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The precursory flight of chimpanzee Enos

Much to the chagrin and bewilderment of Alan Shepard, a trained chimpanzee named Ham was launched on a proving suborbital flight aboard a Mercury capsule before the Navy astronaut was given a similar chance to fly into space. He felt it was an unnecessary step. Once, when asked why he had been selected as America's first astronaut, he wryly quipped, "I guess they ran out of monkeys!"

HAM'S MERCURY MISSION

On 31 January 1961, Ham was launched atop a Redstone booster on the suborbital Mercury-Redstone MR-2 flight. As John Glenn later noted, even though Ham's flight did not exactly go according to plan, the engineers learned some valuable lessons from the flight and were able to make vital changes to the Mercury spacecraft's systems ahead of a manned orbital flight.

"The scientists had decided to use a chimp as a stand-in because this particular animal closely resembles man from a physiological standpoint and can be trained to take part in a scientific experiment," Glenn observed. "A chimp's reaction to various stimuli, incidentally, is seven-tenths of a second, which is fairly close to the average man's reaction time of five-tenths of a second. Ham had been taught to perform a few simple tricks in order to test his ability to carry out useful functions during the four and a half minutes of weightlessness that he would be subjected to."

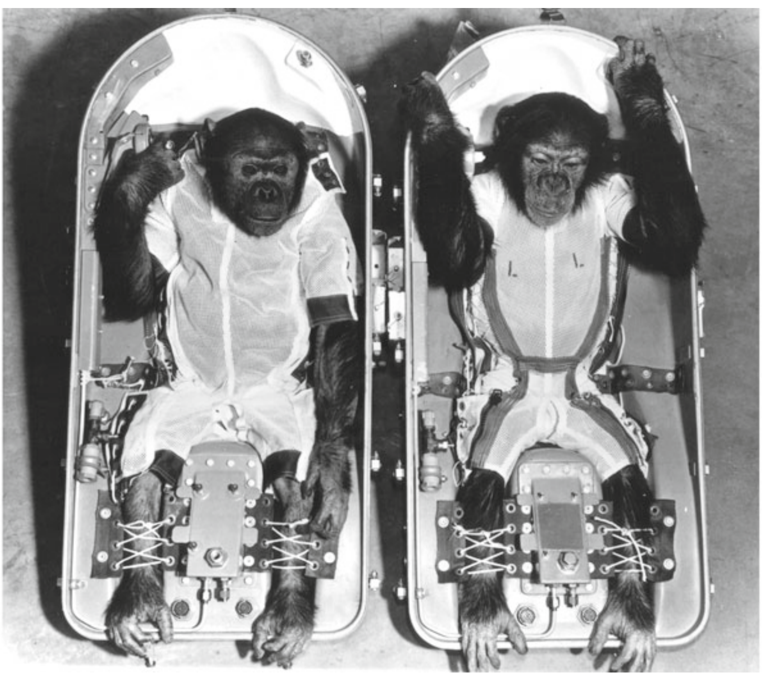
During the ballistic flight Ham would watch a series of flashing lights and pull various levers in sequence when the lights came on. A supply of water and banana-flavored pellets was installed inside his chamber to reward him for his prowess on the levers and keep him happy.

"He was strapped into a small couch which resembled the contour couch we would use," Glenn added, "and he was encased in a pressurized plastic chamber about the size of a small trunk which was fastened in place inside the capsule and connected with the oxygen supply. The chamber was sealed off from the cabin of the capsule, just as a man would be sealed off inside his pressure suit. Ham also had medical sensors attached to his body, much as we would, to record his heart rate, respiration and body temperature during the flight."[1]

C. Burgess, *Friendship 7*, Springer Praxis Books, DOI 10.1007/978-3-319-15654-5_2

Ham had to endure a troubled mission. At lift-off, a faulty valve in the booster led to the fuel pump injecting far too much liquid oxygen into the engine, causing the rocket to over-thrust and accelerate faster than expected. The fuel was rapidly depleted, which triggered an abort. As a result, the escape tower mounted above the capsule fired, ripping the capsule away from the spent booster. Ham was immediately subjected to crushing forces of around 17 g's. The chimpanzee managed to survive all these dramas and was eventually recovered at sea, but when he was extracted from the capsule Ham demonstrated to his rescuers that he was far from happy with the whole situation.

When Shepard later reviewed telemetry tapes and other data from MR-2 he was unshakably confident he could also have survived the flight. As plans then stood, he was due and ready to be launched on his own Mercury-Redstone flight (MR-3) on 24 March. But Wernher von Braun at the Redstone Arsenal in Huntsville, Alabama, and others of influence were deeply concerned about the erratic performance of the Redstone booster on the MR-2 flight. After modifications had been completed they called for a further, unmanned test. The German rocketeer got his wish; the MR-BD (Mercury-Redstone Booster Development) flight was inserted into the schedule and was an entirely successful operation. Shepard's flight was next in line. However, just three weeks ahead of his MR-3 flight, Soviet cosmonaut Yuri Gagarin was launched into orbit, becoming the first person to fly into space. Like Ham before him, but for entirely different reasons, Shepard was understandably irate.



