Psycholinguistic aspects of Hanji processing in Chinese

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1. Introduction

Human signs are typically classified into the two types known as the *semasiographic* and *glottographic* systems of signs.[1] Both make certain cognitive demands as human decoders process them for first recognition and then semantic content. Semasiographic systems are independent of language, as for example, the system of road signs, but glottographic systems represent aspects of spoken language, and in this crucial feature they differ enormously. Glottographic systems can be *phonographic*, as is the case of alphabetic systems like English, or *logographic*, as is the case with hanji characters in Chinese (Sampson, 1994).

As is well-known, Chinese typically represents morphological units and their meanings, with the advantage that its logographic orthography can represent mutually unintelligible dialects of Chinese, and even different spoken languages (see Chen, 1996). Traditionally, Chinese is said to employ two types of hanji: the *pictograph* and the *phonograph*. Pictographs are historically derived from copying some aspect of the shape of the lexical item which it represents, but only 20% of Chinese logographs can be described in this way. The remaining 80% of Chinese logographs are regarded as phonographs, with two possible types of constituent parts: a radical or *signific*, which refers to meaning, and a *phonetic*, which refers to pronunciation (see Chen and Yuen, 1991).

This paper explores the psycholinguistic dimensions of hanji processing and linguistic recognition in Chinese. In so doing, we review the current psycholinguistic literature on Chinese hanji processing, and attempt to synthesize the conflicting explanations offered by current models of Chinese lexical access, word recognition, and the architecture of the Chinese mental lexicon. The central psycholinguistic question in respect to Chinese hanji processing focusses on the degree to which phonological and semantic processing of hanji interact in parallel or sequential modes. Thus, the debate in Chinese word recognition revolves around whether meanings of words written in logographic hanji can be accessed in the mental lexicon without phonetic codes first being retrieved from the written format.

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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 then semantic properties. One view claims that hanji processing does not require any type of orthography-specific processing mechanism. That is, although Chinese orthography is logographic in nature, the processing mechanisms it employs are the same as the processing mechanisms employed by languages which use alphabetic scripts like the roman alphabet. The opposing view maintains that hanji processing is instead unique, employing processing mechanisms which inherently differ from those used for dealing with alphabetic scripts.

2. Psycholinguistic issues in Hanji processing

The basic issue in Chinese hanji processing is whether the phonological properties of a given hanji character must be invoked in order to access its meaning. The psycholinguistic models which attempt to explain how fluent Chinese readers search the mental lexicon are diametrically opposed in respect to the role of phonological information in processing hanji characters. One view claims that hanji processing does not require any type of orthography-specific processing mechanism. That is, although Chinese orthography is logographic in nature, the processing mechanisms it employs are the same as the processing mechanisms employed by languages which use alphabetic scripts like the roman alphabet. The opposing view maintains that hanji processing is instead unique, employing processing mechanisms which inherently differ from those used for dealing with alphabetic scripts. The first explanation, commonly referred to as the Orthography-Independent Processing Hypothesis (also as the Automatic Acoustic Activation Hypothesis) claims that hanji cannot access meaning without first accessing the phonological properties of that hanji. The cognitive route in processing hanji, therefore, would travel from Orthography to Phonology to Semantics, exactly the same as the sound-mediated route which is the general basis of reading in alphabetic and syllabic scripts. The opposing view claims that hanji access meaning without the mediating step of decoding phonological properties. In its strongest version, this model offers a single-step processing explanation, where phonology is secondary to meaning. The cognitive routing proceeds directly from Orthography to Semantics, accessing Phonology only as required.

The Orthography-Independent Processing Hypothesis boasts two versions in actual application, a weaker and a stronger version. The weaker version argues that hanji access meaning without activating the phonology identity of the word, but that this processing step is highly grapheme-dependent and thus differs from alphabetic processing. In contrast, the stronger version of the Automatic Acoustic Activation Hypothesis sees no differences in processing hanji and alphabetic scripts, with both script types automatically invoking phonological properties of the words to be accessed.

A number of studies offer direct support for this notion of automatic phonological activation. For example, Lam, Perfetti, and Bell (1991) tested both bidialectal (Cantonese and Mandarin) and unidialectal (Mandarin) subjects by having them judge whether pairs of characters had the same pronunciation in a given dialect. The naming task produced results in which the phonetic values of the

first dialect was automatically recalled, with judgments both faster and more accurate in that first dialect. Based on the above finding, the authors conclude that regardless of the mono- vs. bi-dialectism difference, automatic acoustic activation necessarily takes place in Chinese.

