Available online at www.sciencedirect.com
SCIENCE DIRECT®
Brain and Language 88 (2004) 47–53
Brain and Language
www.elsevier.com/locate/b&l

Sublexical processing in visual recognition of Chinese characters: Evidence from repetition blindness for subcharacter components

Su-Ling Yeh* and Jing-Ling Li

Department of Psychology, National Taiwan University, No. 1, Sec. 4, Roosevelt Rd., Taipei 106, Taiwan, ROC

Accepted 13 May 2003

Abstract

Repetition blindness (RB) refers to the failure to detect the second occurrence of a repeated item in rapid serial visual presentation (RSVP). In two experiments using RSVP, the ability to report two critical characters was found to be impaired when these two characters were identical (Experiment 1) or similar by sharing one repeated component (Experiment 2), as opposed to when they were different characters with no common components. RB for the whole character occurred when the exposure duration was more than 50 ms with one intervening character between the two critical characters (lag = 1), whereas RB for subcharacter components was more evident at exposure durations shorter than 50 ms with no intervening character (lag = 0). These results provide support for the model of sublexical processing in Chinese character recognition.

Keywords: Visual word recognition; Chinese character; Component; Analytic processing; Repetition blindness; Sublexical processing

1. Introduction

Chinese characters are the basic writing units in Chinese script. They are different from linearly arranged alphabetic words in that each character consists of several parts combined into various structures, including left–right (e.g., 印), up–down (e.g., 昌), P-shaped (e.g., 庫), L-shaped (e.g., 廷), and enclosed (e.g., 固) structures (Yeh, Li, & Chen, 1997; Yeh, Li, & Chen, 1999; Yeh, 2000), and in that each character occupies a constant square-shaped space, irrespective of its structure and the number of strokes in the character. These aspects of Chinese writing have led to the holistic processing view, as it would then seem more efficient to also treat each same-sized character as a perceptually distinct unit for visual recognition (e.g., evidence from Chen, 1984; Cheng, 1981; Tzeng, Hung, Cotton, & Wang, 1979; Yu, Feng, Cao, & Li, 1990). Here we report, instead, evidence for an analytic processing view by adopting the repetition blindness paradigm (RB, Kanwisher, 1987).

RB is the failure to detect or report the second occurrence of a repeated item in rapid serial visual presentation (RSVP) when the repeated items are presented at a rate of 7–12 item/s, with a temporal lag of 0–3 intervening items. It has been shown that RB occurs for various stimulus types, including words presented in sentences and lists (Kanwisher, 1987; Kanwisher & Potter, 1990), letters presented in words, lists, and spatial arrays (Kanwisher, 1991; Kanwisher & Potter, 1990; Kanwisher, Driver, & Machado, 1995; Park & Kanwisher, 1994), colors (Kanwisher, 1991; Kanwisher et al., 1995), nonobject pictures (Arnell & Jolicoeur, 1997), object pictures (Kanwisher, Yin, & Wojciulik, 1999), sentences consisting of words & pictures (Bavelier, 1994), and homophones (Bavelier & Potter, 1992; Bavelier, Prasada, & Segui, 1994).

According to a leading hypothesis proposed by Kanwisher and her colleagues (the *token individuation failure hypothesis*, Kanwisher, 1987, 1991; Kanwisher & Potter, 1990; Park & Kanwisher, 1994), RB results from

* Corresponding author. Fax: +11-886-2-23629909.
E-mail address: suling@ccms.ntu.edu.tw (S.-L. Yeh).