The two Holloman-trained chimpanzees that would complete Mercury flights: Enos (left) and Ham. (Photo: NASA)

Despite all the dramas associated with Ham's flight, the 3-year-old chimpanzee had convincingly shown that a human being could similarly survive the dynamics of rocket launch and re-entry, and function quite normally in a weightless environment.

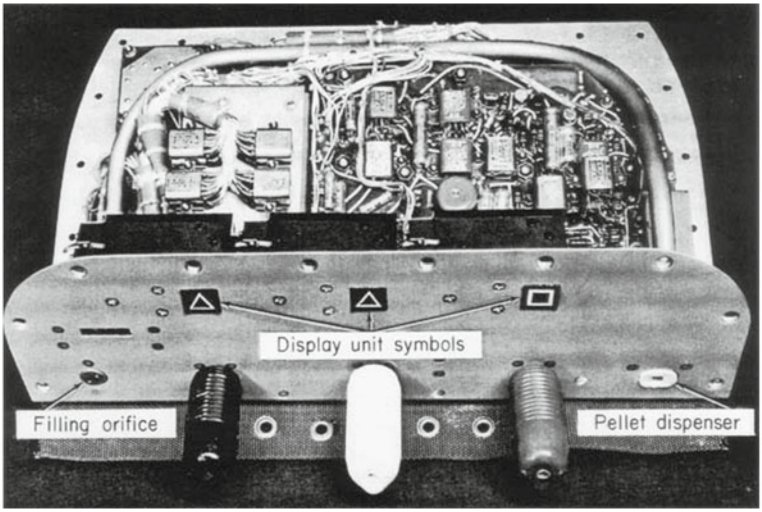
Both Alan Shepard and Gus Grissom (MR-4) flew suborbital missions that meant they were only weightless for about five minutes, allowing them very little time to explore this phenomenon. With virtually no gravity at orbital height, NASA was anxious to ensure that an astronaut could perform simple tasks while weightless for an extended period. Some scientists were still concerned that orbiting astronauts, on seeing the planet passing so quickly beneath them, might even lose their normal concepts of up and down, speed and direction, and become critically disoriented. Once again, it was decided to conduct a precursory flight – this time orbital – using a suitable chimpanzee from the animals undergoing training in the special facility administered by the 6571st Aeromedical Research Laboratory at Holloman Air Force Base in New Mexico.

TRAINING THE CHIMPS

Whereas the Redstone chimpanzee candidates had been tested for their ability to remember commands during a ballistic flight through the use of a training device called a psychomotor panel, which dispensed a banana pellet if the animal pressed the correct lever when given a lighted cue, the unit used for training an orbiting animal was rather more complex. This advanced psychomotor involved the use of colors and symbols. In training the candidate chimpanzees, technicians could illuminate three symbols – circles, triangles, and squares. When two symbols having the same shape lit up on a panel facing the animal, it had to press a button below the non-matching third symbol. As a reward, every time the chimpanzee got it right a banana-flavored pellet popped out of a tube near its mouth. "They had to hit the lever so many times for a drink of water and so many times for a banana pellet," former aeromedical technician Master Sergeant Ed Dittmer pointed out.[2] At other times a small green light would illuminate during the tests. If the subject chimp noticed this and pressed a button to turn it off within 20 seconds, their reward was a drink of water or fruit juice from another tube situated near their mouth. But if any task was overlooked there was a penalty to pay; a small but unpleasant electrical shock would tingle a plate attached to the chimp's feet to demonstrate that something had not been done correctly.

The primate candidates also learned how to turn display lights on and off by hitting right- and left-hand levers, and were taught to count by pulling another small lever exactly fifty times. As they grew conditioned to the test sequence the animals would reach their own count of forty-nine, deliberately slowing as they approached the end of their task, and then eagerly place a hand under the tube for their banana pellet reward on the last pull. Trainers were amazed at how quickly their playful charges learned this routine and how they hardly ever got it wrong.