Tzeng, Hung, and Wang (1977) report two experiments in short-term retention, in which the results suggest the effect of phonological activation. A first experiment visually presented target lists of Chinese characters, which differed in syllable structure from each other, while interference lists were being presented orally. Immediately after visual presentation of the target list, subjects were asked to say aloud the interference words which they had just heard. They were next asked to write down the target characters which they had just seen. If speech recoding did take place, one could expect that any phonological similarity between the target and interference characters would disrupt the memory for items that subjects were to recall. The results demonstrated that phonological similarity did have a significant effect, with vowel similarity in the pronunciation of the characters eliciting interference on recall abilities. The second experiment tested grammaticality judgments for sentences, manipulating normal vs. anomalous sentences and phonologically similar vs. phonologically dissimilar sentences. As in the first experiment, phonologically similarity again interfered with subjects' performance.

Perfetti and Zhang (1995) report similar results from two experiments which manipulated synonym judgments. A first experiment asked subjects to judge whether a given pair of hanji was synonymous or homophonic. The results revealed that negative judgments required longer reaction times when the characters were homophonic. The second experiment, using a similar experimental design with synonym judgments, found that phonological interference took place within 90 msec of stimulus onset, while semantic interference was initiated much later, at the 140 msec boundary. They conclude that phonological processing is activated before semantic processing, with the implication that phonological activation is a necessary component in word recognition.

Tan, Hoosain, and Peng (1995) manipulated targets and masks in two experiments which examined speed and accuracy in target recognition. A first experiment with short presentations of targets (50 msec) and masks (30 msec) found that graphemic masks affected target recognition, but that both phonological and semantic masks failed to do so. However, the second experiment employed a longer presentation of the targets and masks (60 msec and 40 msec, respectively), with significant facilitation effects for phonological masks in the case of high-frequency words with generalized meanings.

Much research in short-term memory (STM) suggests that STM is phonetic in nature rather than visual. The implication is that hanji processing, insofar as memory storage and recall are concerned, may not be able to ignore phonetic decoding in placing linguistic information in the STM store. For example, Zhang and Simon (1985) found that acoustic STM cues were more effective than either visual or semantic cues, for both alphabetic languages and logographic languages like Chinese. Similarly, Hue and Erickson (1988) report that hanji characters in high-frequency use will elicit phonological short-term memory effects, and Liu, Zhu, and Wu (1992) failed to find visual superiority effects for short-term memory probes.

Xu (1991) also provides indirect evidence for automatic phonological activation through his experimental work with Tone Sandhi rules. One of his experiments exposed subjects to stimuli which either required the application of Tone Sandhi rules or which did not. Recall tests demonstrated that the errors with the stimuli involving Tone Sandhi rules were almost double the rate for those which did not involve such rules, suggesting that STM operates with phonological representations in both storage and recall.

Lastly, a review of 14 different STM experiments using an immediate recall paradigm leads Yu, Zhang, Jing, and Peng (1985) to conclude that the short-term memory span which can be phonologically encoded in Chinese is in the neighbourhood of six or seven, whereas the span which can be visually or semantically discriminated is only two or three. The implication here is that phonological encoding is an efficient metric for STM tasks, while visual encoding does not offer any particularly significant visual or graphemic processing advantages associated with hanji recognition or storage.

Supporters of the Orthography-Independent Hypothesis generally agree that hanji processing requires phonological activation at a pre-semantic stage, but not all supporters agree that hanji processing is the same as alphabetic processing. Some suggest that the earliest stage of hanji processing is more grapheme-dependent, and makes more use of the visual information inherent in logographs, than is the case with alphabetic processing. For example, Hung and Tzeng (1981) suggest that, although script-sensitivity is not an issue at higher levels of hanji processing, at the lower level of processing script-dependency is a feature. This same view is also proposed by Leong (1986), who argues that phonemically-based English has an inherent morphological component that needs to be accessed, while morphemically-based Chinese allows, and sometimes requires, phonological information. Thus, cognitive mechanisms involved in processing such disparate orthographies may differ at the initial stage and at the micro level, but likely converge at the later stage and at the macro level.

In reviewing previous work on laterality preferences and hanji processing tasks, Hasuike, Tzeng, and Hung (1986) observe that previous studies which found superiority for the non-linguistic, or pattern-matching gestaltic, right hemisphere in hanji processing did so when there were very short exposure durations for hanji stimuli. Such stimuli must have elicited this right hemispheric superiority because they were essentially treated as non-linguistic stimuli. When stimulus exposure durations exceeded 50 msec, these right hemisphere superiority effects did not appear. Conversely, one may speculate that the non-analytic, non-phonological, right hemisphere has some input at the earlier stage of hanji processing, and that graphemic information is being registered in some way by the cognitive mechanisms allied to interpretative procedures.

In sum, supporters for the Orthography-Independent Hypothesis tend to the view that hanji processing is not exactly equivalent to alphabetic processing. Nevertheless, hanji processing does invoke the phonological properties of the lexical item to be accessed, just like lexical items presented in alphabetic scripts do. The key tenet of this view remains, namely that phonological properties are accessed at a stage preliminary to accessing semantic properties.