

## **Neighborhood Size Effects of Chinese Words in Lexical Decision and Reading\***

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Two experiments manipulating neighborhood size and word frequency were used to investigate the lexical processing of Chinese words. The neighborhood size of a word is defined as the number of two-character words sharing the same initial constituent character. The first experiment measured the response latencies of lexical decision and the second experiment recorded the eye movements in reading the same set of stimuli embedded in sentences. Both lexical decision times and eye movement measures consistently showed the facilitative effects of neighborhood size. Words with many neighbors produced faster response of lexical decision, higher skipping rate, and shorter fixation duration than words with few neighbors. The results indicate that, representations of all neighboring word are partially activated and play a supportive role in the early stage of lexical access.

Key words: Chinese compound word, neighborhood size, lexical decision, eye movements

One of the issues for visual word identification concerns the influence of a set of lexical items that share similar features with the target word. This issue has been addressed by many investigations of orthographic neighborhood size in word reading. Research in alphabetic languages has shown that processing time for identifying a word is affected by its neighboring words, which contain similar orthographic information by sharing many letters at the same positions. The neighborhood effects indicate that, when attempting to identify a word, not only can the target word's representation be activated, but so can lexically similar words. In Chinese, more than 70% of the words in the modern lexicon are made up of two or three characters. Many of these compound words share the same constituent character in the same character position. The investigation of neighborhood size effect can shed some light on how lexical knowledge is represented

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in mental lexicon and the underlying mechanism of lexical access in reading Chinese words.

## 1. Introduction

The neighborhood size of a word can be quantified by an N metric, representing the number of words that can be generated by changing one letter at any position within the word (Coltheart, Davelaar, Jonasson & Besner 1977). Based on this definition, words in the same neighborhood share similar orthographic information. Coltheart et al. (1977) studied the effects of neighborhood size for both words and nonwords in a lexical decision task (LDT). They reported that nonwords with many word neighbors were correctly classified more slowly than those with few neighbors but the words had no effect of neighborhood size. The neighborhood effect of nonwords indicates that representations of neighboring words were activated, yet none could reach the threshold for a wrong 'yes' response. The overall lexical activation prolongs the time to make correct 'no' response on nonwords. As for the null neighborhood effect of words, it can be explained by the fact that word frequency is the primary determinant and neighborhood activations have less contribution on lexical response.

However, many researches manipulating both neighborhood size and word frequency have consistently demonstrated the facilitative effects of neighborhood size for low frequency words in LDT and naming tasks (Andrews 1989, 1992, Carreiras, Perea & Grainger 1997, Forster & Shen 1996, Johnson & Pugh 1994, Peereman & Content 1995, Sears, Hino & Lupker 1995). That is, responses to words with many neighbors were faster than words with few neighbors. The facilitative effects of neighborhood size were stronger for low frequency words than high frequency words. These neighborhood effects can be explained by the models assuming an activation mechanism for lexical access in the framework of the interaction activation model (McClelland & Rumelhart 1981). For words with many neighbors, the letters in a word receive more top-down support from the word's neighbors at the word unit level than words with few neighbors. Consequently, the speed of retrieving the word's lexical representation is accelerated. The interaction of word frequency and neighborhood size can be easily explained in the activation models. High frequency words have higher resting activation in lexical units and they can reach the threshold for identification more quickly than low frequency words. Therefore, word identification for high frequency words relies less on the contribution of their neighbors than it does for low frequency words (Andrews 1997, Sears et al. 1995).

Another lexical factor found to exhibit the opposite effects of neighborhood structure is the neighbor frequency. Lexical decision for words with at least one higher

frequency neighbor was slower than words without any higher frequency neighbor (Carreiras et al. 1997, Grainger & Jacobs 1996, Grainger, O'Regan, Jacobs & Segui 1989, 1992, Perea & Pollatsek 1998). The activation models can account for the inhibitory effects of neighbor frequency by assuming lateral inhibition of higher frequency neighbors within the word level (McClelland & Rumelhart 1981), or by adding a component reflecting the overall lexical activity (Grainger & Jacobs 1996).

