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Roles of pictures and native language in lexical processing for elementary American learners

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This study investigated the effects of pictures and native language (L1) on processing second language (L2) words for elementary American learners of Mandarin. The primary goal was to examine whether beginning L2 learners must revert to their L1 to process L2 words, or whether pictures representing pre-existing concepts facilitate processing. The second focus was to compare the participants' responses to two elements of Chinese, pinyin and characters. This study supports the idea that an initial-stage adult language learner uses L1 as a medium to connect a concept with L2, predicted by the word association model (Potter et al, 1984). Moreover, the different orthography in the writing systems is shown as a determinant for the speed of processing words.

1. Introduction

The majority of the people in the world are able to speak two or more languages. Among these bilinguals, a fair amount learn their second language (L2) as an adult, in a classroom setting. How do these adult second-language learners process their L2? What is the representation and connection between the two languages? Do these beginning learners tend to use their native language (L1) as an intermediate tool, or can they process L2 independently of their L1? To reveal the answers to these questions, we need to examine two fundamental representations. First, does a bilingual have one shared conceptual system for both languages or two separate systems? Second, words are the basic units of a language; hence, how and at what level are lexical and conceptual systems of a bilingual interconnected?

1.1. The Representation of Conceptual and Lexical Systems

Starting from a half century ago, Weinreich (1953) proposed a three-manner hypothesis about the organization of a bilingual's word and world knowledge. According to his framework, there are three bilingual types: coordinate, compound and subordinate. A coordinate bilingual is a person with separate conceptual representations for translation equivalents. A compound bilingual is a person with one conceptual representation shared by both languages. Lastly, a subordinate bilingual associates L2 to the conceptual representations through L1, which is a characteristic of low-level L2 proficiency. These three different types of connections provide a framework of bilingual lexical processing.

Ervin and Osgood (1954) later focused on the differences between coordinate and compound bilinguals, implying that the differences lie in the acquisition context. Soon afterwards, Lambert and Fillenbaum (1959) proposed a compound-coordinate distinction substrate in terms of neuropsychological viewpoints. They tested the distinction hypothesis on polyglot aphasics and found that the data were generally compatible with the compound-coordinate distinction: coordinate bilinguals contain more functionally separate neural structures underlying their languages than compound bilinguals. Kolers (1963) recast the issue in terms of shared or separate bilingual memory systems. The shared-store hypothesis says that two languages share a single storage with access to each language; the separate-store hypothesis, on the other hand, indicated that the representations of words in two languages mapped onto two discrete memory storages.

1.2. The Bilingual Processing Models

1.2.1. Word Association Model and Concept Mediation Model.

In 1984, Potter, Von Eckardt, and Feldman published a key paper, returning to Weinreich's original distinctions of the organization of bilingual knowledge by postulating two alternative models and testing them explicitly. The first model, the word association model, shown in figure 1, assumes that L1 is the medium for L2 to access the concepts. The second model, the concept mediation model, shown in figure 2, predicts that L2 can access the concepts without any intermediate. Using word translation and picture naming tasks, Potter et al. (1984) tested these alternatives on fluent and less-fluent bilinguals. They found the same pattern across the two groups of subjects: both fluent and less-fluent bilinguals used approximately the same amount of time in the word translation and picture naming tasks (which is believed to necessarily involve concept retrieval) in

L2. Their result supported the conceptual mediation model; that is, both fluent and less-fluent bilinguals showed the connection between concepts and their L2.

Subsequent studies either replicated or extended Potter et al. (1984), finding that subjects who were of even lower L2 proficiency than the subjects in the less-fluent group in Potter et al.'s study performed in the pattern predicted by the word association model: naming pictures in L2 took longer than translating words into L2 (Kroll & Curley, 1988; Chen & Leung, 1989). On the other hand, there has been evidence to support the idea that fluent bilinguals build a direct link between the concepts and their L2, which more likely resembles the concept mediation model. Semantic priming tasks were applied to test fluent bilinguals. If they use a shared conceptual system, and if they are able to activate a concept directly from L2, then supposedly there would be semantic priming within each language and across languages. Cross-linguistic semantic priming has been found in fluent bilinguals in many studies, which has been taken as additional support that fluent bilinguals directly access the concepts via their L2 (e.g., Kirsner et al 1984; De Groot & Nas, 1991; Altarriba, 1992).

More evidence has supported the claim that there is a difference in lexical mediation between fluent and less-fluent bilinguals. Talamas, Kroll and Dufour (1999) used a translation recognition task to test fluent and less-fluent bilinguals in Spanish and English. What is of interest lay in the non-translation-equivalents pairs, which included form-similar, semantic-similar, or unrelated pairs. Talamas et al. (1999) found interference, such as longer response latencies, for both form-related and meaning-related pairs relative to unrelated controls. Moreover, the magnitude of the interference pattern reversed for the two groups: the more fluent group suffered more interference from meaning-related than form-related pairs while the less fluent group was disrupted more by form-related than meaning-related pairs. The result was taken as evidence for the shift of lexical mediation from form connection to meaning connection as the L2 proficiency increases.

