History of Rocketry and Astronautics

Proceedings of the Ninth, Tenth and Eleventh History Symposia of The International Academy of Astronautics

Lisbon, Portugal, 1975

Anaheim, California, U.S.A., 1976

Prague, Czechoslovakia, 1977

Frederick I. Ordway, III, Volume Editor

R. Cargill Hall, Series Editor

AAS History Series, Volume 9

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 4

AAS Publications Office
P.O. Box 28130
San Diego, California 92128

Affiliated with the American Association for the Advancement of Science
Member of the International Astronautical Federation

First Printing 1989

ISSN 0730-3564

ISBN 0-87703-309-9 (Hard Cover)
ISBN 0-87703-310-2 (Soft Cover)

Published for the American Astronautical Society
by Univelt, Inc., P.O. Box 28130, San Diego, California 92128

Printed and Bound in the U.S.A.

Chapter 3

BEGINNINGS OF AIRBORNE AEROMEDICAL WEIGHTLESSNESS RESEARCH*

Harald J. von Beckh†

The astronautical pioneers, Tsiolkovsky, Goddard, and Oberth, first considered the possible effects of space flight on humans early in the twentieth century. After World War II, an increasing number of aeromedical investigators became interested in the medical problems of space flight, particularly its most challenging aspect: weightlessness. Until 1950 these efforts remained limited to theoretical deliberations and predictions. Beginning in the early fifties, however, researchers began actively to experiment with zero gravity. Weightlessness was investigated aboard aircraft in vertical diving flights and later by flying Keplerian trajectories. Less accurate simulations of weightlessness using immersion and sub-gravity towers on the ground, complementing the airborne research, yielded additional findings.

This paper examines these early studies, and contrasts the experimental results obtained with the medical data returned in the 1960's when manned space flight became a reality.

INTRODUCTION

I was a pilot and a flight surgeon of the German Luftwaffe in February 1940. At the end of World War II I had over five years of experience in Aviation Medicine. After the war I wanted very much to stay in this specialty. It became obvious, however, that after the war flying in Germany would not be possible for many years, so I volunteered at the Argentine Mission in Genoa to work for the Argentine Air Force.

In Argentina, a country of the southern hemisphere, many physical phenomena differed from the northern part of our globe. For example, due to the Coriolis effect, the water in a washbowl flows clockwise as opposed to counter-clockwise in the northern hemisphere. This was not a particular bother to transplanted pilots, as was the fact of the sun being in the north direction at noon. At first, this somewhat affected our orientation. In helpful contrast, however, was the Argentine Railroad

* Presented at The Tenth IAA History of Astronautics Symposium, Anaheim, California, U.S.A., October 1976.

† M.D., Naval Air Development Center, Warminster, Pennsylvania 18974-5000, U.S.A.

System. All rails originate in Buenos Aires and go fanlike to the west and by law all the railroad stations had their names painted on the roof of the station in big white letters. One of the most important navigational instruments was a railroad timetable which each pilot had in his cockpit. If a pilot wished to orient his position, he would fly at a low altitude and read the name of the railroad station he was over, consult his timetable and navigate to his destination. This maneuver was called in the pilot's jargon "to buy a railroad ticket."

Soon after my arrival in Buenos Aires, I became a consultant in the National Institute of Aviation Medicine of the Argentine Air Force.

THE PRECURSORS OF ASTRONAUTICS

Authors like Edgar Allen Poe (1809-1847), and Jules Verne (1828-1905) treated weightlessness as an interesting aspect of space flight. But the first authors who brought space flight problems in the scientific sphere were the Russian, Konstantin E. Tsiolkovsky (1853-1881), the American, Robert E. Goddard (1882-1945) and the Transsylvania-born German, Hermann Oberth (born in 1894).

THEORETICAL PAPERS ON WEIGHTLESSNESS

In 1950, the Space Medicine Branch of the Aeromedical Association, and in 1951 the International Astronautical Federation were founded.

