PSYCHOLINGUISTIC DIMENSIONS OF THE MENTAL DICTIONARY IN CHINESE VS. JAPANESE

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1. Introduction

This paper contrasts one of the central issues in psycholinguistic models of lexical access and word recognition in Chinese, Japanese, and English. The relationship between phonology and orthography differs across languages, with some languages boasting a close relationship between the two and others not. We know that different orthographies are based on different aspects of language, namely, phonemes. syllables, and morphemes, or the interstices of these features (like morphophonemes), and that these orthographies can present such linguistic information in different ways. But we are not always sure of what cognitive processes handle these orthographic representations and how the human processor takes information out of these various orthographic shapes. While Chinese has been held out to exhibit an opaque relationship between phonology and orthographic type and English a closer relationship, these assumptions do not always find themselves reflected in the facts. For example, Chinese has phonetic radicals; and English has oblique spellings for familiar words which are read at processing glance, instead of through phonological decoding. Moreover, English is not such a simple phonemically-based writing system; rather, graphemic units are often tied to an intermediate morphophonemic level before they are related to sound (see Venezky, 1967). And although Chinese is morphemically-based, Chinese allows, and sometimes requires, phonological information to be accessed during its word recognition procedures. The fact is that the phonemically-based orthography of English is more morphophonemic than we give it credit for. In turn, Chinese has many phonetic elements which can be and are used in reading hanji[1] (see Leong, 1986, for an excellent outline of just such processing hints).

A central psycholinguistic question in respect to Chinese hanji processing focusses on the degree to which phonological and semantic processing interact when the mental dictionary is consulted. Do they interact in parallel or sequential modes? From a psycholinguistic viewpoint, there have been two opposing explanations for how fluent Chinese readers access the mental lexicon as they cognitively process hanji characters for recognition and their semantic properties. One view, the speech recoding view, claims that hanji processing does not require an orthography-specific processing mechanism. This means essentially that lexical access goes from the written form of the word through the speech coding for the word to the semantic representation for the word. Although Chinese orthography is logographic in nature, the processing mechanisms it employs are claimed to resemble the processing mechanisms employed by languages which use alphabetic scripts. The opposing view, the direct access view, instead claims that lexical access is achieved directly, with the written image of the word allowing direct access to the semantic representation of the word. This view, as applied to Chinese orthography, maintains that hanji processing is unique, employing processing mechanisms which inherently differ from those used for dealing with other script types (see Chen, 1996, for an overview which draws this conclusion). Not surprisingly, there is evidence for both views on

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[1] Hanji are the logographic written symbols used in the Chinese orthography, common known as Chinese characters. Kanji are those logographic written symbols imported into Japanese orthography from Chinese in four separate and distinct historical periods. In Chinese, their use consitutes the only writing system, but in Japanese, the use of Chinese characters is complemented by three other types of orthographic symbols, two of which are syllabic in origin and one alphabetic.

whether speech recoding is essential or even helpful to readers of other languages, and the situation with Chinese is no different. The evidence can be equivocal, and we will make an attempt to survey those differences and resolve their apparent differences.

Perhaps a better test of the characteristics of logographic systems is a comparison between Japanese and Chinese, two completely unrelated languages which, through the vagaries of history, have come to employ the logographically-based Chinese characters in somewhat different ways. An interesting way to make this comparison is through examination of what is considered to be one of the central psycholinguistic issues in the study of the mental lexicon in each of the two languages, and how recent psycholinguistic research has addressed these issues and with what results. Actually, such inquiry has a much wider interest, for it not only tells us about possible universalistic vs. orthography-specific processes that correlate with their various writing systems, but it also lays the foundations for a general theory of lexical access and word recognition.

