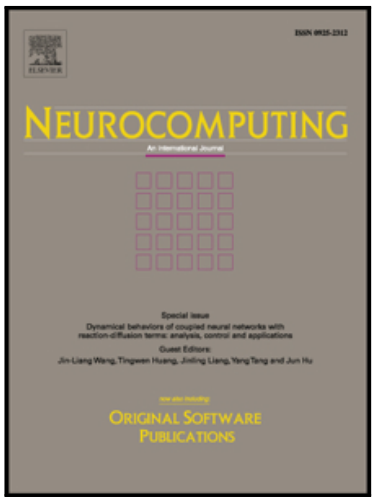

Effects of ion channel blocks on electrical activity of stochastic Hodgkin-Huxley neural network under electromagnetic induction

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Effects of ion channel blocks on electrical activity of stochastic Hodgkin-Huxley neural network under electromagnetic induction

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Abstract: The effects of channel blocks on the spontaneous spiking activity and neuron networks pattern selection are investigated by using an improved Hodgkin-Huxley (HH) model in which the electromagnetic induction is considered and the magnetic flux is used to describe the influence of electromagnetic field. The discharge behavior of neurons induced by potassium ion and sodium ion channel blocks was analyzed by numerical simulation in the improved HH model. The results suggest that changes in the maximum conductance of potassium channels can cause spontaneous discharge behavior of neurons. The poisoning of potassium ion can be weakened by the electromagnetic radiation in the neural network, and the neural network presents a state of spatial order in the case of spiral waves. It is interesting that the ordered waveform is generated by no-flux boundary condition when the initial states are selected as wedge-shaped type in the network. In addition, potassium channel blocks can promote the discharge of neurons and facilitate the formation of spiral waves in the neural network. By contrast, the electrical activity of neurons is inhibited by sodium channel blocks. The influence of membrane patch size on the electrical activity of single neuron is greater than that on the collective behavior of neural network. This research will enhance understanding of the role of toxins in neuronal firing and collective behavior of real neural systems.

Keywords: Neural network; Channel block; Pattern selection; Electromagnetic induction

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1. Introduction

The Hodgkin-Huxley model [1] is the cornerstone of modern computational neuroscience, which is a