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The Japanese Writing System and Lexical Understanding

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ABSTRACT

The Japanese language contains four scripts: *hiragana*, *katakana*, *kanji,* and *romaji* (i.e., romanized Japanese). Due to the multi-scriptal representation, some unique trends in JFL learners' lexical understanding can be observed. The present article introduces several studies concerning learners' lexical understanding as it relates to the writing system, with a particular focus on native English and Chinese speakers. Topics cover the script similarity effect, the visual complexity effect, the script familiarity effect, and the imageability effect. Critiques on the use of *romaji* as a tool for improving alphabetic background for Japanese learners' listening and speaking skills at the early stages of learning are also discussed. Finally, evidence is presented concerning the contribution of lexical knowledge to the processing speed and accuracy of words within a text.

1. Introduction

The writing system of modern Japanese contains three different scripts, *kanji, hiragana,* and *katakana*. In addition, the alphabetized script called *romaji*, literally meaning "Roman letters," is also used for transcribing Japanese words (see Hadamitzky and Spahn 1981, Miller 1967, Tamaoka 1991). In this paper, the four different scripts—*kanji*, *kana* (i.e., *hiragana* and *katakana*), and *romaji*—are discussed from the perspective of lexical understanding by Japanese learners primarily from Chinese and English backgrounds. The effects of each script type are explained from the perspective of JFL learners' lexical understanding. Finally, the relationship between lexical knowledge and reading comprehension, and the one between lexical knowledge and lexical processing are discussed.

2. *Kanji*—Effects of Script Similarity and Visual Complexity

The largest population of Japanese language learners in Japan is native Chinese speakers. According to the Agency for Cultural Affairs in Japan, or *Bunkachō* (2011), approximately half of all learners studying Japanese in Japan were estimated to be from China. Since the *kanji* script is originally adapted from Chinese characters, both Chinese and Japanese share a great number of morphemes by way of *kanji*. According to Chen (2002), among a selection of 4,600 Japanese *kanji* compounds, 54.5% in mainland China and 55.1% in Taiwan are not only written with the same *kanji*, but also imply the same meanings as their Chinese counterparts. Hishinuma (1983, 1984) estimated that native Chinese speakers know about 98.1% of the former list of 1,945 commonly used Japanese *kanji* (*jōyō kanji-hyō*), if slight differences in *kanji* orthography between Chinese and Japanese are ignored. As such, native Chinese speakers bring an excellent knowledge of *kanji* to the task of learning Japanese. The former *jōyō kanji-hyō* was established in 1981 by the Japanese government as a standardized list containing 1,945 basic Japanese *kanji*. This *jōyō kanji-hyō* has been used to standardize Japanese printed texts including newspapers, magazines, and educational materials (see Tamaoka, Kirsner, Yanase, Miyaoka, and Kawakami, 2002; Tamaoka and Makioka 2004). In 2010, the *jōyō kanji-hyō* was revised by the Japanese government, now including a total of 2,136 *kanji*.[1]

Japanese language instructors commonly note that native Chinese speakers are quick to understand Japanese words presented in *kanji*. This observation has been tested by means of a lexical decision task (Tamaoka 1997). The lexical decision task measures how quickly and accurately a word presented on a computer monitor can be determined to exist in Japanese by pressing a "yes" or "no" key. Figure 1 shows the typical procedure for this task. For example, a two-*kanji* compound, 未来 *mirai* 'future', is presented to a participant after an eye fixation "*" is displayed for 600 milliseconds (ms). The participant must determine as quickly and accurately as possible whether or not this word exists in Japanese. In the lexical decision task, incorrect stimuli are also needed for "no" responses such as nonsense *kanji* compounds like 本海, 空花, and 家林. Lexical decision is measured by two indices: (1) speed in milliseconds from the onset of visual presentation of the word to decision, and (2) accuracy in percentage of all visually presented words. In the psycholinguistic experimental approach, the speed for the lexical decision task is considered to be a more sensitive measurement than accuracy of the task. Using the lexical decision task, Tamaoka (1997, Experiment 1) compared 10 native Chinese speakers and 17 native English speakers, who had been studying Japanese for two to three years under an identical curriculum at a university in Canada. A large, significant difference for Japanese *kanji* compounds was observed between the two groups: native Chinese speakers displayed an average speed of 982 ms with an accuracy

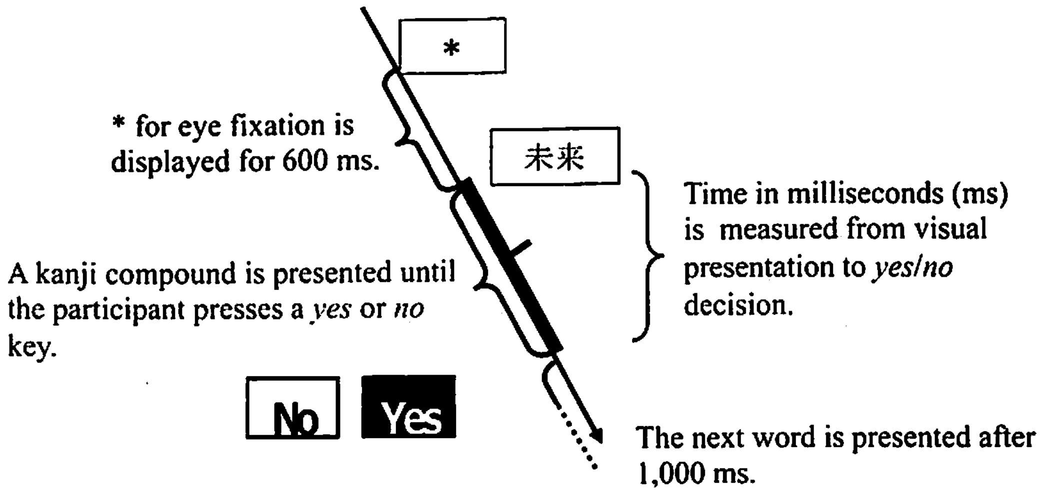

Figure 1. A typical procedure of the lexical decision task.

of 71.3%, while native English speakers required an average of 1,808 ms to respond and had an accuracy of 63.7%. In summary, native Chinese speakers performed 826 ms faster and 7.6% more accurately than native English speakers, even though they had been studying Japanese for nearly the same length of time, used a common textbook, and had the same instructors. As predicted by the large overlap of *kanji* morphemic units between Chinese and Japanese (Agency for Cultural Affairs in Japan 2011; Chen 2002; Hishinuma 1983, 1984), Chinese speakers showed a marked advantage in lexical understanding of visually presented *kanji* compounds over native English speakers. It should be noted that, hereafter, all differences in speed (ms) and accuracy (%) reported in this paper are statistically significant; otherwise, they are reported as being the same.

In order to examine the phonological aspect of two-*kanji* compounds, Tamaoka (2000, Experiment 1) conducted a naming task, which is similar to the lexical decision task described above. As shown in Figure 2, the target word 未来 was presented to a participant following an eye fixation. In the naming task, instead of pressing a key to indicate "yes" or "no," each participant was required to say the word aloud as quickly and accurately as possible. Naming latency (ms) from visual onset to the initiation of vocalization was automatically measured, and the experimenter recorded for each spoken stimulus whether the participant's pronunciation was correct or incorrect. Overall accuracy of pronunciations (%) was calculated out of all of the test words. The lexical decision task in Figure 1 is used for investigating visual (or orthographic) processing of morphemes and/or words, while the naming task in Figure 2 is for phonetic (or phonological) processing. These two tasks can be used to clarify how Japanese learners utilize their first language features for lexical understanding.

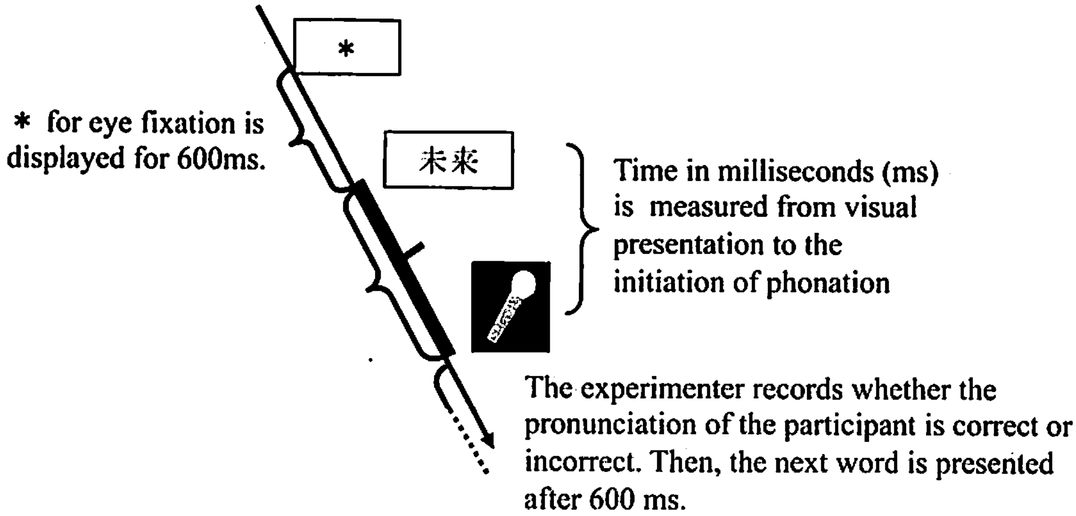

Figure 2. A typical procedure for the naming task.

Tamaoka (2000, Experiment 1) tested 15 native Chinese speakers and 13 native English speakers who had been studying Japanese for two to three years at a university in Australia under the same curriculum. A large, significant difference was again found between the two groups. Native Chinese speakers named two-*kanji* compounds (e.g., 会話 *kaiwa* 'conversation', 仕事 *shigoto* 'work', 映画 *eiga* 'movie') with an average naming latency of 1,027 ms, a standard deviation of 188 ms, and attained an average accuracy of 87.62 %, whereas native English speakers named the same words with an average latency of 1,635 ms, a standard deviation of 555 ms, and an average accuracy of 53.85 %.

Similar to the lexical decision task, native Chinese speakers responded 608 ms faster and 33.77 % more accurately than native English speakers on the naming task. Due to the close resemblance of *kanji* and their native script, Chinese speakers showed a great advantage over English speakers in pronouncing aloud *kanji* compounds (Tamaoka 1997, 2000). Djojomihardjo, Koda, and Moates (1994) reported that English as a Second Language (ESL) learners who use an alphabetic script in their first language (L1) are faster at English lexical and text processing tasks than those with a background in non-alphabetic languages. This script-similarity advantage for native Chinese speakers on *kanji* presented Japanese words over those from non-*kanji* backgrounds is more generally labeled as the *script similarity effect*.

This effect was also replicated by a Japanese-proficiency-controlled comparative study between non-*kanji* script native Korean speakers ($N = 20$) and *kanji*-script native Chinese speakers ($N = 20$) on their speed of understanding *kanji* compound words embedded in a text (see details in Yamato and Tamaoka 2013). Needless to say, native Chinese speakers understood Japanese *kanji* compounds much faster than native Korean speakers, even though both groups were at the same level of Japanese proficiency.

There seems to be a remarkable contrast between native Chinese and English speakers in the way that they understand visually simple and complex Japanese *kanji*. *Kanji* visual complexity is indexed by the number of strokes required to write a single *kanji*. The former 1,945 commonly-used *kanji* required an average of 10.84 strokes with a 3.76 standard deviation to write a single character (Tamaoka, Kirsner, Yanase, Miyaoka, and Kawakami 2002). As previously mentioned, the official *jōyō kanji-hyō* was revised in 2010 by the Japanese government to include a total of 2,136 Japanese *kanji*. The *kanji* in the 2010 list are similar to those on the earlier list, with an average of 10.47 strokes with a standard deviation of 3.80 strokes. Among native Japanese speakers, an inhibitory effect for both *kanji* correctness decisions and naming tasks was found only in a segment of single Japanese *kanji* with low frequency (Tamaoka and Kiyama 2013). Among low frequency *kanji*, native Japanese speakers processed visually complex *kanji* slower than they did visually simple *kanji*.