0093-934X/$ - see front matter © 2003 Elsevier Science (USA). All rights reserved.
doi:10.1016/S0093-934X(03)00146-9

the failure to initiate two distinct episodic tokens from the same activated type within a short interval. When the first instance (critical item 1, C1[1] hereafter) has been individuated as a token related to a particular type (e.g., the word "ink," presented in the 5th position in RSVP), the token individuation of the second occurrence that belongs to the same type (e.g., "ink" shown in the 8th position) will be inhibited, causing "blindness" to the second, repeated item. Thus, the sentence "When she spilled the *ink* there was *ink* all over" may sometimes be reported as "When she spilled the *ink* there was all over" due to omission of the second token (C2) of the repeated type "ink," though at the sacrifice of grammar (Kanwisher, 1987). In this view, a general processing limit imposed on the visual system has been proposed for the mechanism of RB, and the language deficit described above is simply a manifestation of such a limitation.

Although this account of RB inevitably leads to the prediction that the occurrence of RB should be independent of language-related idiosyncrasies, whether that is correct, nevertheless, remains to be seen. Doubts arise because most studies of RB have been conducted with English words when verbal items were used. Though RB has also been reliably found for languages other than English, such as French (Bavelier et al., 1994), Spanish (Altarriba & Soltano, 1996), and German (Kammer et al., 1998), these languages all employ alphabetic systems. As far as we know, there are no published findings or consensus as to whether Chinese characters, a logographic script, can also produce RB.

We have found in a previous study (Yeh & Li, 2001) some signs of RB for repeated subcharacter components.[2] In the particular experiment (Experiment 1) that is relevant to the current study, two different Chinese characters were shown successively in an orthographic priming paradigm. When the target character had one component in common with the preceding prime character, the target character was sometimes reported as the leftover component or a new compound character that combined the leftover component with another, unpresented component. Since the occurrence of RB depends on the identity of the two critical items, the existence of component RB indicates that subcharacter components are also treated in the mental lexicon as independent types during the course of character recognition. Therefore, the finding of component RB, if confirmed, will be very intriguing, for it poses an important theoretical question on the relative roles that the whole character and its constituent components play in Chinese character recognition.

[1] We followed the convention in RB literature (e.g., Kanwisher, 1991) by labeling the first and second critical items as C1 and C2, respectively.

[2] By component we mean either the radical that conveys the meaning or the phonetic that carries the sound of the whole character.

The primary goal of this study was to examine whether RB for Chinese characters and for subcharacter components indeed exists when a conventional RB paradigm is used (e.g., Park & Kanwisher, 1994). Establishing this is important, as the component RB reported in Yeh and Li (2001) was discovered quite by accident, and not under the conventional RB paradigm. In that experiment, only two characters were shown and an orthographic priming task was used. Also, there were no nonrepeated control pairs to provide the baseline comparison against which to evaluate the performance of the repeated condition when C2 remained the same in the repeated and nonrepeated conditions, the importance of which has been stressed in recent RB literature (e.g., Downing & Kanwisher, 1995). For these reasons, we conducted two experiments in this study by following the RB paradigm to examine whether RB can also be found with Chinese characters. Two kinds of RB were explored here: one is character RB (C1 and C2 were identical characters), and the other is component RB (C1 and C2 were similar in that they shared one common component). The second goal of this study was then to examine the relative time courses of character RB and component RB by manipulating the exposure duration of each item and the lag between C1 and C2. It was predicted that both character RB and component RB should be observed, but under different conditions. Particularly, component RB should be associated with shorter exposure duration than character RB if there exists sublexical processing in Chinese character recognition.

2. Experiment 1

To provide the basic measurement of RB with Chinese characters, repetition at the character level and at the subcharacter component level were first examined within the same experimental framework. Items presented in RSVP included Chinese characters and symbols, and only the characters were to be reported. To reduce memory load so as to avoid possible confounding variables involved with memory, only two or three characters were shown in each RSVP sequence. For the repeated trials at the character level, C1 and C2 were identical characters. For the repeated trials at the component level, they were similar characters that had a repeated component. Their nonrepeated control conditions were constructed by replacing C1 with another completely different character. C1 and C2 were separated by another character, namely, a lag-1 condition.

2.1. Method

2.1.1. Participants

Forty-eight native speakers of Mandarin Chinese, all undergraduates at National Taiwan University, participated in this experiment in exchange for course credit.

