SUMMARY OF Ph.D. DISSERTATION

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Title

A Study of the Voltage Sensitive Optical Recording System for Revealing the Learning and Memory Mechanism of the Brain

A characteristic feature of the brain compared to various artificial computers is its flexibility of learning and memory. It is expected that a new information processing architecture will be found by exploring the mechanism of learning and memory of the brain. The voltage sensitive optical recording (VSOR) method is a novel method for recording from many neurons simultaneously. Thus it opens a way to reveal collaborated activities of a group of neurons from a spatial aspect.

In this study, the stimulation and acquisition control system and the analysis software for the VSOR method were developed. By using them, two physiological experiments to study the mechanism of learning and memory were carried.

The first experiment is to investigate the characteristics of the hippocampocortical system, which is considered as the essential system for declarative memory. In the experiment, the sound evoked responses in the auditory cortex were recorded by VSOR method. Stimulation of the CA1 region in the hippocampus at the same timing of the sound stimulus caused either excitatory or inhibitory effect to the auditory cortical response by the hippocampal stimulation intensity dependent manner. This result showed that the hippocampus can modulate the auditory cortical activity in various ways. It is suggested that this ability of hippocampus is a basis for long term memory consolidation.

The second experiment aims to observe the plastic changes in the cerebral cortex induced by classical conditioning. In this experiment, classical conditioning of sound and electrical shock was used, and both pair conditioned and pseudoconditioned group were prepared. The result showed that, after conditioning, the response area was increased only for the conditioned frequency sound in the pair conditioned group. This is the evidence that a tonotopical map in the auditory cortex can be dynamically modified within a few hours.

From these results, it is concluded that the stimulation and acquisition system and the analysis software are useful for actual physiological experiments using the VSOR method, especially for a study of the learning and memory mechanism in the brain.