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MEDICAL SCIENCES DIVISION PROGRAM

AS RELATED TO PROBLEMS OF THE

BUREAU OF AERONAUTICS

Enclosure (H)

[redacted]

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PROGRAM OF THE MEDICAL SCIENCES DIVISION AS RELATED TO PROBLEMS OF THE BUREAU OF AERONAUTICS

[redacted]

The following presentation was prepared and given as a part of a general information conference presented by the Office of Naval Research to the Bureau of Aeronautics on Friday, 14 March 1947. We believe that it has sufficient interest and pertinence to the immediate presentation to be included as an illustration of the way basic research can be utilized in a purely military situation. Again, here as in the previous submarine program, no attempt has been made to select problems and ask contractors to work on them. We have simply reviewed the presently going program in its relationships to the Bureau of Aeronautics.

This sort of approach can be utilized in every instance of Navy need and it is the conviction of the Medical Sciences Division that no general program of Navy need is left uncovered by the ONR contracts we have in operation at the present time. In other words, this is simply another illustration of the fact that basic research selected only on the basis of its merit as research yields information of value to the military situation as well as of general interest to the nation as a whole.

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MEDICAL SCIENCES DIVISION

By

CAPTAIN A. J. DONALD (MC) USNR

The investigations being pursued by the Medical Sciences Division in the interest of Aviation are aimed primarily at the accomplishment of the most perfect integration between man, the machine and the environment. Although man is our paramount interest in this tripartite integration, nevertheless it is obvious that an effective solution of problems pertinent to man as an aviator must consider also those forces intrinsic to the machine and the environment which influence him.

With respect to man, the scope of the research interests is broad. In essence, it encompasses, first, a complete knowledge of the physiological, biochemical and psychological processes of the normal man in his native environment - second, the identification of deviations from the norm by experimental and clinical researches upon man when subjected to conditions imposed by flying - and third, the application of certain physiological props for the maintenance of man within the narrow limits of his norm.

Much is known about the normal biological processes of man in his natural environment and a considerable amount of new knowledge has been collated concerning the physiological insults occasioned by conventional flying. Many of these insults have been neutralized or mitigated by the introduction of certain compensatory devices which if reviewed would identify the "anti G suit", liquid and chemical oxygen, oxygen equipment, flight clothing, shoulder harness, safety belt, armored jackets, goggles and sun glasses, ear defenders and warders, water and food, communication systems and a host of other devices including those for selection, indoctrination and training. In spite of these accomplishments, there remains still much to be learned and applied if man is to be an integral part of aviation envisioned for the future. Many studies of the past must be reopened and expanded to consider new problems among which there are those concerning the tolerance of man to the forces developed by accelerations accompanying trans and supersonic speeds, the most advantageous positioning of the aviator with respect to such speeds, temperature, respiration, vibration and noise, fatigue, neuro-muscular mechanisms, emergency escape and last but not least such problems as relate to vertigo and motion sickness, vision, speech intelligibility, hearing, orientation in flight, psychomotor skills, physical fitness, selection and classification of personnel. The solution of these problems is not a simple

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matter. It will necessitate long and precise experimental and clinical studies before man is integrated most effectively with future aviation. The new knowledge obtained by these studies cannot be applied in all instances to man, per se. Unfortunately, his genetically endowed structure and delicately balanced functions prohibit the application of practices commonly used in mechanical design, function and lateration. Fortunately, however, the machine is also an essential component, a partner in that tripartite integration mentioned previously. The aircraft lends itself much more easily to alterations in structure and function which cannot be effected in man per se, but which influence man. Therefore, the aeronautical engineer, the flight surgeon, the medical scientists, and the aviator must work together from the drawing board stage of aircraft design into final production of the plane. This collaboration must effect cabin pressurization allowing man to function normally at high altitudes, must introduce provisions for adequate oxygen, temperature control, clear vision, easy and precise manipulation and control of instruments, protection against possible cosmic energies, explosive decompression and escape at high altitudes. Time will permit a brief elaboration of only one of these problems, namely, emergency escape at high altitude. The anoxia and decompression, the extreme cold and the very high G forces developed at high altitudes, the wind blast, and many other problems indicate that the classical concept of escape from aircraft and parachuting cannot be retained. The only solution one can contemplate is an ejectible cockpit or capsule containing the man.