2.1.2. Materials and apparatus

The RSVP sequence consisted of 2–3 Chinese characters in the Si-Ming style and 4–5 symbols that can be easily discriminated from the characters, extended about $1.2° \times 2.1°$ at a viewing distance of 55 cm. The fixation was a "+" sign, roughly equal in size to the character. Only one stimulus was presented in each frame, and it was a white character displayed in the center of a black background. For each RSVP sequence, there were 7 items in total, with the first and last positions being filled with symbols. C2 was always in position 6. C1 was presented variably in positions 2, 3, or 4. C1 and C2 were separated by another character as well as 1 or 2 symbols. The experiment was controlled by an IBM-compatible 486 MHz personal computer, and the stimuli were displayed on a 20-inch Eizo color monitor with a refresh rate of 70 Hz. Normal lighting was provided in the experimental chamber.

2.1.3. Design

For the character condition, a list of 48 characters, in which C1 and C2 were identical characters, was first built (the repeated–identical, R–I condition). Two other sets of characters were then established by either replacing C1 with a nonrepeated character (the nonrepeated–identical, N–I condition) or with a blank (the blank–identical, B–I condition). For the component condition, another set of 48 characters, in which C1 and C2 were different characters with one repeated component, was constructed (the repeated component, R–C condition), along with the associated nonrepeated control condition (the N–C condition) and the blank condition (the B–C condition).

For each set of R–I vs. N–I, as well as R–C vs. N–C, target and control characters were matched in their frequency of occurrence and number of strokes, $Fs < 1$. The characters selected were listed in Tsai (1996) as having middle to high frequency of occurrence and from the two most frequently used structures, horizontal and vertical. Target and control characters did not necessarily have the same structure. No homophones or synonyms existed for the characters shown in each RSVP sequence. Also, no sequence was comprised of characters that formed a two-character or three-character word.

The six variants of each list (R–I, N–I, B–I, and R–C, N–C, and B–C) appeared in three different versions (i.e., a yoked design) and were counterbalanced between participants. Therefore, the three versions of experimental trials were presented to three groups of participants, with 16 participants in each group viewing the same versions of 96 lists. The presentation order of the 96 trials for each participant was completely randomized. Each item was presented for 57 or 86 ms in RSVP, and the exposure duration was a between-subjects factor.

2.1.4. Procedure

Each trial was initiated by the participant's pressing the space bar. A fixation plus was first presented for 800 ms, followed by the RSVP sequence containing the stimuli, and then followed by the same fixation plus, signaling the end of the trial. Participants were told that each trial contained either 2 or 3 characters, and they should write down all the characters they saw within each RSVP sequence. They were also told that some trials contained repeated characters, and if they saw the same character twice they should write down that character twice. Each participant conducted eight practice trials before the 96 formal trials.

2.2. Results and discussion

We followed the conventional calculation of joint probability by counting the percentage of correct reports of C1 and C2 when both were correct, due to the fact that the exact order was difficult to decide when an item list such as ours was used (e.g., Kanwisher et al., 1999; Kanwisher, 1991). As the blank conditions (i.e., the B–I and B–C conditions) were simply used as fillers, data in these conditions were excluded from analysis.

A three-way analysis of variance (ANOVA, Chen & Cheng, 1999) was conducted on the factors of exposure duration (57 vs. 86 ms), repetition (yes vs. no), and type (character vs. component). The results showed a lower degree of accuracy in the repeated condition (74%) than in the nonrepeated condition (83%), $F(1,46) = 24.809$, $MSE = 4.233$, $p < .0001$. Also, accuracy was lower in the character conditions (77%) than in the component conditions (83%), $F(1,46) = 35.198$, $MSE = 23.49$, $p < .0001$. The accuracy was improved (from 72 to 86%) as the exposure duration was lengthened (from 57 to 86 ms), $F(1,46) = 30.711$, $MSE = 7.913$, $p < .0001$.

