TRANSMISSION OF INFORMATION ALONG ARBORISED MYELINATED AXON

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ABSTRACT

Differential conduction of action potentials (AP) at branching points of arborised axons is supposed to be responsible for a spatiotemporal filtering of spike pattern propagating through axonal tree. The inhomogeneity of membrane properties of axonal branches caused by the accumulation of potassium ions in periaxonal space, by varying branching geometry and membrane noise (mainly the channel noise), affects the AP conduction and may [2] decrease the amount of information represented by neuronal spike train on its way from the beginning of axon to its terminals.

We built multicompartmental models of an arborised myelinated axon with K ion concentration in periaxonal space dynamically linked to the activity of axonal fast K channels in the paranodal region [3]. Using the reconstruction method, we estimated the mutual information between spike train at the beginning of axon (input pattern) and spike trains at axonal terminals (output pattern). To describe AP filtering by axonal tree, these mutual informations were compared with the mutual informations between output patterns at terminals. We studied the influence of axonal morphology, membrane noise and input pattern on the estimated mutual information.

Our model, exhibiting propagation failures at branching points at higher firing frequencies, selectively relayed different pieces of input information (contained in input pattern) into different terminals. This selectivity was dependent on input pattern and weakened by membrane noise, especially at terminal branches of small diameters. Despite the effect of failures, the net information represented in output patterns at all terminals did not significantly dissipate thorough propagation; the difference between input pattern and its reconstruction from all output patterns differed only by few μs in axons of few μm in diameter [1].

Keywords: Axon, Information, Noise.

References

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