Lexical Representations of Chinese Single Characters Tested Through Reformed and Standard Phonetic Compounds.

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ABSTRACT

The present investigation comprised three studies aiming at understanding the lexicon representations and reading routes for Chinese single characters of reformed and standard scripts. Altogether 80 male subjects of young and old ages were included from China and Hong Kong. In study one, normative reading data were gathered to test the reading model of Patterson & Morton (1985). Study II specifically tested reading strategies and the presence of semantic and phonetic cueing rules. Study III examined the script-specific effect of reformed script on phonological cueing. The overall results suggested the basic framework of the reading model, except the grapheme-phoneme conversion system was abolished. The augmentation of graphemic segmentation and cueing process was proposed instead. The language specific factors in reading Chinese had clinical and theoretical implications on acquired and developmental dyslexia. Finally, the need to consider other cognitive domains, e.g. Parallel Distribution Processing in explaining reading mechanisms was suggested.

INTRODUCTION

Information processing has been studied using normal and brain damaged subjects in the cognitive psychological and neuropsychological domains. The reading process of alphabetic languages, e.g. English, have been actively examined. From dissociation studies, the plausible processing modules, retrieving-routes and lexicon representations was established as in Patterson and Morton (1985), and Coltheart (1987). The application of reading model in Japanese (Sasanuma, 1988) has provided cross-linguistic data that illustrated the feasibility of adopting a reading model for a syllabic language, and at the same time, the need of accommodating language specific factors.

The kanji of Japanese is morphographic in nature. It is processed along the lexical route. The kana is a syllabic script. It can take two different pathways, lexical or phonological. Both scripts can also be assessed through a third route which gives direct access from orthographic to phonological representation by-passing semantics. When compared to the English, they both involves the basic tri-route framework of reading. Figure 1a and 1b showed the similarity of routings as adopted from Patterson and Morton (1985), and Sasanuma (1988).

Fig.1a Lexical Semantic & Lexical Phonological routes

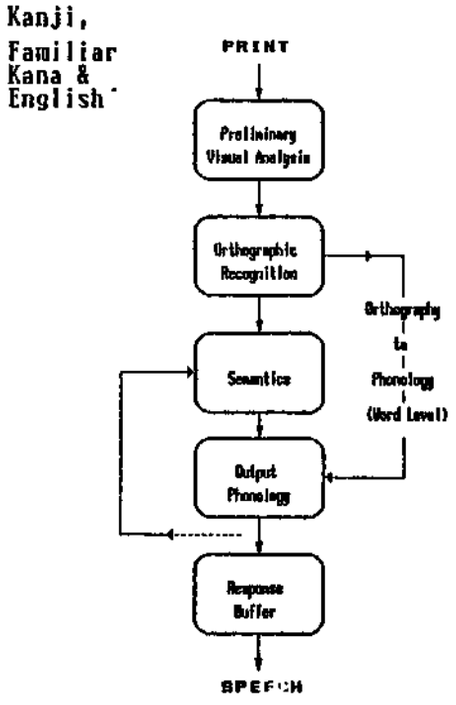
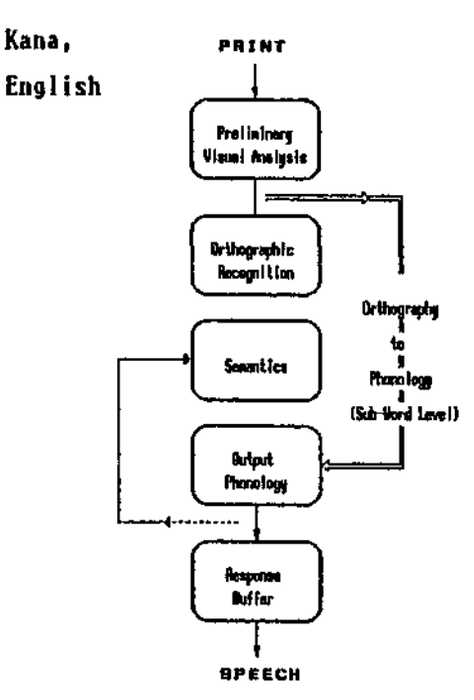


Fig.1b Sub-lexical Phonological route



The Chinese writing, liked the Kanji of Japanese, is logographic in nature. However, it does not have an orthographic-to-phonologic conversion system (Hoosain, 1991). The logographs are highly stylised and high in iconicity (Bloomberg, 1990). The two dimensional visuo-spatial structure may enhance recognition, and offer learnt hints to meaning. It would be of clinical and theoretical value to know if a script representing meaning could also be represented by the same scheme of cognitive reading model originally derived from scripts mapping onto sounds.

Varley, Yiu & Leung (1992) have posited the fundamental step for establishing Chinese reading model. Their study in a reading aloud test revealed normal male subjects' phonological and semantic strategies in reading non-words. From empirical observations, these strategies are commonly used among Chinese for reading unfamiliar real characters as well, in particular, the phonological one. The prevalence of this strategy would raise several queries : what are the reading rules underlying this habitual reading strategy ? Are they merely an intended metalinguistic strategies or are they internalised rules underneath readers' awareness ? Would they bear a specific position in a reading model as the orthography-to-phonology conversion system ?

The Chinese writing consists of three main categories, pictogram, ideogram and phonetic-compounds. The phonetic-compound constitutes about 90% of total characters in use (Cheng 1977). Each of them is composed of semantic indicator and phonetic indicator (figure 2). Some special characters (ideograms) may appear similar to a phonetic-compounds. They contain a semantic indicator, but a graphic differentiator instead (figure 3). They were not a true phonetic-compound. The components may combine in different spatial orientations : top-bottom, left-right, interior-exterior. Overall, 70% are in left-right orientation (Ann, 1982).

left-hand-side (LHS) right-hand-side (RHS)

semantic indicator phonetic indicator

Fig.2 Phonetic-compound

left-hand-side (LHS) right-hand-side (RHS)

semantic indicator graphic differentiator

Fig.3 Special character

The Chinese language prescribed two variants of writing systems, the traditional one and the simplified version, here named as standard and reformed scripts. The reformed script was implemented in 1956. A total of about 3,000 characters have been published in 1964 and 1977. They are now widely used in Mainland China. The simplification was based on several principles (Chen, 1988):

a) using simple phonetic components, e.g. 懺(忏) 徵(征)
b) simplification of shape, e.g. 齒(齿) 務(务)
c) extension of simplified components, e.g. 義(义) 儀(仪)
d) substitution of simpler homophonous characters, e.g. 後(后) 迹跡

The strong reliance on phonology-indication was immediately evident in above a, c & d. This emphasis has been perceived as " a move towards phoneticization [sic] of the writing system" (Cheng, 1977).

Owing to their unique properties, the phonetic-compounds may be suitable material to tap for the phonological, orthographic and semantic codings of writing; whereas the reformed variant may be useful for testing the strength of scripts-specific effect on phonological strategy.

Reading and writing are learnt skills (perceptual, linguistic and social) which demand memory processing (Baddeley, 1990). Norman (1988), in Varley (1992) claimed that an adequate usage of Chinese would require acquisition of 3000 - 4000 characters. This implies that learning Chinese would demand great amount of memorisation as distinguished from those of alphabetic languages (Hoosain, 1991). Indeed, the simplification scheme has been an reaction of the Chinese government in " facilitating memorization of characters " (Cheng, 1977). One could not disregard the huge involvement of cognitive memory in learning to read.

The memorisation process and the visuo-spatial feature may constitute some language-specific patterns in Chinese reading. These may be the aspects that the Cognitive neuorpsychological approach does not have parallel advancement (Margolin 1991). However, given that Chinese characters are linguistic symbols, as the other writing systems, it is speculated that the basic reading process may still be maintained and therefore, would conform to the representation modules in a reading model.

Therefore, the present investigation included three studies aiming at :

I)a. collecting normative data for illustrating plausible lexical representations and the accessing routings in reading of Chinese single characters.

b. To test for the applicability of reading model among China and Hong Kong subjects, either young or old, who used different variants of scripts.

II) probing for the roles of the semantic- and phonological- indicators in reading aloud and in particular, to search for the rules comprising the phonological strategy.

III) obtaining further evidence of phonological rule among the native-users of reformed script which has more regular sound to phonetic-root correspondence.

The hypotheses pertinent to each study are stated below :

I) a. Correct pronunciation if elicited, will indicate the intact of the lexical orthographic, phonological representations, as well as the operation of lexical accessing pathway.

b. phonological error, e.g. Lph, will be present. It indicates the recognition of the orthographic input lexicon, while the phonological output lexicon is partially accessed.

c. Semantic errors in reading aloud, e.g. Lme, will be present. It indicates the presence of lexical semantic representation and lexical semantic route.

d. Visual reading aloud errors will be present. This indicates the operation of visual analysis process, e.g. Lan, Lon, Los, Lsh.

e. Direct read-off of the phonetic-root or semantic-root will be present, e.g. Lo, La. This indicates the operation of graphemic segmentation process.

f. Consistency of response patterns will exist among four subject groups. This indicates the applicability of the postulated reading model.

