Sentence Comprehension of Two Languages : an fMRI Study with Korean-English Bilinguals

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Abstract

Concerning the neural mechanism of bilingual sentence comprehension, the issue of whether the processing of L1 and L2 are identical or not, is currently a subject of debate. In the present study, we investigated the neural mechanisms of L1 (Korean) and L2 (English) using functional magnetic resonance imaging techniques. Our subjects were so called late bilinguals, who began to learn English after puberty and achieved a very fluent level. As stimuli, we used relative sentences of L1 and L2. For a comparison study, simple conjoined sentences with the same meaning were also presented. We observed the areas of L1 and L2 that are shared in the left inferior frontal, bilateral inferior parietal, occipital (incl. cuneus, lingual gyrus), and precentral gyrus. These shared activations are in agreement with the results reported in other studies of language processing, either in L1 or L2. The left middle frontal activation is L1 specific. This might be related to the overloaded working memory task, including difficulties in the syntactic processing of L1. The right medial frontal and middle temporal activation is also L1 specific, and this can be attributed to the process of implicit engagement during the stem completion of L1 sentences.

Introduction

Recent neuroimaging studies have drawn a heterogeneous picture on the cerebral organization of a first language (L1) and a second language (L2). There had been some evidences that L1 and L2 are supported by identical brain regions [1], whereas contradictory results indicate a differential cerebral organization for L1 and L2 [2]. The purpose of the present paper is to see whether brain region activation during comprehending any difficult sentences represents any spatial distinction between L1 and L2. To examine whether the bilinguals' two languages were represented in distinct or overlapping areas of the brain, we performed functional magnetic resonance imaging (fMRI).

Methods

Twelve right-handed Korean-English bilingual students were scanned during sentence comprehension tasks of both Korean and English. Two types of the tasks are visually presented; relatively difficult sentences and control conjoined sentences. Before the experiment in the MR scanner, the participants were familiarized with the task paradigm. Tasks were presented using the E-prime (Psychology Software Tools, Inc., Pittsburgh, USA). The images of each subject were realigned, coregistered, and normalized using the SPM99. Finally, the images were smoothed using a 7 mm full-width, half-maximum (FWHM) Gaussian filter. Condition and subject effects were estimated using the general linear model at each voxel in brain space. Significant changes in hemodynamic response for each subject and condition were assessed using t-statistics. For the group analysis, single subject and condition were analyzed using a random effect model. Activations were reported if they exceeded a threshold $P < 0.001$ uncorrected on the single voxel level and on an extent level of ten voxels.

Results and Discussion

Shared areas of activation exist for the processing of relative sentences of L1 and L2 in our results. The left inferior frontal, bilateral inferior parietal, occipital (including cuneus and lingual gyrus), and precentral gyrus activation was observed for both L1 and L2 processing. This activation is in agreement with other studies of language processing. The left middle frontal activation is L1 specific and this might be related with the overloaded working memory task, including difficult syntactic processing. The right medial frontal and middle temporal activation is regarded as the accompanying one during the relatively difficult sentence processing of L1.

References

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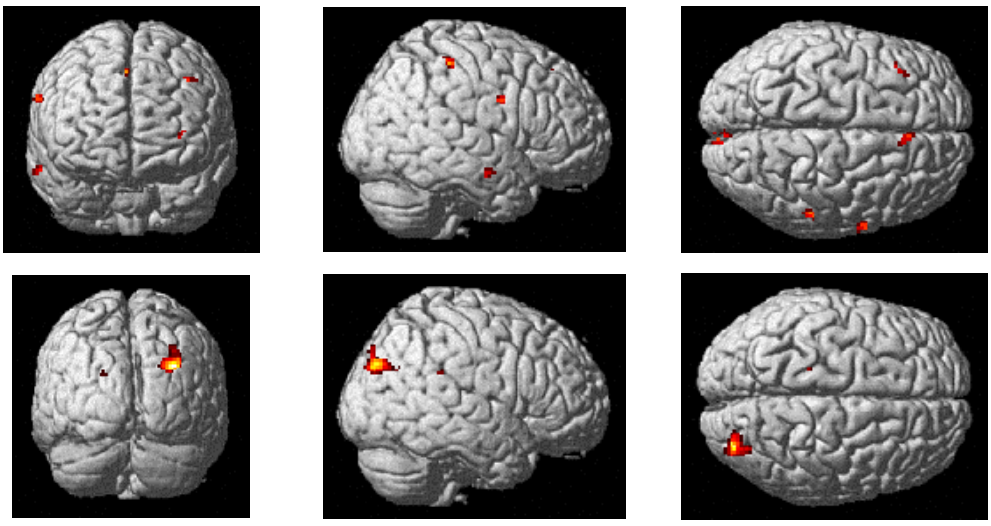

Figure 1. Activation map of regions for the direct comparison between relative sentences in L1 and L2 ($p > .001$ at the single voxel level).