Exploring the cosmos

The problems of flying to Mars

Astronauts will have to worry about space radiation—and also each other

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voyagers. And, at this year's meeting of the American Association for the Advancement of Science (AAAS), held in Washington, DC, several presentations described work towards that end.

One such effort is the NASA Twin Study, full results of which are to be published in the next few months. The AAAS meeting was, however, given a taster.

The NASA Twin Study took advantage of identical-twin astronauts Mark and Scott Kelly. Scott was launched to the International Space Station in 2015 for a 12-month tour as station commander. Mark remained on Earth for the same period. Both men gave regular samples of blood, urine and so on for scientific analysis. Both also undertook batteries of physical and mental tests. Not knowing exactly what might change in the men's bodies, ten teams of researchers spread across America combed through the samples and results to track as many molecular, cognitive and physical changes as possible.

As Chris Mason of Weill Cornell Medical College told the meeting, these teams found lots of surprises. For example, Scott's telomeres got longer during his sojourn in space. Telomeres are strands of DNA that cap the end of chromosomes in a cell's nucleus. They normally get shorter as that cell divides and ages.

Dr Mason then compared the operation of Scott's genes with [illegible] of his brother back on Earth. Genes in Scott's body

stress of space flight. But however detailed the Twin Study has been (and it was in fact the most detailed scientific portrait of human beings ever made) a sample size of two is still rather limited. In the coming years NASA is planning dozens more long-duration tests on people, including tracking astronauts heading to the moon in preparation for future trips to Mars.

When Scott returned from the space station, he said that "teamwork makes the dream work" when it comes to a successful mission in space. Cutesy. But it was an apt statement. Understanding how teams function, how they go wrong and how to prevent social problems will be a critical element of any successful mission to Mars.

Such a mission might involve half a dozen people, perhaps from different cultures, cooped up together for some three years in a space no bigger than a typical family home. There would be no emergency-escape strategy. One of the attempts being made to model these conditions is that of Noshir Contractor, a behavioural scientist at Northwestern University, in Illinois. As he told the meeting, he has been studying the dynamics of groups of people isolated for long periods in the Human Exploration Research Analogue, a facility at the Johnson Space Centre in Houston, Texas. Here, volunteers are locked away for up to 45 days at a time on mock space missions. They are poked and prodded, physiologically and psychologically, and monitored day and night.

Send in the clown

Something researchers have already learned from these experiments is that certain personality characteristics are essential to helping groups work well together. A good group needs a leader, a social secretary, a storyteller and a mixture of introverts and extroverts. Intriguingly, by far the most important role seems to be that of the clown. According to Jeffrey Johnson, an anthropologist at the University of Florida who has spent years examining relations between people in Antarctic crews overwintering at the South Pole, the clown is not only funny, he is also smart and knows each member of the group well enough to defuse most of the tensions that might arise during long periods of close contact. This sounds rather like the role of a jester in a royal court. The clown also acts as a bridge between different groups of people—in Antarctica the clowns linked scientists on the base with the tradesmen who also worked there. In groups that tended to fight most or to lose coherence, Dr Johnson found, there was usually no clown.

Even if a perfect, balanced group of astronauts is assembled for a Mars mission, however, things could still go awry. On December 28th 1973, for example, the three crew members of *Skylab*, an early American space station, decided to cut off contact with ground control and refused to do any of their assigned tasks—something they called a "work slowdown". Newspapers at the time referred to this incident as the first strike in space.

Dr Contractor's group wanted to understand what happened on *Skylab* and whether or not the crew's reaction could have been averted. They took transcripts of conversations that had occurred on *Skylab* over the many years it had hosted astronauts, and applied textual and network analysis to them to try to understand the nature of relations between the people who had been on the station.

The cause of the strike, they found, was that the crew's close ties with one another had become detrimental to their relationship with the team back on Earth. Crew members ha´ `rted using a lot of negative words about their daily tasks.

Predicting problems is just the start. Ground-control teams monitoring the flight could help with crew conflict near to Earth, but on a mission to Mars the astronauts will need to operate autonomously, given the large communications delays. NASA's engineers are therefore working on software that can be used to analyse data about a crew's behaviour in real time and provide a sort of digital counselling service, helping them find ways to mitigate any problems. "Good mental health on a mission is not the absence of conflict, but how you handle that conflict," said Thomas Williams, a specialist in human factors at the Johnson Space Centre.

All this detailed understanding of teams will have uses far beyond lengthy space missions, the researchers hope. Behavioural scientists are already trying to apply such "people analytics" to the understanding of sentiments within companies. They might, perhaps, replace performance surveys, monitor inclusion and diversity, identify high potential or put together dream teams for certain tasks.

Building a perfect team for a long mission to Mars will not be easy, says Dr Contractor, and there is much to learn yet. But if human beings are ever to travel to other parts of the solar system, then understanding the behaviour of those who will be crewing the hardware should make a successful voyage far more likely.

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