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Japanese *Kanji* Word Processing for Chinese Learners of Japanese: A Study of Homophonic and Semantic Primed Lexical Decision Tasks

Makiko Tanaka
Foreign Languages and Literature Department, National Cheng Kung University, Tainan, Taiwan

***Abstract*—The current study investigates phonological involvement in Japanese word recognition by advanced and intermediate Chinese learners. A homophonic, semantic and unrelated (control) primed lexical decision task was used to test the participants' reactions times (RTs) and accuracy scores. Only the RTs of the participants' accurate YES responses in the lexical decision task (yes/no) were used as dependent measures for evaluation. The results showed that there were no significant effects on priming types as well as proficiency levels. An analysis of the interaction also indicated no effects between priming effects and groups. That is, both the advanced learners and the intermediate learners performed similarly with all prime types. These results support the claim that the Universal Phonological Principle does not apply to Chinese readers when they encounter Japanese *Kanji* as they do not activate phonological representations while reading Japanese cognates. The present findings constitute a partial explanation of the word recognition process for Chinese learners of Japanese.**

***Index Terms*—Japanese, L2, reaction time, lexical decision**

I. Introduction

Visual word processing is a skill whereby readers encountering a word form, "activate links between the graphic form and phonological information, activate appropriate semantic and syntactic resources, recognize morphological affixation in more complex word forms, and access her or his mental lexicon" (Grabe, 2009, p. 23). However, the role of phonology in the visual word recognition process has been intensely debated, specifically with regard to the Universal Phonology Principle and the dual route model. That is, whether phonological processing in word recognition is activated before or after accessing semantic meaning (Chen, et al. 2007; Machida, 2001).

The Universal Phonology Principle states that readers activate phonology in pronouncing a word prior to processing the semantic representation of the word. Substantial studies on word recognition have been done on readers of alphabetic languages. For example, Van Orden, et al. (1988) found that presenting homophonic heterographs – such as *meat* and *meet* – in priming, increased recognition errors when compared to pairs with similarly spelling – such as *meat* and *melt* – in a semantic categorization task. Moreover, Rubenstein, et al. (1971) observed that lexical decision time was longer for homophonic words, such as *weak* and *week*, than non-homophonic words. These studies suggest that activating phonological processing of the visually presented words interferes with the identification of appropriate lexicon. This in turn indicates the significant role of phonological processing during word recognition.

On the other hand, the dual model of reading comprehension proposes that meaning proceeds from dominant direct orthographic access whereas the phonological route plays a slower, indirect role (Chen, et al. 2007). Jared and Seidenberg (1991) conducted a modified version of Van Orden's study and claim that homophonic effects are observed in the case of low-frequency words.

Recently, more studies on readers of non-alphabetic languages such as Chinese and Japanese have investigated word recognition processing (Keung & Ho, 2009; Perfetti & Liu, 2005). Some researchers argue that native Chinese speakers access letters-to- meaning directly without any phonological processing (e.g. Chen, et al. 1995). Others argue that a phonological effect does occur when Chinese readers access meaning (e.g. Perfetti & Zhang, 1995). Although Chinese and Japanese belong to different linguistic families, both of the languages use Chinese characters (Japanese employs *Kanji* which originates from Chinese) in logographic representations. Regardless of their pronunciation systems, Chinese and Japanese share a number of compound words which are identical or similar in morphological representations as well as semantically i.e. cognates. For example, "規則", pronounced /kisoku/ in Japanese and /gueitzer/ in Chinese, means "rules" in both languages (Chiu, 2002). Previous studies on lexical decision tasks and naming tasks recorded faster responses with cognate languages such as Dutch (L1)-English (L2) than non-cognate languages (De Groot, et al. 2002). Thus language distance appears to be a crucial factor in word processing. The above researchers did focus a little on cross linguistic processing in non-alphabetic cognate languages: Chinese and Japanese. The present study examines which cognitive processing route, namely, letter–to–meaning or sound–to–meaning processing, is activated by Taiwanese learners of Japanese when they encounter Japanese *Kanji*.