As noted by Andrews (1997), the neighborhood effects found in a task which presumably can reflect lexical retrieval may be contaminated by the processes specific to the task. Investigations have shown that the neighborhood effects can be influenced by the decision components in the LDT. For example, the facilitative neighborhood effects were stronger in an easier decision environment or when the nonwords were less word-like (Andrews 1989, Forster & Shen 1996, Johnson & Pugh 1994) or when speed of response was emphasized (Carreiras et al. 1997, Grainger & Jacobs 1996). The inhibitory neighborhood effects were found in LDT when the stimuli were block presented by conditions (Carreiras et al. 1997, Johnson & Pugh 1994, Sears et al. 1995). It has also been argued that the facilitative neighborhood effect in word naming tasks may reflect processes of phonological information or articulation specific to the naming task rather than processing of orthographic information (Treiman, Mullennix, Bijeljac-Babic & Richmond-Welty 1995).

Grainger et al. (1989) recorded the eye movements in a semantic judgment task in which both neighborhood size and neighborhood frequency were varied. Participants were asked to read a test word, shift their eyes to read a comparison word, and then press one of two buttons to indicate whether the two words were semantically related. Consistent with the LDT data, the gaze duration for words with at least one higher frequency neighbor was longer than words with no higher frequency neighbor. The neighborhood effects found in this study may not have been contaminated by the decision process, which is irrelevant to lexical access in the LDT (Grainger et al. 1989). One reason is that the eyes' gaze duration would not likely reflect the decision components since the averaging gaze duration was around 200ms shorter than lexical decision times (about 400ms vs. 600ms, respectively). Second, the absence of nonwords in the semantic judgment task avoids the confounding factor of response set or tendency induced by the extent of word-likeness for nonwords.

In addition, eye movement recording provides an opportunity to investigate the neighborhood effects of words which are embedded in sentences. There are two main advantages of analyzing eye movement data in a sentence reading task. First, it can be done in a natural context of reading rather than in a laboratory task. The possibility for subject strategy or specific task demand to contaminate the neighborhood effects is reduced. Second, the separate and gathered durations of sequential fixations near or in

the target word area may suggest different time courses of which the neighborhood effects may occur. For example, the effects observed in the **first fixation duration** on target word and the **gaze duration**, which is the summation of fixation durations before the eyes move outside of target word, can reflect the early or intermediate stage of lexical processing. The spillover effects, such as the first fixation duration after leaving the target word area or regression back to the target word, can reflect the processes at later stages.

The neighborhood effects have been demonstrated by eye movement data in reading sentences (Perea & Pollatsek 1998, Pollatsek, Perea & Binder 1999). Perea & Pollatsek (1998) reported inhibitory effects of neighbor frequency on late indices of eye movement measures. Words with at least one higher frequency neighbor elicited higher probability of regression back to the target words, longer duration of the first fixation subsequent to leaving the target word, and longer total viewing time on target word than words without any higher frequency neighbor. Pollatsek et al. (1999) manipulated the neighborhood size while controlling the frequency of the highest frequency neighbor. The same stimuli were used in a lexical decision task (their Experiment 1) and a normal reading task (their Experiment 2). The opposite effects were found in the two tasks. The time of lexical response showed a facilitative neighborhood effect but the eye movement data showed inhibitory effects in gaze duration and total time on targets. In their further regression analyses of Experiment 2, the inhibitory effects in reading data were due to the cumulative effects of the number of higher frequency neighbors. This analysis also suggested a weakly facilitative influence exerted by the number of lower frequency neighbors. When the number of higher frequency neighbors was held constant in their Experiment 3, the manipulation of the number of lower frequency neighbors showed an inhibitory effect in total time on targets. However, the skipping rate of target words showed a facilitative effect, in which words with many lower frequency neighbors were skipped more than words with few lower frequency neighbors.

