Clearing the space fog

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NASA astronaut Kjell Lindgren works through 10 cognitive tests developed to test how spaceflight affects mental abilities. Credit: NASA

The term "space fog" refers not to water droplets blocking the view in space - there's no water out there - but rather a phenomenon affecting the mental abilities of astronauts. Those who have spent time aboard the International Space Station coined the term to describe the difficulty concentrating and mental fatigue they sometimes experience.

Astronauts need to maintain a high level of mental performance, so scientists need a tool to objectively measure how spaceflight changes that performance - the density of the fog, if you will. An investigation called Cognition is evaluating the in-flight use of one such tool, a comprehensive battery of computerized tests.

The battery includes 10 different cognitive tests and lasts about 20 minutes. Crew members will complete the battery 11 times during six months aboard the station. The tests cover a wider range of mental or cognitive functions than can be currently assessed in space and provide immediate, real-time feedback on performance.

Designing the series of tests took about four years, said principal investigator Mathias Basner, an associate professor at the University of Pennsylvania Perelman School of Medicine who holds an M.D. and Ph.D. in research. The tests couldn't be too easy, which might bore astronauts, or too hard, which might cause frustration. The entire battery couldn't take too long, either, as time is very valuable in space.

In addition, the tests need to evaluate a variety of brain functions in

order to create a clear picture of astronaut health and performance capability. The battery covers cognitive abilities such as working memory, stability of attention, and sensory motor speed; emotional recognition, such as whether a subject can "read" a fellow astronauts' face; a subject's willingness to take the appropriate amount of risk in decision-making; and spatial orientation, a critical ability in microgravity.

The problem of space fog is hardly surprising. In space, astronauts deal with disruption of sleep and daily rhythms, heavy mental and physical workloads, and environmental stressors such as microgravity, high levels of carbon dioxide, and radiation. There are also psychological issues related to isolation and confinement.

As part of his Year in Space, NASA astronaut Scott Kelly regularly takes a test battery for the Cognition investigation on the International Space Station. Credit: NASA

"We have done other work on understanding what kind of things impair cognitive ability," said co-investigator David F. Dinges, a professor in the University of Pennsylvania Department of Psychiatr, who holds a Ph.D. in physiological psychology. "We know that sufficient length and quality of sleep is paramount for performing at high levels, yet astronauts on the station often get six or fewer hours of sleep every 24 hours. That is comparable to chronic sleep deprivation, which we know causes impairment."