II) a. Phonetic-roots will mediate more total right-hand-side (RHS) cued responses than graphic-differentiators.

b. Semantic-roots will be used as reference in assessing semantic categories of individual characters.

c. The "read-the-segment (RHS)" strategy embodies both explicit metalinguis tic knowledge as well as the internalised, implicit cueing principles.

III)a. the reformed stimuli will elicit an overall higher certainty level.

b. the first-learner and users of reformed script will demonstrate higher certainty level in applying the phonetic-root rule for pronunciation.

METHODOLOGY

Subjects

The experimental procedures were administered to four groups of 20 male subjects, namely, the Hong Kong Young, China Young, Hong Kong Old and China Old. Subjects equal to or older than 50 belonged to the Old groups, while those below 50 would belong to the Young groups. Table 1 displayed subject groups' characterisation : age range, resident location, handedness, first-learnt script, script prevalently used, level of education received as well as the results of a literacy test.

Subject groups	No./group	Age range	Handedness	Education	First-learnt script	Use script	Spoken languages	Literacy Test
Hong Kong Young	20	17 - 30	Right	University to postgrade	Standard	Standard (reformed)	Cantonese, English	PASS
China Young	20	19 - 22	Right	University	Reformed	Reformed (standard)	Cantonese, Putonghua Dialects	PASS
Hong Kong Old	20	62 - 86	Right	3 years to secondary	Standard	Standard (reformed)	Cantonese, Dialects	PASS
China Old	20	50 - 75	Right	Secondary to tertiary	Standard	Reformed (standard)	Cantonese, Putonghua, Dialects	PASS

Table 1 Characterisation and literacy adequacy of subject groups: the Hong Kong Young, China Young, Hong Kong Old & China Old. Script enclosed in ( ) was of less proficiency.

Each subject was required to pass the screening tests of handedness and basic literacy. The literacy test also served as a vision test. The handedness was screened by three questions on habitual used of tools : pens, chopsticks and scissors. Only right-handed subjects were included. The literacy test consisted of two paragraphs, each of 36 characters. (Appendix 1). They were identical but differed in scripts (standard and reformed). They were selected from the Peoples Daily which has circulation both in Hong Kong and China. Each subject was required to read aloud the two paragraphs. Only four errors were allowed in total, otherwise the test would be considered failed.

Test Stimuli

Four character types were used : high, mid, and low frequency phonetic-compounds as well as the special character which contained no phonetic-root. A sample of the stimuli were illustrated in fig.4. For each character type, five reformed and five standard stimuli were selected. Altogether there were 40 different characters.

	high freq.	mid freq.	low freq.	special*	Total
reformed	5	5	5	5	20
standard	5	5	5	5	20
	10	10	10	10	40

Table 2 Composition of character types of 40 stimulus items.
* characters consist of semantic-root and graphic differentiator (special characters).

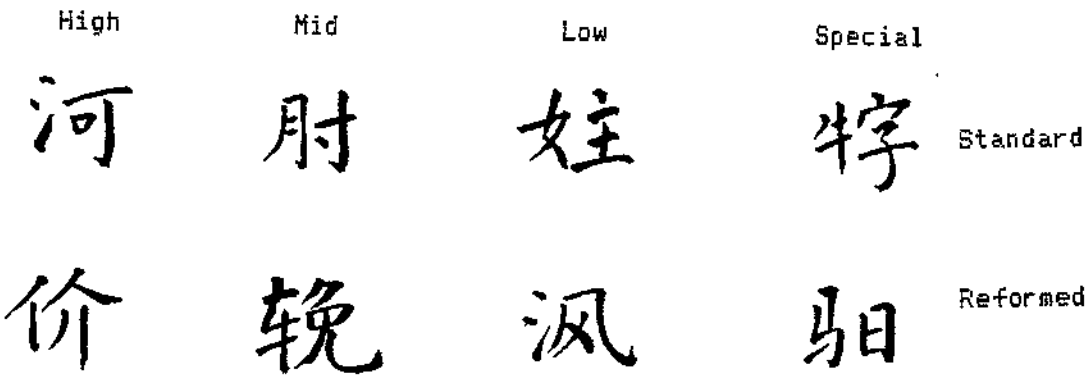


Fig. 4 Examples of stimuli used for reading aloud and semantic categorisation.

The high frequency phonetic-compounds were selected from high frequency count reference book (Suen 1986). They ranged in frequency rank from 37 to 1001 from a corpus of 40032 characters. They were included to ensure presence of correct responses. To guard against part-whole (character) response, the pronunciation of each character had been controlled to be different from the phonetic-indicator.

The mid frequency phonetic-compounds were taken from personal collection list of "unfamiliar characters". The list were first tested on 40 ordinary level students. Only those characters (reformed and standard) which received 30% to 50% recognition rate were taken. A further screening of these characters was performed by one secondary student, one young adult and one old adult from each location (three Hong Kong, three China). They helped to reduce the 30 characters into 10 + 5 before the last screening. They had to be the characters known to six screening persons , but not correctly pronounced. These characters served for eliciting a variety of correct and error responses.

The low frequency phonetic-compounds were selected from dictionaries. They went through the similar screening procedure as the mid frequency one, but with different criterion. They had to be entirely unknown to the persons used in screening.

The special characters were also selected from dictionaries. They had to be comprised of semantic indicator and graphic differentiator (not phonetic-indicator). The screening procedures and criterion were identical to those of the low frequency ones.

The preliminary stimuli lists were finalised into two lists of reformed and standard characters, each containing 20 items, in the last screening by a native Chinese doctor from Mainland China. The number of strokes of all character were also controlled. Each character contained no more than 13 strokes because characters over that limit are hard to read (Cheng, 1977).

For each test, two sets of stimuli, 20 reformed and 20 standard characters, were presented separately. Within each set, the high, low and very low characters were randomized. The order of presentation of reformed and standard sets were counterbalanced. The characters were presented individually in regular brush style, written on 5cm X 5cm card. A training procedure was presented at the beginning of each task. The maximum length of the test session was 30 min.

Procedure

Both reading aloud task and the semantic categorisation task were conducted among residents of Shenzhen, Guangzhou and Hong Kong. The entire procedure was either audio or video recorded depending on subjects' consent. All subjects went through the following steps:

a. Test A , read aloud two lists of characters, 20 reformed & 20 standard; the subjects had to further indicate their certainty level on each response on a four-point scale.

b. Test B , categorizing the characters into superordinate groups by pointing to one of the four categories : ' physical nature, fauna, flora and men. (Tsou 1976)

c. Answer the questions in Personal Data Form

d. Answer the Validation questions (five subjects from each group only)

e. Read Literacy-check passage (4 sentences).

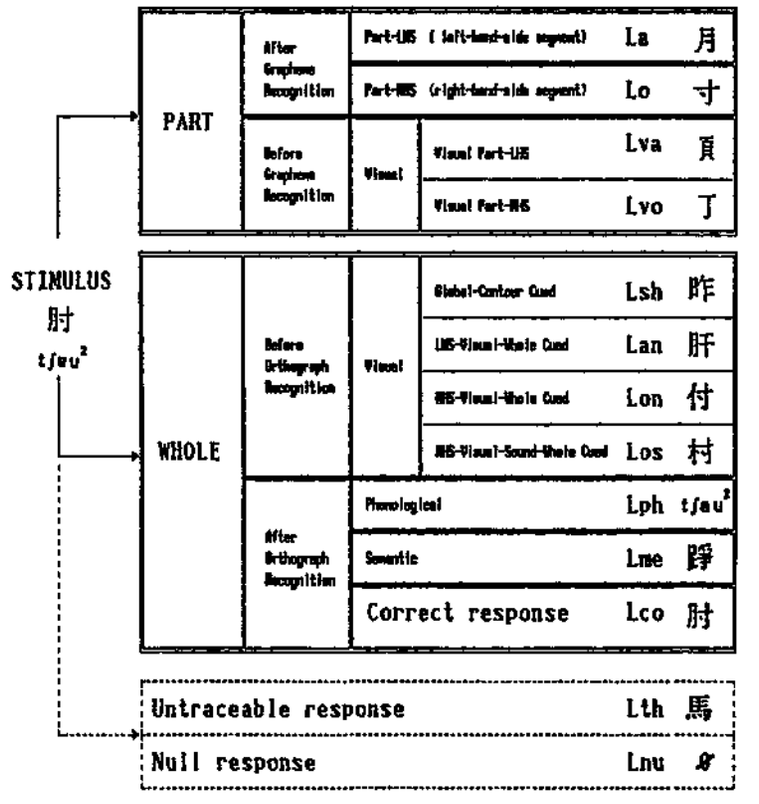
In the Validation questions, five subjects from each group had to indicate whether they had come across each character of the stimulus-lists (yes/no), their impression on reformed and standard scripts, and how they go about reading unfamiliar characters. In the Personal Data Form, the items checked were age group, scripts that firstly learnt, literacy level, handedness and the prevalent use and the years of use of the scripts.