It was important for the upcoming MA-5 flight that the chimpanzees memorized the order in which they were to perform such tests, as one chimp would be replicating them in orbit. It followed that if an extended space flight had no effect on the ability of a primate



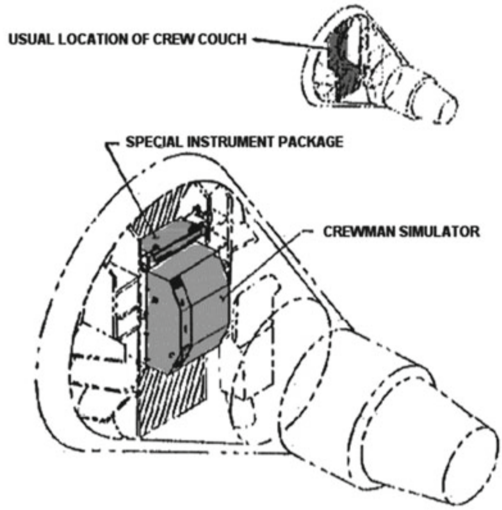
A psychomotor similar to the one installed on the MA-5 flight. (Photo: NASA)

to conduct simple sequential tasks, then there was no doubting a human's ability to do the same.[3] Yuri Gagarin seemed – at least back then – to have completed his orbital mission without any physiological problems, but garnering any reliable contemporary data on his flight was a near impossible task.

A SUITABLE CANDIDATE FOR ORBIT

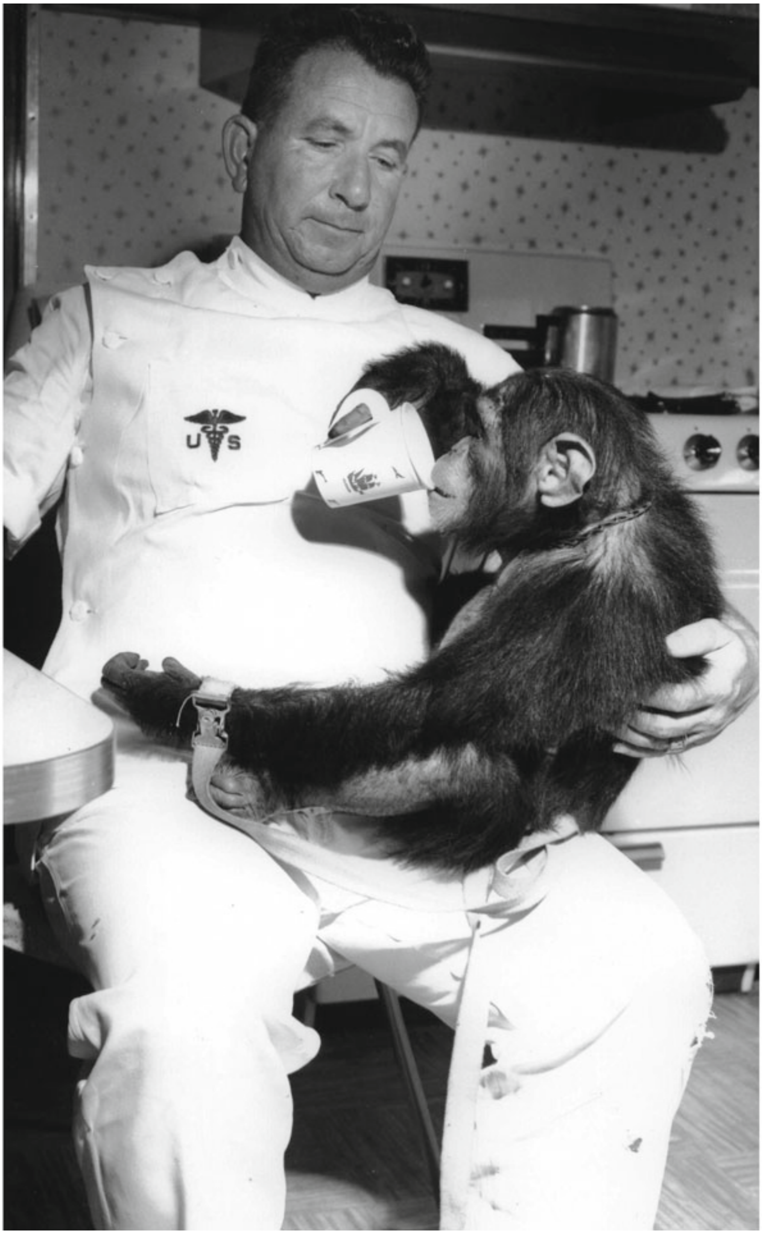
On 13 September 1961, ahead of the chimpanzee flight, an unmanned test mission began with the launch of MA-4 from Cape Canaveral. A mechanical "simulated astronaut" was wired into the spacecraft as part of an extensive systems check, consuming oxygen and expending carbon dioxide at the same rate as an astronaut. Having completed a planned single orbit of the Earth the capsule was successfully recovered after splashdown.

