LABORATORY OF NEUROPHYSIOLOGY

Associate Professor
WATANABE, Eiji

NIBB Research Fellow: *NAKAYASU, Tomohiro*
Visiting Scientist: *AONO, Sachiko*

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 visual system of animals, we are researching animal behaviors through psychophysical and computational methods.

I. Psychophysical study of Medaka fish

One of our major subjects is the psychophysical and computational study of medaka (*Oryzias latipes*). 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 (Matsunaga & Watanabe, 2012).

This year, we have made progress in studies of the schooling behaviors of medaka (Figure 1). 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. We found that the presentation of biological motion could prominently induce shoaling behavior. We have shown what aspects of motion (such as movement speed and temporal order) are critical in the induction of shoaling behavior (Nakayasu & Watanabe, 2013). Motion or behavioral 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. Shoal of Medaka fish (*Oryzias latipes*).

II. Psychophysical study of Human vision

Another of our major subjects is the psychophysical and theoretical studies of the visual illusions 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. 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). This year, we have made progress in studies of novel visual illusion, shelf-shadow illusion (Figure 2).

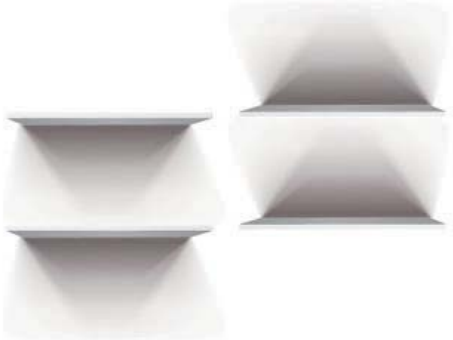

Figure 2. Shelf-Shadow Illusion. Upward shadows look darker than downward shadows. Third award of The 5th Illusion Contest in Japan.

Publication List

〔Original paper〕

● Hiyama, T.Y., Yoshida, M., Matsumoto, M., Suzuki, R., Matsuda, T., Watanabe, E., and Noda, M. (2013). Endothelin-3 expression in the subfornical organ enhances the sensitivity of Na_x, the brain sodium-level sensor, to suppress salt intake. Cell Metabolism *17*, 507-519.

〔Original paper (E-publication ahead of print)〕

● Nakayasu, T., and Watanabe, E. Biological motion stimuli are attractive to medaka fish. Animal Cognition 2013 Oct. 20.