Pilot Testing

The procedure was piloted on sample subjects, two from each group. Nine Singaporean young adults also participated because they were also familiar to reformed script. The result of pilot testing confirmed the feasibility of the procedure.

Scoring procedure

Responses were scored by reviewing the recordings, determining what type of the first response to each stimulus item was, and assigning a code to that response. The analysis was based on a classification system devised after a preliminary examination of responses. The responses were coded according to the scheme displayed in fig. 5. Descriptions were listed in Appendix 2.



Ler = total errors (Lvo + Lvo + La + Lo + Lsh + Lon + Lan + Los + Lph + Lse + Lth)
RHS = right-hand-side , LHS = left-hand side

Fig.5 The secheme of analysis & the coding of responses.

Analysis Reliability

To determine the reliability of the error analysis, a third year student familiar with the cognitive neuropsychological approach of reading disorders and the classification procedure, analyzed 10% of sampled responses from all subject groups. Interscorer agreement, calculated by taking the ratio between number of agreements and disagreements and resolved differences was 90%.

RESULTS

STUDY (I) : A CHINESE READING MODEL AND ITS APPLICABILITY

This study sought to collect data for the following hypotheses :

a) Correct pronunciation if elicited, will indicate the intact of the lexical orthographic, phonological representations, as well as the operation of lexical accessing pathway.

b) phonological error in reading aloud, e.g. Lph, will be present. It indicates the intact access to orthographic input lexicon, but partial access to phonological output lexicon.

c) Semantic errors in reading aloud, e.g. Lme, will be present. It indicates the presence of lexical semantic representation and the lexical semantic route.

d) Visual reading aloud errors will be present. This indicates the operation of visual analysis process, e.g. Lan, Lon, Los, Lsh.

e) Direct read-off of the phonetic-root or semantic-root will be present, e.g. Lo, La. This indicates the operation of graphemic segmentation process.

f) Consistency of response patterns will exist among four subject groups. This indicates the applicability of the postulated reading model.

The findings of (a) to (e) are grouped into category one for supporting the presence of individual module in a reading model. The findings of (e) is presented in category two for examining the applicability of the model.
As each area involved the analysis of a number of dependent variables, the results of each separate analysis include details of significant differences in performance.

Category one : Data for supporting presence of modules

The results of percentage of responses among Hong Kong Young, Hong Kong Old, China Young, China Old for both standard and reformed characters are summarised in Tables 3. The distribution pattern of (a) to (e) responses are shown in figures 6a & 6b.

Subject Groups		A			B	C	D				E				G	H
		Lco	Lnu	Ler	Lph	Lme	Lsh	Lan	Lon	Los	La	Lo	Lva	Lvo	Lth	Map
HKY	S	27.8	0	72.2	.3	4.5	0	5.5	8.9	19.7	2.4	53.7	0	0	4.9	83.0
	R	28.2	0	71.8	0	1.1	2.5	8.1	5.3	22.0	1.4	52.9	0	1.4	5.9	78.0
CAY	S	26.2	0	71.8	4.9	5.0	.3	3.1	6.1	12.5	.7	59.9	0	.3	4.2	81.0
	R	32.4	0	67.6	.7	3.0	.4	2.2	5.9	27.2	.4	53.6	0	.7	4.4	88.0
HKO	S	27.8	3.0	69.2	0	.7	1.1	10.4	11.9	20.8	2.2	48.6	0	1.5	2.9	65.0
	R	31.8	5.8	62.4	1.6	2.0	.4	8.4	4.4	26.3	.4	48.7	0	1.2	4.4	64.0
CAO	S	34.8	6.4	58.8	.9	4.3	.4	5.5	10.5	19.1	3.0	56.1	0	.4	.9	84.0
	R	43.0	8.2	48.8	0	.5	0	7.4	1.0	34.8	0	55.7	0	0	1.6	86.0

Table 3 Percentage of responses in reading standard & reformed characters (with semantic categorisation).
HKY = Hong Kong Young, CAY = China Young, HKO = Hong Kong Old, CAO = China Old , S = Standard stimuli, R = Reformed stimuli , A = Accuracy rate, B = Phonological error, C = Semantic error, D = Visual errors, E = Segmentation erros, G = Untraceable error, H = Appropriate semantic categorisation. Lco = Total correct response, Lnu = Total null response, Ler = Total errors, Lph = Phonological error, Lme = Semantic error, Lsh = Global contour cued, Lan = LHS-visual-whole cued, Lon = RHS-visual-whole cued, Los = RHS-visual-sound cued La = Part-LHS, Lo = Part-RHS, Lva = Visual Part-LHS, Lvo = Visual Part-RHS, Lth = untraceable errors, Map = Appropriate semantic categorisation.

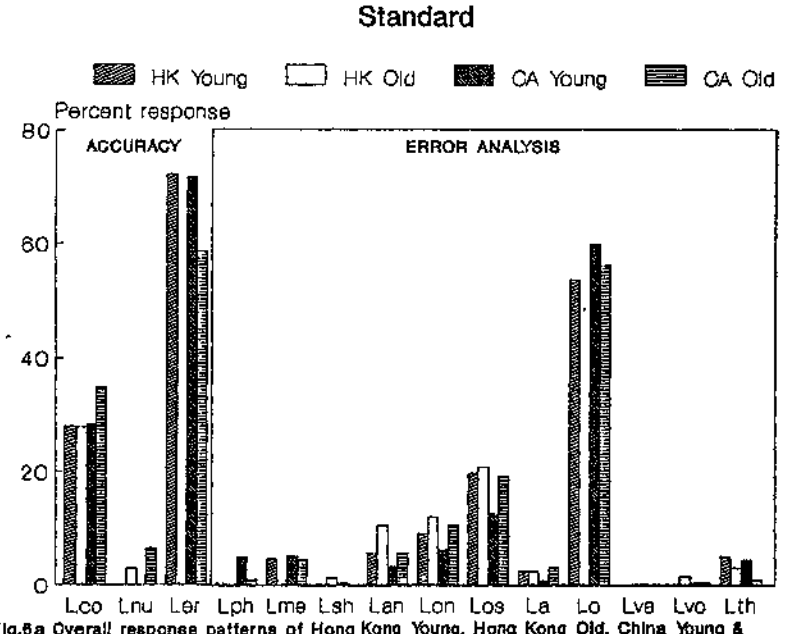


Fig.6a Overall response patterns of Hong Kong Young, Hong Kong Old, China Young & China Old in reading aloud standard characters.

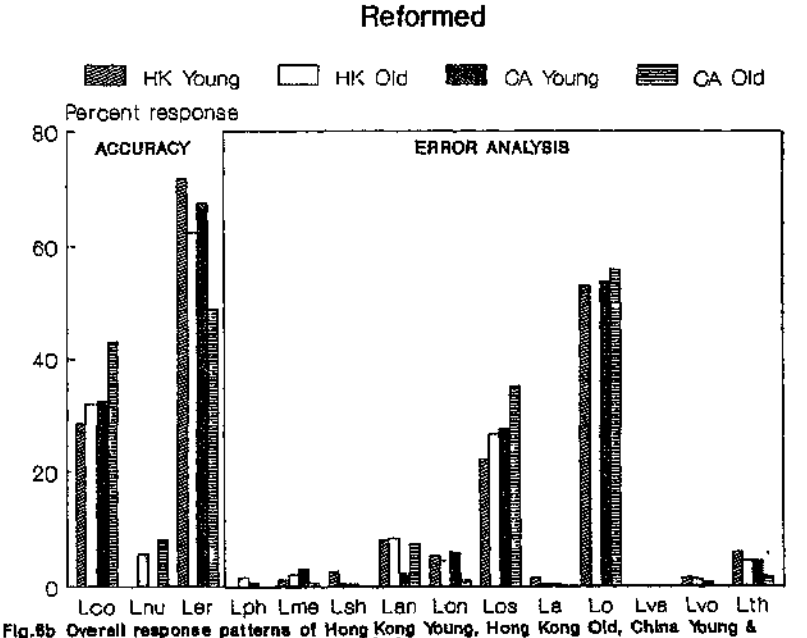


Fig.6b Overall response patterns of Hong Kong Young, Hong Kong Old, China Young & China Old in reading aloud reformed characters

a) Accuracy Rate

The lowest to highest accuracy from all groups ranged from 27.8% to 43%. The China Old (CAO) subjects scored the highest mean of accuracy (standard = 34.8%, reformed = 43.0 %) as compared to their Hong Kong counterparts (HKO) (standard = 27.8%, reformed = 31.8%. Most members of the China Old were tertiary teachers who had received intensive drilling in using Chinese.