Things were moving along. On 29 October 1961, the 6571st Aeromedical Research Laboratory delivered three of their best-trained chimpanzees to Cape Canaveral as potential candidates for MA-5, accompanied by twelve handlers. They linked up with eight handlers and another two chimps already in training at the Cape. In addition to space veteran Ham, the animals involved were Duane and Jim (named after project veterinarians Duane Mitch and James Cook), Rocky (named for boxer Rocky Graziano), and Enos. It soon became apparent that Ham, having endured a drama-filled ballistic flight, was less in contention for the role this time. Although he undertook his tests with a disappointing lack of enthusiasm, Ham nevertheless remained one of the three prime candidates just two days before the flight. However the 39-pound Enos (previously known by the designation No. 81) had proved to be a superior and intelligent candidate, although his handlers found him to be something of a handful at times.



A schematic of the MA-4 capsule, showing the location of the crewman simulator. (Illustration: NASA)

Launch of the unmanned MA-4 proving flight. (Photo: NASA)



A wary handler with the unpredictable Enos. (Photo: NASA)

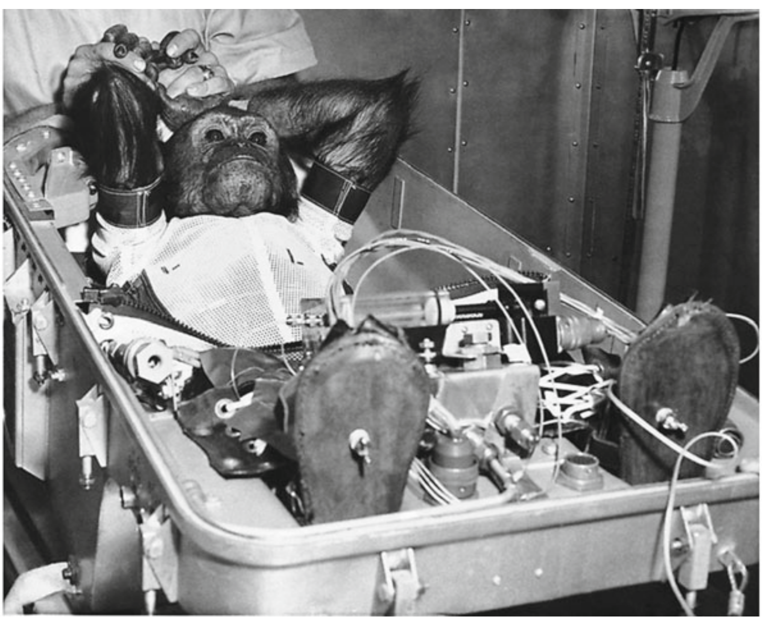
Enos (which means "man" in Hebrew) was a feisty, 4-year-old *Pan satyrus* chimpanzee. Although he was the star pupil, Enos often misbehaved badly and was far less tolerant of his human handlers than Ham. "No one ever held Enos," Ed Dittmer recalled. "If you had him, he was on a little strap. Enos was a good chimp and he was smart, but he didn't take to people. They had the wrong impression of him; they said he was a mean chimp and so forth, but he just didn't take to cuddling. That's why in any pictures you ever see of Enos you don't see anyone holding him."[4]

Enos became notorious for dropping his training diapers and stroking his genitalia whenever reporters paid a visit to the sheet-metal building where the chimpanzees were housed. It was this unsavory practice that caused him to be given the nickname of "Enos the Penis." The primate enclosure was right next to Hangar S, where the Mercury astronauts worked and trained, and where their offices were located. To minimize any disruption for the animals, visitors were discouraged, but every so often someone would want to see the chimp colony.

On one occasion a visiting politician somehow managed to pull a few VIP strings and was given a tour of the facility by a reluctant McDonnell launch pad leader, Guenter Wendt. "He wanted to see the monkeys," Wendt recalled. "I told them they weren't monkeys, they were highly intelligent chimpanzees. But he insisted on seeing the monkeys." Wendt, knowing all too well Enos's notoriously bad temperament, attempted to talk the congressman out of the viewing, especially as the chimpanzee had only just come back from a training session and was in a particularly foul mood.

"When those chimps didn't do what they were supposed to do, they'd receive a little shock through their feet," Wendt said. "So I knew this wasn't a good time to see Enos. But this guy said, 'I'm a congressman, and I want to see the monkeys.' So I took him, even though I knew exactly what was going to happen." Wendt dutifully opened the door leading into the chimp's quarters and ushered the congressman in first. Enos, upon seeing a stranger enter his abode, immediately squatted down, emptied his bowels into his hand, and flung a pile of steaming feces at the congressman, who recoiled in horror, his pristine white shirt and suit splattered with the stinking mess. He later sheepishly admitted to Wendt, "I can see why you didn't want me to see him." Wendt doesn't believe the congressman was ever a guest again at the Cape.[5]

