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Modification of Coding of Human Brain Data Based on Cognitive Method

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Introduction: Information in neural systems is conveyed by way of phase and rate codes. Neuronal signals are processed through transformative biophysical mechanisms at the cellular and network levels. Neural coding transformations can be exhibited mathematically in a device called the cognitive rhythm generator (CRG). In this study, the CRG model was used. This model simulated hippocampal brain function. In this paper, parameters of the model were modified using genetic algorithm. Results showed that these modifications caused the model regenerate a more realistic output, and reduced the error of the model.

Methods: The CRG model has complicated non-linear calculations. In this study non-linear calculations were eliminated by substituting compact non-linear model with linear network model. Also, by using of genetic algorithm, results of linear networks and nonlinear CRGs were closed to each other and coupling strengths were optimized.

Results: Various modes were tested. In one mode all coupling strengths were used as input for genetic algorithms. In other modes, some of them had not participated in genetic algorithms for modification. Using this way we could study the role of each parameter on the output of networks. Results of inhibitory and excitatory network are demonstrated below. Inhibitory network had 3 parameters (x_1, x_2, and x_3); by modification the combination of x_1, x_2, and x_3 the value of error was 0.0501. By modification of only one parameter, the value of error was 1.2320, 1.4428, and 1.4429 for change x_1, x_2, and x_3 respectively. By modification of two parameters, the value of error was 1.1327, 1.1371, 1.4396 for change in x_1 along with x_2, x_1 along with x_3, and x_2 along with x_3 respectively. Results showed that all parameters affected on the output. Excitatory network has 5 parameters (x_1, x_2, x_3, x_4, and x_5). By modifying only one parameter the value of error was 0.00541. By modifying a combination of parameters, which included: x_3, x_4, and x_5; x_1 and x_4; x_1, x_2, and x_3, the value of error was 0.0644, 0.0092, and 0.0942.. Results indicated that parameters x_1, x_4, and x_5 had more effect on output.

Conclusion: Coupling strengths play an important role in the behavior of networks. Various behaviors across different regions of the hippocampus can be investigated by changing these parameters. In this research we studied the effect of these parameters on the output of CRG model, and showed that error of the output decreased by modification of these parameters.

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