【学位論文内容の要約】

Dissertation abstract

Superior neuronal detection of snakes and conspecific faces in the macaque medial prefrontal cortex

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〔**Objective**〕

Primates devote considerable attention to snakes and conspecific faces, and the medial prefrontal cortex (mPFC) has been implicated in attentional allocation to biologically relevant stimuli. Recent neurophysiological studies investigations that monkey pulvinar neurons respond more quickly and more strongly to snakes and faces than to other stimuli. The pulvinar is a visual structure in the subcortical visual system that also includes the superior colliculus and amygdala. This visual system has been implicated in fast and coarse visual processing, and it appears to be particularly sensitive to snakes and emotional faces. The medial pulvinar and amygdala send robust inputs to the medial prefrontal cortex. Human fMRI studies support this prediction by showing increased activity in the mPFC in response to a virtual predator, live snakes, and emotional faces. However, it is not known whether snakes and emotional faces hold an elevated position in the mPFC or whether other predators, for instance, also generate strong responses. We tested the predictions that snakes and emotional faces are particularly salient visual stimuli for primates by conducting single-cell recordings of mPFC neurons in Japanese macaques (*M. fuscata*) in response to photographs of snakes, raptors, and mammalian carnivores, and photographs of neutral and emotional faces of monkeys and humans in a delayed non-matching to sample (DNMS) task.

〔**Methods**〕

We used two adults (1 female and 1 male) macaque monkey. Monkeys were trained to perform a delayed non-matching to sample (DNMS) task which monkeys were required to discriminate 8 categories of visual stimuli (snakes, monkey faces, human faces, raptors, carnivores, non-predators, monkey hands, and simple geometrical patterns). All of stimuli were adjusted to be the same luminance [(luminous intensity) ranged from 38.432 to 41.248 mcd] and the size of the stimulus area was 5-7 × 5-7°. While monkeys performed the DNMS task, a glass-insulated tungsten microelectrode (0.8-1.51.5 MΩ at 1kHz) was stereotaxically inserted into the mPFC. Activities of mPFC neurons were recorded and then were isolated into single neurons for further analyses.

We also analyze responses of mPFC neuron to the scrambled and filtered [low pass filter (LPF) with 6 cycles/image and high pass filter (HPF) with 20 cycles/image] stimuli that elicited strongest responses among the 8 categories.

For stereotaxic localization of the mPFC neurons, a tungsten marker was inserted near the target area and MRI scans of the monkey brain were taken. After the last recording session, tungsten

markers were implanted near the target area under anesthesia. The brains were perfused, fixed with formalin solution, removed from the skulls, and cut into 120-μm sections containing the mPFC. The sections were stained with Cresyl violet, and the location of each recording sites were then determined by comparing the stereotaxic coordinates of recording sites with those of maker positions.

〔**Results**〕

Of 538 mPFC neurons recorded, 215 were tested with all 32 visual stimuli. Of these 215, 93 neurons responded to one or more stimuli. The responses to snakes and monkey faces were unique. First, the ratios of neurons that responded best to snakes and monkey faces were larger than those of neurons that responded best to other categories. Second, mean response latencies were faster to snakes and monkey faces than to other stimuli. Third, population activity of the mPFC neurons discriminated snakes within 100 ms latency. These responses were dependent on low-frequency images; HPF of the visual stimuli decreased neuronal responses but LPF did not. Furthermore, emotion significantly affected responses of the mPFC neurons; responses to emotional faces were larger and faster than those to neutral faces. In the present study, snake and monkey faces-best neurons were concentrated in the ventral part of the mPFC that roughly corresponds to the pregenual and subgenual parts of the anterior cingulate cortex.

〔**Conclusions**〕

The present results indicated that the mPFC neurons responded preferentially to snakes and emotional monkey faces compared to other predators, non-predators, neutral faces, and other visual stimuli. These neurons were mainly located in the pregenual and subgenual parts of the anterior cingulate cortex. Predation by snakes (the Snake Detection Theory) and primate sociality (the Social Brain hypothesis) are suggested to be important selective forces in brain evolution. Our findings suggest that these selective forces might have been important in shaping the response characteristics of mPFC neurons.