NEURAL MASS MODELING OF POWER-LINE MAGNETIC FIELDS EFFECTS ON BRAIN ACTIVITY

Neural mass models are an appropriate framework to study brain activity, combining a high degree of biological realism while being mathematically tractable. These models have been used, with a certain success, to simulate brain electric (electroencephalography, EEG) and metabolic (functional magnetic resonance imaging, fMRI) activity. However, concrete applications of neural mass models have remained limited to date. Motivated by experimental results obtained in humans, we propose in this paper a neural mass model designed to study the interaction between power-line magnetic fields (MFs) (60 Hz in North America) and brain activity. The model includes pyramidal cells; dendrite-projecting, slow GABAergic neurons; soma-projecting, fast GABAergic neurons; and glutamatergic interneurons. A simple phenomenological model of interaction between the induced electric field and neuron membranes is also considered, along with a model of post-synaptic calcium concentration and associated changes in synaptic weights Simulated EEG signals are produced in a simple protocol, both in the absence and presence of a 60 Hz MF. These results are discussed based on results obtained previously in humans. Notably, results highlight that (1) EEG alpha (8-12 Hz) power can be modulated by weak membrane depolarizations induced by the exposure; (2) the level of input noise has a significant impact on EEG power modulation; and (3) the threshold value in MF flux density resulting in a significant effect on the EEG depends on the type of neuronal populations modulated by the MF exposure. Results obtained from the model shed new light on the effects of power-line MFs on brain activity, and will provide guidance in future human experiments. This may represent a valuable contribution to international regulation agencies setting guidelines on MF values to which the general public and workers can be exposed.