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An Application of the Bilingual Asymmetry Model to Japanese: A Dissociation Between Kanji-to-English and Kana-to-English Translation

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ABSTRACT

This study addresses two questions: the first question is about whether backward translation (i.e. the second language to the first language or L2-to-L1) exploits a different mental process from forward translation (i.e. the first language to the second language or L1-to-L2). A qualitatively difference has been proposed by Kroll and Stewart's (1994) asymmetry model of bilingual memory representation: forward translation is largely conceptually mediated whereas backward translation is largely lexically mediated. Thus, the model predicts that backward translation will be faster than forward translation and also both L1 and L2 picture naming. We have examined this hypothesis using Japanese learners of English, who have rarely been taken up so far in the research of the bilingual memory. Our results of the backward translation task by Japanese-English bilinguals show that backward translation is conceptually mediated like forward translation, a contradicting result to Kroll and Stewart's model. The second question is how kanji (Japanese logographic script) will be processed in the forward translation, i.e., whether kanji script accesses L1 lexicon (the set of L1 phonological labels) through or without phonological mediation. Our experiments show that kanji in the first encounter is most likely processed via phonological mediation. Thus we have obtained decisive evidence regarding the phonological-mediation controversy in the area of kanji recognition.

Key words : asymmetry model, forward translation, backward translation

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INTRODUCTION

An important issue in bilingual research is how the two lexicons and the underlying conceptual memory are organized. Kroll and Stewart proposed the asymmetry model of bilingual memory on which lots of relevant research has been undertaken[1].

The asymmetry model, a theoretical framework for the study of the bilingual verbal memory, was proposed to explain how communications between first language (L1) and second language (L2) lexicons are achieved by two different pathways. It has been assumed that translation from L1 into L2, or forward translation, is mediated by an underlying conceptual memory. On the other hand, L2-to-L1, or backward translation, is lexical and direct:

In Fig.1, the thick solid arrow that points both ways indicates a very strong link between conceptual memory and the L1 lexicon. The L2-to-L1 thin solid arrow represents the prominent lexical communication, which is of less strength, responsible for backward translation. Forward translation is accomplished by first going through the strong L1-to-Concept route and then the weak Concept-to-L2 path represented by the dashed arrow. They further assume that L2-to-Concept weak connection gets strengthened as bilinguals become more proficient in L2. Thus the asymmetry model predicts shorter latencies for backward than for forward word translation, since the former does not normally require Concept access, whereas the latter usually necessitates the activation of both the L1-to-Concept and the Concept-to-L2 link, taking a longer time.

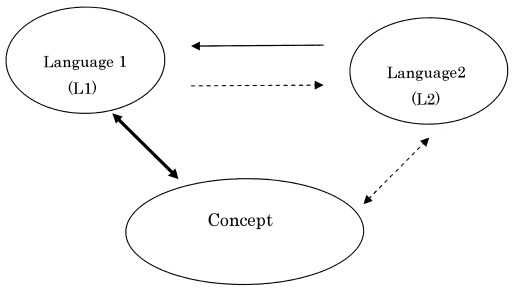

Fig. 1.
The asymmetry model of bilingual memory, adapted from Kroll and Stewart(1994)

There are several consequences derived from the asymmetry model. First, forward translation would be slower than backward translation because the former involves both concept activation and L2 labeling whereas the latter requires only activating the L2→L1 lexical path[1), 2), 3), 4), 5)]. Second, backward translation would be faster than L1 picture naming, because the former is accomplished by lexical association whereas the latter has to be mediated by concepts[6]. Thirdly, L2 picture naming would be almost as slow as forward translation, because both involve concept access and L2 labeling[6]. Fourthly, it is claimed that differential involvement of lexical and conceptual processes should be observed in the performance of less and more fluent bilinguals because of a developmental shift from lexical to conceptual retrieval for L2 words with increasing fluency[7]. Thus the difference between translation performance of less and more fluent bilinguals would be greater for backward translation than for forward translation, and semantic context effects will be larger in translation from L1 to L2 than in translation from L2 to L1[8].