In the Pollatsek et al. (1999) study, the opposite neighborhood effects may reflect different stages of processing lexical similar representations. The inhibitory effects which were found in the late indices of eye movements may reflect a later stage of resolving lexical competition between neighbors, especially in cases in the context of higher frequency neighbors. The facilitative effects on both lexical decision time and the skipping rate of eye movements may reflect initial lexical activity in the early stage, mainly due to the number of lower frequency neighbors. However, it is also possible that the facilitative effect on skipping rate are actually due to the fact that a word with many neighbors increases the probability of misidentifying as its higher frequency neighbor when the word is in the parafovea. Consequently, the words are skipped more and the misidentification makes it more likely that the reader will regress back to target

words, thereby increasing the total time spent on reading target words (Pollatsek et al. 1999).

In the modern Chinese lexicon, over 76% of words are composed of more than one character. Chinese characters can be regarded as the perceptual unit of the Chinese written system (Hoosain 1991). In contrast to the letters in alphabetic languages that do not carry meaning, Chinese characters usually can map onto morphemes with clear boundary, making Chinese compound words monomorphemic or polymorphemic. Nevertheless, the relationships between the meaning of the constituted characters and the meanings of words containing them are often not apparent. Many studies have examined the role of morphological structure in the lexical representation of compound words (Taft, Liu & Zhu 1999, Taft & Zhu 1995, Zhou & Marslen-Wilson 1994, 1995, Zhou, Marslen-Wilson, Taft & Shu 1999). It has been proposed that the constituent morphemes of compound words have the representations at all orthographic, phonological, and semantic levels (Zhou & Marslen-Wilson 1994, 1995). The whole word representation for compound words exists only at the semantic level. When a visual compound word is presented, the semantic representations are accessed through the connections from the orthographic and phonological representations of constituent characters. The activated semantic representations include both the whole word and the constituent morphemes. Therefore, the semantic overlap of constituent morphemes and whole word affects the speed of lexical access. This model can account for the effects of morphological processing, indicating the influence of semantic similarity between whole word and constituent morpheme. Nonetheless, it is unclear whether the constituent characters in one compound word can activate all the compound words having the same character and what role the lexical activation plays in word recognition. This issue can be addressed by investigating the neighborhood size effect of Chinese compound words.

According to a Chinese word corpus, over 60% of two-character words have at least one neighbor, sharing a constituted character at the same position (Chinese word corpus of Academia Sinica Taiwan 1998). For those words with position-specific neighbors, more than half have six or more neighbors. For example, the word 大人 *dàrén* ‘adult’ has the largest number of neighbors in the corpus. It has 193 neighbors (termed N1) sharing the initial constituent character 大 *dà* ‘big’ (e.g., 大家 *dàjiā* ‘everybody’, 大眾 *dàzhòng* ‘the masses’, etc.) and 239 neighbors (termed N2) sharing the end constituent character 人 (e.g., 名人 *míngrén* ‘famous person’, 友人 *yǒurén* ‘friend’, etc.). Previous study has suggested that the contribution of the neighborhood size to lexical access may differ according to the character’s position within a compound word (Huang 2003). In this study, we computed the neighborhood size separately for each character position rather than the summation of neighborhood size at all positions.

The goal of the present study is to shed a light on the role of neighborhood size in

identifying Chinese words. The N1 effects of compound words were examined in a lexical decision task and a sentence reading task. Both experiments used the same set of two-character compound words as stimuli, manipulating N1 (small N1 vs. large N1) and word frequency (low frequency vs. high frequency) in a 2 by 2 design. The N2 was held constant across experiment conditions (the average value being 11). Experiment 1 employed a lexical decision task in which pseudo-words were created by concatenations of two characters that never occurred in the word corpus. The neighborhood size of pseudo-words was matched with those of real words. In experiment 2, the same target words were embedded in sentences and the eye movements were monitored while reading those sentences. Fixation times and skipping rates in the target word region were used to examine the neighborhood size effects. A facilitative N1 effect was expected in the latency of lexical decision if the words sharing the initial constituent were partially activated and lexical processing could benefit from the co-activations. Moreover, low frequency words should be more likely to show the N1 effects if any (Andrews 1989). Consistent with the predictions, the N1 effect should be observed in the eye movement data of normal reading. The different measures of eye movements indexing early or late processing might reveal the time course of neighborhood size effects in lexical access.

