Effects of Face Contour and Features on Occipitotemporal Activity when Viewing Eye Movement

Kensaku MIKI[1,2], Shoko WATANABE[1], Yukiko HONDA[1,2], Maiko NAKAMURA[4] and Ryusuke KAKIGI[1,2,3,5]

[1]*Department of Integrative Physiology, National Institute for Physiological Sciences, Okazaki, Aichi 444-8585, Japan*
[2]*RISTEX, Japan Science and Technology Agency, Chiyoda-ku Tokyo 100-0004, Japan*
[3]*The Graduate University for Advanced Studies, Hayama, Kanagawa 240-0913, Japan*
[4]*Department of Neurology, Jikei University School of Medicine, Minato-ku, Tokyo 105-8461, Japan*
[5]*Japan Space Forum, Chiyoda-ku, Tokyo 100-0004, Japan*

(Received 3 December 2006 / Accepted 16 February 2007)

We investigated whether the activity in MT/V5 is influenced by a face contour and/or features such as the mouth using magnetoencephalography (MEG). We compared two conditions as visual motion stimuli using apparent motion as follows; (1) **CDL**: A schematic face consisting of a face Contour, two Dots & a horizontal Line and (2) **D**: Two Dots only. Subjects described a simple movement of dots for **D**, but eye movement for **CDL**, though movement modalities were the same through both conditions. We used a single equivalent current dipole (ECD) model between 145-220 ms after stimulus onset and estimated the location, dipole moment (strength) and peak latency. There were no significant differences in the peak latency of the estimated dipoles between each condition, but the activity was significantly stronger for **CDL** than for **D** ($p < 0.01$) in the right and left hemispheres. These results indicated that there is specific information processing for eye movements in the occipitotemporal area, the human MT/V5 homologue, and this activity was significantly influenced by whether movements appeared with the face contour and/or features, in other words, whether the eyes moved or not, even if the movement itself was the same.

Keywords: face, eye movement, MT/V5, MEG

DOI: 10.1585/pfr.2.S1128

1. Introduction

In our daily lives, the facial movement is very important. Especially, we can read another mind and mental state by viewing his/her eyes movement. In previous studies [1, 2], we reported that there may be specialization to facial movement within human MT/V5 area where is sensitive to motion in general. However, the question still remains what is the main factor which causes the differences between facial motion and general motion.

In this study, we used a schematic face to investigate the effect of face contour and/or features by viewing eyes movement. This article summarized our manuscript [3].

2. Methods

2.1 Subjects

We studied thirteen right-handed volunteers (6 females, 7 males) ranging in age from 24 to 46 (means; 33.6) years with normal or corrected visual acuity. All subjects gave informed consent to participate in the experiment, which was approved by the Ethics Committee of the National Institute for Physiological Sciences.

author's e-mail: kensaku@nips.ac.jp

2.2 Visual stimuli

We used apparent motion where the first stimulus, S1, was replaced by a second stimulus, S2, with no interstimulus interval as described previously [1–5] and presented two conditions as follows (Fig. 1);

(1) **CDL**: A schematic face consisting of a face Contour, two Dots & a horizontal Line.
(2) **D**: Two Dots only.

Subjects described a simple movement of dots for **D**, but eye movement for **CDL**, though movement modalities were the same through two conditions.

Filler (Fig. 1), which consisted of a scrambled image of the S1 stimulus in the **CDL** condition, was presented between stimulus conditions, to avoid large changes in luminance and contrast during the experiment.

In both conditions, S1 and S2 were shown for 800 ms and **Filler** was presented for 1000-1200 ms between each stimulus session. Each condition was randomly presented during the experiment.

Stimuli were projected centrally, and subtended a visual angle of 8.0 × 8.0 degrees. The dots moved 0.7 degrees. Subjects were asked to maintain their gaze at a point in the center of the stimulus indicated by a small red cross.

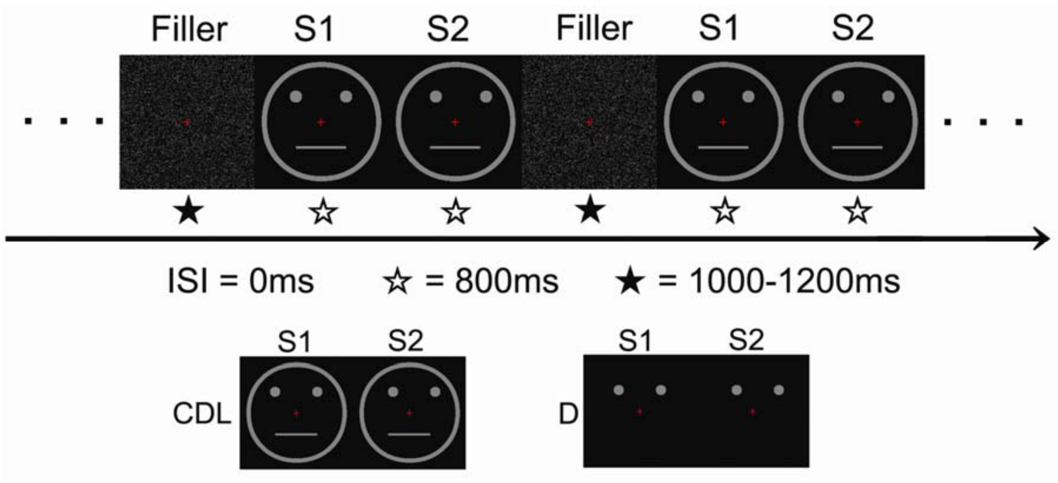

Fig. 1 The course of stimulus presentation in the two conditions.