1.1 Previous Analyses

So far the asymmetry model and its hypotheses by Kroll and Stewart[1] was mainly evaluated in the experiments and analysis with alphabetical languages, for example, English-German,[9] English-French[10], Dutch-English[11),12)], English-Spanish.[4] In contrast, there has been paucity of the verification of the model using allophylian languages such as Chinese and Korean[6),8),13)]. With these languages, a lot of supportive evidence has been presented for the asymmetry model; on the other hand, there are a number of findings that contradict the views of the asymmetry model, for example, that backward translation is achieved through conceptual mediation instead of direct connection between L1 and L2[6), 8), 11)].

We would like to begin with a brief review of some studies which have challenged the views of the asymmetry model. Firstly, La Heij et al. found semantic context effects in both directions of translation and evidence for more semantic involvement in backward than in forward translation[11], which indicates the involvement of conceptual mediation in backward translation. Secondly, de Groot and Poot clarified that forward translation was faster than backward translation and claimed that the effects of a semantic context were equally obtained in both translation directions[14].

Thirdly, in the experiment of Chinese-English bilinguals[6], backward translation turned out to be slower than L1 picture naming, which is inconsistent with the assumption that the L2-to-L1 path is lexical. They concluded that the dominant L2-to-L1 lexical link is considered incorrect and that conceptual processing exists for backward translation.

Choi found in the study of Korean-English learners that translation performance was affected by L2 proficiency[8]. The participants of the higher proficiency level were faster in translating words between Korean and English than the lower proficiency group and they were faster in forward than backward translation. Choi asserted that both directions of the translation were conceptually mediated. This conclusion was also drawn from the finding that both directions of translation were faster with a semantically related context than with a semantically unrelated context.

1.2 Research Aims

The present study is partly aimed at further investigation on the hypotheses of the asymmetry model in the case of Japanese learners of English. Japanese, like Chinese and Korean, is typologically rather different from English and other western languages. Given little research attention at such a unique language as Japanese with respect to the asymmetry model, Japanese may provide another diagnosis for whether the model is universally adequate. With the experiments of word naming and picture naming by Japanese-English learners of higher and lower proficiency, the present study intends to examine whether the asymmetry model of bilingual memory is applicable to Japanese-English learners.

Another aim of the present study is to find out how the Japanese writing system is incorporated in the asymmetry model. Japanese is a unique language that has its special writing system comprising of two types of script: kana (kind of phonogram, each letter representing one syllable) and kanji (morphemic script with semantic as well as phonetic values). Kana orthography is analytic with rather straightforward correspondence between sound and symbol, whereas kanji orthography is represented by logographic

characters in a way that the sound-symbol relation is not obvious.

The experiments of the present study are designed on the following assumptions of word and picture recognition. The forward (L1-to-L2) translation proceeds as follows: first a visually presented kana word is converted into a sound sequence by Grapheme-Phoneme Correspondence rules to find a target phonological form in L1 (see Fig. 1). Then the phonological lexical form retrieved from the L1 lexicon goes to the concept system, by way of which the corresponding L2 lexical label will be finally retrieved. In contrast, L2 picture naming is performed in a way that a visually presented picture directly accesses the concept then to find the L2 word (see Fig. 2).

Now let us consider how a kanji word undergoes the forward L2 translation. In the study of the visual word recognition and the cognitive process of conceptual access, a dominant question is whether kanji words are associated with their meanings via or without phonological mediation[15),16),17),18)]. On the direct access hypothesis, i.e. kanji taking route (2) in Fig.2, the reaction time taken to translate the kanji word into L2 (English) would be faster than that of a kana word translation, more or less close to that of the picture to L2 (L2 picture naming), since it can skip the L1 phonology. On the other hand, if a kanji word is semantically recognized indirectly through phonological mediation (via L1), the L2 translation would take more time than kana forward translation, since the kanji word would firstly be lexically recognized at the orthography and then proceed to L1 for the retrieval of its phonological label, which then takes the L1-Concept-L2 route.

