Recognition of pictures of human faces by pigeons
—Transfer from dynamic to static stimuli—**

Hiroshi MAKINO* and Masako JITSUMORI*, **

Chiba University*

In a go/no-go discrimination procedure, four pigeons were trained to discriminate dynamic images of four human faces which were rotating around the y-axis from $+67^\circ$ to $-67^\circ$. After completion of the training, transfer to static images at nine depth orientations ($0^\circ$, $\pm 23^\circ$, $\pm 45^\circ$, $\pm 67^\circ$, and $\pm 90^\circ$) was tested in extinction. The pigeons showed excellent transfer to the static stimuli, but responses to the positive faces significantly decreased for novel views outside the range spanned by the dynamic stimuli. The findings suggest that the responses of the pigeons were based on two-dimensional properties of the faces seen in the training images rather than the three-dimensional properties of the human faces.

Key words: dynamic stimuli, face recognition, pigeon, rotation invariance

Introduction

The retinal image of an object varies as a function of orientations, distances, lighting conditions, background scenes, and other aspects at the time of viewing. Invariance operations are required for observers to identify objects despite a variability of retinal stimulation. One of the most sophisticated invariance operations is the recognition of objects from novel viewpoints.

Jitsumori & Makino (in press, Experiment 1) trained pigeons to discriminate between frontal views of human faces on a CRT monitor in a go/no-go discrimination procedure. The pigeons showed substantial generalization to novel views, even though images of human faces change radically as the viewpoint changes. However, the discrimination of novel views was not perfect, and responses to the positive faces declined systematically with the degree of rotation from the training view.

One possible explanation was that the pigeons perceived "three-dimensional" video images of human faces but generalization to the faces at novel viewpoints was decreased due to discrimination between the familiar and novel views. In the present experiment, we trained pigeons to discriminate images of human faces which were dynamically rotating in depth. If seeing a human face continuously changing its orientation in depth enabled the pigeons to integrate the different views as a unified 3D object, then transfer would occur not only to the corresponding static views but also to the novel views outside the range spanned by the dynamic stimuli.

Method

Subjects Four experimentally naive homing pigeons were used as subjects.

Apparatus Two conventional operant chambers, each of which had a screen key and a start key, were used. The stimuli were displayed via a laser video disk player to a CRT color monitor.

Stimuli Images of the faces of four undergraduate male students were used as stimuli. A dynamic sequence consisted of a face which rotated from $+67^\circ$ to $-67^\circ$ in 5 seconds, so that the face in the display continually rotated to the left and right. During generalization testing, static images of the faces at nine depth orientations ($0^\circ$, $\pm 23^\circ$, $\pm 45^\circ$, $\pm 67^\circ$, and $\pm 90^\circ$) were presented. Examples of the stimuli

---

1) A detailed version is included in Jitsumori, & Makino (in press) as a part of the series of experiments reported in the article.

* Graduate School of Science and Technology, Chiba University, Yayoi-cho, Inage-ku, Chiba 263-8522

** Department of Cognitive & Information Sciences, Faculty of Letters, Chiba University, Yayoi-cho, Inage-ku, Chiba 263-8522
Procedure The subjects were trained to respond to the dynamic images of two faces but not to respond to those of the remaining two faces in a go/no-go discrimination procedure similar to that used by Vaughan and Greene (1984). A training session consisted of 30 positive and 30 negative trials, with an intertrial interval of 5 seconds. Training continued until 80% or more of the total responses occurred on positive trials. The birds then received generalization testing with the static stimuli. A set of 36 different static stimuli was presented twice in a session. Two sessions were given in extinction.

Results and Discussion

Three of the four pigeons learned the discrimination. Figure 2 shows the mean relative generalization gradients averaged across the three pigeons. The pigeons showed an excellent transfer from the dynamic to the static views over the ±67° range. But the responses to static images significantly decreased when the novel views (±90°) of the positive faces were outside the range spanned by the dynamic stimuli. In the investigation of Jitsumori and Makino (in press), the pigeons which were trained and tested with static stimuli failed to show a transfer to the dynamic images. This finding, together with the observation in the present experiment of a failure to transfer to the novel views, suggest that pigeons are insensitive to the three-dimensional cues in video images. It is therefore likely that the pigeons' generalization responses were based on the 2-dimensional training images rather than the 3-dimensional properties of human faces.

References