For the extend of errors made by subject groups, the groups showed a total of errors ranged from 48.8% to 72.2%. This indicated that the low frequency and special characters were effective in eliciting errors for quantitative and qualitative analyses. In figures 6a and 6b, the proportion and distribution of total correct, null and error responses were displayed by Lco, Lnu and Ler.

b) Phonological error

The phonological error (Lph) was whole-word response related phonologically to the target (range : standard = 0 - 4.9% ; reformed = 0 - 1.6%). This error usually occurred in the mid frequency characters, to which subjects either gave approximation of target sounds, or pronunciations related to known Putonghua.

c) Semantic error

All four groups showed minute incidence of Lme error as shown in figures 6a and 6b (range : standard = 0.7% - 5.0% ; reformed = 0.5% to 3.0%). The errors were usually a substitution of colloquial spoken word of the same meaning for target sound. Sometimes, the error response was mediated by morphemic association of the character within a bi- or multi-syllabic word.

d) Visual errors

The visual errors, Lon, Lan , Los & Lsh were also illustrated in figures 6a and 6b. It is noted that the average Los in reformed script was 9% higher than the standard script. In total, the visual errors scored by each group for both standard and reformed stimuli were : Hong Kong Young, 34.1% & 37.8% ; China Young, 22.1% & 35.7%; Hong Kong Old, 44.2% & 39.5%; and China Old, 35.5% & 43.2%.

e) Graphemic segmentation errors

Indeed, the Lo & La results not only indicated the ability of subjects for

graphemic segmentation, they also reflected subjects' metalinguistic knowledge in seeking for best approximation of pronunciation. Their metalinguistic knowledge is reported in study II.

While the whole character was segmented into two sub-components, subjects displayed differential reliance of segments. The Lo results were strongly dominating over all other error responses (range : standard = 48.6% – 59.9% ; reformed = 48.7% - 55.7%). In contrast, the La only occurred occasionally (range : standard =0.7% – 3.0% ; reformed = 0 % ~ 1.4%). The strong prevalence of Lo was illustrated in figures 6a and 6b.

The preliminary findings supported the presence of predicted modules and the lexical accessing routes of a reading model. This is resembled to the Kanji processing in Japanese (figure 1a). Yet, there was no direct syllable or phoneme–to-grapheme conversion system for translating orthography to assembled phonology.

Category two : Consistency of responses among subject groups

As the four subjects groups differed by both age and resident location, the results were examined through a two-way (AGE X LOCATION) Analysis of Variance (ANOVA) for all the responses. This was to test if any discrepancy or consistency existed among four groups differed by age and location. Consistency would serve to support the applicability of the reading model across young and old subjects in both China & Hong Kong. On the other hand, any significant difference would imply that generalisation must be applied with caution.

a) Main Effects

Main effect of AGE was mainly found in total errors, Ler ($F(3,638) = 10.6$, $p < .005$) , null response Lnu ($F(3,638) = 33.24$, $p < .0001$) and Part-RHS error, Lo ($F(3,638) = 10.95$, $p < .005$). Old groups (70.8%) appeared making less errors than young ones (60.2%). While young subjects attempted every items, old subjects gave some null responses (5.8%). The young subjects preferred the right-hand-side "part" response (39%) more than the old ones (31%).

Main effect of LOCATION was even less extensive and mainly found in Ler ($F(3,638) = 4.9$, $p < .05$). The Hong Kong subjects scored more errors (69%) than the China subjects (62%). The subjects in China may have more chances of using Chinese in daily life, hence leading to higher accuracy scores.

b) **Interactions**

For responses showing significant interaction effect, the Post Hoc Protected F test was performed to locate the origin of difference between subject groups. The group difference and similarity found were :

(i) Group differences

The groups differed in their total number of errors (Ler) (standard : $F(3,316) = 1.62$, $p = 0.2$; reformed : $F(3,316) = 4.88$, $p < .005$). The .05 significance level was taken. The Post Hoc Protected F's test revealed that the China Old significantly made less errors than all other groups.

For their error types, responses showing significant difference were the Lph, Lan and Lsh. However, as these errors constitute only a minute portion of total errors in figures 6a and 6b, the analyses was not taken further.

(ii) Group similarities

Despite the above differences, the groups displayed a similar distribution pattern of responses in both reformed and standard scripts (figures 6a and 6b). For distribution of error types, Lo was the most common error. The next common one was the Los. Then it is followed by Lon & Lan. The next category further down were the Lph & Lne. In contrast to the Lo segmentation response, the La only constituted a very minute range of responses. The Lvo & Lsh responses, did occur, but were rare. They both had lowest score from zero to less than 0.1. No groups had scored any Lva responses (Numerical data was listed in table 3).

Taken together, apart from the major difference in accuracy, the similarity in error types and distributions suggested a relative consistency of responses among subjects differed by age.

STUDY II : THE ROLES OF PHONETIC-ROOTS AND SEMANTIC-ROOTS, AND THE NATURE OF "READ-THE-SEGMENT (RHS)" STRATEGY

This study sought to confirm the following hypotheses :

a) Phonetic-roots will mediate more total right-hand-side (RHS) cued responses than graphic-differentiators.

b) Semantic-roots will be used as reference in assessing semantic categories of individual characters.

c) The "read-the-segment (RHS)" strategy embodies both explicit metalinguistic knowledge as well as the internalised, implicit cueing principles.

a) The role of phonetic-roots

In this study, the responses from low frequency phonetic-compounds and from the special characters (without phonetic-roots) were taken for further analysis. The total sound cued errors from the RHS segment of individual character (Ltos) was calculated : Ltos = Lo + Los. The total sound and visual cued errors from the RHS segment (Ltsno) was also computed (Ltsno = Lo + Los + Lvo + Lon). The Ltsno differed from Ltos by including the purely visually mediated errors. Both the Ltos and Ltsno were taken as dependent variables.

The character type effect on Ltos and Ltsno were analyzed by one-way Analysis of Variance. This was to test the cueing effects of phonetic-roots and graphic differentiators. The .05 level of significance was selected. Figure 7 illustrated the Ltos & Ltsno results. The semantic categorisation (Map) was also displayed in the same diagram.

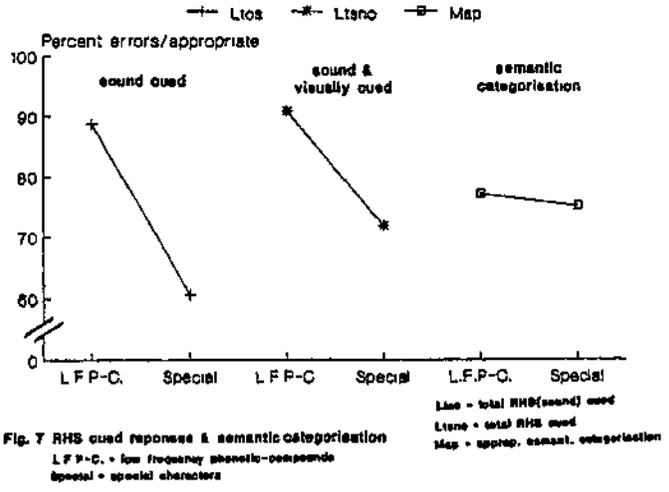


Fig. 7 RHS cued reponses & semantic categorisation
L F P-C. = low frequency phonetic-compounds
Special = special characters

Ltos = total RHS(sound) cued
Ltsno = total RHS cued
Map = approp. semant. categorisation

(i) Sound cueing

Significant differences were obtained between two types of characters for both Ltos as well as Ltsno. (Ltos : $f(1,318) = 118.55$, $P < .0001$; Ltsno : $f(1,318) = 67.42$, $P < .0001$). The low frequency phonetic compounds consistently showed much higher percentage of Ltos and Ltsno (Ltos = 88.75% , Ltsno = 90.88%) than the special characters (Ltos = 60.6% , Ltsno = 71.84).

To reveal the sound cueing effect based on phonetic-root only, simple subtraction was made between two types of characters for Ltos.

	phonetic-compounds		special characters		Difference
Ltos	88.75 %	(minus)	60.59 %	=	28.16 %

The phonetic-root cueing for sound effect found in this study was around 28.16%.