Other evidence came from laboratory training on L2 acquisition. Chen (1990) did lexical processing studies using word translation and picture naming tasks. One of the studies involved training native Chinese speakers with a new language, French, by associating the French words with their Chinese translation equivalents. Subjects were divided into two groups, which received different amounts of training. The results showed that for the low-training group, the response time of translating Chinese words to French was significantly faster than that from pictures to French words. For the high-training group, however, there was no such difference. In another study, native Chinese speakers were trained to acquire French in different ways; one group was trained by using Chinese words and their French translation equivalents, and the other group was trained by using pictures and the corresponding French reference words. The subjects' performance was initially in accordance with their training modality: those who received word-association training did better in word translation tasks while those who received picture-association training did better in picture naming tasks. Yet in the later phase, after receiving more training in French, neither group was found to have a significant difference between word translation and picture naming tasks. Together these studies indicated that the amount of exposure to the learned language as well as the learning strategy could be part of the contributors to bilingual's lexical processing.

These studies showed that less-fluent bilinguals performed word association modality while relatively fluent bilinguals did concept mediation modality.

1.2.2. The bilingual interactive activation model (BIA model).

The bilingual interactive activation (BIA) model (Grainger & Dijkstra, 1992), explains recognition and distinction of words between two languages, shown in figure 3. The BIA model simulates lexical competition results found from both within- and between-languages. According to the model, the input of a string of letters will activate words with similar letters (neighborhood effect) irrespective of the language. During the competition of the activated words, facilitation and inhibition are involved; however in the end, the target word surpasses the activation threshold and then is recognized. The model predicts the asymmetries observed in unbalanced bilinguals as well. For less-fluent bilinguals, words in L2 are of lower subjective frequency than those in their L1. Thus, words in L2 with a higher activation threshold are activated slower than L1 words. It is the extent of the similarity to the input letters that determines the activated competitors. Therefore, words in languages which have similar orthographic systems may be activated by an input letter string of either language. Logically it is assumed that if two languages have no orthographical similarity, word candidates cannot be activated across languages. Chinese characters, a logographic system, and English words, an alphabetic system, thus would not have cross-linguistic activation effects in terms of form similarity. Nevertheless, such language pairs may still have the effects of phonological similarity (Dijkstra & Van Heuven, 2002).

The BIA model provides an alternative viewpoint especially in terms of cognate status and orthographical similarities for processing two languages.

1.3. Lexical Processing of Chinese-English Bilinguals

Studies (Potter et al. 1984; Chen & Leung 1989; Chen 1990; Cheung & Chen 1998) have been done with fluent Chinese-English bilinguals or Chinese-speaking children in the beginning stage of learning English. These studies were based on Potter et al.'s (1984) work and then were extended to bilinguals with different L2 proficiency levels or those who acquired their L2 at different ages. All the studies employed picture naming in L1 and L2, word naming in L1, and word translation from L1 to L2. Their findings showed that for adult L2 beginners, translating L1 into L2 was faster than picture naming in L2, as predicted by the word association model. For proficient adult bilingual subjects, picture naming in L2 and translating L1 words into L2 were equally efficient, as presumed by the concept mediation model.

There are two writing systems involved in the process of learning Mandarin Chinese: one is *pinyin*, an alphabetic system used to represent Chinese sounds, in which the letters used are the same as those used in English. For example, the letters REN, pronounced /rɛn/, means "person/people". The other writing system is Chinese characters, a logographic system in which a symbol usually stands for its individual meaning with no indication of the sound. For example, "人" means "person/people". *Pinyin* is a supplementary tool for learning Chinese. Once native speakers of Chinese are able to recognize the sounds of individual character, *pinyin* is no longer used.

2. The Present Study

The research mentioned above was mostly performed on adult fluent Chinese-English bilinguals. The present study uses a quite different group of participants, native English-speaking adults in a beginning stage of learning Chinese, to examine lexical processing and extent of applicability of the word association model (Potter et al, 1984). In addition, in light of the BIA model (Grainger & Dijkstra, 1992), the similarities or differences of two orthographic systems of the two languages would activate or deactivate each other. The present study looked at the influence of the different orthographical features within Mandarin Chinese for these speakers.

Another group of native speakers of Mandarin Chinese who were relatively fluent in English were also recruited to serve as a control group to see how Chinese process their L1 as opposed to how Americans process Chinese as L2. Moreover, they could also serve as a contrasting group to see the effect of the different proficiency in L2 performed in the language-processing task.