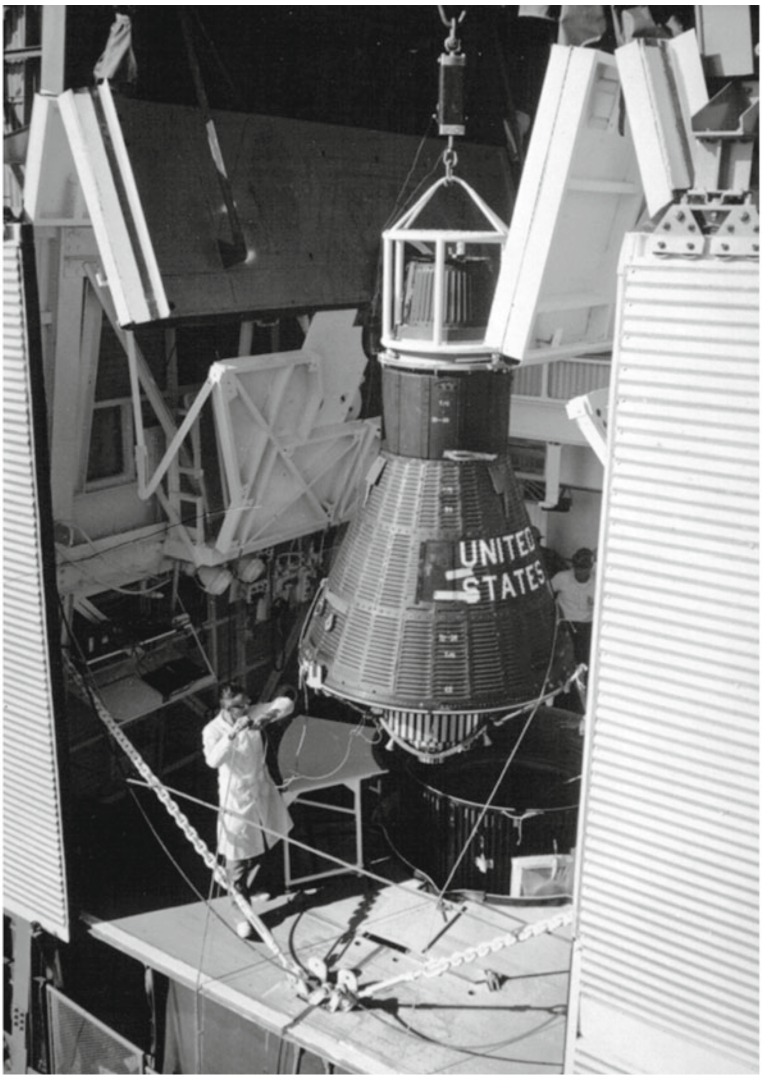
Eventually, despite his wayward behavior, it was decided that Enos would fly on the three-orbit MA-5 mission.



Enos relaxing in his form-fitting flight couch. (Photo: NASA)

ENOS AND MA-5

Originally scheduled for lift-off on 7 November 1961, the MA-5 flight was delayed a week before being indefinitely postponed on 11 November as a result of a hydrogen peroxide leak in the spacecraft's manual control system. By this time NASA's future planning had been further thwarted following Soviet cosmonaut Gherman Titov's day-long mission four months earlier. As a consequence, there had been urgent calls from within and outside NASA for the MA-5 flight to be shelved and for John Glenn to be launched on America's first orbital flight before the end of the year. However good sense prevailed; it was crucial that additional flight data be gathered and for systems tests to be carried out before an astronaut could be launched on top of the unpredictable Atlas rocket.



Enos's MA-5 Mercury capsule being mated to the Atlas booster. (Photo: NASA)

When asked, the chief of the Mercury medical team, Air Force Lt. Col. Stanley White, said it would be "extremely hazardous" to abandon the Enos flight at such a critical proving time. "The MA-5 mission is more than a matter of just checking the spacecraft," he stated. "So far we have had experience with just one [unmanned] Mercury shot in orbit, and that for only one trip around the world. We need another shot now, for three orbits, so we can be sure that everybody in the system will have a chance to do his job."[6] In a worrying statistic, two of the four previous Atlas launches had ended in failure, so a great deal of work was still needed to make the Atlas a safer and more reliable launch vehicle.

On 29 November 1961 the MA-5 launch finally took place from Launch Complex 14. Enos had been woken at 3:00 a.m. and supplied with his normal breakfast. Then, dressed in his diapers and nylon flight suit, he was led out to a panel van which transported him around to Hangar S. Once there, he was given a thorough veterinary examination and clearance to fly by physician Capt. Dan Mosely. The handlers then escorted Enos out and into a waiting, air-conditioned medical van which would carry him out to the launch gantry, in much the same procedure as his astronaut counterparts. Once inside the van, sensors were taped onto his skin and a balloon catheter was carefully inserted. Enos was then placed into his custom couch and securely fastened down, although his hands were left free in order to allow him to perform his in-flight tasks. The lid was then closed on his container and sealed shut, the capsule's life support systems activated, and connections made to enable physiological data to begin flowing. The container was then carefully lifted out of the medical van, carried up in the gantry elevator and locked into place inside the Mercury spacecraft, ahead of a planned 7:30 a.m. lift-off.