Visual complexity at the word level was examined using the number of strokes required to write an entire two-*kanji* compound. As shown in the example in Figure 3, the visually complex word 新聞 *shinbun*

新 聞
(1) Visually complex: *shinbun* 'newspaper' JLPT fourth level;
13 strokes + 14 strokes = 27 strokes; JLPT third and fourth levels

夕 方
(2) Visually simple: *yūgata* 'evening' JLPT fourth level
3 strokes + 4 strokes = 7 strokes; JLPT third level and third level

Figure 3. An example of visually complex and visually simple *kanji* words.

'newspaper' consists of two visually complex *kanji*: 13 strokes for 新 *shin* 'new' and 14 strokes for 聞 *bun* 'hear'. This word contains a total of 27 strokes, and is assigned to the fourth level (beginning proficiency) of the Japanese Language Proficiency Test (JLPT)(Japan Foundation and Japan Educational Exchange and Services 2002). In contrast, the sample word 夕方 *yūgata* 'evening' consists of two visually simple *kanji*: 3 strokes for 夕 *yū* 'evening', and 4 strokes for 方 *gata* 'direction'. This word contains only 7 strokes, and is also found in the fourth level of the JLPT. This approach of stimulus word selection was used in experiments examining the effect of visual complexity of *kanji* compounds on lexical decisions (Tamaoka 1992, 1997).

According to Tamaoka (1992, Experiment 2; only reaction times are reported), native Japanese speakers did not show a significant difference in lexical decision speed for simple *kanji* compounds (*M* = 621 ms) versus complex *kanji* compounds (*M* = 603 ms). In contrast, native English speakers learning Japanese at a Canadian university showed both the effects of *kanji* visual complexity and the length of Japanese learning, with no interaction of these two factors. Namely, as their length of Japanese study increased, learners were able to understand compound words more quickly, but the effect of the visual complexity of *kanji* remained unchanged over an additional year of study. If we examine the results in detail, we find that learners (*N* = 16) with a length of Japanese learning greater than one year but no longer than two years understood simple *kanji* compounds (*M* = 1,786 ms) much more quickly than complex *kanji* compounds (*M* = 2,063 ms). Likewise, those (*N* = 16) with a length of Japanese learning greater than two years but no longer than three years also understood simple *kanji* compounds (*M* = 1,307 ms) much faster than complex *kanji* compounds (*M* = 1,432 ms). Although the familiar, high frequency two-*kanji* compounds were understood by native Japanese speakers at an equal speed regardless of complexity, *kanji* visual complexity persistently inhibited the understanding of compounds by native English speakers.

The persistent effect of visual complexity was investigated further by Tamaoka (1997, Experiment 1). He compared three groups: native English speakers (*N* = 17), native Chinese speakers (*N* = 10), and native Japanese speakers (*N* = 13). Both native English and native Chinese learners of Japanese had a similar length of study in the same curriculum at a university in Australia. As expected, the overall speed of understanding complex or simple two-*kanji* compounds greatly differed by native language, with Japanese speakers (*M* = 602 ms) being quickest, followed by Chinese speakers (*M* = 982 ms), then English speakers (*M* = 1,808 ms). However, native English speakers were the only group who showed a significant difference in speed between complex (*M* = 1,891 ms) and simple (*M* = 1,725 ms) *kanji* compounds. As Tamaoka (1992, Experiment 2) showed, native English speakers exhibited the visual complexity effect in processing frequently used *kanji* compound words.

Native English speakers from an introductory to an intermediate level seem to employ a different strategy in understanding *kanji* morphemes and their compounds. At the morphemic level, English speakers are most likely analyze the individual elements used to construct a single *kanji*. For example, the *kanji* 新 can be divided into two elements on its left and right sides. Likewise, the *kanji* 聞 can be analyzed as a combination of two simpler *kanji*, 門 'gate' and 耳 'ear'. Furthermore, learners have to combine these two complex *kanji* into the single lexical unit 新聞 'newspaper'. This analytic approach seems to require extra processing time when making lexical decisions. Yet, since breaking *kanji* down into components is not always helpful in accessing its meaning or phonology, it can be expected that learners will begin to process frequently used *kanji* compounds more holistically as their proficiency increases. However, this possible processing shift has not been satisfactorily investigated.

In contrast, there was a null effect of visual complexity for understanding Japanese *kanji* compounds among native Chinese speakers. Since Chinese speakers can apply their native language *kanji* knowledge (i.e., the script similarity effect), they are presumed to be using a holistic approach in order to understand individual *kanji* and compound words in the same way that native Japanese speakers do. Ehri and her colleagues (Ehri 2014, Ehri and Saltmarsh 1995, Scott and Ehri 1990) describe this processing with the term *sight words*, which are directly mapped from orthography to phonology and concepts. This orthographic mapping facilitates the processing of *sight word* reading. Both native Japanese and native Chinese speakers in Tamaoka (1997, Experiment 1) have already acquired *kanji* to a degree that enables their orthography to be directly mapped to morphemic phonological and conceptual units, regardless of whether Japanese or Chinese is their first language. Such processing is not unique to *kanji*-compound words, but high frequency English words also show a similar mechanism. For instance, if a high frequency word "book" is presented as "bOok," the holistic visual image is distorted, resulting in increased processing times in comparison to "book." As observed by both the effects of script familiarity and visual complexity, differences in script knowledge from Japanese learners' L1 result in divergent lexical processing strategies for Japanese *kanji* morphemes and their compound words.

Homophonic aspects of *kanji* have not been discussed so far. Matsumoto (2013) tested 42 students learning Japanese at a Midwestern university in the United States. These participants were divided into the three groups: (1) 23 students at the beginning level (in the fourth semester), (2) six students at the intermediate level (in the sixth semester) with an alphabetic background, and (3) 13 students at the beginning level (in the fourth semester) with a logographic background (hereafter Chinese students). Using these three groups, Matsumoto (2013) investigated the understanding of three different types of words including

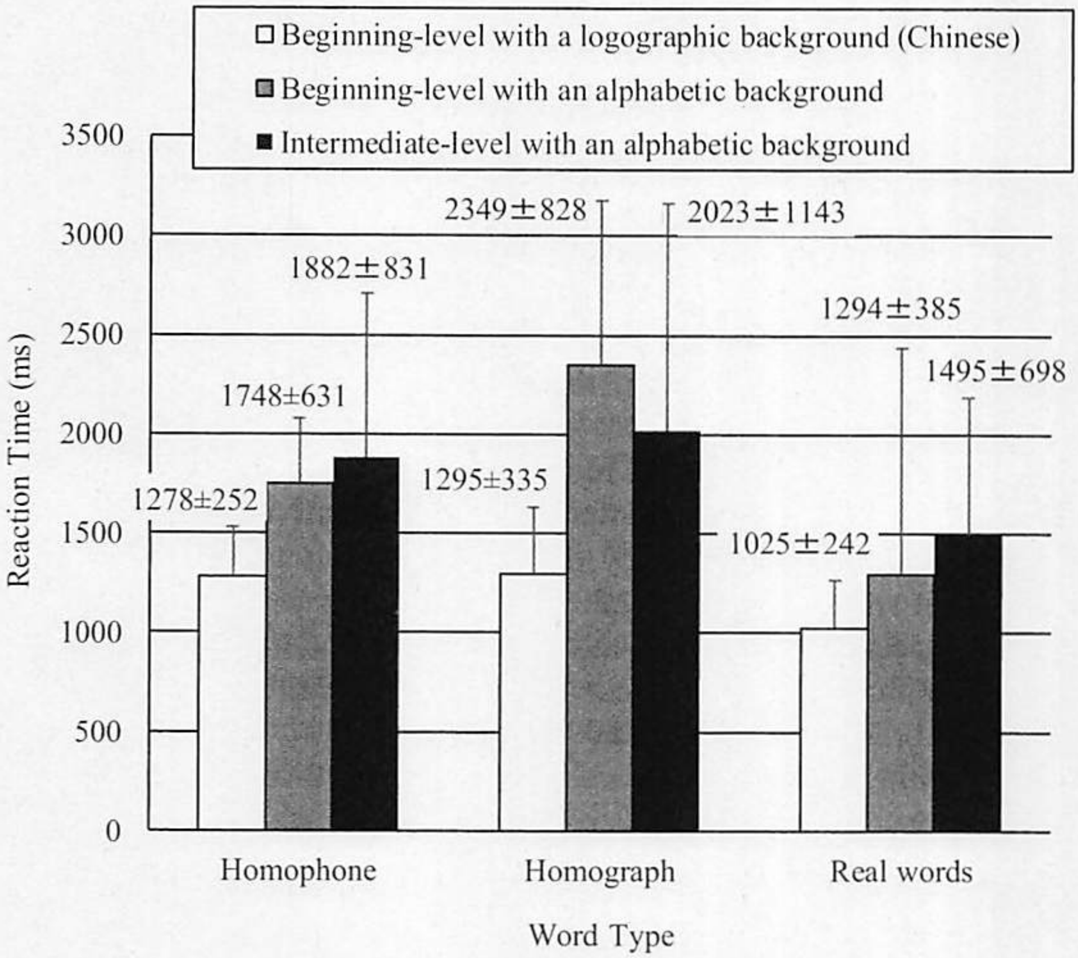

Figure 4. RT means of lexical decision by beginning and intermediate Japanese learners with alphabetic and logographic backgrounds (with standard deviation bars and values after ±). Figure adapted from Matsumoto (2013).

kanji: pseudo-homophones (英画 instead of the real word 映画, both pronounced as *eiga*), pseudo-homographs (大い instead of the real word 多い, both pronounced as *ō-i*), and real words (辞書 *jisho* 'dictionary', 重い *omo-i* 'heavy', 歩く *aru-ku* 'walk'). As shown in Figure 4, students with an alphabetic background at both levels of beginning and intermediate showed significantly slower lexical decision latencies than Chinese students at the beginning level under all three conditions. In addition, Chinese students (M = 88.89%) showed much higher accuracy for pseudo-homographs than the beginning level students (M = 54.78%)

and the intermediate level students (*M* = 50.94%). However, this great discrepancy in accuracy among the three groups was not observed for either pseudo-homophones or real words.

The results of Matsumoto (2013) verified the commonly observed notion that Chinese students, even at the beginning level, have a great advantage in the processing of *kanji* units in comparison to students with an alphabetic background. Particular pseudo-homographic words constructed by orthographically similar *kanji,* such as 字供 instead of 子供 'child' (子 is replaced by 字), 家旅 instead of 家族 'family' (族 is replaced by 旅), were easily understood as incorrect by Chinese students. As for Chinese students, small orthographic differences such as 字 and 子, and 旅 and 族 were effortlessly (i.e., quickly and accurately) recognized as different *kanji* and they were processed as a whole unit without analyzing the orthographic details of *kanji*, whereas those with an alphabetic background could not apply this holistic approach to *kanji* recognition, at least after having learnt Japanese for only four to six semesters. The results of Matsumoto (2013) are compatible with those found in Tamaoka (1997, 2000), which supported the script similarity effect on the speed and accuracy for the processing of *kanji* orthography.

