LABORATORY OF NEUROPHYSIOLOGY

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In order to interact successfully with the environment, animals must deduce their surroundings based on sensory information. The visual system plays a particularly critical role in such interactions with the environment.

"Why can we see?" This question is fundamental for a thorough understanding of vision-dependent animals, including human beings. In order to better understand the sensory systems of animals, we moved ahead from our previous research of the salt-sensing system to new research on the visual system.

I. Psychophysical study of Medaka fish

One of our major subjects is the psychophysical and computational studies of medaka (*Oryzias latipes*). Medaka have many advantages for behavioral work. First, genetic examination of medaka is progressing at a rapid pace, opening up new approaches to the understanding of genetic control of behavior. Second, although the central nervous system of medaka is relatively simple, its basic structure is the same as that in mammals. Thirdly, they provide invaluable comparative material for work on mammals. Examination of such a relatively simple yet vertebrate system should thus aid in the determination of the basic mechanisms of how genes affect behavior. This year, we have made progress in studies of the prey-predator interaction using medaka and zooplankton.

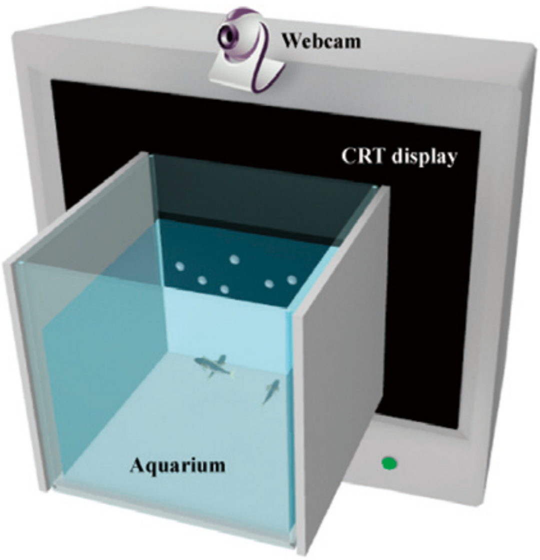

Figure 1. Virtual plankton system. The test aquarium was attached to a CRT display on which virtual plankton were shown. The behaviors of the 3 fish in the test aquarium was recorded by a webcam placed above the test aquarium.

Visual motion cues are one of the most important factors for eliciting animal behavior, including predator-prey interactions in aquatic environments. To understand the elements of motion that cause such selective predation behavior, we used a virtual plankton system (Figure 1) where the predation behavior in response to computer-generated prey was analyzed. First, we performed motion analysis of zooplankton (*Daphnia magna*) to extract mathematical functions for biologically relevant motions of prey. Next, virtual prey models were programmed on a computer and presented to medaka, which served as predatory fish. Medaka exhibited predation behavior against several characteristic virtual plankton movements, particularly against a swimming pattern that could be characterized as pink noise motion. Analyzing prey-predator interactions via pink noise motion will be an interesting research field in the future (Matsunaga and Watanabe, Scientific Reports, *in press*).

II. Psychophysical study of Human vision

Another of our major subjects is the psychophysical and theoretical studies of the visual system of human beings (*Homo sapiens*).

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 (Figure 2), in which a moving object is perceived to lead a flashed object when both objects are aligned in actual physical space. Last year, we proposed a simple conceptual model explaining the flash-lag effect (Delta model, Watanabe *et al*., 2010). This year, we have attempted to expand the model for application to the motor control mechanisms of the brain.

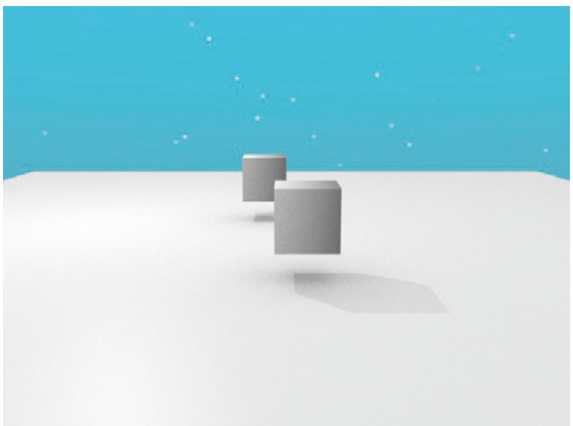

Figure 2. Flash-lag effect. A moving cube is perceived to lead in space a flashed cube when both objects are aligned in actual physical space. This effect has been utilized for understanding human motion perception. This year, we successfully produced a 3D version of the Flash-lag effect using Blender 3D software. Please refer to YouTube (DUBM-GG0gAk).