A translation-recognition task (De Groot, 1992, Experiment 2; Talamas et al., 1999) was used in this study, in which participants see a word in one language and then a second word in another language, and determine whether the second word is the translation equivalent of the first word. Along with translation recognition, this study included a picture-recognition task in order to compare the reaction times (RTs) of L1-L2 and picture-L2. There are two main reasons for employing the translation-recognition task in the present study. First, elementary L2 learners are not very familiar with L2, and they may still feel uncomfortable speaking it out loud. The translation-recognition task avoids having them miss responses due to the unfamiliarity with L2 or the discomfort or embarrassment of speaking out loud. Secondly, De Groot (1992) indicated that translation recognition bypasses the translation-retrieval process that occurs in translation production, and can eliminate the possible confusion of the locus of the observed effects as opposed to translation production.

There are five hypotheses of the present study. For the English group, since they were beginning learners of Chinese, the word association model predicts that reaction times of picture-L2 will be longer than that of L1-L2. Secondly, the word association model would also predict that L1-L2 character RTs is shorter than picture-L2 character RTs. Third, English and *pinyin* both use Roman letters, while English and Chinese characters use different orthographic systems. Based on the BIA model, it is easier for American learners of Chinese to access *pinyin* than characters. Thus, L1/picture-L2 *pinyin* would be faster than L1/picture-L2 characters. For the Chinese group, their relatively fluent English results in approximately the same RTs of L2-L1 character and picture-L1 character, predicted by concept mediation model. Furthermore, according to the BIA model, English shares the same orthographical form as *pinyin*; therefore L2-L1 *pinyin* would be faster than picture-L1 *pinyin*.

2.1. Participants.

Nine native speakers of American English, participated in the study. They were all students of Mandarin Chinese enrolled in a second-semester Chinese class at the University at Buffalo at the time of the study. Their proficiency at the point of participation was quite comparable. Their Chinese class was one hour a day, five days a week. Other than from their class, they did not have much exposure to Mandarin Chinese.

The second group of participants was fourteen native speakers of Mandarin Chinese from mainland China, enrolled in the graduate school at the University at Buffalo at the time of study. They started learning English in high school. Each of them had studied English for more than ten years, with the average studying span being 14.2 years. Each had been in the United States for at least eight months, with the average length of time being 1.71 years.

2.2. Materials.

The test materials consisted of 84 pairs, with the first word or picture serving as the stimulus and the second as the target. The 84 pairs were divided into six blocks, 14 pairs in each block, the presentation order of which was counterbalanced across subjects. The six blocks were as follows: (1) English-English, (2) pictures-English, (3) English-Chinese characters, (4) English-Chinese *pinyin*, (5) picture-Chinese characters, and (6) picture-Chinese *pinyin*. For non-translation equivalents, semantically or orthographically unrelated word pairs were designed for the experiment. The first block is a synonym test block. The reasons to utilize synonyms were to ascertain that the subjects would access the words' meaning. Secondly, the synonyms task is paralleled with the remaining translation-recognition task in a way that translation equivalents of two languages were also synonyms to some extent.

All English words were from three to eight letters in length, while all *pinyin* words were composed of four to eight letters. The Chinese targets all consisted of two characters, and the *pinyin* were always two syllables. The pictures were all line drawings. The Chinese words were all chosen from the Chinese textbooks which the participants had been using in their classes. Since the stimuli were from the beginning-level textbooks, they were all of high frequency and with relatively low difficulty. All of the stimuli were concrete nouns except for four pairs consisting of an action picture followed by a Chinese verbal noun, chosen due to the limitation of the participants' useable vocabulary. The English synonyms were judged by three native speakers of English and were examined on the WordNet website, version 1.7.1 by Princeton University. They were also concrete nouns with high frequency.

Prior to the test stimuli, there was an additional block of 18 practice pairs presented, including a combination of all six conditions, with three practice trials in each condition. None of the practice items were used for the real task.

2.3. Design and procedure

All subjects passed through a familiarization stage, in which each of the critical stimuli was presented by a picture and its English and Chinese equivalent, including *pinyin* and character, on a single sheet. Familiarizing the subjects with the items in the upcoming experiment ensured that these elementary learners would avoid missing too many responses, and ascertained that all subjects were at the same baseline of picture recognition. This was another way to control for the frequency of the stimuli as well, given that the available vocabulary pool was not very large. The testing date was different from the training date to avoid the potential effects of long-term priming or psychological training association.

The subjects were tested individually in a normally lit room in the Linguistic Department, at the University at Buffalo. The experiment was run using E-Prime software, an experiment generation and testing software developed by Psychology Software Tool, Inc. The responses and RTs were recorded automatically by the software.