## **2. Experiment 1: Lexical decision task**

### **2.1 Methods**

#### **2.1.1 Participants**

A total of 20 university students were paid to participate in the experiment. They were all native Chinese speakers with normal or corrected vision.

#### **2.1.2 Stimuli**

A list of 120 two-character words was selected from the Academia Sinica Balanced Corpus (1998). The words were divided into four groups of 30 items, manipulating word frequency (low vs. high frequency) and neighborhood size N1 (small N1 vs. large N1; see Table 1). In addition, 120 pseudowords were created for the lexical decision task. Half of them have few word neighbors sharing the initial constituent character and the other half with many word neighbors sharing the initial constituent. The number of neighbors sharing the second constituent and the number of strokes of constituent characters were controlled across all conditions of words and pseudowords.

**Table 1:** Mean Value of Word Frequency and Neighborhood Size of Stimuli as a Function of the Conditions in Experiment 1 and 2

	Low frequency word	High frequency word	Pseudoword
<i>Word frequency(per million)</i>			
Small neighborhood size	0.37	46.7	--
Large neighborhood size	0.44	46.7	--
<i>Neighborhood size</i>			
Small neighborhood size	4.13	4.83	4.37
Large neighborhood size	57.93	56.10	44.70

### 2.1.3 Procedure

An IBM-compatible personal computer was used to present the stimuli. The width of a presented two-character word on the monitor subtended 2 degrees of visual angle. In each trial, a fixation point (+) appeared for 500ms before the stimulus was presented. When a two-character string was presented, participants were instructed to press an assigned button (*Yes*) if it was a real word and to press another button (*No*) if it was not a word. The string remained on the monitor up to a maximum of 1500ms or until the lexical decision was made. Once a button was pressed, the monitor went blank for 1500ms and followed by the next trial. The experiment took about 25 minutes to complete.

## 2.2 Results

The mean reaction times and average error rates were computed across participants and conditions. For real word conditions, analyses of variance (ANOVAs) with the within-subject factors of word frequency and neighborhood size N1 were performed on both RT and error rates. The pair t-tests were performed for the comparisons of pseudo-words with large N1 and those with small N1. The data of incorrect responses was excluded from the analyses of reaction time. The mean reaction times and error rates are presented in Table 2.

The main effect of word frequency was significant in the analyses of reaction time ( $F(1,19)=112.23$ ,  $p<.01$ ); the reaction time for high frequency words were 67ms faster than low frequency words. The main effect of N1 was significant ( $F(1,19)=4.50$ ,  $p<.05$ ); the reaction time for words with large N1 were 17ms faster than words with small N1.

The interaction of word frequency and N1 failed to reach significance ( $F(1,19) < 1$ ). The analysis of error rates revealed a main effect of word frequency ( $F(1,19) = 37.88, p < .01$ ), and an interaction effect of word frequency and N1 ( $F(1,19) = 6.25, p < .05$ ). The error rate for high frequency words was smaller than low frequency words. The simple effects showed that the error rate for words with large N1 was lower than those with small N1 only for low frequency words ( $F(1,38) = 7.37, p < .01$ ). For pseudo-words, the paired t-tests indicated that the responses for pseudo-words with large N1 was slower ( $t(19) = 3.26, p < .01$ ), and less accurate ( $t(19) = 4.31, p < .01$ ) than pseudo-words with small N1.

