タコ類における視覚・触覚間クロスモーダル認知に関する行動学的研究

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A behavioral study on cross-modal recognition between visual and tactile senses of octopus

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[Abstract]

Octopuses, a member of molluscan class, possess well-developed nervous system such as lens eyes that is anatomically similar to our own, and the relative proportion of brain to body is equivalent to vertebrates. Octopuses are also characterized with their highly sensitive muscular sensory receptors, namely, suckers on their arms. Due to this biological uniqueness, octopuses have been a target for psychological studies and were reported for their advanced abilities for learning and memory, which are achieved via visual and tactile perceptions. Most of these findings have come from experiments that tested single sensory perception (*i.e.*, vison or tactile). On the other hand, in our previous research about learning ability of tropical octopus, I observed an interesting feature of an Algae octopus. When octopuses faced with an object on a computer screen (visual stimulus), they needed additional period to learn a virtual specific image on a computer screen compared with the period to learn a real specific object (visuo-tactile stimulus). This finding tentatively suggests that the task concerning the image present on the computer screen was more difficult than the same task with a real object, and that an octopus might perceive an object via both visual and tactile senses in order to build the image of the specific object within their brain. Based on this background, I focused on the multiple senses of visual and tactile in tropical octopuses. I investigated the existence of cross-modal cognition in Plain-body octopus (Fig. 1) in the context of how the octopuses are using visual and tactile information when it learn, judge, and explore new and known targets. For this purpose, I conducted behavioral tests using classical learning experiments such as conditioning task and learning transfer task as well as creative methods utilizing innate behaviors such as octopus hunting and exploration. These experiments revealed that there are interactions between visual and tactile information in the plain-body octopus (Fig. 2), and the characteristics of their cognitive behavior associated with this phenomenon such as dynamic sensory weighting (Fig. 3). The confirmation of cross-modal cognition in the octopus, which has a completely different neural and behavioral characteristics from those of many other organisms that have been shown to have cross-modal cognition, will provide important insights into the origins of cross-modal cognition in the whole organism.

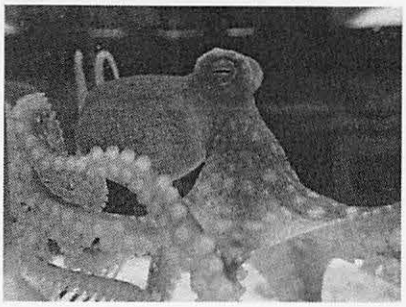

Fig. 1. Plain-body octopus (*Callistoctopus aspilosomatis*).

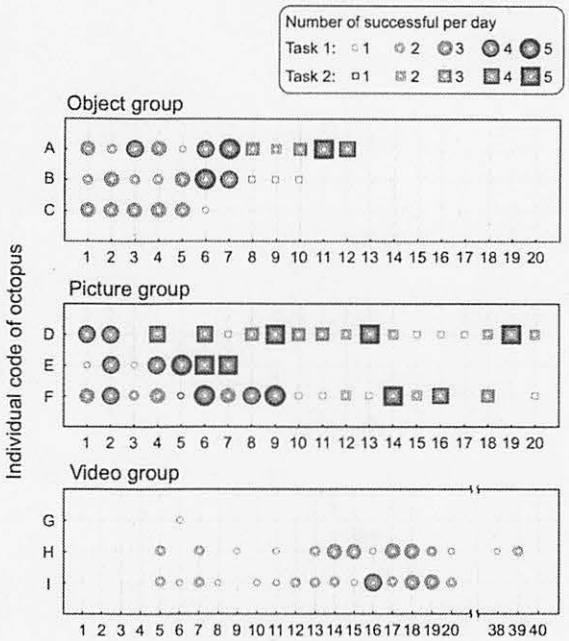

Fig. 2. Octopuses in the object group and the picture group learned about a specific object via both sight and touch. Furthermore, once octopuses have learned to recognize a specific object, they can visually recognize the object again despite a lack of tactile information. In contrast, octopus in video group never succeeded the task only by sight.

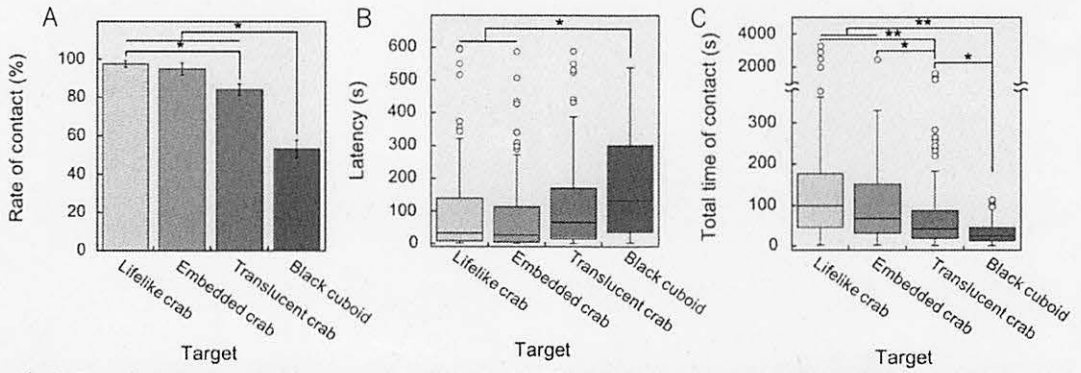

Fig. 3. Experimenter presented four types of models the Lifelike crab (similar to a crab in color and form), the Embedded crab (similar to a crab in color and form but embedded in a transparent cuboid), the Trans- lucent crab (similar to a crab in form but colorless), and the Black cuboid (a control) 20 times each to six plain-body octopus. (A) Mean rates of contact for models. (B) The latency (the time from the point at which the experimenter presented the model to an octopus, to the point at which the octopus contacted the model) of octopuses for the four types of models. (C) The total time of contact (the sum of the duration spent by an octopus in contact with a model within a single presentation) by an octopus for the four types of models. (Steel-Dwass' test, $*P < 0.05$, $**P < 0.01$).

Author's Publication List

1. Kawashima, S., Yasumuro, H., & Ikeda, Y. (2021). Plain-Body Octopus's (*Callistoctopus aspilosomatis*) Learning about Objects via Both Visual and Tactile Sensory Inputs: A Pilot Study. Zoological Science, 38(5), 383-396, DOI: 10.2108/zs210034
2. Kawashima, S., & Ikeda, Y. (2021). Evaluation of Visual and Tactile Perception by Plain-Body Octopus (*Callistoctopus aspilosomatis*) of Prey-Like Objects. Zoological Science, 38(6), 495-505, DOI: 10.2108/zs210037