II. ORTHGAPHIC PROCESS AND PHONOLOGICAL PROCESS

Visual word recognition of word forms from a text requires letters, letter groups, word shapes and key shapes of letters. The length of a word corresponds directly to word-recognition time (Grabe, 2009). That is, the more letters are present, the more visual processing time is required. In English, longer letter words or more complex words with morphological affixes such as prefixes and suffixes - highlighted here in ***un**event**ful*** - involve a great deal of orthographic processing skills. Not only graphic forms but also morphological forms play a very important role in word recognition (Grabe, 2009).

As a non-alphabetic language, Chinese is considered a morphosyllabic language. It is based on Chinese characters which indicate a meaning as well as a phonetic or syllabic component. When reading Chinese, orthographic information is more crucial due to the nature of the Chinese writing system (Wang & Geva, 2003). A number of studies suggest that Chinese readers, both children and adults, tend to rely extensively on visual skills in recognizing Chinese characters.

Similarly, Koda (1992) found that Japanese ESL learners who were literate in non-alphabetic languages, such as *Kanji* (which originates from Chinese) and *Kana*, performed better in coding graphic similarities than phonological similarities. Wang & Geva (2003) stress that logographic readers tend to access lexicons via an orthographic representation rather than phonological information (Figure 1: A) whereas alphabetic readers rely more on a direct analysis of phonological information when encoding lexical representations (Figure 1: B).

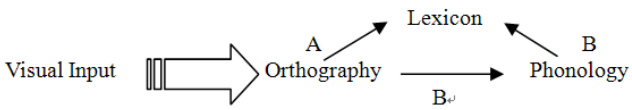

Figure 1. Cognitive processing in L1 (adapted from Chiu, 2002, p. 358)

In addition, some studies show that phonological awareness predicts reading ability across alphabetic languages (Geva & Wang, 2001; Keung & Ho, 2009). “In children learning to read English, the negative effect of phonological awareness deficit occurs early and affects the acquisition of phonological coding in word reading, and further slows down the build-up of the orthographic lexicon” (Geva & Wang, 2001, p. 194).

Recent Chinese language research has found that phonological awareness in Chinese children plays a significant role in accurate word recognition and successful reading performance (Ho & Bryant, 1997). Chinese children are able to segment larger sound units such as partial homophones and later conceptualize smaller elements like rhymes or tones while they develop reading skills (Ho & Bryant, 1997).

Likewise, reading Japanese *Kanji* involves phonological activation in native Japanese speakers (Morita & Tamaoka, 2002). Wydell, et al. (1993) found that subjects made more errors and took longer to decide on correct answers when homophonic words were presented as priming effects. This was not the case with the target words which had no homophones. The example of their semantic categorization task is to present a category name *a good result* as a prime followed by a target word *an achievement*. When the target words were homophones of a correct exemplar, participants took more time to make a decision than with the target words with no homophones. Moreover, Morita & Tamaoka (2002) showed phonological involvements in lexical decision at the word level and semantic decisions at the sentence level. These studies support the notion that regardless of orthographic systems, phonological information is activated in L1 word recognition.

III. JAPANESE AS A FOREIGN LANGUAGE FOR CHINESE BACKGROUND LEARNERS

Readers of Japanese as a foreign language need to consider two types of writing systems, namely *Kana* and *Kanji*, during the process of word recognition. Japanese orthography consists of a combination of *Kana* (e.g. にほんご “Japanese”) and *Kanji* characters (e.g. 日本語 “Japanese”) (Chen, et al. 2007; Leong &Tamaoka, 1995; Machida, 2001). Each *Kana* represents a syllabic unit, a mora. When pronounced, each mora is of equal duration which makes Japanese language very rhythmical (Chen, et al. 2007; Leong & Tamaoka; 1995). *Kanji* words represent nouns, roots of verbs and adjectives in Japanese reading text, while *Kana*, a highly transparent writing system, is assigned for function words and grammatical morphemes.