In the study by Matsumoto (2013), the advantage of Chinese students was not seen in pseudo-homophonic words. Chinese students have excellent *kanji* knowledge from L1 Chinese, but their *kanji* knowledge in Japanese is still unbalanced: Chinese students cannot use their L1 *kanji* knowledge for Japanese *kanji* phonology. However, regarding this null effect, it should be noted that the 15 pseudo-homophones used in Matsumoto (2013: 176) include some inappropriate items. A pseudo-homophone 病決, *byōketsu* is not homophonic with 病気 'illness' (pronounced as *byōki*); the corresponding real word should be spelled as 病欠. In the case of another homophonic item 火りる for the real word 借りる *kariru* 'borrow', the *kanji* 火 has multiple pronunciations—*ka* for *on* reading, *hi* for *kun*-reading.[2] With the *hiragana* inflection of りる *-riru*, *kun* reading *hi* is preferred, so it is no longer a homophonic item as *hiriru*. Similarly, a homophonic item 帰す *kaesu,* which is used for the real word 返す 'return', is also the *real* homophonic word 'to send back', not *pseudo*-homophonic word. Some other items also have similar problems. As such, Matsumoto's list of pseudo-homophones included some inappropriate items, so it is rather difficult to draw a clear conclusion about homophonic advantage among the three students groups.

At the introductory and intermediate levels, native Chinese speakers have so far shown a great advantage for comprehension of *kanji* in comparison with their English-speaking counterparts. However, it is commonly known that Chinese speakers tend to employ their L1 character knowledge to understand words written in Japanese *kanji*. Hayakawa (2010) conducted an experiment using a lexical decision task with auditory presentation of *kanji* compounds with no visual presentation of *kanji* while the test subjects were hearing the pronunciation. She compared two different types of Japanese two-*kanji* compounds: (1) those that exist in both Chinese and Japanese like 記憶 *kioku* 'memory', and (2) those that do not exist in Chinese such as 面倒 *mendō* 'troublesome'. Using the Japanese Language Proficiency Test (Japan Foundation and Japan Educational Exchange and Services, 2002), Hayakawa tested two proficiency groups of L1 Chinese-speaking Taiwanese learners of Japanese ($N = 48$), those ($N = 22$) who had passed the former second level of the JLPT (second level), and those ($N = 26$) who had passed the former first level (first level). It was predicted that the speed of lexical understanding would differ between the first and the second proficiency levels. However, despite the prediction, on the lexical decision task when the words were presented by audio, the orthographically/semantically similar (i.e., shared in Chinese and Japanese) words (second level, $M = 1{,}400$ ms; first level, $M = 1{,}201$ ms) were processed more slowly than the orthographically/semantically different (not shared) words (second level, $M = 1{,}192$ ms; first level, $M = 1{,}086$ ms). The finding that shared words that were presented via audio stimulus required longer decision times than non-shared words was therefore unexpected.

One possible explanation of Hayakawa (2010)'s finding is that Chinese students may be unmotivated to memorize the Japanese pronunciations of words for which they have already acquired the meanings in their L1. As a result, Chinese learners' lexical knowledge is strongly biased towards the orthographic aspect of *kanji* words to the detriment of their phonological knowledge. In other words, because of their orthographic knowledge of *kanji*, Chinese students might have been reluctant to memorize the Japanese pronunciations of words that exist in both languages. From the perspective of phonological processing of *kanji*, Chinese existing *kanji* pronunciations interfere with Japanese *kanji* sounds which Chinese students should learn. If particular *kanji* compounds do not exist in Chinese phonology, Chinese learners are more likely to memorize Japanese pronunciations of these dissimilar compound words. In addition, multiple pronunciations of *kanji on*/*kun* readings (Tamaoka and Taft 2010, Verdonschot *et al.* 2013) could increase the difficulty for Chinese speakers to learn *kanji* sounds.

Kanji writing errors by native Japanese speakers and learners of Japanese at a university in Australia was investigated by Hatta, Kawakami, and Tamaoka (1998, 2002). Based on 374 *kanji* writing errors made by native Japanese college students, they reported that phonology-related *kanji* writing errors were most numerous (60.0%), followed by errors (43.6%) related to orthography and errors (29.7%) related to semantics including the overlap of three types. In contrast, a majority of 408 *kanji* writing errors produced by students learning Japanese were classified as being related to orthography, including a great number of non-existing *kanji*. These JFL students in the intermediate level of Japanese without having learned many kanji do not have enough *kanji* knowledge to experience phonological interference caused by multiple homophonic *kanji*, whereas, for native Japanese speakers, phonology of Japanese *kanji* comes into play even in tasks which are ostensibly devoted to the orthographic aspect of *kanji* writing.

Many homophones are found in two-*kanji* compounds in Japanese. For example, the sound *kōka* can be written several ways, such as 硬貨 'coin', 高価 'valuable', 校歌 'school song', 効果 'effect', 降下 'falling'. Two-*kanji* compounds with the same sound are often seen in written Japanese and have very different meanings. Even though these homophonic words are activated together with the target word, they seem not to have any benefits for the performance of lexical decision and naming. Yet, using native Japanese speakers as participants, Tamaoka (2007) found that lexical homophony has an inhibitory effect on cognitive processing for lexical decision (Experiment 1) and naming (Experiment 2). As depicted in Figure 5, when one of homophonic words, *kōka* 硬貨 'coin' was visually presented, other orthographic representations of its homophones were also activated by its phonological representation without any specific benefit for the task. As a result, this activation process slowed down the task performance. Based on the consistency of an inhibitory effect, Tamaoka (2007) proposed the idea of *rebounding activation* that an orthographic representation activates the phonological representation, which then rebounds to activate orthographic representations of homophonic forms (Figure 5). The processing mechanism of *rebounding activation* could be the reason for a high percentage of phonology-related *kanji* writing errors among native Japanese students (Hatta *et al.* 1998, 2002). Even though many Japanese teachers are aware of the lack of phonological knowledge of *kanji* among Chinese students, researchers have yet to pinpoint the degree of discrepancy between orthographic and phonological lexical knowledge of Japanese *kanji* compounds among Chinese speakers.

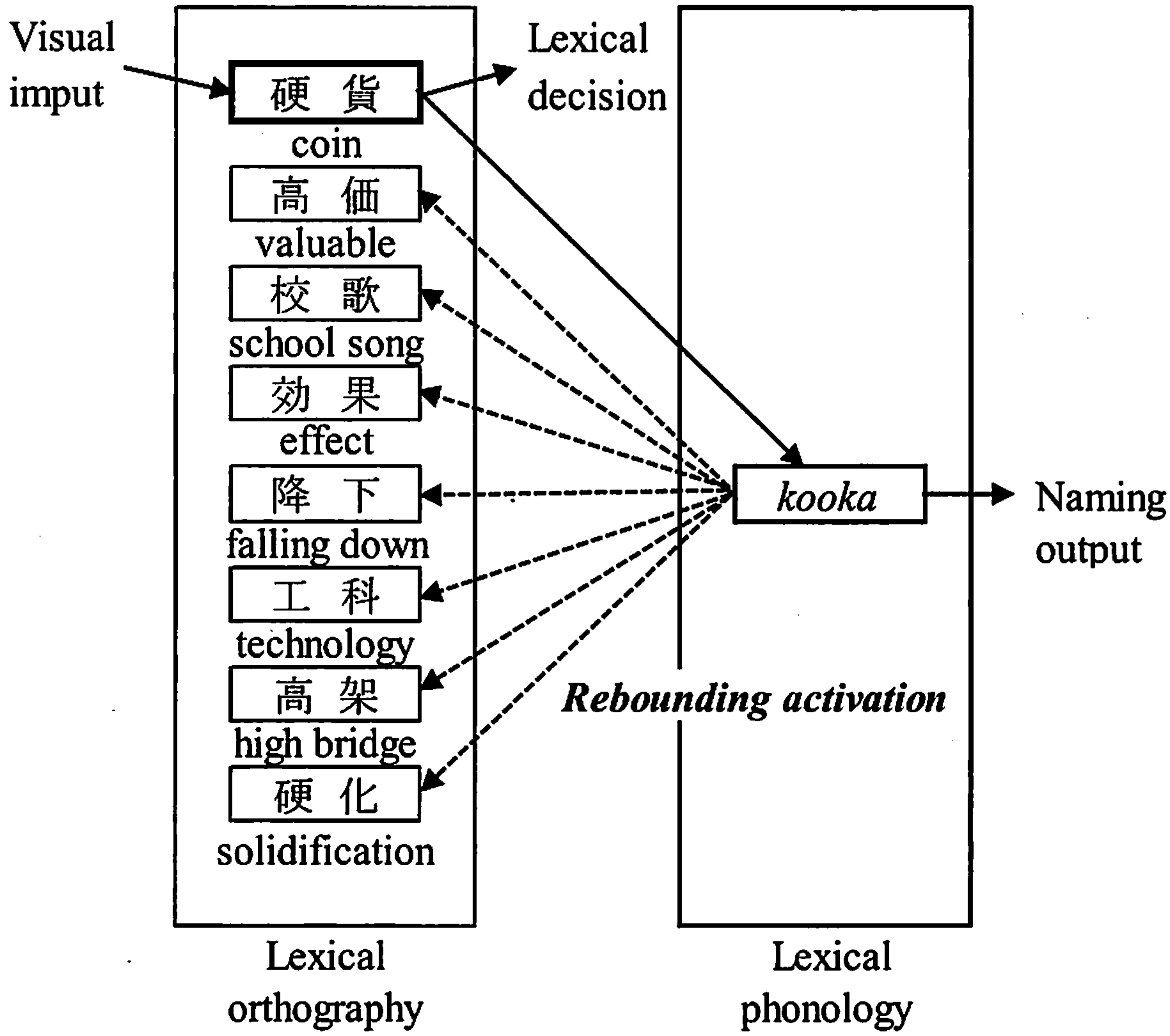

Figure 5. Rebounding activation of lexical homophones.
Figure based on Tamaoka (2007).

3. *Kana*—Effects of Script Familiarity and Imageability

Both *katakana* and *hiragana* scripts share similar characteristics in terms of orthographic units and *kana*-to-sound mapping regularity. *Kana* represents the mora unit while the English alphabet fundamentally corresponds to phonemes. In fact, experimental results of an implicit priming task (Kureta, Fushimi, and Tatsumi 2006) and a masked priming naming task (Verdonschot, *et al.* 2011) indicated that that the mora is the processing unit for Japanese words. In accordance with the size of the processing unit, each *kana* basically follows a one-to-one regular correspondence between a *kana* symbol and a mora unit. By contrast, alphabetic languages such as Dutch and English are processed at the phonemic level (Forster and Davis 1991, Meyer 1991, Schiller 2004). However, the English alphabet, in particular, involves various irregularities at the phonemic level, making it more difficult to apply a phonological strategy to access a word's sound.

Many Japanese compounds are typically written in *kanji*, not *kana*. Given that the phonological processing of *kana* are very regular in *kana*-to-mora phonological conversions, *kanji* words presented in *kana* (i.e., unfamiliar script presentation) must be processed at equal speed in both *hiragana* and *katakana* by simply applying regular conversion rules. For instance, the *kanji* compound 算数 *sansū* 'mathematics' is usually written with the characters *san* 算 and *sū* 数. If this word is presented with four *kana* either as サンスウ in *katakana* or さんすう in *hiragana* as shown in Figure 6, not only native Japanese speakers, but also Japanese learners should process both *kana*-presented stimuli at an equal speed. Tamaoka (1997, Experiment 2) reported that three groups showed no difference in lexical decision speed between the two different *kana* scripts: (1) 669 ms in *katakana* and 699 ms in *hiragana* for native Japanese speakers, (2) 2,017 ms in *katakana* and 1,984 ms in *hiragana* for native English speakers, and (3) 2,016 ms in *katakana* and 2,195 ms in *hiragana* for native Chinese speakers. Although the basic *kana*-to-mora conversion speed differed between native Japanese speakers and English- and Chinese-speaking Japanese learners, no group showed a difference on either *kana* script, suggesting that *kanji* compounds presented atypically in *kana* script are similarly processed based on regular *kana*-to-mora phonological conversion rules.

