Orthographic Knowledge of Chinese

in Adults of 40 to 65 years

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Abstract

The present study investigated the role of Chinese orthography in the organization of the mental lexicon. In the experiment, four radicals used to carry semantic information and four phonetics used to carry phonological information in pictophonetic characters were presented. Subjects were asked to generate characters that contain the given radicals or phonetics in one minute and write them down. In analysis of variance, there were no significant effect of sex and stimulus types i.e. radicals or phonetics but a significant effect of the size of the pool (i.e. the number of characters containing the given radicals or phonetics a subject knows) on the number of characters retrieved. The findings support a view that the orthographic organization of mental lexicon of Chinese is evident.

There are a number of models of lexical organization (e.g. McClelland and Rumelhart, 1981; Caramazza, Laudanna and Romani, 1988). Many of them suggest that the lexicon is stored in a network where component features serve as units. Spreading occurs when these units are activated.

Opinions vary as to what is/are the basic unit(s) of activation. Priming studies conducted by Laudanna, Badecker and Caramazza (1989) and Napps and Fowler (1987) found that the lexical organization was morphologically rather than orthographically based. However, in other priming studies, (e.g. Lupker and Williams, 1989) orthographic and phonological organization of the lexicon was evident. Glushko (1979) in an experiment on reading aloud, found that when a word was presented, pronunciation of orthographically similar words would be activated. This finding supports the idea that in adults, orthographic relations exist in the mental lexicon.

At this stage, no single model can explain satisfactorily all empirical findings. Information associated with words includes letters, letter clusters, phonetic patterns, semantic features, and syntactic relations. As Taylor and Taylor (1990, p.175) point out, each of these features is associated not only with a single word, rather the features are shared among different words in a distributed representation. When a word is presented, other words sharing some of the features will be activated.

However the findings are based on alphabetic languages such as English. One may question how generalizable it is to logographic languages such as Chinese. Before answering this question, it is important to understand differences between English and Chinese.

Traditionally, Chinese has been viewed as a logographic language lacking correspondence between spelling and sound. Characters occupy a square space and each stands for a morpheme - the smallest meaningful unit. Its inflectional system does not develop as systematically as English and the inflections stand alone as a separate character e.g. '緊' /gan/ (the progressive aspect marker) is a free morpheme not bound as English '-ing' is. English, by contrast, has a well developed inflectional system and a systematic, though non- transparent relationship, between spelling and sound. The letter strings in English are arranged sequentially. On the surface, morphological or phonological information looks hard to obtain from a written character and Chinese characters are processed as a whole. However, clinical studies of Chinese dysgraphic or dyslexic patients do not support this notion. Rather than losing the whole representation of the character, dysgraphic patients produce attempts at characters that retain some of the features of the original ones e.g. '鎖' instead of '鏡' Morpho-semantic component retained), and '跐' instead of '從' (phonological component retained) (Huang, 1984).

In fact, a large percentage of Chinese characters are of the pictophonetic/semantic- phonetic type i.e. a compound character where one component, the radical, carries the semantic information and the other component, the phonetic, carries information about the pronunciation. According to DeFrancis (1989), in the 18th century, 97% of the characters found in the great imperial Kang Xi dictionary are pictophonetic. He claims that phonological coding is by no means impossible in reading Chinese. However, unlike English, where sound to spelling correspondence is made between letters or letter clusters and phonemes, in Chinese the correspondence is made between a phonetic orthograph and a syllable. Defrancis believes that the phonetic gives more specific clues than the radical which, at best, suggests only a general semantic area.

DeFrancis' claim is supported by empirical evidence. Chinese readers are able to guess at the pronunciation of an unknown characters by making use of the phonetic. Further evidence for phonological coding by means of the phonetic comes from studies on naming and short term memory (STM). In 1985, Seidenberg found that the naming latencies for low frequency pictophonetic word were shorter than for low frequency non-pictophonetic words. It indicated that phonological coding occurred in accessing the low frequency words. Moreover, phonemic similarity affects the visual processing of Chinese characters (Tzeng and Hung, 1977).

In 1979, Glushko proposed a model of reading aloud called activation synthesis model and made the following claim:

'As letter strings are identified, there is parallel activation of orthographic and phonological knowledge from a number of sources in memory. This knowledge may include stored pronunciation of the letter string, pronunciation of words that share features with the letter string, and information about the spelling-to-sound correspondence of various subparts of the letter strings'. [p.678]

Many researchers (Tzeng et al, 1986; Seidenberg, 1985; Lien 1985 in Chen, 1986) suggested that this model laid the foundation of the phonological system for reading Chinese. Phonological coding of Chinese character is based on one of the subunits of the character - the phonetic.