The countdown was held at T-30 minutes, allowing technicians to reopen the hatch of the Mercury spacecraft and correctly position an on/off telemetry switch, causing an 85-minute delay. In the final two minutes before lift-off, Enos began systematically pulling his levers in response to the signal lights, which had now been activated. After several minor technical hitches had further delayed the launch, Enos was finally blasted into the skies at 10:08 a.m. During the ascent phase he was pressed back into his contoured couch with a maximum 7.2 g's. But he had often experienced this force pressing down on his body during centrifuge rides in training, and so knew it was only a temporary discomfort. Atlas 93D propelled the Mercury spacecraft up and out to the northeast. Once the booster rocket had done its task it dropped away and the capsule finally settled into an elliptical west-to-east orbit of 99 miles by 147 miles, inclined at an angle of 37 degrees to the equator.

All the spacecraft systems functioned as planned during the early part of the flight, and Enos happily resumed his tasks. In the first pre-programmed test period he won 13 banana pellets on the 50-count lever, and drank just under a liter of water through a tube. A small wiring malfunction on one of the tests meant that, like Ham, he received some undeserved electric tingles to the soles of his feet, but for the most part Enos did everything that was required. Despite an overheating problem, he remained calm. Everything seemed quite natural to him after his extensive training, and he continued jiggling levers and pushing buttons as his Mercury spacecraft swooped around the Earth. Occasionally he would relax

The container holding Enos in his flight couch is gently lifted from the transfer van at the launch pad ready to be inserted into the Mercury capsule. Handler Ed Dittmer is on the right of the photo. (Photo: NASA)

during pre-allocated rest periods, which had also featured in his training. His handlers were pleased to note that Enos did not attempt to hit any levers during these periods.

As the flight continued, a pre-recorded message was relayed from within the capsule to simulate voice contact with an astronaut. "CapCom [Capsule Communicator], this is astro," said the taped greeting. "Am on the window and the view is great. I can see all the colors and can make out coastlines." Later, at a post-flight press conference at the White House, an amused President Kennedy would tell reporters that "the chimpanzee took off at 10:08. He reported that everything is perfect and working well."[7]

A TROUBLESOME FLIGHT

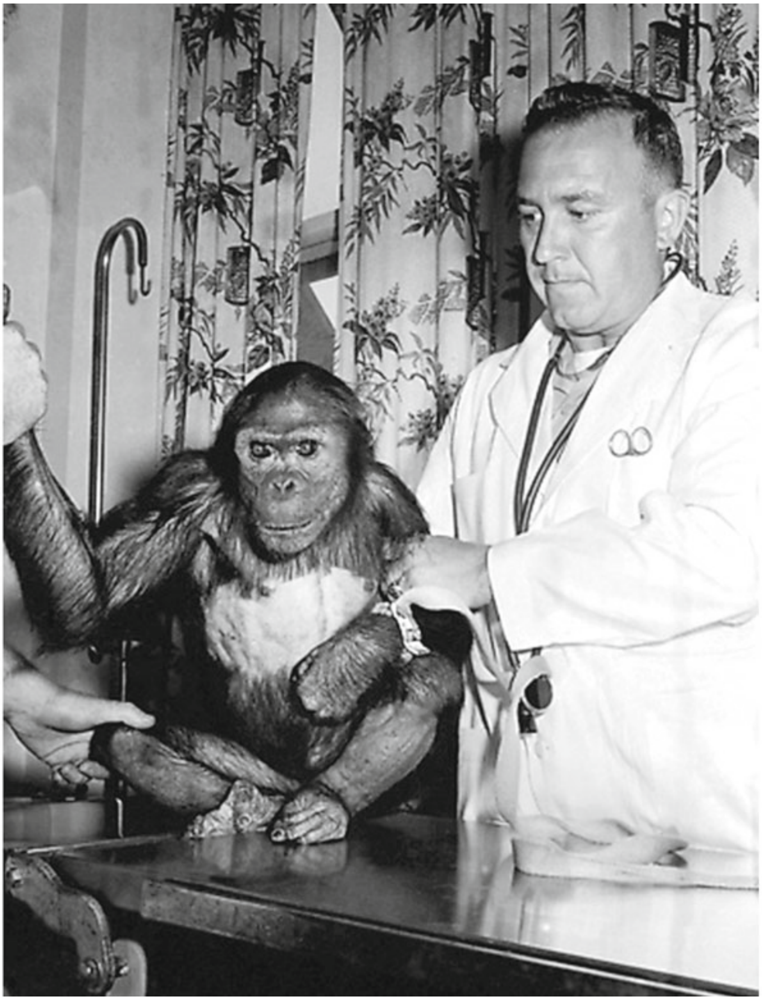
The wiring defect that eventually gave Enos a recorded total of 76 highly irritating tingles to his feet proved to be just one of a series of problems detected when the capsule flew into the listening cone of Muchea in Western Australia during the second of its planned three orbits. Data emanating from the craft indicated there was a small but persistent wobble in the motion of the craft, while the attitude control system began to exhibit a degraded performance due to a thruster failure. The environmental control system was also unable to maintain the required temperature within the spacecraft. As a result, Enos's body temperature gradually rose to a dangerous 100.5 degrees Fahrenheit before it finally stabilized. The malfunctioning attitude control system eventually caused the spacecraft to begin slowly tumbling. This gave rise to considerable concern. There were grave fears that a lack of attitude control, combined with excessive thruster and propellant usage, could result in the capsule not achieving the correct position for retrofire. It was later discovered that the thruster problem resulted from a stray metal chip clogging a fuel supply line, which caused the spacecraft to drift from its planned attitude.

