Virtual tool for treating epilepsy

A personalised brain modelling technique developed with EU support shows promise in detecting seizure-causing areas in the brain.

Researchers from the Human Brain Project (HBP) have developed advanced brain modelling methods that could help doctors more reliably identify where epileptic seizures start in the brain and consequently improve surgical prognoses. Achieved with support from the EU-funded HBP SGA3 project, this personalised brain modelling approach is described in a research article published in ‘Science Translational Medicine’.

In about one third of people with epilepsy, medicines are mostly or even completely ineffective in controlling seizures. For this group of patients, surgical removal of the epileptogenic zone – the part of the brain where the seizures originate – is the only potentially effective treatment. However, despite the increasing use of invasive explorations in the last two decades, prognoses have improved only modestly. Currently, surgery has a 60 % success rate.

Simulating seizures

To construct and simulate personalised brain network models, the research team used an open-source platform called The Virtual Brain (TVB), a simulation service available through the EBRAINS digital research infrastructure, powered by the EU co-funded HBP. TVB was developed by HBP scientist Dr Viktor Jirsa of HBP SGA3 project partner Aix-Marseille University, France, together with collaborators.
The technology makes it possible to simulate how abnormal activity spreads in a patient’s brain during an epileptic seizure. This helps clinicians to more reliably detect the target areas for surgery. As reported in a news item posted on the HBP website, each patient’s computational models are created using “individually measured anatomy, structural connectivity and brain dynamics data.” The personalised simulations essentially provide a virtual epileptic patient (VEP) tailored to each real patient. According to the news item, the approach has been tested in a number of retrospective studies, with the most recent paper published in the journal ‘Epilepsia’.

The VEP is the first computational model to estimate the extent and organisation of the epileptogenic zone network. It also shows good precision in detecting target areas compared with current state-of-the-art model-free approaches. It can also provide information on brain regions not sampled by surgically implanted electrodes.

The personalised brain modelling approach is now being tested in a large-scale clinical trial as a predictive tool for surgery preparation. The trial is expected to run until 2025.

The researchers are using the EBRAINS infrastructure to further enhance the tool’s predictive power with new high-resolution data from the HBP’s Human Brain Atlas. “Computational neuromedicine needs to integrate high-resolution brain data and patient specificity,” states Dr Jirsa. “Our approach heavily relies on the research technologies in EBRAINS and could only have been possible in a large-scale, collaborative project such as the HBP.” The HBP SGA3 (Human Brain Project Specific Grant Agreement 3) project ends in September 2023.

For more information, please see: Human Brain Project project website.

**Keywords**

HBP SGA3, brain, epilepsy, brain modelling, seizure, epilepsy, epileptogenic zone

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