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How Similarity in Morphological Representation Affects Chinese-Japanese Bilinguals' Word Recognition?

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Abstract

A visual lexical decision task and a cued language-switching task were used to explore the cognitive processing of two-Chinese-character compound words in proficient Chinese-Japanese bilinguals. Consistent with previous findings, the results showed one-way facilitation and inhibition from L1 to L2 when bilinguals performed lexical decision tasks in both languages respectively. Interactive interference and facilitation were observed in a cued language-switching task. Moreover, language-switching costs were present for both directions of switching, and for both groups of Chinese-Japanese bilinguals. However, asymmetry in the cost of switching languages was found only in those bilinguals who speak Chinese as a first language.

Keywords: Bilinguals; word recognition; language set; language switching; switching costs.

Introduction

Bilinguals have the ability to switch from one language to the other in daily conversation without hesitation. How do they select the proper language for the context? Do bilinguals disable the lexicon that they are not using? These questions concern how a bilingual speaker's two languages are interconnected, especially during language switching. Language production and language comprehension are two dimensions related to switching between languages.

With respect to language production, Meuter and Allport (1999) tested bilinguals using a digit-naming task in which the cued language stayed the same or switched across trials. They found that switching from the second language (L2) to the first language (L1) was much slower than switching from L1 to L2. In other words, bilingual participants found it more difficult to switch to their more proficient first language than to their weaker second language. Meuter and Allport (1999) suggested that the switching costs reflect "task set inertia", which means that the active suppression of one of the two competing languages from the former trials persists in the succeeding trials, resulting in a larger switching cost for the shift to the dominant language. However, this asymmetry of switching costs is not always present when bilinguals switch between languages. Costa and Santesteban (2004) investigated the picture-naming performance of bilinguals in a language-switching task. Although language-switching costs were observed in their bilingual participants, asymmetrical switching costs were found only in L2 learners, but not in highly proficient bilinguals. They argued that the differences between L2 learners and highly proficient bilinguals reflect differences in the mechanisms of lexical accessing.

Thomas and Allport (2000) investigated language-switching costs for language comprehension by using a lexical decision task. Language-switching costs were found in their English-French bilinguals. They suggested that the switching cost arose from the switching between task schemas. According to Monsell, Sumner and Waters (2003), a task schema or task set "is an organization of mental resources that will accomplish a particular cognitive task, given appropriate input." In the case of language, a language schema or language set is an organization which regulates the output from the word recognition system by altering the activation levels of representations (Green, 1998). If a language schema is in charge of language activation, then will manipulating the levels of language schema activation influence bilinguals' language processing? This is one of the questions we explored in the present study.

Another question that we examined in this study is whether bilingual lexical access is language-selective. There might be an interaction between lexical processing in both languages, especially when the two languages share most parts of a common writing system, such as Chinese and Japanese. Although Chinese and Japanese belong to different linguistic families, and differ greatly in grammar, both languages use Chinese characters (Kanji) in morphological representations. When the Chinese characters (Kanji) were introduced into Japan, not only were the characters themselves adopted, but also the related Chinese vocabulary was adopted. There are many words that are identical in the Chinese and Japanese language at both graphemic and semantic levels (cognates). Therefore, we could assume that for Chinese-Japanese bilinguals, the connection of orthographic representations in both lexicons is relatively tight.

However, there are several differences between these two languages. First, all written Chinese is represented only by Chinese characters, while written Japanese simultaneously uses two distinct types of script: the logographic Chinese characters (Kanji) and the two slightly different forms of Kana characters, Hiragana and Katakana. This mixing in script may unequally impact Chinese-Japanese bilinguals in their morphological processing. In addition, Chinese characters (Kanji) in Japanese represent not only content words originally adopted from Chinese, but also compounds created by the Japanese themselves and native only to Japanese vocabulary. Approximately 70 percent of the Japanese lexicon is two-Kanji compound words (Yokosawa & Umeda, 1988). Second, a single Chinese character usually has only one pronunciation, in contrast to Japanese where a single Kanji in isolation typically has several possible pronunciations that are highly context-dependent. Third, the simplified Chinese characters, currently used in mainland China, are slightly different from the traditional Chinese characters which were adopted by the Japanese, although some of these characters do not vary in these two morphological representations.

