the camer recordings of pilot glances to answer this question (table 1).

Таблица 1  
ПОКАЗАТЕЛИ СБОРА ПИЛОТАЖНОЙ ИНФОРМАЦИИ ПРИ ВЫВОДЕ  
ИЗ СЛОЖНОГО ПОЛОЖЕНИЯ (УСРЕДНЕННЫЕ ДАННЫЕ)

1. Приборы	2. Показатели структуры сбора информации		
	3. количество фиксации, в % к общему числу фиксации	4. время контроля, в % к общему времени контроля	5. средняя длительность фиксации, в с
Авиагоризонт 6.	50,1	80,2	2,5
Вертиметр 7.	22,8	9,3	0,5
Указатель скорости 8.	19,3	7,4	0,6
Высотомер 9.	7,8	3,1	0,5

Table 1. Indices of pilot activity during extrication from a complicated position (mean data)

Key:

1. Instrument
2. Indices for the nature of data collected
3. Quantity of fixation, in percent of total number of glances
4. Time required to regain control, in percent of total time of control activities
5. Mean length of fixation in seconds
6. Gyrohorizon
7. Vertical speed indicator
8. Speedometer
9. Altimeter

As is evident from the table, the greatest amount of attention during extrication from a complicated flight position was focused

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on the gyrohorizon, the indices of which were focused on in all experimental cases, without exception. By comparison, we noted that even in those situations when altimeter indices were controlled, an average of only 3.1 percent of the total time of pilot control of all the instruments was directed at it, whereas the gyrohorizon was focused on 26 times longer!

In a number of cases, the subjects reported that they had achieved horizontal flight while not once controlling the indices of the altimeter. In fact, these same pilots did not evaluate the actual position of the "plane" with regard to altitude margin. The pilots were not always able to detect at an opportune moment the danger of altitude loss (created by the investigator) and continued to operate the steering controls for a period of 8-10 seconds after which time the altitude was already equalled to zero.

Thus, parameters for roll and pitch are controlled immediately by all pilots during extrication from a CP. Thus, we assume that these parameters occupy a central place in and are significant components of the formulation of the object-goal by the pilots. In this sense, the parameter of altitude in the experimental situations which we created can not be considered the pressing and significant component of the object-goal.

Of course, the altitude parameter is always included in the content of the pilot's object-goal in so far as for any pilot there is an obvious need for a defined altitude margin to conduct any flight. However, this parameter can have a different subjective significance. In those cases when the very maintenance of a defined altitude of flight is not a direct requirement, but is nevertheless part of the task, the altitude parameter frequently becomes not a primary focus. This implies that the changing indices shown on the altimeter merely "have a form" to the pilot and are controlled given a time margin but are of secondary importance. Hence, it follows that timely detection by the pilot of danger from altitude loss while extricating a plane from a CP depends on the subjective significance of the altitude parameter as a component of the object-goal.

In order to explain the factors which define the varying subjective significance of the altitude parameter we conducted a special series of investigations. We controlled the variables in the tests by using the dimensions of the initial altitude (N initial) formulated by the pilot and the altitude margin in a complicated position (N CP). By changing these variables, we created four types of experimental situations (table 2).

In the initial plan, we always used horizontal flight and the

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Таблица 2

КОЛИЧЕСТВО СЛУЧАЕВ (ЧАСТОТА) ВОСПРИЯТИЯ ВЫСОТОМЕРА  
В ПРОЦЕССЕ ВЫВОДА ИЗ СЛОЖНОГО ПОЛОЖЕНИЯ

1. Тип экспериментальной ситуации	2. Величина исходной высоты (N <sub>исх</sub> ) (м)	3. Запас высоты в сложном положении (N <sub>сп</sub> ) (м)	4. Частота восприятия высотомера (в % к общему числу каждой ситуации)
A5.	1500	1500	86
Б 6.	1500	5500	86
В 7.	5500	5500	73,5
Г 8.	5500	1500	72

Table 2. Frequency of fixation on the altimeter during extrication from a complicated flight position

Key:

- |  |      |
|--|------|
| 1. Type of experimental situation  | 4. A |
| 2. Dimensions of initial altitude (N initial) (meters)   | 5. B |
| 3. Margin of altitude in a CP (N CP) (meters)  | 6. C |
| 4. Frequency of fixation on the altimeter (in percent of total number of glances per each situation) | 7. D |

complicated position consisted of a descending spiral from a right or left roll of 80°. Situations in which N CP equalled 1500 meters were called critical and situations where N CP equalled 5500 meters were considered safe (the altitude was altered during the investigator's programming of the instruments for a CP and concealed from the pilot).

