Diversity of Interneuronal Networks and neural Computation: Meaning of Means and Variability of Variances

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Abstract

One of the major characteristics of the GABAergic system is the presence of high levels of diversity, from the existence of many distinct GABA-A receptor subunits to the evolution of various classes of interneurons in cortical networks. The underlying, albeit frequently unstated, assumption regarding the heterogeneity of the GABAergic system is that each molecular or cellular subtype evolved to serve a certain set of specific functions, such as sensitivity to benzodiazepines, or the generation of perisomatic inhibition. However, an alternative possibility is that GABAergic diversity itself serves important functional roles in neuronal systems, and that alterations in the population variance of GABAergic synaptic inputs and interneuronal properties modulate the excitability of neuronal networks. Recent computational modeling and experimental studies demonstrate that the degree of scattering of synaptic or cellular parameter values of GABAergic processes around the population mean is a powerful regulator of the excitability and behavior of neuronal circuits, including alterations in input-output functions, rhythmicity and synchrony of principal cell and interneuronal networks. These results indicate the functional importance of the diversity of interneurons in cortical and hippocampal circuits, and suggest that plastic changes in GABAergic synaptic diversity modulate neuronal excitability under both normal and pathological conditions.