Chapter 6

Neuronal Substrates for Language Processing and Word Priming

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ABSTRACT

The authors of this chapter studied behavioral performance and brain activities associated with word priming using a Japanese Word Stem Completion (WSC) task. They compared the results of this task with the results of a Korean character cognitive task. Their results showed facilitatory effects on subject performance. The percentage of correct answers in the non-priming (P/N) word condition was 94%, whereas the priming (P/Y) condition yielded 100% correct answers. The average reaction time during the P/N word condition was 1501 ms, whereas it was 978 ms and 3106 ms for the P/N non-word and word P/Y word conditions, respectively. In the fMRI experiment, the same tasks were performed using a block-design experimental paradigm without any overt response from the MRI scanner. As seen in the fMRI results, the bilateral middle and inferior frontal gyrus were active with a right hemispheric prevalence. In addition, the superior and inferior parietal gyrus and the supplementary motor area were activated. The prefrontal-parietal network observed in this study is consistent with the areas that were activated during an English word stem task. These results suggest that the facilitatory effects observed in the WSC test were successful for implicit memory retrieval.

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INTRODUCTION

Serious diseases, such as dementia, result from dysfunctional memory formation. To improve the quality of life of the patients and their families, it is important to detect disease symptoms in the early stages and administer treatment immediately. To provide early screening, we have to understand how the human memory system works. Despite much research in the memory field, the fundamental mechanisms of memory formation remain unclear. In this study, we focused on priming, which is a specialized form of implicit memory.

Priming is measured as the ability to identify a word as a result of a specific previous encounter with the item that the word describes. To investigate the neuronal substrates that control priming, we conducted functional magnetic resonance imaging (fMRI) while patients performed a word stem completion (WSC) test in Japanese (e.g., ホレンウ). In the WSC paradigm, a word is used as the pre-stimulus and then a portion of the word is used as the experimental stimulus (Figure 1).

The response time and the percentage of correct answers on the WSC test were measured. Based on the behavioral experiment, we designed an fMRI experiment and evaluated brain activity by measuring the blood oxygenation level.

WORD PROCESSING

Language processing is classified as orthographic, phonological and semantic. One of the central concepts in word representation is the existence of a lexicon, i.e., a mental store of information about words that includes semantic information, syntactic information, and the details of word forms. Most psycholinguistic theories agree that a mental lexicon is central for the development of language comprehension and production, while other models distinguish between input and output lexica. The representation of orthographic and phonological forms must be considered in any model. The principal concept, though, is that a store of information about words exists in the brain, and we have some, albeit limited, theories about how information must be conceptually or- ganized (Michael S. Gazzaniga, Richard B. Ivry & George R. Mangun, 2002).

PRIMING EFFECT

Priming provides a facilitatory and control effect that can facilitate the identification of successive stimuli that were previously subconsciously obtained. Priming is a form of implicit memory. Direct priming occurs when the precedent stimu-
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