With these considerations in mind, it is reasonable to posit that there are common processing mechanisms for these two written language systems. Investigating the cognitive processing of Chinese characters (Kanji) in Chinese-Japanese bilinguals may be a key for answering questions of how lexical processing works in these two languages.

Tamaoka, Miyaoka and Matsushita (2004) investigated how Chinese-Japanese bilinguals process two-Chinese-character compound words in a monolingual lexical decision task, with an interest in how Chinese-Japanese bilinguals' conceptual lexicon functions. Chinese bilinguals responded to cognates significantly faster than to words that were specific to Japanese in a Japanese lexical decision task, but not significantly faster than to words that were specific to Chinese in a Chinese lexical decision task, showing a one-way facilitation from L1 to L2. In contrast, when participants responded to non-words, words that were specific to L1 had a greater interference on rejection responses in lexical decisions in L2. However, a second language facilitation and interference for L1 was observed in error rates.

Returning to the question of language switching, how will the similarity in morphological representations affect cognitive processing by Chinese-Japanese bilinguals? Will both lexicons interact when sporadic language switching is required? Costs of switching between languages are expected. However, will an asymmetry in language-switching cost be observed in a lexical decision task involving language switching? The majority of previous studies regarding language switching were carried out between two alphabetic languages or between alphabetic and non-alphabetic languages. It is also important to see how switching between non-alphabetic languages works, especially for languages like Chinese and Japanese that share many morphological representations. Therefore, in the present study we examined bilinguals' language switching in Chinese and Japanese, focusing on the comprehension of visually presented words.

Two monolingual lexical decision tasks and a cued language-switching task were conducted. The first hypothesis tested was that the degree of a language schema's activation would influence bilinguals' language processing. In a monolingual lexical decision task, where only one language schema was highly activated, interference from the task-irrelevant language was expected to be small. In a cued language-switching task, where two competing language schemas were activated, we expected stronger interactive interferences from both languages. In addition, we also predicted that the similarity of morphological representations between Chinese and Japanese would affect Chinese-Japanese bilinguals' word recognition. Since the morphological orthography for constructing two-Chinese-character compound words exists in both languages, rejecting words existing in the task-irrelevant language was expected to be more difficult for bilinguals, especially when sporadic language switching is required.

Method

Stimuli and Tasks

Four types of two-Chinese-character (Kanji) compound words were used as stimuli: (1) words that are identical in Chinese and Japanese at both graphemic and semantic levels (cognates); (2) words specific to Japanese, having no semantic meaning in Chinese (Japanese words), although each Chinese character of the compound form exists separately in Chinese; (3) words specific to Chinese, having no meaning in Japanese (Chinese words), although each Chinese character of the compound form exists separately in Japanese; (4) non-words in both languages (pseudo-words). There were 25 stimuli for each type. All of the single Chinese characters (Kanji) that appeared in each compound word had the same morpheme in both Chinese and Japanese, which were simplified Chinese characters. Except for pseudo-words, all stimuli had a high frequency and familiarity in both Chinese and Japanese. Within each language, the stimuli in the word conditions (cognates vs. Chinese words, or cognates vs. Japanese words) were matched for word frequency and familiarity (based on Amano and Kondo, 1999; The Language Teaching and Research Institute of Beijing Language Institute, 1986). Pseudo-words were created by combing two real Chinese characters (Kanji) that were randomly selected from stimuli in our cognates condition.