Kanji, which are logographic characters, originate from Chinese and are either used alone or combined with *Kana* to form a word. Each *Kanji* carries its phonetic and semantic meaning, but not pronunciation. Knowing the pronunciation of a *Kanji* character in one context cannot help one to recognize the *Kanji* in another sentence (Machida, 2001). Koda (1992) claims that *Kana* and *Kanji* involve different processing strategies. *Kana* represents phonographic orthography whereas *Kanji* is a morphographic writing system. For example, in the study of the different processing systems in *Kanji* and *Kana*, younger native Japanese speakers processed the commonly-used target words faster in *Kanji* than in *Kana* with the lexical decision task (Tamaoka, et al. 1992). Although there could be some influence whether the target words they selected were familiar to the subjects for *Kanji* or *Kana*, they concluded that *Kanji* might relate directly to meaning in the retrieval process while *Kana* might relate more to the phonological aspects of word processing.

When comparing an alphabetic language to Chinese and *Kanji*, one finds that the latter two display components of orthography which do not demonstrate phonemes in pronunciation. However, some characters carry pronunciation cues, in other words, phonetic radicals, and radicals themselves also have their own pronunciations as well as meanings. Unlike Chinese, *Kanji* has more than one pronunciation: *Kun* which is Japanese in origin and *On* which originates from Chinese (Chen, et al. 2007; Leong & Tamaoka; 1995). For example, "馬" (horse) in *Kanji* can be pronounced /ba/ in *On* and /u-ma/, with two syllables of equal length, in *Kun*. Reading Japanese texts involve the integration of *Kanji,* including multiple possible *On* pronunciations and *Kun* pronunciations, as well as *Kana* orthographies in one writing system. Readers with a Chinese background are confronted by all these factors which entails a great deal of phonological processing in their L2, Japanese.

A comparative study of native Chinese speakers and native English speakers learning Japanese reveals a significant phonological involvement by native Chinese speakers when processing *Kanji* but not with the native English speakers (Tamaoka, 2000). The researcher concluded that the degree of knowledge in *Kanji* possibly caused the different processing trend. Compared with alphabetic language speakers, learners with a Chinese background have at least a basic knowledge of *Kanji*. They are able to understand the core meaning of *Kanji* characters and distinguish similar types of orthographies. Chiu (2002) studied *Kanji* processing in Taiwanese JFL learners and pointed out that Taiwanese learners tend to engage with the letter-to-meaning route or the use of Chinese phonological processing regardless of their proficiency when they encounter cognates (Figure 2: A or A'). On the other hand, they process Japanese phonology in the case of non-cognates recognition (Figure 2: B). However, fluent Japanese learners could develop independent mental lexicon on cognates for both languages and it is possible to process Japanese words in Japanese phonology for Chinese learners (Jiang, 2000).

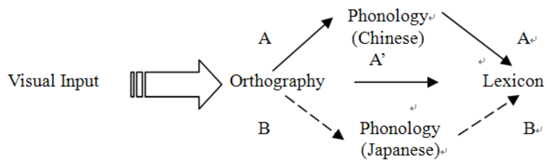

Figure 2. Cognitive processing for Taiwanese learners of Japanese (adapted from Chiu, 2002, p. 359)

IV. The Aim of the Present Investigation and the Hypothesis

As these previous studies indicate, phonological activation may play a role in the word processing of Chinese readers. However, it is still not clear whether Chinese learners who study Japanese as a foreign language process phonology to access lexicon because both languages share a common writing system, Chinese characters (*Kanji*). Considering the effect of L1 knowledge on L2 word recognition, Chinese readers may access lexicon through visual coding to infer meaning without pronouncing words. On the other hand, if Chinese readers engage with phonological awareness, in accordance with the Universal Phonology Principle, they may rely more on L1 sounds than that of L2 when processing cognates (Figure 2).

