

[Grant - in - Aid for Scientific Research on Innovative Areas(Research in a proposed research area)]
Interdisciplinary Area



Title of Project : Non-linear Neuro-oscillology: Towards Integrative Understanding of Human Nature

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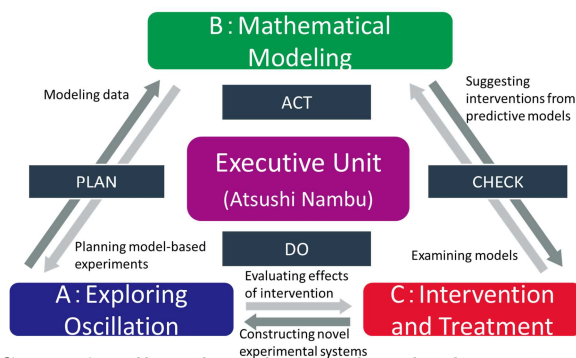
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【Purpose of the Research Project】

In this program, we intend to create a new academic field of neuro-oscillology, which enables us to understand human nature. "Oscillology" is a pragmatic knowledge that approaches "human brain" combining findings from state-of-the-art experimental research and ideas from a non-reductionism perspective that regard complex human being as indivisible unitary system. We share a working hypothesis that the spontaneous oscillation and synchronization in the neuronal systems yield its functional differentiation and self-organization, and also share a database of a body of relevant experimental research. We unify the team to create a new academic field "oscillology" which harmonizes neuroscience, mathematics, and clinical medicine to achieve mathematical and systematic neuroscientific comprehension of human nature.

【Contents of the Research Project】

The research team for this project is composed of three groups of research units that associatively proceed research activities: exploring oscillation, mathematical modeling, and the intervention and treatment.



Group A will explore the novel multi-dimensional and multi-layered oscillatory phenomena, working on intracellular events, primate/rodent models, direct recordings of human brain activity, and advanced measurements of human brain systems. Group B will develop mathematical models of functional differentiation and self-organization of the multi-dimensional and multi-layered oscillatory neuronal network. Group C will investigate genetic engineering and optogenetic intervention into oscillatory phenomena in animal models, control of dynamics in human neural network by non-invasive brain stimulation methods, and induction of

reorganization of nervous system and clinical intervention for network diseases in human, including neurological and psychiatric disorders.

Establishing oscillology requires close association between experimental and theoretical studies. As shown in the schema, group B draws up model-based experimental plans and then groups A and C cooperatively perform examinations on the suggested models. Also, group B will model novel oscillatory phenomena observed by groups A and C and develop ways to manipulate them. In addition, group A will analyze the effect of intervention methods developed by group C and examine validity of the models provided from group B.

【Expected Research Achievements and Scientific Significance】

Based on an oscillological perspective, we can regard various neurological and psychiatric disorders, such as dementia, epilepsy, Parkinson's disease, and schizophrenia, as "network diseases", that is, dysfunction in dynamism of spontaneous networks in human brain.

With the progress of this field, we expect the advent of "clinical mathematical scientists" who can treat and control neurological and psychiatric disorders based on mathematical models of the phenomena of non-linear collective oscillation.

We also expect that our field contributes to psychological and sociological comprehension of human nature with oscillological perspective. Human being do not always make complete rational judgments, but sometimes make irrationalistic decisions, which evoke fluctuation in social and economic activities. Oscillology will clarify associations between human irrationality and a wide range of neuro-oscillation and provide scaffolding to understanding such complex behaviors by the non-linear nature of the human nervous system.

【 Key Words 】 Brain and Nervous System, Soft-Computing, Mathematics for Complex Systems, Neurological and Psychiatric Disorders, Physiology

【Term of Project】 FY2015-2019

【Budget Allocation】 1,149,700 Thousand Yen

【Homepage and Contact Address】

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