For the solution of these problems, the Medical Sciences Division is pursuing a wide range of basic investigations. In so doing, it collaborates with the Physical Sciences and Naval Sciences Divisions of the Research Group, with Special Devices Center, the Naval Research Laboratory, the Bureau of Aeronautics, the Bureau of Medicine and Surgery, the Air Surgeon of the Air Department, the Civil Aeronautics Authority and the Committee of Aviation Medicine of the National Research Council. The Branch is making every effort to accomplish its mission through the action of various Branches arbitrarily established according to certain basic disciplines of the Medical Sciences.

You will now have an opportunity to hear the heads of these various Branches.

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PHYSIOLOGY AND BIOCHEMISTRY SECTIONS [redacted]

by

Dr. G. E. REYNOLDS

The contribution of the physiology and biochemistry Branches related to present and projected future aviation operational problems is as follows:

Study of the physiology and chemistry of respiration, important for the design of future oxygen equipment, cabin pressurization and high altitude escape considerations, is being pursued at six universities - Harvard, Yale, Ohio State, Colorado, Maryland, and Virginia. Two of these projects are directly associated with the problem of "explosive decompression" which would occur at high altitude in case of failure of the pressure cockpit. Others are associated with the activities of certain respiratory enzymes which have already been shown to favorably affect anoxia tolerance.

The physiological aspects of fatigue are being investigated principally from a standpoint of nerve physiology. This program involves five task orders at Harvard, Johns Hopkins, Chicago, and the Worcester Foundation. Other studies in nerve physiology related to the problems of neuro-muscular coordination of basic concern in problems of human factors in engineering design represent five projects at Illinois, Northwestern, Johns Hopkins, Chicago, and the Worcester Foundation.

Toxic gases which may be encountered in flight or pre-flight conditions are under study in four projects at Pennsylvania, California, and Loyola Universities. The principal object of concern here is carbon monoxide.

Problems related to food and nutritional metabolism important from a standpoint of in-flight feeding, metabolism during anoxia, and survival rations constitute a large program at thirteen institutions, both educational and industrial.

In addition to these projects currently in effect, proposals have been received in important related problems concerning muscular activity and respiratory exchange, other studies in respiratory enzymes and nutritional metabolism for which funds have not yet been made available.

From a standpoint of budgetary allocation, the physiology and biochemistry sections are expending approximately 70% of their effort in problems directly related to aviation.

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PSYCHO-PHYSIOLOGY
by
MR. H. A. IMES

The Branch of Psycho-physiology is concerned chiefly with problems of vision and hearing. Under a contract with the Office of Naval Research, the Dartmouth Eye Institute is cooperating with the School of Aviation Medicine and Research at Pensacola, Florida, in an investigation of the various factors which cause or contribute to vertigo. These factors are the innervations from the non-auditory labyrinth, the visual mechanism and the kinaesthetic mechanism. Even slight innervations of the first factor may produce profound disturbances of the pilot's orientation in space and may cause him to make the wrong compensatory adjustments of the controls of the aircraft. Sometimes such errors prove fatal. Both the Bureau of Aeronautics and the Bureau of Medicine and Surgery are vitally concerned by, and interested in the furtherance and financial support of this research program. The Flight Section of the Special Devices Center is also contributing.

At the University of Michigan a broad research program is underway on the probability of detection and recognition of visual targets. This is a fundamental study which will provide necessary information for military maneuvers of extremely high speed aircraft. A corollary study relative to the conditions and limitations for the improvement of visual observation by training is being made.

At the Harvard Psycho-Acoustic Laboratory another broad program is being conducted on various problems of the human ear and auditory system, the factors governing the intelligibility of voice communications and investigations of the parameters of radio circuits and components which affect the intelligibility of speech and other types of signals. This program is sponsored jointly by the Office of Naval Research, the Bureau of Aeronautics and the Bureau of Ships. A parallel program in the testing and development of communication equipment and the training of personnel is being sponsored by the Special Devices Center under the cognizance of the Human Engineering Section. These basic and applied research programs are of critical importance to radio and voice communications, ground controlled approach of aircraft, fighter-director operations, inter-plane communications and airgroup command operations.

The basic research proposals submitted to the Psycho-physiology Branch are reviewed, when necessary, by the Bureau of Medicine and Surgery, the Advisory Panel on Psycho-physiology, the Committee on Ophthalmology, Vision, Hearing and Sensory Devices formed by the National Research Council. Liaison is maintained with the Bureau of Aeronautics through the Medical Liaison Officer in Military Requirements.