(ii) Spatial orientation cueing

The special characters, despite lower in percentages, also elicited greater than 50% responses in both Ltos and Ltsno. (Ltso = 60.59, Ltsno = 71.84). The high percentages in special character may reflect subjects' metalinguistic knowledge on the spatial implications of components , e.g., "taking the segment at the left-hand side for pronunciation". Hence, in reading phonetic-compounds, both the spatial orientation rule and phonetic-root cueing rule were operating.

(iii) Visual cueing

The differences between Ltos and Ltsno revealed that RHS segments not only cued for pronunciation but also other orthographies visually share the segment.
The differences between two character types on Ltos and Ltsno were examined further.

	phonetic-cpd.		Special.		Difference
Ltsno	90.88 %	(minus)	71.84 %	=	19.04 %
Ltos	88.75 %	(minus)	60.59 %	=	28.16 %
(Ltos - Ltsno)	2.13 %		11.25 %	=	9.12 %

The differences supported that special characters, if they contained no phonetic-root, would encourage less sound cued errors but more purely visual errors (11.25% - 2.13% = 9.12%).

(iv) Phonetic-root cueing within groups

To ensure that the overall phonetic-root cueing effect was not masked by the dominance of individual subject groups, a 3-way (AGE X LOCATION X CHARACTER TYPE) ANOVA was conducted for Ltos & Ltsno. The .05 level of significance was selected. The results were shown in figures 8a and 8b.

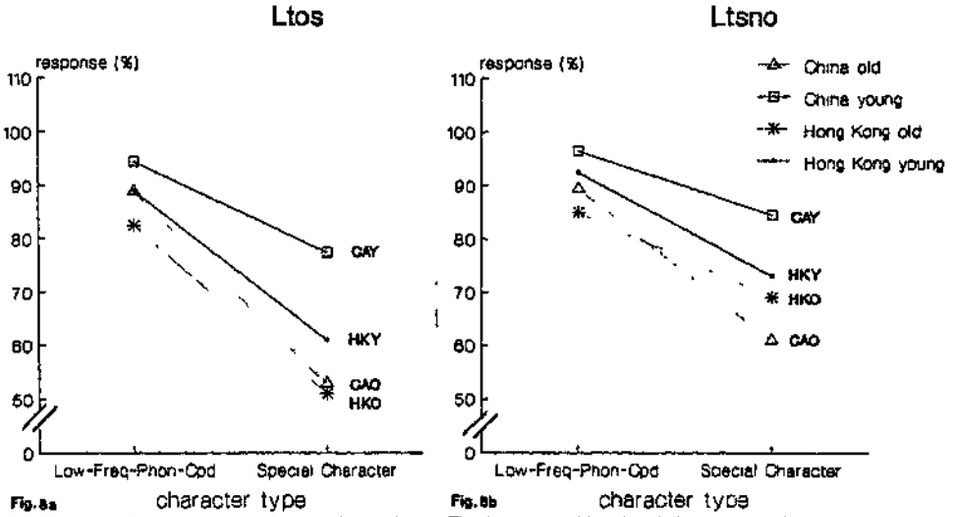


Fig.8a The 3-way age X location X character type interaction for Ltos - total RHB(sound) used

Fig.8b The 3-way age X location X character type interaction for Ltsno - total RHB used

Although, there were significant interaction effects for Ltos and Ltsno (Ltos : $F(7,312) = 24.95$, $p < 0.0001$; Ltsno : $F(7,321) = 15.83$, $p < 0.0001$), the Post Hoc Protected F's test revealed that the interaction did not bias the differences between two character types within each group. All groups responded significantly different on character types (All p values were less than 0.01). This supported the presence of phonetic-root cueing effect within all groups.

b) The role of semantic-roots

In testing for semantic-root cueing effect, an one-way Analysis of Variance was conducted. The .05 level of significance was selected. Dependent variable were Map, i.e., number of appropriate categorisation using semantic-root as reference. Subjects were able to classify 64% to 88% of characters appropriately. In response to the two character types, no significant difference was obtained ($F(1,318) = 1.11$, $p < .3$) The pattern has already shown in figure 7.

c) The relationship of the semantic and phonetic cueing

To test whether the semantic and phonetic cueing relationships are independent of each other, the Map result was further compared to the Ltos and Ltsno for correlations. The Pearson product-moment correlation was run. For Ltso and Map, r = .1 (N=160), for Ltsno and Map, r = .03 (N =160). F test of correlations for Map revealed non-significant correlations with either Ltos or Ltsno (For Ltos, $F(1,318) = 3.12$, $p = .07$; For Ltsno, $F(1,318) = 0.25$, p = n.s.). The results suggested that, the semantic-root cueing was not affected by presence of phonetic-roots. The two cueing relationships was independent of each other.

The information from validation enquiries supported the findings further. In asking for subjects' conscious strategies and their impression on reformed and standard characters, the four subjects displayed similar opinion. They recognised the greater aesthetic value of standard script and agreed that the standard script facilitates the guessing of meaning. The reformed script is faster in writing, and required less memory load to distinguish a large set of characters. Yet, as a trade-off, there are more confusions. They recognised the "read-the-segment" as strategy to guess meaning and sound of the whole character. However, they were aware that the sound derived from right-hand-side (RHS) components may not be always correct. Finally, only very few of them is conscious of themselves taking the visual cues of components.

To summarize, findings confirmed the following :
In reading unfamiliar characters, subjects rely on explicit metalinguistic rule of spatial orientations (e.g.left side for sound, right side for meaning). They recognised the phonetic-root cueing for phonological codings as well as other orthographic codings leading to known pronunciations. Visual cueing was evident, but often not realised. All groups responded significantly to the character types. The semantic-roots were important for cueing character's gross semantic category and the two cueing relationships were independent of each other.

STUDY III : THE PHONETIC-ROOT CUEING RULE AND SCRIPT SPECIFIC FACTOR

The study sought to answer the follow hypotheses :

Given that the reformed script is more rule-based for phonetic-root cueing,

a) the reformed stimuli will elicit an overall higher certainty level.

b) the first-learner and users of reformed script will demonstrate higher certainty level in applying the phonetic-root cueing rule for pronunciation.

In this study, only low frequency stimuli of standard and reformed scripts were selected. This was to control the familiarity factor. The old subjects' results were not taken because of the complex script learning histories. They were exposed to two scripts in a variety of life-stages. The young subjects' responses were analyzed because they were influenced by maximal script-specific-factors. Since the first-learnt and use factors could not be separated, they were treated as one single factor, namely as,"NATIVE-USER" .

The stimuli scripts and native-user were taken as independent variables. The dependent variable was the subjects' certainty level (Lconl). This served to reflect the linguistic regularity effect imposed by the independent factor.

A two-way Analysis of Variance (STIMULUS SCRIPT X NATIVE-USER) was conducted on the certainty level. The .05 level of significance was selected. No significant main effect of STIMULUS SCRIPT was observed. However, a significant main effect of NATIVE-USER, was obtained on the certainty level, Lconl ($F(1,78) = 32.8$, $p < .0001$). The result was shown in figure 9.

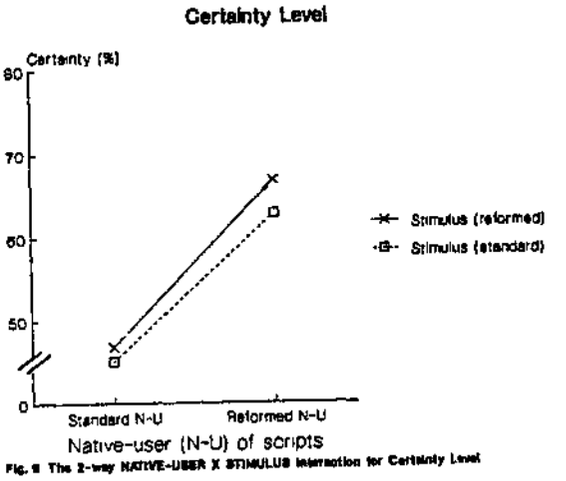


Fig. 9 The 2-way NATIVE-USER X STIMULUS interaction for Certainty Level

Taken together, the reformed stimuli did not create much difference in subjects' us of rule, whereas, native-users of reformed script were significantly more certain of their responses.

Summary

In study I, significant difference was mainly found in the accuracy rates of reading aloud task among Hong Kong Young, China Young, Hong Kong Old and China Old. The basic modular structure of a reading model and the lexical routings are supported. The groups displayed similar types and proportions of responses. The applicability of the reading model in these subject groups was sustained.

In study II, the semantic-roots and phonetic-roots were confined to two specific batteries of components which cue for meanings and sounds independently. The "read-the-segment (RHS)' strategy indeed, comprises three cueing rules, the phonetic-root cueing, the spatial orientation cueing and the visual cueing. Enquiry of subjects revealed the prevalent use of the reading strategy.