The stimuli were presented in black color against a light-gray background on a 14-inch computer screen, with the English words in lowercase letters, Chinese characters in standard simplified version, and *pinyin* in the same font as the English lowercase letters. The type of pairs presented in each block was counterbalanced across subjects. The order of the trials within each block was randomized. No stimulus was ever repeated in any form for any given participant. For instance, if a participant saw “spring-春天” (English-character), then a different participant would see “spring-*chuntian*” (English-*pinyin*).

The first word or picture was presented in the middle of the computer screen for one second, followed by a fixation point, a plus sign, for one second, and then by a second word for a maximum of five seconds. The participants were instructed to make a decision as to whether or not the second word was the correct translation of the first word or picture, or a correct synonym if it was an English-English block. They were told to respond as quickly and accurately as possible. Response latencies were recorded automatically by the computer from the onset of the second word until the participant pushed the yes/no button on the computer.

3. Results

3.1. Accuracy

Table 1. Percent accuracy of the American and Chinese groups in the six conditions.

	E-E	Pic-E	E-*pinyin*	E-character	Pic-*pinyin*	Pic-char
American	98.4	98.4	95.2	91.3	89.7	84.9
Chinese	88.3	99.0	96.9	98.0	96.9	99.0

Table 1 shows the percent accuracy of both groups in the six blocks. Mean percent accuracy to the target word was subjected to a three-factor analysis of variance (ANOVA) with one between-group factor, native language (English and Chinese), and two within-group factors, type of critical stimuli (English and pictures) and type of target word (English, *pinyin,* and characters). The analysis showed that for the American group, the only significant contrast was the target language difference: L1-L1 and picture-L1 had a higher percent accuracy (M=98.4 %) than L1-L2 and picture-L2 (M=90.3 %), [F(1, 52)=11.3, p<.001]. For the Chinese group, one significant difference occurred when the stimuli type was L2, English, with a higher accuracy of L2-L1 (M=97.5 %) than L2-L2 (M=88.3 %), [F(1, 40)=22.3, p<.001].

3.2. Latencies

Mean correct response latencies to the target word were subjected to three-factor ANOVA, with one between-group factor, native language (English and Chinese), and two within-group factors, type of critical stimuli (English and pictures) and type of target word (English, *pinyin,* and characters). The mean response times for the six blocks of the two groups are shown in Table 2.

Table 2. Mean response latencies (in milliseconds) of the American group and the Chinese group in the six conditions.

	E-E	Pic-E	E-*pinyin*	E-character	Pic-*pinyin*	Pic-char
American	887	734	1332	1392	1344	1721
Chinese	1220	804	1329	796	1556	842

3.2.1. The American group

When the target language was L2 (including *pinyin* and character), there was a significant effect of stimuli type, with L1-L2 (M=1361 ms) faster than picture-L2 (M=1528 ms), as shown in figure 4, [F(1, 453)=6.39, p<.012]. This supports our first hypothesis that for L2 novices, L1-L2 is faster than picture-L2 due to the direct connection between L1 and L2, according to the word association model.

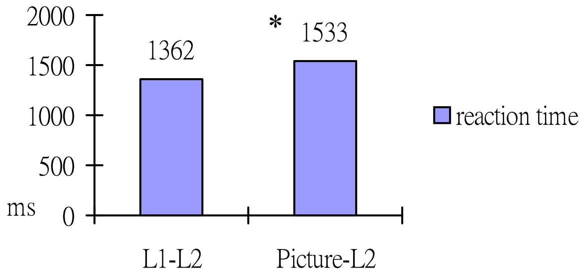


Figure 4. For American group, L1-L2 was significantly faster than picture-L2.

* There is a significant difference between these two measures.

ANOVA analysis showed that when the target was a character, there was a main effect of stimuli type, with L1-L2 character being faster than picture-L2 character, [$F(1, 220)=12.8$, $p<.001$], which is predicted by the word association model.

In figure 5, one-way ANOVA indicated that there was a main effect of the target type, L2 *pinyin* and L2 character, showing that L1/picture- L2 *pinyin* (M=1338 ms) was faster than L1/picture-L2 characters (M=1550 ms), [$F(1, 453)=10.5$, $p<.001$]. This also supported the hypothesis: due to the same orthographical form shared by Americans' L1 (English), and L2 (*pinyin*), they would respond faster to *pinyin* than to characters.

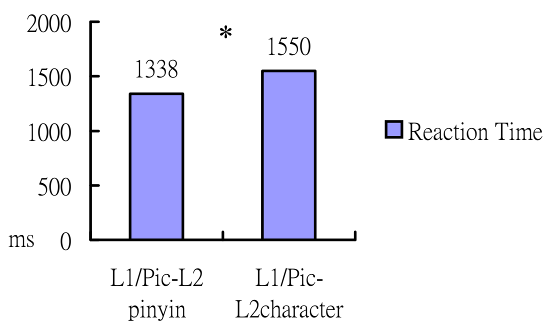


Figure 5. The American group responded significantly to L1/Pic-L2 *pinyin* than to L1/Pic-L2 character

* There is a significant difference between these two measures.

