The Virtual Epileptic Patient

Neurotechnology for the patient with epilepsy

Epilepsy in numbers:
1% of the world's population is diagnosed with epilepsy. ~400.000 new cases in Europe each year: 1 every minute.[1]

30% of patients are drug-resistant and require surgical treatment:
Epilepsy surgery is delayed up to 20 years on average, decreasing the patient's quality of life.[2]

The life expectancy of patients with epilepsy is reduced by 2-10 years:
The Standardized Mortality Ratio (SMR) ranges from 1.6 to 3.0 in High-Income Countries, whereas 19.8 in Low/Middle-Income Countries.[3]

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VEP: A virtual simulation of neural networks.

Introducing a diagnostic tool for patients with refractory epilepsy amenable to surgical intervention.

The Virtual Epileptic Patient is a non-invasive technique, by which the brain is reconstructed into a three-dimensional model, applying subsequently a modeling in which neuronal groups are reflected in nodes mathematically. According to Jirsa et al. (2016) creators of this model, VEP uses an application called Epileptor with downloaded variables and slow processes to combine patient's brain connectivity and their reconstructed white matters. Through this high-dimensional modelling, VEP engineers could test clinical hypothesis about anomalies identified from magnetic resonance imaging (MRI) to the network, demonstrating also the evolution of the areas that trigger epilepsy, identifying possible areas or Epileptic Zones (EZ), as well as Propagation Zones (PZ) in the absence of epilepsy.

Custom neural network model

Exploration and prediction of epileptogenic zones

Greater accuracy with high-performance software

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One more step towards highly personalized medicine

VEP is a multimodal tool that provides significant prediction tailored to each patient's brain parameters.

VEP technology models the brain network of patient's who require surgical procedure using recordings such as electroencephalogram (EEG) and stereoelectroencephalography (SEEG) obtained from non-invasive methodologies. This information is then used for reconstructing the patient's brain in a personalised way, considering its 3D morphology, for pre-surgical evaluations.

According to Jirsa et al. (2016), VEP and the other models evaluate the brain at a macro levels and are base on three determining aspects: brain network connectivity, neural mass model and the lesions through magnetic resonance imaging (MRI).

The Epileptor is an application associated with this epilepsy model and represents a neural mass model created from mathematical formula. It models the process of the seizures from their origin, so these formulations allow to generate a network node that applies to the model: "MRI lesions provide a spatial map of altered parameters that thus enter into the VEP model and affect the network dynamics" (Ibíd. 385).

"We find excellent correspondence of the spatiotemporal seizure evolution between simulation and empirical data"
- *Jirsa et al. (2016)*

Application and Market Potential

Currently, the efficiency of VEP software prototype in providing informative neurosurgical strategies is being assessed in a European clinical trial with 356 drug-resistant epilepsy patients in the EPINOV project (2019-2022).

Competitive Advantages:

EBRAINS

Is a platform providing tools and services which can be used to address challenges in brain research and brain-inspired technology development. The services were developed by, and are powered by the *Human Brain Project.*

Visit: www.ebrains.eu

THE HUMAN BRAIN PROJECT

Is one of four Future and Emerging Technology Flagships, the largest scientific projects ever funded by the European Union. Started in 2013, this project spans for 10 years and is a research infrastructure to help advance neuroscience, medicine, and computing. VEP is developed partly by the Human brain project.

Visit: www.humanbrainproject.eu

References:

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Epinov project: www.epinov.com

Institut de Neurosciences des Systèmes www.ins-amu.fr/epinov

NIH U.S National Library of Medicine. www.clinicalTrials.gov

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(2)Schmidt, D. y Shorvon, S., (2016). *The End of Epilepsy? A history of the modern era of epilepsy 1860-2010.* Oxford University Press. United Kingdom.

(3)Beghi, E. T*he Epidemiology of Epilepsy*. Neuroepidemiology. 2020;54:185-191. doi: 10.1159/000503831

Technology Readiness Level

7

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