

Neural Representations of Semantic Processing in Chinese-English Bilinguals

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Introduction To what extent multiple languages are represented in distinct or shared brain regions is a prominent question in the language studies. However, the results from previous brain lesions and neuroimaging studies are still far from consistent (1), some studies suggested that different languages may be impaired separately and represented in distinct brain regions (2,3), while other studies revealed overlapping neural substrates (4). These inconsistencies have been partly explained by the age of language acquisition and proficiency (3,5). In present study, we suggested that the stimulus category may play a role in the aforementioned inconsistent findings. We used functional MRI to investigate the neural representations of the native and second languages during two semantic matching tasks with different stimuli categories in normal Chinese-English bilinguals.

Methods Ten native Chinese-English bilinguals (7 male, age 25-33 years, started to learn English from 11-15 years old) were scanned on a Siemens 3.0T Trio scanner in two experiments while performing the semantic matching tasks in their native and second languages. Experiment1 was the nouns to pictures matching task, and Experiment2 was the number words to Arabic numbers matching task. They were required to press a button whenever they found the mismatch stimuli (10% trials). Passive viewings of pictures and of Arabic numbers were served as the baselines of two experiments, respectively. For each experiment, two scans in which four blocks of Chinese and English matching tasks were alternated with 4 blocks of baselines were performed. Functional imaging used a single-shot, T2*-weighted EPI sequence [24 slices, 4mm thk/1mm sp, TR: 1500 ms, TE: 30 ms, FOV: 24 × 24cm², Matrix: 64 × 64, Flip angle: 60°]. Imaging data were analyzed by SPM99. Four contrasts were defined as the four tasks compared to the respective baselines.

Results Behavioral results of correct detection rate and reaction time showed significant difference between two languages (P<0.05) but no differences between two categories (P>0.1). Compared to baseline, all matching tasks activated a predominantly overlapping semantic processing cortical network, including bilateral fusiform/lingual gyrus, inferior/middle frontal gyrus, insula/putamen, posterior temporal, parietal and cerebellum (Fig.1). In experiment 1, Chinese nouns matching task induced greater brain activations than the same English task, while in experiment 2, English number matching task induced greater brain activations than the same Chinese task. Moreover, ROI analysis on the activations within bilateral frontal language-sensitive regions (Broca areas) showed significant interaction between languages and categories (P<0.05; Fig.2).

Conclusions The findings of overlapping brain activations underlying four tasks were consistent with the view of shared neural representations of different languages in bilinguals. The results of interactions between languages and categories in the brain activation pattern supported our hypothesis and suggested that the semantic processing of native and second languages may be category dependent.

References

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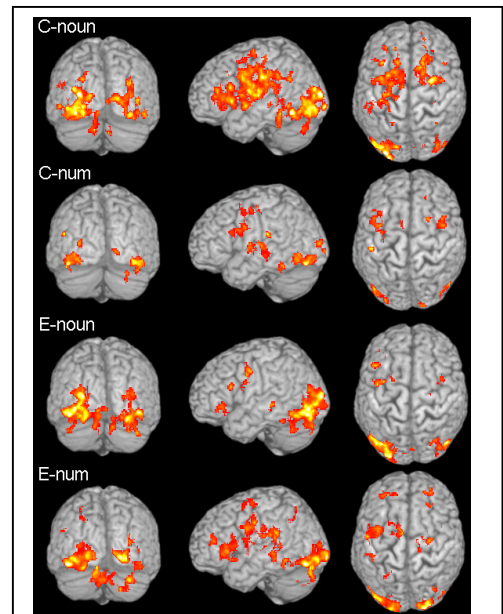


Fig.1 Brain activations in four tasks.

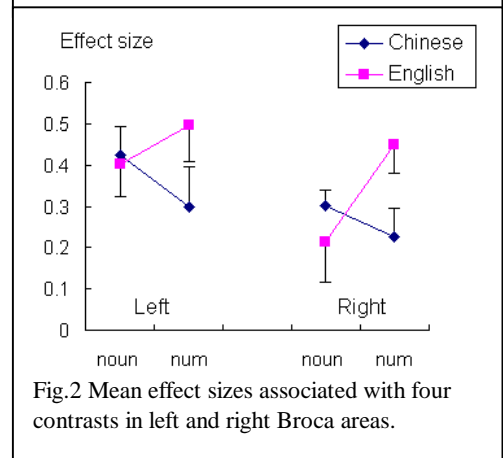


Fig.2 Mean effect sizes associated with four contrasts in left and right Broca areas.