3.2.2. The Chinese group

For the Chinese group, L1 was Chinese while L2 was English. One-way ANOVA showed that when the target was L1 character, there was no difference between stimuli types (L2 and picture), [$F(1, 390)=1.4$, $p>.232$]. This supported our first hypothesis for the Chinese group that picture-L1 character RTs would be approximately equal as L2-L1 character RTs. Second, with an L1 *pinyin* target, there was a significant effect of the stimuli types (L2 and picture); L2-L1 *pinyin* was faster than picture-L1 *pinyin*, as shown in figure 6, [$F(1, 390)=9.7$, $p<.002$]. This is predicted by the BIA model.

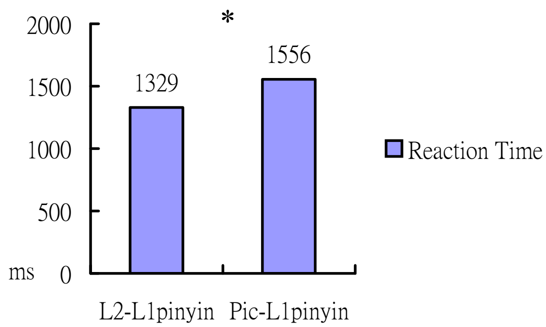


Figure 6. The Chinese group responded significantly faster to L2-L1 *pinyin* than to picture-L1 *pinyin*.

* There is a significant difference between these two measures.

3.2.3. The interaction between the two groups

The two-way ANOVA showed that when the condition was picture-L1 for both groups (picture-English for the American group and picture-Chinese, including *pinyin* and character, for the Chinese group), there was a reliable effect of the native language: picture-L1 for the American group was faster (M=734 ms) than picture-L1 for the Chinese group (M=1199 ms), [$F(1, 514)=55.4$, $p<.001$]. Upon detailed inspection of the two types of targets within Chinese, picture-L1 for the American group (M=734 ms) was quicker than picture-L1character (M=842 ms), [$F(1, 318)=9.9$, $p<.002$], and quicker than picture-L1 *pinyin* for the Chinese group (M=1556 ms), [$F(1, 318)=136.7$, $p<.001$].

Next, the results of the two groups for picture-L2 were examined. Picture-L2 for the American group (M=1528 ms) was slower than the Chinese group (M=804 ms), [$F(1, 414)=160.9$, $p<.001$]. Consistently, detailed analyses with *pinyin* and characters as separate targets also showed that picture-L2 *pinyin* for the American group (M=1344 ms) was slower than picture-L2 English for the Chinese group (M=804 ms), [$F(1, 307)=96.1$, $p<.001$]. Similarly, picture-L2 character (M=1721 ms) in the American group was slower than picture-English (M=804 ms) in the Chinese group, [$F(1, 301)=215.7$, $p<.001$].

Figure 7 shows that for both groups, there is a main effect on English/picture-*pinyin*, and English/picture-character. Figure 8 shows that the American group responded significantly faster than the Chinese group in picture-L1 (including *pinyin* and characters for the Chinese group). As for picture-L2, the American group was slower than the Chinese group, because the Chinese group is relatively more fluent bilinguals than the American group. This can be explained by the word association model and concept mediation model (Potter et al., 1984), that beginning second language learners do not yet build a direct link between concepts and L2 while fluent bilinguals do.

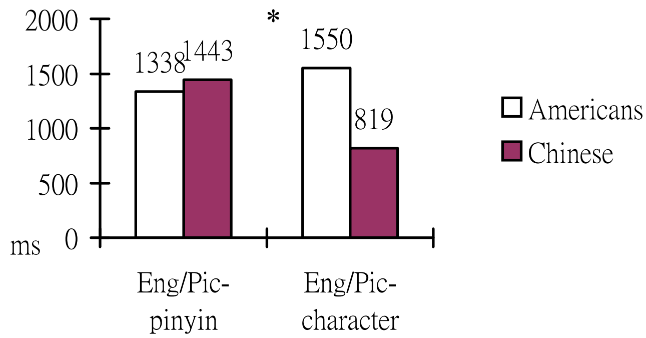


Figure 7. Comparisons of RTs of the two groups of target types as *pinyin* and character. (Eng/Pic-*pinyin*: English- and picture-*pinyin,* Eng/Pic-character: English- and picture-character)
* There is a significant difference between these two measures.

