30th Annual Computational Neuroscience Meeting

CNS*2021, Online

July 3 to 7, 2021

P Poster

JULY 5 • MONDAY

6:00pm – 7:00pm

P **P193: Dynamical Origin for Winner-Take-All Competition in A Biological Network of The Hippocampal Dentate Gyrus** TBA

Speakers: Woochang Lim

Dynamical Origin for Winner-Take-All Competition in A Biological Network of The Hippocampal Dentate Gyrus

Sang-Yoon Kim and Woochang Lim

Institute for Computational Neuroscience and Department of Science Education, Daegu National University of Education, Daegu 42411, Korea

We consider a biological network of the hippocampal dentate gyrus (DG). The DG is a pre-processor for pattern separation which facilitates pattern storage and retrieval in the CA3 area of the hippocampus. The main encoding cells in the DG are the granule cells (GCs) which receive the input from the entorhinal cortex (EC) and send their output to the CA3. We note that the activation degree of GCs is so low (~ 5 %). This sparsity has been thought to enhance the pattern separation. We investigate the dynamical origin for winner-take-all (WTA) competition which leads to sparse activation of the GCs. The whole GCs are grouped into lamellar clusters. In each GC cluster, there is one inhibitory (I) basket cell (BC) along with excitatory (E) GCs. There are three kinds of external inputs into the GCs; the direct excitatory EC input, the indirect inhibitory EC input, mediated by the HIPP (hilar perforant path-associated) cells, and the excitatory input from the hilar mossy cells (MCs). The firing activities of the GCs are determined via competition between the external E and I inputs. The time-averaged ratio of the external E to I conductances, $\overline{R_{\mathrm{E-I}}^{(\mathrm{con})}(t)}$, may represents well the degree of such external E-I input competition. It is thus found that GCs become active when their $\overline{R_{\mathrm{E-I}}^{(\mathrm{con})}(t)}$ is larger than a threshold R_{th}^{*}, and then the mean firing rates of the active GCs are strongly correlated with $\overline{R_{\mathrm{E-I}}^{(\mathrm{con})}(t)}$. In each GC cluster, the feedback inhibition of the BC may select the winner GCs. GCs with larger $\overline{R_{\mathrm{E-I}}^{(\mathrm{con})}(t)}$ than the threshold R_{th}^{*} survive, and they become winners; all the other GCs with smaller $\overline{R_{\mathrm{E-I}}^{(\mathrm{con})}(t)}$ become silent. In this way, WTA competition occurs via competition between the firing activity of the GCs and the feedback inhibition from the BC in each GC cluster. In this case, the hilar MCs are found to play a role of enhancing the WTA competition.

Keywords: Hippocampal dentate gyrus, Winner-take-all competition, Sparsity