A Japanese lexical decision task, a Chinese lexical decision task, and a cued language-switching task were conducted. All tasks used the same set of stimulus words. In the Japanese and Chinese lexical decision tasks, a total of 100 stimuli, 25 for each of the four conditions described above, were presented in white at the center of a black computer screen background. Participants were instructed to make a lexical decision by pressing a key. For example, if a Japanese-specific word stimulus (see Table1) was presented in the Japanese lexical decision task, pressing the "Yes" key is the correct response. If the same Japanese-specific word stimulus was presented in the Chinese lexical decision task, pressing the "No" key is the correct response. All correct responses for the four conditions in the lexical decision task are summarized in Table 1. The cued language-switching task had 200 trials, with 100 stimuli presented twice, one time in a green color, the other in a red color. The color of the stimuli told the participant in which language the lexical decision should be made, depending on the instructions. Half of the participants were instructed that "red" indicated "respond in Chinese" (Chinese lexical decision task) and "green" indicated "respond in Japanese" (Japanese lexical decision). The response color was reversed for the other half of the participants. Within each task, the stimuli were generated randomly for each participant.

Procedure

Participants were tested individually. They were seated approximately 114 cm from the computer monitor. Each trial started with a 1500 ms presentation of a fixation point. Then a stimulus was presented for 1400 ms, followed by a 1500 ms blank. Participants were instructed to make the lexical decision as rapidly and as accurately as possible. Response latencies (RTs) were recorded by the computer and measured from stimulus onset to the triggering of the response.

Participants

Three groups of participants took part in the experiment. Japanese monolinguals served as a control group, and two groups of Chinese-Japanese bilinguals served as experimental groups.

Chinese bilinguals Eighteen native speakers of Chinese with an advanced level of Japanese participated in all three tasks (9 females, 9 males). The average age of starting to learn Japanese as a second language (L2) was 14.4 years old (SD = 2.6). All participants had studied Japanese for a minimum of five years (Mean = 7.9), and had been studying in Japanese universities for a minimum of three years (Mean = 3.8). The average of their estimated vocabulary of L2 was 29,372 words (SD = 10,342), based on the same estimation test mentioned above. All participants were unbalanced bilinguals, with Chinese their stronger language, who reported frequent, intentional switches of spoken language as an everyday occurrence.

Japanese bilinguals Fourteen graduate school students majoring in Chinese language and literature were recruited through advertisements at the University of Tokyo (6 females, 8 males). All of the participants were native Japanese speakers, who started learning Chinese as L2 in the first year of university (Mean = 19 years old). All participants had studied Chinese for a minimum of four years (Mean = 6.3). Only one of them had ever been a resident in China (for one year). Their average estimated Chinese vocabulary (L2) was about 10,000 words. All participants were unbalanced bilinguals, with at least an intermediate level of Chinese. 12 of these participants participated in all three tasks; the other two participants only took part in the Japanese lexical decision task and the Chinese lexical decision task.

Japanese monolinguals Eighteen native speakers of Japanese with no learning experience of Chinese participated in the Japanese lexical decision task (8 females, 10 males). According to the online vocabulary estimation test (NTT communication Science Laboratories), the average of their estimated Japanese vocabulary was 50,030 words (SD = 7,939).

Results

As described in Table 1, for the Japanese lexical decision task and Japanese trials in the cued language-switching task, "pseudo-words" and "Chinese words" are non-word conditions; whereas "cognates" and "Japanese words" are word conditions. In contrast, for the Chinese lexical decision task and Chinese trials in the cued language-switching task, "pseudo-words" and "Japanese words" are non-word conditions; whereas "cognates" and "Chinese words" are word conditions. Reaction times for correct responses and error rates for the word conditions and the non-word conditions were analyzed separately using t-tests. Reaction times were scored as errors if they fell more than 3 SD from the mean for the given participant. Reaction times and error rates for the three tasks are shown in Table 2 and Table 3.

Chinese bilinguals

Japanese lexical decision task There were no significant differences between reaction times for Chinese words and pseudo-words, nor were there differences in error rates. Responses to cognates were significantly faster than to words specific to Japanese [$t(17) = 3.08$, $p < .01$], although not significantly more accurate.

