Times August 12th 2016

Paralysed patients move limbs after virtual reality training

Tom Whipple Science Editor

Eight completely paralysed people have regained function in their limbs following virtual reality training, in an accidental result that has astonished the scientists involved.

Using a brain-machine interface, scientists showed that people with long-term severe paralysis could retrain the few remaining connections in their damaged spines, letting their brains talk to their extremities once more. This enabled them to feel sensation, move their limbs and improved their bladder and bowel control.

The results came about as a wholly unexpected side effect of training to help people use robotic exoskeletons, which let them walk upright.

Miguel Nicolelis, of Duke University in the US, said: "When we started the project, our simple goal was to develop a brain-controlled exoskeleton that could be used to restore mobility. We never really imagined — nobody did — that we would be talking about the possibility of a brain-machine interface to induce partial recovery in patients who had been diagnosed with complete spinal cord injury."

To use the motorised legs, the patients had to be given intensive training so that they could control them using their mind. This training started with a virtual reality program in which the patients controlled an "avatar" of themselves. They were asked to think about moving their legs and, over time, those thoughts were translated into movement on the screen. Simultaneously, vibrators on their forearms provided feedback, which corresponded to the movement of the legs.

Researchers made the breakthrough during a project in which patients used brain-controlled exoskeletons to restore mobility

Once they had mastered the virtual world, they were moved into the real one. Attached to the exoskeletons, they then used the same thought-controlled mechanism to walk.

As this was going on Dr Nicolelis and his colleagues realised that there were changes in their patients.

"It started with sensitivity and motor improvements," he said. "They started regaining sensitivity below the level of the lesion. They started exhibiting voluntary movements." Some could twitch muscles, some could move their legs. "For almost a decade they had remained on the most severe classification of paralysis. When we reanalysed them, half had to be reclassified."

The scientists believe that the training process led to a reorganisation of patients' brains and exploited the few remaining intact nerves in the spine to direct signals around the injury.

The research, published in the journal *Nature Scientific Reports*, details the first year of the training up to 2014. Dr Nicolelis said that the improvements had continued. He said there was no precedent he knew of for these kind of results. "This has not been seen with any rehabilitation technology we know of so far."

Spine tingling

- A Polish man whose spine was completely severed by a knife attack was able to walk again thanks to a cell transplantation from his nasal cavity in 2014.
- Earlier this year Ian Burkhart, 24, from Ohio, who had quadriplegia, used his hands to grasp bottles and pour water thanks to a brain implant that stimulated muscles.
- Trials of an electrical stimulator that doctors believe can retrain damaged spinal nerves have had apparently startling results.