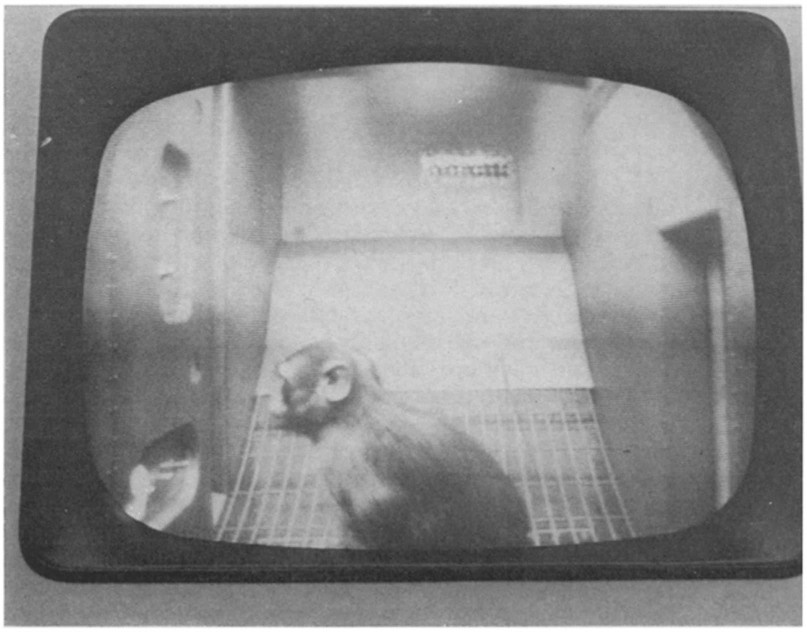
SPACE BIOLOGY

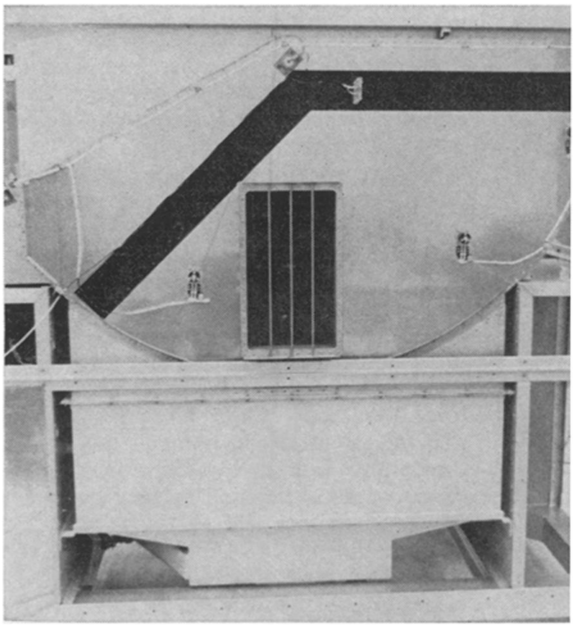
Two monkeys are better than one in space

by Jonathan Eberhart



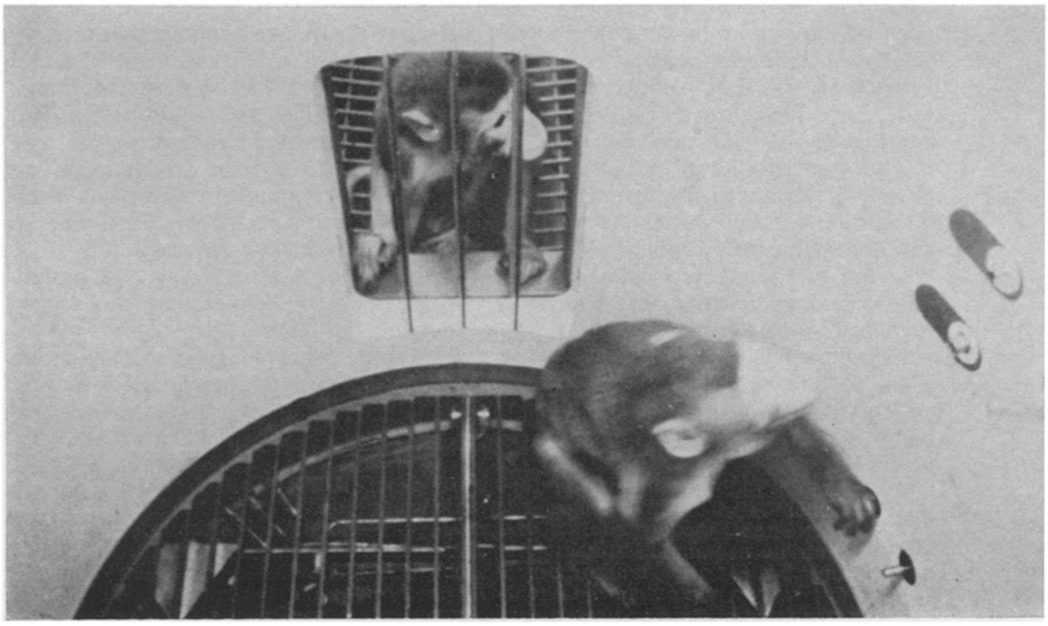
Northrop

Isolation and confinement in space are avoided in the next bio-experiment



". . . an optimum, natural little monkey world" as designed by Northrop and by Lockheed (below).

