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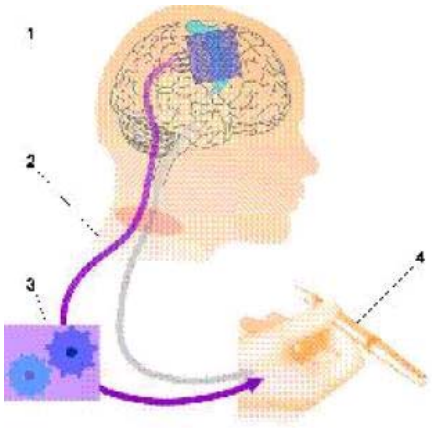
Improve the quality of life of severely paralysed people

The idea is fascinating: scientists at the University of Freiburg hope to develop a computer-based motor neuroprosthesis that will help improve the quality of life and motor ability of severely paralysed people. The concept, developed by Dr. Carsten Mehring, Department of Neurobiology, Dr. Jörn Rickert, Bernstein Centre, and Dr. Tonio Ball, Epilepsy Centre, won the "Go-Bio" competition of the Federal Ministry of Education and Research (BMBF).

Over the next three years, the research project will receive funds to the tune of approximately 2 million euros. This makes it possible for the Freiburg scientists to work on their economically highly interesting approach in an own research group and to develop prototypes for the future commercialisation of their idea.

In healthy people, the motor areas of the cerebrum govern voluntary movements. The motor commands are then transferred to the muscles via the spinal marrow. Accidents, neurodegenerative diseases or stroke might impair or even completely block this connection. "Our goal is to replace such interrupted paths with an artificial path," said Mehring. In order to achieve this goal, the researchers are using a "brain-machine interface" (BMI). Electrodes measure the brain activity of the motor areas. An amplifier transfers the signals to a computer where mathematical analyses help to determine the patient's intention to move. The translated signals are then used to direct a computer, prosthesis or robotic arm. "In the best case scenario, the stimulation of muscles might even lead to the ability to move the patient's own limbs," said Mehring, who has studied both neurobiology and physics.



Function of the BMI: (1) electrodes measure the activity of the brain. (2) System for the transfer of the signals to (3) a well-tuned system consisting of amplifier, computer and learnable software for the decoding of signals. (4) Effector, such as e.g. a computer cursor, an arm or hand prosthesis or one's own muscles, activated by direct muscle stimulation. (Fig. Mehring)

A current study being undertaken by the American government highlights the importance of the innovative BMI technology. Severe, permanent paralysis affects the quality of life of more than a million people throughout the world. Since the Freiburg researchers do not want to raise false expectations they are at pains to make it clear that this type of research is in its very early stages and that at the moment they are working on how a computer might sensibly target the brain signals. The possibility of moving a prosthesis will be the next step, explained Mehring.

The electrodes are attached to the brain surface

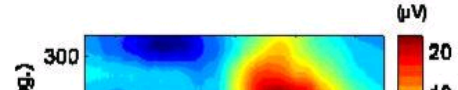
BMI is being investigated from many different angles by many groups of researchers around the world. The team from Freiburg is one of those groups that are working to establish a minimally invasive method. The researchers measure brain activity with electrodes attached to the brain surface. "This requires opening the skullcap and the meninges, but we do not penetrate into the brain," explains Mehring.

Arm movements can be predicted from brain signals

In contrast to the aforementioned method there are also less invasive methods. In one such method, the electrical signals are recorded on the skull surface and have therefore passed through bones, fat tissue and skin. This means that they have been altered and filtered, and are thus relatively inaccurate. "One can imagine this as a landscape seen through a shard of opaque glass where everything is blurred," said Mehring. He finds it difficult to imagine how precisely a volunteer might eventually be able to control complex movements of a hand or arm prosthesis with this method. A third method is invasive, in which the researchers use compressed air to shoot very thin electrodes into the brain from where they record the signals. This method might lead to functional neuronal tissue injuries.

The Freiburg team is confident that it is sufficient to attach a foil with electrodes to the brain surface and that successful BMI does not require the researchers to penetrate the brain. The researchers have been working on this project for four years. They have been able to show that their concept is largely feasible and that information can be obtained from surface signals. The scientists have also been able to predict arm movements from recorded brain signals.

The investigations involved epilepsy patients in whom drugs did not have the desired effect and who hoped that brain surgery would improve their situation. Before the operation, the patient's brain has to be examined thoroughly using electrodes that are implanted into specific brain regions for a limited time period. Mehring and his colleagues use the same electrodes for their investigations.



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