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Optimal neural connection mechanism in cortical network

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Background

The mammalian cortical system consists of diverse neurons with different spatial coverage. Previous studies suggest that neurons with only local connections and those with most widespread connections should be most and least numerous, respectively [1]. However, synaptic connection mechanisms between neurons are still unclear. Based on the previous studies [1,2], we assume that neurons with large spatial coverage may be preferentially synaptically connected. We applied the methods of complex networks to model the neural connection mechanism. The cortical network was modeled in a two-dimensional Euclidean plane, in which neurons can only connect to those in their spatial coverage. For connection mechanisms, random connection and the preferential attachments to nearest neurons and to neurons with large spatial coverage were considered.

Results and conclusion

Results indicated that compared with other cases, the cortical network with the preferential attachment to neurons with large spatial coverage (PANLSC) showed an optimal architecture, represented by high clustering, short processing steps and short wiring lengths that are important statistical properties and constraints for the design of neural networks. We speculate that the PANLSC is an optimal neural connection mechanism in cortical systems.

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