**Table 2:** Mean Value of Reaction Time and Error Rate in Experimental Conditions

	Low frequency word	High frequency word	Pseudo-word
<i>Reaction time (msec)</i>			
Small neighborhood size(N1)	677.31	606.63	693.37
Large neighborhood size(N1)	656.92	593.61	719.54
Difference	20.39	13.02	-26.17
<i>Error rate (%)</i>			
Small neighborhood size(N1)	8.23	1.01	2.84
Large neighborhood size(N1)	5.77	1.85	6.43
Difference	2.46	-0.84	-3.79

The results of lexical decision latencies clearly showed a facilitative neighborhood N1 effect of Chinese compound words and an opposite N1 effect for pseudo-words. The error rate analyses indicated that the facilitative N1 effects were more prominent for low frequency words than high frequency words. The findings were consistent with previous studies (Andrews 1989, 1992), suggesting that words sharing the initial constituent character are partially activated when presenting a Chinese compound word. The purpose of Experiment 2 was to determine whether the N1 effects could be consistently obtained in normal reading as well as in the lexical decision task.

### **3. Experiment 2: Sentence reading task**

#### **3.1 Methods**

##### **3.1.1 Participants**

A total of 40 university students were paid to participate in the experiment. None had taken part in the previous experiment. All of them were native Chinese speakers with normal or corrected vision.

##### **3.1.2 Stimuli**

The 120 two-character words for Experiment 1 were used as the target words which were embedded in sentences. These sentences were written in the length of 24 or 25 characters and the target words were located between the 11<sup>th</sup> and 16<sup>th</sup> character. As in Experiment 1, word frequency and neighborhood size N1 were manipulated. There were 30 sentences for each of the four conditions.

##### **3.1.3 Apparatus**

Eye movements were recorded by an EYELINK I eye-tracking system manufactured by SR Research Inc., sampling eye position at 250 samples/sec. The sentences were displayed on a ViewSonic PT795 monitor. The size of a character presented on the screen was 24 × 24 pixels, and there was a space of 8 pixels between characters. The viewing distance was 70 centimeters and the width of a character and the space before it subtended 0.9 degree of visual angle.

##### **3.1.4 Procedure**

Prior to the experiment, a nine-point calibration procedure was used for each participant. This procedure was to determine the correspondence between pupil position and gaze position. After the initial calibration, ten practice trials were presented and followed by 120 experimental sentences. A validation procedure was performed every three trials to check the accuracy in predicting gaze position from pupil position. The calibration procedure was performed again if the eye position had drifted which was detected in the validation procedure. At the beginning of each trial, a small circle was shown at the left-most position of the sentence on the centre of the monitor. The subject was asked to fixate on the circle first. Once the eyes had fixated on that location, the circle disappeared and the sentence was shown. Subjects pressed a button when they

understood the meaning of the sentence. A comprehension question followed one-third of the sentences. The experiment took about 45 minutes to be completed.

### 3.1.5 Data analysis

Chinese readers acquire information not only from the character to which the gaze is directed, but also from as much as 2.5 characters to the right (Inhoff & Liu 1998). Previous work has shown that the landing likelihood on low frequency words, immediately adjacent to the fixated character, was larger than on high frequency words (Tsai & McConkie 2003). This evidence indicates that the reader can perceive two-character words to the right of the fixated character. In the present study, viewing durations of a critical area comprised of the two-character target word and the preceding character were used to measure the neighborhood size effects. Three first-pass measures were used for indicating initial processing of Chinese two-character words. These measures include first fixation duration (the duration of the first fixation in the critical area), gaze duration (the sum of fixation durations on the target word before the eyes left the critical area), and skipping rate (the probability of initially skipping the critical area). One measure used to indicate late processing of words is the total viewing duration in the target area.

## 3.2 Results

Analyses of variance (ANOVAs) with the within-subject factors of word frequency and neighborhood size N1 were performed for all eye movement measures. The critical area's skipping rates, first fixation durations, gaze durations, and total viewing durations as a function of word frequency and neighborhood size N1 are shown in Table 3. The skipping rate of critical area was approximately 8% of the trials. The main effect of N1 on skipping rate was significant ( $F(1,39)=4.10$ ,  $p<.05$ ); words with many neighbors were skipped more than words with few neighbors. Neither the main effect of word frequency nor interaction approached significance ( $F_s<2.28$ ,  $p_s>.14$ ). Analyses of fixation durations showed that all measures revealed the main effect of word frequency: for first fixation duration,  $F(1,39)=6.92$ ,  $p<.05$ ; for gaze duration,  $F(1,39)=8.06$ ,  $p<.01$ ; for total viewing duration,  $F(1,39)=13.35$ ,  $p<.01$ . The fixation durations were shorter for high frequency words than for low frequency words. The main effect of N1 was robust in gaze duration ( $F(1,39)=36.23$ ,  $p<.01$ ), and marginally significant in first fixation duration ( $F(1,39)=2.89$ ,  $p<.10$ ). The total viewing duration failed to reach significance ( $F<1$ ). All duration measures showed that words with many neighbors were fixated on for a shorter time than words with few neighbors (Table 3).