In study III, native-users of reformed script, though using same strategy in reading, showed higher certainty level of their guess. The operation of phonetic-root cueing rule was further supported. This also indicated the influence of script-specific factor on the internalisation of the phonetic-root cueing rule.

DISCUSSION

ADOPTION OF A READING MODEL

In study I, it was expected that the reading aloud characters would mediate through visual analysis, lexical phonological pathway and lexical semantic pathway. The visual, semantic and phonological errors together with correct pronunciations had provided evidences of the lexical orthographic, semantic and phonological representation and their accessing routings. The presence of graphemic segmentation process was supported by the "part' errors. The exclusive erroneous responses in the low frequency phonetic-compounds and special characters substantiates the claim of absence of grapheme-phoneme conversion system. Drawing these findings together, the basic scheme of a reading model from Patterson, Marshall & Coltheart (1985) was tentatively adopted as in

previous figure 1a. The major modification would be the abolition of the non-lexical phonological pathway and the addition of the graphemic segmentation module. Its functional implication was investigated in Study II.

APPLICABILITY OF A SINGLE READING MODEL ACROSS SUBJECT GROUPS

In considering the applicability of a single model for subjects differed by age, location and writing scripts, several factors were considered :

a) Literacy factor

If the literacy level was considered, the Hong Kong Old were of the lowest rank, because most of them received only few years of formal training. They were also the oldest among the four subject groups. On the other extreme, the China old subjects were at the highest literacy level. Most of them were tertiary teachers -a career that demands high proficiency of language. All younger subjects were at university or tertiary education levels. (Owing to sampling difficulties, matching of literacy level could only be achieved among younger sector.)

With such a diverse backgrounds, the subjects from all groups were expected to show different responses. However, the discrepancies were not as high as we anticipated. The major difference was the accuracy rate which is most sensitive to the language level. The highest correct scoring of China Old may be a reflection of the literacy influence. They would not give answers when doubted, nor would they give casual answers on recognising global contour only. The orthographic rules were highly respected. As their literacy level was skewed, their performance may only represent the minority in Mainland China.

The Hong Kong Old received the least years of education. However, their accuracy score was no less than subjects at university level. This illustrated that the definition of literacy is a difficult issue in literacy research. Whether it should be based on ideological model or autonomous model (Parr 1991) was still an unresolved problem. It is speculated that the average China residents may show performance comparable to Hong Kong Old, because this group received their education mostly in Mainland China.

b) Age factor

The Hong Kong Old were also the oldest group. However, their performance scores were similar to the younger subjects. The similarity of error patterns between older subjects and the younger ones revealed that young or old age was not an influential factor in this study of reading aloud Chinese single characters.

c) Spoken language influence

The China Young did give more phonological errors, otherwise, the responses of China young and Hong Kong Young were relatively similar. This was mainly due to the influence of the Putonghua. In some mid frequency stimuli, pronunciations had been offered as a hybrid of the Cantonese and Putonghua phonology,

e.g. 人 /jiŋ 4/ ——> [jiŋ 1] (Putonghua : /ren 1/).

This type of linguistic confusion may be comparable to a bilingual situation.

d) Script factor (reformed and standard)

In reviewing the figure 6a and 6b, both scripts scored the same pattern of responses. However, the Los , while remained as the most common error in both scripts, its average value in the reformed script (27.6%) was higher than the one in standard script (18.3%). The reformed scripts appeared encouraging more phonological responses. This script-specific factor is addressed in later.

e) Consistency of reading patterns

According to figures 6a and 6b, the above influences only constituted a small proportions of differences. Responses still displayed similar arrays and gradation patterns. The overall consistency of response patterns could readily be discerned, if figures 6a & 6b were converted into line charts (figures 10a and 10b). The charts revealed that the four subject groups were conformed to a similar shape of response-envelops. The similarity of the envelop shapes would become more striking if a left-brain damaged subject's pattern was included for contrast. Figure 10c and 10d demonstrated the variabilit of responses away from from the normative envelops. Some peaks, e.g. Lo and Los could be missing.

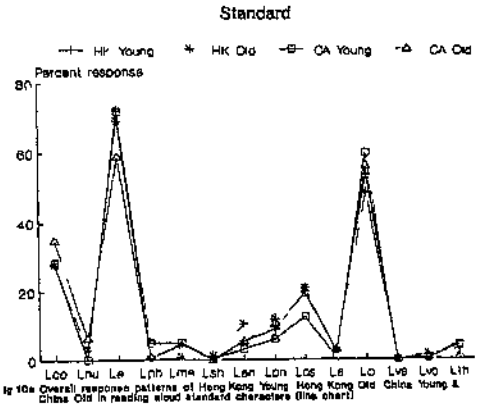


Fig 10a Overall response patterns of Hong Kong Young Hong Kong Old Chinese Young & China Old in reading aloud standard characters (line chart)

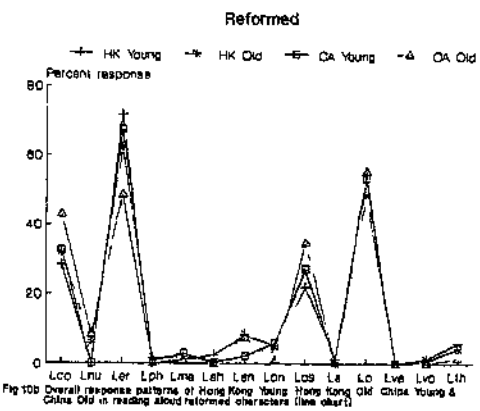


Fig 10b Overall response patterns of Hong Kong Young Hong Kong Old Chinese Young & China Old in reading aloud reformed characters (line chart)

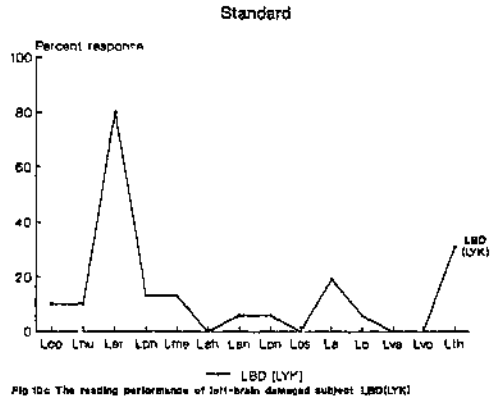


Fig 10c The reading performance of left-brain damaged subject LBD(LYK)

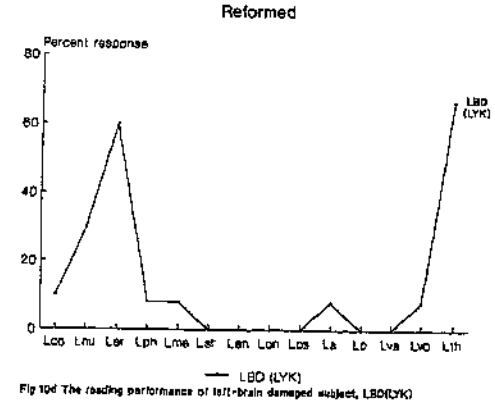


Fig 10d The reading performance of left-brain damaged subject, LBD(LYK)

Literacy level may exert influence on mid and low frequency characters, but for daily encounter characters, its effect may subside with the familiarity factor. Although literacy level affects accuracy, our findings suggested that the similar faulty processing could be resulted whenever subjects fell into difficulties. As yet, the high and low contrast of performance reminds us the importance of taking individual's literacy level as baseline reference for assessments of reading and writing. Lastly, if senility is taken to extreme end, the reduction in cognitive ability may become a decisive factor. To be more conservative, the applicability of a reading model across groups was plausible if individual's age, literacy background and use of language are taken into consideration.

THE CUEING BATTERIES AND THE NATURE OF THE "READ-THE-SEGMENT(RHS)" STRATEGY

As seen in the study I, the process of graphemic segmentation seemed to serve important functional roles. It would only occur when the gestalt-whole character recognition was failed. The Lo component had been exclusively used for pronunciation. This response was described in Varley et al.(1992) as the "phonological strategy". From the validation enquiries of subjects, they

were aware of using the reading strategy : reading the segment if it could be recognised. This rule though well known, was ambiguous at the first glance. It may imply for two situations : Is it referring to a metalinguistic rule based on spatial orientation (left/right, top/bottom) ? Or is it referring to specific batteries of graphemic segments, being internalised for reading ? The findings of study II helps clarifying the ambiguity.

a) Phonetic-root cueing for sound

The reading strategy and the phonetic-root cueing was tested by the presence and absence of phonetic-roots in characters. An overall 28% of sound cued effect by phonetic-root was obtained. This may imply the functional specificity of the phonetic-roots for phonological cueing.