These times are described in detail in my paper published in the *Journal of Aviation Space and Environmental Medicine* [28]:

The spectacular advances in rocketry during the 1940's stimulated an increasing number of aeromedical investigators to become interested in the biological and medical aspects of space flight. The great majority of the scientific community, however, remained skeptical as to whether space travel would be possible at all.

Showing great foresight, scientific know-how, and not a small amount of courage for those times, Major General Harry G. Armstrong, USAF-MC, organized a Panel Meeting on the topic of "Aeromedical Problems of Space Travel" in November of 1948. The presentations at the meeting held at the USAF School of Aviation Medicine, Randolph Field, Texas, were made by Armstrong, Prof. Hubertus Strughold (who even then was regarded as the "father" of space medicine), and the astrophysicist, Dr. Heinz Haber. Armstrong showed the same foresight a year later when he established a Department of Space Medicine at the School.

At the 20th Annual Scientific Meeting of the Aero Medical Association, held in New York in 1949, two papers were presented pertaining to space flight. The word "space," however, did not appear in the titles because, at that time, "space" was relegated to science fiction writers, and its use would not have been compatible with the serene and dignified atmosphere of the scientific sessions. Thus, the authors, Armstrong and Dr. Paul A. Campbell, respectively, spoke about "Some Aviation Medical Problems Associated with Potential Rocket Flight" and "Cybernetics and Aviation Medicine."

The negative attitude concerning "space" very likely existed in most countries. As an interesting parallel, I would like to recount a situation that occurred at the same time in Buenos Aires. At the Aeromedical Institut of the Argentine Air Force I conducted airborne studies on the effects of weightlessness producing brief periods of weightlessness by vertical diving flights in an open cockpit aerobatic biplane (Focke-Wulf 44). The duration of weightlessness was severely restricted by the limited maximal allowable diving speed of the aircraft and by the altitude necessary to recover from the dive at a sufficiently high altitude over the airfield. As the experiments involved some risk, the responsible safety officers took a grim look at these studies, and threatened to ground the aircraft and the investigator several times. To obtain weightlessness of longer duration, it was necessary to fly parabolic (Keplerian) trajectories, and this could be accomplished only with a more powerful aircraft. In the formal request to Headquarters, Argentine Air Force, for the assignment of such an aircraft, the official justification also avoided the mention of "space" flight; rather, it emphasized that periods of weightlessness could occur in some air combat maneuvers. The justification reads:

> "...combination of diving flights and pull outs into parabolas do occur when fighter aircraft make -- for instance -- gunnery runs on bombers. The attacking plane penetrates the fighter escort by high-speed diving from a superior altitude, makes its pass at the bomber from below as he pulls out, then evades the bomber's tail guns by another dive. If this parabolic flight path by accident approximates a Keplerian trajectory, the pilot would experience short periods of weightlessness. Thus, it is desirable to investigate whether these periods of weightlessness affect the pilot's neuromuscular coordination and/or orientation, as has been predicted by several authors."

This diplomatic formulation very likely eased the favorable decision of the official at headquarters, although he may have suspected the real purpose of the flights. The assigned aircraft (Fiat G 55) was deployed with a Fighter Wing at Mendoza, near the Andes Mountains, about 600 miles from Buenos Aires. Only one week after the request had been submitted, this aircraft was ordered to El Palomar Air Base in Buenos Aires. The Aeromedical Institute was notified of the favorable decision when the aircraft had already taken off from Mendoza, so that the investigator had to prepare the protocol and the airborne zero-G instrumentation very hastily.

This rapid assignment of a research aircraft was unprecedented and, for quite a while, was the topic of discussions in the aeronautical circles of Buenos Aires. Jokingly, it was stated that this victory over bureaucratic inertia was only possible because the project was "weightless."

Meanwhile, in the United States, the conception of a space medicine organization merged as a result of a significant meeting. This was the symposium on "Biological Aspects of Manned Space Flight" held at the Medical College of the University of Illinois on 3 March 1950. Armstrong and the late Dr. Andrew C. Ivy, then Vice President of the Chicago Professional Colleges of the University of Illinois, co-sponsored this historic meeting.

