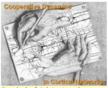
# Ad Aertsen - an expedition into the brain

**"How does our brain work?" For Ad Aertsen this is the most exciting question on earth. The Professor of Neurobiology and Biophysics at the University of Freiburg is convinced that "this is the last expedition humans are going to undertake". And Aertsen has secured his place on it.**

He has been part of the venture for more than twenty years. Born in the Netherlands, Aertsen studied physics but turned to biology during his doctorate. He investigated the auditory system of cats and frogs and measured how individual nerve cells in the brain react when the animal hears something. At first, he was looking into individual nerve cells. Later, as a postdoc in Philadelphia, he started to investigate groups of neurons. Aertsen wanted to find out how they influenced each other. Back in the early 1980s, this type of work did not have a name. Nowadays, it is known as neural network research. Aertsen is convinced that understanding the brain requires knowledge of the interaction between the individual elements. If one is aware that one cubic millimeter of brain consists of 100,000 neurons and that each of these neurons is connected with 10,000 neurons, then one is conscious of the challenges Aertsen has taken on.

"How does our brain work?" For Ad Aertsen this is the most exciting question on earth. (Photo: Aertson)

## A clear task – the combination of theory and experiment



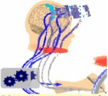

Symbol of Ad Aertsen's research approach (Photo: Aersen)

Nevertheless, Aertsen knows what he wants: He wants to combine experiment and theory. He is hoping to translate the results gained in brain measurements into models and turn them into computer simulations. "If the results of our brain examinations correspond to those gained with the computer, then we have understood our work," said Aertsen explaining his approach. "If we see discrepancies, then our model is not right."

In 1984, Ad Aertsen left the USA to work at the Max Planck Institute of Biological Cybernetics in close cooperation with the Institute's former director, Professor Valentino Braitenberg once said of his former colleague: "Ad Aertsen succeeds in allowing his sense of humour to shine through the deep seriousness of his scientific ethos. He also has a very balanced attitude to the question of "theory or experiment": Theory is necessary, but only if one takes the experimental facts seriously."

## The beginning of "computational neuroscience"

Then the BMBF launched a call for a junior research group competition. "This was the first time a ministry had launched such a call," recalls the neurobiologist who subsequently became the head of the neurobiology project group at the University of Bochum. This was back in 1990. At that time, the first theory-based computer models of brain functions emerged and Aertsen found new ways of combining experiment and theory. He combined the new computer models with the knowledge gained from the measurement of action potentials and the growing knowledge about the brain's anatomy. For him, this is the beginning of "computational neuroscience". In Bochum, Aertsen focused on the processing of visual information. The scientist is still interested in finding out which nerve cells interact with each other when the eye is active.



Schematic representation of a brain-machine interface (Photo: Aertsen)

Ad Aertsen contacted Israeli researchers and spent a year as visiting professor at the Hebrew University in Jerusalem before he became professor at the Weizmann Institute. He spent three years at this renowned institute where he experienced one of the most creative periods of his life. That's when the idea of the "brain-machine interface" project was born, a project also dealt with enthusiastically by his Freiburg team, on which great expectations are placed. "We are very strong in this field and have already discovered a lot," said Aertsen adding that he does not want to raise false expectations. "A lot of research is needed before this technology can actually be applied," said Aertsen assuming that it is at least 10 years before paralysed people are able to use the technology to control a prosthesis.

**Brain-machine interface (BMI):** In healthy people, the motor areas of the cerebrum control arbitrary movements. From there, the motor commands are transferred via the spinal marrow to the muscles. Accidents, neurodegenerative diseases or stroke can impair or even completely interrupt this connection. The BMI attempts to replace such interrupted paths with an artificial path. The scientists use electrodes to measure the remaining brain activity of the motor areas. The signals are then transferred to a computer via an amplifier. Mathematical analyses are used to determine the intended movements of the patient from the measured brain activity. The translated signals can then be used to control a computer, prosthesis or robotic arm.

## Understanding the causes of neurological diseases

Ad Aertsen has been teaching and carrying out research in Freiburg since 1996. He succeeded in bringing one of the four Bernstein Centres for Computational Neuroscience (BCCN), funded by the German Federal Ministry of Education and Research, to Freiburg. This helped to boost the strong neuroscientific profile of the University even more. It is one of Aertsen's major aims to not only understand "normal" brain function but also the causes of neurological diseases. Aertsen and his Freiburg colleagues are concentrating mainly on motor diseases, epilepsy and Parkinson's and hope to understand what happens in the brain of patients suffering from these diseases. "We need to understand this in order to be able to develop an effective therapy," said Aertsen highlighting the importance of once again combining theory and experiment. The model, which will then be simulated on the computer, must deliver the same results as the brain experiments. "If this is the case, then we have understood how the brain works," summarises the researcher.

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