NASA



The controversial demise of Bonnie, the monkey that died after landing from a nine-day earth-orbiting ride aboard Biosatellite 3, has left an uncertain future for animal research into problems of long stays in space by man. A duplicate follow-on mission was canceled for largely budgetary reasons, and a similar fate had already befallen two planned subsequent flights with lesser life forms. But there are enough people who believe animals must provide experimental data at least to complement studies of man himself in space, that pressure for animal experiments continues to be felt.

Animal experiments continue to queue up for support, taking up in their design where Biosatellite 3 left off. In future experiments it will be necessary to insure against extraneous factors that might have contributed to Bonnie's death.

A major concern is that Bonnie's heavy load of implanted electrodes and catheters, designed to provide detailed, real-time data about functions from eye movements to brain waves, may have contributed to his physiological decline. Secondly, the monkey was securely restrained, except for his arms and head, both to protect the biomedical wiring and to keep him from damaging his spacecraft or himself. The restraint had the effect of preventing the exercise that apparently is necessary in the absence of gravity.

At the Pensacola Naval Air Station in Florida, a team of researchers is developing a project the basic philosophy of which is to get around these limitations. Called the Orbiting Primate Experiment, it is being planned for the National Aeronautics and Space Administration, under contracts with NASA's Langley Research Center in Virginia.

The experiment was conceived well

before the Biosatellite encountered its difficulties, so the differences are not responses to Bonnie's death. But the contrast is clear.

"We have actually quite a different notion as to how a first experiment of this sort ought to be conducted," says Dr. Ashton Graybiel, the project's chief mentor at Pensacola. "If you tether an animal the way the Russians tethered their dogs or the way Bonnie was tethered, you have imposed about the maximum stress relative to the weightless condition."

Instead, the OPE will use a pair of monkeys in separate cages, each with about 25 cubic feet of living space, in which they will be free to move unencumbered. In place of the Biosatellite's elaborate complement of sensors and the accompanying wires and tubes connecting the monkey with equipment in the spacecraft, the OPE monkeys will carry only body temperature and electrocardiograph electrodes; implanted transmitters will take the place of any physical connection between the monkeys and their enclosures.

At present, the plan is for the monkeys to remain aloft for six months, although the life-support systems being considered for the project have been designed to operate a full year. The OPE researchers admit that they will be sacrificing the more complete real-time biomedical information provided by the Biosatellite. In exchange, however, they hope to be gaining data about the effects of life in a much more behaviorally complete environment. In place of data gathered as they happen, the investigators will get most of their information by examining the monkeys after the flight, including a detailed postmortem of one.

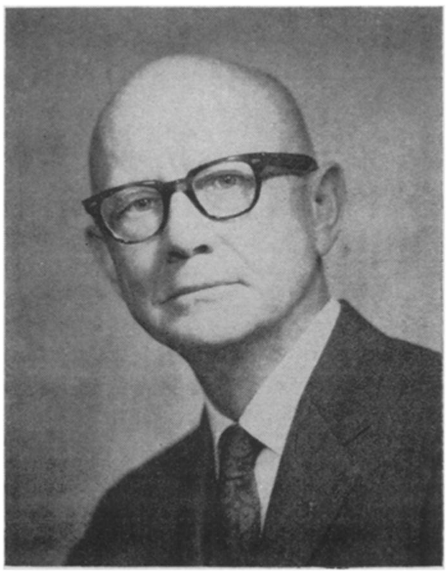
"Essentially," says Dr. John S. Thach, in charge of the behavioral aspects of the OPE, "what I've tried to devise is an optimum, natural little monkey world." A key element in doing this, Dr. Thach and his colleagues agree, is the second monkey.

The two monkeys in the OPE will occupy separate cages, but will share a common window through which they can communicate by touch and sound. "Having two monkeys is almost essential to a long-duration experiment of this sort," says Dr. Graybiel. The experimenters feel that a single monkey, even in the relatively unconstrained environment of the OPE, might succumb to melancholy and merely sit sulkily in his cage.

Two monkeys, however, provide social stimulation for each other that could be included in the experiment in no other way. In ground tests at Pensacola, the researchers have found that favorable interaction between the monkeys increases as time passes. The monkeys would touch, groom each other and even share their food. The dividing window could probably be done away with altogether, except that it enables the monkeys to be better studied as separate individuals.

One of the main tasks that has faced the OPE experimenters has been to find ways of keeping the monkeys active. Monkey or not, six months in the space of a large steamer trunk could easily become stultifyingly boring, as well as producing physical decline.

"We want to give the animal a goodly amount of work to do," says Dr Graybiel. One technique that is likely to be used, for example, rewards the monkey with food when he repeatedly moves a horizontal bar.