The results of this series of experiments demonstrated that the subjective significance of the altitude parameter depended as much on N CP as on the dimensions of N initial.

To begin with, the likelihood of controlling the indices of the altimeter during extrication from a complicated flight position depends on the dimensions of N initial (see table 2). If one compares the situation of A and B or C and D then it is apparent that given an identical N initial the altimeter is controlled in the same number of cases independent of actually being in a situation of altitude margin loss. On the other hand, situations with different N initial revealed that the frequency of controlling the altimeter varied. Thus, in situation A (N initial = 1500 meters) in comparison with situation

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D (N initial = 5500 meters) the altimeter in 14 percent of cases was controlled more frequently. However, in both situations, the altitude margin for extrication was identical (N CP = 5500 meters).

Secondly, an analogous dependence was demonstrated by data characterizing the moment of the first fixation on the altimeter after beginning extrication from the complicated position. For example, in situation A and B in which N initial was identical the moment of first fixation on the altimeter was almost the same although the margin of altitude in situation A was critical and almost four times less than in situation B. Moreover, in the safe situation B the altimeter was fixated on earlier by 2-3 seconds than in the critical situation D (figure 1)

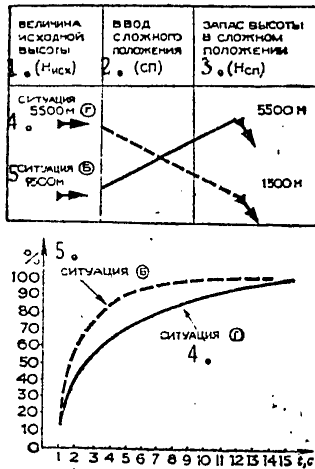


Figure 1. Integral function of distribution of first visual fixation on the altimeter in situations C and D

Key:

1. Dimensions of initial altitude (N initial)
2. Introduction of complicated position (N CP)
3. Margin of altitude in complicated position (N CP)
4. Situation D -- 5500 meters
5. Situation B -- 1500 meters

Рис. 1. Интегральная функция распределения времени первой зрительной фиксации на высотемере в ситуациях Б и Г.

Thus, according to the data obtained, the difference in the significance of altitude parameters is determined by the dimensions of N initial. This relationship can be viewed as the influence of subjective evaluation of objective conditions of activity (1), (6). In this context, the pilot's plan can be understood to mean the preparedness of the pilot for selective perception and comprehension of an expected complicated flight position. In such situations when N initial is not great, the pilot formulates a plan anticipating the worse and his object-goal contains an altitude parameter as a pressing and significant component. In these cases regardless of the actual presence of N CP the changing indices on the altimeter will be perceived as of primary importance. Given a conflict between the plan for the worse

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and a safe situation for extrication from a CP, the former can take hold of the pilot's actions.

We quote an example of an incorrect evaluation of a safe situation as a result of the influence of the pilot's plan for the worse. After completing the initial flight plan in situation B (N initial = 1500 meters) the pilot in the B situation began to extricate the plane from the complicated position, having an altitude margin of 5500 meters (see figure 1). After uncovering the screen, visual fixation was turned first to the altimeter at which time the pilot began to carry out activities to counter the roll and pitch. After 6.1 seconds of attempting to extricate the plane from the position, the pilot announced "We are falling!" although at this moment N CP exceeded 5000 meters. Radio interviews were conducted throughout. In as much as the initial altitude was not great, the pilot earlier on prepared for the worse. Acting under the influence of plans for the worse, he erroneously evaluated the altimeter; the number 5 on the network in the center of the altimeter, which indicates the number of whole kilometers, was taken to be a number corresponding to meters. Therefore, the altitude margin was assumed to be 500 meters rather than the actual 5000 meters --or 10 times less.

Given a sufficiently large N initial (situation C and D) the pilot created a plan for the subsequent confident extrication from a CP. He formulated an object-goal in which the altitude parameter was included as a potentially significant component. Therefore, during extrication of the plane from the CP the pilot above all considered the indices of the gyrohorizon to be wholly sufficient and did not lose time in considering the indices of the altimeter.

