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Intermittent synchronization in gamma-band neural oscillations

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Gamma synchronization plays a significant role in many cognitive functions, and abnormal gamma synchronization is often associated with brain diseases such as schizophrenia (Uhlhaas and Singer, 2010). Synchronization, observed through experiments (Ahn and Rubchinsky, 2017; Malaia et. al., 2020), fluctuates over time. In fact, neural networks can come in and out of synchronization, i.e. desynchronization. Networks with similar synchrony strength may yield different temporal patterns; some can have many episodes of desynchronization but the majority of those episodes do not last long while others do not have as many instances of desynchronization but many of those instances last a long time. The former phenomenon (short desynchronization duration) is predominantly observed in both healthy and diseased brains (Anh et al., 2013; Ratnadurai-Giridharan et al., 2016). In our study, we use a medium-size conductance-based pyramidal-interneuron gamma network. Our simulation consistently shows that the temporal patterns of synchrony can be altered by synaptic strength of local and distant connections. Moreover, the changes are opposite for the local and distant synapses. Finally, we demonstrate that circuits with different temporal patterns of synchrony may response to input differently. This observation can have an implication to examine how intermittent synchronization may be functionally important and thus correlated with behavior/diseases.

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