This time, the prominent authors no longer had to avoid the word "space," as can be seen from the titles of the lectures: "Space Medicine in the United States Air Force," by Armstrong; "Multi-Stage Rockets and Artificial Satellites," by Dr.

Wernher von Braun; "Physiological Considerations on the Possibility of Life under Extraterrestrial Conditions," by Strughold; "Astronomy and Space Medicine," by Haber; "Orientation in Space," by Campbell; "Bioclimatology of Manned Rocket Flight," by Dr. Konrad Buettner.

The great number of enthusiastic attendees, the spirited discussions, the public response, and the news media coverage were beyond all expectations. Dr. John Marbarger, then head of the Environmental and Aviation Medical Laboratory of the University of Illinois, participated in the organization of the meeting, and edited and published the symposium proceedings in book form at the University of Illinois Press. This book, entitled *Space Medicine -- the Human Factor in Flights Beyond the Earth*, was soon in its third printing. Thus, for space sciences, the year 1950 can be considered as the breakthrough from the science fiction level to accepted scientific status.

The immediate outgrowth of this successful meeting was that the participants and attendees agreed that an organization was necessary to coordinate the exchange information related to space medical research. It was the consensus that this organization should be within the framework of the Aero Medical Association.

Thus, an "Informal Committee Interested in Space Medicine" was formed. Dr. A.C. Ivy kindly agreed to be the pro tem chairman of the group. The first session was scheduled as a luncheon meeting during the 21st Annual Meeting of the Aero Medical Association in Chicago. Strughold and Dr. Gauer were asked to make formal presentations at this luncheon meeting in the Palmer House Hotel on 31 May 1950.

Strughold made the first presentation, which contained the following prophetic remarks:

> "It can be predicted that rocket and space flight are in the same state of development as was aviation in 1920, whose field of research, including the medical sciences, experienced an explosive development in the following decades. It appears that the space sciences will develop along similar lines. In order to enable the medical faculty to keep pace with the presumable technical development, it is mandatory to place space medicine on the broadest possible basis and, in this manner, effect a rapid and extensive development."

Haber summarized the physical characteristics of the high-altitude atmosphere and of sealed cabins. Also, he recommended a formal space medical organization. Drs. O.O. Benson, E.J. Baldes, P.A. Campbell, and R.S. Benford participated in the discussion and agreed.

Following the discussion, a motion was made, seconded and passed, to petition the Aero Medical Association for affiliation as a section. A committee was established to prepare the petition for admission to be submitted to the Executive Council; its membership consisted of Drs. Ivy, Marbarger, Benford, Campbell and A. Graybiel.

THE FIRST EXPERIMENTAL PAPER ON WEIGHTLESSNESS

During World War II as a pilot flying Junkers 87 dive bombers I experienced that, when diving nearly vertical, I had the sensation of free fall and weightlessness during the first three to five seconds of the dive. The object was to begin the free fall with minimal speed and then increase the acceleration to prolong the free fall as long as possible, i.e., until the permissible diving speed was reached. I selected a test vehicle, the Focke-Wulf 44. This was a German aerobatic two-seater biplane, which was fabricated in Argentina and was a very common school plane for primary instruction. These experiments began in 1950. It was dangerous to pull out at maximal speed (and sufficient time of weightlessness) and to still have sufficient altitude between the ground and the aircraft. (The Base Commander threatened to ground me on several occasions.) With the Focke-Wulf 44, I made two different series of experiments, one with humans, who had to perform a "cross drawing test" during the diving flight, and second, a series of tests with water turtles (see below).

THE ZERO-G METER

The zero-G meter used in these experiments consisted of an 11-in. long glass tube which was suspended perpendicularly. On the upper extremity was a steel spiral which was fixed on an iron sphere whose diameter was nearly the inner diameter of the glass tube. In the horizontal position, the spiral drew the sphere until a position which roughly corresponded to zero-G and which was marked as such. In the vertical position, the sphere descended to a mark which was designed 1 G.