In real conditions of flight, danger arises in those situations when there is a contradiction between plans for safe extrication and the presence of a minimal actual altitude margin. Arrangements for a safe outcome are made difficult for the pilot because his awareness of the upcoming critical situation impedes him from transforming in his mind, the altitude parameter from being one of potential secondary significance to one that is a pressing component of his object-goal. Hence, the impression is created that the pilot has forgotten about the altitude, although the psychological nature of this error is absolutely otherwise.

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PSYCHOLOGY

EFFORTS AT CREATING ARTIFICIAL INTELLIGENCE ANALYZED

Moscow INTELLEKT CHELOVEKA I PROGRAMMY EVM (Human Intelligence and Computer Programs) in Russian 1979 signed to press 23 Jul 79 pp 2-10, 229-230

[Annotation, Table of Contents, and Foreword from book edited by Doctor of Psychological Sciences O. K. Tikhomirov, Izdatel'stvo "Nauka", 7,100 copies, 230 pages]

[Text] Annotation

This book examines psychological problems associated with automation of mental labor. It describes the methods and results of experimental psychological investigations of the intellectual activity of an individual participating in a "dialogue" with a computer, and it discusses the prospects for bringing the potentials for manmade systems closer to those of human intelligence. The general psychological prerequisites for raising the effectiveness of automated systems are analyzed.

This book is intended for psychologists, philosophers, and specialists in automation of mental labor.

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Foreword, by O. K. Tikhomirov

Decisions of the 25th CPSU Congress have posed an important task--raising the effectiveness with which computers are used and broadening the range of their application. Naturally, various sciences can and must make their contribution to this complex task. However, the effectiveness of integrated research depends on how clearly the specific tasks of each scientific discipline are outlined. This is an especially important premise in relation to psychology, since the present practice is often to substitute the psychological approach by the information-and-cybernetics approach. As a consequence we must state the basic ways we are to use psychological knowledge in automation of mental labor, and we must formulate those problems of automation that are specific to psychology and which, when solved, would make application of this knowledge possible and effective.

One important direction for the use of psychological knowledge in automation is associated with one of the forms of computer application--the "dialogue" approach. As V. M. Glushkov noted, "further development of dialogue methods poses many technical and scientific problems. They pertain mainly to accounting for human psychology..." ((34), p 41). Consideration

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of the psychological features of human activity associated with writing (evaluating, improving) dialogue programs is a new area of applied psychological research. This is precisely why most of the attention of this collection is devoted to it. In order that human activity mediated by computer dialogue programs would be structured with sufficient effectiveness, these programs must be evaluated on the basis of not only logical and mathematical parameters but also the parameters of human creative activity. The possibility for posing new goals is one of the most important attributes of creative human activity capable of change, and this is precisely why we recommend interpreting change in goal formation as one of the concrete parameters to be used in evaluating dialogue programs. The program must be evaluated on the basis of whether or not it broadens the possibilities of goal formation. The study of new forms of human activity, mediated by computer programs and thus maximally "unburdened" of technical, "routine" operations is one of the directions of applying psychological knowledge in practical automation.

The practice of building automated systems generally requires the use of psychological knowledge as well. Until recently the operator was the focus of the attention of psychologists concerned with the man-machine problem. Today, research on the activity of computer users (planners, scientists, managers, and so on) is acquiring ever-greater significance. I have formulated several psychological principles of the planning of man-computer systems oriented on such "users."

1. Satisfaction of cognitive needs. The range of changes occurring in cognitive needs must be considered when we select the information to be furnished to the individual by the computer. If it is difficult to determine the range of changes (in the case of purely creative tasks), the optimum strategy would be one in which the individual is given maximum freedom of selecting the information to be furnished by the computer, and of selecting the modes of computer use.
2. Enlargement of the creative components of labor. Such enlargement may be achieved by freeing the individual from routine operations. It is important in this case that he be freed of not the maximum but the optimum number of operations. "Overautomation" may disturb the system of human activity and reduce its effectiveness, rather than producing the expected growth in the creative content of labor. If we are to upgrade the quality and increase the speed of problem solving, we would have to study the factors affecting this process, and we would have to make sure that the data employed are complete and verified.
3. The possibility of voluntary regulation of information flows between man and computer. When using a computer, it is important to regulate the flow of information from the computer center, to personally monitor the work of the computer and, when necessary, to perform back-up calculations.