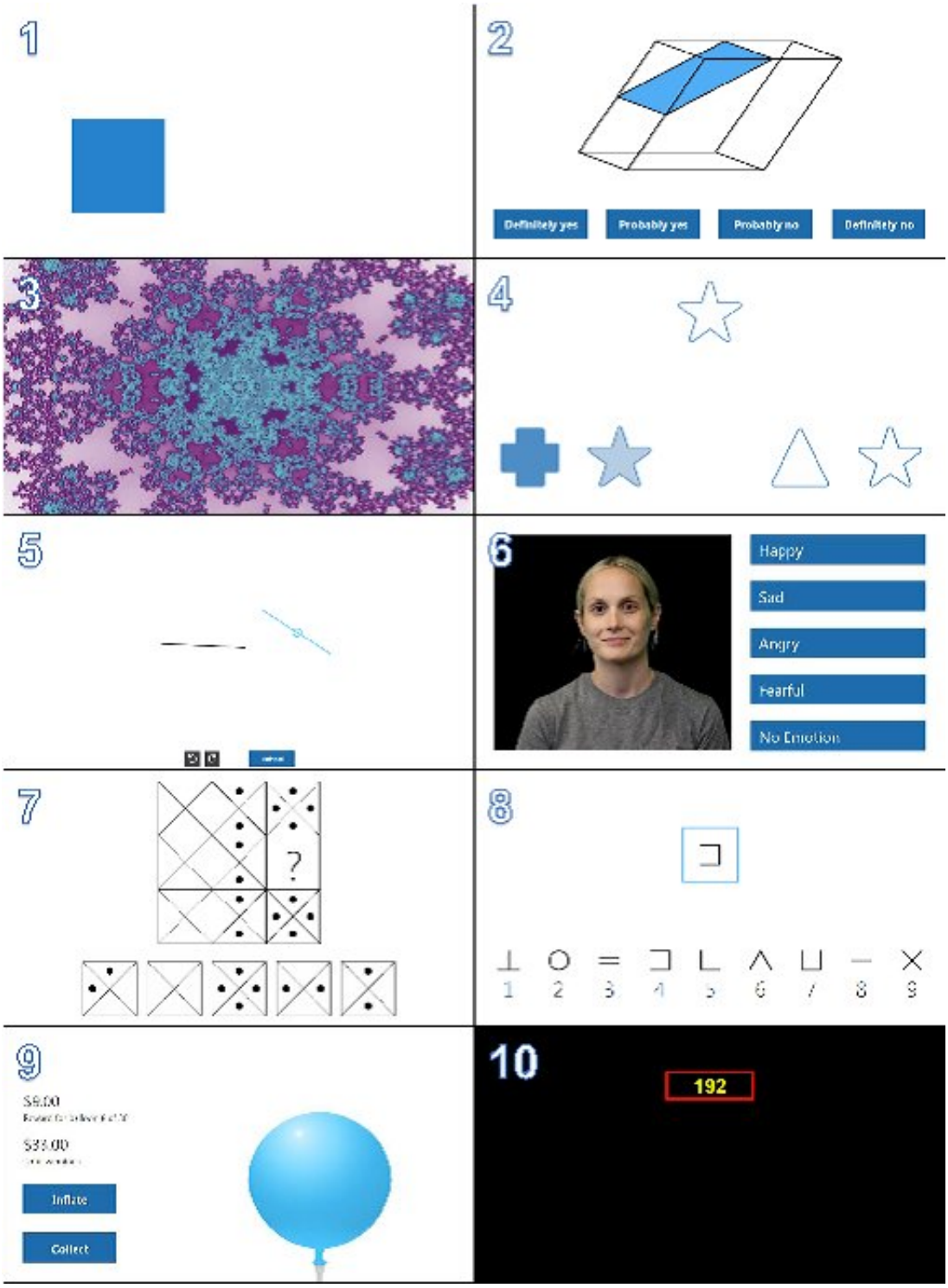
Scientists do not yet know the exact role of fatigue in causing space fog, or that of other physical effects of spaceflight such as changes in vision, higher pressure in the brain, or medications used to manage sleep and fatigue. For the most part, all they have are subjective reports of problems from the astronauts themselves.

"There can be a huge disconnect between subjective and objective assessment, especially during sleep deprivation," Basner said. "You just get used to feeling tired and think that is normal, and then you may overestimate your performance capability."

As highly-trained, highly-effective individuals, astronauts also may be able to better compensate, at least temporarily. Data from the test battery provide an objective, rather than subjective, measure of an astronaut's level of impairment and the role various stressors play.

Researchers also have been giving the tests on the ground to astronauts, astronaut candidates, and subjects from mission control. The data from

these tests show how a similar population performs in normal gravity, which then can be compared to data from space.



Screenshots of 10 of the tests used to measure cognitive function in space. Credit: University of Pennsylvania

The test battery could be useful in a variety of situations on Earth.

"This is designed for high-performing individuals, not necessarily for a standard population," said Basner. "But it could be administered to medical doctors, who have problems with fatigue, or to pilots, for example. We've implemented it with scientists in Antarctica, an environment with some of the same challenges as space."

The level of difficulty of the tests could be adjusted for other uses as well, such as assessing whether mental changes represent normal aging or signs of dementia.

By enabling more effective measurement of the performance of crew members in space or populations on the ground, the test battery should help clear up the fog.

Provided by NASA