There were also interaction effects of exposure duration and repetition ($F(1,46) = 4.429$, $MSE = 4.233$, $p < .05$), as well as repetition and type ($F(1,46) = 14.817$, $MSE = 3.657$, $p < .0005$). Further analysis of the interaction effects indicated that there were simple main effects of repetition at exposure durations of 57 ms ($F(1,46) = 25.101$, $MSE = 4.233$, $p < .0001$) and 86 ms ($F(1,46) = 4.136$, $MSE = 4.233$, $p < .05$). The accuracy at 57 ms was lower than at 86 ms for the repeated condition ($F(1,92) = 32.666$, $MSE = 6.073$, $p < .0001$) and nonrepeated condition ($F(1,92) = 10.436$, $p < .005$). In the repeated condition, accuracy in reporting the repeated character was lower than for the repeated component ($F(1,92) = 45.077$, $MSE = 3.003$, $p < .0001$). For the character condition, accuracy for a repeated character was lower than for a nonrepeated character ($F(1,92) = 39.299$, $MSE = 3.945$, $p < .0001$), indicating RB for characters. However, for the component condition, there was no significant difference in accuracy for a repeated component versus a nonrepeated component ($F(1,92) = 1.056$, $p = .307$), indicating no RB for components.

These trends of statistical analysis can be depicted as in Fig. 1, which plots the percent correct of C1 and C2 as a function of exposure duration. As is clear from this figure, a general pattern can be seen: accuracy improves with exposure duration for all four conditions. More important, the accuracy in the R–I condition was lower than that in the N–I condition, indicating an effect of RB for identical characters. However, there is no indication of component RB, as the accuracy in the R–C condition was not different from that in the N–C condition.

Therefore, we have established the case for RB for Chinese characters, using the RB paradigm, by showing that repeated characters were more difficult to report than nonrepeated ones. The lack of component RB, however, seemed to be at odds with our previous results (Yeh & Li, 2001). There are three possible explanations for the lack of component RB in this experiment. First, if components are processed first and then combined to form the whole character, the finding of character RB but not component RB in this experiment may be due to the fact that the range of exposure durations used was in favor of the whole character, but not the component. Such a trend may be more evident when repetition at both the character level and the component level is manipulated within the same experimental framework, which may, presumably, increase the contrast between the two levels of processing. In the next experiment, only repetition at the component level was used, and the exposure duration was reduced to see whether component RB could then be observed. Second, in this experiment, C1 and C2 were separated by another character (i.e., lag = 1), which may also override the processing of components if it occurs very early, as expected by the analytic view. This is hinted at by the fact that in Yeh and Li (2001) there was no lag between the two characters. Accordingly, a lag 0 condition was also added in the next experiment to explore whether component RB was more likely to occur when no intervening characters were presented between the two critical characters. Third, component RB may be sensitive to the relative positions of the repeated components in the whole character. That is, character structure may impose a constraint on the occurrence of component RB. To avoid this possible confounding condition, C1 and C2 were then controlled to have the same structure; only horizontal characters were used in the next experiment.

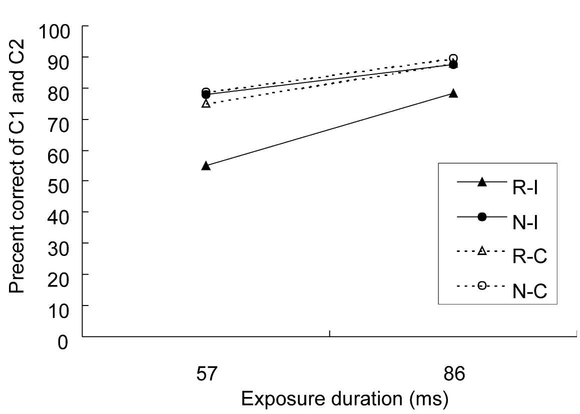

Fig. 1. Percent correct of C1 and C2 at different exposure durations for repeated identical characters (R–I), repeated-components (R–C), and their control conditions (N–I and N–C) in Experiment 1.