Graybiel: Active animal is important.

Another approach has been to try spacing the monkey's equipment around the enclosure so that he will have to do some work just getting from one item to another. Push-buttons used in behavioral testing are among the devices that have been strategically located. The researchers also tried placing the food and water dispensers at opposite ends of the cage, but this merely demonstrated that one anticipated problem, dehydration, was a particularly critical one.

Human beings in space seem to drink less water than they need, and NASA has actually had to nag its astronauts to bring their water intake up to recommended levels. With monkeys, nagging is obviously out.

As a result, the OPE planners have had to sacrifice exercise-producing placement of the water taps in favor of ensuring that the monkeys will get as much to drink as they need. At least a dozen possible approaches are being considered, says Dr. Thach. These range from a layout that would require the monkey to pass by the water tap on the way to the food dispenser, to an interlock device that would not let the food dispenser operate until the monkey had first taken a drink.

As various individual techniques and pieces of equipment are under development, the investigators are considering two basic designs for the overall structure of the chamber, one from Lockheed Missiles and Space Co. in Sunnyvale, Calif., and the other from Northrop Corp. in Beverly Hills. There are various small differences: Lockheed, for example, uses a sort of gumball dispenser with a bulk reserve for its food system; Northrop's consists of a flexible, pellet-filled food tube that unzips to dispense the food as it unrolls from a drum.

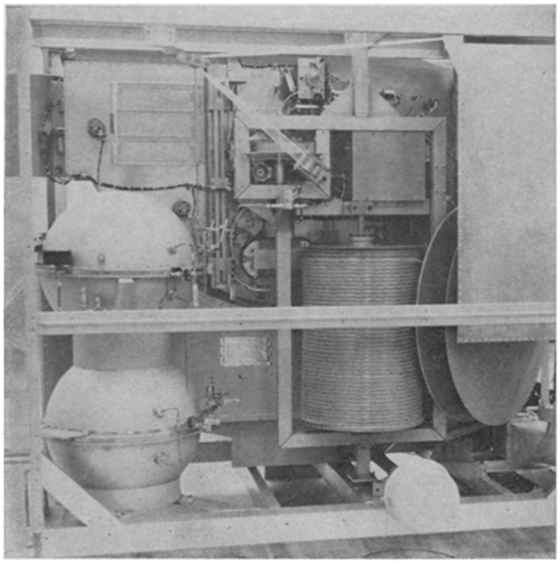
The main difference in the appearance of the two systems, however, is determined by the way in which the monkeys are to be retrieved when the mission is over.

The present plan, says Dr. Thach, is that the OPE spacecraft will be launched along with an Apollo command module and a team of astronauts, perhaps an Apollo Applications Workshop crew. Before reporting for duty aboard the workshop, the astronauts will free the OPE payload to go off on its own orbit; at the end of the mission, a second astronaut team will rendezvous with the OPE and remove the monkeys in small retrieval capsules, each with its own 48-hour life-support system, for return to earth.

Transferring the monkeys from their full-time enclosures to their retrieval capsules, however, must be done automatically, largely to minimize the amount of work that the astronauts have to carry out in space and because a rule of the mission planners is to keep the humans from being directly exposed to the monkeys. This is the major difference in the two companies' approaches.

Northrop's chamber is about a 40 percent wedge-segment of a cylinder in which the monkey is nudged into the retrieval capsule at one end by a grate that swings radially along the curvature. The grate can also be used as an exercise device by nudging the monkey to move around the enclosure.

Lockheed's entry—the two companies are competing for subsequent development contracts—operates like a cylindrical version of the shrinking room in "The Pit and the Pendulum." To move the monkey into the retrieval capsule at one end, the cylinder begins



Northrop

OPE hardware: Water (left) and food.

to shrink, its walls winding slowly up like a tightening spiral. Then a piston at one end of the reduced cylinder nudges the monkey toward the capsule at the other.

It is possible that astronauts could serve a more active role in the OPE. Dr. Charles Berry, director of medical research at the Manned Spacecraft Center, for example, believes that for animal research in space to be truly meaningful, man must be along for comparison. There is no plan for the OPE to be expanded to include men, but it might be possible, depending on schedules and program plans, to mount the primate capsules on the Apollo Applications workshop structure.

This would not necessarily fulfill Dr. Berry's desires, since the workshop crews would be aloft only for one or two months each and would probably not have much time to study the monkeys anyway. The astronauts could, however, provide some baseline data and, more important to the OPE researchers, they could improve the experiment's chances of going its full length by repairing minor malfunctions. "It certainly wouldn't be like having the monkeys in your own laboratory," says Dr. Graybiel, "but on the other hand it would almost ensure success."

Despite the differences between the OPE and the Biosatellite flight, the OPE researchers believe the earlier mission to have been a necessary one. Its most useful contribution, says Dr. Graybiel, was that it indicated the rapidity with which changes occur in weightlessness. The Biosatellite and Orbiting Primate Experiment, says Dr. Thach, are looking from opposite ends of the spectrum toward the same subject: the welfare of man in space. □