None of the interactions was significant in the duration measures ( $F_s < 1.9$ ,  $p_s > .17$ ).

To summarize, the eye movement data showed that words with many neighbors were skipped more often and held a gaze for shorter periods than words with few neighbors. Moreover, the facilitative effect of neighborhood size N1 for high frequency words was as large as that for low frequency words. The facilitative N1 effects on skipping rate and gaze duration were consistent with those reported by Pollatsek et al. (1999) findings, although the gaze duration in their study showed only a small but insignificant effect. Our study showed no effect in total viewing duration, compared to the inhibitory effects reported in their results.

**Table 3:** Mean Value of Eye Movement Measures on Critical Area in Experimental Conditions and Effect Size of Word Frequency and Neighborhood Size N1

	Low frequency word		High frequency word		Word frequency effect	Neighborhood size N1 effect
	Small N1	Large N1	Small N1	Large N1		
Skipping rate	7.22 %	8.19%	8.03%	9.83%	-1.23 %	-1.39 %
First fixation duration	248.04	245.98	244.59	239.16	5.14	3.74
Gaze duration	337.20	313.89	322.05	300.96	14.04	22.20
Total viewing duration	394.74	398.62	370.87	360.69	30.9	3.15

#### 4. Discussion

This study shows the facilitative neighborhood effects of Chinese compound words in both the lexical decision times and the eye gaze durations. Our finding that lexical decision times were faster for words with many neighbors than words with few neighbors agrees with the findings of previous studies using the same task (Andrews 1989, 1992, Sears et al. 1995). We also observed the facilitative effects in both skipping rate and gaze duration when the same targets were embedded in sentences. The converging evidence across the two tasks suggest that the neighborhood effects reflect the process of lexical access rather than some decision process specific for task demand. Therefore, it is reasonable to conclude that words which share the initial constituent character are simultaneously activated when identifying a word. Moreover, the neighborhood of a word sharing the initial constituent character plays a supportive role in lexical access.

In our study, the neighborhood for Chinese compound words refers to those words

having the same character for the initial constituent unit. Our manipulation of neighborhood is similar to Lima & Inhoff's (1985) manipulation of "constraint", defined by the number of words having the same initial trigram. Studies have shown that words with less constraint (many words begin with the same trigram) had shorter first-pass durations than words with higher constraint (few words begin with the same trigram) (Lima & Inhoff 1985, Pynte 1996). The effects found in the early stage of lexical access have been interpreted as the involvement of the initial activation of a set of orthographically similar candidates. In our Experiment 2, the facilitative effects of neighborhood size in skipping rate and gaze duration also support this assumption. In fact, the early lexical activations coincide with the partial processing stage of "familiarity check" which is specified in the E-Z reader model of eye movements (Reichle, Pollatsek, Fisher & Rayner 1998). In this model, it was proposed that the first stage of familiarity check on a word triggers the saccadic programming for the next landing target. Therefore, the first-pass durations mainly reflect a partial stage of lexical processing rather than the completion of lexical access. The completion of lexical access may show in later "spillover" indices, like the fixation durations after leaving the target word or regressions back to it. More specifically, the familiarity checking of a word could be on the basis of the overall activation of similar lexical items, which are primarily determined by the word frequency and neighborhood size. Adopting the assumption of a familiarity checking mechanism in lexical access, the performance in lexical decision task might use the same process to signal the word-likeness of the stimulus (Perea & Rosa 2000). Similarly, the multiple read-out model has proposed an early phase influenced by the summed lexical activation that might account for the neighborhood size effects (Grainger & Jacobs 1996). As indicated in the read-out model for lexical decision or the E-Z reader model for eye movements, there is an early stage involving the overall activation of similar lexical items. Also, the decision of lexical judgment or moving eyes to the next location can rely on this partial processing rather than the completion of lexical access.