After the weightless phase and before the aircraft produced the high accelerations of the recovery, the instrument had to be placed in a horizontal position to prevent the high accelerations from ruining its sensitivity.

Although the instrument functioned properly, a better zero-G meter was discovered after a series of flights. This so-called meter consisted of a glove or a ping pong ball, suspended before the pilot, and indicating by floating freely whether there was exact weightlessness present giving the pilot the indications necessary to change the flight parabola.

Much later, in 1958, at Holloman Air Force Base, we had a sophisticated device available for weightlessness flights which consisted of two microammeters. When both needles were on zero, then the parabola was exact. The needles, however, had a noticeable time lag, so that the simple glove and ping pong ball "instruments" were generally preferred.

PUBLICATION AT THE FOURTH IAF CONGRESS IN ZURICH

I published the results at the Fourth International Astronautical Congress in Zurich, 3-8 August 1953; its German title was "Untersuchungen ueber Schwerelosigkeit an Veruschspersonen und Tieren waehrend des lotrechten Sturzfluges" ("Investigations about weightlessness on human and animal subjects

during Vertical Diving Flights"). This was the first experimental weightlessness paper ever published. Its enlarged form was published in the *Journal of Aviation Medicine* in June 1954.

On 20 August 1952, I was invited by Dr. Odoris, the Director of the Department of Physiology of the Buenos Aires Medical School, to speak about my experiments in a lecture open to the public. The title of my lecture was "Physiology of Flights at Extreme Altitudes." At the end of the lecture a distinguished gentleman congratulated me and introduced himself: Colonel Roadman, Air Attaché, American Embassy. He asked me if I could give him a copy of my paper. After properly clearing my paper with the Argentine authorities I visited Colonel Roadman in his office at the American Embassy and gave him the paper. Later he showed me the evaluation of my paper by Dr. J.P. Henry, of the Aeromed Lab in Wright-Patterson AFB which stated:

"von Beckh's paper is an example how .... ingenuity can replace resources...."

Roadman later became my superior as Commander of the Aerospace Medical Division.

In 1950, Heinz Haber and Fritz Haber had published an article with the title, "Possible Methods of Producing the Gravity-Free State for Medical Research". My wish was to fly parabolas with an aircraft which was available at the airbase in Mendoza. That was the Fiat G 55-B which was similar to the Messerschmitt 109, with which I was familiar.

On 31 August 1952, I gave a lecture at the Institute of Aviation Medicine to which Brigadier General Feliciano Zumelzu was invited. General Zumelzu was Cuartel Maestro General de Aeronaútica; i.e., he was the Commander of all units of the Argentine Air Force with the exception of the flying units. Also, the surgeon general and his Medical Corps were under him. I described my flights with the Focke-Wulf 44 and stated that it would be desirable to reach a much longer time of weightlessness if I could use a higher performance aircraft like the Fiat G 55. I observed the General during my speech, and he made no favorable indication of my suggestion. After my speech, he congratulated me but said nothing about the availability of the Fiat G 55.

I was therefore very astonished when I received a telephone call three days later from the Base Commander of the Air Base El Palomar (near Buenos Aires) informing me that a Fiat G 55 aircraft from the base in Mendoza had landed in Palomar and was awaiting my instructions. This rapid decision in my favor was unique in the Argentine Air Force. In the aeronautical environment this rapid decision became well known and sensational. It was humorously said that my weightlessness experiment request was approved so quickly because it was weightless. After the phone call, I rushed into a glass blower shop nearby and bought another glass tube for my zero-G indicator, because the glass tube was broken in one of the last Focke-Wulf 44 flights. Then I rushed to the Palomar Air Base. The pilot, Capt. N. Gonzalez, understood the problem of parabola flying immediately and we started the experiments which gave us a zero-G duration of 20 sec., consequently enabling me to enlarge upon my paper significantly. It was published in the *Journal of Avia-*

tion Medicine in 1954 under the title "Experiments and Animals and Human Subjects under Sub- and Zero-Gravity Conditions during the Dive and Parabolic Flight."

This paper was the very first in the literature that contained experimental data of humans and animals under weightless conditions.