3. Experiment 2

3.1. Method

3.1.1. Participants

Forty-two undergraduates at National Taiwan University participated in this experiment to earn extra course credits. None had participated in the previous experiment.

3.1.2. Stimulus and procedure

Each RSVP sequence consisted of 6 items, including 2–3 Chinese characters and 3–4 symbols. We manipulated three factors: repetition (repeated, nonrepeated), lag (0, 1), and exposure duration (29, 43, and 71 ms). Repetition and lag were within-subject factors, and duration was a between-subject factor. There were 26 trials with repeated conditions and 26 trials with nonrepeated conditions, all of which contained 3 characters and 3 symbols. C2 in the repeated and nonrepeated conditions remained the same, and it was viewed by two groups of 7 participants in each. Another 26 filler trials, which contained 2 characters and 4 symbols, were constructed. C1 and C2 were both horizontal characters. They shared one repeated component in the repeated trials and had no common component in the nonrepeated trials. For the lag-1 trials, C1 and C2 were separated by one character and one symbol, and the intervening characters were vertically structured. For the lag-0 trials, C1 and C2 were separated by a symbol. For the two characters in the filler trials, the first one was a vertical character, and the second, a horizontal character. The participants were asked to write down all the characters as they had seen in each RSVP. Note that in this experiment there was no repetition at the character level, so that even if the participants saw two different characters with a common component, they should not have trouble writing down the two characters (same as has been done for orthographic repetition blindness in English, Harris & Morris, 2000). Other details were the same as described in Experiment 1.

3.2. Results and discussion

The percent correct of C1 and C2 as a function of exposure duration is shown in Fig. 2. ANOVA showed that there were main effects of exposure duration ($F(2,18) = 8.177$, $MSE = 0.069$, $p < .005$), repetition ($F(1,18) = 47.080$, $MSE = 0.015$, $p < .0001$), and lag ($F(1,18) = 8.871$, $MSE = 0.013$, $p < .01$), as well as the interaction effect of repetition and lag ($F(1,18) = 8.364$, $MSE = 0.020$, $p < .01$). Planned comparison (Tukey test) showed that the difference between the accuracy at 29 ms was lower than at 43 and 71 ms, $ps < .01$, but there was no difference between the accuracy at the latter two durations.

Further analysis of the interaction effect of repetition and lag indicated that there were simple main effects of lag in the nonrepeated condition ($F(1,36) = 16.956$, $MSE = 0.016$, $p < .0005$), but not in the repeated condition ($F < 1$). There were also simple main effects of repetition at lag 0 ($F(1,36) = 44.813$, $MSE = 0.017$, $p < .0001$) and lag 1 ($F(1,36) = 5.479$, $MSE = 0.017$, $p < .05$).

This pattern of results thus demonstrates the existence of component RB. Also, it was more evident when there was no intervening character between the two critical characters and when each character was presented very briefly. Further analysis by subtracting the accuracy in the repeated condition from that in the nonrepeated condition (i.e., RB) has confirmed this. There was a main effect of lag ($F(1,39) = 53.553$, $MSE = 5.62$, $p < .0001$), as well as an interaction effect of lag and duration ($F(2,39) = 6.882$, $MSE = 5.62$, $p < .005$). At the duration of 29 and 43 ms, the difference in the magnitude of RB was significant ($F(1,39) = 39.661$, $MSE = 5.62$, $p < .0001$ and $F(1,39) = 26.03$, $MSE = 5.62$, $p < .0001$, respectively). No significant difference was found when the exposure duration was 71 ms ($F(1,39) = 1.627$, $MSE = 5.62$, $p = .21$). There was a simple main effect of duration at lag 0 ($F(2,78) = 6.123$, $MSE = 5.79$, $p < .005$), but not at lag 1 ($F(2,78) = 1.632$, $MSE = 5.79$, $p = .219$). At lag 0, the magnitude of component RB was higher at 29 and 43 ms than at 71 ms, $ps < .05$.

