hippocampal CA1 region which regulates spatial memory. Spine is a postsynapse. We observed a significant decrease in the spine density by going from young rat (3 month old, ~20 years in human) to aged rat (24 month, ~70 years in human). The density of spine as well as the head diameter are analyzed with Spiso-3D software (mathematical and automated software developed by Bioinformatics Project of our group, now commercially available). Spine morphology is classified into three categories according to the head diameter; (1) small-head spine (0.2-0.4 μm) (2) middle-head spine (0.4-0.5 μm) (3) large-head spine (0.5-1.0 μm). In aged rats, dendrites had significantly less spines (1.7 spines/ μm) than young rat (2.3 spines/ μm). The density of large-head spine and middle-head spine was significantly decreased in aged rats. From many studies, surprisingly, the number of neurons is not decreased and the dendritic atrophy does not occur upon aging in the hippocampus. Therefore, the observed decrease in spine density may be essential for loss of memory capacity. It is well known that sex-hormone replacement therapy rescues memory loss in humans, rats and mice, probably by restoration of synaptic density. Therefore, we have been investigation a correlation between the decrease in spine density and reduction of sex hormone levels in aged rat hippocampus (not only in blood circulation), using mass spectrometric determination.

3PT218 オプトジェネティクスを用いた光によるウィスカへの触覚刺激 Whisker photostimulation induces spike and LFP responses in barrel cortex of ChR2 transgenic rat

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In one of thyl.2-channelrhodopsin 2 (ChR2)-Venus transgenic rat lines, W-TChR2V4, the ChR2-Venus conjugate was expressed exclusively in the mechanoreceptive, not in the nociceptive subpopulation of trigeminal ganglion neurons (Ji et al., poster of the 35th annual meeting of the Japan Neuroscience Society). As the sensory nerve endings are densely innervating each whisker follicle, its photostimulation is well expected to induce a whisker-related sensory perception.

The rats were anesthetized with urethane (1.2g/kg body weight). All whiskers of right side were trimmed to photo-stimulate the trigeminal nerve endings innervating the hair follicles. For extracellular recording, a 1.4-mm diameter craniotomy was performed over the barrel cortex of left hemisphere. Glass electrodes filled with 0.5M Na acetate were inserted into the cortex through an opening of the dura. Right whisker pad was illuminated broadly with a 50ms light pulse of blue LED.

We found that the whisker photostimulation could induce the spike and LFP responses of neurons in somatosensory barrel field. It is suggested that the whisker photostimulation could activate the whisker-barrel cortex pathway of mechanoreceptive signaling. The optogenetic actuation of the whisker mechanoreception would facilitate detailed studies of the rodents' whisker-barrel sensory system.

All animal procedures were conducted in accordance with the guiding principles of Physiological Society of Japan and NIH.

3PT219 軟体動物ナメクジの嗅覚中枢における長期活動ダイナミクス Dynamics of long-term activities of the olfactory center in the land slug

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Spontaneous oscillation of activity in olfactory system is commonly observed in various species and is thought to be important for odor-information processing. However, the functions of the oscillatory activity are not well understood. The land slug *Limax valentianus* has a highly developed olfactory center, the procerebrum (PC), which exhibits oscillation of local field potential (LFP) at about 1 Hz. Because the application of conditioned odor changes the frequency of the LFP oscillation in slug PC, odor information is thought to be represented as the temporal pattern of the oscillation. Here, we investigated the statistical property of spontaneous oscillation in the PC over an extended timescale. To analyze the autocorrelation of the time series of interspike intervals, we performed a detrended fluctuation analysis (DFA), which is a scaling analysis technique used to provide a quantitative parameter (scaling exponent, α). We found that the fluctuation of spike timing of the PC possessed a long-term correlation and can be characterized as $1/f$ noise at timescales larger than 10^2 spikes ($\alpha \sim 1.10$). Furthermore, to investigate the contribution of innervations to spontaneous oscillation, we measured the LFP following the tentacle

amputation. In the scaling region for small n ($n < 10^2$ spikes), the scaling exponent α decreased from 0.73 to 0.58, indicating that the fluctuations of spike timings are uncorrelated under this experimental condition. These results suggest that the innervations to PC maintain the intrinsic dynamics.

3PT220 ヨーロッパモノアラガイの中枢神経系における神経活動の膜電位イメージング

Fluorescent Voltage Imaging of the Neural Activities in the Central Nervous System of the Pond Snail

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The brain or ganglia forms a complex network composed of so many neurons which communicate with one another. We have found that a regulatory neuron (cerebral giant cell; CGC), which is involved in feeding responses, in the cerebral ganglion of the pond snail *Lymnaea stagnalis* shows regular beating, regular bursting and irregular bursting discharges depending on the d.c. current through the cell membrane. In the present study, we examined how the activities of CGC affect the neural activities of the buccal ganglion by using fluorescent voltage imaging technique. After the central nervous system was isolated from the body, it was stained with a voltage-sensitive dye, Di-4-ANEPPS. The stained preparation was illuminated by a LED (530 nm; LEX2-G, Brain Vision), and the 705 nm fluorescent images were acquired through a CCD camera (iXon X3 897, Andor or ORCA-Flash 4.0, Hamamatsu Photonics). The activities of CGC were measured simultaneously by intracellular recording using a glass electrode. The d.c. current was injected into CGC through the electrode to control the activities. The fluorescent images showed that some neurons in the buccal ganglion fired coherently, and the firing patterns were affected by the discharge of CGC.

3PT221 マウス海馬スライスのCA1領域における様々な時空間活動パターンのレーザー共焦点イメージング

Laser confocal imaging of various spatiotemporal activity patterns in the CA1 region of mouse hippocampal slices

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The brain forms a complex network composed of so many neurons which communicate with one another. In addition, even a single neuron shows very complex activities, and some neurons spontaneously fire due to nonlinear characteristics. Recently, Ikegaya et al. have developed functional multineuron calcium imaging which enables us to access brain function with single-neuron resolution. In the present study, we observed spatiotemporal activity patterns in the CA1 region of mouse hippocampal slices by a similar technique. The slices (350 μm) were prepared from 1-week-old male ddY mouse. The slice preparation was stained with a Ca^{2+} -sensitive dye, Oregon green. The stained slice was illuminated by an Ar laser (488 nm; 532-BS-A04, Melles Griot), and the 520 nm fluorescence images were acquired through a Nipkow confocal unit (CSU-10, Yokogawa) and a CCD camera (iXon X3 897, Andor). As a result, some dozens of neurons fired incoherently in some slices, while they exhibited a completely coherent activity pattern in other slices. The coherent pattern occurred more frequently under the existence of penicillin and a higher K^+ concentration which are often used to induce the epilepsy-like state. Interestingly, we also observed the irregular switching between the coherent and incoherent activity patterns in other slices. This phenomenon may be explained by the dynamics of itinerancy among quasi-stable states reported in some neural network models.

3PT222 QM/MM 法による同化型亜硝酸還元酵素の反応機構についての理論的研究

A QM/MM study on the reaction mechanism of assimilatory nitrite reductase

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Assimilatory nitrite reductase (aNiR) catalyzes a multi-electron reduction reaction of nitrite to ammonia, which is a fundamental process for the biological synthesis of