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Poster presentation

Complex writing systems may entail distinct profiles of brain activation. A magnetoencephalography study

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Background

Receptive language-specific cortical maps have been repeatedly verified through normative and clinical Magnetoencephalography (MEG) studies. However, different writing systems may entail distinct neuro-anatomical substrates, hence different brain activation patterns for reading the various types of script. MEG, the most recent of the functional brain imaging techniques, allows mapping of task-specific changes in neurophysiological activity in real time. The project presented here is an attempt to describe the brain mechanisms mediating printed word recognition in languages with complex writing systems, such as Japanese. The multiplicity of orthographic systems has serious consequences on the level of difficulty in learning, producing and comprehending each type of script. The present MEG study addressed the question as to whether the Japanese mixed logographic (Kanji) and phonetic (kana) writing system is associated with distinct brain activation profiles, as compared to the basic Indo-European alphabetic writing systems.

Methods and analysis

Ten normal native Japanese speakers without any history of neurologic or psychiatric disorder participated in this study. Language-specific brain activity was elicited using three single-word recognition conditions (Kanji, Hiragana and Katakana). In each task a list of printed word stimuli were arranged in blocks of target and distractor words. The subjects were instructed to lift their right index finger whenever they recognized a target word. MEG recordings were made with a whole-head MEG system equipped with magnetometer sensors (Magnes 2500, 4D Neuroimaging, Inc., San Diego, CA). The signal was filtered online and then subjected to the adaptive filtering procedure (4D Neuroimaging signal analysis package). The intracranial generators of the ERFs were modeled as single ECDs and fitted by using nonlinear Levenberg-Marquardt algorithm. The ECD computation was restricted to latency periods during which a single pair of magnetic flux extremes dominated the left and /or right half of the head surface. All participants underwent a T1-weighted MRI scan in order to determine the anatomical regions of the brain corresponding to each activity source.

Results

All participants showed activity sources in: (1) temporoparietal cortex, including the posterior part of the superior temporal gyrus, extending into the adjacent supramarginal and angular gyri, the MTG and the underlying mesial temporal cortex, ventral temporo-occipital areas (including the fusiform and lingual gyri), and the inferior frontal region. Spatial overlap in activation was typically observed in the Wernicke's area for the three components. Tendency for Kanji and Hiragana to be associated with more lateralized temporoparietal activity did not reach statistical significance.

Discussion

The profiles of brain activity observed during the entire event-related magnetic response revealed similarities with the profiles found in previous studies of reading alphabetic scripts, such as English and Spanish. This profile features more lateralized (left) temporoparietal activity for two components of the Japanese writing system (Kanji and Hiragana) and a slightly greater degree of activity in the right for the third (Katakana), while spatial overlap

was observed in the superior temporal gyrus across the three reading tasks. The brain activation profiles show substantial spatial overlap among the three components of the Japanese script, as well as similarity with maps associated with alphabetic writing systems.

Conclusion

The preliminary results of this study support the need for further comparison and analysis (using a larger number of subjects and more measures of neurophysiological activity), in order to formulate firm neurolinguistic theories concerning language comprehension and distinct profiles of brain activation.