The Japanese system of orthographic scripts provides an informative counterpoint in its use of several different systems. The most important of these are the two kana syllabaries, which match the simple syllabic structure of the language, and a large inventory of logographic kanji which can have varying pronunciations derived from either borrowed Chinese readings or native Japanese readings. The issue in Japanese is similar to the debate in Chinese lexical access: Can meanings of Japanese words written in kanji be understood even when their phonetic codes are not retrieved from the written transcriptions? However, unlike Chinese, Japanese kanji characters can have two possible types of reading for a given kanji; *on* Chinese readings, derived from one of four periods of historical borrowing from China, can compete with *kun* Japanese readings of the same kanji.

This paper first explores psycholinguistic dimensions of hanji processing and word recognition in Chinese. In passing, we survey relevant psycholinguistic literature on Chinese hanji processing, and attempt to chart issues related to phonological activation in research on Chinese lexical access, word recognition, and the architecture of the Chinese mental lexicon. We then explore similar psycholinguistic issues for kanji processing in Japanese, attempting to contrast relevant findings in this structurally unrelated language which also employs some of the same principles in its orthographic system. Finally, we attempt to provide a synthesis of the research findings and posit a word recognition model which accounts for how both Japanese and Chinese employ phonological activation in lexical access procedures.

2. Lexical Access in Chinese

2.1. Introduction

As is well-known, Chinese employs both the *pictograph* and the *phonograph* types of hanji. Pictographs comprise a small percentage of Chinese logographs, but the majority of Chinese logographs are phonographs (Wang, 1981). It is this type of logograph that draws our attention in matters of lexical access and word recognition, because phonographs exhibit two possible constituent parts: a radical or *signific*, which refers to meaning, and a *phonetic*, which refers to pronunciation (see Chen and Yuen, 1991). The figures vary, and some put the number of Chinese characters that use phonetic compounds as high as 90% (see Tan, Hoosain, and Peng, 1995). Even so, the pronunciation of many of these phonetic compounds are not identical to their phonetic radicals.

A central issue in Chinese hanji processing is related to this dichotomy, and reflects research into whether the phonological properties of a given hanji character must be invoked before its meaning can be accessed. One possibility that has been suggested is that hanji processing does not require an orthography-specific processing mechanism. This is the same as saying that, logographic script type notwithstanding, the processing mechanism that Chinese employs is the same as the processing mechanism employed by other languages. In other words, languages like English that use alphabetic scripts, as well as languages like Chinese that use logographic scripts, ultimately use the same cognitive mechanisms to deal with those scripts. Another possibility is that hanji processing is instead unique. This has, of course, been the commonly held belief in the general literature, namely, that the processing

mechanism which Chinese uses in dealing with logographic script is inherently different from the processing mechanisms used for dealing with alphabetic scripts. This view maintains that hanji achieve access to meaning without the mediating step of decoding phonological properties. There are in fact two variations on this basic theme, a weaker version and a stronger version. The strong version of this view posits a simple, single-step processing explanation, wherein phonology is secondary to meaning. The cognitive routing in this view proceeds directly from Orthography to Semantics, accessing Phonology only as required. A weaker version argues that hanji can access meaning without activating the phonological identity of the word, but that this processing step is highly grapheme-dependent and in this way differs from alphabetic processing.

2.2. Orthography-independent Hypothesis

The first explanation in respect to hanji processing, the Orthography-independent Processing Hypothesis, holds that the meaning for hanji cannot be accessed without first accessing the phonological identity of that hanji. Thus, the cognitive route goes from Orthography through Phonology and then on to Semantics. This is, of course, exactly the same route as the sound-mediated path that reading in alphabetic and syllabic scripts entails. In theory, then, the properties of all scripts are such that the processing demands they make on the cognitive architecture in the symbolic decoding of language-based written materials are essentially the same.