The present study examines the issues raised in Chiu's (2002) findings which are concerned with whether Taiwanese Japanese learners tend to access meaning through orthography or their L1 phonology when processing cognates. According to Chen, et al. (2007), the studies on phonological activation in Chinese readers should include a naming task which requires articulation as well as tasks without verbal involvement such as a lexical decision task. Chen, et al. (2007, p. 64) stress that a test of the universal phonological principal "would require a demonstration of phonological priming on a task that could arguably be performed without phonological processing *and* a demonstration that phonological priming precedes semantic priming". Thus, their design of a primed lexical decision task was adopted for the experiment.

The present task was constructed with three types of priming words (Chinese pseudo-homophones, Japanese semantically related words and unrelated words) paired with 18 Japanese compound words. In the paradigm of the priming task, participants made a decision whether the item was a real *Kanji* compound word as quickly and as accurately as possible after they saw one of the priming word types. The hypothesis was if there was early phonological activation in processing Japanese *Kanji* (cognates)[1], Chinese pseudo-homophonic priming of *Kanji* targets should be faster than semantic priming. Alternatively, if orthographic-to-meaning was primarily activated for *Kanji* recognition, Chinese pseudo-homophonic priming should not be a factor.

V. Methodology

A. Participants

A total of 30 (14 female and 18 male) technology college students from the southern part of Taiwan participated in the experiment. All were native speakers of Chinese who studied Japanese as a second language in the Japanese department for either the Master program (Advanced) or the Undergraduate program (Intermediate). Their proficiency level was set at the first and third level of the Japanese language proficiency test (JLPT) respectively, followed by the

[1] Note cognates in this paper means two-Chinese-character compound words which are identical or similar in Chinese and Japanese language at both orthographic and semantic levels.

former classification[2].

B. *Design and Materials*

The experimental design is a 2 (advanced and intermediate) × 3 (prime type: Chinese pseudo-homophones, semantically related and unrelated) mixed factorial design. The target words consisted of 18 high-frequency Japanese compound words (two character *Kanji*), two to four syllables in length (e.g. 英語 "English"), and each target word was paired with three types of *Kanji* primes: Chinese pseudo-homophones (e.g. 桜雨), semantically related words (e.g. 言葉 "language") and an unrelated control group (e.g. 注意 "attention"). Moreover, in order to balance the number of "yes" and "no" responses, another 18 pseudo-word target pairs with a Japanese homophone, which were made by combining two existing *Kanji* characters, as well as semantic and unrelated primes were intermixed for a "no" response. The Chinese pseudo-homophones were formed from two existing visually dissimilar characters which are not normally paired with one another. Semantically related primes were selected from actual two-character Japanese *Kanji* in which pairs of the target words and the semantic primes have no characters in common.

All the Japanese words including the 18 target words, the 18 homophone primes paired with the pseudo-word targets, the 36 semantic primes and the 36 unrelated primes were selected from JLPT third level character list and all the priming words were carefully controlled in terms of the number of strokes (http://www.ira.org.tw/fate/23.htm; http;//60.250.4.156:8080/stroke/Bopomofo.htm). A total of 108 *Kanji* pairs were prepared for the experiment. Each of the three prime conditions was paired with each main target word across three groups of five participants so that the participants saw only one prime condition for each target. Each participant received 10 practice test questions prior to the experiment and then a total of 36 experimental questions were given in random order. All tests were structured through DMDX experimental software in the TOSHIBA notebook.