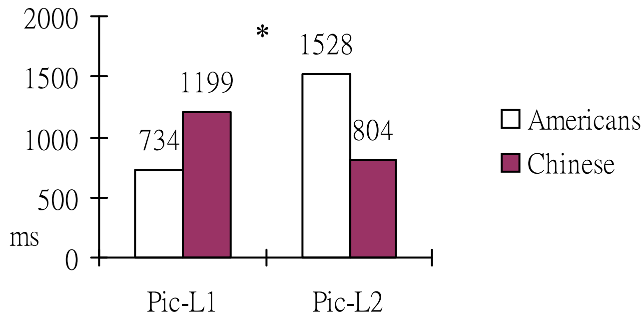


Figure 8. Comparisons of RTs of the two groups of target types as L1 and L2. (L1 includes *pinyin* and characters for Chinese; L2 includes *pinyin* and characters for Americans)
* There is a significant difference between these two measures.

The main findings in this study are summarized as three parts. First, stimuli type L1 and pictures made a difference for the response latencies for the American group, showing that L1-L2 was faster than picture-L2, which was predicted by the word association model. Next, L2-L1 characters RTs were not significantly different from picture-L1 characters RTs for the Chinese group, which supported the concept mediation model. Finally, a response to *pinyin* was faster than to characters for the American group, as can be explained by the BIA model.

3.3. Results supporting the Word Association Model and Concept Mediation Model

The American group showed that L1-L2 was faster than picture-L2, while the results showed the reverse patterns in the two control blocks, with picture-L1 being faster than L1-L1, the synonym-decision task. As beginning learners of L2, the American students might have a direct link between L1 and L2, rather than concepts-L2. Meanwhile, these Americans should possess a direct connection between L1 and concepts. The Chinese group showed no difference in processing the picture-L2, L2-L1 character, and picture-L1 character tasks. Picture-L2 was rather fast for the Chinese group, yet given that the studying period of L2 for the Chinese participants was long, and they had been exposed to L2 environment for some time, this result would not be surprising.

Together these results demonstrated that novices of an L2 might tend to use their L1 as a medium to process L2 words, as shown by the American group's longer response latencies in the picture-L2 than in the L1-L2 conditions, but not in picture-L1 than in L1-L1. This indicated that L1 and picture play a different role when these L2 elementary learners process their L1 and L2.Nevertheless, as L2 proficiency increases, the link between concepts and L2 gradually builds, as shown by the performance of the Chinese group where the processing of L2-L1 character, picture-L1 character, and picture-L2 were quite comparable. This was consistent with previous findings that for less fluent adult bilinguals, translating L1 into L2 was faster than picture naming in L2, while more fluent bilinguals performed L1-L2 translation and picture naming in L2 equally efficiently (Kroll & Curley, 1988; Chen & Leung, 1989; Chen 1990; Cheung & Chen, 1998). It demonstrated that less fluent bilinguals use L1 as an intermedium to process their L2; picture-L2 is thus slower than L1-L2. More fluent bilinguals, on the other hand, use the direct link between L2 and concepts to process their L2; picture-L2 is thus not processed longer than L1-L2.

3.4. Results Supporting the BIA Model

The American group responded faster in general to *pinyin* than to characters, regardless of the type of stimuli. The Chinese group performed significantly faster to English-L1 *pinyin* than to picture-L1 *pinyin* but English-L1 character and picture-L1 character were not significantly different. In terms of the BIA model, these convergent results were due to the advantage of the orthographical form shared by English and *pinyin*. Both the American and Chinese participants thus could activate the reciprocal orthography more easily. Previous research has also found that languages such as English and Dutch which have the same orthography would facilitate each other as well (van Heuven, Dijkstra, & Grainger, 1998).

3.5. Combination of the Above Three Models

One note of special interest is that the RTs of L1-L2 *pinyin* and picture-L2 *pinyin* for the American group were not significantly different. Only when the target was an L2 character did the stimulus type have a reliable effect, with L1 being faster than a picture. This was possibly due to the common orthography of English and *pinyin* that allows the American students to be more familiar with and have higher access to *pinyin* than to characters. This helps them to make the connection between L2 *pinyin* and concepts, but not between an L2 character and concepts at this stage. They may still need to process L2 characters through either *pinyin* or their L1, so possibly the phonetics is involved in the L2 process as well. *Pinyin* and English letters are both phonetically alphabetic symbols, and this shared feature may facilitate English learners of Chinese, especially in the beginning stage.

