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Addressing risk of brain damage in spaceflight

A physicist checks cabling on the radiation beam line, an apparatus at the Energy Department's Brookhaven National Lab in New York. The beam line transmits charged particles to irradiate mice for NASA and simulate what astronauts would experience in deep space.

The research article, "What happens to your brain on the way to Mars," earned some sensational headlines when it was published in May on a website run by the American Association for the Advancement of Science. Smithsonian.com declared, "A trip to Mars could give you brain damage." The Space Foundation ran the headline in its news roundup.

The headlines weren't wrong. NASA-funded researchers set out to learn whether deep-space radiation would have a different effect on the brain than radiation on Earth and, if so, what those effects might be. They irradiated mice at Brookhaven National Lab on Long Island and six weeks later put them in pens with toys. The irradiated mice showed less curiosity to new toys in the pen or new placement of familiar toys. Researchers later dissected the mice brains and found that the normally thick network of neuron dendrites in their medial prefrontal cortices had thinned compared to control mice.

Charles Limoli, professor of radiation oncology at the University of California at Irvine and senior author of the study, likened the effect to pruning the branches of a tree. "Perhaps most concerning to NASA is that we have no evidence that these changes ever resolve," he says.

The report's findings raise a serious concern, but judging by comments from researchers, it seems unlikely to derail NASA's aspirations to send astronauts to Mars sometime in the 2030s.

Limoli says the findings need to be viewed in context.

"The astronauts, when they get in the car, they expose themselves to higher risk of dying than when they go into space," he says. "Everything has to be taken in perspective." The ultimate goal of this and other research is to come up with possible solutions to whatever the damaging effects might be, possibly in the form of pharmaceutical therapies, he says.

NASA in a prepared statement says "these studies and future studies will continue to inform our understanding as we prepare for the journey to Mars." In fact, earlier this year, as the researchers were heading toward publication, NASA announced a new $9 million grant to Limoli's team for more mice experiments to study early and long-term effects of galactic cosmic radiation on the central nervous system.

Just how much can be learned from mice remains an open question. Mice are far from ideal surrogates for astronauts, not least because the animals have relatively short lifespans, And primates haven't been used for radiation experiments since the 1990s because of animal welfare concerns.

It's costly to generate particles to simulate deep space. So, mice are typically irradiated in one session, whereas astronauts would experience lower levels of radiation that would be cumulative over the three-year duration of a Mars mission. Astronauts also would return to Earth to live for decades, but mice don't live long enough to assess impacts for that length of time.

Those factors point to "the biggest hole" in all of the research published to date, says Dr. M. Kerry O'Banion of the University of Rochester, who was not involved with the recent mice experiment but whose 2012 study with mice linked deep-space radiation exposure to increased risk of Alzheimer's disease.

It's "recognized that radiation and brain don't mix," but how bad and long-lasting is the damage? "If the [human] brain sustains such damage — but at a very low level — are there intrinsic repair mechanisms or plasticity of the brain? Or ways that it can recover if you have a slow chronic problem? And people in neuroscience will have different answers for that," he says.

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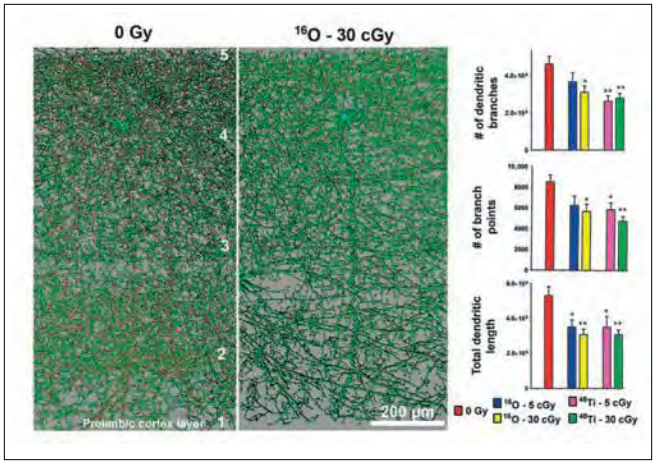
American Association for the Advancement of Science



Brains of mice before (left) and after exposure to simulated deep-space radiation showed a thinned network of neuron dendrites in their medial prefrontal cortices. The mice were genetically engineered to express green fluorescent protein in certain neuronal subsets.