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Synchronization of asynchrony-favoring neurons – wireless clustering

Hideyuki Câteau* and Tomoki Fukai

Address: RIKEN Brain Science Institute, 2-1 Hirosawa, Wako, 3510198 Saitama, Japan

Email: Hideyuki Câteau* - cateau@brain.riken.jp

* Corresponding author

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Paired neurons tend to fire synchronously or asynchronously depending on the membrane potential dynamics. Traditionally, those neurons that favor synchrony are associated with temporal coding, while rate coding is associated with those that favor asynchrony. However, as we show here, the effects of spike-timing-dependent plasticity (STDP) challenge this view. Under STDP, a population of neurons that favors asynchrony appears to self-organize into clusters, each of which exhibits synchronous firing. This paradoxical synchronization within each cluster is possible because STDP selectively disrupts intra-cluster connections, thereby nullifying the asynchrony tendency inherent in neurons. We call this a wireless clustering. When we run the same simulation with neurons that favor synchrony, no cluster-wide synchronization is observed. Instead, these neurons are synchronized globally. Where the impact of a single neuron on other neurons can be as small as 0.5 mV, a cluster of synchronously firing neurons can reliably elicit firing in other neurons, making the cluster the likely unit for information processing in the brain. Therefore, based on this study, asynchrony-favoring neurons appear to contribute to the temporal coding scheme, not synchrony-favoring neurons which exhibit global synchrony which is more common in pathological events like a seizure.