The above evidence show that the organization of lexicon is similar in Chinese and English,being based on smaller units of a word or character. However, the unit of processing is less defined in Chinese. Though some studies have shown that the phonetic is probably one candidate for processing, very few people have made comments on the functions of the other subunit of a character - the radical. The presence of radical makes Chinese very different from English because there is no such similar component in English that is not pronounced. In the present study, it is made use of the unique properties of the radical and phonetic to investigate the organization of the mental lexicon of Chinese.

Many of the radicals and phonetics composing a pictophenetic character are themselves independent characters. When they stand alone, their status is equal, i.e. the relationship between the meaning or phonology and its form is opaque. Viewing each as a whole seems to be the only way to access its representation. If it is true that Glushko's model is applicable to reading Chinese, then we should observe that when a radical or phonetic is presented, characters that share the component will also be activated. The activation will be similar if they are viewed in orthographic form only. However, phonologically or semantically related words e.g. homophones, synonyms, may also be activated if this information is decoded when the character is presented. It has been mentioned that a pictophonetic character used to have its meaning related to the radical it contains and its pronunciation related to the phonetic. Thus, for radicals, its semantic information will be more useful than the phonological information in retrieving pictophonetic characters containing it. For phonetics, it will be the opposite. By comparing the effect of radicals and phonetics on retrieval, we can get clues about the roles played by the phonological and semantic information, other than the orthographic information, in character retrieval.

A procedure similar to verbal fluency tasks used to examine semantic memory was employed. The difference lies in the fact that the input and output mode was visual (written characters) rather than verbal. Radicals and phonetics were presented and subjects were asked to generate characters containing the given radical or phonetic.

In the present study, subjects were not required to process the radicals or phonetics deeply. Therefore, the meaning or pronunciation may not be decoded. However, speech recoding is evident in memorising characters and might help in working memory (Tzeng, Hung, and Wang, 1979). This suggests that phonological information would likely to be decoded. I hypothesize with the decoding of phonological information, phonologically similar characters may be activated. Since phonologically similar characters used to carry the same phonetic but not radical, the retrieval cued by the phonetic may be enhanced with phonological decoding. On the contrary, decoding of meaning information will not enhance much on the retrieval for radicals because a the radical only suggests a general semantic area. A high proportion of characters it activated may not contain it e.g. the radical '足' (foot) may activate the character '行' (walk) which does not contain the radical '足'.

Consequently, there were two hypotheses : (1) A phonetic will be more effective than a radical in cueing character retrieval. (2) The size of the memory storage of characters containing the given radicals or phonetics (referred as 'the size of pool' in the following discussion) will have an effect on the number of characters one can retrieve.

Method

Subjects

Thirty adults (15 males and 15 females), native speakers of Chinese aged between 40 to 65 years, served as volunteer subjects. All subjects had normal or corrected vision and were right-handed. Their formal education ranged from no education up to form five and reading habits varied considerably from daily reading to nil. All of the subjects passed in screening task described below.

Screening

A screening procedure was conducted to ensure that the writing speed did not interfere with the results. Each subject was asked to copy ten characters as fast and as clearly as possible. Those who could write the ten characters within one minute were accepted. Totally thirty subjects were tested and all were accepted.

Stimuli

(a) Characters generation task.

The stimuli were four radicals, each with six to nine strokes and four phonetics, each with five to eight strokes. These high frequency characters can be used independently and the frequency index was determined with reference to the Commercial Press New Dictionary (1991). They were

'米', '足', '雨', '食', '包', '古', '各', and '者'. Each was carefully selected on the basis of their frequency, meaningfulness, imageability, specificity, pronunceability, and size of the pool of compound characters containing the same radicals or phonetics that people know. The phonetics selected tend to be less imageable and meaningful than the radicals. Their meanings are less defined but become more transparent when they combine with another character to form a multisyllabic word.

(b) Recognition task: Size of the pool.

The stimuli was a list of characters containing the four radicals and four phonetics used in the characters generation task.