3.6. Other Results

First of all, both groups showed relative difficulty (significantly longer response latencies) in processing the English-English task versus the picture-English task. For the Chinese group, this difficulty was not only shown by the longer RTs, but by relatively higher error rates (11.7 %) than in the other five blocks. This reflected the fact that these Chinese-English bilinguals were not as fluent in English as in Chinese. Secondly, it was found that the Chinese group was not as familiar with *pinyin* as with characters, so that picture-L2 was faster than picture-L1 *pinyin*. This was also shown by the response times of the Chinese processing picture-L1 *pinyin* being significantly longer than those of the Americans. Considering that Chinese characters is a logographic system, in which each individual symbol does not entail its respective sound, the process of *pinyin* and characters for Chinese people might not be the same. In addition, the Chinese speakers do not use *pinyin* as frequently as they use characters, which may also trigger their poorer *pinyin* performance. On the other hand, the English writing system that involves the sound by each individual letter helped to boost the activation of *pinyin* not only for the American group, but for the Chinese group, proved by their quicker response to L2-L1 *pinyin* than to picture-L1 *pinyin*.

Both the American group and the Chinese group showed a significant effect from different target languages, as shown by the error rates. For the American group, the highest error rates lay in the longest RTs block, picture-L2 characters. For the Chinese group, there were relatively higher error rates and longer response latencies in L2-L2 (the synonymous test) block.

4. Conclusion

Most of the previous studies focus on fluent or less fluent bilinguals employed either groups with the same native language background and different L2 proficiency (Chen & Leung, 1989; Chen 1990), or two groups with completely distinctive languages (Potter et al. 1984). This study contributes to the literature by using two groups, while one (the Chinese group) served as another's (the American group) control, to examine how the American participants process Chinese *pinyin* and characters as compared to the Chinese participants. In addition, the Chinese group also served as a contrasting group, to compare language processing in terms of different L2 fluency. Perhaps more crucially, the contribution of this study was the inclusion of an orthographical differences factor, between English and Chinese and especially between *pinyin* and characters.

The major findings were as follows. First, for less fluent bilinguals or novices of an L2, L1-L2 was processed faster than picture-L2. This indicated that they processed their L2 through their L1 or other source (in this case, *pinyin*) before they can eventually access L2 directly. This was compatible with the hypothesis based on the word association model. Next, the shared orthographical form (English and *pinyin*) helped English as well as Chinese speakers to process *pinyin*. As a result, English-*pinyin* was significantly faster than picture-*pinyin* for both groups. This was in accord with the BIA model that claims that form similarity in the two languages facilitates each other's activation.

