Some otological problems during space flight

W. H. Johnson (Toronto)

Space flight achievements by both the American astronauts and Soviet cosmonauts have demonstrated that man, if appropriately selected, trained and protected, can leave his terrestrial environment and explore with safety the weightless and sub-gravity conditions of nearby space. Few, if any, achievements in all history have challenged human ingenuity to such an extent as have the requirement involved in manned lunar exploration and the establishment of an orbiting space laboratory. Such accomplishments have exposed the space pioneers to a complexity of factors the like of which has no counterpart in human experience and constitutes the challenge of discovery for which man, as always, will sometimes sacrifice his life. Accordingly, the science of Bioastronautics has been established, essentially to study the maintenance of life, as we know it, in space.

It is not possible to discuss here all the medical problems encountered in space flight, only those of the neuro-physiological aspects pertaining to the non-auditory part of the inner ear.

There are considerable problems associated with spatial orientation under conditions of sub-gravity and complete weightlessness. Normally we maintain orientation by means of vision, vestibular sense, and proprioception. In complete weightlessness, conditions are very different. Proprioception depends to a large extent on the force of gravity for the stimulus and the vestibular system, certainly as far as the otolithic receptors are concerned, depends also on the pull of gravity. The semicircular canals do function under conditions of weightlessness, but the control that the otolithic receptors have over their response is modified to a certain degree. Weightlessness occurs on the journey to the moon and gravity is cancelled out during earth orbit and during this time both American and Soviet experience has been that surrounding objects appear to float upwards. The astronauts have illusions of being in an inverted position. Soviet scientists claim that these oculo-gravic illusions result from otolithic stimulation. Proprioception must also be taken into consideration, however, plus its central connections with visual vestibular pathways and their interactions. Attempts to simulate weightlessness have been made by flying aircraft in a parabolic curve when the centrifugal force almost cancels out the effect of gravity and physiological measurements can be made. During these flights, this illusion of being upside down was reported, despite the eyes being open.

https://doi.org/10.1017/S0022215100074739 Published online by Cambridge University Press

In early experiments many subjects tended to develop motion sickness and this would be a very serious hazard in space because of the danger of asphyxiation by aspiration while in a space suit. The early Russian flights probably had to be shortened because of motion sickness, but during the first two American flights this problem did not occur. This was probably because the Americans were very restricted in their movements within the capsule, and they were able to keep the space capsule fixed in space in relation to the earth. The most potent stimulus to induce nausea and vertigo is multiplanar angular acceleration which produces severe vestibular disturbance and when the position of the space craft can be controlled this is reduced. This vestibular sickness can be brought on by head movements and is due to any angular motion rather than to weightlessness as such. After sleep this disappears almost entirely. Vestibular sickness has become a problem again in the Apollo flights. This is probably related to the increase in the possibility of movement in the larger spacecraft. Five of these astronauts have reported symptoms of motion sickness associated with head and body movements in weightlessness, but all have adapted in from two hours to five days. Antinauseants have been developed but the astronauts dislike admitting to motion sickness and rebel against taking them. The kit contains, however, cyclizine, and more recently a combination of 0·6 mg. of Scopolamine and 10 mg. of Amphetamine. Recent research shows that those drugs with a parasympatholytic or sympathomimetic action and some of the antihistamines are effective and adding 50 mg. of Ephedrin to Scopolamine is especially successful.

Another method of combating motion sickness is for the astronauts to carry out a series of programmed head movements over the first two days which hasten their adaptive process.

Several years ago, N.A.S.A. established a progamme to launch into orbit a rudimentary space station called a 'Saturn Workshop'. The target date was 1972, but unfortunately this has been put off for several years. Meanwhile the Russians now have such a laboratory in orbit. An orbiting research laboratory is an absolute necessity to be able to study long periods of exposure to the weightless environment and certainly we must learn more about man's physiology in this condition before exposing astronauts to any more than three weeks of such conditions. The Saturn Workshop will actually be stage IV, a propellent part, of the Saturn rocket, which contained liquid hydrogen and the propulsion water. This will be removed and inside will be a research laboratory instead. The shuttle service back and forth will be the Apollo command module. This laboratory will have the space equivalent to a three-bedroomed house with comfortable sleeping quarters. Attached to the front of the workshop will be a multi-docking adapter which provides attachment for the module. It will contain three astronauts or scientists plus animals for research.

https://doi.org/10.1017/S0022215100074739 Published online by Cambridge University Press

There is a second generation of space stations planned which will accommodate 50 to 100 persons with a re-usable craft for the shuttle service.

Once these space laboratories are in orbit, some very important fundamental research can be carried out. This is not only important from the point of view of space exploration, but will also help to understand the basic physiology of the non-auditory labyrinth.

A film was then shown of Apollo 14 mission to the moon.

https://doi.org/10.1017/S0022215100074739 Published online by Cambridge University Press