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'Synaptic Theory of Working Memory'

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ABSTRACT:

Current theoretical framework holds that information is actively maintained in working memory through enhanced firing rates (delay activity). This would be achieved either via persistent activity reverberation within selective neural populations or as a result of intrinsic single-cell properties (i.e. bi-stability). Electrophysiological studies show, however, that delay activity increase can be modest, sometimes completely disappearing during part of the delay period. We therefore propose a new theoretical framework whereby working memory is sustained by calcium-mediated synaptic facilitation in the recurrent connections of neocortical networks. In this account, the presynaptic residual calcium is used as a 'buffer' which is loaded, refreshed and read-out by spiking activity. Due to the long time constants of calcium kinetics, the refresh rate can be very low, which results in a mechanism that is metabolically efficient and resistant to external interferences. The duration and stability of working memory can be effectively regulated by modulating the spontaneous activity in the network.