A New Method for Evaluating the Dynamics of Human Brain Networks Using Complex-Systems

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Abstract. To understand the temporal dynamics of brain networks, we applied a model based on complex-systems for brain networks, with a new measure of stability that corresponds to the network integrated with multiple oscillators. The simulation demonstrated that elementary coupled network shows high stability measure. This is the first step in our efforts to estimate the temporal dynamics of human brain networks.

Keywords: Brain Networks, Stability, Complex-Systems.

To understand the function of human brain as a system for information processing, many researchers study functional networks among the brain regions. The correlation coefficient value, which is conventionally used to evaluate functional connectivity across brain regions, has weakness in treating temporal dynamics of the network structure. Here, we propose a new method to evaluate the dynamics of brain network.

This method, whose difference from the conventional ones is shown in Fig.1, consists of two major steps: (1) We modeled the brain network as an elementary coupled network consists of two oscillators (Cf. X_1 and X_2 in Fig.2), and every parameter of this model was estimated to obtain the network stability in empirical way. (2) We introduced a *stability measure* (Cf. Z_0 in Fig.2) as a new index of functional connectivity between two oscillators. To describe the network structure quantitatively, the stability measure is used for analyzing non-linear dynamical system.

Through the simulation experiment, we confirmed that a high stability value corresponds to functionally connected network (see, Fig.2). This result indicates that our method is able to estimate the temporal dynamics of functional connectivity map for human brain [1].

Reference

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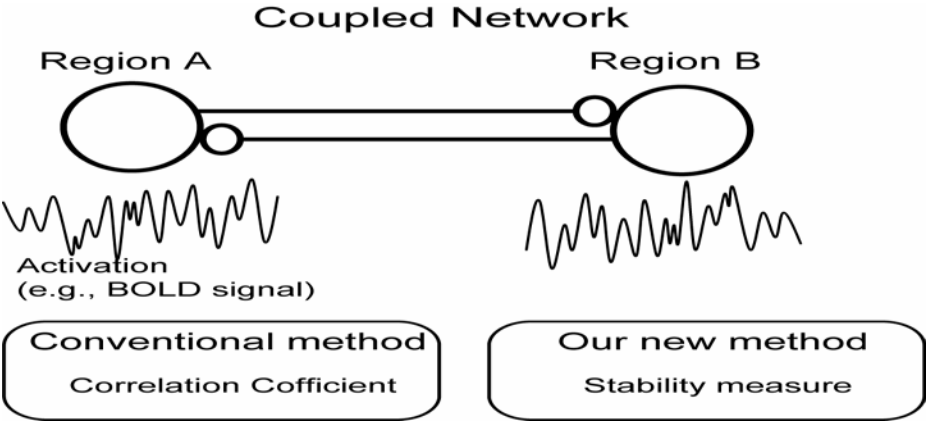

Fig. 1. Difference between the conventional methods and our new method in concepts

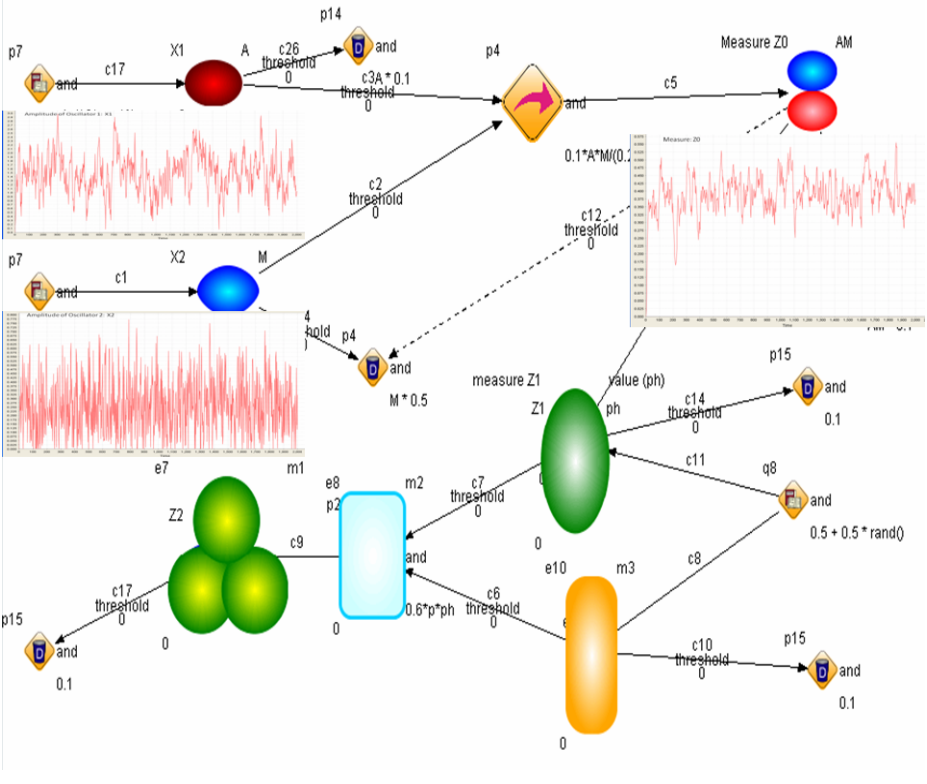

Fig. 2. Elementary coupled network integrated with multiple oscillators (X_1 and X_2) where the stability (Z_0) is obtained by empirical estimation of the corresponding parameters. The experimental result of the simulation of the model is obtained by (tentatively) using Cell Illustrator® Professional Version 3.