An advantage we had in our task was that we asked the participants to write down all the characters they saw in each trial; thus, the error patterns could be further analyzed to reveal meaningful information that may be disguised in verbal reports. In the erroneous trials, typical component RB was observed as follows. For example, when C1 and C2 were 誠 and 諸, the participants wrote down 者, 賭, or 堵 as C2. That is, the repeated component (言 in this case) was either omitted (thus leaving the leftover component, 者), or replaced by another component (thus causing 賭 or 堵 to be reported). Note that in this example, all the misreported C2 (者, 賭, and 堵) are also existing characters. Similar examples can be seen, as in 油-治 for 台 and 胎, 訴-語 for 吾 and 悟. There were also examples in which the presumed leftover, nonrepeated component was not an actual character. In these cases, only erroneous actual characters formed by combining the leftover component with another component were observed, such as 險-臉 for 脂, 揚-湯 for 濟, and 詳-群 for 郡. In addition to the statistical analysis comparing the accuracy in the repeated condition vs. the nonrepeated condition, these examples provide further evidence to confirm the existence of component RB. In fact, 27.47% of the erroneous responses fell into this category in the lag-0 condition, and 9.89% in the lag-1 condition. The majority of the erroneous responses were blank in the repeated condition. This also indicates possible component RB, as some participants reported that something seemed to be there, but it was hard for them to remember what it was. The same situation did not occur in the nonrepeated trial, yet the same C2 had been used in these two conditions. Since there were no identical characters in this experiment, the blank response for C2 was clearly caused by the existence of the repeated component in C1.

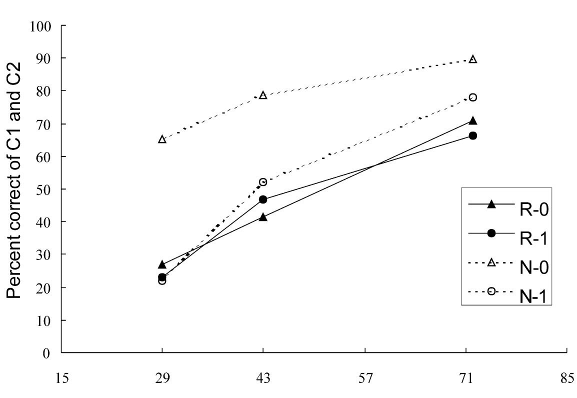

Fig. 2. Percent correct of C1 and C2 at different exposure duration for repeated-component at lag 0 (R-0) and lag 1 (R-1), as well as their control conditions (N-0 and N-1) in Experiment 2.

4. General discussion

We have demonstrated in this study that repeated Chinese characters were more difficult to detect than nonrepeated ones, a phenomenon of RB also found in Chinese logographs, indicating that RB is insensitive to language-related idiosyncrasies. This is important since written Chinese provides a salient contrast with other alphabetic systems, which have been used as the major stimulus materials in existing RB literature. More significantly, RB occurred not only for identical characters, but also for similar characters that shared one repeated component. These, taken together, constitute the first findings of both character RB and component RB in the same study by adopting the conventional RB paradigm.

Several methodological advantages in this study are worth mentioning. First, our success in observing RB for Chinese characters, especially for component RB, may be largely due to the low memory load in the recall of the RSVP sequence. Participants were required to report up to three characters in this study. This may be critical because a high memory load may interfere with the processing of components. The need to reduce memory load in order to observe the effect of repetition has also been observed and emphasized in the auditory counterpart of RB, repetition deafness (e.g., Soto-Faraco & Sebastian-Galles, 2001). Second, by asking the participants to write down the characters, the erroneous pattern of misreported characters obtained in Experiment 2 can be used to further confirm the true existence of component RB, in addition to quantitative measurement by summing up all the incorrect responses as done conventionally. This may shed some light on the controversy of whether RB for similar words (e.g., fish and dish) occurred at the word level (i.e., by treating two similar words as the same type, Chialant & Caramazza, 1997) or at the letter level (i.e., RB for repeated letters, Morris & Harris, 1999). Our results obviously support the latter view.