Procedures

Subjects were tested individually. Each was given the same four radicals and four phonetics consecutively; each radical/phonetic being on a separate card. The cards were presented one at a time. Subjects were asked to write down as many characters containing that radical/phonetic as they could in one minute. Before the experimental trials, they were reminded of the strategies they could use to retrieve the characters. They were told that they could think of the characters in a variety of ways: by form, by meaning and/or by sound. Illustrations with examples were provided. Before presentation of the phonetics, the subjects were again reminded of strategies to use in character retrieval. When all the experimental trials were finished, the subject was asked to complete a checklist on the strategies they used (see Appendix 1). Then, the list of characters comprising of the radicals or the phonetics were given. The subjects were asked to circle those characters that they knew. They were told that knowledge about a character meant knowing the sound, the meaning and/or knowing that the character was a component of a multisyllabic word e.g.'古' (old) is a component of the bisyllabic word '古惑(witty). The total number of characters circled in the recognition task were counted and computed as one independent variable - the size of the pool[1]. The score was the number of correct responses i.e. a real character containing the given radical or phonetic.

Results

In this experiment, two hypotheses were made. (1) The effectiveness in cueing character retrieval is greater for phonetics than radicals. (2) The number of characters retrieved will be affected by the size of the pool of characters that contain the radicals or phonetics in the lexical memory store.

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[1]the independent variable, size of the pool, refers to the total sum of the characters known for radicals and phonetics. This way of computation can be warranted by the high correlation (r=0.93) between the two separate pool sizes. Other than specified, size of the pool in the following discussion will refer to the sum of the two pool sizes for phonetic and radicals.

The basic design used was a 2(Sex) x 2(Stimulus types i.e radical or phonetic) x Size of the pool (the total number of characters that contain the four given radicals and phonetics people know) ANOVA with repeated measure on the second factor. The dependent variable was the number of characters retrieved. For these hypotheses, a significant level of 0.05 was used. The means and ranges of the number of characters retrieved, and of the size of the pool as a function of stimulus types are shown in Table 1 and Table 2. Since analyses of variance showed no significant main effect for sex, findings for the two sexes is not discussed separately in the following discussion.

Table 1. The means and ranges of the number of characters retrieved, and the size of the pool, for radical and phonetic stimuli.

	number of characters retrieved		size of the pool	
Stimulus	Mean	Range	Mean	Range
Radicals				
1(米) 'Rice'/mei/	2.1	0-5	29.5	14-40
2(足) 'Foot'/tsuk/	2.0	0-5	36.4	10-54
3(雨) 'Rain'/jy/	3.2	0-6	31.9	16-41
4(食) 'Eat'/sik/	2.4	0-4	27.5	14-36
Total	9.7	2-19	125.3	54-167
Phonetics				
1(包)'Wrap'/pau/	1.7	0-3	12.3	6-18
2(古)'Old'/ku/	2.6	0-6	15.7	7-20
3(各)'Every'/kok/	1.4	0-4	18.5	6-24
4(者)'Man'/tse/	2.4	0-6	17.1	8-22
Total	8.1	1-19	63.6	31-79
Radicals and Phonetics			188.9	85-243

Table 2. Zero response rates for radical and phonetic stimuli

	Radical				Phonetic			
Trial	1	2	3	4	1	2	3	4
No Response	3	2	2	1	4	2	10	3
Total			8				19	

Number of characters retrieved and size of the pool

The mean of the total number of characters retrieved for the radicals and phonetics differed only slightly, with 9.8 and 8.1 respectively. Every trial had subjects giving no response. As shown in Table 2, the zero response rate was higher in trials of phonetics. Five subjects failed in giving responses to two or more trials. Not surprisingly, they were the ones who obtain lower scores in the characters generation task. It can be seen from fig. 1 and 2 that subjects scored low tended to have smaller size of pool for phonetics, and radicals

fig.1 Relationship between character retrieval and size of the pool for radicals.