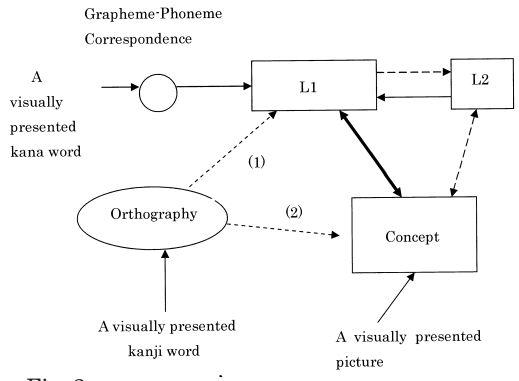

Fig. 2
The Forward translation (kana to L2)&L2 Picture naming process of a Japanese-English Leaner

Thus how kanji forward translation behaves as compared with kana forward translation would serve as establishing the role of phonological mediation in the semantic recognition of kanji words, a long-pending issue in the area of word recognition. Therefore we would carry out both kanji and kana L2 translation to do some research on the issue.

2 Materials and Methods

2.1 Materials and apparatus

Stimuli were 20 items (denoting concrete objects) presented in the forms of four stimulus types: pictures and their corresponding Japanese (both kanji and kana) and English names. Additional three items were used for practice. A complete set of pictures and their corresponding Japanese and English names used in our experiments is presented in Appendix I. All the pictures used are selected from "Standardized Set of 260 Pictures: Norms for Name Agreement, Image Agreement, Familiarity, and Visual Complexity"[19)].

The five block tasks were programmed by E-Prime software and each item was shown sequentially. A TOSHIBA Dynabook Satellite J12 notebook computer was used to present the stimuli and record the reaction time.

2.2 Method

Participants: 23 Japanese-English learners participated in the present experiment. They were divided into two groups by their English proficiency levels. The proficient group consisted of 15 participants and the less proficient group included 8 participants. All of the higher proficiency level learners, being around 40 to 50 years old, have been learning English for more than twenty years and are English instructors at Yamagata University, a national university in Japan. In contrast, all of the lower proficiency level learners, with the average age of 20 years old, are non-English major undergraduates at the same university and they have been learning English for about six to seven years in the Japanese education system.

2.3 Design and procedure:

(1) The same 20 items were presented respectively in five blocks in the forms of pictures, Japanese kanji script, English names and Japanese kana script. Pictures are used for the two test blocks: one is designed to name the corresponding English labels for the 20 pictures, the other one is to name the corresponding Japanese labels. All the objects in the five blocks were presented at random order. An instruction and the same three sample items in the respective forms were shown prior to each block to participants for them to get familiar with the experimental procedure and requirements.

(2) 23 participants were tested individually in a special sound-proof experiment room. The stimuli of pictures, Japanese kanji, English word and Japanese kana are presented on the computer screen, and then the participants were asked to name the pictures in each language, translate the each target word into the other language. They were asked to respond as fast as possible with accuracy. The five blocks were presented in the order of picture naming in Japanese, translating Japanese kanji into English, translating English words into Japanese, picture naming in English and translating Japanese kana into English. Their response latencies were measured by using a voice-key connected with the TOSHIBA notebook computer.

The RTs over AVERAGE + (STDEV × 2) were judged as errors and excluded from the data to be examined.

(3) The less proficient group was asked to take a second round of the experiments, the same task as the first one. The five blocks were presented again to them in order to see if they have learned and memorized the first set of stimuli so that we could find how that would affect their response latencies and processing route, especially with the kanji-to-English translation.

RESULTS

3.1 Forward Translation and Backward Translation

Let us start with the first consequence of the asymmetry model, namely that backward translation would be faster than forward translation. This tendency would be more prominent with a less proficient group for whom the lexical link is supposed to be dominant.

In Table 1, the mean RT in forward word translation for the proficient Japanese-English learners is 885.06 ms and in backward word translation is 1026.72 ms. For the less proficient group the RT in forward translation

is 804.61 ms and in backward translation is 995.07 ms. Both groups were significantly faster in forward translation (with the proficient group: $p<0.01$, $t=4.23$; with the less proficient group: $p<0.01$, $t=5.94$). Furthermore the less proficient group was faster than the proficient one in both forward and backward translation. This fact will be discussed below in Section 4.