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PSYCHOLOGY SECTION

by

Dr. J. McMILLAN

The Psychology Branch is concerned with problems of selection, classification, and training of personnel, the study of certain aspects of performance in relation to engineering problems, and a program of research in the field of Human Relations. The Branch is aided in its work by the other sections of the Medical Sciences and other Branches of ONR and by two advisory groups, 1. The Intra-Navy Personnel Research Committee which is composed of representatives from BuMed, BuPers, BuAer, BuOrd, C/O, and the Special Devices Center and the Naval Research Laboratory of ONR. 2. The Human Relations Advisory Panel, which is composed of 15 members representing the fields of psychology, anthropology, economics, political science, sociology, labor relations, and business administration. Research proposals are reviewed and commented upon by these two groups and are included in the program of the section upon their recommendations.

The section has at present several contracts which are of particular interest to the Bureau of Aeronautics. These fall into four general areas:

1. In the field of motionsickness there are two contracts. At the University of Rochester extensive studies are being made of the duration, extent, and direction of motion necessary to produce sickness, and of methods to prevent the onset and severity of nausea produced by varieties of motion. At Brooklyn College studies are being made of disorientation with emphasis on visual factors and variations in susceptibility among individuals.

2. In the field of performance of motor skills or psychomotor performance there are three research contracts. At Northwestern University studies are being made which attempt to analyze the component skills necessary for the performance of highly skilled tasks such as that of flying an airplane. At the University of Southern California studies are being made in the human centrifuge of changes in the accuracy and effectiveness of psychomotor performance under accelerative forces, and of methods to increase tolerance to these forces. At Cornell University studies of relationship of skilled performance to tension and fatigue are being conducted in an effort to determine the effect of various conditions of work, etc. on the performance of skilled tasks.

3. In the field of selection and classification there are several studies. One at Northwestern University is devoted to the development of better and more effective intelligence tests. One at the University of Chicago is devoted to the analysis of the complex known as mechanical aptitude. Another at the University of Minnesota is making analysis of the interests of Naval personnel in an effort to develop methods of assignment which will make use of the interest patterns of new personnel in relation to those interests required by various Naval billets.

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4. In the field of leadership, group performance, and morale efforts are being made to isolate and evaluate some of the basic determinants of human behavior which are responsible for effectiveness of leadership in varieties of situations, the maintenance of morale under conditions of stress and non-stress, and the improvement of group performance in combat or in peacetime operations. The studies at present underway are being conducted at Ohio State University, the Survey Research Center at the University of Michigan, and at the Massachusetts Institute of Technology.

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ENVIRONMENTAL PHYSIOLOGY

by

DR. M. C. [illegible]

It is universally accepted that man in very high speed aircraft, when such aircraft is not moving in a straight line, is subjected to physical forces so serious in nature that full advantage of such high speeds as the engineering has achieved cannot be taken. Present aircraft performance extends beyond the limits of human tolerance of forces of acceleration. The largest share of potential successes for the exploitation of piloted high speed aircraft is directly dependent upon the understanding of the nature of body reactions to these forces. Only by understanding the reactions of the body we can explore the possibilities of developing equipment or techniques which will permit the pilot to withstand these forces. Without exaggeration this field is the most critical area in regard to piloted aircraft.

The Environmental Physiology Branch has contracts with the University of Virginia, University of Southern California, University of Pennsylvania, and the Mayo Clinic, pursuing specific problems in this area. These civilian projects are augmented by the programs under Bureau cognizance, at Philadelphia and Pensacola, and the development of the Human Centrifuge under the Special Devices Center. There is moreover and extensive program in crash injury in which ONR is participating.

The second phase of interest ot high speed is the problem associated with vibration. There is ample evidence to indicate serious physiological and psychological effects developing when the human is subjected to the vibrational energies of present day and projected aircraft. The Environmental Physiology Section is also supporting studies in Naval laboratories. This program is exclusive of all the studies on vibrations of the auditory range which are supported by one of the other sections and a broad University program on biological reactions to mechanical forces.

Associated with problems of high altitude and high speed are the physiological factors of heating, cooling, and ventilation of aircraft. The study on the bodily reactions to environmental temperature includes research projects with Cornell University, University of Rochester, and the University of Pennsylvania.

An area of singular importance and special interest to the Environmental Physiology Section is the Arctic. No one group has had greater contact with Arctic problems than the aviation group. Its importance needs no further pleading. However, a paucity of information regarding life and survival in the Arctic is overwhelming. The Environmental Physiology Section is pursuing programs of a broad nature including the writing and editing of a summation of known Arctic information in encyclopedic form, and analytical bibliography of the Arctic and a roster of Arctic Specialists. In addition it is supporting six field projects in the North American Arctic, and is pursuing a program in support of an Arctic Scientific Station at Point Barrow on the Arctic Sea.