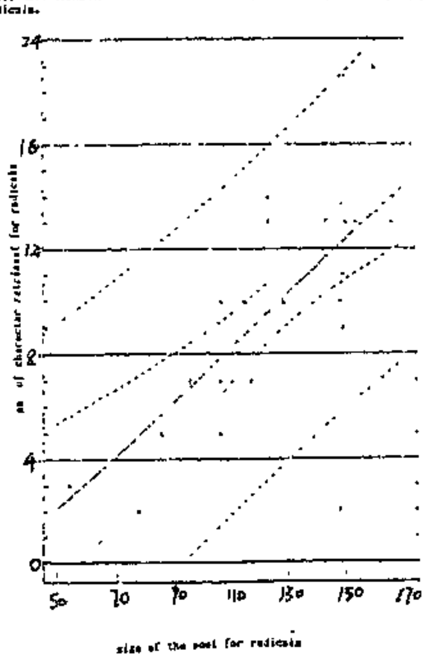
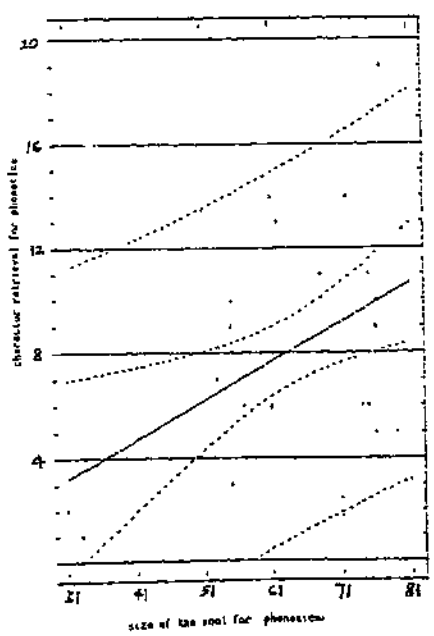
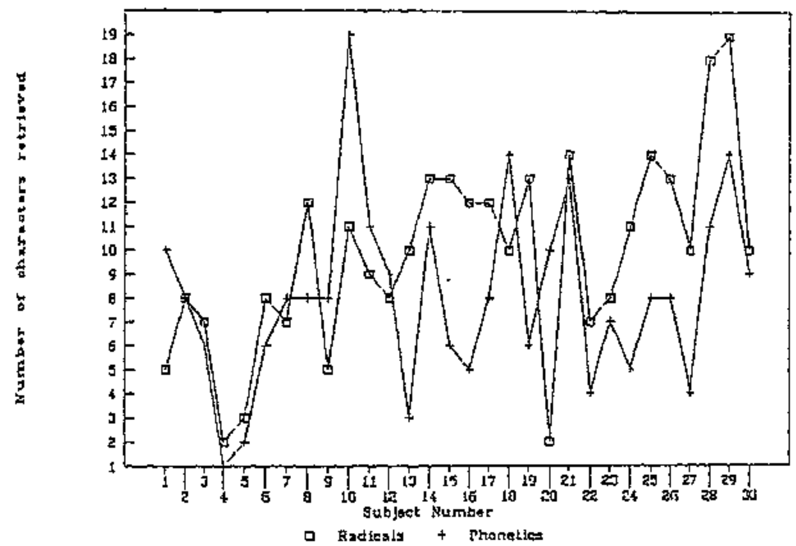


fig.2 Relationship between character retrieval and size of the pool for phonetics.



as compared to the others. However, one subject had a large size of pool despite the fact that he scored low in generating characters with radical stimuli (see fig. 1).

Fig.3 Comparison of character retrieval for radicals and phonetics within each subject.



The overall mean size of the pool for the phonetics was 63.6 which was about half of the radicals', 125.3. The coefficient of correlation for the two sizes (r) was 0.93. All subjects had their size of pool for radicals larger than for phonetics, however, not all of them have more retrieval for radicals than phonetics (see fig. 3). The correlation computed between the retrievals for the radicals and phonetics was .41.

Fig.4 Relationship between total no. of characters retrieved and the sum of sizes of radicals and phonetics.

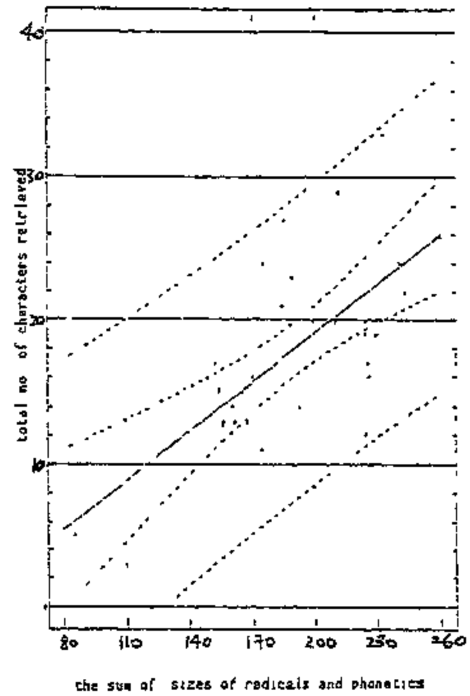


Table 3. Coefficient of correction between character retrieval and size of the pool

Character Retrieval	Size of the Pool		
	Radicals	Phonetics	Both
Radicals	0.69	—	0.68
Phonetics	—	0.47	0.44
Both	—	—	0.67

The coefficient of correlation between the character retrieval and the size of the pool for the radicals, phonetics and their sum were computed and are summarised in Table 3. All of them are significantly greater than zero, and ranging from .45 to 0.69 (at .05 significance level, the critical value is .31 for df=28).