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4. The unity of the principles of improving automated and unautomated control. The evaluation a person gives to information furnished by a computer depends on the content of this information, its correspondence or lack of correspondence with the user's previous experience, and the user's relationship to the computer and his relationship to other people (those transmitting the data for computer processing, and those servicing the computer). Mistrust of a computer may be based on a mistrust of other workers, and this is why automation must be tied in with improvements of management as a whole.

These principles, which I had formulated in the book "Man and Computer" in 1973 (105), were introduced into the practice of creating a concrete automated system owing to the initiative of L. M. Berger. His article, written together with B. K. Koshkin and contained in Part II of this collection, examines concrete problems concerned with implementing the psychological approach in automation practice; it is within the framework of this approach that the authors analyze "needs," "goal formation," and so on. Approximately the same theme can be found in the article by E. D. Telegina and L. A. Abramyan, who associate growth in the effectiveness of automated control with "the activity of the personality." Thus research described in the collection's second part is in a sense a continuation of the research described in "Man and Computer" (105).

Another direction for the use of psychological knowledge in the practice of automating mental labor is associated with determining the prospects of automation, the possibilities and means of bringing "artificial intelligence" based on computer programs closer to human intelligence. Our country's leading scientists hold different opinions on this question. In his report "The Scientific Problems of Developing Computer Technology" given at a jubilee session of the USSR Academy of Sciences, V. M. Glushkov worded the end goal of this development as "creation of artificial intelligence that is not only not inferior to, but which also greatly exceeds, in its capabilities, natural human intelligence. Although this goal is still rather far away, we are working toward it at full steam" ((34), p 41). The work he is referring to is aimed at raising the "intelligence level" of computers with the purpose of quickly raising the labor productivity of persons engaged in intellectual activities. In V. V. Chavchanidze's opinion "were we to have computer concepts at our disposal, we could cause an artificial conceptual intelligence to deal in deductive processes, including those of scientific and artistic creativity" ((101), p 219). A. M. Prokhorov states another opinion: "There is a fundamental difference between modern computers and the human brain. Its roots lie in the very foundation of these systems.... What is interesting is that attempts have been made to utilize some principles of living matter to build computers. This direction came to be called 'bionics.' However it has not as yet produced tangible practical results. Thus computer development is proceeding in its own unique direction, one which will continue to dominate in the near future" ((74), p 21).

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The differences we find in the assessments of the prospects of automation stem, from my point of view, from differences in interpretation of human intelligence, and from whether the psychological characteristics of human intelligence are ignored or taken into full account, and therefore precise psychological definition of human intelligence is a priority prerequisite for scientifically grounded prediction of the trends in development of computer technology.

Materials pertaining to this range of questions are published in the collection's third part, which includes reports given at the All-Union Seminar "Psychology and Artificial Intelligence" in 1975. The points of view presented in these reports differ, which attests to the complexity and ambiguity of these problems. I believe that the main prerequisite for effectively developing all three directions is to study the unique qualitative features of human thinking in comparison with computer information processing. Such research is precisely the main psychological problem with which efforts at automating mental labor are concerned. Therefore we must dwell on it in greater detail.

Both "artificial intelligence" specialists and psychologists sometimes ignore the unique qualitative features of human thinking. "In relation to artificial intelligence, the question as to what is doing the perceiving and what is doing the thinking--man or machine--is unimportant. This is an insignificant detail," writes N. D. Nil'son (62). At the same time the formula adhered to by positivistically oriented psychologists, "intelligence is that which is measured by intelligence tests" ((130), p 588), offers support to those who are prepared to interpret cases of computer solution of some problems as evidence of the computer's "intelligence."

We often encounter the following assertions in the literature: "Creativity is information processing" (57), "Thinking is a random process," "The essence of thinking lies in construction of a model of the outside world," and "Invention algorithms do exist" (7). The information theory of thinking, which is sometimes called the "modeling" theory, having in mind mainly semeiotic models, has taken shape. In my opinion any comparison of an information theory of human intelligence with a psychological theory must include a comparison of the realities described by the terms "psychological reflection" and "intellectual activity" on one hand and the terms "model" and "information processing" on the other, as well as the revelation of qualitative differences between them.

