Mice Brains Shrink During Winter, Impairing Some Learning And Memory

The brains of one species of mouse actually shrink during the winter, causing the mice to have more difficulty with some types of learning, a new study found. The results showed that, during the short days of winter, white-footed mice had impaired spatial memory â€“ the mental map that helps them remember important places in their environment.

This is one of the first studies to show seasonal changes in the structure and the functioning of brains of mammals, said Randy Nelson, co-author of the study and professor of psychology and neuroscience at Ohio State University .

The changes in the brain may help the mice conserve energy to survive during the cold winter season when food is scarce and conditions are harsh.

â€œThe brain uses a lot of energy relative to its weight,â€? Nelson said. â€œLike many mammals, mice need to reduce their energy costs during winter, and the brain is a good place to do that.â€?

And while there are obviously many differences between mice and humans, studies like this may one day help researchers gain insight into seasonal brain dysfunctions in humans such as seasonal affective disorder, Nelson said.

Nelson conducted the study with Leah Pyter, a graduate student in neuroscience at Ohio State , and Brenda Reader, an undergraduate psychology major at Ohio State . The findings were published in the May 4 issue of the Journal of Neuroscience.

In one set of experiments, the researchers used 20 adult male white-footed mice. Using artificial light, some mice were kept in short days â€“ such as they would face in winter â€“ with eight hours of light per day for 13 weeks before the beginning of the study. Other mice were kept in long days, simulating summer, with 16 hours of daylight for 13 weeks.

Their spatial learning and memory were tested using a water maze test in which the mice had to swim to find an escape platform hidden just below the surface of opaque water. They were tested for several days to determine how long it would take them to find the platform, and whether they remembered where the platform was from day to day.

Results showed that mice that were kept in short days â€“ simulating winter â€“ took longer and swam farther before they found the hidden platform than did the long-day mice, indicating they had more trouble learning where the platform was. Moreover, they didn't remember its location as well from one day to the next.

However, other tests showed that nonspatial learning and memory, including sensory abilities, were not affected by short days.

â€œIt appears that only specific kinds of brain function are impaired during winter,â€? Nelson said.

In a second experiment, 16 adult male white-footed mice were kept in short or long days for 14 weeks, after which they were sacrificed. The researchers then examined differences in the brains between mice kept in the two differing conditions.

These results showed that mice kept in short days had on average a smaller brain mass compared to the other mice, even when taking into account that their overall body mass was smaller, too.

In addition, the researchers found changes in a region of the brain â€“ the hippocampus â€“ that is involved in spatial memory. Mice in short days had a proportionally smaller hippocampus, as well as changes in spine density there that have been associated with spatially related memory and learning performance.

â€œWe predicted that when you reduce the size of the hippocampus, it would have an impact on learning, and that's what we found,â€? Nelson said.

The shrinking of the brain corresponds to a season when the mice may have less need for spatial memory, Nelson said.

â€œThey don't maintain as large a territory in the winter,â€? he said.

Nelson said he and his colleagues believe it may be the hormone melatonin which controls the changes in brain size and function in mammals such as these white-footed mice. Scientists know that levels of melatonin are associated with seasonal changes in daylight.

Melatonin is also found in humans, and that's one reason why future research on how brain structure changes by season may be applicable to human conditions like seasonal affective disorder.

The researchers are continuing work to look at the role of melatonin, and also to examine seasonal changes in brain structures in other types of mammals.