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. 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 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.

Furthermore, we have made progress in studies of the schooling behaviors of medaka. Many fish species are known to live in groups. Visual cues have been shown to play a crucial role in the formation of shoals (a shoal is defined as social group of fish). Using biological motion stimuli, depicting a moving creature by means of just a few isolated points, we examined for the first time whether physical motion information is involved in the induction of shoaling behavior. To generate biological motion stimuli, medaka were videotaped and then six points were placed along the body trunk using computer software (Figure 1). We found that the presentation of biological motion could prominently induce shoaling behavior. We are now analyzing what aspects of motion (such as movement speed and temporal order) are critical in the induction of shoaling behavior. Motion or behavioural characteristics can be valuable in recognizing animal species, sex, and group members. Studies using biological motion stimuli will enhance our understanding of how non-human animals extract and process the information which is vital for their survival.

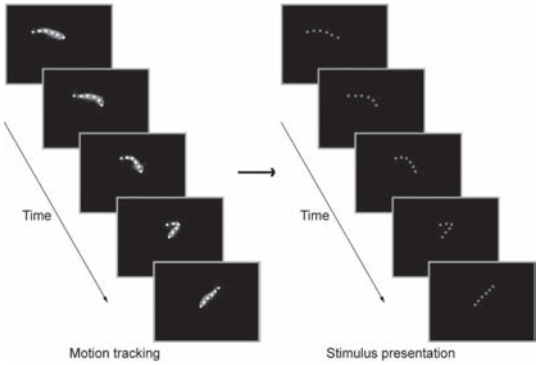

Figure 1. Animation sequence depicting biological motion of medaka. Six points were automatically placed along the body trunk (Motion tracking). Based on the tracking data, the movements of medaka were expressed as those of six gray dots (Stimulus presentation).

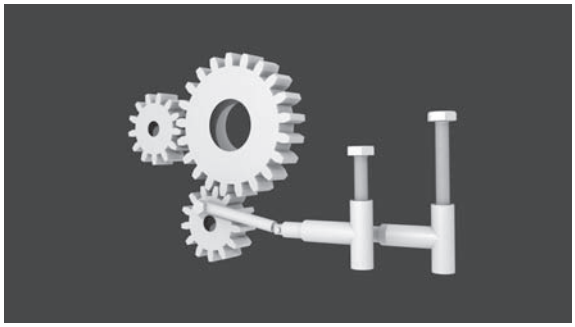

Figure 2. Sample video of Flash-lag effect. This year, we successfully produced a new version of the 3D Flash-lag effect using Blender 3D software. Please refer to YouTube (http://youtu.be/X8RiaNUFIaU).

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*). 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 (Figure 2). This effect has been utilized for understanding human motion perception. We developed a simple conceptual model explaining the flash-lag effect (Delta model, Watanabe *et al*., 2010).

Publication List

〔Original paper〕

● Matsunaga, W., and, Watanabe, E. (2012). Visual motion with pink noise induces predation behaviour, Scientific Reports, *2*, 219.