A distinction is made in A. N. Leont'yev's work between a sensory image and a model. The unique features of a sensory image are activity (interest) making deeper penetration into reality possible, objectivity, and participation of effector units in the arisal and operation of the image (56).

In addition to reflecting the world in the form of sensory images, the human mind can reflect at the thinking level, which is also typified by objectivity. What we usually encounter is not individual objects but

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entire objective situations, which include complex mutual relationships and interactions among objects. Activity, interest, and selectivity are also inherent to mental reflection, but in this case they assume a specific form of manifestation. A mental image also requires effector units for its development, which can be seen especially clearly in cases of active visual thinking, though it may also be discovered at the level of verbal thinking (objective manifestations of internal speech).

"Artificial intelligence" specialists are interested in human thinking mainly as a problem solving process. Turning to this particular case, we must distinguish between initial, final, and intermediate reflection of the problem by the subject (that is, its conditions and requirements). It should be noted that activity is inherent to initial reflection of the conditions of the problem. As experiments by V. Ye. Klochko (53) showed, when subjects first acquaint themselves with the conditions of a new problem they prepare themselves in a certain way for formulation of a particular goal, one which sometimes anticipates and even displaces the goal formulated by the experimenter. "Initial orientation in an assignment" (this is what we sometimes call this process of initial reflection) may be very heterogeneous in terms of its psychological structure.

Human mental reflection includes within itself both conscious and unconscious elements including generalization. It is typified by operational and personal meanings of complex dynamics. As was demonstrated by I. A. Vasil'yev's research (25), operational meanings transform into personal ones during solution of a particular problem. These unique features of real human thinking, in particular, are not accounted for by the "modeling" theory, and thus development of artificial systems satisfying the requirements of modeling theory would not mean re-creation of human thinking.

The qualitative difference between human thinking and computer "information processing" is expressed in the description of the former as the activity of a subject. As with all other activity, human thinking is the product of human needs and models. Developed forms of thinking are typified by the presence of special cognitive needs and a specific "object" with the help of which the range of needs for knowledge is satisfied. These needs are not only a prerequisite of mental activity, and they are not only transformed after the completion of mental activity; they also arise and undergo modification in the course of solution of a concrete problem. New goals arise on the basis of cognitive needs. The goal forming process, various forms of which are examined in a special paper (76), is one of the most important characteristics of real human thinking. During his activity, man makes various evaluations expressing the relationship between the results attained (or anticipated) and the motives of activity. These evaluations may be emotional, they may be verbal-logical, and they perform a role in internal regulation of activity. Research by Yu. Ye. Vinogradov (75,76), I. A. Vasil'yev (25), and V. Ye. Klochko (53) showed that solution of subjectively complex problems would be impossible without emotional

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regulation, though presence of such regulation does not guarantee attainment of an objectively valid result. Research has revealed the existence and the great role played by emotional anticipation in the solution of complex problems. If we are to arrive at an objectively valid solution to a problem, we would have to achieve coincidence of subjective and objective value characteristics; if they do not coincide, the problem will not be solved. At certain stages of the search for the solution contradictions may arise between emotional evaluations (manifested in involuntary reactions of the body) and verbal evaluations (right, wrong) of certain intellectual acts, in which case the emotional evaluations sometimes do in fact have greater validity. If the latter are dominant in such cases, the activity leads to an objectively valid result (75). It has been demonstrated that intellectual emotions play a part in all stages and levels of goal formation, and that revelation of the un verbalized operational meaning of elements within a situation is a prerequisite of the arising of intellectual emotions (25). Emotional anticipation may also alter the structure of the problem solution process.

All activity includes technical procedures (operations) within itself. Efforts at creating "invention algorithms," "techniques of invention," and so on are essentially based on the failure to distinguish between activity and operations. The procedures by which we transform objects are a part of creative activity, but they are not all of it. The expression "algorithm" often bears a metaphoric nature, and it may be used in relation to a program of planned, directed actions ((7), p 101); it is sometimes even used synonymously with the expression "stages of activity." However, it misleads engineers who have become accustomed to viewing the algorithm as a formalized procedure guaranteeing a solution. We must clearly see that instructions such as "study the principal technological sectors," "study the subordinate technological sectors," "gather information on ways for solving technical problems, on physical effects, and on new materials," "learn creative decision making," and "correctly state the problem" resemble the instructions of an algorithm in outward appearances only.

