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Mental preparation for Mars

Psychologists craft systems to lessen the mental strains astronauts might face 100 million miles away from earth.

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"What a renewed interest in Mars does is provide a catalyst to do research that might be otherwise overlooked. And this research has implications outside of space as well."

Albert Harrison
University of California, Davis

On Jan. 14, President George W. Bush announced that the United States would set its sights on a manned mission to Mars and asked the National Aeronautics and Space Administration (NASA) to marshal its resources accordingly.

Though many presidents have called for a flight to the red planet, the most recent appeal spurred NASA to take a closer look at the scientific research that would be needed to support such a mission, says NASA human factors work group member Albert Harrison, PhD, a psychology professor at the University of California, Davis.

And, he says, some of the most difficult challenges future space explorers may face will be psychological--because delving farther into space than anyone ever has before means great danger and also grinding monotony.

"Unprecedented periods of confinements, people being away for three years or more, the period of isolation, the lack of capability to rescue people--all these things become intensified in the case of Mars," Harrison notes.

As psychological research has well documented, the stress of being

in an enclosed space with a small group of people for long periods of time can result in cognitive decline, depression and interpersonal conflicts in an otherwise well-adjusted group, says Harrison. These problems, however minor, can easily escalate into a disaster in an experimental spacecraft or any other environment already fraught with danger, he notes.

So, as physicists work out how to protect astronauts from cosmic radiation, Harrison and other psychologists--many funded through NASA's National Space Biomedical Research Institute (NSBRI)--are developing ways to predict, identify and deal with the behavioral and interpersonal problems that may arise. This work, which includes research on space mission stress, development of a handheld cognitive ability test and the creation of a computer program that can stand in for a therapist, may even result in some terrestrial applications, scientists say.

Foreseeing potential problems

Such research must begin with an understanding of the effect of long-duration spaceflight on today's astronauts, says University of California, San Francisco, psychologist Daniel Weiss, PhD, and psychiatrists Nick Kanas, MD, and Charles Marmar, MD, also of the University of California, San Francisco. These three researchers hope to identify the problems most likely to occur on future missions, including a trip to Mars.

Their 2001 Aviation, *Space and Environmental Medicine* (Vol. 72, No. 5) study of stressful incidents on the Mir, a Russian space station launched in 1986 and manned until 2001, chronicled how a tightly knit team of astronauts can displace their frustration with each other onto mission control, and was the first psychological study conducted in space to appear in a peer-reviewed journal, Kanas says.

Such research is difficult to conduct, says Kanas, due to the astronauts' busy schedules and also because of their concerns that test results may deem them unfit to fly on future missions. To assuage these concerns, the NASA-funded team devised a 15-

minute assessment of the space explorers' and ground control workers' mental states, culling items from the Profile of Mood State Scale, the Group Environment Scale and the Work Environment Scale. The researchers protected the identity of the participants by identifying them by number instead of name and encrypting all data.

Thirteen astronauts and 58 mission control employees completed the evaluation once a week, starting four weeks before the mission and ending two weeks afterward.

The researchers found that the Mir crew tended to feel unsupported by mission control when they faced such stressors as equipment malfunction. And similarly, as pressures increased at mission control, the workers there tended to report feeling hindered by their managers.

"We found strong support for a displacement phenomenon," says Kanas. "People under isolation can displace their affect to the 'out group' from the 'in group.'" Such irrational anger at other spaceflight team members could lead to miscommunication and other barriers to collective problem-solving, he notes.

These findings led researchers to recommend that NASA coordinate the training of the flight crew, mission control and NASA management so the three groups see themselves as a cohesive unit. The researchers also underscored the importance of ensuring that everyone involved in a space mission be aware of their propensity to lay blame for malfunctions at each other's feet, says Kanas.

Early identification

Despite such knowledge, astronauts will undoubtedly experience mental strain, and Harvard psychology professor Stephen Kosslyn, PhD, hopes to help them identify its effects so they can avoid making critical mistakes.

To do this, Kosslyn and his NSBRI-funded team have worked since 2000 to develop a Palm Pilot-based program called MiniCog, which measures astronauts' cognitive abilities during space flight, comparing them with the astronauts' usual Earth-based scores or to population norms. For example, before going to work on a difficult task--perhaps repairing malfunctioning equipment on the spacecraft's hull--an astronaut might use MiniCog to see whether his or her spatial relations are up to snuff. If an astronaut performs poorly at mentally rotating three dimensional objects--a task adapted from the 1970s work of Stanford psychologists Roger Shepard, PhD, and Jacqueline Metzler, PhD--a nap or a cup of coffee might be in order, Kosslyn notes.

In addition to tests of spatial ability, MiniCog can evaluate an astronaut's level of attention, motor control, working memory and problem-solving, say its developers.

"The goal was to create a blood-pressure cuff for the mind," says Kosslyn. "Astronauts need a quick readout of specific cognitive functions."

Other professions, say the researchers, could also adapt the technology for use in situations requiring high levels of mental performances under potentially stressful or sleep-deprived conditions, such as emergency-room surgery. And in fact, Kosslyn's team is currently testing the device on mountain climbers scaling the highest reaches of Mount Everest, he reports. While MiniCog targets cognitive abilities, Kosslyn says that it may also detect depression or isolation-related cognitive decline.

"What MiniCog does is raise a red flag, telling you that you should pay attention to a specific mental ability and perhaps use a countermeasure," says Kosslyn.

Long-distance fixes

However, dealing with mental health or interpersonal problems in space can be a tricky task, says University of Pennsylvania psychologist David Dinges, PhD, who heads NSBRI's

neurobehavorial and psychosocial factors research team.

"One of the problems with deep-space flight is the distances are so great there can be a 24-minute communication delay between Earth and Mars," says Dinges.

Because of this time lag, an Earth-bound clinician cannot provide therapy to a crew member in need, he says.

So, a group of NSBRI-funded researchers headed by James Carter, PhD, a clinical psychologist at Harvard Medical School, and including former astronaut Jay Buckey, MD, of Dartmouth Medical School, is developing a computer program to assist astronauts dealing with depression or interpersonal conflicts--the two most likely problems to appear during extended space travel, say the scientists.

The program guides the astronauts through an intervention known as "problem-solving treatment," developed by Dartmouth College psychologist Mark Hegel, PhD, and others. In this intervention, the computer or therapist asks the client to brainstorm a list of problems, and then rank them in terms of intractability and irksomeness. Using these scores, the client selects one problem to tackle and comes up with a strategy for doing so. Later, the client evaluates the success of the solution and, if necessary, thinks of other possible fixes.

To supplement this behavioral approach, the computer will also prompt the astronauts to evaluate their interpretations of situations, especially in the case of interpersonal conflict, says Carter. Perhaps the program would prompt a spacefarer to consider that a colleague acted unpleasantly due to sleep deprivation, rather than personal dislike, he says.

"Astronauts are selected to be generally free of psychological and psychiatric problems," says Buckey. "But anyone working in a demanding environment in a small, isolated group for three years runs the risk of experiencing some."

In addition to aiding in a mission to Mars, developers of this program hope that applications may be found for analogous situations, such as in deep-sea submarines. Eventually, such a program might even be applied in a primary-care setting for the treatment of depression or to provide self-guided conflict management in the workplace, Carter says.

And even if the political support for deep-space exploration does not hold, these psychologists hope their applications may be adapted for civilian use.

"What a renewed interest in Mars does is provide a catalyst to do research that might be otherwise overlooked," says Harrison. "And this research has implications outside of space as well."

To read more about NSBRI-funded projects, visit http://www.nsbri.org/.

FURTHER READING

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