An early pair of experiments by Tzeng, Hung, and Wang (1977) on short-term retention first suggested phonological activation. Their first experiment visually presented target lists of four Chinese characters which differed in syllable structure from each other. This was followed by an oral interference task which contained items that were either phonemically similar or dissimilar to the target list of characters. Immediately after visual presentation of the target list, subjects had to say aloud the interference words which they had just heard. They were next asked to write down the target characters which they had first seen, and in the order that they had appeared. If speech recoding takes place, one would expect that phonological similarity between the target and the interference characters would disrupt the memory for the items that subjects had to recall. The results demonstrated that phonological similarity did have a significant effect; in particular, it was vowel similarity in the pronunciation of the characters that elicited interference on recall abilities.

The second experiment tested grammaticality judgments for sentences, manipulating normal vs. anomalous sentences that contained phonologically similar words vs. phonologically dissimilar words. As in the first experiment, phonological similarity again interfered with subjects' performance, affecting not only their short-term memory for unrelated characters, but even the reading of the normal meaningful sentences. Both experiments were taken as early evidence suggesting that phonological factors have a very real cognitive presence in processing.

Similarly, Tzeng and Hung (1980) found subjects to be more accurate in detecting logographs that contained a target radical with a phonetic value in the pronunciation of the hanji in which it appeared. To put the example into English terms, this would be like reporting where the letter *e* appears; is it easier to notice in words like *red* or in words like *date*. In the word *red*, the letter *e* is directly linked to the pronunciation of *red* and is therefore more readily noticed than the *e* in the word *date*. The 'silent *e*' in *date* is not linked to its pronunciation and might not be reported as having been seen as often. In both experimental reports for Chinese (Tzeng, Hung, and Wang, 1977, and Tzeng and Hung, 1980), the authors concluded that phonetic recoding does take place, but left open to further research the important question of where that speech recoding takes place. Does it take place at the pre-lexical stage before word recognition has been achieved? Or at the post-lexical stage once word recognition has been achieved?

Several recent studies offer direct support for automatic phonological activation in Chinese. Lam, Perfetti, and Bell (1991) took as their working hypothesis the automatic availability of the phonetic code of the first language or first dialect to proficient readers of that dialect or language. They compared subjects who were bidialectal in Cantonese and Mandarin with subjects who were unidialectal in Mandarin. One can expect that, because some hanji have different pronunciations in Cantonese and Mandarin, there will be interference for native Cantonese readers. They suggest that it is the phonetic representation in the first language, Cantonese, that will be indelibly stored in

memory; this will be the one automatically retrieved from memory in reading individual characters. Thus, the inference is that when making judgments about whether pairs of words are pronounced the same or differently in Mandarin, the Cantonese phonetic representations will be automatically recalled, causing the interference. When subjects were given pairs of characters and had to determine whether they had the same pronunciation in a given dialect, Mandarin or Cantonese, this task revealed that judgments were both faster and more accurate in the first dialect. This suggests that phonetic values in the first dialect were automatically recalled and that automatic acoustic activation necessarily takes place.

Perfetti and Zhang (1995) also report supportive results for the notion of phonological activation in two experiments which manipulated synonym judgments. But, in keeping with their *at-lexical* view of the identification event in word recognition, they tested both factors of phonological interference and semantic interference. Giving precedence to neither, they probed whether Chinese readers can suppress phonological activation when a semantic judgment is required, and then probed whether semantic activation can be suppressed when phonological judgments are required. In the first experiment, subjects were asked to judge whether a given pair of hanji was synonymous or homophonic. When the characters were homophones, negative judgments resulted in longer reaction times than when the characters were not. The second experiment used a similar experimental design with synonym judgments to check the time course of such interference, and found that phonological interference took place within 90 msec. of stimulus onset. Semantic interference, on the other hand, was initiated much later, at the 140 msec. boundary. Thus, in a task in which phonological activation has no obvious value, the name (or pronunciation) of the character is activated within 90 msec. of processing. This, of course, does not rule out semantic activation, but simply shows that visual processing of a hanji for a semantic judgment task will nevertheless bring up its phonological characteristics. The one conclusion from the perspective of the issues raised in this paper must be that phonological activation is a necessary component in word recognition, and furthermore, that phonological processing may be activated before semantic processing. It may be that phonological and semantic processing levels are automatically and simultaneously activated, but once again, the implication must be that phonological activation is an integral part of the access path to final word recognition.