TABLE 1
MEAN NUMBER (SD) OF STROKES OF *KANJI* PRIMES USED

Prime type	Pseudo-homophone (n=36)	Semantically Related (n=36)	Unrelated (n=36)
Mean strokes	18.7(6.8)	19.3(4.4)	19.1(5.7)

C. *Procedure*

Participants were instructed to decide whether or not the item was a real *Kanji* compound word as quickly and as accurately as possible by pressing the "yes" key or the "no" key on the keyboard. The instructions were provided in Japanese. Together the ten 10 practice questions and then 36 questions for the experiment lasted approximately 5 minutes. The test was individually administrated only once per research section in the school classroom. First the participants observed a focus point, in this case, an asterisk, for 600ms at the center of a computer screen, followed by a 150ms presentation of a prime word. Then a *Kanji* target appeared for 600ms at the center of screen and wait until the participant's response for a maximum of 6000ms. The computer recorded the reaction time (RT) from the onset of target presentation until the participant pressed the button and the response key (yes or no).

VI. RESULTS

For the inter-item reliabilities of the *Kanji* prime task, Cronbach's alpha value (0.7) proved to be fairly reliable. The study employed 2 levels (Advanced and Intermediate) × 3 factors (Prime type: Chinese pseudo-homophones, semantically related words and unrelated words) design for the *Kanji* lexical decision task. Only the RTs of the participants' correct YES responses in the lexical decision task (yes/no) were used as dependent measures for evaluation. The RT measures from two intermediate male students were edited for outliers with the boundary of 2.5 standard deviations plus and minus the mean. The edited RTs on the *Kanji* word recognition task were analyzed using a mixed-model ANOVA. The description of the mean RTs, correct responses and error rates on three prime types by the two proficiency groups is shown in Table 2.

A 2 (Advanced and Intermediate) × 3 (Prime type: Chinese pseudo-homophones, semantically related words and unrelated words) mixed-model ANOVA revealed that the main effect for subjects was not significant F (1, 28) = 0.03, $p > .05$. Thus, there was no overall difference in the RTs of the advanced students (M = 828ms) compared to the intermediate students (M = 811ms). A main effect for prime types was not obtained (homophone = 818 ms, semantic = 782 ms and unrelated = 859ms), F (2, 56) = 1.25, $p > .05$. An interaction of prime type x proficiency level was also not obtained, F (2, 56) = 0.26, $p > .05$.

The same ANOVA was carried out and showed that there was no significant main effect for items F (1, 34) = 0.44, $p > .05$. Thus, there was no overall difference in the RTs of the advanced students (M = 829ms) compared to the intermediate students (M = 805ms). A main effect for prime types was not obtained (homophone = 825 ms, semantic = 765ms and unrelated = 860ms), F (1, 34) = 1.1, $p > .05$. An interaction of prime type x proficiency level was also not obtained, F (1, 34) = 0.4, $p > .05$.

[2] The JLPT has been revised since 2010.

TABLE 2
THE DESCRIPTION OF MEAN REACTION TIMES (RT IN MILLISECONDS), MEAN SCORES AND ERROR RATES (SD) OF THE LEXICAL PRIMING TASK FOR ADVANCED GROUP AND INTERMEDIATE GROUP

	Advanced(n=16)			Intermediate(n=14)		
Prime type	RT (ms)	Score	Error rate (%)	RT (ms)	Score	Error rate (%)
Pseudo-homophone	806(303)	5.9(0.5)	0.02(0.08)	838(449)	5(1.8)	0.17(0.3)
Semantics	800(255)	5.8(0.6)	0.04(0.1)	763(277)	6(0)	0(0)
Unrelated	877(351)	6(0.0)	0(0)	840(258)	5.9(0.2)	0.01(0.05)

VII. DISCUSSION

The question in the present study was whether Chinese readers of Japanese as a Second Language would process Japanese *Kanji* (characters which originated from Chinese) by the activation of phonology before following the orthographic route, in accordance with the Universal Phonological Principle. The results showed that in comparison with the unrelated prime, the pseudo-homophone prime had no significant effect on *Kanji* word recognition by Chinese readers. The failure to obtain the homophone effect indicates that phonological processing was not activated by Chinese learners when encountering cognate Japanese *Kanji*.