サンスウ

(1) *Katakana* representation

さんすう

(2) *Hiragana* representation

Figure 6. An example of a *kanji* compound word *sansū* 'mathematics' presented in *katakana* and hiragana.
Note: *Sansū* has 748 tokens (Amano and Kondo 2000) *and* is a second level JLPT word.

Then, the question arises whether all words written in *kana*, including *gairaigo*, are processed based on the regular *kana*-to-mora phonological conversion rules. A majority of loanwords are adapted from the English vocabulary. Even in the older figures provided by NINJAL (1964), 80.8% of loanwords used in 90 different magazines were of English origin, followed by 5.6% of French origin, 3.3% of German origin, and 1.5% of Italian origin. As for native Japanese speakers, Besner and Hildebrandt (1987) reported that loanwords adopted from English (e.g., オレンジ *orenji* 'orange') and presented in *katakana* had shorter naming latencies than counter stimuli of both *kanji* words presented in *katakana* (e.g., オンガク *ongaku* 'music', normally written in *kanji* as 音楽) and nonsense *katakana* strings (e.g., オロアイ *oroai*). The tendency that words presented in a familiar script are processed faster than those presented in an unfamiliar script is called the script familiarity effect. Furthermore, Besner and Hildebrandt (1987) explained that the meanings of loanwords written in *katakana* can be accessed directly, without the need for *kana*-to-mora phonological conversion.

Chikamatsu (1996) investigated the script familiarity effect on 45 Americans (not necessarily native English speakers) and 17 native Chinese speakers in an introductory level Japanese course (five days a week for two semesters) in the United States. In her study, *hiragana* and *katakana* were used to present both English loanwords and *kanji* compounds: (1) 40 *katakana* loanwords presented in their normal orthography as in テレビ *terebi* 'television', ラジオ *rajio* 'radio', and *amerika* アメリカ 'America', and their unfamiliar *hiragana* representations as in てれび, らじお, あめりか, respectively, and (2) 40 *kanji*-compounds presented in hiragana, such as えいが *eiga* 'movie', なまえ *namae* 'name', and えんぴつ *enpitsu* 'pencil', and their unfamiliar *katakana* equivalents, as in エイガ, ナマエ, エンピツ, respectively. Note that the second types are normally written in *kanji* as 映画, 名前, and 鉛筆. However, since the participants in the experiment were all novice learners, their textbook introduced these words in *hiragana*. Thus, Chikamatsu assumed that for her participants, *kanji* compound words in *hiragana* were more familiar than those written with *katakana*. She found that although lexical decision speed did not differ between Americans (M = 4,909 ms) and Chinese (M = 4,450 ms), a significant difference was found between words in the familiar script (M = 2,703 ms) and the unfamiliar script (M = 3,823 ms). I assume that Chikamatsu calculated the learners' mean reaction times using both real words for correct "yes" responses and nonwords for correct "no" responses, which resulted in longer reaction times in the group means than in the script familiarity means. Otherwise, the means should have been similar under the same experimental conditions using shared stimuli. Since overall mean reaction times are relatively long even for high frequency words presented in the regular *kana*-to-mora mapping scripts of *hiragana* and *katakana*, we can assume that Chikamatsu (1996)'s participants were of low proficiency at the time of testing.

Whether length of Japanese learning contributes to lexical understanding is a pivotal question for Japanese language education. Using a similar script familiarity paradigm, Chikamatsu (2006) further tested lexical decisions by native English speakers at two levels of

Japanese language proficiency: a one-year beginning group ($N = 18$) who received 50 minutes of Japanese instruction for five days a week over two semesters, and a second-year group ($N = 16$) who had studied for four semesters. Although Chikamatsu (2006) called these 16 students "intermediate" in her paper, I named the participants of Chikamatsu (2006) to be "first year beginning" and "second year students" since intermediate proficiency for native English speakers in the United States is usually considered to reflect those who completed at least six semesters (three years) of Japanese learning. The second year students ($M = 3{,}970$ ms) showed significantly faster lexical decisions than the beginning group ($M = 5{,}503$ ms), while accuracies of both groups were the same. Independent of the length of Japanese learning, as shown in previous studies by Besner and Hildebrandt (1987) for native Japanese speakers, and by Chikamatsu (1996) and Tamaoka (1997) for learners of Japanese as a foreign language, the script familiarity effect was apparent in the study by Chikamatsu (2006), indicating that the familiar-script words ($M = 3{,}644$ ms) were processed much faster than the unfamiliar-script words ($M = 6{,}298$ ms) both for the beginning and second year levels.

The script familiarity effect can be explained by the framework of "the dual route model" or by the newer version of this model called "*the cascaded dual route model*" (Coltheart and Rastle 1994; Coltheart, Curtis, Atkins, and Haller 1993). This model consists of two processing routes, the phonological processing of real words as a whole lexical unit (i.e., *addressed phonology*), and the processing of nonwords or unfamiliar words by piecing together smaller phonological units (i.e., *assembled phonology*). *Addressed phonology* is the direct route to accessing lexical items stored in the mental lexicon. In the results from Besner and Hildebrandt (1987), loanwords like オレンジ 'orange' presented in *katakana* and *kanji* compound words like 音楽 'music' presented in *kanji* enabled direct access to their corresponding entries in the mental lexicon. In contrast, nonwords like オロアイ were processed via the indirect assembled route of *kana*-to-mora phonological conversion. *Kanji* compounds like 音楽, presented in *katakana* as オンガク, lose the whole visual image of the word, so native Japanese speakers cannot process these words via the usual direct lexical route and must perform *kana*-to-mora conversions.

The question then shifts to how Japanese learners process loanwords written in the unfamiliar *hiragana* script. Chikamatsu (1996) used *katakana* loanwords as the script familiar condition over their *katakana* presentations. However, she analyzed *kanji* compounds in *hiragana* and *katakana* mixed with loanwords in *hiragana* and *katakana*, so that the result of the script familiarity was unclear in terms of whether the script familiarity effect was caused by the *katakana* loanwords or the *kanji* compound words, or even both.

Tamaoka (1997, Experiment 2) investigated the script familiarity effect with Japanese learners by only focusing on loanwords. Tamaoka used English loanwords normally written in *katakana* and the same words in *hiragana*, like the examples in Figure 7. As Besner and Hildebrandt (1987) clearly indicated, native Japanese speakers displayed the script familiarity effect by showing a significant difference in reaction times on loanwords written in *katakana* (*M* = 613 ms) and *hiragana* (*M* = 718 ms). If Besner and Hildebrandt's finding that script familiarity speeding up word understanding holds for Japanese learners, then those learners should likewise be able to process loanwords in *katakana* like テレビ faster than the same words in *hiragana* like てれび. However, Tamaoka (1997, Experiment 2) showed that neither native Chinese (*M* = 2,460 ms for *katakana* and *M* = 2,579 ms for *hiragana*) nor native English (*M* = 2,419 ms for *katakana* and *M* = 2,428 ms for *hiragana*) speakers showed a difference in lexical decision speed between *katakana* and *hiragana*. In other words, the script familiarity effect was not observed for Japanese learners. Thus, Japanese learners seem to be utilizing the indirect lexical route, that is, *kana*-to-mora conversions, even for processing loanwords presented in the typical *katakana* orthography.

テレビ

(1) *Katakana* representation

てれび

(2) *Hiragana* representation

Figure 7. An example of high frequency loanword *terebi* 'television' in *katakana* and *hiragana*.
Note: *Terebi* has a high frequency of 60,636 tokens (Amano and Kondo 2000) and is on the beginner's fourth level of the JLPT.

If Japanese learners simply apply the *kana*-to-mora conversion rules to process all loanwords normally written in *katakana*, does their processing speed for loanwords improve the longer they study Japanese? This assumption can be tested by the degree of *imageability* affecting the speed of loanword processing. *Imageability* is indexed by the frequency with which native Japanese speakers associate words with a given category. Ogawa (1972) created a list of associative word frequencies in 52 categories provided by 344 university students in a one-minute timed task. Under the category of clothes, 202 students wrote セーター 'sweater', while only 15 students produced the associated word スカーフ 'scarf'. The number of students who wrote a given associated word under the instructed category was used as the index of imageability.

Based on Ogawa's database, shown in Figure 8, *sweater* is categorized as having high-imageability while *scarf* is categorized as having low-imageability. High or low imageability is usually correlated with the index of word frequency in printed materials such as newspapers and magazines. In fact, *sweater* appears 1,063 times in editions of the Asahi newspaper from 1985 to 1998 (Amano and Kondo 2000), while *scarf* appears 422 times. Furthermore, imageability is usually related to JLPT levels; *sweater* is assigned to the easiest fourth level, while *scarf* falls under the more difficult second level. Again, if the indirect route of *kana*-to-mora conversion is the only approach used by Japanese learners for understanding English loanwords written in *kana*, the processing speed should remain relatively constant regardless of imageability.

セーター
(1) High imageability
(344 written responses, Printed-frequency = 1,036 tokens) *sētā* 'sweater', JLPT fourth level

スカーフ
(2) Low imageability
(15 written responses; Printed-frequency = 422 tokens) *sukāhu* 'scarf', JLPT 2nd level

Figure 8. An example of high and low imageability loanwords.
Note: Word frequencies were taken from Amano and Kondo (2000). Written responses for the category of clothes were taken from Ogawa (1972).

Despite this prediction, the imageability effect was observed among native English speakers. Tamaoka (1992, Experiment 3) investigated the processing speed of loanwords with high and low imageability on a lexical decision task with native English speakers. Results showed that native English speakers with one to two years of Japanese learning made lexical decisions on high imageability loanwords (M = 3,322 ms) faster than for low imageability (M = 4,091 ms) loanwords. Furthermore, there was a marked improvement following an additional year of study. High imageability loanwords (M = 2,147 ms) were processed faster than low imageability words (M = 2,693 ms) by those who had been learning

Japanese for two to three years.

Combining the findings of Tamaoka (1992, Experiment 3) with those of Tamaoka (1997, Experiments 2 and 3), Japanese lexical processing by native English speakers could be explained as follows. Using the processing framework of "the cascaded dual route model" (Coltheart and Rastle, 1994; Coltheart, Curtis, Atkins, and Haller, 1993), and considering the null effect of script familiarity on *gairaigo* written in *katakana* and *hiragana* (e.g., テレビ versus てれび), native English speakers used the indirect *kana*-to-mora conversion route for all words written in *katakana* (e.g., テ to /te/, レ to /re/, and ビ to /bi/) and *hiragana* (e.g., て to /te/, れ to /re/, and び to /bi/) to access a phonological representation (e.g., /terebi/). Nevertheless, the imageability effect was observed (e.g., スカート versus スカーフ). Thus, native English speakers who find themselves at the introductory level of Japanese learning must compile each mora unit into a single word, leading to activation of the target word's phonological representation in their L2 lexicon, whereby they can finally access the conceptual representation. The difference in processing speed resulting from high and low imageability must be created in the processing of phonological and conceptual activations in the mental lexicon in order to accomplish the lexical decision task. In summary, native English speakers who study one to three years of Japanese use a very different processing strategy for *kana* words than do native Japanese speakers.

