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Breakthrough for electrode implants in the brain

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For nearly nine years, researchers at Lund University have been working on developing implantable electrodes that can capture signals from single neurons in the brain over a long period of time - without causing brain tissue damage. They are now one big step closer to reaching this goal, and the results are published in the scientific journal *Frontiers in Neuroscience*.

This technology would make it possible to understand brain function in both healthy and diseased individuals.

"There are several elements that must go hand in hand for us to be able to record neuronal signals from the brain with decisive results. First, the electrode must be bio-friendly, that is, we have to be confident that it does not cause any significant damage to the brain tissue. Second, the electrode must be flexible in relation to the brain tissue. Remember that the brain floats in fluid inside the skull and moves around when we, for instance, breathe or turn our heads.

The electrode and the implantation technology that we have now developed have these properties, which is unique", says Professor Jens Schouenborg who together with Dr Lina Pettersson led the project.

The Lund researchers' tailored electrodes, which they call 3-D electrodes, are unique in that they are extremely soft and flexible in all three dimensions, in a way that enables stable recordings from the neurons over a long time.

The electrode is so soft that it deflects against a water surface. In order to implant such electrodes, the researchers have developed a technique for encapsulating the electrodes in a hard but dissolvable gelatine material that is also very gentle on the brain.

"This technology retains the electrodes in their original form inside the brain and can monitor what happens inside virtually undisturbed and normally functioning brain tissue", says Johan Agorelius, a doctoral student in the project.

Until now, developed flexible electrodes have not been able to maintain their shape when implanted, which is why they have been fixated on a solid chip that limits their flexibility, among other things. Other types of electrodes that are used are much stiffer. The result in both cases is that they rub against and irritate the brain tissue, and the nerve cells around the electrodes die.

"The signals then become misleading or completely non-existent. Our new technology enables us to implant as flexible electrodes as we want, and retain the exact shape of the electrode within the brain", says Johan Agorelius.

"This creates entirely new conditions for our understanding of what happens inside the brain and for the development of more effective treatments for diseases such as Parkinson's disease and chronic pain conditions than can be achieved using today's techniques", concludes Jens Schouenborg.

Facts about the electrodes:

The electrodes are made of 4 mmgold leads and individually insulated with 4 mm parylene. The array of electrodes consists of eight flexible channels, designed to follow the movement of the brain.

Both the electrode and implantation technology, which have been tested on rats, are patented by NRC researchers, in Europe and the US, among other places.

More information: "An array of highly flexible electrodes with a tailored configuration locked by gelatin during implantation—initial evaluation in cortex cerebri of awake rats" *Front. Neurosci.*, 25 September 2015 dx.doi.org/10.3389/fnins.2015.00331

Provided by Lund University