Autaptic transmission regulates high-frequency firing in a single-neuron level

Daqing Guo[1,2*], Chuan Xia[1], Shengdun Wu[1], Mingming Chen[1], Tiejun Liu[1,2], Yang Xia[1,2], Dezhong Yao[1,2]

[1]Key Laboratory for NeuroInformation of Ministry of Education, School of Life Science and Technology, University of Electronic Science and Technology of China, Chengdu 610054, People's Republic of China

[2]Center for Information in Medicine, University of Electronic Science and Technology of China, Chengdu 610054, People's Republic of China

Corresponding author: dqguo@uestc.edu.cn

Rational： Neural oscillations are electrical activities of the brain measurable at different frequencies. High-frequency neural oscillation (HFO) with frequency larger than 250 Hz is an important type of neural oscillations. There is a broad consensus that abnormal HFO is correlated with epilepsy. Theoretically, high-frequency firing in a single-neuron level is associated with the HFO, but so far its generation and modulation mechanisms still remain controversial.

Methods： We address this question by computational modelling. To this end, we simulated a spiking model neuron driven by both the balanced excitation-inhibition input and the autaptic input from itself. It should be noted that different classes of neural excitabilities and various types of autaptic connections were considered in our model.

Results： By computational modeling, we found that interneuron with inhibitory and electrical autapses is a fundamental module to generate the high-frequency firing (>250 Hz). More importantly, we observed that chemical and electrical autapses perform complementary roles in the generation and modulation of high-frequency firing.

Discussion： These results highlight the functional importance of autaptic self-innervation in regulating high-frequency firing in a single-neuron level.