4. *Romaji*—The Myth of L1 Interference

Up until the 1980s, textbooks written in *romaji* were widely used for teaching Japanese in the United States. During the 1990s, a shift towards textbooks written with a mixture of *kana/kanji* occurred, although some universities have continued using *romaji* textbooks (Takatori 2012). Eleanor Harz Jorden, in collaboration with Mari Noda, wrote a well-known introductory Japanese textbook employing the *romaji* script, titled *Japanese: The Spoken Language* (Part 1 published in 1987, Part 2 in 1988, and Part 3 in 1990), and developed a teaching methodology which delayed the introduction of *kanji* until students had received 100 hours of basic Japanese grammar, vocabulary, and conversation instruction. As the title of the book "The Spoken Language" indicates, Jorden's approach is not entirely based on *romaji*, but on the materials from which their course was created. They first constructed the audio/video materials, then transcribed these into *romaji*, and added grammar explanations to create textbooks for spoken Japanese. Thus, in Jorden's method, students use audio/video input (DVD) to study the spoken language at home. During this time, students are actively discouraged from relying too heavily on *romaji*.

University students who choose to minor in Japanese often receive only limited contact hours in the classroom. For instance, in a 2014 class schedule provided by Yuki Takatori at Georgia State University, Japanese students receive 3 hours (1 class hour equals 50 minutes) a week, and 42 total class hours (3 hours a week for 14 weeks equals 42 hours) of Japanese instruction in a single semester. Japanese students at Georgia State University receive instruction based on Jorden's method. As this example shows, with such limited contact hours allotted to Japanese minors in countries where an alphabetic writing system is used, teaching *kanji* and *kana* occupies a disproportionate amount of available instruction hours. If these students wish to learn Japanese as a communication tool for sightseeing and business greetings, presenting Japanese in *romaji*, especially when transcribing both grammar and basic vocabulary instructions, could be an efficient approach.

In the field of Japanese language education, the use of *romaji* script, however, has been viewed critically by various researchers (e.g., Amanuma 1995; Kano 1992; Kimura 1974; Takebe 1991, 1992). Before looking into the details of the *strong negative* arguments against the use of *romaji*, I would like to review the experimental results of Hatakeyama, Sugita, Oue and Shimoyama (2007) and Tamaoka (2000). These studies compared the processing speed and accuracy of Japanese words and texts presented to Japanese learners in the *romaji* and *kana/kanji* scripts. Through this approach, I hope to examine *romaji* from an unbiased standpoint.

Hatakeyama *et al.* (2007) compared the oral production speed in varying lengths of nonword *kana* strings including one (e.g., ろ, よ, ぬ), two (e.g., ねれ, もま, れね), and four *kana* (e.g., ぬねわれ, さきちろ, きさわれ) with the same nonwords presented in *romaji* (e.g., RO, YO, NU; NERE, MOMA, RENE; and NUNEWARE, SAKICHIRO, KISAWARE) by eight Italian university students who majored in Japanese at a university in Italy. Hatakeyama *et al.* measured learners' naming latencies of these nonsense words (see methodology in Figure 2, but they recorded the whole experiment). The results ($N = 8$) showed that the mean naming latencies of *romaji*-script nonwords were 714 ms for one mora (*kana*), 764 for two moras (*kana*), and 1,009 ms for four moras (*kana*). In the *hiragana* script, mean latencies were much longer at 1,024 ms for one *kana*, 1,529 for two *kana*, and 1,803 ms for four *kana*. The results indicated a clear advantage of *romaji* over *hiragana* in pronouncing nonsense words. However, their naming experiment featured only nonsense *kana* and *romaji* stimuli; what about learners' production of existing Japanese words in these scripts?

Tamaoka (2000, Experiment 1) conducted a naming experiment with real Japanese words (for methodology, see Figure 2) presented in three

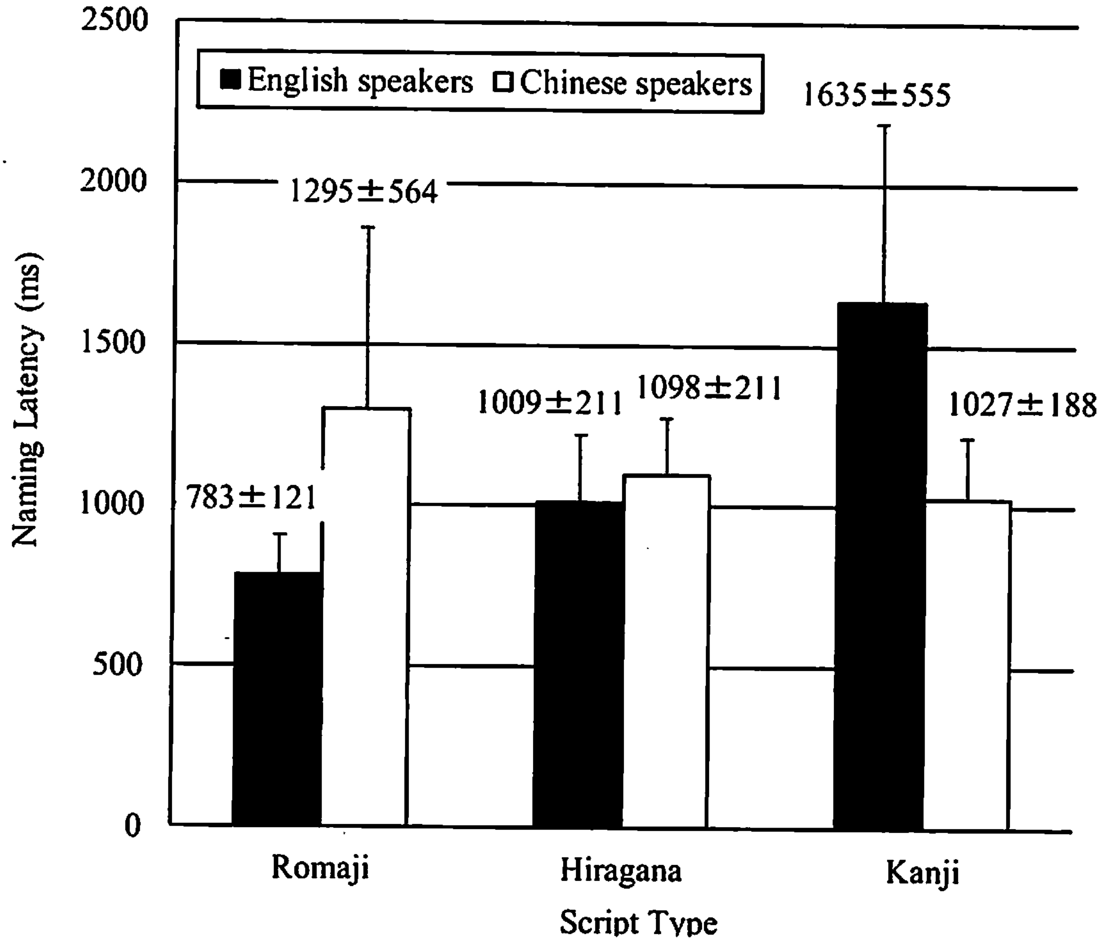

Figure 9. Mean latencies (with standard deviation bars and values after ±) for word naming by native Chinese (*N* = 15) and English (*N* = 13) speakers learning Japanese as a function of script. Figure adapted from Tamaoka (2000, Experiment 1).

different scripts to native Chinese (*N* = 15) and English (*N* = 13) speakers majoring in Japanese at a university in Australia at the second-year and third-year levels. As shown in Figure 9, native English speakers displayed a clear slowdown of lexical processing with the fastest naming speeds (or the shortest naming latencies) for *romaji* (*M* = 783 ms), then *hiragana* (*M* = 1,009 ms), and finally *kanji* (*M* = 1,635 ms). Although the difference between each script was smaller, the reverse pattern was found for native Chinese speakers, with *kanji* being the fastest (*M* = 1,027 ms), followed by *hiragana* (*M* = 1,098 ms), and lastly *romaji* (*M* = 1,295 ms). For native English speakers, script similarity between the alphabet and *romaji* clearly facilitated the speed of naming Japanese real words. Considering that the Chinese speakers had been studying in Australia, their English ability must have been high enough to understand academic lectures in English. Nevertheless, unlike English speakers, Chinese learners did not exhibit facility with Japanese word naming due to script familiarity on words presented in *romaji*. Therefore, the script similarity of the alphabet with Japanese *romaji* must greatly affect the speed of L2 phonological processing.

Experiment 1 of Tamaoka (2000) showed that the naming speed of words presented in *romaji* was facilitated by the script similarity effect among native English speakers. However, word-level processing might differ from how learners process an entire text. A task requiring readers to process a text in *romaji* may elicit phonetic interference from the L1 alphabetic script. To test this assumption, Tamaoka (2000, Experiment 2) compared how native Chinese (N = 12) and English (N = 12) speakers learning Japanese at a university in Australia (Japanese majors) processed a text. Tamaoka used two different texts, titled "The History of *Kanji*" composed of 596 mora, and "The History of Kites" composed of 431 mora. These texts were counterbalanced by script type (*romaji* and *kana/kanji* mix) for presentation to the two learner groups. The participants' task was to read the text aloud as quickly and accurately as possible. They were then asked 10 comprehension questions about the content for each text.

No difference was found between Chinese and English speakers' comprehension of the text. Furthermore, native English speakers showed no difference in understanding the text regardless of whether it was presented in *kana/kanji* or in *romaji*. On the other hand, results of native Chinese speakers indicated that they comprehended the *kana/kanji* text better than the text in *romaji*. This result likely reflects the script similarity between L1 Chinese and L2 Japanese *kanji*. Given that the comprehension level was identical for the two texts in both scripts, reading speed, or the number of mora read per second, becomes crucial. Native English speakers read the texts in *romaji* (M = 3.27 mora/sec) much faster than those in *kana/kanji* (M = 2.25 mora/sec), whereas native Chinese speakers showed the opposite pattern for *romaji* (M = 1.95 mora/sec) and *kana/kanji* texts (M = 2.69 mora/sec). In other words, English speakers can read *romaji* texts much faster than the same text presented in *kana/kanji*. Interestingly, the average speed of four Japanese TV announcers reading a newscast in *kana/kanji* mixed script was measured at 9.7 mora per second (Sugito 1999). Thus, although comparing reading of different scripts (i.e. *kana/kanji* mixed and *romaji*), roughly speaking, native English speakers take three times longer to read aloud the same text in *romaji* than a TV announcer while native Chinese speakers take five times longer.

Reading speed, however, does not exactly reflect phonetic interference. The number of mora-level errors is likely a better indicator of phonetic interference caused by *romaji*; thus, Tamaoka (2000, Experiment 2) counted instances of pronunciation errors at the mora level. As shown in Figure 10, native English speakers clearly made fewer errors when reading the texts in *romaji* (M = 11.04 mora) compared to those in *kana/kanji* (M = 38.58 mora). This trend is slightly reversed with Chinese speakers, who made fewer errors on the *kana/kanji* texts (M = 23.59 mora) than the *romaji* texts (M = 30.55 mora). Therefore, in addition to faster reading speeds on *romaji* texts, native English speakers also made fewer pronunciation errors on texts written in *romaji*.

