別紙２

Results report

１． Title of Research and Development： The influence of feature salience over microsaccades in normal and blindsight humans and monkeys: an experimental and theoretical investigation

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４． Results of Research and Development:

Microsaccades are tiny saccadic eye movements that take place during periods of gaze fixation. Even though the detailed mechanisms for microsaccade generation, as well as their functional role in vision, are not fully understood, recent research has revealed that these eye movements can act as an important proxy for larger saccades in understanding several aspects of perception and cognition. One such aspect concerns the relationship between selective visual attention and eye movements, in which it was shown that microsaccades, in contrast to their classic description as random and spontaneous, are related to attention. The neural mechanisms for such a relationship are not fully understood, and its characteristics in pathological states of vision are completely unexplored. The purpose of the proposed research is to understand how feature salience that is commonly included in models of selective visual attention can influence microsaccades.

1. Animal experiments

Monkeys were trained to make a fixation to a spot on a display. By using retinal stabilization, we examined how a peripheral cue affects microsaccades. We also tested with a free-viewing experiment in which normal monkeys and monkeys with lesion in V1 or the superior temporal gyrus viewed movie clips. We found that the number of saccades toward the affected hemifield was reduced in the V1-lesioned monkeys.

2. Human experiments

Subjects with normal vision participated in a Posner task in which a pre-cue is presented and a saccadic target appeared immediately after that. When the time difference between the cue and the saccadic target was varied, the saccadic reaction time was modified (inhibition-of-return (IOR) effect). We analyzed microsaccades during the trials and found evidence that the rhythmic process under microsaccade generation can explain the IOR effect.

In a free viewing task, one subject with a damage in V1 and six control subjects participated in the experiment. We measured eye movements during the free-viewing task and a fixation task with the same movie clip and found that the direction of microsaccades during the fixation task is anti-correlated with the direction of saccades during the free-viewing task.

3. Neural network model

We constructed computational models of the superior colliculus based on a neural-field model and a spiking-neuron network model. We found that the models worked as a saliency detector and are able to replicate the effect of saliency on microsaccades (published in Frontier is Systems Neuroscience 2016). Based on these finding, we constructed a model about neural network of saliency computation and proposed the model in a reviw paper submitted to the theme issue "Auditory and Visual Scene Analysis" of Philosophical Transactions B.