Chinese lexical decision task No significant differences were observed between reaction times for Japanese words and pseudo-words. However, responses to Japanese words were less accurate than to pseudo-words [$t(17) = 2.70$, $p < .05$]. Neither the reaction times nor the error rates for cognates significantly differed from Chinese words.

Cued language-switching task For Japanese trials, responses to Chinese words were significantly slower than to pseudo-words [$t(17) = 5.06$, $p < .01$]. There were more errors in responses to Chinese words than to pseudo-words [$t(17) = 4.83$, $p < .01$]. Responses to cognates were significantly faster than to words specific to Japanese [$t(17) = 4.55$, $p < .01$], although not significantly more accurate. For Chinese trials, a similar response pattern was found, with slower responses and more errors for Japanese words than pseudo-words [RT, $t(17) = 7.98$, $p < .01$; ER, $t(17) = 6.92$, $p < .01$]. Responses were significantly faster to cognates than to Chinese words [$t(17) = 4.72$, $p < .01$], and significantly more accurate [$t(17) = 2.23$, $p < .05$].

The language-switching cost is defined as the difference between switch and non-switch RTs. With respect to language switch costs across trials, there was a larger RT cost to switch from the weaker Japanese language to the more dominant Chinese language (70.57 ms) than to switch from Chinese to Japanese (39.74 ms) [$t(17) = 2.57$, $p < .05$]. This replicates Meuter and Allport's (1999) finding that it is more difficult for bilinguals to switch to L1 than L2.

Japanese bilinguals

Two participants mistook all the pseudo-words as Chinese words in the Chinese lexical decision task; one of them also misjudged similarly in the cued language-switching task. Therefore, their data were dropped from the analyses.

Japanese lexical decision task There was no significant difference between reaction times for Chinese words and pseudo-words, nor was there a difference in error rates. No significant differences were observed between cognates and Japanese words in response times and errors.

Chinese lexical decision task Responses to pseudo-words were much slower than to Japanese words [$t(11) = 3.12$, $p < .01$]; no significant difference in error rates was observed. Responses to cognates were significantly faster than to Chinese words [$t(11) = 2.60$, $p < .05$], although not significantly more accurate.

Cued language-switching task For Japanese trials, responses to Chinese words were significantly slower than to pseudo-words [$t(10) = 4.66$, $p < .01$]. More errors in responses to Chinese words were found, compared to pseudo-words [$t(10) = 4.39$, $p < .01$]. Responses to cognates were significantly faster than to words specific to Japanese [$t(10) = 2.42$, $p < .05$], although not significantly more accurate. For Chinese trials, slower response were observed for Japanese words than pseudo-words [$t(10) = 3.00$, $p < .05$] , although there was no significant difference in error rates. Responses to cognates were significantly faster than to Chinese words [$t(10) = 5.30$, $p < .01$], although not significantly more accurate.

With respect to language-switching costs across trials, great costs for language switching were found both from the weaker Chinese language to the more dominant Japanese language (46.35 ms) and vice versa (55.60 ms). However, these switching costs did not significantly differ with the direction of switching.

Japanese monolinguals

Japanese lexical decision task For lexical decisions for correct "No" responses, Chinese words were more slowly than pseudo-words [$t(17) = 3.79$, $p < .01$]. Error rates were higher for Chinese words than for pseudo-words [$t(17) = 3.50$, $p < .01$]. For correct "Yes" responses, cognates were faster than Japanese words [$t(17) = 5.26$, $p < .01$]. However, no significant differences were found between error rates.

Comparison between monolinguals and bilinguals

Analyses of variance (ANOVAs) of reaction time data for correct responses and error rates were used to compare monolinguals' and bilinguals' processing of two-Chinese-character compound words. There were significant main effects of stimulus type [$F(1,3) = 78$, $p < .001$] and participant group [$F(3,3) = 15.51$, $p < .001$] in reaction times. For error rates, there was a significant main effect of stimulus type [$F(1,3) = 8.35$, $p < .001$]. Overall, Japanese monolinguals' responses were faster than Japanese bilinguals. Participants showed slower reaction times and higher error rates for Chinese words than pseudo-words.

