Brain mechanisms for the generation of adaptive behaviour (or biological intelligence): from genes, neural networks, and behavior to robots

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After a presentation of the activities at the Research Center for Advanced Science and Technology (RCAST) of The University of Tokyo, some of our research in neuroscience and robotics will be introduced.
The aim of our research is to clarify the basic neural mechanisms for generating adaptive behaviors or biological intelligence acquired through natural selection using the interdisciplinary approaches of informatics, engineering and biology. We have taken combined approaches at various levels, from genes over single neurons to neural networks, behavior, modeling, and robotics, owing to the insects' seamless accessibility to a wide variety of methodological approaches.

One of the most important aspects of our research is the investigations of the neural bases of behaviors. The relatively small size of moth brains combined with a large body of identified neuron data are now being used to attempt rebuilding behaviorally relevant circuits of the moth brain by means of realistic biophysical simulations. So far, we have collected about 1,600 brain neurons' data with 3D morphologies and physiological responses using electrophysiology and genetic engineering techniques. For this research, we have developed

several transgenic silkmoths, some of which were shown by Proc Natl Acad Sci USA in 2013. All the neurons' data have been registered in a neuron database called "Bombyx Neuron Database (BoND)", some of which are open for public through the Invertebrate Brain Platform maintained by Neuroinformatics Japan Center at RIKEN. Using this database system, we have investigated the neural circuits involved in sensory processing to generate locomotor commands for odor (pheromone)-source orientation in the moth. Finally, the pathways from sensory inputs to command outputs in the brain were revealed for the first time at the level of identified neurons. These results were reported in Nature Communications in 2014.

SHORT BIO

Ryohei Kanzaki received his B.S., M.S. and D.Sc. degree in Neurobiology from the Institute of Biological Sciences, University of Tsukuba in 1980, 1983 and 1986, respectively. From 1987 to 1990 he was a postdoctoral research fellow at the Arizona Research Laboratories, Division of Neurobiology, University of Arizona (John Hildebrand and Edmund Arbas laboratory). From 1991 to 2003 he was successively an assistant professor, associate professor, and full professor at the Institute of Biological Sciences, University of Tsukuba. From 2004 to 2006 he was a full professor at Department of Mechano-Informatics, Graduate School of Information Science and Technology, the University of Tokyo. Since 2006 he is a full professor at the Research Center for Advanced Science and Technology (RCAST), the University of Tokyo. Since 2016 he has been a director of RCAST. He was a president of the Japanese Society for Comparative Physiology and Biochemistry (JSCPB) from 2012 to 2015. Ryohei Kanzaki is also contributing greatly to science education of children through children's science and technology development projects by Japan Science and Technology (JST) as chairs of the projects.