Indeed, the value (28%) was comparatively higher than the figure quoted by Hoosain (1990), which stated that about 18% of the pronunciations was related to the phonetic-root. Nevertheless, as the China subjects were included in this study, this may contribute to the tendency of obtaining a higher sound cued effect. [A small scale of analysis of reformed scripts (obtained from China) was then conducted and revealed a higher incidence of 38.3% phonetic-root related pronunciations. Curiously, the average of standard (18%) and reformed (38%) values resulted in 28% which coincided with our Ltos findings.]

The coincidence may again suggest that if a script (reformed) encourages the phonetic-root to sound correspondence, it will as a result, encourages subjects' use of the cueing rule. This implication is tested out in Study III.

b) Semantic-root cueing for meaning

For semantic cueing, at least two/third of the semantic categorisation was primed by the semantic-roots resided in left hand side. Subjects were able to abstract information up to superordinate levels, e.g. water 氵 => physical nature group, worm 虫 => animal group. tree 木 => plant group, speech 言 => human group. As the semantic-root cueing was not affected by the variation of character type, the two cueing relationships could be quite independent of each other.

c) Spatial orientation of RHS component

What out of expectation was that, the spatial orientation was exerting a dominant cueing power as well. The special characters displayed over than 50% of Ltos sound cueing responses even in the absence of phonetic-roots. Therefore, the ambiguous rule at least included two rules, one explicit and one implicit : Take the RHS component and check the sound if it is a phonetic-root.

d) Visual cue of RHS component

We also realised that the cueing of RHS component was not confined to phonology only, it also subserved a visual cueing effect. In some cases, gestalt-whole errors were purely visual error relating to the RHS components (Lon), where the phonological relationship between stimuli and responses could hardly be traced. With special characters, there could be a bias on visually cued responses up to a difference of 11.25% Furthermore, the most frequent gestalt-whole error was the one having both visual and phonological resemblance to the RHS component (Los). This indicated that subjects would take the visual cues together with the phonological cues from the RHS segment (An example of simultaneous processing ?).

Taken together, the phonetic roots serves for cueing sound. The semantic roots serves for cueing gross semantic category. Subjects were usually aware of taking components at right-hand-side as spatial orientation cues for pronunciation. However, they often did not realise that they had internalised the rules of phonetic-root cueing and the visual cueing. Hence, the generalised "phonological strategy" described in Varley, et al. 1992, may at least entails three rules in operation : the spatial orientation cueing, the visual cueing and the phonological cueing from the phonetic-roots. Although both the cueing batteries did not have systematic correspondence, there were the preferred graphemes allocated for sound and meaning cueing.

PHONETIC-ROOT CUEING AMONG SUBJECT GROUPS

As shown in figure 8a and 8b, the phonetic-root cueing rule had been internalised by the four subject groups to different extend. A slight location effect was also observed in the low frequency phonetic-compounds. The China subjects, no

matter young or old, produced more phonetic-root cued effects. It may be that, the reformed script has a more regular rule of sound to phonetic-root correspondence. Hence the learning and use of it may have facilitated the internalisation of the rule. This speculation was supported in study III.

THE STRENGTHENING OF PHONETIC-ROOT CUEING RULE BY SCRIPT-SPECIFIC-FACTOR

Previous evidences suggested the facilitative effect of reformed script for phonological cueing. In study III, a significant higher certainty level from native-user of reformed script was demonstrated, whereas a slight effect of reformed stimuli was obtained.

It is possible to explain the weak stimuli effect. If subjects had ever known about the "read the segment" strategy, they would explicitly apply the strategy to all stimuli items so long as they were all phonetic-compounds. Therefore, they exhibited similar extend of strategy whose difference may only be detected at a deeper internal state : their certainty level. The fact that China Young were more confident of their responses, especially when exposed to reformed stimuli had supported our hypothesis. The cueing rule had been abstracted with a stronger realisation under the influence of script-specific factor of reformed script. As a whole, the presence of a more regular cueing rule was further suggested.

The findings also indicated that it is possible to have the cueing battery strengthened to compensate the absence of the grapheme-phoneme conversion system for reading. The "phoneticisation" motion of the China Language Reformed Committee had been incidentally moving in this direction though their purpose was simply to facilitate the learning and memorisation processes.

MODIFICATION OF THE READING MODEL

In view of the specific roles played by the cueing batteries, our previous lexical model was augmented with the cueing process as shown in figure 11.

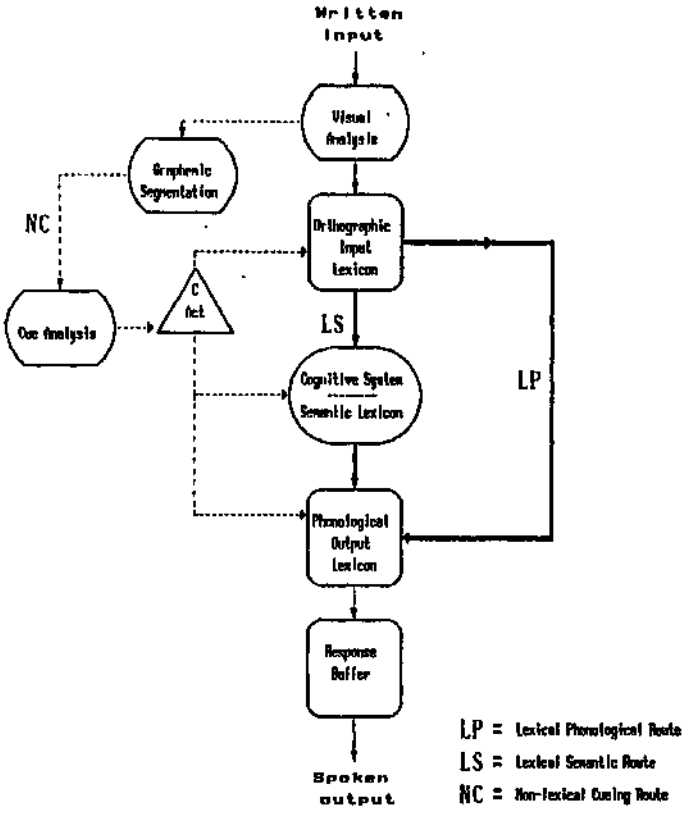


Fig. 11 A tentative reading model for Chinese single Characters, augmented with non-lexical cueing pathway.

In sum, study I provided evidences for a reading model. Studies II & III substantiate the augmentation of graphemic segmentation and the cueing process.

INADEQUACY OF THE POSTULATED READING MODEL

To test for the application of the proposed model, the accessing routings of errors displayed by one single stimulus was tentatively drawn up (fig.12a & 12b)

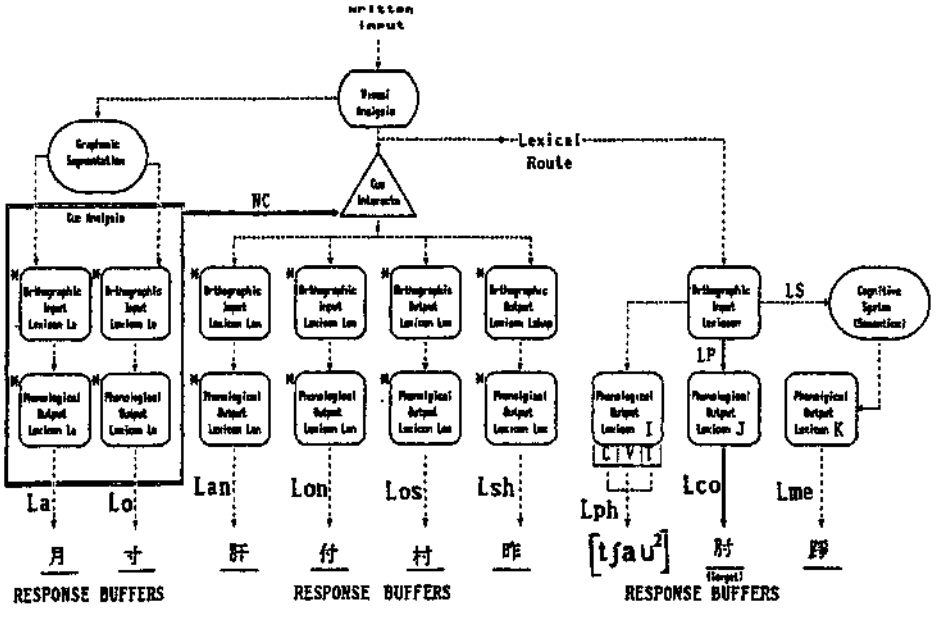


Fig. 12 Parallel Distributed Processing in reading chinese single characters, combined routings.
NC = Non-lexical Cueing route, # = To cognitive system for meaning extraction.
LP = Lexical Phonological route, LS = Lexical Semantic route.