Scatterplots relating the character retrieval and size of the pool showed that there were linear trends (see fig. 1, 2 & 4). The number of characters retrieved was increased with the size of the pool. Just a few departures from linearity with phonetic stimuli were noted (see fig. 2). All but two data fell within two standard deviations. One exceptional data was found with radical stimuli (which was out of +2SD) and the other with phonetic stimuli (which was out of -2SD). However, when the sum of the size of the two separate pools was plotted against the total number of characters retrieved, all data were found to be within two SD.

Analyses of variance are summarised in Table 4. It showed that the main effect of stimulus type and the interaction effect were not

Table 4. Significant main effect and between subject effect in characters retrieval analyses for sex, stimulus types, and the size of the pool.

Independent Variable	df	F	p-value
Sex			
-Main Effect: a)Radicals	1	1.12	0.2991
b)Phonetics	1	0.47	0.4974
-Between Subject Effect	1	0.03	0.8721
Stimulus Types			
-Main Effect	1	0.05	0.8193
-Interaction with Sex	1	1.82	0.1890
-Interaction with Size	1	0.42	0.5205
Size of the Pool			
-Main Effect: a)Radicals	1	15.53	0.0005
b)Phonetics	1	7.06	0.0131
-Between Subject Effect	1	17.76	0.0003

significant. Therefore, the first hypothesis stating that cueing effectiveness produced by phonetics is greater than radicals is rejected. There was a highly significant main effect for the size of the pool when either radicals or phonetics were presented, $F=15.53$, $p=0.0005$ and $F=7.06$, $p< 0.02$ respectively. Furthermore, the between subject effect for size of the pool, $F=17.76$, $p=0.0003$ was also highly significant. These findings support the hypothesis that the size of the pool affects the number of characters retrieved.

Retrieval strategies

Seven subjects reported that they made use of the meaning and/or the sound of the presented radicals or phonetics to think of the characters for some of the trials. However, they tried to use these strategies only when they could not think of characters by looking at the orthograph. These strategies were reported not so helpful in retrieval. The remaining subjects reported that no specific strategies were used and the characters came up "automatically".

During the experiment, some subjects were able to say out characters containing the given radicals or phonetics but unable to write them down. They reported they forgot the detailed structure of those characters. Under these circumstances, they tried to write the given radical or phonetic down first and then tried to make some educated guesses by adding some familiar orthographs.

Characteristics of the correct responses

a) *Frequency*

The frequency was determined based on the Commercial Press New Dictionary (1991). It was shown that 96.9% of the total responses given for the radicals are high frequency characters whereas for the phonetics, 96.3% are high frequency characters. The low frequency characters were mainly simplified characters and incidence could be found in subjects having varied degree of pool size.

b) *Structural formation of characters*

With reference to Cheung (1989) and Li (1990), the responses were classified into two categories: pictophonetic and non-pictophonetic characters. Non-pictophonetic characters identified in this study include pictographic, associative compound, and self-explanatory characters. Pictophonetic characters comprised about 89% of the total responses. Twenty-seven pictophonetic responses containing compounded phonetic (a phonetic component composing of two or more radicals/phonetics) were also found. Eighteen of them were given by subjects who have just written the constituent compounded phonetic of those characters as response, e.g. '蕃' after '番', and '湖' after '胡'.

Errors

A response is considered as an error when it is a 'non-existing' character or a real character which does not contain the presented radicals/phonetics. The judgement of a 'non-existing' character were made with reference to the Commercial Press Dictionary (1991) which is one of the prestigious dictionaries designed for both Primary and Secondary school students.

The error rate occurred with radical and phonetic were similar with 13.6% and 18.0% respectively, and the overall error rate was 15.6%. Errors are categorised as follows: Phonological errors (Ph) were homophones of or characters at least shared the vowel or consonant with the stimulus. Semantic errors (S) were synonyms, homonyms of, or characters that contain subparts having associated meaning with the stimulus. Visual/Structural errors (V) were responses that were real characters that contain several orthographic features similar to the stimulus or non-existing characters that contain the stimulus and approximate a real character sharing several contiguous orthographic features (strokes or subcomponents). Interference errors (In) were non-existing characters that approximate a character which was a component of a bisyllabic word and the subpart of the response shared the subpart of the other component in a word. Others (O) were the responses which have their strokes or parts misplaced, or strokes or subparts missed out or added. Errors which could not be assigned to the above categories were grouped as miscellaneous. These included incomplete characters, or educated guesses by adding high frequency radicals.

The number of errors of different types are summarised in Table 5. A high proportion of them conform to the structural rules of Chinese. Visual errors were the most common and 31% of errors were of this type. Very few phonological and semantic errors were noted.