2.3. Orthography-dependent Hypothesis

An opposing view to this notion of automatic phonological activation claims that hanji recognition accesses semantic properties directly. Often this is tied to other corollaries about processing Chinese characters, namely, that lexical access is more direct or quicker for hanji than for alphabetic words, that hanji are more distinctive in shape than alphabetic words, and that hanji can facilitate recall through graphic features like semantic radicals to access semantic categories. These premises cannot be taken as proven, however, as a series of ten experiments by Liu, Zhu, and Wu (1992) have shown in their examination of and explanation for the visual superiority effect in Chinese subjects' performance in the immediate free recall and serial paradigms. Rather, their results suggest a multivariate set of factors for reported findings; they demonstrate that Chinese subjects exhibit visual superiority effects for a complex of reasons, not simply because Chinese lexical access is simple, rapid, and direct (see Leong, Cheng, and Mulcahy, 1987, for another multi-variate analysis, as well as Tan, Hoosain, and Peng, 1995).

Semantic categorization tasks have been used to test the possibility of a direct cognitive route from Orthography to Semantics. But these experiments for Chinese report results that are different from the results reported for English. Let us review the results for English first. Van Orden (1987) and Van Orden, Johnston, and Hale (1988) gave English-speaking subjects a category name like *flower*, and then had them decide whether a later target word was a member of that category. But they manipulated target words to include targets like *rows*, which is a homophone with a word like *rose*. *Rose* is obviously a real member of that category. Both experiments found that subjects made more categorization errors with, and spent more time on, the homophone foils than they did on the spelling controls. What this means is that when the category was *flower* and the target word was *rows*, homophone foils like *rose* gave more problems than spelling controls like *snobs*. In fact, such homophonic identity gave rise to problems, even when their spellings were very different. Van Orden, Johnston, and Hale (1988) introduced as targets non-words that were homophones, as for example, *brane*, to be matched with the category entitled *a part of the human body*. The reasoning

is that since non-words such as *brane* are obviously not entries in the mental lexicon, there must be a mandatory phonological activation of such words if categorization errors occur. And indeed, this is just what happens with *brane*, a homophone with *brain*; but it does not happen with *blane*, a non-word spelling control. What we are led to believe from such results is that there is automatic activation of phonological information in lexical access for English words.

But this does not seem to be the case in Chinese. When the experimental paradigm was applied to Chinese word recognition, the situation seems to be quite different. Chen, Flores d'Arcais, and Cheung (1995) applied semantic categorization tasks to their investigation of hanji processing, and report results which differ from the English results. In one experiment, Chinese subjects silently read a category name and then looked at a fixation point. A target character was then presented, and the subjects had to judge whether the target was a member of the category that had just been presented by pressing a response key labelled 'yes' or 'no'. Subjects were relatively accurate at making judgments about semantic categorization, producing the same proportion of false positive categorization errors and showing the same decision latencies on homophone foils as on the non-homophone controls. The confounding factor of phonological information did not seem to affect the semantic task in this instance, and the authors concluded that phonological information associated with a character does not become active in processing the character for semantic decisions.

A second experiment added orthographic similarity as an extra condition to check whether there were possible interference effects arising from orthographic similarity. Such interference would reveal whether the orthographic code is active during the process of coming to a semantic decision. This time subjects made more errors and produced longer response times on graphemically similar foils than they did on the corresponding controls. Such clear effects from visual similarity in the Chinese characters on the semantic categorization task stand in sharp contrast to the absence of phonological effects, and suggest that phonological information is not automatically activated during semantic processing for Chinese characters. The authors did not rule out the possibility of optional phonological activation, but observe that their results cannot support the notion of automatic phonological activation.

