

Sense of location and the Moser research environment at NTNU

How do we find our way from one place to another, and how do we know where we are? There are connections in the brain that enable us to do this, and it has taken a very long time to understand something this essential.

Frimerke med illustrasjon av nettverk i hjernen som danner stedssansen, hyller Moser-paret for Nobelpris

Illustrator: Enzo Finger

Edvard and May-Brit Moser found out what actually happens through systematic experiments with rats. They were awarded for their efforts with the most prestigious prize a researcher in the field can hope to get – the Nobel Prize in Physiology or Medicine.

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The brain's GPS

We know that a road sign that points us in the right direction and tells us the distance remaining is not enough. People with, for example, Alzheimer's disease have an impaired sense of location, which we are almost helpless without. It took over 30 years from when John O'Keefe made the first discovery of the hippocampus until researcher colleagues the Mosers made the next breakthrough with what the Norwegian Nobel Committee called 'the brain's GPS', when O'Keefe and the Mosers received the Nobel Prize in Physiology or Medicine 2014. They shared the prize for their respective groundbreaking discoveries in the area of memory biology.

Discovered new nerve cells

In 2005, the Mosers discovered that nerve cells in the brain form a grid that provides coordinates, telling the rat where it was in the room. The grid cells were later also identified in the human brain. The Mosers' discovery is of fundamental importance to research on diseases that destroy the brain and impair orientation abilities, such as Alzheimer's disease. We can use this knowledge to find the causes of Alzheimer's and then hopefully also solutions that can delay or prevent the disease.

Why the Mosers?

How did Edvard and May Brit Moser manage to experiment their way to finding the answer to a question that has engaged philosophers and brain researchers alike for so many decades? How did they reach the breakthrough that provided us with so much more knowledge and that formed an entirely new basis for medical and brain research? They had a genuine curiosity and burning interest to find the answer to some of the big questions about how the brain works. They took a targeted approach to their chosen path and had a great ambition to understand the memory and, subsequently, another unexplainable process: How do we know where we are and how do we manage to find our bearings?

Both took degrees in psychology and neuroscience, and shortly after completing their PhDs, they established the Kavli Institute for Systems Neuroscience at the Norwegian University of Science and Technology (NTNU). The outstanding level of their research there earned them the status Centre of Excellence (CoE) given by the Research Council in 2002.

Grid cells – sense of location

Edvard and May-Britt Moser had already started to work with the pioneer in the field John O'Keefe when studying for their PhDs. They gained insight into existing research early in their careers and were inspired to continue work on the same issues.

In 1971, O'Keefe discovered that the cells in the hippocampus triggered signals in rats that were located in specific places. It was thought at that point that the cells in the hippocampus created a mental map of the surroundings. The Mosers took the research further and in 2005, they published findings indicating that our sense of location was not based in the hippocampus but in a part of the brain called the entorhinal cortex, which is where the signals appear before reaching the hippocampus. The hippocampus forms part of our sense of location, but it is more important to our memory. Researchers at the Institute for Systems Neuroscience could explain how the mental map worked by way of the entorhinal cortex making general estimates and then sending signals on to other parts of the brain, including to the hippocampus, which remembers what is special about each place.

If you connect all the dots between the nerve cells that are triggered when the rats move around in a room, you are left with a visual impression of a grid made up of triangles. Each cell in the entorhinal cortex has an area of responsibility and it is these that form an endless systematic network. This mental map is not dependent on specific places and works everywhere the rat, or human, happens to be the world. The grid cells tell us where we are in our surroundings, which means that we can always find our bearings.

Skills, ambitions and resources

As highly skilled researchers with good project ideas, they were awarded important funding from the Research Council of Norway, the European Research Council (ERC) and other sources, such as the Kavli Trust. Few Norwegians can boast receiving the ERC's Advanced Grant, which is only awarded to established researchers in the absolute top class internationally. Both May-Britt and Edvard Moser have been awarded an Advanced Grant. They have also received funding from the Research Council of Norway for two Norwegian Centres of Excellence (CoE).

The generous funding from the CoE scheme, the Kavli Trust and ERC has given the researcher couple predictable conditions for their work in the long-term. The big breakthrough with the discovery of the grid cells' importance to our sense of location came three years after the first CoE grant in 2002.

Recruiting and training new talent

The Moser centre is renowned among the leading international researchers in the field and it therefore attracts top researchers from across the world. Edvard and May-Britt Moser were awarded the Nobel Prize in Physiology or Medicine in 2014 along with their mentor from the early days John O'Keefe. The Moser research environment is very important not just for research but also for the recruitment and training of young talent from across the world to this field of research.

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