Flight Director Chris Kraft was worried that there might be insufficient fuel remaining at the end of a third orbit to achieve correct attitude control during re-entry. He consulted with his Mission Control team, and it was decided to end the flight early by setting procedures in motion to fire the retrorockets. The decision was made and implemented just twelve seconds before they would otherwise have had to commit to a third orbit.

Meanwhile, an overheated Enos was growing increasingly annoyed. In line with his training, he had been pressing the psychomotor buttons in the correct sequence, but the wiring defect meant he was only being rewarded by shocks to the soles of his feet. He began banging away at the buttons in frustration. Now in a state of outrage, he turned his attention to a different source of annoyance, grasping his internal balloon catheter and ripping it out. This action must have really hurt, but it seems he was beyond caring. Perhaps in reaction to the pain – or as a protest against all that had happened to him – he began fondling himself in front of the camera.

With the decision made in Mission Control to shorten the flight by an orbit, the necessary commands were relayed up to the spacecraft. The capsule slowed under the influence of retrofire, then dipped back into the atmosphere, heading for the planned recovery area some 200 miles south of Bermuda. The crew of a Martin P5M Marlin search aircraft eventually spotted the craft descending under its main parachute at around 5,000 feet. They relayed its position to the recovery destroyers USS *Stormes* (DD-780) and *Compton* (DD-705), which were 30 miles away. An hour and a quarter later the MA-5 capsule was safely plucked from the sea by the crew of the *Stormes*.

Once the capsule had been secured on deck, the hatch was explosively blown, the sealed container removed and opened, and an excited but overheated chimpanzee extracted from his couch. The temperature inside his airtight capsule measured 106 degrees Fahrenheit, but Enos soon cooled down and rapidly devoured two oranges and two apples. As a NASA report later recorded, "The subject had broken through the protective belly panel and had removed or damaged most of the physiological sensors. He had also forcibly removed the urinary catheter while the balloon was still inflated."[8]



Post-flight, Enos undergoes a thorough veterinary examination by Capt. Jerry Fineg at Kindley Air Force Base, Bermuda. (Photo: NASA)

According to the official history of Project Mercury in the NASA publication *This New Ocean*, the USS *Stormes* dropped Enos at Kindley Air Force Base hospital, Bermuda, where chief veterinarian Capt. Jerry Fineg conducted a full evaluation of the animal's health and post-flight condition. As he reported, "the chimp was walked in the corridors and appeared to be in good shape. His body temperature was 97.6 degrees; his respiratory rate was 16; his pulse was 100. Apparently re-entry, reaching a peak of 7.8 g, had not hurt him."[9]

On the first day in December, Enos was transported by airplane back to the Cape. There he underwent a further battery of physical tests. The following week he made a joyful return to the chimp colony at Holloman Air Force Base in New Mexico.

Back at the Cape once again, Enos is escorted down the aircraft steps by M/Sgt. Ed Dittmer (right) and Airman Michael Berman. (Photo: NASA)

RESULTS PAVE THE WAY

The flight of Enos, and the way that he methodically performed his tests in 181 minutes of weightlessness despite the technical problems, gave an assurance that a human should be able to conduct any tasks which would be required of them in Earth orbit. Although troubling at the time, the issues affecting Enos's flight were able to be resolved, paving the way for John Glenn to make America's first manned orbital flight just three months later.