Although there was no significant difference of the mean RTs between proficiency levels, the obtained figures showed that the intermediate participants responded faster in semantics priming than the pseudo-homophone prime and unrelated semantic features. Thus it could be claimed that the intermediate group relied more on orthographic processing. Alternatively, as the advanced group demonstrated no clear difference in RT across three priming types, it may indicate that the learners from the higher proficiency level process a more robust level of automatic retrieval of *Kanji* targets due to their high proficiency in the target language. Overall, the phonological principle did not apply to *Kanji* processing for Chinese readers. That is, orthographic readers do not employ phonology as a core process when encountering familiar words.

The results partially support the previous study by Chen, et al. (2007) in which they found the absence of homophonic priming but obtained semantic priming effects with native Japanese participants. Thus, as a follow-up study, the researcher slightly modified the homophonic priming items — due to the difference in pronunciation between Chinese and Japanese — and tested seven native Japanese speakers using the same procedure. The result showed that there was no statistically significant effect on priming types for the native subjects, the same results as with the L2 learners in the previous experiment. The comparison of the Means in priming types revealed a similar pattern of RTs in both groups; they performed faster in the homophone/semantics prime and slower in the unrelated prime (Native Japanese Speakers: M = 879ms in Pseudo- homophones, M = 890ms in Semantically Related and M = 907ms in Semantically Unrelated). Although the difference in RTs may be considered statistically insignificant, this may indicate that mature readers are more likely to access internal lexicons through sounds whereas immature learners rely more on visual memory.

Conversely, the present results may indicate that test participants employ phonological activation when encountering Japanese words. Studies on semantic categorization tasks (e.g. Chiu 2002; Sakuma, et al. 1998; Van Orden, 1987; Wydell, et al. 1993) show that the reaction times of participants are longer and that participants make more errors when there is a homophone effect. In a task of presenting an exemplar of a category name when the target words are homophones, participants take more time to make a decision than if the target words contain no homophones. A possible explanation of the homophone effect is that Chinese phonological representations were activated by the priming set and consequently conflict was created at the presentation of the target words. Thus it would take a longer time to complete the lexical decision task. It would be worthwhile to justify such a conflict interpretation through the use of a semantic categorization task for future study.

VIII. CONCLUSION

The present results can claim that the Universal Phonological Principle does not apply to Chinese readers when they encounter Japanese *Kanji*. Nevertheless, the failure of priming effects for the L2 learners needs to be taken into consideration for further study. One reason for this may be the existence of parallel access to semantics via orthographic and phonological routes. Another possible explanation may be an automatic retrieval process for cognates or familiar words by Taiwanese Japanese learners. A comparison with unfamiliar words and non-cognates should be made so as to explore the phonological involvement in *Kanji* word recognition processing by logographic readers.

Generally competent readers are likely to intentionally access mental lexicons when encountering unfamiliar words as opposed to using automatic retrieval with familiar words. Likewise, non-cognates do not share the same Chinese characters and therefore familiarity with a character is not a factor in word processing. Thus Chinese learners tend to develop an independent access route to meaning. Moreover, the researcher believes that a comparison between *Kanji* primes and *Hiragana* primes would be considered. This is because *Hiragana*, Japanese phonological units, shows phonological information directly to readers and might facilitate phonological activation.

Finally, the pedagogical implication here is that Chinese learners should place more emphasis on Japanese pronunciation while reading Japanese Kanji, especially the lexical items which share common orthography and meaning.

Chinese adult readers have already established such lexicons internally and it would be difficult to develop another independent lexicon with different pronunciation. Reading aloud should be exercised in the classroom as well as during self-learning.

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Makiko Tanaka was born in Chiba, Japan in 1975. She received her M.A. degree in Education from Bath University, UK in 1999. She is a Ph.D. student at Department of Foreign Languages and Literature in National Cheng Kung University in Taiwan. She also teaches Japanese at Southern Taiwan University currently. Her interest is mainly on second / foreign language learning and teaching, especially on Japanese as a foreign language.