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Synaptic activity and excitability modulates information transfer in Purkinje cells: a modeling study

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Dendritic excitability is the consequence of the different concentration and distribution of active conductances. The excitability of the cell could be a mechanism for storing memories and is affected by development and experience. Information in Purkinje cells (PCs) flows from dendrites to soma without the influence of back-propagating action potentials. Thus, PCs are ideal to quantify the incremental contribution of dendritic channels to information processing.

We used a previously published PC model [1,2]. The model was stimulated with several combinations of excitatory and inhibitory rates of synaptic activity (EI_r). Since our objective was to quantify information processing in dendrites we chose EI_r to evoke the same firing rate at the soma. The simulations were run for 400 s; the total current of all the synaptic and dendritic channels was recorded every 0.1 ms; and were implemented in a pre-release version of GENESIS 3 (http://www.genesis-sim.org/; http://www.cbi.utsa.edu).

We quantified the effects of several EI_r on the histogram of each dendritic current. We found that only the histograms of the CaP (I_{CaP}) and Kc currents (I_{Kc}) varied, while all others remained constant. The source of this variability comes from the synaptic activity and from interactions among channels. We used mutual information (MI) to quantify the information from the total excitatory synaptic current (I_{Glu}) encoded in each dendritic current. In this context, each active current was considered an *information channel*. MI(I_{CaP}, I_{Glu}) and MI(I_{Kc}, I_{Glu}) was sensitive to different EI_r that resulted in the same firing rate at the soma. We quantified the changes in MI(I_{CaP}, I_{Glu}) and MI(I_{Kc}, I_{Glu}) as a function of the density of dendritic conductances (g_{CaP} and g_{Kc}). This analysis showed that MI(I_{CaP}, I_{Glu}) was less sensitive to changes in g_{CaP} than to variations in g_{Kc}. Thus, the interactions between I_{Kc} and I_{CaP} are important to regulate information transfer in the dendrite. We extended our analysis to determine MI($I_{CaP}(t)$ or $I_{Kc}(t)$, $I_{Glu}(t-\Delta t)$), for Δt from 0 to 1 s and as a function of channel density and EI_r. We found that MI decayed in about 100 ms as a function of the combination of g_{CaP} and g_{Kc} with the level of synaptic activity, reducing this window to a few milliseconds with high rates of EI_r. Overall, our results show that different dendritic conductances differentially encode synaptic activity and that dendritic excitability and the level of synaptic activity regulate the flow of information in dendrites.

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References

1. De Schutter E, Bower JM: **An active membrane model of the cerebellar Purkinje cell II. Simulation of synaptic responses.** *J Neurophysiol* 1994, **71(1)**:401-419.
2. Santamaria F, Tripp PG, Bower JM: **Feedforward inhibition controls the spread of granule cell-induced Purkinje cell activity in the cerebellar cortex.** *J Neurophysiol* 2007, **97(1)**:248-263.

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