3.2 L1 Picture Naming and Backward Translation

The model of Kroll and Stewart also predicts that backward translation would be faster than L1 picture naming.[1)] Is this prediction applicable to the Japanese-English bilinguals?

From the data shown in Table 2, the RT of backward translation of the proficient group is 1026.72 ms, and L1 picture naming is 890.97 ms; for the less proficient group the RT of backward translation is 995.07 ms and L1 picture naming 807.52 ms. It is obvious that the mean response time of backward translation (English to Japanese) is longer than L1 (Japanese) picture naming for both the proficient group and the less proficient one (with the proficient group: $p<0.05$, $t=2.84$; with the less proficient group: $p<0.05$, $t=2.77$).

3.3 Forward Translation of Kanji and Kana Words

Table 1 shows the data of the forward word translation from kana words to their corresponding English words. If stimulus words are presented in kanji form instead, would the forward translation be the same as the kana forward translation?

There have been two possible ways proposed on how kanji words are lexically recognized: one is that kanji, being logographic, have directly access to concepts, and the other is that it is indirectly recognized via phonological mediation, i.e., after retrieving its phonological form. The direct access theory predicts that the forward translation of kanji is faster than the kana-to-L2 translation, whereas the phonological mediation hypothesis predicts that it would be slower than the forward kana translation because of the complicated phonological conversion process due to irregularity of kanji-sound correspondence. The results are in accordance with the latter assumption.

Table 1. Mean RTs(in ms) in Translation Directions (Japanese Kana)across Proficient and Less Proficient Groups

	Proficient	Less Proficient
	RT ms(SD)	RT ms(SD)
Translation Direction		
Forward	885.06 (62.4)	804.61 (59.77)
Backward	1026.72 (136.5)	995.07 (90.40)

Notes: Forward translation is word translation from Japanese(kana) to English; backward translation is word translation from English to Japanese.

Table 2. Mean RTs(in ms) of Backward Translation and L1 (Japanese) picture naming across Proficient and Less Proficient Groups

	Proficient	Less Proficient
	RT ms(SD)	RT ms(SD)
Block of Experiment		
Backward Translation	1026.72 (136.5)	99.07 (90.40)
L1 Picture Naming	890.97 (160.52)	807.52 (164.34)

From the data shown in Table 3, it can be seen that forward translation of kanji words is significantly slower than that of kana words for both the proficient and less proficient groups: for the proficient group, the mean RT of kanji is 1212.41 ms and that of kana 885.06 ms; for the less proficient group, the mean RT of kanji is 1027.97 ms and that of kana 804.61 ms (with the proficient group: $p<0.01$, $t=3.60$; with the less proficient group: $p<0.01$, $t=4.38$). This difference may be attributed to the specific pathway in which kanji is visually processed and its phonological form is retrieved.

3.4 Learning Effect of Kanji Forward Translation

Experiment 4 is designed to prove the existence of the intervening phonological process in the semantic activation of visually presented kanji words. The logic goes as follows: at the confrontation task in the forward translation, kanji words are new to the participants, who may necessarily undertake time-consuming conversion of kanji into its phonology, finding phonological labels in the L1 lexicon. On the other hand, if the participants have once learned the kanji phonology, their access of L1 would become faster by skipping the process of kanji-to-phonology conversion because of the learning effect. Thus at the second task conducted immediately after the first one, the RTs of the participants who take the same forward translation task would be much closer to the RTs of the kana forward translation in which phonological conversion is automatic.

On this assumption, the same five blocks of experiments were presented to the less proficient group of Japanese-English learners for the second time. The data is shown in Table 4 below.

The data have shown that in the first time experiment, the kanji-to-English forward translation is much slower than that of the kana-to-English: the former is 1027.97 ms and the latter is 804.61 ms; in the second round of experiment, however, RT of kanji forward translation is 770.17 ms while that of kana is 737.17 ms. Though both kanji and kana forward translation became faster than in the first time, kanji-to-English got much faster, closer to that of kana-to-English forward translation (with the first time experiment: $p<0.01$, $t=4.38$; with the second time: no significant difference, $t=1.23$).

