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Investigation of the Mechanism in Reading Process based on Eye Movements

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Text reading is a process which perceives a text via the visual channel and then comprehend its meaning. It requires an impressive coordination of visual attention, motor control, and long-term memory retrieval. Since the processing is carried out in the brain, reading behavior plays a key role in studies of cognitive process. Investigating of the mechanism in reading process can also help us to understand how human brain do linguistic processing. There is a number of important unresolved questions for investigating the mechanism of reading process. One of them is whether during text reading the coming word influences the preceding word or not. When perceive a word, does human only pay attention to this specific word in foveal or is human able to process the coming word in parafoveal at the same time. This is an important question because it can tell us whether our brain process word in series or parallel. It also provides an important window for studying the mechanism of human cognitive, both visual attention and language processing.

In previous studies, by manipulating the frequency of coming words they tried to solve this question. As unfamiliar word taking more time to be processed, they compared the processing time of preceding word while changing the familiarity of its coming word. According to the processing time changing, they infer whether the coming word influences the preceding word or not during text reading. By employing this method, many studies solved this question by using different languages (such as Chinese, English, Spanish, French). Some of them reported that reading time on a given word increases when the coming word is an unfamiliar word. On contrary, some other research proved that the reading time is not related to the familiarity of words.

In this research, we reviewed the method in previous study at first. Our result shows that whether it is unfamiliar word or not, there was no difference for word perceiving even

the word is displayed only in 80ms. It demonstrates that the method of manipulating the frequency of coming words is lack of rationality. Thus, we proposed a new method to solve this contradiction in which we manipulate the orthography and phonology of the coming words instead of changing words' familiarity. Since Chinese characters are a trinity of semantic, orthographic and phonological information. A little altering of the Chinese characters (such as 名 and 各) will seriously affected the semantic of the word, it is obviously to observe the processing time changing of the preceding word. Although Japanese contains Chinese characters (called kanji), not like Chinese characters, each Japanese character is independent syllable. This is the reason why we selected Chinese characters as our experimental material.

Differing from previous studies, we investigated reading process from both early and later stage. We found that the coming word does not affect both the preceding word and the word following the coming word in early semantic access by manipulating its orthographic and phonological information. And the manipulation influences the understanding of the surrounding words in the later stage of reading process. Our results seem that in the early semantic accessing (0-210ms) of each word is an independent process, and human mainly use bottom-up process to deal with the extracting word information during this period. The result is consistent with the research of brain activity during word recognition which reported only bottom-up connectivity between the inferior frontal gyrus to the left ventral occipitotemporal cortex within the first 200ms. In the later stage of reading, the word begins to influence each other while calculating the reading time, which illustrate how to continuously process the semantic understanding of sentence in working memory. According to our results, we hypothesized that reading process is consist of 2 parts. The first part is like a kind of serial system, all the words which are perceived by vision are pushed to human working memory one-by-one, and attention rarely shifted to another word until preceding word processing finished. In the second part, several words are popped from working memory, and they are formed as a phrase or short sentence for human to understand the whole sentence.

Many studies reported that the orthographic information of Chinese characters give direct access to word semantic meaning without phonological information (orthography to semantic). However, Chinese character phonograms which account for most of the proportion of Chinese characters have phonetic radicals. The phonetic radicals mostly have the same pronunciation as the phonograms. To some extent, the phonetic radicals can provide the phonological information. So, the phonological information of phonetic radicals may play a part in the processing of word semantic accessing. And there is also some other research which reported human must employ phonological information to finish the word semantic accessing (orthography - phonology to semantic). Orthographic information is

only a kind of mediation which help us to acquire phonological information of word. As the effect of orthographic information and phonological information on Chinese character reading process is also a controversial issue. The current research is also investigating the effects of orthographic and phonological information on reading process. According to our result, both orthographic information changing and phonological information changing affect the reading time. However, phonological information contributes more on reading comprehension. Our result supports the orthography - phonology to semantic theory. According to our results, we hypothesized that there are two different routes for word semantic accessing. One is orthography - phonology route, another is top-down route. When the word is not manipulated, the first route works. As the perceiving word can match human mental lexicon, the orthography information of word is transferred to phonological information, the word semantic accessing is activated by phonological information, then human can understand the word. On the contrary, as manipulating word cannot match human mental lexicon, the first route failed to launch. Human must use second route to understand unreasonable words. In second route, top-down information (such as context) is used to make a kind of loop system to access the unreasonable word until it can be a reasonable explanation in the text.