

Cerebral activation in picture naming task including word reading, picture-word matching and semantic categorization

Hyojeong Sohn¹, Jaebum Jung¹, Sung-Bom Pyun², Kichun Nam¹

¹Department of Psychology, Korea University

²Department of Rehabilitation Medicine, Korea University College of Medicine
(kitty@korea.ac.kr)

Abstract

To date, there has been minimal research regarding the cerebral activation of Korean language. There need the database for Korean language that is quite different from alphabetic system. This study examined the brain activation of picture naming, word reading, picture-word matching, and semantic categorization in Korean language.

Moreover, we investigated the cortical activation pattern according to semantic demand for the above tasks.

Introduction

Previous neuropsychological studies supposed that there are several stages in picture naming. The first stage is visual perception of pictures, and in order of the next stages are visual input lexicon, semantic system, output lexicon, and finally through the articulation stages who can speak name of the picture. And the reading pathway differs from the of the picture naming. This study is designed to investigate the cerebral activation pattern according to each stage of neuropsychological model of picture naming (Ellis-Young model 1988) using fMRI.

Subjects and methods

Participants

Eighteen right-handed participants (thirteen male, five female) were tested. Their mean age was 22.3 years old. All had good Korean language skills. They had normal or corrected vision, and were without known neurological or behavioral abnormality.

Experimental Design and Stimuli

The experiment used a block design consisting of 30s epochs. Participants performed four tasks including four blocks of the experimental condition and five blocks of the control condition each task. Each corresponding control condition designed to exclude simple visual search, motor control

of bulbar muscles or finger movements. Participants were instructed to speak covertly or to press the button during scanning and were given a brief practice session before the experiment for them to be familiarized with the procedure.

The experiment used a block design consisting of 30s epochs. Participants performed four blocks of the experimental condition and five blocks of a control condition during each session. Each block consist of 10 pictures (experimental condition) or meaningless figures (control condition) in picture naming task and 10 words or Arabic word in word reading task. Participants were instructed to speak covertly during scanning and were given a brief practice session before the experiment for them to be familiarized with the procedure.

Data acquisition

fMRI was performed on a ISOL FORTE 3T scanner at KAIST (Korea advanced institute of science and technology) equipped with a standard circularly polarized head coil (DP-Headcoil) using gradient-echo echo-planar imaging (GEEPI, TR=3.0s, TE=35ms, flip angle=80, matrix=64x64, voxel size=3.45X3.45X4). Every 3.0s, 30 slices with a slice thickness of 4mm were acquired.

Data analysis

The image data were analyzed using SPM (statistical parametric mapping) 2 implemented in MATLAB 6.5. All volumes

Cerebral activation in picture naming task including word reading, picture-word matching and semantic categorization

were realigned spatially to the mean volume using sinc interpolation. The realigned volumes were spatially normalized to fit to the template consistent with the MNI(Montreal Neurological Institute) reference brain based on Talairach and Tournoux's stereotaxic coordinate system. The spatially normalized volumes consisting of $2 \times 2 \times 2 \text{mm}^3$ voxels were smoothed with 8.0mm FWHM isotropic Gaussian kernel. Boxcar functions were used to model the experimental conditions and served as regressors for multiple regression analysis after convolution with the canonical hemodynamic response function. Statistical random effects analyses were performed.

Result and Discussion

At an uncorrected level ($p < .0001$) the comparison of the task relative to the control task identified activation in the right middle occipital gyrus, the left inferior occipital gyrus, precentral gyrus, culmen, and the left posterior cingulate during picture naming task. Word reading showed only greater activation in the right lingual gyrus than the control task.

In picture-word matching, the activation compared to the control condition observed in the right lingual gyrus, the left inferior frontal gyrus, middle occipital gyrus, and the left medial frontal gyrus. In semantic categorization, revealed in the left middle and medial frontal gyrus, the right inferior gyrus and middle frontal gyrus.

These results showed that the activation regions are increase by the order of word reading, picture naming, picture-word matching, and semantic categorization. In other words, the cerebral activation patterns are different according to semantic demand. In recent studies, higher semantic demand elicited activation in bilateral prefrontal region including inferior frontal gyrus. And the middle frontal region is related to lexical semantic manipulation.

Fig1 picture naming



Fig2 word reading



Fig3 picture-word matching

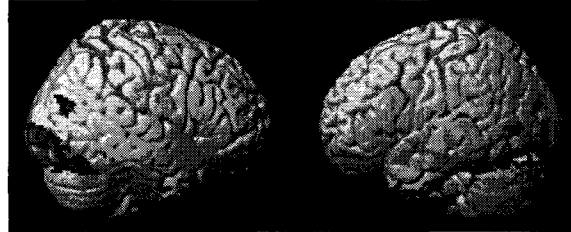
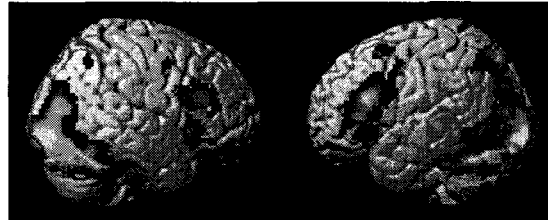


Fig4 semantic categorization



Referene

- Martin, R. C. (2003). Language Processing: Functional Organization and Neuroanatomical Basis. *Annu Rev Psycho.*, 54, 55-89.
- Heim, S. (2005). The structure and dynamics of normal language processing: Insights from neuroimaging. *Acta neurobiol Exp*, 65, 95-116.
- Cabeza, R., & Singstone, A. (1997). *Handbook of Functional Neuroimaging of Cognition*. Cambridge: MIT press.