Table 5. The distribution of different types of errors as a function of stimulus types

	Error Types						
Stimulus Types	(Ph)	(S)	(V)	(In)	(O)	(M)	Total
Radicals	1	5	16	1	8	19	50
Phonetics	0	0	16	6	12	14	48
Total	1	5	32	7	20	33	98

Discussion

The purpose of the present study was to investigate the role of orthography in the organization of mental lexicon. A written task simulating the verbal fluency task was used in examining organization of semantic memory. Responses made under this condition reflect the mental organization of different linguistic knowledge. Most Chinese characters are divisible into smaller units (radical and phonetic) which carries either semantic information or phonological information. So, by constraining the subjects to think of characters which contain either a given radical or phonetic, it is possible to study the role of meaning and sound in addition to the form in the organization of written lexicons in Chinese. The assumption here is that the mental representation matches the linguistic description.

Retrieval vs Recognition

The size of the pool had significant effect on the number of characters retrieved. With a larger pool size, characters retrieval increased accordingly. The pool size for the radicals was greater for phonetics. Thus, the mean number of responses for radicals was greater than phonetics. Two possible explanations can be used to account for this finding. With a larger pool size, there are more suitable candidates for activation and in turn the number of characters retrieval is increased. The size of the pool is used as an indicator of literacy level and is considered to be more objective than the education levels. A greater pool size indicates higher literacy level and so more experience and exposure to prints. According to Morton (1984 in Solso, 1988), word frequency has a long-term effect in lowering the sensory threshold. It infers that more experience and exposure to prints lower the sensory threshold for some commonly encountered words and so become more accessible.

However, the above discussion cannot explain why some subjects had larger pool size for radicals but greater retrieval for phonetics. One of the explanations is the increased familiarity to the test situation and reduction of stress while proceeding with the task.

The number of trials (four for radicals and four for phonetics) presented is believed to be a factor that leads to the above result. Due to the small number of trials, a subject's exceptional response to one trial, e.g. exceptionally large number of characters are retrieved for one of the trials, can greatly affect the total score. It is suggested that the scores become more representative by presenting more trials, e.g six for radicals and six for phonetics and discarding the highest and lowest scored trials.

A number of subjects failed in giving any response to one or more of the trials. However, all of the subjects were able to recognise characters containing those radicals and phonetics. This indicates that there was storage but the subjects could not retrieve them by using part of a character as cue. The discrepancy between the retrieval and recognition can be explained by the amount of cues or features received, for example, the whole configuration and more orthographic cues of the target words can be obtained in recognition.

Orthographically organised mental lexicon

Contradicted my hypothesis, there was no significant stimulus types difference on character retrieval which means that phonetics and radicals having similar pool size will have similar number of characters retrieved.

Data on responses of pictophonetic characters that contain compounded phonetic (i.e. a phonetic composing of two or more radicals/phonetics) and non-pictophonetic characters suggest that characters retrieval was cued by the orthographic form. As mentioned before, the orthographic components presented in these types of characters do not have any meaning or sound relation to the characters that they formed and here, their retrieval should be orthographically dependent. The notion of activation through the orthographic means is supported by the high percentage of visual errors.

Phonological and semantic information of the stimulus were shown to be encoded. For example, during the experiment, it was observed that subjects tended to read the stimulus aloud once it was presented. In addition, few phonological and semantic errors were noted. However, the effect of phonological or semantic information on the retrieval of orthographically similar characters appeared not to be significantly different. In this study, the effect of phonological or semantic from the orthographic information on character retrieval cannot be isolated by looking at the number of characters retrieved. Conclusion cannot be made on whether the phonological or semantic information have exerted any effects on the retrieval. On the contrary, results from error and response nature analysis discussed previously support the idea that orthographic information was certainly encoded and affected characters retrieval.

In this experiment, the subjects were asked to write down characters that contain a given orthograph. This task requirement led the subjects to focus their attention on the visual form of the stimulus rather than its semantic or phonological information provided. Subjects' report using no or minimal specific strategy in retrieval support this hypothesis. The effect on character retrieval caused by the pronunciation or meaning seems to be minimal. This was heavily due to an attention factor. In order to maintain activation levels in related word units, allocation of attentional resources may be necessary (Neely, 1977). This hypothesis can be tested out by asking subjects to write down any characters with or without the given orthograph that they can think of. From the analysis of the response patterns, we can find out whether the retrieval is still orthographically based or not.