We should make note of the conceptual relationship between psychological problems associated with "artificial intelligence" and those associated with "dialogue." "Dialogue" interaction between man and computer may be described at two levels: the information level and the psychological level. At the information level, interaction is typified by the form of the symbols employed, their sequence, and the speed at which they proceed from machine to man and from man to machine. At the psychological level, interaction is once again typified by the goals for the attainment of which the individual communicates with the computer, and by transformation of goals under the influence of the information obtained, the meaning it has to the individual, and the evaluations (including emotional ones) made by the individual of both the overall capabilities of the computer and of the solutions of concrete problems. The same symbols, presented to the user in identical form and at identical speed, may be evaluated, understood,

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and employed differently depending on the concrete situation, on the overall state of the individual, and on the goals and motives of his activities. Given constant information interaction between man and computer, the psychological interaction will vary.

This difference is not accounted for (it is ignored) in the information-and-cybernetics approach; however the studies published in this collection show that if we do not account for it, we cannot evaluate and effectively build dialogue programs. Psychological research on the activity of an individual engaged in a dialogue with a computer must rely first of all on the general psychological theory of activity and on psychological research on creative thinking based on this theory. Paradoxical though it may seem to specialists in computer technology, were we to define engineering psychology as the study of the interaction between man and machine through information, as is often done, we would not be able to achieve effective development of dialogue programs on the basis of engineering psychology since we must consider a broader range of factors than just information interaction alone.

If we are to reorient research from the "operator" to the "user" of automated systems, we would also need to differentiate more clearly between the engineering psychology approach and the psychological approach itself; it would require consideration of the specific qualitative features of man for the creation of man-computer systems, and it would necessitate our not limiting ourselves to superficial analogies between man and machine in our descriptions of information flows in an existing (and in a planned) system.

Thus no matter which of the three named directions we take in our effort to automate mental labor (creation of "artificial intelligence" models, planning and evaluation of the effectiveness of automated control systems, construction of effective dialogue systems), we would have to account for the psychological features of human thinking, and human activity as a whole. Naturally these must become the object of further, deeper research.

Expansion of man's intellectual potentials is associated today by many psychologists with assimilation of the logical apparatus (concepts, the methods of logic) and with increasingly fuller (more "rigid") control of the process of assimilating this apparatus. Thinking formed in this way is said to be more sophisticated than creative, independent, intuitive thinking.

The use of computers opens a fundamentally new way for broadening the intellectual potentials of the individual--that of unburdening him of formalized, logical procedures, and permitting him to utilize such procedures without having to assimilate them. Let me clarify this idea with an example. We could get an individual to assimilate a certain algorithm, and then assert that from here on in, no more errors would be

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made in solving problems of a certain class, and that the problems would be solved faster and on a more general basis. The second way is to solve the problems utilizing an algorithm already contained within a computer program, without having to assimilate it. The advantages of the second way lie in the fact that the algorithm may be implemented significantly faster and that the complexity of the algorithm itself could exceed the practical capabilities the individual has for assimilating this algorithm.

In psychology, we commonly distinguish among three types of thinking--visual-active, visual-descriptive, and verbal-logical. How, then, do we define thinking mediated by computer programs? It appears to me that in application to verbal-logical thinking, we need to differentiate between two of its variants--thinking mediated by logical procedures outside of the subject, and thinking mediated by internal logical procedures--that is, by assimilated concepts and methods of logic. Thinking mediated by computer programs is the most complex form of externally mediated verbal-logical thinking. Analysis of this sort of thinking is a new task of general psychology, posed to it by the practical problems of automating mental labor.

The collection offered here to the reader was prepared in conjunction with the scientific research program "Psychological Problems of Creating and Using 'Artificial Intelligence'" organized by the Scientific Council for the Problem "Artificial Intelligence" of the USSR Academy of Sciences Presidium Committee for Systemic Analysis. Books published previously in this series include "'Artificial Intelligence' and Psychology" (50) and "Psychological Mechanisms of Goal Formation" (76). Naturally, not all of the psychological problems of automation were illuminated in this collection. Problems such as the use of computers in training and in psychological experimentation, and the plans for intracerebral use of computers (152) require special discussion.

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