ACTIVITIES OF DESCENDING NEURONS OBSERVED DURING CRICKET WALKING

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Descending neural pathways that carry an efference copy signal of walking were investigated in crickets to verify our hypothesis that this signal is essential for behavioral compensation after unilateral cercal ablation. Neural activities were recorded from connectives of a tethered-walking cricket by an extraceller recording. During the cricket walking, rhythmical bursts of descending neurons were observed. Previous studies have shown that the walking velocity was encoded into the burst frequency of descending neurons and the turning angle was encoded into the difference between the burst numbers of the neurons running in the right and left connectives. In the present study, every cricket motion before and a after the start of walking and the CRT of an oscilloscope that displaying the signals recorded from descending neurons were simultaneously recorded on a video tape to clarify the relationship between the timing of onset of neural bursts and the start of body motion. In every case, the bursts of descending neurons preceded to any motion of the body. This result strongly suggests that the bursts of descending neurons are not caused by a self-stimulation during walking.

AIR CURRENT SENSORY SYSTEM IN TWO CRICKET SPECIES

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For the first step to explore whether there are any differences in the function of cercus-to-GI system and wind-evoked escape behavior between two different cricket species, morphology of cerci and cercal filiform hairs were investigated in *Gryllodes sigillatus* and *Gryllus bimaculatus*. Although the averaged body size of *G. sigillatus* was smaller than that of *G. bimaculatus, G. sigillatus* possessed larger cerci and longer cercal filiform hairs than *G. bimaculatus*. As it has been reported that the size of a cuticular structure of a mechanoreceptor hair is closely related to its mechanical properties, the cercal sensory system of the two species were supposed to show different sensitivity to an air current stimulus. In order to explore this, physiological properties of giant interneurons (GIs) in *G. sigillatus* were investigated by an intracellular recording. Most GIs in *G. sigillatus* showed lower velocity thresholds and larger response magnitudes to a unidirectional air current stimulus than those observed in *G. bimaculatus*. It was also revealed that the two cricket species employed different strategy in their wind-evoked escape behavior.

EFFECT OF POPULATION DENSITY ON CHEMOTACTIC RESPONSE IN THE NEMATODE *CAENORHABDITIS ELEGANS*

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Chemotactic response magnitude of the nematode *Caenorhabditis elegans* to chemical attractant correlates negatively with population density on the assay plate, suggesting that the attraction to chemicals of the nematode is inhibited by an increase in the number of animals in the attractant area. In order to confirm the effect of pheromone on chemotaxis, the chemotactic behaviors of wild-type N2 animals and daf-22 mutants, which were defective pheromone production, in response to water-soluble sodium chloride and odorant diacetyl were investigated at various population densities. In N2 animals, the chemotaxis indices at 90 min of assay for low populations (approximately 30 animals on the plate) were significantly higher than those for high populations (approximately 100 animals on the plate) regardless of attractants. In daf-22 mutants, there was no significant difference in the chemotaxis indices for these attractants between the low and high population groups, and the time courses of the chemotaxis indices of both population groups were almost the same. These results suggest that the nematode detects an increase in the number of animals by an increase in concentration of pheromone.

THE CHARACTERISTIC OF PERIODICAL DISTRIBUTION OF TECTAL OUTPUT NEURONS CONTROLLING PREY ORIENTING BEHAVIOR OF THE FROG

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We examined spatial distribution of tectal efferent neurons related to prey orienting behavior in the frog, *Rana catesbeiana*. Horseradish peroxidase or neurobiotin was injected as retrograde tracer into the nucleus of the medial longitudinal fasciculus and the anterodorsal nucleus in vivo or in vitro preparations. Tangential sections of rostral, middle, and caudal tectal region were cut at 40μm with a cryostat. The sections were incubated in the AB-HRP complex, processed by the method of Adams, and counterstained. Spatial autocorrelogram was computed to examine the regularity of the distribution of labeled cells. The results showed that 1) the labeled output neurons are classified into two groups (type A and B) based on their cell body size, 2) in each group, cell bodies cluster together in some sections and stand alone in others, however, all of the cell bodies show characteristic periodical distribution, 3) periodical distribution of type A neurons shows the same interval throughout the tectum, while that of type B neurons shows the region-specific intervals. We discuss the functional organization of prey orienting behavior of the frog based on these experimental results.

HIGHER AUDITORY AREAS IN THE BRAIN OF BUDGERIGARS (*MELOPSITTACUS UNDULATUS*): ZENK IMMUNOREACTIVITY IN THE ANTERIOR TELENCEPHALON

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The higher auditory areas such as NCM (caudal medial nidopallium) in the posterior telencephalon are associated with perception of male song in female songbirds and parrots. In songbirds, auditory information which is conveyed from NCM to brain nuclei in the so-called "song system" is thought to be necessary for "song perception" and/or "song learning". In the budgerigar, a parrot species, NCM is reported to have an indirect connection with nuclei in the "song system". On the other hand, another higher auditory areas such as NF (frontal nidopallium) in the anterior telencephalon have direct connection with a nucleus in the "song system", NLC (central nucleus of the lateral nidopallium), suggesting that those areas have more of a role for song perception. We, therefore, used immunocytochemistry for the protein product of the immediate-early gene *ZENK* (Zenk) to investigate the role of NF for song perception in female budgerigars. There was no significant difference between song stimulus and control silent groups in Zenk immunoreactivity in NF. These results suggest that the NCM in the posterior higher auditory areas is more important for the perception of song in female budgerigars.

ROLE OF NO/cGMP SIGNALING IN A SWITCHING MECHANISM OF PHEROMONE BEHAVIOR IN THE CRICKET

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Male cuticular pheromones evoke fighting behavior in male crickets. The dominant crickets (winner of fighting) started aggressive song threateningly after they beat other male crickets. The indominant crickets on the other hand had aversion to fight again against the dominant crickets. Beaten experience was retained as a short term memory in the cricket. When the interval of twice sequential fighting was more than 1hr, the beaten crickets showed the aggressive again, but most indominant crickets would not fight again if the interval was less than 30 min. Here we investigated how NO/cGMP signaling mediates the behavior of indominant crickets by examining the effects of head-injection of NOS inhibitor L-NAME and SGC inhibitor ODQ on the avoidance behavior. The agents were head-injected 15min before the initial fighting. The indominant animals that were injected L-NAME or ODQ did not show avoidance behavior during the reengagement but aggressive again. These results suggested that NO/cGMP signaling regulated cuticular pheromone learning and short-term memory, which might be important factor of switching mechanism of neuronal circuits for the adaptive behaviors.

CLASSICAL CONDITIONING OF ACTIVITIES OF SALIVARY NEURONS IN COCKROACHES

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Secretion of saliva to aid swallowing and digestion is a basic physiological function found in many vertebrates and invertebrates. In mammals, classical conditioning of salivation has been extensively studied since Pavlov reported in dogs a century ago. However, conditioning of salivation has not been reported in any non-mammalian species. In insects, salivation is regulated by salivary neurons in the subesophageal ganglion. We found that salivary neurons of the cockroach *Periplaneta americana* exhibited a prominent response to sucrose solution applied to the mouth and a weak response to odors applied to an antenna. We also found that after five sets of differential conditioning trials in which an odor was presented before the presentation of sucrose solution and another odor was presented alone, the response of salivary neurons to sucrose-associated odor significantly increased but that to non-associated odor was unchanged. Backward pairing trials in which an odor was presented after the presentation of sucrose solution was not effective to achieve conditioning. The results suggest classical conditioning of salivation in the cockroach, for the first time in non-mammalian species.