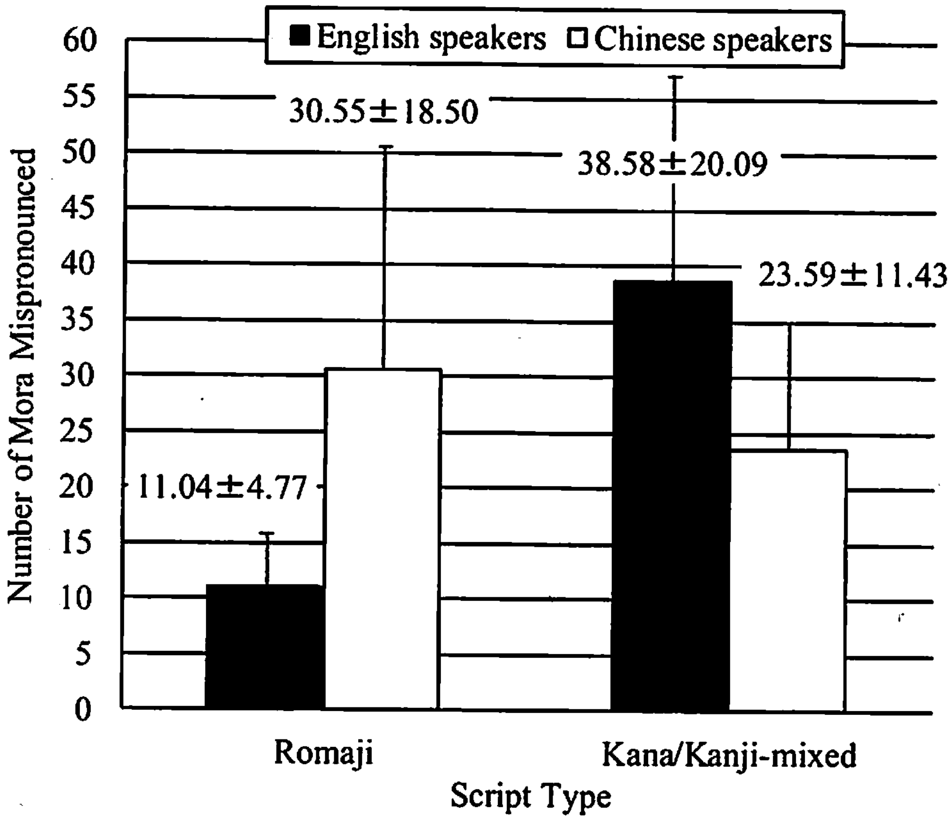

Figure 10. Means (with standard deviation bars and values after ±) of the number of mora mispronounced when reading a text by native Chinese (N = 12) and English (N = 12) speakers learning Japanese. Figure adapted from Tamaoka (2000, Experiment 2).

Mistakes at the mora level, however, look only at the phonemic unit. The overall naturalness of pronunciation during a read-aloud task should also be examined. To this end, Tamaoka (2000, Experiment 2) further had two native Japanese speakers rate the naturalness of pronunciation using a 1-to-7 point scale. As indicated in Figure 11, native English speakers' reading of the *romaji* text (M = 5.13) was perceived to be much more natural than the *kana/kanji* text (M = 2.92). In contrast, native Chinese speakers were judged to be slightly less natural sounding when reading the *romaji* texts (M = 2.95) compared to the same texts in *kana/kanji* (M = 3.82). Thus, Tamaoka (2000) provided evidence that the *romaji* script neither causes nor amplifies L1 English phonological interference during L2 Japanese reading. In summary, there was little indication of phonetic interference by using the *romaji* script among native English speakers; rather, *romaji* facilitated their reading speed, accuracy, and Japanese-likeness.

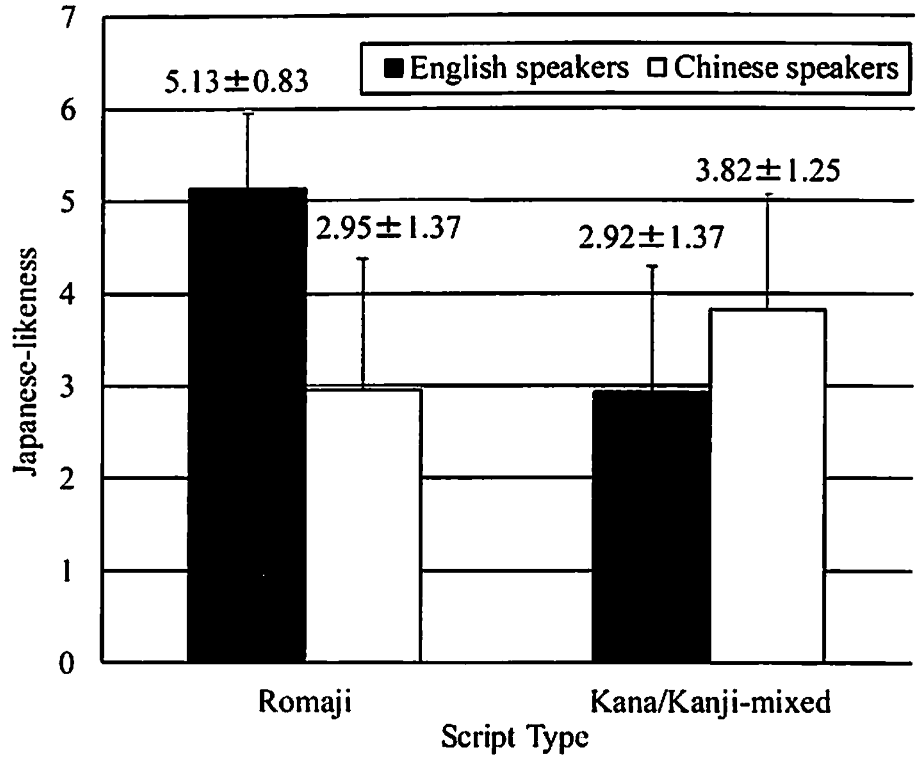

Figure 11. Means (with standard deviation bars and values after ±) of Japanese-likeness for reading a text. Figure adapted from Tamaoka (2000, Experiment 2).

Due to the great similarity between scripts, words and texts presented in *romaji* are more efficiently (i.e., quickly and accurately) processed by native English speakers than those in *kana* and *kanji*. Then, why does script similarity enhance native English speakers' processing and comprehension of L2 Japanese words and texts? O'Seaghdha, Chen, and Chen (2010) proposed the notion of language-specific proximate units for native speakers in the initial construction of phonology—the phoneme for English, the mora for Japanese, and the tonal syllable for Mandarin Chinese. Native English speakers use phoneme-size units for phonologically encoding English words using the alphabetic script, although there are some exceptions in the mapping of letters and phonemes in English. The alphabets used in Japanese *romaji*, however, maps letters to phonemes on a one-to-one basis. Hence, native English speakers can effortlessly handle words presented in *romaji* with little phonological interference between English and Japanese. However, *kana* and *kanji* represent different phonological units—*kana* map to mora, and *kanji* to single or multiple-mora morphemic units. Thus, English speakers at the introductory to intermediate level have difficulty in efficiently processing words and texts in *kana*/*kanji*. Contrastingly, since native Chinese speakers at the same level utilize syllable-size units for Chinese words (Chen and Chen, 2006, 2007), they have difficulty in processing words in *romaji*, while displaying an advantage in understanding words in *kanji*.

Now we will return to the topic of the *romaji* script as a pedagogical tool for Japanese instruction. Japanese language education researchers (e.g., Amanuma 1995; Kano 1992; Kimura 1974; Takebe 1991, 1992) are generally against the use of *romaji*. Criticisms focus on three aspects: (1) sound mismatch with spellings between *romaji* and the L1 alphabet, (2) occurrence of irregular syllabification, and (3) errors of phonetic description by *kana* and *romaji*.

First, *romaji* spellings occasionally mismatch students' L1 alphabet spellings (Kano, 1992). For instance, the initial spelling of *h* is silent in French, so native French speakers tend to pronounce the *romaji* spelling of *higasi* 'east' as /igasi/ without the initial *h*. The spelling of *oo* in English can be pronounced multiple ways: *oo* in *book* as [u], but *oo* in *food* as a long vowel [u:], while *oo* in *brooch* as [oU], and so on (Takebe, 1991). Such spelling-to-sounds mismatches between alphabetic scripts and L2 *romaji* can be found in multiple European languages.

Despite the claim by Kano (1992) and Takebe (1991, 1992), both phonological and psycholinguistic evidence supports the use of *romaji*. The Japanese sound system is simple in two ways. There are only 19 phonemes, consisting of 5 vowels and 14 consonants. The phonological structure is fundamentally CV (e.g., *ka*, *so*, *pa*), if we consider CSV (e.g., *kya*, consisting of consonant/semivowel *ky* + *a*), SV (e.g., *ya*, constructed with an empty consonant φ + semivowel *y* + vowel *a*) and V (e.g., *u*, consisting of an empty consonant φ + vowel *u*) to be variations of CV. There are three special sounds making up a syllable with two mora: gemination (e.g., *ki* + *t* = *kit* in *ki<u>t</u>te* 'stamp'), the moraic nasal (e.g., *shi* + *n* = *shin* in <u>*shinshi*</u> 'gentleman'), and long vowels (e.g., *yo* + *o* = *yō* in *taiy<u>ō</u>* 'the sun'). With this phonological regularity and simplicity, the Japanese language can be easily transcribed in *romaji* script; consequently, it can be assumed that, by using *romaji*, the number of script-mismatch mistakes made by Japanese learners from alphabetic languages may be reduced. In fact, as indicated by the aforementioned study by Tamaoka (2000) shown in Figure 10, mispronunciations seldom occurred among native English speakers. Tamaoka and Menzel (1994, 1995) also reported case studies of native English, French, and German speakers reading Japanese texts in *romaji* and *kana/kanji*, who showed few script-mismatch mistakes in words and texts in *romaji*. Yet, it should be also noted that there is some possible interference from *romaji* as well. For example, in Jorden's (1987) textbook, the word *chigaimasu* (written in the Hepburn style *romaji*) would change to *tigaimasu* when using the Kunrei style. A native English speaking student may possibly pronounce [tigaimasu] based on *romaji*.

Second, Takebe (1991) pointed out irregular syllabification when a word is presented in *romaji*. He used the example of *obasan* 'aunt', syllabified into the three units *ob*, *as*, and *aN* (N refers to a nasal), resulting in an unnatural pronunciation. Despite Takebe's claim, native English speakers are more likely to divide it into *o*, *ba* and *saN*. In the English language, native speakers have to learn various syllabic combinations. Since Japanese sounds are regular and simple, native English speakers can easily master the Japanese sound system via *romaji*, which enables them to segment Japanese words based on the CV structure. Again, as demonstrated by Tamaoka (2000) as shown in Figure 11, the texts in *romaji* were rated as higher in Japanese-likeness than the same texts read aloud in *kana/kanji*. The *romaji* texts were read by native English speakers with few pronunciation errors.

Third, some have claimed that *romaji* cannot accurately represent Japanese words and texts (Kimura, 1974). However, this claim is invalid since it was originally devised to transcribe the sounds of multiple languages. Takatori (2012, 2014) asserts that *romaji* is even more suitable for describing Japanese than are either *kana* or *kanji*. For example, the three-mora verb *kawaru* is written with a combination of *kana/kanji* as *ka+wa+ru* 変わる meaning 'to change', but its stem is *kawar-*. This verb inflects as *kawar-a*, *kawar-e*, *kawar-i*, and so on. The verb stem and its inflections, however, cannot be distinguished by the *kana/kanji* mixed script. Likewise, the formation of the negative inflection *-nai* cannot be clearly distinguished when only seen with *kana/kanji*. In *romaji*, we can clearly see that the negation is added to the verb stem, as in *kawar-a-nai*, but this inflection is hidden in the *kana/kanji* moraic presentation of the verb, as in *ka+wa+ra+na+i*, 変わらない.

