An fMRI Experiment of Counting Strokes of Kanji

K. Matsuo[1], C. Kato[1,2], T. Nakai[1], T. Moriya[1], G. H. Glover[3]
[1]Electrotechnical Laboratories, Tsukuba, [2]Toyohashi Sozo College, Toyohashi, Japan
and [3]Stanford University, Stanford, CA

Introduction

It is often observed that the people who use Kanji (morphogram, or ideographic character) move their forefingers to recall Kanji. Inhibition of the finger movements sometimes prevents from recollecting the accurate spelling, or extends the response time(1). It can be hypothesized that the role of the finger movements is to assist the retrieval of Kanji. A comparative fMRI experiment was designed to investigate the relationship between the finger movements and the processing of Kanji in the brain. Counting strokes of the character was chosen for the task because the Japanese often use their forefingers to do it.

Materials and Methods

Subjects: Six right-handed native Japanese speaking volunteers (2 females, 4 males, age 21 - 38, average 31.5) participated in this experiment.

Data Acquisition: All the imaging and functional studies were performed on a 3 T MR scanner (GE Signa). The gradient echo spiral sequence(2) with standard birdcage head coil was used for the functional studies. TE 30 msec, FA 50, FOV 240 mm, 128 x 128 matrix, slice thickness 10 mm interleaved, TR 750 msec, and 4 shots for one image. Acquired 10 axial slices covered form parietal region to visual cortex.

Paradigm: Next 4 tasks were employed. In Kanji-Movement (KM+) task, a Kanji was projected on the screen for one second and the volunteers counted the strokes of the character by moving their forefingers to trace the character in the following 6 seconds. In Kanji-without-Movement (KM-) task, the volunteers had to count the strokes in prohibition of finger motion. In Meaning-Movement (MM+) task, meaning of a Kanji written in Hiragana (Japanese syllabic characters) was projected and the volunteers counted the strokes of the recalled corresponding Kanji by moving their forefingers (like KM+). Meaning-without-Movement (MM-) task was movement prohibition version of MM+ (like KM-). Four task-rest cycles (30 sec task, 30 sec rest) were performed after 30 sec rest period. The volunteers counted strokes of 4 Kanji per one task period. Total acquisition time was 270 seconds for one trial.

Data Analysis: Four task-rest cycles (240 seconds) were examined by the cross correlation analysis (threshold 0.5) (3).

Results and Discussion

It was remarkable that the activation in the premotor cortex and the supplementary motor area (SMA) was detected in the motion-inhibited conditions (KM-, PM-) of all the subjects despite the fingers were not moved. It strongly suggests that the counting stroke task of the character bears relations to the regions. Four of the six volunteers showed the activation of the contralateral premotor cortex. The hot pixels around the calcarine fissure (V1) were comparatively more detectable in PM- than PM+ in four of the six volunteers. It suggests that the actual finger movements compensate for the activation of V1. The V1 activation was generally more detectable in the meaning task (MM+, MM-) than KM+. It can be explained that the conversion of 'meaning' into Kanji possibly requires intensive visualization of the character.

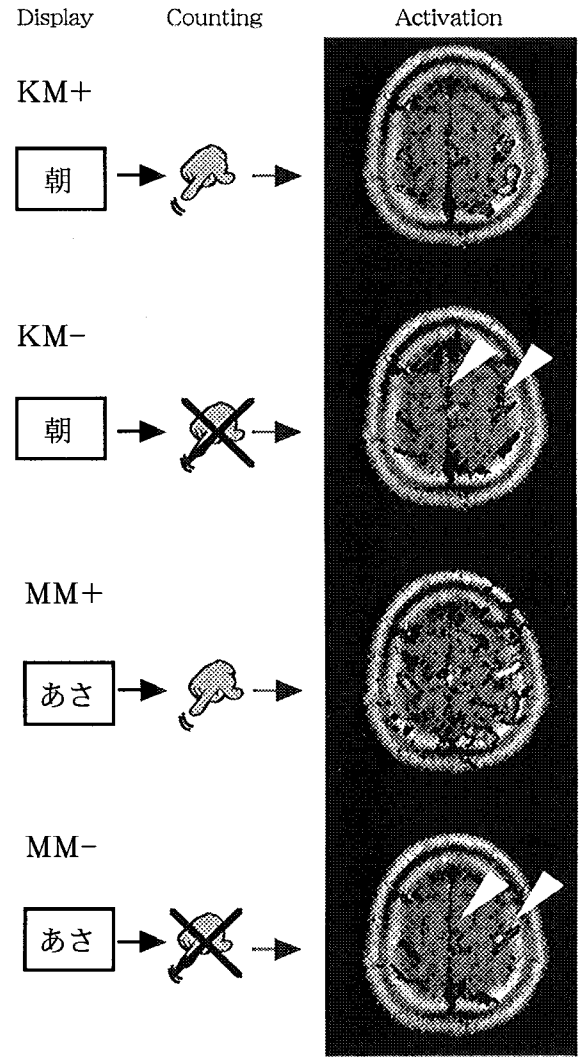

Figure: A volunteer's performance. Activation in the premotor cortex and the SMA was detectable in motion-inhibited conditions. "朝" means morning. "あさ" is syllabic representation of "朝".

Conclusions

Our findings suggest that the finger movements plays an important roll in the retrieval of Kanji, as a part of the network of the language processing in the brain.

Reference

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