Besides the methodological caveats for observing RB with Chinese characters, the manipulations of exposure duration and lag in this study also manifest important theoretical points. The time windows for observing component RB and character RB were different, which indicate different processing speeds for components and for whole characters during visual character recognition. Combining the results of Experiment 1 and 2, we can see that when the presentation speed was relatively slow (>50 ms/item) and there was one intervening character, only RB for repeated character was found, whereas at higher speeds (<50 ms/item) with no intervening characters, RB for subcharacter component was then observed. It thus seemed that components, though embedded within the whole character, had also been identified as independent types at an earlier stage than the identification of the whole character.

This result is consistent with the view that sublexical processing occurred relatively early in Chinese character recognition (Chen, Allport, & Marshall, 1996; Feldman & Siok, 1999; Pollatsek, Tan, & Rayner, 2000; Taft & Zhu, 1997; Zhou & Marslen-Wilson, 1999). Most noticeably, in the RB paradigm employed here, the participants were required to report the whole character, yet component RB still occurred, indicating that the subcharacter components had been processed as recognizable units even though this was not part of the task demand. This pattern of results therefore argues against the holistic view that each character is treated as a unit of processing, without the need to go through the level of component processing (e.g., Yu et al., 1990).

References

Arnell, K. M., & Jolicoeur, P. (1997). Repetition blindness for pseudoobject pictures. *Journal of Experimental Psychology: Human Perception and Performance, 23*, 999–1013.

Altarriba, J., & Soltano, E. G. (1996). Repetition blindness and bilingual memory: Token individuation for translation equivalents. *Memory and Cognition, 24*, 700–711.

Bavelier, D. (1994). Repetition blindness between visually different items: the case of pictures and words. *Cognition, 51*, 199–236.

Bavelier, D., & Potter, M. C. (1992). Visual and phonological codes in repetition blindness. *Journal of Experimental Psychology: Human Perception and Performance, 18*, 134–147.

Bavelier, D., Prasada, S., & Segui, J. (1994). Repetition blindness between words: Nature of the orthographic and phonological representations involved. *Journal of Experimental Psychology: Learning, Memory and Cognition, 20*, 1437–1455.

Chialant, D., & Caramazza, A. (1997). Identity and similarity factors in repetition blindness: Implications for lexical process. *Cognition, 63*, 79–119.

Chen, H. C. (1984). Character detection in reading Chinese: Effects of context and display format. *Chinese Journal of Psychology, 26*, 29–34.

Chen, H. C., & Cheng, C. M. (1999). ANOVA and trend analysis statistical program for cognitive experiment. *Research in Applied Psychology, 1*, 229–246.

Chen, Y. P., Allport, D. A., & Marshall, J. C. (1996). What are the functional orthographic units in Chinese word recognition. The stroke or stroke pattern? *The Quarterly Journal of Experimental Psychology, 49A*, 1024–1043.

Cheng, C. M. (1981). Perception of Chinese characters. *Chinese Journal of Psychology, 23*, 137–153.

Downing, P., & Kanwisher, N. (1995). Types and tokens unscathed; A reply to Whittlesea, Dorken, and Podrouzek (1995) and Whittlesea and Podrouzek (1995).. *Journal of Experimental Psychology: Learning, Memory and Cognition, 21*, 1698–1702.

Feldman, L. B., & Siok, W. W. T. (1999). Semantic radicals contribute to the visual identification of Chinese characters. *Journal of Memory and Language, 40*, 559–576.

Harris, C. L., & Morris, A. L. (2000). Orthographic repetition blindness. *The Quarterly Journal of Experiment Psychology, 53A*, 1039–1060.

