Contribution ID: **7** Contribution code: **K2** Type: **Keynote**

Simulating the neural bases of pathological behaviors with NEST: a use case on dystonia

Thursday 15 June 2023 13:20 (45 minutes)

Understanding neural bases of behaviors is fundamental in neuroscience, particularly for brain diseases/disorders. Data-driven models of brain circuits are being developed to simulate neural activity and the resulting behaviors. Applying localized lesions models, it is possible to study *in silico* altered neural activity and behaviors, providing insights into neural bases of pathological conditions [1].
We here applied this approach to study the role of cerebellar alterations in dystonia.
Dystonia is a movement disorder, traditionally associated with basal ganglia dysfunction. Recent animal studies suggest a role of the cerebellum, a key brain area for motor control [2], but the causal mechanisms remain unclear. To address this issue, we used a data-driven cerebellar spiking neural network and simulated a cerebellum-driven behavior, Eye-Blink Classical Conditioning (EBCC) [3], which is impaired in some types of dystonia. The model, implemented in NEST [4], include about 10,000 neurons and 1,5 million connections, with parameters tuned on neural data [5]. Through supervised plasticity triggered by inputs, the model was able to reproduce physiological EBCC learning curves. We then modified local features in the network reproducing alterations in dystonic mice [6–8]. Simulations suggest that only certain types of lesions, namely reduced olivocerebellar input and aberrant PC burst-firing, but not imbalance of excitatory-inhibitory input on PCs, are compatible with EBCC changes observed in dystonia, indicating which cerebellar lesions can have a role in generating symptoms.
Overall, we here provide a tool for studying cerebellum alterations in dystonia, paving the way to *in silico* investigation of brain diseases using NEST.

Acknowledgements

This research has received funding from the European Union's Horizon 2020 Framework Program for Research and Innovation under the Specific Grant Agreement No. 945539 (Human Brain Project SGA3). Special acknowledgment to EBRAINS and FENIX for informatic support and infrastructure.

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Topic area

models and applications

Keywords

brain disease simulation, cerebellum, dystonia, motor dysfunction, spiking neural networks

Speaker time zone

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Talk (& optional poster)

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Session Classification: Keynote