# Brain Activation in Reading Regular and Irregular Chinese Characters

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## Introduction

The basic orthographic units, the characters, in the logographic Chinese writing system can be differentiated broadly into two categories: simple and complex. Simple characters are holistic visual patterns that cannot be divided meaningfully into sub-lexical units. Complex characters constitute about 95% of all modern Chinese characters and most of them (80%) are composed of a semantic radical on the left and a phonetic radical on the right. Phonetic radicals have the function of indicating the pronunciations of whole characters, i.e., encoding phonological information at the sub-character level. However, due to the evolution of the writing system, this function is not complete. Only about one third of complex characters are regular, with the same pronunciations as their phonetic radicals while about another one third are irregular, with their pronunciations having no relations with their phonetic radicals. Behavior studies have found an interaction between regularity and frequency, with low frequency regular characters named faster than low frequency irregular characters, but with no significant difference between high frequency regular and irregular characters. The purpose of this study is to investigate whether we can find a similar interaction in brain activation for such characters.

## Methods

fMRI data were collected on nine young right-handed, native Chinese speakers on a 1.5T GE MRI system. Subjects were asked to name 40 regular words and 40 irregular words presented in blocks while a series of MR images were acquired. Half of these pictures and words describe living things and half non-living things. Naming of a plus sign ~{!0~}+~{!1~} and passive viewing of an unnamable symbol were served as baselines. Ten axial anatomic images were collected with an echo sequence (TR/TE=500ms/14ms, FOV=24*24cm2, thickness=6mm, skip=1mm, matrix=256*192). One hundred and twenty functional images per slice were acquired using a single shot gradient-echo echo planar imaging (EPI) pulse sequence (TR/TE=2000ms/40ms, matrix=64*64, thickness=6 mm,skip=1mm). Sixty four continuous sagittal slices were acquired with a fast SPGR pulse sequence (TE=2.2ms, matrix=256*256, thickness=2.5 mm). Cross correlation analyses and paired t-tests were used to statistically generate activation map.

## Results and Discussion

We found higher brain activation for low frequency irregular characters as compared with low frequency regular character in the following areas: bilateral inferior frontal cortex (BA 44), bilateral middle frontal cortex (BA 9), bilateral fusiform, bilateral inferior posterior temporal cortex (BA 37). High frequency regular and irregular characters had very similar brain activation patterns. The only difference is that regular characters had higher activation in extrastriate cortex (BA 18) and in fusiform. Thus we found parallel patterns of effects in naming Chinese characters in both reaction times and brain activation. We interpret the interaction in brain activation as indication of competition between lexical and sublexical processing for low irregular characters.