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Sat. Jul 31, 2021 1:00 PM - 2:00 PM Online

Poster | I. Computational Theories

[4P] Others

[4P-470] Population and Individual Firing Behaviors in Sparsely Synchronized Rhythms Appearing in The Hippocampal Dentate Gyrus

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[4P-470]Population and Individual Firing Behaviors in Sparsely Synchronized Rhythms Appearing in The Hippocampal Dentate Gyrus

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Keywords:Hippocampal dentate gyrus, Sparsely synchronized rhythms, Random spike skipping

We investigate emergence of sparsely synchronized rhythms (SSRs) in a biological network of the hippocampal dentate gyrus (DG). The main encoding granule cells (GCs) are grouped into lamellar clusters. In each GC cluster, there is one inhibitory (I) basket cell (BC) along with excitatory (E) GCs, and they form the E-I loop. Winner-take-all competition, leading to sparse activation of the GCs, occurs in each GC cluster via competition between the firing activity of the GCs and the feedback inhibition from the BCs. Such sparsity has been thought to enhance patter separation performed in the DG. During the winner-take-all competition, SSRs are found to appear in the GC(E)-BC(I) loop through interaction of excitation of the GCs with inhibition of the BCs. Successive synchronized stripes appear with the population frequency f_p ($\simeq$ 13 Hz) in the raster plots of spikes in each population of GCs and BCs. We also note that the excitatory hilar mossy cells (MCs) control the firing activity of the GC-BC loop by providing excitation to both the GCs and the BCs. SSR also appears in the population of MCs via interaction with the GCs (i.e., GC-MC loop). All these SSRs are quantitatively characterized in terms of the synchronization measures. In addition to the population behavior of the SSRs, we investigate individual firing activity of GCs, BCs, and MCs in the SSRs. Individual GCs exhibit random spike skipping, leading to a multi-peaked inter-spike-interval histogram, which is well characterized in terms of the random phase-locking degree. In this case, population-averaged mean-firing-rate (MFR) $<f_i^{(GC)}>$ is less than the population frequency f_p. On the other hand, both BCs and MCs show "intrastripe" burstings within stripes, together with "interstipe" random spike skipping. Thus, the population-averaged MFR $<f_i^{(X)}>$ (X= MC and BC) is larger than f_p, in contrast to the case of the GCs. MC loss may occur during epileptogenesis. With decreasing the fraction of the MCs, changes in the population and the individual firings in the SSRs are also studied. Finally, association between the population/individual firing behaviors in the SSRs and the winner-take-all is discussed.

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