

Regenerative dendritic events at the dendritic arbor - a mechanism for internal sense of a place that reflects binding at the time of learning

Re-interpretation based on the IPL mechanism

Each place field consists of a unique set of CA1 neurons that fire action potential. At the dendritic regions, calcium transients inform about a change in potentials occurring regeneratively either due to back propagating action potentials (bAP) or by dendritic spikes. Recent studies observed calcium transients secondary to regenerative dendritic events in place cells that can predict place field properties (Sheffield and Dombeck, 2015a; Sheffield et al., 2017). These calcium transients have a highly spatiotemporally variable prevalence throughout the dendritic arbor. In some cases, only a subset of the observed branches displayed detectable spikes, which indicates that spikes originated at these dendritic branches. None of the observed branches in many cases displayed detectable spikes during place field traversals while the soma (and axon) fired. This means that the bAP did not reach these locations. From the findings of Sheffield and Dombeck, it is clear that dendritic spikes relate to spatial precision. However, this finding needs a mechanistic explanation.

The above finding can be explained by the occurrence of dendritic spike occurs at an islet of inter-LINKed spines that belong to different CA1 neurons (Vadakkan, 2013). This has the following advantages. a) Activation of inter-LINKed spines within an islet of inter-LINKed spines induces units of internal sensations for a specific place. b) One dendritic spike at an islet of inter-LINKed spines that belong to different neurons can explain the firing of different CA1 neurons that are being maintained in a sub-threshold state at the time of the dendritic spike. It also supports why a high percentage of place cells are shared between different places. c) Since potentials degrade as they reach the axonal hillock, it may require potentials arriving from more than one spike to contribute to the firing of a CA1 neuron depending on latter's sub-threshold level. d) The highly spatiotemporally variable nature of spike

depends on the qualia of internal sensations that they induce in response to and matching with the place (which depends on previous associative learning events with different places). The latter property can explain the expected binding feature (Sheffield and Dombeck, 2015b).

References

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