While it is possible to trace the lexical routings (LP, LS) and the cueing routings (NC) for the responses, the original linear, serially operating model were expanded into parallel routings and there was the cueing interactions among the routes. These may reflect the inadequacy in of the model in explaining some reading failure of Chinese characters. Furthermore, the model is also fall short in specifying how information is represented within each module (Mitchum & Berndt, 1991). Perhaps, a microscopic account from the model of Parallel Distributed Processing may complement the adequacy. In view of the language specific properties of Chinese, e.g. the rote memorization, the consideration from other cognitive perspectives, e.g. memory, in information processing as claimed by Margolin, 1991, is particularly warranted.

IMPLICATIONS

The failing of reading could have been traced to one or more parts of the process : a) analysis of the visual structures, (b) mapping among the codings ortho-graphic, phonological and semantic stores, (c) establishment of the regularities in grapheme-phoneme correspondences, (d) grouping of words into larger units at the sentence processing levels (Garrett 1982, in Lesser, 1987). The lexicon reading model will be limited to a to c only in clinical and theoretic aspects.

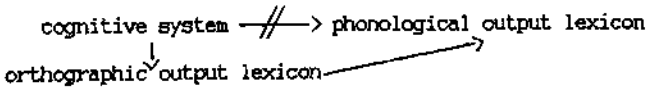
CLINICAL IMPLICATIONS

As Chinese writings do not have grapheme-to-phoneme conversion system, the Chinese readers would have spare the difficulties in establishing the rules as well as in the on-line mapping of grapheme-to-phoneme. The well-established memory may lead to better chance of preserved reading in Chinese. In opposite, problems in memory processing, e.g. short-term memory deficits would in turn become more detrimental to Chinese reading. Furthermore, the visual-spatial deficits may hamper the reading of Chinese more by intervening the visual analysis of the configurations.

Kuo, 1978 (in Hoosain 1991) mentioned that the incidence of reading disability (developmental) amongst the Chinese (in Republic of China)is lower than in the West. In a comparison among Chinese, American and Japanese children conducted by Stevenson, Stigler, Lucker, Lee, Hsu and Kitamura (1982), 33% of the American children, 12% of the Chinese children, and 24% of the Japanese children were identified. Would the low incidence of developmental dyslexia be a close estimate of the real problem ? Or, is it only because the probing variables for Chinese reading had not been identified and used for screening ? Would our results suggested that Chinese reading problem is less linguistic specific, but more correlated with the general cognitive disability ? These would warrant careful diagnosis and (re)habilitation of dyslexia among Chinese populations.

Similar speculations would also be on the acquired dyslexia in brain-damaged patients. It is plausible that the absence of grapheme-phoneme conversion system may preclude the clinical occurrence of the surface dyslexia or phonological dyslexia. However, the Chinese dyslexic problem may reside more at the visual perceptual or visual memory deficits that are less addressed in the alphabetic languages (Goulandris & Snowling, 1991). Moreover, given the presence of the semantic-root for cueing, it is wondered whether this will affect the manifestation of deep dyslexia. The presence of cueing batteries may be useful for the rehabilitation of Chinese dyslexia as they are the basic components and tend to be well recognised as in our studies.

If the principle of functional re-organization (Luria, 1970) is considered, the orthographic memory may be of some value in speech rehabilitation of Aphasia. For a Chinese aphasic fails to access to the phonological output lexicon, if he could self generate the orthographic output lexicon first, and from which retrieve the phonological output lexicon, then it is feasible to by-pass his original difficulty by re-organizing the routings.



These are some speculations still awaiting for testing in clinical trials.

THEORETICAL IMPLICATIONS

Farah & Wallace, 1991, reconsidered the visual impairment hypothesis as one of the underlying causes for pure alexia. Traditionally, the word form hypothesis (the reading difficulty results from damage to reading-specific mechanisms) is accepted as the main explanation. Since Chinese reading involves more visual processing, it is wondered if future research would provide supporting evidences for the visual impairment hypothesis.

As the hemivisual field studies of Chinese single characters were often confounded by various physical variables, e.g., the illumination intensity, exposure time (Hoosain, 1991); testing reading performance in left and right brain damaged patients may provide insights for the linguistic and visuo-spatial status of Chinese single characters.

Finally, the memory loading of Chinese characters, the cue-dependent retrieval, interactions of modules and the synchronous processing have been indirectly shown in the present studies. The language specific features may require more collaboration of studies from other cognitive domains, e.g. the PDP model.

CONCLUSION

Shallice (1979) indicated that in domains such as reading, one can often develop predictions from normal literature about what should happen if a particular subsystem were damaged. The present investigation has collected some normative data for a tentative reading model in reading aloud Chinese single characters. The overall consistency of groups' performance renders the use of a single non-variant model for two populations plausible, if age, literacy level and use of language was also considered.

The cueing batteries for sound and meaning and detailed cueing principles were identified and confirmed. The results helped determining the position of the cueing process in the reading model as well as the nature of the "read-the-segment (RHS)" strategy. A stronger abstraction of the phonetic-root cueing rule and the script-specific effect were demonstrated.

The findings of these studies have both theoretical and clinical implications. Clinically, the differential manifestation and the underlying deficits of both acquired and developmental dyslexia were predicted. The rehabilitation may have different procedures specific to the language.

Theoretically, the re-consideration of the definition of dyslexia by visual deficit hypothesis was reinstated. The need of incorporating other cognitive psychology domains for reading studies was advocated. The cross-linguistic difference in reading may present a challenge to the macroscopic reading model.

The studies also raise the concern of literacy level in reading research and rehabilitation. The need of taking literacy level and socio-political background as normative reference is warranted.

Finally, findings were limited to their use on single lexicon level. Speculations are awaiting for validation from negative investigations among brain-dysfunction subjects as well as from studies in other cognitive domains.

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KNOWLEDGE

Knowledge - Only when it is derived from active thinking process, but not from rote memorisation; then it is the real knowledge being possessed.

Tolstoi, Lev Nikolaevi
[A Russian Writer]
(1828 - 1910)

Peoples Daily, Nov. 21, 1991.

ORIGINAL VERSION

知　識

知識，只有當它靠積極的思維得來，而不是憑記憶得來的時候，它是眞正的知識。

——列夫・托爾斯泰（俄國

SIMPLIFIED VERSION

知　识

知识，只有当它靠积极的思维得来，而不是凭记忆得来的时候，它是眞正的知识。

——列夫・托尔斯泰（俄国

（繁簡字對照）

Appendix 1 : Literacy Test Passages.

A) ACCURACY

Correct response	Lco	Same designation of sound with the target, in term of consonant, rhyme, tone.
Null response	Lno	No response, or indicated inability to give answer, despite prompted with " what is the first sound come into your mind"
Errors	Ler	Any pronunciation differs from target either by consonant, rhyme, or tone.

B) WHOLE-ERRORS

Phonological	Lph	Phonologically, the response is related to target pronunciation.
Semantic	Lse	Spoken responses mediated by meaning or semantics relating to stimulus only. Usually, pronunciation is unrelated to target.
RHS-Visual-Whole cued	Lov	Phonologically, the response is unrelated to stimulus's RHS component. Its cued orthography preserves the RHS, but differs in semantic-root.
RHS-Visual-Sound-Whole cued	Los	Phonologically, the response is related to stimulus' RHS component, either by consonant, rime or tone. It also preserves the orthograph of RHS component, though with a different semantic-root.
LHS-Visual-Whole cued	Lsv	Visually consists of the same semantic-root component (LHS) with the stimulus, but phonetic-root was replaced.
Global-Contour cued	Lsh	Sound originated from another character whose global contour is similar to the shape of stimulus's orthographic form.

C) GRAPHEME SEGMENTATION ERRORS

Part-RHS	Lo	Direct reading-off of the right hand side (RHS) segment of character.
Part-LHS	Ls	Direct reading-off of the left hand side (LHS) segment of character.
Visual Part-RHS	Lvo	Visually mediated error of the parted RHS component.
Visual Part-LHS	Lvs	Visually mediated error of the parted LHS component.

D) TOTAL RIGHT HAND SIDE (RHS) MEDIATED ERRORS

Total RHS(sound) cued	Lrso	All errors phonologically related to the RHS segment.
Total RHS cued	Lrno	All errors visually or phonologically related to the RHS segment.

e) SEMANTIC CATEGORISATION

Appropriate Semantic Categorisation	Map	Classification of characters according to the referent of the constituent semantic-root.

Appendix 2 : The description and coding of the responses in reading aloud and semantic categorisation.