General discussion

We have reported findings about Chinese-Japanese bilinguals' lexical processing in a series of three lexical decision tasks to examine how similarity of orthographic representation in both languages affects the language-switching process. The effect of language schema activation on word recognition was also examined.

Chinese-Japanese bilinguals showed complicated response patterns. First, we discuss the responses to word conditions in monolingual tasks, where only the one task relevant language schema is highly activated. Cognates were processed significantly faster than those words specific to L2. This is a one-way facilitation effect from L1 to L2. An opposite facilitation or inhibition effect from L2 to L1 was not found, which indicates that bilinguals can effectively activate the conceptual representation via both Chinese and Japanese orthographic representations, facilitating the lexical processing in L2. However, their processing in L1 was not affected by the L2 lexical status. This kind of asymmetrical facilitation and inhibition between bilinguals' two languages is consistent with the previous findings of Tamaoka et al. (2004).

Regarding responses to non-words, pseudo-words were much harder to reject as non-words when bilinguals performed the lexical decision task in L2 compared to L1. Our Japanese bilinguals with lower proficiency in L2 showed this tendency more strongly. One possible explanation is that people acquire a common meta-knowledge for compound-acceptability through the learning of single Chinese characters (Kanji) and real compounds in L1. Similarly, meta-knowledge of L2 develops as the degree of language proficiency rises. Our Japanese bilinguals were at an intermediate level of L2, so they may not yet have acquired this kind of meta-knowledge for compound-acceptability in Chinese. Therefore, when a pseudo-word was presented, they could not easily tell whether it was a non-word or whether it was a real word in L2 that they did not know. Moreover, Chinese bilinguals were affected by L2 lexical status as indicated by the correctness of their lexical decisions rather than speed of processing, showing an inhibition effect from L2 to L1. This also suggests that lexical candidates from the task-irrelevant language are activated, which indicates that lexical access is not language-selective.

Japanese monolinguals participated in our experiment, serving as a control group. Overall, monolinguals showed significantly faster responses than Japanese bilinguals. For bilinguals, there was always interference from one language when performing in the other language, resulting in slower response times. Interestingly, a delay in rejecting Chinese words was found, although these monolingual participants had no Chinese learning experience. This finding may be attributable to the nature of Chinese characters (Kanji). Different from alphabetic representations, each single Chinese character (Kanji) has semantic meaning. Thus, when rejecting non-words in Japanese, monolinguals may first process each morpheme of compound words individually, and then semantically combine them. Those words specific to Chinese, which are non-words in Japanese, actually have semantic meaning in Chinese. Therefore, monolinguals may gain some idea of meaning for the compound words, which at the same time feel more word-like than pseudo-words, resulting in significantly slower responses to Chinese words relative to pseudo-words.

On the cued language-switching task, where two competing language schemas are activated, interactive interference and facilitation were found between the bilinguals' two languages, not only from L1 to L2, but also in the opposite direction. Cognates were processed significantly faster than words specific to one language. In responses to non-words, slower responses and more errors were made to words specific to one language that were non-words in the current task-relevant language than to pseudo-words. It is reasonable to assume that both the bilinguals' languages were constantly activated during the language-switching task. Since cognates share identical orthographic and semantic representations in both languages, they were activated via both Chinese and Japanese languages at the same time. As a result, cognates were responded to faster than language-specific words (Chinese words/Japanese words) whose semantic representations were activated via only one of the two languages.