Table 3. Mean RTs(in ms) in Forword Translation of kanji and kana across Proficient and Less Proficient Groups

	Proficient	Less Proficient
	RT ms(SD)	RT ms(SD)
Script of writing		
Kanji	1212.41 (365.76)	1027.97 (124.82)
Kana	885.06 (62.4)	804.61 (59.77)

Table 4. Mean RTs(in ms) kanji-to-English and Kana-to-English Forword Translation in First Time and Second Time Experiments of the Less Proficient Groups

	Kanji to English	Kana to English
	RT ms(SD)	RT ms(SD)
Time		
First	1027.97 (124.82)	804.61 (59.77)
Second	770.17 (84.74)	737.71 (44.32)

4. Discussion

Let us begin with Experiment 1. According to the hypothesis of the asymmetry model, forward translation should be slower than backward translation especially for the less proficient group since it is conceptually mediated whereas the latter is directly associated with items in L1, but in our experiment of Japanese-English learners the results were not in agreement with it, i.e., forward translation was faster than backward translation for both the proficient and the less proficient group.

Contrary to our expectation, in this experiment the less proficient group was faster than the proficient one in both forward and backward translation. This tendency is also observed in the other 3 experiments. This rather unexpected result may be attributed to the age-related slowing of word and picture naming. The average age of our less proficient group is around 20, whereas the ages of the proficient group range from around 40 to 50. It is widely accepted and well documented that the slowing of behavior in older ages may result in a decline in processing speed, reduced processing resources, inhibitory causes, and decreased cognitive control.[20), 21), 22), 23)]

The results of Experiment 2 contradict the hypothesis of the asymmetry model that backward translation would be faster than L1 picture naming. It has been assumed that the former is accomplished by lexical association and the latter has to be mediated by concepts but our results are inconsistent with this assumption. We would suppose that backward translation (in our case, English to Japanese) may not be performed in direct lexical route but achieved through the L2-Concept-L1 route (see Fig. 1). This is why it is much slower than L1 (Japanese) picture naming, which has been considered to be achieved through Picture-Concept-L1 route. The part L2→Concept part may have delayed the backward translation because of the weakness of the connection between them (see Fig.2).

Experiment 3 suggests that the difference of the two scripts, i.e. logographic kanji and phonographic kana, may cause the participants to take different access routes, resulting in different RTs. The delayed RT of the kanji-to-English as compared with that of the kana-to-English may be attributed to the phonological intervention involved in the process of semantic activation of kanji script. If kanji script directly activated the meaning (Concept) without phonological mediation, the RT of the forward translation of kanji words would be faster than the RT of the kana forward translation since this route would skip the time-consuming L1 (=Phonology) access. The results in Table 3 contradict this alleged route. Rather, they bear out the phonological process of kanji script (see Route (1) in Fig.2), which takes a certain amount of time since it is not amenable to straightforward phonological conversion due to its logographic nature.

Then if the phonological conversion process was skipped in the kanji-to-L2 translation, the RTs would get closer to those of the kana-to-L2 translation. To this end, we conducted Experiment 4 where the less proficient participants were selected and asked to execute the second round of the same kanji and kana forward translation. The prediction is that in the second round only the kanji forward translation will exhibit significant shorting of RTs since the phonological conversion unique to kanji is skipped due to the learning effect. A visually presented kanji word will directly

activate the corresponding phonological label in the L1 lexicon just as a kana word does. Let us examine these results.

The data of the second-round experiments in Table 4 show that the kanji-to-L2 (English) forward translation is much faster than that in the first time. We suspect whether in the repeated kanji forward translation the same kanji-L1-Concept-L2 process has been carried out in the brains of the participants. From the data, it would be reasonable to think that the phonological images of all the kanji were retained in their minds, so the participants did not have to repeat the same phonological process. They could skip the phonological recognition process of kanji and take the direct L1-Concept-L2 route. In consequence the repeated kanji-to-English forward translation became much faster.

The significant difference between the first and second round experiments of the kanji forward translation in contrast to the difference between the two kana forward translations, paradoxically proves the existence of the process unique to kanji, namely the phonological mediation.