Kammer, T., Saleh, F., Oepen, G., Manschreck, T., Seyyedi, S., Kanwisher, N., Furmanski, C., & Spitzer, M. (1998). Repetition blindness in schizophrenic patients. *European Archives of Psychiatry and Clinical Neurosciences, 248*, 136–140.

Kanwisher, N. G., Yin, C., & Wojciulik, E. H. (1999). Repetition Blindness for Pictures: Evidence for the Rapid Computation of Abstract Visual Descriptions. In V. Coltheart (Ed.), *Fleeting memories* (pp. 119–150). Cambridge, MA: MIT Press.

Kanwisher, N. (1987). Repetition blindness: type recognition without token individuation. *Cognition, 27*, 117–143.

Kanwisher, N. (1991). Repetition blindness and illusory conjunctions: Errors in binding visual types with visual tokens. *Journal of Experimental Psychology: Human Perception and Performance, 17*, 402–421.

Kanwisher, N., & Potter, M. (1990). Repetition blindness: Levels of processing. *Journal of Experimental Psychology: Human Perception and Performance, 16*, 30–47.

Kanwisher, N., Driver, J., & Machado, L. (1995). Spatial repetition blindness is modulated by selective attention to color or shape. *Cognitive Psychology, 29*, 303–337.

Morris, A. L., & Harris, C. L. (1999). A sublexical locus for repetition blindness: Evidence from illusory words. *Journal of Experimental Psychology: Human Perception and Performance, 17*, 404–421.

Park, J., & Kanwisher, N. (1994). Determinants of repetition blindness. *Journal of Experimental Psychology: Human Perception and Performance, 20*, 500–519.

Pollatsek, A., Tan, L. H., & Rayner, K. (2000). The role of phonological codes in integrating information across saccadic eye movements in Chinese character identification. *Journal of Experimental Psychology: Human Perception and Performance, 26*, 607–633.

Soto-Faraco, S., & Sebastian-Galles, N. (2001). The effects of acoustic mismatch and selective listening on repetition deafness. *Journal of Experimental Psychology: Human Perception and Performance, 27*, 356–369.

Taft, M., & Zhu, X. (1997). Submorphemic processing in reading Chinese. *Journal of Experimental Psychology: Learning, Memory and Cognition, 23*, 761–775.

Tsai, C.H., 1996. Frequency and stroke counts of Chinese characters [On line]. Available http://casper.beckman.uiuc.edu/c-tsai4/chinese/charfreq.html,visited on 8/31/1999.

Tzeng, O. J. L., Hung, D. L., Cotton, B., & Wang, W. -Y. (1979). Visual lateralisation effect in reading Chinese characters. *Nature, 282*, 499–501.

Yeh, S. L., Li, J. L., & Chen, I. P. (1997). The perceptual dimensions underlying the classification of the shapes of Chinese characters. *Chinese Journal of Psychology, 39*, 47–74.

Yeh, S. L., Li, J. L., & Chen, K. M. (1999). Classification of the shapes of Chinese characters: Verification by different pre-designated categories and varied sample sizes. *Chinese Journal of Psychology, 41*, 65–85.

Yeh, S. L. (2000). Structure detection of Chinese characters: Visual search slope as an index of similarity between different-structured characters. *Chinese Journal of Psychology, 42*, 191–216.

Yeh, S. L., & Li, J. L. (2001). Repetition blindness for radical: The main cause of the inhibitory orthographic priming effect in Chinese-character recognition. *Perception (suppl.), 30*, 112.

Yu, B., Feng, L., Cao, H., & Li, W. (1990). Visual perception of Chinese characters—Effect of perceptual task and Chinese character attributes. *Acta Psychologica Sinica, 2*, 141–147.

Zhou, X., & Marslen-Wilson, W. (1999). The nature of sublexical processing in reading Chinese characters. *Journal of Experimental Psychology: Learning, Memory and Cognition, 25*, 819–837.