Even here, variations on the experimental task defined above might produce conflicting results, as suggested by Chua's results (1995). Adapting the same general semantic task (see Van Orden, 1987, and Van Orden, Johnston, and Hale, 1988) in three experiments, Chua had subjects decide if a target logograph fit a previously presented definition. The results show phonological recoding as obligatory, and not optional; in addition, this recoding was not easily inhibited, and took place before semantic access was completed, thus making it a candidate for pre-lexical automatic activation. As with the van Orden studies in English, Chua's subjects' performance suffered when homophones were introduced; in this condition subjects were less accurate and took longer to make their decisions.

3. Lexical Access in Japanese

The issues in lexical access for Japanese words are complicated by the fact that Japanese does not have a single script type. Instead it has three script types, two of them syllabaries and one of them based on Chinese characters borrowed and adapted over the centuries. Even though Chinese characters are employed in Japanese, these kanji are in many ways quite different from Chinese characters. The early literature entertained the notion that the two types of writing system, kana syllabary vs. kanji logographs, would employ different mechanisms and perhaps even different sides of the brain. The expectation was that kana syllabaries would be processed through phonological decoding, whereas kanji would allow direct access to meaning. In this respect, the two writing system types, one based on a phonological principle and the other based on the same morphological principle as Chinese hanji, would ostensibly rely on different processing principles. The expectation was that the morphologically-based kanji would allow direct whole-word access to meaning direct from the orthography, while the phonologically-based kana would have to go through the step of phonological decoding to get at meaning. This expectation was further enhanced by the fact of extreme regularity in the relationship of the hiragana and katakana syllabaries to their respective syllables. The facts are, as we shall see, otherwise, and in some ways reminiscent of the Chinese findings while in other ways quite different.

The findings are colored by the relationship of kanji to their various readings or pronunciations. Among other things, a kanji character may have a Chinese reading, called the *on*-reading, or a native Japanese reading, called the *kun*-reading. In fact, it can have more than one of either of these readings, *on* or *kun*, and these readings (or pronunciations) are very much tied to context. Moreover, although the characters imported from China often retain their phonetic radicals, these are nowhere as reliable or useful as they are in Chinese. In fact, the percentage of phonetic radicals with reliably correct readings for a given kanji are very limited in Japanese. This basic difference in and of itself makes the discussion of phonological activation different for character recognition in Japanese discussions of lexical access. Nevertheless, the basic findings regarding automatic phonological activation for kanji characters are congruent with the Chinese, as we shall see below.

4. The Issue of Phonological Activation in Japanese

In line with the expectation that kanji meanings could be directly accessed without being mediated by the phonological code, some early experiments demonstrated that the meaning of words presented in kanji could be retrieved directly. This was shown in both the experimental literature (see, for example, Hatano, Kuhara and Akiyama, 1981, and Saito, 1981), and to some degree, in the clinical literature on aphasia (see Yamadori, 1986). Nevertheless, three recent experiments by the same authors (see Kuhara-Kojima, Hatano, Saito & Haebara, 1996) qualify this position somewhat. This qualification rests on the finding that vocalization latencies for fifth graders repeatedly show that vocalization latencies for less skilled readers were longer than skilled readers for both hiragana and kanji words. Vocalization latencies are operationally defined as the elapsed time from the presentation of a word to the subject's initial vocalization, and the task explicitly targets such vocalized responses. On the one hand, this finding corroborates the findings in English that show vocalization latencies to single printed words to be a reliable measure of automaticity in word recognition. Apparently, the same reliability as a metric applies in non-alphabetic writing systems used in languages like Japanese. But for our purposes here, it implies that some speech processing accompanies lexical access in Japanese even for kanji-transcribed words, for the same effect applies across both orthographic types.

