LABORATORY OF NEUROPHYSIOLOGY

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Animals respond to the physical and chemical stimuli of their environment. Most higher vertebrates have evolved a highly developed visual system to respond to light. “Why can we see?” This question is a fundamental one for a thorough understanding of these animals, including human beings. In order to more completely understand the sensory systems of animals, we decided to move ahead to research of visual systems this year, though we had been researching the salt-sensing system (~March, 2008). The research objects of our new project were the medaka fish and human beings. Various aspects of their behaviors rely on their visual systems.

Ⅰ. Psychobiological studies of Medaka

One of our major subjects is the psychobiological study of medaka (*Oryzias latipes*). Medaka is a world-wide teleost fish model, as is zebrafish (*Danio rerio*). Important discoveries (including advances in the areas of heredity of body colour and the sex-determning gene) were brought about through developmental studies of medaka. Medaka is not widely used, however, in neurobiological fields, and standardized methods of behavioral phenotyping for medaka have been not established.

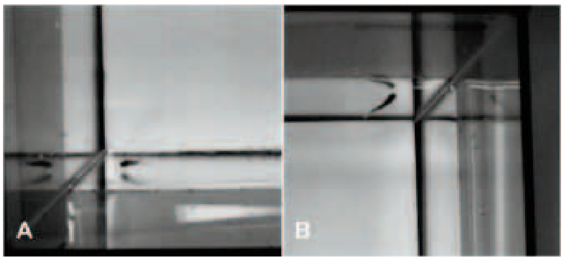

Figure 1. Representative examples of Medaka fish behaviors. A) Diving response. When Medaka fish are transferred to a novel environment, they immediately move to the bottom of the water tank. B) Climbing response. Medaka move to the water surface within several minutes.

The brain structure of medaka meets the minimum requirements for simulating the human brain. For neurobiological or behavioral studies, small teleosts (including medaka) are sometimes more useful than rodents thanks to their simplicity. Presently, zebrafish is more popular as a model animal than medaka. Medaka, however, has unique behavioral characteristics. Medaka can swim backward and hover within water flow by doing so. Moreover, medaka show interesting optomotor responses such as the dorsal light response under microgravity and the maintenance of their relative position to a rotating stripes pattern around them. Medaka, therefore, is a noteworthy model for the study of brain and behavior.

Our first goal is finding the medaka's behavioral characteristics that are applicable to the behavioral phenotyping of mutants and the study of relations between brain and behavior. We are attempting to classify typical normal behaviors of medaka (Figure 1). We are also studying the effects of acute stimulations by psychoactive drugs such as ethanol, nicotine and caffeine on medaka. These attempts will enable us to precisely describe the behaviors of medaka, which will form the basis of our future studies.

Ⅱ. Psychobiological studies of Human

Another of our major subjects is the psychobiological study of human beings (*Homo sapiens*). The visual system of an animal can be correctly understood by comparing two or more animals. Therefore, in our laboratory we address the issue of the human visual system in tandem with that of medaka. Recently, it has become possible to make complex visual stimuli easily by using computers and digital display systems, and the importance of psychophysics is once again beginning to be recognized.

In order to interact successfully with the environment, animals must know the accurate positions of objects in space, though those positions frequently change. Neural processing, however, requires considerable time. By the time a conclusion is reached about location, the moving object has moved on to a new position in the actual world. Does our visual system compensate for this difference?

One recent focus of this debate is the flash-lag effect, in which a moving object is perceived to lead a flashed object when both objects are aligned in the actual physical space (Figure 2). The discoverer Dr. Nijhawan has proposed that the human visual system uses the motion signals to extrapolate the position of a moving object (motion extrapolation hypothesis). The differential latencies hypothesis proposes that the flash-lag effect occurs simply because the visual system responds with a shorter latency to moving objects than to flash stimuli. Besides these major two models, various modified models have been proposed. The problem, however, has not yet been solved, and the debate continues. How does our brain decide the position of the moving object? In the present study, we are making an attempt to correctly interpret the flash-lag effect.

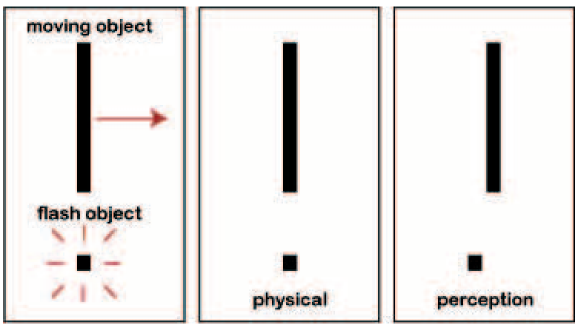

Figure 2. The flash-lag effect. A moving object is perceived to lead in space a flashed object when both objects are aligned in the actual physical space.