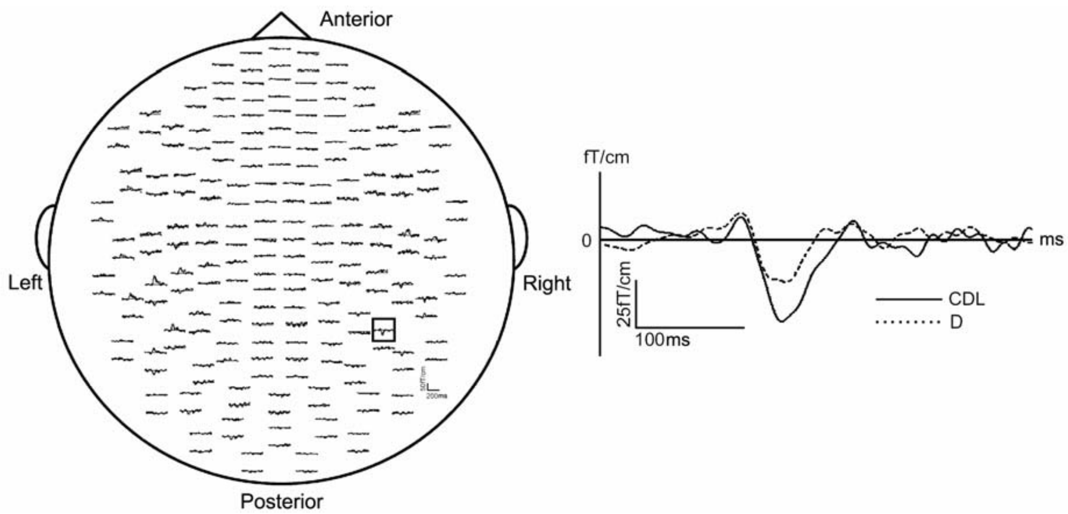

Fig. 2 MEG waveform in one representative subject.

2.3 MEG recordings

We used a 306-channel biomagneometer, 204 gradiometers, and 102 magnetometers (VectorView^{TM}, Elekta Neuromag Oy; Helsinki, Finland) for recording MEG. We analyzed only the results obtained with the 204 gradiometers in this study. A bandpass filter (0.1-50 Hz) and a sampling rate of 999 Hz were used. We analyzed the period within 300 ms after S2 onset. A 100 ms pre-stimulus baseline was used for responses to S2.

2.4 Data analysis

We analyzed results obtained by 204 gradiometers. We used 6-14 channels which cleared the following criteria; (1) Goodness of fit was more than 90 %. (2) The estimated dipoles were located in the occipitotemporal area, human MT/V5 homologue [4, 5] and (3) stable within 0.5 cm over 10 ms. The dipole location, maximum moment and peak latency were measured using these channels.

A two-way factorial ANOVA (Subjects x Conditions or Subjects x Hemisphere) with the Tukey-Kramer multiple comparison test was used to assess the difference among conditions or hemispheres and $p < 0.05$ was considered to be significant.

3. Results

A clear component was evoked about 180 ms after visual motion stimulus (S2) onset in two conditions (Fig. 2).

We estimated the dipole location, maximum moment and peak latency in 11 subjects from the right hemisphere and 12 from the left hemisphere (10 from both hemispheres). The dipoles estimated in both conditions were located in the occipitotemporal area, human MT/V5 homologue (Fig. 3). There were no differences of the location among two conditions in the right and left hemisphere.

In 10 subjects whose dipoles were estimated from both hemispheres in both conditions, there were no interhemispheric differences for the peak latency and the maximum moment among two conditions (Table 1). In the peak

Fig. 3 The estimated dipole location overlaid on MRI image.

Table 1 The dipole moments (nAm) and peak latencies (ms) following S2 onset (eyes movement). Means and SDs for **CDL** and **D** in the right and left hemispheres.

	Right (n = 11)		Left (n = 12)	
	(nAm)	(ms)	(nAm)	(ms)
CDL	14.4± 6.2	179.3±26.3	12.7± 6.7	180.2±14.9
D	10.3± 5.3*	180.3±23.7	8.9± 5.5*	177.7±20.3

*$p < 0.01$ compared with **CDL**

latency, there were no significant differences among two conditions. However, the maximum moment was significantly larger for **CDL** than **D** in the right and left hemispheres (Table 1).

4. Discussion

The occipitotemporal activity was largest for **CDL** and significantly larger than for without contour and mouth (**D**) in the right and left hemispheres.

It showed that this activity was significantly influenced by whether movements appeared with the face contour and/or features, even if the movement itself was the same. In this study, we consider that the presence of both face contour and features play an important role for human in perception of facial movement.

Acknowledgments

This study was supported by the Research Institute for Science and Technology for Society (RISTEX), Japan Science and Technology Agency (JST) and a Grant-in-aid for Young Scientists (19700253) from the Ministry of Education, Culture, Sports, Science and Technology.

[1] S. Watanabe *et al*., NeuroImage **13**, 351 (2001).
[2] K. Miki *et al.*, Clin. Neurophysiol. **115**, 1559 (2004).
[3] K. Miki *et al*., NeuroImage **35** (2007).
[4] Y. Kaneoke *et al*., Neuroreport **8**, 677 (1997).
[5] Y. Noguchi *et al*., Cereb. Cortex **15**, 1592 (2005).