別紙４－１（課程博士（英文））

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Department of Computer Science and Engineering	Student ID Number	D153335	Supervisors	Tetsuto Minami
Applicant's name	Fumiaki Sato			Shigeki Nakauchi

Abstract (Doctor)

Title of Thesis	Subjective perception of ambiguous figures: Evidence from pupillometry and electroencephalography

Approx. 800 words

Our visual system receives two-dimensional information from each image on the retina. From these two-dimensional images, vision of the three-dimensional shape of the object is restored, sometimes resolving ambiguities in the visual input in an automatic and unconscious manner. In addition, human subjective visual perception is generally stable and uniquely determined. To uniquely determine perception, the brain defines and solves constraints. Since its constraints may vary from person to person, even if they see similar object, there is a possibility that different appearances occur for the individual. In the present situation, all judgments rely on subjective introspection to comprehend which appearance is seen. Today, as a global society, it is important to prevent discrepancies or misunderstandings in processing information, and seeking an index of how much can be perceived object identically is worthwhile regardless of the person seeing it. However, the technique to quantify subjective perception has not yet been established, and it is difficult to determine the index. Therefore, the quantification of subjective perception is required. In this thesis, to quantify subjective perception, I focused on the phenomenon of perceptional rivalry, primarily upon conducting three studies.

First, to clarify the relationship between attentional state and the pupil diameter during participant observed bistable figure, I performed the measurement of Steady State Visual evoked potentials (SSVEP) and the pupil diameter simultaneously. Rotating sphere stimuli composed of flickering black and white dots for tracking pupillary change, as the presentation stimulus. Resultantly, a significant difference was found in the SSVEP amplitude during left-right rotated perception. In addition, a change in pupil diameter seems to be a shift of attention target before observer response of perceptual switches. These results indicate that the shift of attention may be the trigger for the perceptual switches.

Second, I investigated perceptual bias when observing ambiguous figures using pupillometry. I hypothesized that a perceptually ambiguous or bistable object (Necker cube) can be more effectively biased, to assume a point of view-from-above (VFA) than from below the object, by cueing attention. In the results of my experiment, I found the presence of a VFA bias with forced attention, which was accompanied by reduced attentional effort, as indexed by a reduced pupil diameter, compared with the view-from-below. Conversely, participants exhibited no bias during passive viewing. Based on these pieces of evidence, I suggest that the level of intensive attention, when retrieving and maintaining a specific view from memory, is mirrored in the size of the eye pupils and may reflect ecological constraints on visual perception.

Finally, using a VR environment, I extended the second study on perceptual bias to conditions with changes in neck posture. In this study, I investigated how perceptual biases and experiential contexts of human perception affect the observer's perception when the posture is changed. I hypothesized that a change in the perceptual probability caused by perceptual bias also depends on posture. To verify this hypothesis, I focused on the Necker cube, which can be interpreted as two types of appearances from above and below despite the input remaining constant, and investigated the change of the probability of perceptual content. Specifically, I conducted the experiment by asking the observers their perception of the appearance of the Necker cube, placed at any of the five angles in VR space with pupillometry. Consequently, during the condition of looking down vertically, the probability of view-from-above perception of the Necker cube was significantly greater than during the condition of looking up. Interestingly, the pupillary results were also consistent with the probability of the perception. These results indicate that perception is modulated by the posture of the neck and suggest that neck posture is incorporated into ecological constraints.