Moving moments

Analysing brain signals to let a patient control his arm

Implants and algorithms offer hope for the paralysed

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DURING a 250km (150-mile) bike ride for charity in Ohio, William Kochevar found himself cycling behind a mail van when it pulled over to make deliveries. Distracted and tired, Mr Kochevar did not brake in time. The accident, in 2006, left him paralysed from the shoulders down. Now, with the help of electrodes that transmit signals from his brain to his muscles, he has been able to grasp a fork and feed himself for the first time in over a decade. The procedure that allowed Mr Kochevar to achieve the feat is reported in the Lancet this week.

Bolu Ajiboye and Bob Kirsch, biomedical engineers at Case Western Reserve University, in Cleveland, used functional magnetic resonance imaging to locate nerve cells responsible for arm movements in the motor cortex of Mr Kochevar's brain. The technique highlighted a patch of his brain to which the blood supply increased whenever Mr Kochevar imagined moving his arm. The team then implanted at that spot two 4x4mm chips, each with an array of 96 tiny electrodes, to measure the electrical activity of the 100 or so nerve cells there. They also implanted 36 stimulating electrodes in the muscles of his right hand and arm.

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With the chips in place, Mr Kochevar was asked to imagine moving a virtual arm in a computer simulation, and, later, to imagine moving his own arm while it was moved for him. The patterns of electrical activity from the nerve cells firing in Mr Kochevar's brain were fed to a computer algorithm, which matched them to the motions of the virtual arm and later, his own arm. After this training, the algorithm was able to detect brain activity associated with Mr Kochevar's intention to move his arm and then trigger the contraction of muscles needed to bring about the desired motion.

Because Mr Kochevar had lost the nerves required to move many of his shoulder muscles, his arm movements were assisted by a motorised platform, which he was also able to control using the system. Around a year after receiving the implants, he was able to grasp a coffee cup and drink from it using a straw. To feed himself took a further year of training.

The technique Dr Ajiboye and Dr Kirsch employed to achieve all this, which is called functional electrical stimulation (FES), has been used in monkeys and has also permitted paralysed human patients to move a robotic arm. Last year a different group of researchers reported that use of the technique had allowed a paralysed man who was still able to move his elbow to reach and grasp objects. Mr Kochevar's paralysis is more severe, however, and the motions he can perform with the aid of FES are more complex.

Even so, there are some hurdles to clear before FES can be used routinely. The electrodes implanted into the brain do not last more than a few years. More robust ones need to be developed before FES can be deployed widely. Several groups are working on that. Also, they are connected to the outside world by cables. A wireless connection would be better. Such a set-up was demonstrated last year in monkeys. With luck, people will not have to wait too much longer to follow suit.