Global configuration: a feature for encoding

Data of a considerable number of error responses containing only some part of the given radicals/phonetics or that approximate the global shapes of the given radicals or phonetics suggest that visually similar characters could be activated on presentation of an orthograph. Based on the present findings, I hypothesise that global configuration of a character is one feature to perceive and process. One can test out this hypothesis by asking people to read or recognize characters with some strokes missing or added.

Frequency effect

The finding that a large proportion of responses (over 95%) were of high frequency suggests that high frequency characters are more easily activated and accessible. This agreed with the claims of Morton and Jackson (1984 in Solso, 1988), and McClelland and Rumelhart (1981) which stated that sensory threshold for high frequency words are lowered than those for low frequency words.

It is interesting to note that the low frequency responses noted were mainly of simplified characters. It can be explained by the fact that some of the subjects received education in China and they have learned simplified characters. In fact, these characters may not be unfamiliar to them.

Implications: phonological coding in Chinese

Many researchers (Lien, 1985 in Chen, 1986; Hung, Tzeng, Salzman, and Dreher, 1984) suggest that the activation synthesis model proposed by Glushko (1979) for English, can be applied to naming Chinese characters. Their focus has been on the phonetic component in a pictophonetic character. They claimed that when a phonetic was presented, characters that contain the phonetic with similar pronunciation would be activated. However, similar claim was not made on the radicals. In this study, it was found that when an orthograph, either a radical or phonetic, was presented, characters containing the orthograph with similar or dissimilar pronunciation were also activated. This observation agrees with what Glushko (1979) has claimed i.e. when a letter strings is presented, words that share the letter strings will be activated.

Here, we find that both radicals and phonetics can activate the visual representations with or without the pronunciations of a cohort of characters that share the orthographs. Based on this finding, I postulate that when a pictophonetic psuedocharacter is presented, the pronunciation of characters that share either the radical or phonetic will be equally activated. Response types, i.e. whether the response is based on the radical or phonetic, will depend on the people's metalinguistic knowledge of Chinese characters and the instructions given. For example, when subjects are asked to name a psuedocharacter, they may focus their attention on the phonetic whereas when they are asked to guess the meaning of the character, they will focus on the radical. There were empirical and experimental evidence (e.g. Varley, Yiu, & Leung, 1992) showing the use of phonetic and less commonly of radical in guessing pronunciation.

We can test out whether metalinguistic knowledge has any effect on character retrieval by comparing performance of children and adults in similar studies. Rather than separate radicals and phonetics, psuedocharacters that contain both radical and phonetic can be presented. Subjects can be asked: (1) to think of characters that contain elements of the given psuedocharacter and sound similar to it; (2) to think of characters that contain elements of the given psuedocharacter and have similar or related meaning to it; (3) to think of characters that contain elements of the psuedocharacter. If, as hypothesised, metalinguistic knowledge has a role in phonological coding or semantic coding, we may see that children with immature metalinguistic skills will give similar types of responses across the three conditions whereas adults will focus their attention on the appropriate subparts and then generate responses accordingly.

Clinical applications

The finding sheds some light on the investigation and rehabilitation of dysgraphic or dyslexic patients. Orthographic organization was shown evident in the present study. Thus, one may find out whether a patient's reading or writing disability is due to the disruption of the orthographic organization by conducting similar experiment on them. Furthermore, by comparing the cueing effectiveness of a radical or phonetic (with similar complexities) in helping dysgraphic patients to give labels to pictures, one can get clues about the patients' level of breakdown. For example, when both orthographs are effective in cueing the retrieval, an orthographic level of breakdown may be suggested. However, when only the radical is effective, then the breakdown may be at the semantic level.

Conclusion

In conclusion, the present study found that the written lexical representation was stored in orthographically decomposed form. Both phonetics and radicals were found to be possible units for storage. In fact, units smaller than a radical or phonetic may also serve as retrieval cue.

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References

Caramazza, A., Laudanna, A., & Romani, C. (1988) Lexical access and inflectional morphology. *Cognition*, 28, 297-332.

Chen S-Y. (1986) Viewing the nature of Chinese word from the patients with head injury (trasl.) In Speech-Language-Hearing Association. *The Annual Report of the Speech-Language-Hearing Association (3)*. Taipei: Speech- Language-Hearing Association.

Cheung K.T.(章季濤) (1989) 怎樣學習《說文解字》 中国：河南人民出版社

The Commercial Press New Dictionary (1991) Hong Kong: The Commercial Press.

DeFrancis, J. (1989) *Visible speech: the diverse oneness of writing systems*. Honolulu: University of Hawaii Press.

