New statistical method provides way to analyze synchronized neural activity in animals

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Researchers from the RIKEN Brain Science Institute have developed a new method of statistical analysis that can estimate the extent to which the activity of multiple neurons is group-wise synchronized.

The synchronized electrical activity of multiple neurons gives rise to coordinated network activity. This cooperative activity is highly dynamic and widely thought to be critical for organization behavior and cognitive processes.

Current methods for the statistical analysis of synchronized activity can analyze pairs of cells or detect the existence of correlations between multiple neurons. However, there is no way of accurately determining specific groups of neurons that interact with each other, and how this activity changes with time.

Working in collaboration with researchers from Germany and the U.S., Hideaki Shimazaki and colleagues developed a statistical tool that extracts information about the interactions of neuronal activity recorded from the brains of animals as they perform actions. To do so, the team adapted and extended an algorithm typically used in GPS tracking software, allowing them to measure interacting groups of neurons and how these interactions change with time.

The researchers tested their method on computer simulations of sequences of neuronal impulses produced by two and three neurons. These initial tests suggested that the higher-level analyses performed by the new method would enable discovery of the network activity that cannot be revealed by interactions between pairs of cells.

To confirm this, Shimazaki and his colleagues applied their method to a set of data obtained by simultaneous recordings of multiple neurons in the primary motor cortex in the monkey. These data were recorded in an earlier study, which demonstrated that the synchronized activity of two neurons increases when a monkey is preparing for motor action. However, this earlier study did not determine whether the cells were part of a larger group that coordinate their activity.

The new method enabled Shimazaki and his colleagues to analyze the activity of three neurons simultaneously. Their analyses revealed that synchronicity of the three neurons increases during the preparatory period, confirming that the neurons examined in the earlier study do indeed belong to a larger group of cells that act together.

"Currently the method is limited to analysis of a few neurons," says Shimazaki. "We would like to extend that number to hundreds or more. This would considerably increase the probability of observing assemblies of neurons involved in planning and controlling behavior."

More information: Shimazaki, H., Amari, S., Brown, E.N. & Grün, S. State-space analysis of time-varying higher-order spike correlation for multiple neural spike train data. *PLoS Computational Biology* 8, e1002385 (2012). dx.doi.org/10.1371/journal.pcbi.1002385

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