However, slower responses to language-specific words could also be interpreted as the result of inhibition from the task-irrelevant language. For instance, Chinese words are non-words in Japanese, and a "No" response based upon Japanese is correct. This "No" response from Japanese is accompanied even if in Chinese lexical decisions where Japanese is not the task-relevant language. In contrast, responses to cognates are always "Yes" in both languages, resulting in faster processing. Furthermore, the simultaneous activation of two languages also strongly interfered with responses to non-words. When a bilingual was making a lexical decision in one language, words specific to the other language were also activated at the same time. Consequently, an inhibitory control of the non-response language was needed, which resulted in responding more slowly when the non-words were words specific to the other language.

All bilinguals showed language-switching costs, not only in the direction of switching from L1 to L2, but also vice versa. The switching costs reflect the time that was needed to reset the cognitive system and to select the proper language schema for the next trial. Another component contributing to the switching costs may have been the inhibition of the current task-irrelevant language. Meuter and Allport (1999) argued that in order to make a language production in the weaker language, active suppression of the stronger language is needed. This suppression persists over succeeding trials, which contributes to the asymmetry in language switching costs. However, their explanation may not correspond directly to our lexical decision task. First, the language-switching requirement was not predictable across trials in our experiment, which would not allow participants time to entirely suppress the task-irrelevant language. Second, the presentation of stimuli automatically activated both of the bilinguals' languages at the same time, because both Chinese and Japanese are similar in morphological representation. As a result of this simultaneous activation, cognates were efficiently processed, while words specific to the current task-irrelevant language were hard to reject as non-words. We assume that the switching costs mainly stemmed from the interference of the non-words, especially those words that are specific to the current task-irrelevant language.

Table 1: Four types of stimuli and the correct responses in the lexical decision task. ("C": Chinese; "J": Japanese)

		Chinese	
		Words	**Non-words**
Japanese	**Words**	"Yes" Response **Cognates** e.g.: 学校	C-"No", J -"Yes" **Japanese Words** e.g.: 彼女
	Non-Words	C-"Yes", J -"No" **Chinese Words** e.g.: 老板	"No" Response **Pseudo-Words** e.g.: 油部

Table 2: Mean Response Times (in milliseconds) and Error Rates (% shown in parentheses) for the Japanese Lexical Decision Task and the Chinese Lexical Decision Task. ("PSE": pseudo-words; "CW": Chinese words; "C": cognates; "JW": Japanese words)

	Japanese Lexical Decision Task				**Chinese Lexical Decision Task**			
	PSE	CW	C	JW	PSE	JW	C	CW
Japanese Monolinguals	616.02	667.91	500.78	521.90				
	(2.44)	(8.00)	(1.78)	(3.33)				
Chinese Bilinguals	746.39	722.32	624.19	661.74	665.98	682.08	587.16	596.04
	(8.44)	(10.22)	(3.33)	(3.78)	(2.67)	(6.67)	(2.44)	(4.22)
Japanese Bilinguals	735.48	761.62	607.24	621.62	900.99	838.96	669.42	718.67
	(1.33)	(5.67)	(3.33)	(3.67)	(22.67)	(14.33)	(3.33)	(6.67)

Table 3: Mean Response Times (in milliseconds), Error Rates (% shown in parentheses) and Switching Cost for the Cued Language-Switching Task. ("J to C": Costs for switching from Japanese to Chinese; "C to J": Costs for switching from Chinese to Japanese)

	Cued Language-Switching Task									
	Japanese trials				**Chinese trials**				**Switching cost**	
	PSE	CW	C	JW	PSE	JW	C	CW	J to C	C to J
Chinese Bilinguals	754.76	869.11	754.57	825.17	745.29	905.75	730.30	781.22	70.57	39.74
	(5.56)	(17.56)	(9.33)	(10.89)	(2.22)	(14.67)	(1.78)	(5.56)		
Japanese Bilinguals	808.23	895.37	722.96	760.89	850.50	922.76	731.07	782.12	55.60	46.35
	(2.18)	(10.55)	(2.55)	(3.27)	(15.19)	(16.73)	(5.09)	(6.18)		

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