In addition to inflections, both Takatori (2012) and Tamaoka and Menzel (1994, 1995) pointed out that *kana* cannot clearly describe consonant gemination. Takatori (2012) provided the example of compound words with *ma* 真 'pure'. This prefix morpheme becomes geminate as in the case of *ma* 'pure' + *shiro* 'white' changing to *masshiro* 'purely white,' which is written in *hiragana* as まっしろ or in *kana/kanji* as 真っ白. Other examples include *ma* 'pure' + *kuro* 'black' becoming *makkuro* 'purely black' (*hiragana* まっくろ or *kana/kanji* 真っ黒) or *ma* 'pure' + *chairo* 'brown' becoming *matchairo* 'purely brown' (*hiragana* まっちゃいろ or *kana/kanji* 真っ茶色). Gemination resulting from the morpheme 'pure' is written with the small っ /tu/ in *hiragana*, but this *hiragana* also transcribes geminate /s/, /k/, and /t/ in the above examples, despite their sound differences. In short, *romaji* can depict phonemic level differences in gemination while *hiragana* cannot. Therefore, contrary to Kimura's (1974) claim, the *romaji* script is more efficient and precise for transcribing Japanese than is a combination of *kana/kanji*.

Given the limited teaching hours allocated for Japanese learners at the introductory level in the United States, course organizers and instructors must clarify students' needs in order to identify what to teach and how to present it in the Japanese classroom. Students with no *kanji* background have to spend many hours memorizing *kanji*, which would take away valuable time needed for cultivating verbal communicative skills. Considering the case of learners who only need enough Japanese for sightseeing or performing business greetings, it is likely more efficient to concentrate on the acquisition of listening and speaking skills. Empirical evidence has shown the *romaji* script to be the more effective and effortless medium for Japanese learners with alphabetic backgrounds such as Dutch, English, French, German, Italian, Spanish, Swedish, and including Asian languages in Indonesia and the Philippines. Without the burden of learning *kanji* at the introductory level, the *romaji* script can function as a tool for improving learners' listening and speaking skills over a short period of study.

5. Lexical knowledge and efficiency of lexical understanding by L1 Chinese

Research has shown that for native Japanese speakers learning their first language, word processing speed as an index of automaticity (LaBerge and Samuels 1974) greatly influences general reading comprehension (Tamaoka, Leong, and Hatta 1992). Using a general reading comprehension test, the reading ability of 12 skilled and 12 less skilled (taken from grades four to six; totaling 36 skilled and 36 less skilled readers) Japanese children was measured. Tamaoka *et al.*, (1992) found large processing differences concerning loanwords and words presented in *kanji* between skilled and less-skilled readers for each grade. Similar to Tamaoka *et al.* (1992), Leong and Tamaoka (1995) demonstrated that skilled readers at grades four to six were significantly better at finding pronunciations for difficult *kanji* using phonetic cues via so-called phonetic radicals than less skilled readers at the same grades. Both Tamaoka *et al.* (1992) and Leong and Tamaoka (1995) demonstrated the centrality of phonological and orthographic morphemes and word processing to reading comprehension.

In studies investigating English as a second language, Hu and Nation (2000), Nation (2001), and Stahl and Nagy (2006) claimed that knowledge of 98% of the words in a written text is required to achieve accurate understanding of the text. Under the general reading condition of native Chinese speakers learning Japanese, the index of minimum lexical knowledge is frequently referred to as the lexical threshold for text comprehension. Komori, Mikuni, and Kondo (2004) estimated that knowledge of 96% of the words in a written Japanese text is necessary for comprehension. This figure implies that the threshold for an appropriate level of reading comprehension would require that less than 4% of the vocabulary in a given text is unknown. Similarly, Mikuni, Komori, and Kondo (2005) calculated the threshold for listening comprehension to be around 93%. Since the spoken language is less dense in lexical richness than the written language, listening comprehension likely necessitates a lower lexical threshold, in terms of percentage of lexical knowledge, in comparison to reading comprehension. Regardless, it seems that a high degree of lexical knowledge is required to accurately comprehend both spoken and written Japanese.

This gives rise to the question of exactly how a greater lexical knowledge results in better and more efficient lexical understanding. Lexical processing efficiency can be measured by speed and accuracy. Yamato and Tamaoka (2009) investigated the lexical processing of Japanese *kanji* compounds by native Chinese speakers learning Japanese. Based on a Japanese vocabulary test (Miyaoka, Tamaoka, and Sakai 2011), two groups participants composed of 21 higher and 18 lower lexical knowledge were selected from a pool of 51 native Chinese speakers. A lexical decision task employing Japanese *kanji* compounds was conducted with both groups. The researchers selected two types of two-*kanji* compounds, those with high and low frequency. Frequencies were calculated from Amano and Kondo (2000)'s lexical database, with additional controls for stroke count and existence in Japanese and Chinese.

As shown in Figure 12, reaction times showed a significant effect of word frequency on the processing of *kanji* compounds, but no difference was found between the higher and lower lexical knowledge groups in processing speed. As both groups displayed very rapid reaction times—within 1,000 ms even for low frequency words (see values in Figure 12)—we can surmise that Chinese speakers indeed have a great advantage in processing *kanji* and their compounds. However, the higher lexical knowledge group processed Japanese *kanji* compounds more accurately than the lower lexical knowledge group. The error rates were particularly attenuated in the processing of low frequency words. Furthermore, as clearly depicted in Figure 12, the higher lexical knowledge group ("high group" in Figure 12) showed higher accuracy than the lower lexical knowledge group ("low group" in Figure 12) in correctly rejecting *kanji* compounds existing in Chinese but not in Japanese. The overall results suggest that regardless of Japanese lexical knowledge, native Chinese speakers can process *kanji* very quickly because of the shared knowledge of characters in both Chinese and Japanese, while Japanese lexical knowledge plays an important role in *kanji* identification accuracy.

How about loanwords written in *katakana*? Because the *katakana* script is not a part of the Chinese writing system, native Chinese speakers cannot use their L1 script knowledge when reading Japanese. Instead, their Japanese lexical knowledge should enhance efficiency in loanword processing. Yamato and Tamaoka (2013) conducted a lexical decision experiment with *katakana* loanwords of high/low familiarity. L2 high familiarity loanwords were selected from Levels 3 and 4 in JLPT such as レストラン *resutoran* 'restaurant' and パソコン *pasokon* 'personal computer', while the L2 low familiarity loanwords were taken from Levels 1 and 2 in JLPT, including ピクニック *pikunikku* 'picnic, and セレクション *serekushon* 'selection'. JLPT stimulus words were also checked for word frequency in the 14-year corpus of the *Asahi Shinbun* (Amano and Kondo 2000) and for imageability in the L1 imageability index (Sakuma, Ijuin, Fushimi, Tatsumi, Tanaka, Amano, and Kondo 2005), which revealed a significant difference between the high and low familiarity stimulus words as classified on this proficiency test.

As depicted in Figure 13, Yamato and Tamaoka (2013) showed that the high lexical knowledge group performed lexical decisions on loanwords faster than the low lexical knowledge group. L2 high/low familiarity was also a significant factor. Furthermore, the interaction of high/low lexical knowledge and L2 high/low familiarity was significant. The difference in processing speed between high and low familiarity loanwords for the high lexical knowledge group was only 152 ms, while this difference was 292 ms for the low lexical knowledge group. This trend implies that, unlike the processing of words written in *kanji*, a richer L2 Japanese lexicon strongly affects the processing speed of loanwords.

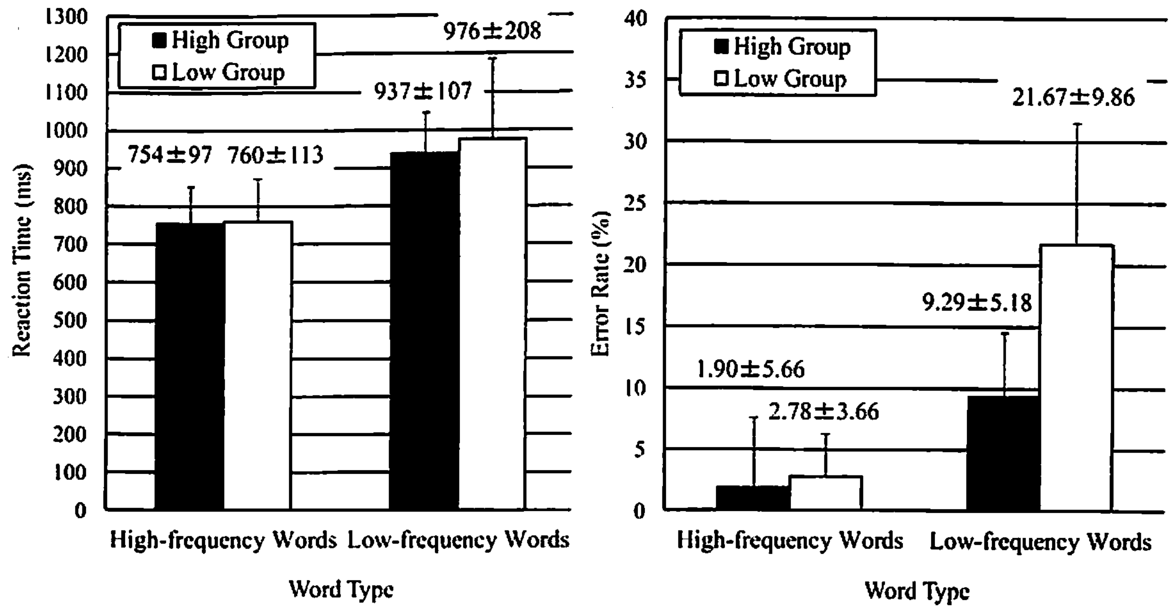

Figure 12. Means (with standard deviation bars and values after ±) of reaction time (ms) and error rate (%) in lexical decisions for Japanese high/low frequency *kanji* compounds by native Chinese speakers with high/low lexical knowledge. Figure adapted from Yamato and Tamaoka (2009).

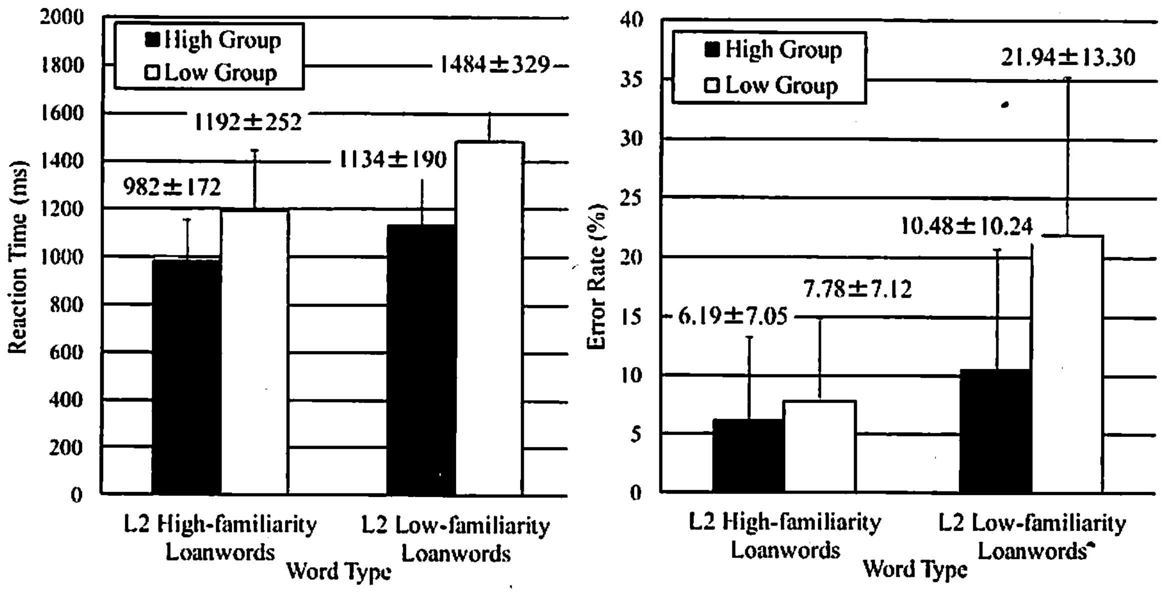

Figure 13. Means (with standard deviation bars and values after ±) of reaction time (ms) and error rate (%) in lexical decision for Japanese high/low familiarity *katakana*-presented loanwords by native Chinese speakers with Japanese high/low lexical knowledge. Figure adapted from Yamato and Tamaoka (2013).

