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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 to research of the visual system, though we had previously been researching the salt-sensing system (~March, 2008).

I. Psychobiological study of medaka fish

One of our major subjects is the psychobiological study of medaka (*Oryzias latipes*). Medaka, as well as zebrafish, have many advantages for behavioral work. First, genetic examination of medaka is progressing at a rapid pace, like that of the mouse, 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; it is composed of the spinal cord, brainstem, cerebellum, and cerebrum. Thirdly, because they are fish, 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.

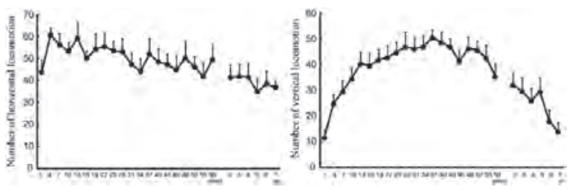

Figure 1. Temporal changes in horizontal (left) and vertical (right) locomotion of medaka fish in an open field in 3-min bins.

This year, we examined the habituation of medaka to a novel environment by measuring long-term temporal changes in locomotion by using open-field apparatus. The open-field test is commonly used in behavioral studies of rodents. However, it has not been used in most behavioral studies of fish. We therefore examined the open-field behavior of medaka as measured by temporal changes in two conventional indices, locomotion and position. Considering the characteristic motility of fish, we focused on vertical as well as horizontal locomotion. In 7-hour as well as 24-hour exposure of fish to the open field, the pattern of temporal changes in vertical locomotion differed from that of horizontal locomotion (Figure 1). During repeated open-field testing over two consecutive days, locomotion on the second day was less than that on the first day. This habituation-like behavior ceased with the addition or deletion of a visual cue on the second day. We also found that males and females differed in temporal patterns of habituation to the open field. These findings clearly show that medaka change their behavior as they become more familiar with a novel location, as observed in ethological studies of other animal species. The open-field test of medaka will thus provide findings of use in elucidating abnormal phenotypes of mutant medaka.

II. Psychophysical study of human vision

Another of our major subjects is the psychophysical study 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, in which a moving object is perceived to lead a flashed object when both objects are aligned in actual physical space. The discoverer of this phenomenon, Dr. Nijhawan, has proposed that the human visual system uses motion signals to extrapolate the position of a moving object. 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 two major 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? We are now making an attempt to correctly interpret the flash-lag effect by developing a novel motion illusion (Kabob illusion, Figure 2).

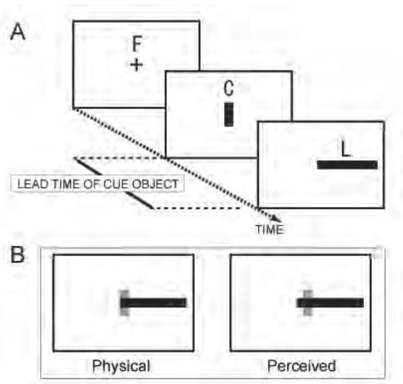

Figure 2. Kabob illusion. A: Sight line of observer is fixed on a central cross (F). A fixed time after the cross disappears, a cue (C) appears in the center. After an appropriate time interval (lead time of cue object), a line (L) is presented. Observer perceives illusory motion from cue side toward the opposite side of the line (line-motion effect). B: When the line-motion effect occurs, a leading cue (gray) is perceived to move along the line (solid).