Figure 1. The Word Association Model

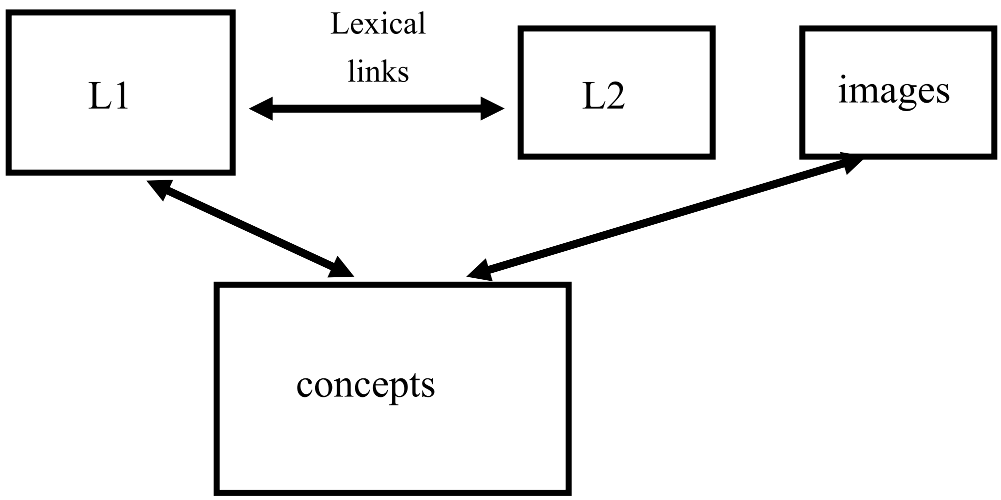


Figure 2. The Concept Mediation Model

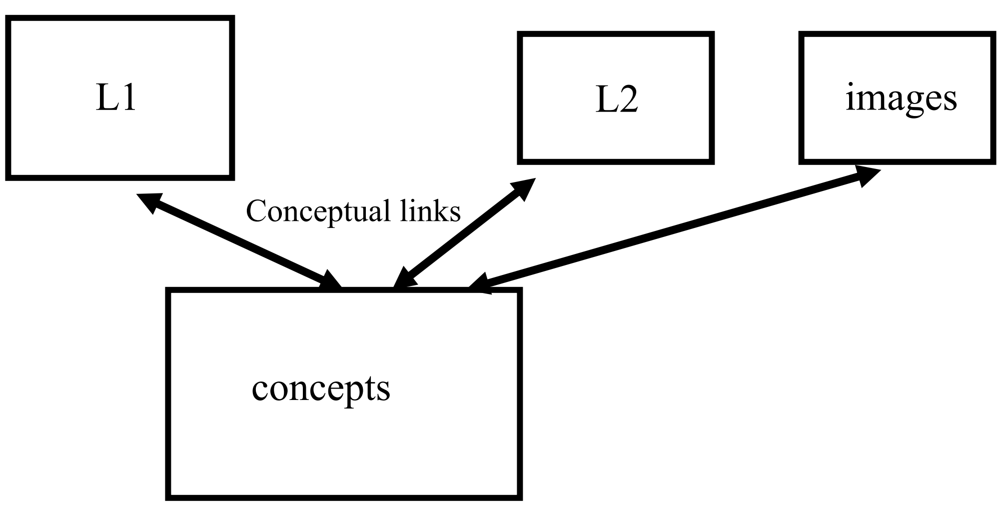
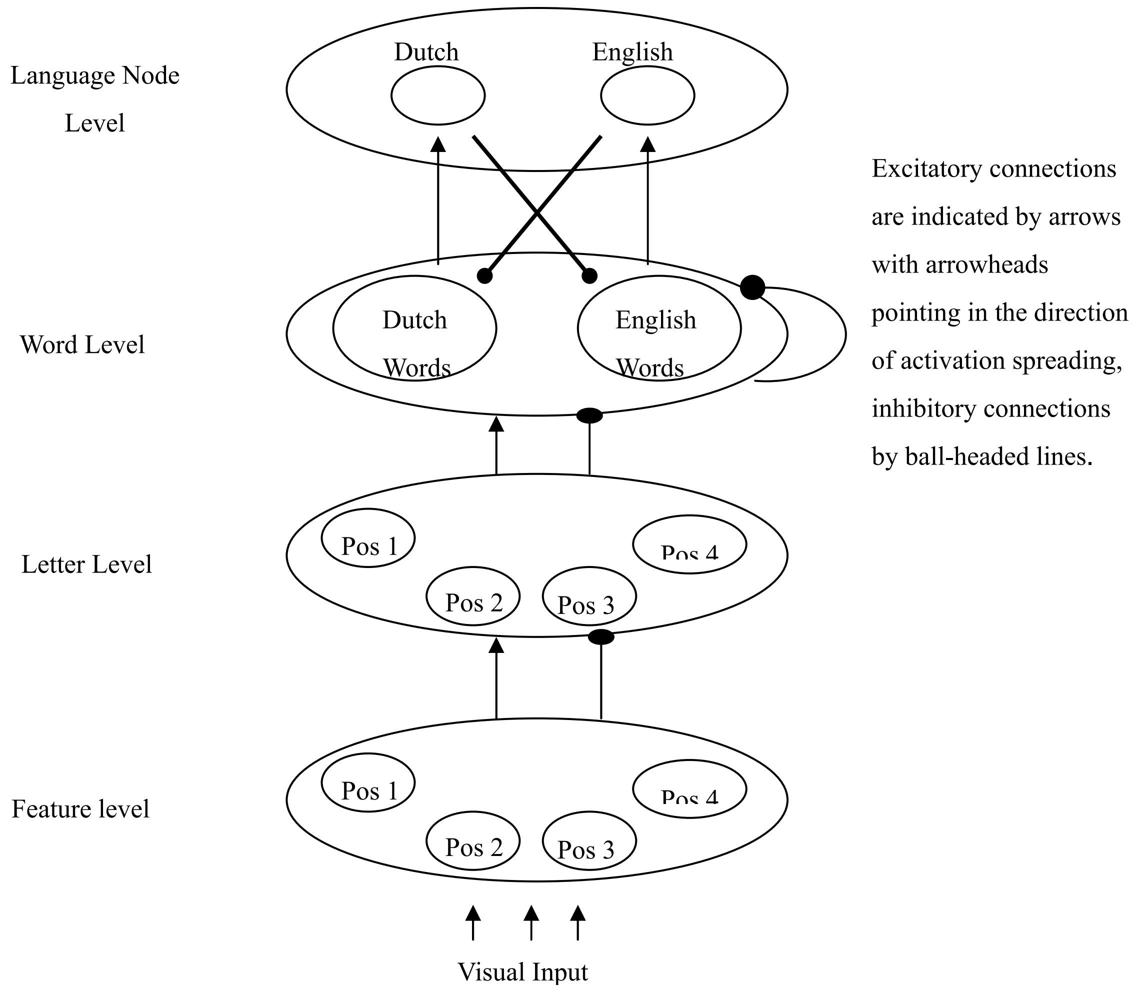


Figure 3. The bilingual interactive activation model (BIA) model



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