Accuracies or error rates also showed the same significant trend as reaction times. As shown in Figure 13, the high lexical knowledge group made fewer errors on both the high /low familiarity loanwords while the low lexical knowledge group made more errors on low familiarity loanwords, a trend which reflects findings from words presented in *kanji*.

In sum, the difference in processing speed between words written in *kanji* and in *katakana* must have been caused by orthographic similarities between Japanese and Chinese. Native Chinese speakers utilize their L1 script knowledge to process L2 Japanese *kanji*. In contrast, the Chinese language has no regular syllabic script like *katakana*, so that Chinese speakers had to rely on their Japanese knowledge to identify loanwords, which resulted in the finding that L2 lexical knowledge related to the processing speed and accuracy of loanword decisions, especially those of low-familiarity.

After the end of World War II, many English loanwords entered into the Japanese language. Almost all Chinese students who major in the Japanese language have been studying English for several years prior to entering a university. Hence, we can assume that their English knowledge, at least to a degree, influences their understanding of Japanese loanwords. Yamato and Tamaoka (2013) measured the processing speed and accuracy of English and Japanese words on a group of Chinese participants. No differences in accuracy and speed of English word recognition were found between the Japanese high and low lexical knowledge groups. Yet, as depicted in Figure 14, the causal relations found with structural equation modeling (SEM) indicated that the processing speed of words written in the English alphabet strongly contributed to the processing speed of *gairaigo* presented in *katakana* (beta = .44, $p < .001$), which further affected the processing speed of a text containing many *gairaigo* from English (beta = .41, $p < .01$). Consequently, besides their native language, the English acquired later facilitated the processing of *grairaigo* of English origin written in *katakana*. We can therefore claim that native Chinese speakers learning Japanese in China display intricate interactions among their three languages of Chinese, English, and Japnese.

So far, I have limited my discussion to the processing of single word units. Finally, I would like to mention the processing speed of words at the text level. Yamato, Tamaoka, and Chu (2013) investigated the effects of lexical and grammatical knowledge on Chinese speakers' reading of Japanese texts containing many loanwords. Tests of lexical (Miyaoka, Tamaoka, and Sakai 2011) and grammatical knowledge (Miyaoka, Tamaoka, and Sakai 2014), and on-line self-paced reading for phrasal parts of a text were conducted on 127 native Chinese speakers majoring in Japanese at a university in China. Based on test scores of lexical and grammatical ability, these participants were divided into three groups.

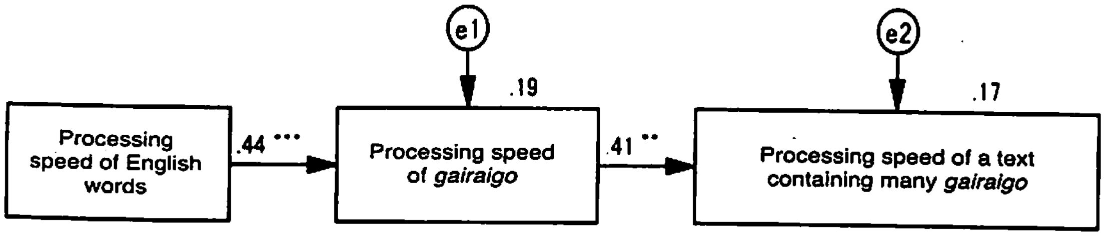

Figure 14. SEM model of the causal relations of lexical processing of English words via *gairaigo* of English origin in a text containing many *gairaigo*.
Note: $X^2(1) = 0.095$, $p = .758$, *ns*. GFI = .999. AGFI = .992. CFI = 1.000. NFI = .995. ** $p < .01$. *** $p < .001$. The data (Yamato and Tamaoka 2013) were originally analyzed with pass analysis using multiple regressions, but were re-analyzed with structural equation modeling (SEM) by the author.

Processing speed of each phrase-based part in a text was analyzed among higher ($N = 43$), middle ($N = 37$) and lower ($N = 47$) lexical knowledge groups, and among higher ($N = 46$), middle ($N = 39$) and lower ($N = 42$) grammatical knowledge groups.

Figure 15 describes part of the text read by the three lexical knowledge groups. For instance, the three lexical groups showed significant differences in the processing speed of the phrase *to yū dentatsu ga* written as という伝達が 'such a message' ($p < .001$), but no difference was found in the three groups divided by grammatical knowledge (not shown in Figure 15). Within just a short selection of the text, seven phrases marked by squares were significantly affected by lexical knowledge while only a single phrase *tsutae-rarete kuru to* written as 伝えられてくると 'when it has been told' was significantly influenced by grammatical knowledge ($p < .05$) as well as lexical knowledge ($p < .05$). Results showed the following three points. First, lexical knowledge had a greater influence on phrase-level reading speeds in a text than did grammatical knowledge. Second, lexical knowledge significantly contributed to reading speeds not only on an independent single phrase but also on sequences of continuous phrases. Third, the effect of grammatical knowledge was limited to phrases with complex grammatical structure or parts with a shift in semantic context. As previous studies (Leong and Tamaoka 1995; Takahashi 1996, 2001; Tamaoka *et al.*, 1992; for native Japanese children, and Komori, Mikuni and Kondo 2004; Mikuni, Komori and Kondo 2005 for learners of Japanese as a second or foreign language) have suggested, lexical knowledge seems to be a strong contributor to reading speed and accuracy in longer texts.

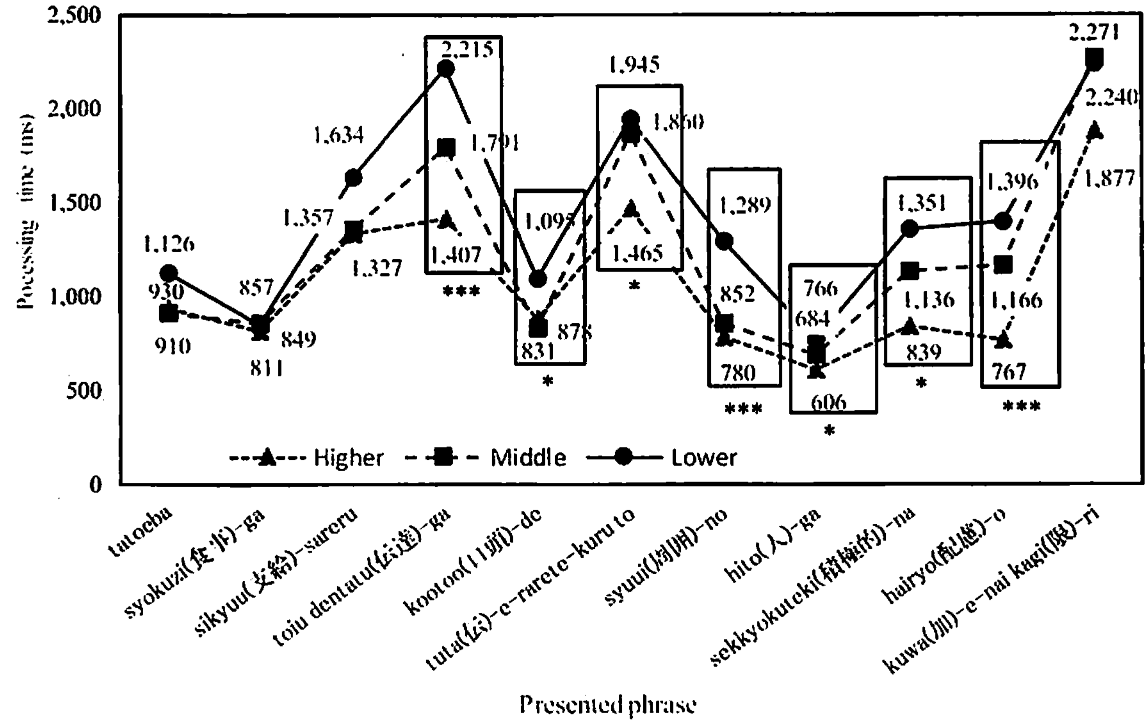

Figure 15. Processing speed (ms) of a part in a text by higher, middle, and lower lexical knowledge groups.
Note: Boxed-in areas indicate significant main effects in processing times.
* $p < .05$. ** $p < .01$. *** $p < .001$. Mean processing speeds were taken from Yamato, Tamaoka and Chu (2013:6).

6. Summary

In this paper, I explained four different script-related effects. First was the script similarity effect. Since Chinese characters largely overlap with Japanese *kanji*, native Chinese speakers have a great advantage over native English speakers in orthographical processing of L2 Japanese *kanji* words. This effect can also be extended to include all Japanese learners with backgrounds in alphabetic languages. However, words and text written in *romaji* are phonologically processed more quickly than *kana*/*kanji* words among these learners. Second was the visual complexity effect. In processing Japanese *kanji* compounds, neither L1 Japanese nor Chinese-speaking learners of Japanese differed in their processing speeds of frequently used, visually simple, and visually complex *kanji* compounds, while native English speakers did. Native

English speakers, at least at the introductory level, on the other hand, must analyze the individual elements which comprise a single *kanji*. Third is the script familiarity effect. Loanwords, or *gairaigo*, are written in *katakana*. Native Japanese speakers showed a clear difference in processing speed for loanwords presented in *katakana* than the same words in *hiragana*. This effect, however, was not observed in either native Chinese or English speakers, at least at the introductory to low intermediate levels. It is assumed that script familiarity begins to influence word processing only at highly advanced levels of Japanese. Fourth is the imageability effect. Words which are easier to imagine as representative of a certain category (e.g., vegetables) can be processed faster than those that are not considered "typical" examples of a category. This effect was found among native English speakers (no experiment was done with native Chinese speakers). I also advocated for the use of *romaji* as a tool for improving listening and speaking skills of learners of Japanese whose native language use an alphabetic writing system at the early stages of learning. The Japanese language is typically written with a mixture of *kana/kanji*, but it is very possible to transcribe Japanese with *romaji*. In fact, experimental studies demonstrated that words and texts in *romaji* were phonologically processed much faster by native English speakers than those in *kana/kanji*. Thus, we can expect that *romaji* will assist novice-level Japanese learners with alphabetic languages in developing their verbal communicative skills. Finally, some evidence was presented on the contribution of lexical knowledge to the processing speed and accuracy of words within a text.

NOTES

[1]Refer to the details of the new *jōyō kanji-hyō* available in Japanese at the web site of the Japanese Agency for Cultural Affairs http://www.bunka.go.jp/kokugo_ihongo/pdf/jouyoukanjihyou_h22.pdf, and the database of these *kanji* at http://www.kanjidatabase.com/ created by Tamaoka, Makioka, Sanders, and Verdonschot (2013).

[2]For details of *on* and *kun* reading, see Tamaoka and Taft 2010; Verdonschot, La Heij, Tamaoka, Kiyama, You, and Schiller 2013.

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