Glushko, R.J. (1979) The organization and activation of orthographic knowledge in reading aloud. *Journal of Experimental Psychology : Human Perception and Performance*, 5, 674-691.

Hung, D.L. Tzeng, O.J.L., Salzman, B. & Dreher, J. (1984) A critical evaluation of the horse-racing model of skilled reading. In H.S.R. Kao & R. Hoosain (Eds). *Psychological Studies of the Chinese Language*. Hong Kong : Chinese Language Society of Hong Kong.

Huang, C.Y. (1984) Reading and writing disorders in Chinese - some theoretical issues. In H.S.R., Kao & R. Hoosain (Eds). *Psychological Studies of the Chinese Language*. Hong Kong: Chinese Language Society of Hong Kong.

Li, Y-C.(李永清)(1990) 漢字偏旁部首例說 中國：成都科技大學出版社

Laudanna, A , Badecker, W. & Caramazza, A. (1989) Priming homographic stems. *Journal of Memory and Language*, 28, 531-546.

Lupker, S.J. & Williams, B.A. (1989) Rhyme priming of pictures and words: A lexical activation account. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 1033-1046.

McClelland, J.L. & Rumelhart, D.E. (1981) An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review*, 88, 375-407.

Napps, S.E. & Fowler (1987) Formal relationships among words and the organization of the mental lexicon. *Journal of Psycholinguistic Research*, 16, 257-272.

Neely, J.H. (1977) Semantic priming and retrieval from lexical memory: Roles of spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General*, 106, 226-254.

Seidenberg, M.S. (1985) The time course of phonological code activation in two writing systems. *Cognition*, 19, 1-30.

Solso, R.L. (1988) *Cognitive Psychology*. Boston : Allyn and Bacon.

Taylor, I & Taylor, M.M. (1990) *Psycholinguistics: Learning and Using Language*. New Jersey : Prentice-Hall, Inc.

Tzeng, O.J.L, Hung, D.L., Chen, S., Wu, J. & Hsi, M-S. (1986) Processing chinese logographs by Chinese brain damaged patients. *Graphonomics: Contemporary Research in Handwriting*. In H.S.R. Kao,

G.P. Van Galen, R. Hoosain (Eds). North Holland: Elsevier Science Publishers B.V.

Tzeng, O.J.L., Hung, D.L. & Wang, W. S-Y. (1977) Speech recoding in reading Chinese characters. *Journal of Experimental Psychology: Human Perception and Performance*, 3, 621-630.

Varley, R.A., Yiu, E.M-L., & Leung, C-S. (1992) *Reading test battery for Chinese-speaking aphasic subjects*. Hong Kong : University of Hong Kong.

編號：＿＿＿＿＿

問卷：找字的方法

1. 你怎樣去想、去找出那些擁有'米'、'足'、'雨'和'食'這些邊旁的中文字？請細閱以下各項，選出你認為你所採用了的方法，在線上加上'✓'號。

＿＿＿ a. 我嘗試從所提供之邊旁的意思去想。例如：當我看到'雨'字時，我會想一些和雨或天然現象有關的字。

＿＿＿ b. 我嘗試想一些和所提供之邊旁差不多發音的字。

＿＿＿ c. 我採取試驗的方法。我知道所提供的邊旁是一個中文字的一部份，所以我嘗試填寫一些字於這些邊旁的旁邊、裡面、上面或下面。

＿＿＿ d. 我沒有用特別的方法去找字，想要找的字自然地出現在腦海裡。

＿＿＿ e. 我用了多過一種上面所說的方法。(請列出大約的次序，先列出最先用或用得最多的方法。)

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＿＿＿ f. 其他：(請註明) ＿＿＿＿＿＿＿＿＿＿＿＿

2. 你怎樣去想、去找出那些擁有'包'、'古'、'各'和'者'這些邊旁的中文字？請細閱以下各項，選出你認為你所採用了的方法，在線上加上'✓'號。

______ a. 我嘗試從所提供之邊旁的意思去想。例如：當我看到'雨'字時，我會想一些和雨或天然現象有關的字。

______ b. 我嘗試想一些和所提供之邊旁差不多發音的字。

______ c. 我採取試驗的方法。我知道所提供的邊旁是一個中文字的一部份，所以我嘗試填寫一些字於這些邊旁的旁邊、裡面、上面或下面。

______ d. 我沒有用特別的方法去找字，想要找的字自然地出現在腦海裡。

______ e. 我用了多過一種上面所說的方法。(請列出大約的次序，先列出最先用或用得最多的方法。)

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______ f. 其他：(請註明) ______________________________