The present results found no evidence of inhibitory effects of neighborhood size in either the early or late measures of eye movements. In contrast, Pollatsek et al. (1999) found inhibitory N effects in the early measures of gaze durations when the manipulation of N was co-varied with the number of higher frequency neighbors in their Experiment 2. Similarly, in their Experiment 3, they found the inhibitory N effects in late measure of total time on target words when the manipulation of N was co-varied with the number of lower frequency neighbors. One possible explanation for their Experiment 2 finding is that inhibitory N effect on duration measures might simply be the consequence of higher skipping rate for words with large N. Words with large N were skipped more because of the misidentification of target word in parafovea as one

of the higher frequency neighbors (Pollatsek et al. 1999). Consequently, more time was needed to resolve the conflict once the misidentified word was processed in the central field. When the number of higher frequency neighbors was equal in their Experiment 3, the inhibitory effect of neighborhood size might reflect the competition among neighboring words in lexical selection. In our experiment, however, we did not find any effect indicating lexical competition among neighboring words. One possible explanation for our data is the semantic similarity in the neighborhood of Chinese words. For the neighboring English words defined by N, it is clear that the neighbors are orthographically similar but their meanings are divergent in most cases. Because words with many neighbors have more diverse meanings being activated, larger competition in lexical selection would be expected. In our study, the neighboring Chinese compound words refer to words sharing the initial constituent character. The constituent characters are often morphemes and the semantics of the constituent morphemes are transparent to word meanings in most cases. Therefore, the meanings for the neighboring words defined by sharing the initial constituent character could be similar, resulting in less competition in lexical selection.

It is worth noting that the extent of initial lexical activation may depend on the nature of lexical structure and the type of representations being activating. Models of visual word recognition usually assume there are orthographic, phonological, and semantic representations in the lexical structure. It is plausible to assume that the overall lexical activation is influenced by the activated representations in one or more levels. The facilitative effects of word neighborhood density have been demonstrated for orthographic similarity (see Andrews 1997, for a review). Moreover, facilitative effects have been shown for phonological neighborhood and semantic neighborhood (Locker, Simpson & Yates 2003, Yates, Locker & Simpson 2003, 2004). For Chinese compound words, the constituent characters can be morphemes. In contrast to initial English trigrams which mainly reflect orthographic similarity, the neighborhood size defined by the number of words sharing the constituent character in Chinese may reflect the lexical similarity at the form level, the semantic level, or both. This characteristic of Chinese words may be the reason that we find such robust facilitative effects in the present data. Further studies should be done to distinguish the neighborhood effects contributed from different levels of representations.

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# 中文詞在詞彙判斷與閱讀作業的鄰項個數效應

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本研究操弄中文雙字詞的鄰項個數與詞頻，來探討中文詞的詞彙處理歷程。在兩個實驗中，詞的鄰項個數定義為，詞彙中所有具有相同首字的詞個數。第一個實驗測量受試者對雙字詞的詞彙判斷時間，第二個實驗則使用相同刺激材料置於句子中，記錄受試者眼動的凝視時間。不論詞彙判斷的反應時間或閱讀的凝視時間，皆一致地發現低頻詞鄰項個數的促進效應：鄰項個數多的雙字詞，其詞彙判斷的反應時間較鄰項個數少的雙字詞快，在閱讀句子時較易被跳過，凝視時間也較短。本研究的結果顯示，詞彙辨識的過程中，其鄰項詞的表徵也會受到部分激發，且鄰項詞在早期階段對詞彙處理扮演支持性的角色。

關鍵詞：中文雙字詞，鄰項個數，詞彙判斷，眼動記錄