



**Mount  
Sinai**

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**For immediate release:**

May 17, 2022  
9:00 a.m. EDT

## **Scientists See Signs of Traumatic Brain Injury in Headbutting Muskox**

*Preliminary results from Mount Sinai study may contradict consensus on whether ramming animals experience brain damage and provide insights into human injuries*

**New York, NY (May 17, 2022)** – Scientists at the Icahn School of Medicine at Mount Sinai saw for the first time hallmarks of concussions and other head trauma in the brains of deceased headbutting animals—muskoxen and bighorn sheep. The results published in the journal *Acta Neuropathologica* may contradict the commonly-held belief that ramming animals do not suffer brain injuries and support the notion that studies on animals with brains evolutionarily similar to those of humans may help researchers understand and reduce traumatic brain injuries.

“Death and disability caused by traumatic brain injury is a widespread problem that needs better solutions,” said Nicole Ackermans, PhD, postdoctoral fellow at Icahn Mount Sinai and the study leader. “We showed that animals which regularly engage in headbutting may actually suffer the kind of traumatic brain injury seen in humans. This opens the possibility that by studying these animals we could learn a lot about traumatic brain injury.”

Dr. Ackermans and her colleagues studied the brains of three deceased muskoxen from Greenland and four bighorn sheep, which were obtained from parks in Colorado and Utah and the Buffalo Zoo in New York.

Part of the reason for obtaining brains from these horned animals is that they are known to engage in violent head-to-head collisions, usually in mating and social hierarchy rituals. For instance, male muskoxen often reach speeds of up to 30 miles an hour before impact. Although a few studies have observed symptoms of traumatic brain injury (TBI), such as acting dazed, none



### **Do Headbutting Muskox Experience TBI?**

Scientists Icahn Mount Sinai saw signs of traumatic brain injury in headbutting muskox.

*Credit: Musk Ox Farm, Palmer, AK*

have directly tested whether the brains of muskoxen and other ramming animals show any damage.

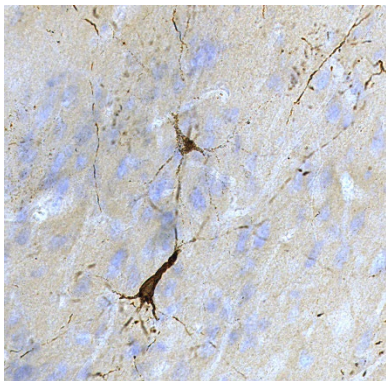
The other reason is that bovids—such as cows, sheep, buffalo, gazelles, and the animals in the study—have gyrencephalic, or folded, brains, which are also seen in humans.

“Our lab tries to use evolution to help solve medical mysteries,” said Patrick R. Hof, MD, Professor of Neuroscience at Icahn Mount Sinai and senior author of the study. “One of the difficulties of TBI research is that most of it is performed on smooth, rodent brains. We thought that studying the brains of ramming bovids might provide a better model for understanding TBI in humans.”

When they first arrived, the animals’ brains looked healthy, and brain scans showed that the overall structure of each animal’s brain was intact.

To look for signs of TBI damage, the researchers then cut the brains into thin slices and treated the slices with antibodies made to detect phosphorylated tau proteins found in humans or mice. This form of tau is a hallmark of damage that is often seen in the brains of Alzheimer’s disease patients, or in people who have suffered TBIs, including chronic traumatic encephalopathy (CTE).

When they looked at the brains under a microscope, they saw that one of the antibodies stained muskoxen brains at easily detectable levels, whereas the bighorn sheep brains had lightly detectable levels of staining by a different antibody.



#### **TBI Hallmarks in Muskox Brains**

Scientists at Icahn Mount Sinai discovered hallmarks of TBI in muskox brains which had been treated with antibodies against phosphorylated tau protein. *Credit: Hof lab, Icahn Mount Sinai, N.Y., N.Y.*

“At first we were surprised. One of the challenges with these kinds of studies is that we don’t know whether antibodies used on human and rodents will work on bovid brains,” Dr. Ackermans said. “The fact that we detected these antibodies was important. It suggested that the brains of these animals, especially the muskoxen, sustain TBI-like damage.”

Further analysis supported the idea. For example, the prefrontal cortex of the muskoxen brains had high levels of tau protein tangles, especially near the surface of the cortex.

“This pattern is sometimes seen in the brains of people who suffer from CTE,” Dr. Ackermans said. “Our results open the possibility that these animal’s brains undergo chronic, repetitive damage, as seen in some TBI patients.”

In contrast, when the researchers looked at brain slices from an Alzheimer’s disease patient, they saw a more even and

widespread staining pattern.

Curiously, an old female muskox had much more—about 20 times more—staining than the older male and five times more staining than another female. This is the opposite of what the researchers hypothesized, as males are known to ram each other harder and more often than females.

“This study left us with many interesting questions, like: Why did the female muskox brains appear to have more damage than the male ones? Is this because of differences in skull anatomy? Why did the brains of bighorn sheep have so little damage? And is it possible to harness the knowledge we gain from these animals to develop better treatments for TBI?” said Dr. Ackermans.

This work was supported by the Swiss National Science Foundation (P2ZHP3\_191255) and the Office of Naval Research (N00014-20-452 1-2762; N00014-17-1-2737).

### **Article**

Ackermans, N.L.; Evidence of traumatic brain injury in headbutting bovids, *Acta Neuropathologica*, May 17, 2022, DOI: [10.1007/s00401-022-02427-2](https://doi.org/10.1007/s00401-022-02427-2)

### **About the Mount Sinai Health System**

The Mount Sinai Health System is New York City's largest academic medical system, encompassing eight hospitals, a leading medical school, and a vast network of ambulatory practices throughout the greater New York region. Mount Sinai advances medicine and health through unrivaled education and translational research and discovery to deliver care that is the safest, highest-quality, most accessible and equitable, and the best value of any health system in the nation. The Health System includes approximately 7,300 primary and specialty care physicians; 13 joint-venture ambulatory surgery centers; more than 415 ambulatory practices throughout the five boroughs of New York City, Westchester, Long Island, and Florida; and more than 30 affiliated community health centers. The Mount Sinai Hospital is ranked on *U.S. News & World Report's* "Honor Roll" of the top 20 U.S. hospitals and is top in the nation by specialty: No. 1 in Geriatrics and top 20 in Cardiology/Heart Surgery, Diabetes/Endocrinology, Gastroenterology/GI Surgery, Neurology/Neurosurgery, Orthopedics, Pulmonology/Lung Surgery, Rehabilitation, and Urology. New York Eye and Ear Infirmary of Mount Sinai is ranked No. 12 in Ophthalmology. Mount Sinai Kravis Children's Hospital is ranked in *U.S. News & World Report's* "Best Children's Hospitals" among the country's best in four out of 10 pediatric specialties. The Icahn School of Medicine is one of three medical schools that have earned distinction by multiple indicators: ranked in the top 20 by *U.S. News & World Report's* "Best Medical Schools," aligned with a *U.S. News & World Report* "Honor Roll" Hospital, and No. 14 in the nation for National Institutes of Health funding. *Newsweek's* "The World's Best Smart Hospitals" ranks The Mount Sinai Hospital as No. 1 in New York and in the top five globally, and Mount Sinai Morningside in the top 20 globally.

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