The semantic categorization paradigm with homophones we discussed earlier for both English and Chinese has been replicated with similar results for Japanese kanji processing. Like those findings, three experiments reported by Wydell, Patterson, and Humphreys (1993) also found a significant homophone effect. In Japanese, as well as in English and Chinese, homophonic words elicited longer reaction times and more errors than their controls. But Wydell, Patterson, and Humphreys, like Chen, Flores d'Arcais, and Cheung (1995), also found a significant effect which arose from orthographic similarity. That is, incorrect target words that were visually similar to correct examplars which did fit into the semantic category were also responsible for longer reaction times and higher error rates, although not to the same extent as the results obtained from phonological overlap in homophones. The effects were strongest when both factors intersected, that is, when homophonic targets were also visually similar in orthographic shape to correct exemplars of the semantic category specified. As a result, Wydell, Patterson, and Humphreys (1993) suggest that, in Japanese, lexical access for kanji invokes both orthographic and phonological representations for the appropriate information. In this respect, kanji processing may exhibit some important differences from alphabetic differences in English, and may be somewhat more like hanji processing in Chinese.

But more important than this finding, from the overall perspective of word recognition models, is the finding that the readings for Japanese kanji are likely computed at the word level, not the individual character level. This conclusion comes from two separate paradigms; one is the work on consistency effects arising from word and character segments, and the other is from an application of the priming paradigm to compound words in Japanese.

Research on potential consistency effects confirm that the normal effects of word frequency, character frequency, and familiarity on word naming tasks hold true. But the phonological rendering of the kanji is highly dependent on the intra-word context, and is finalized at the word level, not at the character level. A series of six experiments by Wydell, Butterworth, and Patterson (1995) note that Japanese is different from both English and Chinese in this respect. This result is tied to the fact alluded to earlier, that Japanese can have two types of reading for its kanji, *on* or *kun* readings. And furthermore, recall that these readings can vary for individual kanji according

to the level of intra-word context, and not the individual pieces of the character in respect to phonetic or semantic radicals.

There are some interesting findings for single kanji characters which include more than a single component. Such complex single kanji may include a segment that signals some aspect of meaning or pronunciation, or both. At the left-hand side of the complex character, for example, there may be an additional component that suggests meaning, the radical *hen*. At the right-hand side of the complex character, there may be an additional component which suggests pronunciation, the radical *tsukuri*. Although the positions of these radicals can vary, they generally appear at the left and right sides, respectively, and thus Flores d'Arcais, Saito, and Kawakami (1995) employed them to investigate phonological and semantic activation in a pair of experiments. The semantic radical only gives a vague idea of the general semantic field through which a set of kanji characters might be 'semantically' related. The phonetic radical is not a very reliable indicator of pronunciation for most words in Japanese lexicon. Nevertheless, these shortcomings notwithstanding, a pair of experiments manipulated characters that did encode phonological and semantic information separately in their two radicals. The method was to present such semantic and phonetic radicals with an onset asynchrony, so that either the phonetic or the semantic radical was presented before the whole character. Assuming that both components are activated in the lexical search, this would give a momentary advantage to either the phonological or the semantic information, depending on which radical was presented ahead of the entire character. The results confirm our previous summarization of findings in Chinese and Japanese that both phonological and semantic information are activated, since subjects in these two experiments made use of the information as soon as it was supplied. Phonological information seems to become available more effectively in this naming task, adding another processing task to the list of those in which the automatic retrieval of phonological information is activated.

In closing this section on phonological activation in Japanese, we should note that it has not been as central an issue in Japanese psycholinguistic research as it has been in Chinese psycholinguistic research (see Kess and Miyamoto, 1994, for a complete inventory, as well as Kess and Miyamoto, 1996). There are several reasons for this. One is that Japanese has concentrated more on the possible processing differences between its two orthographic types, syllabary vs. kanji. Secondly, Japanese research has also expended some effort in finding possible processing differences between its two syllabary types, hiragana vs. katakana. In essence, because Japanese has a phonologically-based orthographic type in common use, namely, the syllabaries, the issue of phonological activation has not received the same attention for Japanese that it has for Chinese which has no phonologically-based script at all. Nevertheless, what research has been recorded seems to be congruent with the research reported for Chinese.

