別紙４－１（課程博士（英文））

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Abstract (Doctor)

Title of Thesis	Investigating the face pareidolia neural mechanism (顔パレイドリア現象の神経機序の解明)

Approx. 800 words

Humans have an excellent ability to face perception. For example, even a casual pattern such as a cloud may appear like a face. The phenomenon that is seeing objects as a face is called "pareidolia." However, the details of the mechanism of this phenomenon have not been clarified. The purpose of this thesis is to clarify the representation in the brain involved in the face pareidolia phenomenon, which is an illusion of face perception, by psychological, electroencephalogram (EEG), and pupil diameter measurements. In particular, we focus on the differences in the brain and behavior before and after the face pareidolia phenomenon.

First, we investigated whether the inversion effect index of the N170 component reflected face-likeness by observing the correlation between the event-related potential (ERP) components and behavioral reports of face-likeness. Previous ERP studies showed that the P1 component (early visual processing), the N170 component (face detection), and the N250 component (personal detection) reflect the neural processing of faces. Inverted faces were reported to enhance the amplitude and delay the latency of P1 and N170. To investigate face-likeness processing in the brain, we explored the face-related components of the ERP through a face-like evaluation task using natural faces, cars, insects, and Arcimboldo paintings presented upright or inverted. We found a significant correlation between the inversion effect index and face-like scores in P1 in both hemispheres and N170 in the right hemisphere. These results suggest that the judgment of face-likeness occurs in a relatively early stage of face processing.

Next, we investigated how both aspects of bottom-up processing and top-down modulation contribute to face-likeness perception. Humans can immediately judge what kind of object it is by looking at the object. Especially for the face, the ability is sharpened. This ability to quickly group experienced stimuli into meaningful categories (perceptual categorization) is undoubtedly one of the most fundamental high-level brain functions. In the visual domain, the method of investigating the perceptual categorization process is to combine visual periodicity with a direct recording of neural activity, for instance, using EEG. We considered this category-selective response might be generated or modulated by face-likeness. We recorded EEG while presenting natural images of objects at a fast-periodic rate of 12 Hz. We compared neurophysiological responses to periodic and non-periodic face and face-like object stimuli in a fast-visual stream. Moreover, we presented an inverted face and face-like object stimuli as a control. As a result, category (face-like object)-selective EEG responses did not elicit in a fast-periodic stream. This result indicates that the face-like category does not generate a unique category-selective response unconsciously. This result suggested that the pareidolia phenomenon does not occur in the bottom-up process.

Moreover, we investigated face pareidolia using pupillary response. The pupillary response was suggested to be influenced by high-level cognition. Therefore, we predicted that the change of pupil diameter might be induced by face pareidolia. We measured that pupil diameter when stimuli were perceived as faces. The stimuli consisted of five circles, including a big circle and four small circles. The subjects performed two tasks (face-like and symmetry) to the same stimuli in the block design. As a result, pupil dilation in face-like conditions showed differences between the face-like task and symmetry task. However, pupil dilation in the symmetry condition showed no differences between tasks. These results suggest that this pupillary effect is specific for the face-like processing by the top-down process and not specific for the symmetry processing.

Lastly, we clarified preference changes with the pareidolia phenomenon. We hypothesized that a face-like object elicited an orienting response, like a face, and attracted more attention than other visual stimuli. However, it is predicted from past studies that the effect does not affect unless a face-like object is recognized as a face. We investigated whether seeing objects as a face would influence preference. In the experiment, we used a pareidolic image that could be perceived as a face or abstracts painting. These images are presented upright or inverted. The participants performed two tasks. 1) to select more preferred in the two alternatives forced-choice task. 2)face-like evaluation tasks. We divided the participants into two groups in the order in which the tasks were performed. The group that first performed "Face-likeness evaluation task," and then performed "Preference task" was defined as "Face biased group." Another group named "No face biased group" performed the first "Preference task" and then "Face-likeness evaluation task." As a result, the Face biased group preferred the upright than the inverted images, although another group did not prefer the upright images. This result suggested that the pareidolia phenomenon affects preference.

We clarified the differences in the brain and behavior before and after the face pareidolia phenomenon. Besides, we identified timing, area, and pupil response associated pareidolia phenomenon. In the future, the findings of the study might be of use to person-to-machine communication or social life.