Parkinson: Scientists decode the neural signals that encode walking in the brain

Most patients with advanced Parkinson's disease develop disturbances of gait and balance, which severely affect their everyday mobility, independence, and quality of life. Using a last generation deep brain stimulation implant able to simultaneously stimulate and record the brain, we identified the neural activity patterns that correlate with normal and pathological gait. These results open new avenues for the development of adaptive neuromodulation therapies that can target gait deficits and prevent falls in real-time.

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Deep brain stimulation of the subthalamic nucleus is a well-established neuromodulation therapy for the symptomatic treatment of motor deficits in Parkinson's disease. For decades, this therapy has been optimized to alleviate symptoms such as tremor, bradykinesia (slowness of movements) and rigidity. However, deep brain stimulation often fails to improve, or can even aggravate gait deficits. To date, little is known about the neural activity patterns underlying gait deficits in PD, which has restricted the development of neuromodulation therapies better targeting these impairments.

In this study, we leveraged a high-resolution gait platform established at CHUV to record the activity of the subthalamic nuclei, wirelessly and in real time, and to map it to whole-body movements and leg muscle activity while patients performed a series of walking tasks. We identified the neural activity patterns underlying basic walking, turning and freezing of gait. We then developed machine learning algorithms able to predict in real-time different aspects of walking, such as locomotor states, gait phases or effort modulations when avoiding obstacles, as well as pathological episodes such as freezing of gait.

These results open new avenues for the development of adaptive neuromodulation therapies that employ predictions of leg motor states in real time to target and prevent gait and balance deficits in people with Parkinson's disease.

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About Lausanne University Hospital (CHUV):

CHUV is one of Switzerland's five university hospitals, alongside Geneva, Bern, Basel and Zurich. It is tasked with three basic missions by the public authorities, namely care, teaching and research. It provides care in all areas of medicine, including physical disorders and psychiatric illnesses, medical and surgical disciplines, outpatient and inpatient treatment. In 2020, CHUV's 11,942 employees cared for 48,227 inpatients, accounting for over 456,974 days of hospitalization. It dealt with 75,457 emergencies, provided 1,346,973 outpatient consultations and welcomed 3,180 new babies into the world. Its annual budget is 1.782 billion Swiss francs. CHUV works closely with the Faculty of Biology and Medicine of the University of Lausanne to provide undergraduate, postgraduate and continuing education for doctors. It also works with other higher education institutions in the Lake Geneva area (including EPFL, ISREC, the Ludwig Institute for Cancer Research and the University of Geneva), with the University Hospitals of Geneva and other hospitals, health care providers and institutions, such as the Federation of Vaud Hospitals and the Vaud Society of Medicine. Since 2019, CHUV has been ranked as one of the best hospitals in the world according to Newsweek magazine.

About EPFL

EPFL, one of the two Swiss Federal Institutes of Technology, based in Lausanne, is Europe's most cosmopolitan technical university with students, professors and staff from over 120 nations. A dynamic environment, open to Switzerland and the world, EPFL is centered on its three missions: teaching, research and technology transfer. EPFL works together with an extensive network of partners including other universities and institutes of technology, developing and emerging countries, secondary schools and colleges, industry and economy, political circles and the general public, to bring about real impact for society.

About .NeuroRestore

.NeuroRestore is an R&D platform based in French-speaking Switzerland that develops approaches for restoring neurological function in patients suffering from paraplegia, tetraplegia, Parkinson's disease or the consequences of stroke. It is headed by Grégoire Courtine, a neuroscientist at Ecole polytechnique fédéral de Lausanne (EPFL), and Jocelyne Bloch, a neurosurgeon at Lausanne University Hospital (CHUV). .NeuroRestore, founded in 2018, brings together engineers, doctors and scientists from EPFL, CHUV and the University of Lausanne, with the support of the Defitech Foundation. It draws on this pooled expertise to develop neurotherapies that can help patients recover motor function. Its innovative and personalized treatments are tested through research protocols and then made available to hospitals and patients. .NeuroRestore is also committed to training the next generation of health-care professionals and engineers on the use of these novel therapeutic approaches.