5. Conclusions on Chinese Lexical Access and Word Recognition

The picture for Chinese hanji processing is not a simple one; certainly the picture is not so clear as to allow us to choose between one simple, thorough-going explanation which places logographic scripts on one side and alphabetic scripts on the other. There is certainly not enough evidence to support either the Orthography-independent Hypothesis or the Orthography-dependent Hypothesis to the complete exclusion of the other. A better way of looking at this problem might be to suggest that hanji processing can employ either of two processing routes in accessing the specific properties of a lexical item presented in hanji script. In fact, this notion of a double-route is not limited to logographic systems using hanji or kanji, but it can apply to access strategies in alphabetic or syllabic systems which are phonologically based.

Nevertheless, we would hesitate to posit that hanji processing is the same as alphabetic processing, particularly in the earliest stage of processing. It seems reasonable to assume that pattern recognition processes are likely to be different for stimuli of the logographic type and stimuli of the alphabetic type, with logographic stimuli having a greater dependence on visual pattern-matching stimuli. There is a vast array of experimental literature using a variety of experimental tasks which suggests a contributory role of graphemic information (see Miyamoto and Kess, 1995; Kess and Miyamoto, 1996).

But, by the same token, we cannot support the equally simplistic view that hanji processing has a single route, which goes from Orthography to Semantics and ignores the contribution of Phonological information. Indeed, we get some glimmer of the likelihood that not all hanji processing is the same either, especially when we review the results of short-term memory for Chinese characters. Immediate free-recall tasks for characters that differ in frequency and complexity show different characteristics when subjects are probed in short-term recall. Radicals or characters with pronunciations that are well-known are apparently maintained in verbal form in short-term memory, whereas characters that are infrequent, with pronunciations that are not well-known, are apparently maintained in their visual shape in the short-term memory of Chinese subjects (see Hue and Erickson, 1988). Not only that, but the short-term memory for the high-frequency characters is more susceptible to interference from verbal than visual tasks; just the opposite is true for the low-frequency characters.

The most plausible cognitive model may mix the basic tenets of the Orthography-independent and the Orthography-dependent Processing Hypotheses. That is, depending upon the contextual setting for a given hanji, and its specific features of familiarity, frequency, and complexity, one of two processing routes may be taken. Both processing routes ultimately access semantic information, but one route is a sound-mediated route and the other route is a grapheme-mediated route. For many processing tasks that involve natural language, hanji symbols are like alphabet symbols in that they must invoke phonological properties as the decoder searches through the mental lexicon. Tasks that are not simple pattern-matching maneuvers take the decoder from Grapheme through Phonology to Semantics. We suggest that phonological properties are automatically accessed in most analytical tasks that are not pattern-matching or category-matching in nature.

We also posit a cognitive routing that can travel a grapheme-mediated route. This is the only way that we can account for how some tasks access information about, as well as make decisions on, hanji logographs that do not require phonological mediation. Moreover, Chinese hanji will employ a direct route especially in cases where hanji exhibit high frequency and high familiarity. There are, of course, examples in alphabetic systems like English where the cognitive route traveled is a direct route. For example, the English lack of a perfectly transparent sound-letter correspondence is overlooked in cases of morphophonemic identity such as the plural <-s>, the past tense <-ed>, the alternation /haws > hawz-/ in *houses*, and so forth. This is certainly the case in repeated instances of highly idiosyncratic spellings; these quickly become immune to phonological analysis and their spellings are soon ignored. Words like *Ubyssey* in British Columbia, *Liliuokalani* in Hawaii, *Thames*, *Gloucester*, and the *admirable Crichton* in Great Britain, and well as common words like *thyme*, are forms of this type. There is experimental support for this. In two experiments using a vocalization task, Seidenberg (1985) has shown that very frequent words in English are recognized visually, without phonological decoding, just as they are in Chinese. Infrequent or newly-coined words were accessed by referring them to the process of phonological decoding, whereas high frequency words and characters were recognized visually without phonological mediation. For the Chinese subjects, phonetic compounds were read more quickly than non-phonetic compounds when the characters were of a low frequency.