5. General Discussion

The present study was designed to test the hypotheses derived from the asymmetry model of bilingual memory, which has been developed mainly on Indo-European languages, with two groups of proficient and less proficient Japanese-English bilinguals. Since Japanese is an allophylian language, it provides valuable information to ascertain the predictions of the asymmetry model. Another interesting point regarding Japanese is that it has a unique writing system with two kinds of script, i.e. kanji and kana. Thus, how kana and kanji are input into the asymmetry model is an intriguing question in that it may shed light on the different processings these two scripts undergo.

The five blocks of picture naming and word naming experiments were carried out between the proficient and the less proficient group. The results of kanji forward translation of both groups are compatible with the first hypothesis of the asymmetry model, that forward translation is slower than backward translation, with the RTs of 1212.41 ms (kanji to English) and 1026.72 ms (English to Japanese) for the proficient group and RTs of 1027.97 ms (kanji to English) and 995.07 ms (English to Japanese) for the less proficient group. Though there is no great difference between forward and backward translation, it is obvious that forward translation is a bit slower than backward translation.

In kana forward translation, however, the results contradict the first hypothesis of the asymmetry model. The RTs of both groups show that forward translation is much faster than backward translation: 885.06 ms (Kana to English), 1026.72 ms (English to Japanese) for the proficient group; 804.61 ms (Kana to English) and 995.07 ms (English to Japanese) for the less proficient group.

The different results between kanji and kana may be attributed to the different script types of kanji and kana, each of which takes different access route to the L1 phonological lexicon. In forward translation, kanji words may first be recognized phonologically, then undergo the L1-Concept-L2 processing to retrieve L2 labels, thus it takes more time and is slower than backward translation. On the other hand, kana words that can be automatically converted to their phonological forms because of their phonogramic nature would go right through

the L1-Concept-L2 route, which turned out to be faster than the backward translation. Backward translation can be considered to be mediated by concept for both the proficient and the less proficient groups because it is significantly slower than the kana-Concept-English forward translation.

Furthermore, L1 (Japanese) picture naming is faster than backward translation, which is another contradiction to the hypothesis of the asymmetry model. The hypothesis predicts that backward translation would be faster than L1 picture naming, which is conceptually mediated, whereas in our experiments L1 picture naming is faster instead. Thus this result is in accordance with the assumption that backward translation goes through the L2-Concept-L1 route rather than the direct lexical route. The former may have been slowed down by the weak L2-Concept path in Fig. 1.

Thirdly, we ran the second rounds of the experiments, i.e. kanji and kana forward translation, using the less proficient group. It has been found that both were accomplished faster in the second time than in the first time. Especially the RTs of the kanji forward translation were greatly improved in the second round, which may be ascribed to the learning effect regarding kanji phonology. Given the time-consuming kanji-phonology conversion, the learning effect spared the participants the phonological mediation, which can explain the significant improvement of the kanji forward translation. It is considered that kanji directly underwent the L1-Concept-L2 retrieving process since the participants had retained the phonological forms of those kanji words. In conclusion, these experiments demonstrate the existence of phonological mediation in the recognition process of kanji.

Finally, there is one thing we want to point out. In our experiments the proficient group was slower in all the five blocks than the less proficient one, who are much younger than the proficient group. The results are different from the finding that the proficient group would perform better in all parts of the experiments when age is properly controlled.[5), 6), 8), 13)] In our experiments in which the age factor is uncontrolled, the difference of RTs between the two groups may be brought about by age-related slowing.

6. Conclusion

Evidence from western languages has mostly supported the predictions of the asymmetry model of bilingual memory, especially for that backward translation is faster than forward translation. On the contrary, the data obtained in the present study of Japanese-English bilinguals have revealed an involvement of semantic processing in the backward translation process for both proficient and less proficient speakers. To put it specifically, backward translation appears to follow the same mental process (concept mediation) that other studies[1),5),17)] have proposed for forward translation.

The present study has also proved the involvement of phonological mediation process during the kanji-to-English forward translation, which was much slower than kana-to-English forward translation. Thus our study of the bilingual memory may provide some crucial evidence to the issue on the role of phonology during semantic recognition of kanji words.

Appendix I Japanese, English, and picture items used in Experiments

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