Processing lexical semantic information in seond language shaped native langauge by event-related fMRI

J-S. Kim[1], B-S. Kim[2], S-S. Jeun[3], B-Y. Choe[1]

[1]Biomedical Engineering, College of Medicine, The catholic University of Korea, Seoul, Korea, Republic of, [2]Radiology, College of Medicine, The catholic University of Korea, Seoul, Korea, Republic of, [3]Neurosurgery, College of Medicine, The catholic University of Korea, Seoul, Korea, Republic of

ABSTRACT

The purpose of the present functional magnetic resonance imaging (fMRI) investigation was to examine the modulation of neural activity with respect to language translation. It is a complex task that entails an interaction between a second language (L2) and the native language(L1). To study the underlying mechanisms, we used fMRI to show bilingual's brain activity in phonological processing of reading English words (L2) shaped Korean words (L1). In our fMRI study, nine Korean-English bilingual subjects performed the experiment while they covertly read four type words such as Korean words, Korean words of foreign origin, English words shaped Korean words, English words. fMRI results reveal that the right occipital-temporal and the left inferior frontal areas have a greater response to the presentation of English words shaped Korean words than for other type words. These results may indicate a change in brain circuitry underlying relational processes of language translation, with transition from a similarity-based process system in the occipital-temporal lobes to a language-related processing system in the left prefrontal cortex.

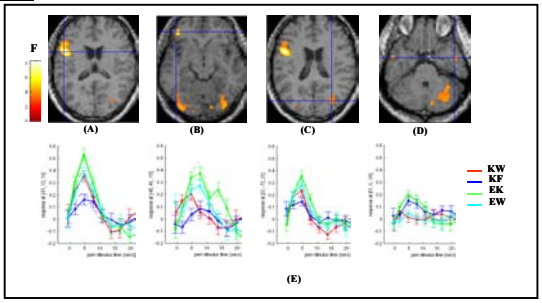
INTRODUCTION

A central issue in cognitive neuroscience centers on understanding how the brain process words. Research using fMRI and PET has yielded to considerable insight into the networks of cortical areas involved in the process of word recognition (1,2). Psycholinguistic research has demonstrated that one important independent factor strongly influence how individual words are processed: a word′s frequency of occurrence. Word frequently probably is the most widely investigated variable in word recognition research. This finding has been interpreted as reflecting differences in the ease with which cognitive mechanisms can access representation of words in the mental lexicon. Recent neuroimaging studies investigating frequency effects during word processing have helped to more precisely characterize the contribution especially of inferior frontal brain areas to the process of word recognition(3). Our interest arises to study how to mediate L2 from L1 and to understand L1 from L2, and we also employed event-related functional magnetic resonance imaging (fMRI) study that permits the more specific isolation of particular psychological events than a block design.

MATERIALS AND METHODS

Nine right-handed normal, bilingual healthy volunteers participated in the experiment. The stimuli consisted of gray presentations of 50 Korean words and 50 words of foreign origin and 50 English words and 50 English words shaped Korean. The words were presented for 1000 ms, replacing a baseline of a fixation cross-hair present throughout the interstimulus interval, with minimal SOA of 4.5 s and 100 randomly intermixed null events. Each subject were scanned during one session, In the session named the retrieval of lexical semantic information from words, the subjects were instructed to press one of two possible buttons with either the index or middle finger of their right hand to indicate whether a word was understanding or not. Incorrect answers were ignored. A 1.5T VISION system (Siemens Corps., Iselin, NJ) was used to acquired T2* weighted transverse EPI images (TR/TE/FA = 3000ms/60ms/90^o, FOV=240 x 240mm^2, 24 axial slices, 5mm slice thickness with no gap). The acquired data were applied to SPM99 for the pre-processing such as realignment, normalization, spatial smoothing, and then the individual contrast images for the effect of interest were entered into one-sample **t-** tests to determine the group-level activation. Subsequent orthogonal analyses were then restricted to the visually responsive areas revealed by the contrast (masking procedure in SPM) and conjunction analysis that discards voxels yielding significant subject by contrast interactions.

RESULTS



The event-related responses to all four types of responses (Korean words, words of foreign origin, English words shaped Korean words, English words) were extracted as described in our method section (Fig.1E). In fMRI study, greater response to the presentation of English words shaped Korean words than to the other types were obtained in the right occipital-temporal lobe and the left inferior frontal cortex related to language related processing network. In contrast, our high-proficient bilinguals show slight difference in the same areas for reading other three types.

*Fig.1. (A)(B) The group activation map of the left inferior frontal areas and (C) the right occipital lobe and (D) the right temporal lobe. A lower statistical threshold was used (**P** < 0.05, corrected). (E)Event-related data, adjusted for confounding (FW as Korean words, KF as words of foreign origin, EK as English words shaped Korean words, EW as English words), were binned every 3s and then averaged over the subjects from corresponding regions based on peristimulus time (PST)[in the left inferior frontal lobes (F(1,8)=8.26,x=-51,y=12,z=18; F(1,8)=6.65,x=-45,y=48,z=-15), and in the right occipital lobe(F(1,8)=4.19,x=33,y=-72,z=21)and in the right temporal lobe(F(1,8)=4.09,x=51,y=0,z=-36)].*

DISCUSSION

The main finding of this study was that greater activation in the right occipital-temporal lobe and the left inferior frontal areas was observed with the presentation of the L2 shaped L1 compared to other types, L1, semi-L1 (Korean words of foreign origin), L2 during reading each word. In one study, low-proficiency bilinguals, activations when reading a L2 vary greatly from one individual to another and often differ from those elicited by L1 (4). This pattern is associated with underlying mechanisms for language conversion from L2 to L1. In our study, high-proficiency bilinguals as our subjects, the nature of other three types as L2, L1, semi-L1 (words of foreign origin) reading system may attributable to the indolence of the one-step language conversion. To the contrary, in reading L2 shaped L1, a language-related processing system may be involved in two-step conversion (L1->L2->L1). It's supposed to be responsible for the role of the language conversion route in Korean-English bilingual's computational processing of phonological information of L2 shaped L1. We need to investigate any changes in brain circuitry underlying relational processes of language translation with behavioral response.

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