Thus, it may not be an all-or-none hypothesis we should entertain. A number of critical factors enter into the question of what will be the most efficient strategy for achieving the task at hand, given the type of stimulus. In Seidenberg's experimental results, the interactive relationship of hanji compounds with low frequency may have exploited phonetic activation as the most effective processing strategy. This is just what Leong, Cheng, and Mulcahy (1987) conclude after analyses of variance underscored the individual contributions of reader ability, frequency of hanji, and complexity of the hanji to vocalization latencies in reading Chinese lexical items.

If our speculation is valid, then, we surmise that the claims for the absolute uniqueness of logographic hanji/kanji systems are considerably weakened. The grapheme-mediated primary route would be unique to neither Chinese nor Japanese, but is a matter of degree, and tied to how often this route is activated as the primary route. This position is congruent with the general theoretical position that has been applied to questions of basic research in both word recognition and reading.

However, the dual route notion, with its suggestion of two possible routes to lexical representation, one a phonological route and the other a direct route, has its shortcomings. Although this position has informed much current research (see Foss, 1988) in alphabetic languages, even there the question of where phonological information is activated is a moot point. The dichotomy of pre-lexical vs. post-lexical is unresolved with respect to whether the phonological representation is addressed following lexical access or before. Maybe it is *at-lexical* (see Perfetti and Zhang, 1995), and as such, is part of the identification event itself. In this view, identifying a word in the culmination of the lexical access approach to it, should include taking account of its phonological name, not just abstracting its semantic values or its general location in the mental dictionary. The address must have a specific name!

There are also arguments that the phonological activation is post-lexical. For example, even in alphabetic languages like English, the assemblage of letter or cluster combinations to phonological representations is not a particularly efficient strategy. After all, just because there are grapheme-to-phoneme conversion rules in alphabetic languages does not mean that these are the processing algorithms that are employed in lexical access to the exclusion of other processing strategies. In turn, Chinese cannot be said to be uniquely opaque in its relationship of orthography to phonology. The number of Chinese logographs that have some phonetic hint carried inside their orthographic shape is far from minimal. Though the figures vary, many characters exhibit a *phonetic* radical with hints as to part or all of the pronunciation. Indeed, a better test case for claims of such exclusivity might have been Egyptian or Mayan hieroglyphs, or even Arabic numerals.

In conclusion, we must recognize that the current philosophy of science inexorably draws our attention to the question of universal constraints on how the mental lexicon is searched. We have noted that there are cognitive mechanisms which respond to considerations of correspondence regularity, frequency, familiarity; and in this light, the analytical task type may drive the choice of the most efficient route for turning lexical access into word recognition. Thus, the two types of orthography, alphabetic and logographic, certainly differ in their representational basis, in being either phonologically based or morphologically based. The two types of orthography, alphabetic and logographic, may not be inherently different in their processing nature, in that graphemic properties and phonological properties will be both processed, but to varying degrees in different tasks. Accessing phonological information may be an optional processing feature, not an obligatory one. It is a crucial processing step, and depending on the task, it may be required in neither Chinese nor English. Then again, depending upon the task, it may be required in both English and Chinese. As we, the decoders, search the mental lexicon for the correct interpretation of a lexical item appearing in its written shape, we will use the phoneme-mediated and the grapheme-mediated routes to varying degrees in English or Chinese. The degree to which we employ these routes may differ across languages, but the fact of their availability will not vary across these languages.

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