According to Dr. James Henry, the respective flights of Ham and Enos had demonstrated several crucial factors:

1. Pulse and respiration rates, during both the ballistic and orbital flights, had remained within normal limits throughout the weightless state. The effectiveness of the animals' heart action, as evaluated from the electrocardiograms and pressure records, was also unaffected by the flights.
2. Blood pressures, in both the systemic arterial tree and the low-pressure system, were not significantly changed from pre-flight values during three hours of the weightless state.
3. The two primates' performance of a series of tasks involving continuous and discrete avoidance, fixed ratio responses for food reward, delayed response for a fluid reward, and solution of a simple oddity problem, was unaffected by the weightless state.
4. Primates trained in the laboratory to perform during the simulated acceleration, noise and vibration of launch and entry were able to maintain performance throughout an actual flight.

Furthermore, Dr. Henry's project group was able to draw the following conclusions:

1. The numerous objectives of the Mercury animal test program were met. The MR-2 and MA-5 tests preceded the first ballistic and orbital manned flights, respectively, and provided valuable training in countdown procedures and range monitoring, as well as recovery techniques. The bioinstrumentation was effectively tested and the adequacy of the environmental control system was demonstrated.
2. A seven-minute (MR-2) and a three-hour (MA-5) exposure to the weightless state were experienced by the primates in the context of an experimental design which left visual and tactile references unimpaired. There was no significant change in the animals' physiological state or performance as measured during a series of tasks of graded motivation and difficulty.
3. The results met program objectives by answering questions concerning the physical and mental demands that the astronauts would encounter during space flight, and by showing that these demands would not be excessive.
4. An incidental gain from the program was the demonstration that the young chimpanzee can be trained to be a highly reliable subject for space flight studies.

"It was quite clear that the space effort at the beginning had to take the approach of a great expedition of exploration and adventure, and that research requirements should wait until the engineering problems had been solved," Dr. Henry told space researcher and author Shirley Thomas several years later. "In view of this, the Mercury animal flights were, in my opinion, an unexpectedly elegant and complex piece of combined physiological and psychological experimentation."[10]

A "GO" FOR ORBITAL FLIGHT

At a press conference held at the Cape press site after the recovery of the spacecraft and Enos by the USS *Stormes* south of Bermuda following the relatively successful two-orbit flight of the MA-5 mission, MSC officials expressed their satisfaction with the way it had gone. MSC Director Robert Gilruth remarked, "I would say we had a superb performance exhibited today on the part of all the various teams and on the part of the equipment. This includes the Atlas boost to orbit, the Atlantic Missile Range support, the [tracking] network and the network teams, the spacecraft, the checkout teams, the manufacturing teams, and the Navy recovery forces. I would also like to say that the fact that we decided to terminate the flight at the end of the second orbit lost very little of the spacecraft and other scientific data that we were after."[11]

Gilruth had already announced a few days earlier at NASA Headquarters in Washington that the next Project Mercury orbital flight would be a manned effort. He said that based on all available data, including a preliminary analysis of MA-5 information, it appeared that no further animal or unmanned flights were necessary. An analysis of the flight performance and post-flight physical condition of the chimpanzee Enos, together with a detailed study of the spacecraft, booster, and tracking network operations, had confirmed that the Mercury-Atlas system was now ready to proceed with the next orbital flight.

Speaking at the press conference a little later about the launch, Walter Williams, the Associate Director of MSC and Flight Operations Director for Project Mercury, said, "The boost was about as near perfect as you would expect to see."

Near the end of the conference Robert Gilruth announced that two crew teams had been selected for Project Mercury's first two manned orbital space flights. He named John Glenn as pilot for the first flight, with Scott Carpenter serving as his backup. Both men were there, participating in the conference. As well, Alan Shepard would act as pilot technical adviser for the MA-6 mission, and Gordon Cooper would head up the pad emergency escape and launch area recovery team. Gilruth then announced Deke Slayton as the

Flight Operations Director Walt Williams (second from right), astronauts John Glenn and Alan Shepard outside the Mercury Control Center with an unnamed program meteorologist. (Photo: NASA) designated pilot for the second manned orbital flight with Wally Schirra as his backup. Gus Grissom would act as technical adviser for this flight.

Choosing his words carefully, Gilruth prefaced his announcement by pointing out that "this statement does not mean that we are necessarily not going to make other flights before a manned flight, nor that we are necessarily going with another flight this year."[12]

Although he had known of his assignment for some time, an obviously delighted John Glenn then indicated his pleasure over his selection. In answer to a press query he stated that he was set to go between then and the end of the year if the Atlas rocket was ready to go and the word was given.

Never given anywhere near the same acclaim as his illustrious predecessor Ham, Enos died less than a year later after his flight, having contracted dysentery from shigellosis, a bacterial infection in the lining of the intestines. Ham died in 1983 at the age of 26 and his soft tissue was buried with honor and a stone tablet outside the New Mexico Museum of Space History. Sadly, it is not known what became of the remains of pioneering space chimpanzee Enos.

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