Neuronal Signals Related to Degree of Reward Expectancy in Anterior Cingulate

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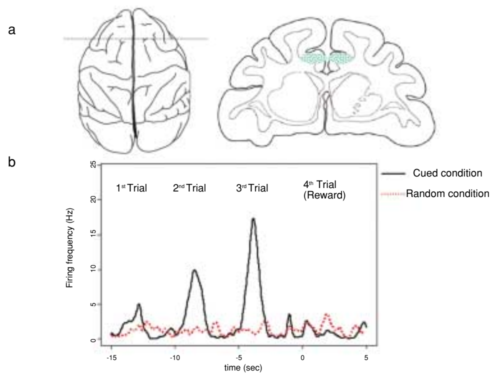
In our daily life, we make plans and act based on the motivation to reach a goal. During the course of the activity, we continually compare our current status against our expectation for reaching a goal, with expectation increasing over the course of the activity. This implies that there are neural signals underlying the increasing expectation.

We developed a task—a cued multitrial reward schedule task—to control level of motivation and investigate the degree of reward expectancy. In this task, monkeys can obtain rewards only after a series of trials had been correctly completed. When there was a cue to indicate how many correct performances were required for a reward, the monkeys made progressively fewer errors as the rewarded trial approached, indicating that the monkeys expectancy of an impending reward grew. For several reasons we hypothesized that the anterior cingulate of the medial frontal lobe (Fig. a) is a promising site for neuronal signals related to the degree of reward expectancy. We recorded single neuronal activity from the anterior cingulate while the monkey was performing the schedule task and discovered that the single neurons showed responses that were progressively increasing through the schedules as the reward expectancy increased (Fig. b, black line). Furthermore, the ordered neuronal response disappeared when the cue sequence was given at random so that the monkeys could not know how close their rewards were (Fig. b, red dotted line).

The knowledge gained through the research should contribute to uncovering the information processing in the brain relating to human motivation and plan-making. It should also lead to the understanding and improvement of the symptoms of those with obsessive-compulsive disorder and drug abuse, conditions characterized by the disturbances in motivation and reward expectancy.

A report of this research appeared in the May 31 issue of the *Science*.



a. Brain map of Rhesus monkey. Left: Dorsal view of whole brain. Right: Frontal section at the line indicated in the left fig. The area of anterior cingulate from which recording was done is shown by green shading.
b. Example of neuronal responses in the anterior cingulate when 4 correct trials were necessary to obtain rewards. black line: spike density plot of neuronal activity when there was a cue to indicate the proximity to the reward. red dotted line: spike density plot of the neuronal activity when the cue sequence was randomized.

Active Enzymes at Around 100ºC

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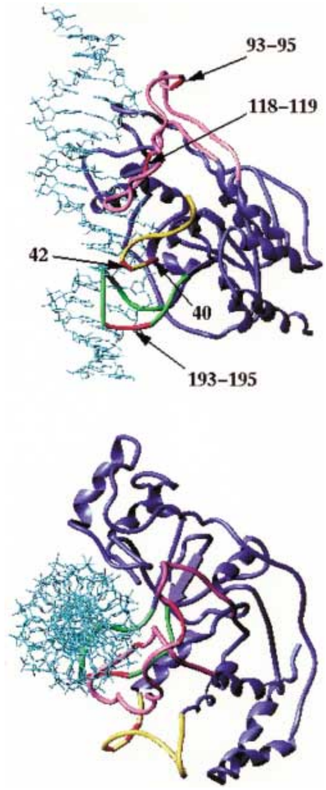
A hyperthermophilic archaeon *Pyrococcus horikoshii* was isolated from a hydrothermal vent in the Okinawa trough in the Pacific Ocean. It optimally grows at around 100ºC. The hyperthermophiles were expected to be good producers of thermostable enzymes active at around 100 ºC. The thermostable enzymes have considerable industrial potential by giving better yields under extreme operational conditions, since the enzymes show not only great stability but also enhanced activity in the presence of common protein denaturants such as heat, detergents, organic solvents, and proteolytic enzymes.

Moreover, hyperthermophilic archaea are

considered to be the prototype of eukaryote. Their DNA replication systems seem to be more simplified and stabilized, compared with the eukaryotic systems. Since the thermostable proteins are more suitable for the structure analysis due to their easy crystal formation than the mesophilic counterparts from eukaryote, the structural information will greatly contribute to comprehend the molecular mechanisms of DNA replication and repair systems effectively working in eukaryotic cells. The thermostable proteins involving DNA replication and repair are also useful as biological tools to develop new biotechnology.

Flap endonuclease-1 (FEN-1) has important roles in DNA replication, repair, and recombination. FEN-1 has dual activities such as 5' flap endonuclease and 5'-3' exonuclease. We have already reported the substrate specificity of FEN-1 from *P. horikoshii* (phFEN-1). Recently we succeeded to solve the molecular structure of a mutant phFEN-1 to a resolution of 3.1 Å. According to the molecular structure, 45 different mutants on one large loop and four small loops of phFEN-1 molecule were constructed and investigated their functions. Consequently, the substrate recognition mechanism of the molecule was elucidated in details as shown in Fig. 1. The facts will largely contribute to the structure/ function analysis of eukaryotic FEN-1s involving human counterpart.



The modeled complex of phFEN-1 with DNA. (A) The small loops 1 and 2, and the large loops are colored yellow, green, and pink, respectively. The numbers indicate the major DNA binding sites on the loops. DNA is colored light blue. (B) The side view of (A).

Information and Communication Technology

A Tele-operated Humanoid Robot Drives a Lift Truck!

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New abilities of humanoid robot to realize proxy drives of a construction machine are developed. We use the tele-operated humanoid robot HRP-1S developed in Humanoid Robotics Project of METI of Japan. The proxy driving of an electric lift truck by HRP-1S was demonstrated at ROBODEX2002 as shown in the figure. It shows us that a humanoid robot can expand its capability by using machines designed for the human. The use of a tele-operated humanoid robot has a possibility to make all machines tele-operated without any modifications and do also incidental tasks instead of the human.

Teleoperated humanoid robot drives a lift truck