Cross-Language Priming Asymmetries in Lexical Decision and Episodic Recognition

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Masked translation priming between languages with different scripts exhibits a marked asymmetry in lexical decision, with much stronger priming from L1 to L2 than from L2 to L1. This finding was confirmed in a lexical decision task with Chinese–English bilinguals who were late learners of English. Following a suggestion made by Bradley (1991), the experiment was repeated using a speeded episodic recognition task. Participants studied Chinese words, and then were tested in an old/new classification task in which Chinese target words were primed by masked English translation equivalents. Significant priming was obtained for old items, not for new items. However, no priming was obtained when lexical decision was used. Unexpectedly, the episodic task showed a reverse asymmetry, since L1–L2 priming was not obtained with this task, although strong effects were obtained for lexical decision. A possible explanation for this pattern of results is that knowledge of L2 lexical items is represented episodically for late learners.

Key Words: bilingual; Chinese; lexical decision; masked priming; episodic recognition; second language.

Much research has been aimed at understanding how a bilingual speaker’s two languages are interconnected. Three types of relations have been outlined by Weinreich (1953). Compound bilingualism refers to the situation where the two lexical systems are directly connected to a common conceptual system. Coordinate bilingualism refers to the situation in which the two lexical systems are connected to separate language-dependent conceptual systems. The remaining type, subordinative bilingualism, occurs when the lexical items of the second language are connected only indirectly to the conceptual system via their translation equivalents in the first language.

Two models of bilingual lexical organization have been the focus of much earlier research (Potter, So, Von Eckardt, & Feldman, 1984; Kroll & Curley, 1988; Chen & Ng, 1989). The word association model, which is similar to Weinreich’s (1953) subordinative bilingualism, postulates that the second language (L2) is linked to the first language (L1) through lexical links only, i.e., via translation equivalents. To a Chinese learner of English, for example, the English word “mistake” is associated with its Chinese translation equivalent “chuowu” and has no direct connection with the corresponding concept. In contrast, the concept mediation model, which can be equated to Weinreich’s compound bilingualism, proposes that a bilingual speaker’s two lexical systems are connected through shared conceptual representations. Thus, when the new word “mistake” is learned, it is directly linked to the existing conceptual representation. These studies often assume that only one type of connection (either lexical or conceptual) exists at one point in time in a bilingual.

More recent studies generally acknowledge the presence of different types of connections and the research focus has shifted to the investigation of the factors that determine the pattern.
of connections. For instance, De Groot (1992, 1993) proposed a mixed representation model in which all three types of connections are present in a bilingual speaker. According to De Groot, the way in which the lexical items of two languages are linked depends to a large extent on the nature of the word. Concrete nouns and cognates are more likely to be related to a common conceptual system than are abstract nouns and noncognates (De Groot, 1992, 1993; De Groot, Dannenburg, & Van Hell, 1994).

Another model that acknowledges the coexistence of lexical and conceptual connections has been proposed by Kroll and Stewart (1994). According to their revised hierarchical model, beginning L2 learners rely more on lexical links between L2 words and their L1 translations. However, these lexical links remain even after conceptual links are later established between L2 words and concepts. Thus, in more proficient bilinguals, L2 words are related to their equivalents in L1 through both lexical links and shared conceptual representations. The model further proposes that links may differ in strength. Specifically, the lexical links from L2 to L1 translation equivalents are stronger than the reverse links, and the conceptual links between L1 words and concepts are stronger than between L2 words and concepts.

Consistent with the view that there are direct lexical links between translation equivalents (see also Gollan, Forster, & Frost, 1997; Keatley, Spinks, & De Gelder, 1994), there is evidence that these lexical links play an important role in bilingual language processing. First, both early and proficient bilingual speakers can translate faster from L2 to L1 than from L1 to L2 (Kroll & Stewart, 1994; Sholl, Sankaranarayanan, & Kroll, 1995). This translation asymmetry has been interpreted as reflecting the use of different links in performing translation in two different directions. Direct lexical links are utilized in L2–L1 translation, which produce faster performance than L1–L2 translation in which conceptual links are involved. The second line of evidence comes from the finding that conceptual factors affect translation from L1 to L2, but not from L2 to L1 (Kroll & Stewart, 1994; Sholl et al., 1995). Sholl et al. found, for example, that picture naming in either language facilitated translation from L1 to L2 but not from L2 to L1. Similarly, the interference that results from semantically categorized lists as compared to random lists occurred only in L1–L2 translation. The translation asymmetry and the lack of semantic involvement in L2–L1 translation both suggest that strong lexical links exist between words in L2 and words in L1.

The existence of strong L2 to L1 lexical links suggests that strong priming from L2 to L1 would be expected in a cross-language priming experiment. However, several recent cross-language priming studies have failed to find translation priming effects from L2 to L1 for noncognates, whereas robust priming effects are found from L1 to L2. All of these studies adopted the masked priming paradigm originally employed by Forster and Davis (1984). The first such study was that of De Groot and Nas (1991), in which translation priming was found from L1 to L2 for noncognates in a lexical decision task. However, Sanchez-Casas, Davis, and Garcia-Albea (1992) found no translation priming when the direction of priming was reversed (i.e., L2 to L1) in a semantic categorization task. More recently, Grainger and Frenck-Mestre (1998) also failed to find significant translation priming from L2 to L1 in lexical decision, although they did report a significant 25-ms effect in a semantic categorization task. The first study that tested both priming directions and found an asymmetrical pattern of translation priming was carried out by

1 It should be noted that L2–L1 translation priming effects have been obtained with cognates (De Groot & Nas, 1991; Sanchez-Casas et al., 1992; Gollan et al., 1997). However, the fact that cognates also have a strong overlap in orthography and phonology gives them a special status. Such priming may be conceptually mediated (De Groot & Nas, 1991), or result from the fact that they are jointly represented in both lexicons (Sanchez-Casas et al., 1992), or be a consequence of orthographic or phonological overlap. Otherwise, L2–L1 translation priming should be found for noncognates too.

2 A 10-ms trend was obtained with a prime–target SOA of 58 ms, but at 43 ms, the effect was only 2 ms (the data are reported as a function of prime exposure, rather than SOA; normally these two measures are equivalent, but in this study, a mask was interpolated between the prime and the target).
Gollan, Forster, and Frost (1997). They tested Hebrew–English bilinguals in a lexical decision task with both cognates and noncognates. For noncognates, they found strong translation priming effects from the dominant language to the less dominant language (L1–L2), but no significant priming from L2 to L1, even though it was clear that the L2 primes were being processed, as evidenced by the existence of strong repetition priming in the nondominant language (L2–L2). This asymmetry was replicated by Jiang (1999), using the same task and procedures as Gollan et al. (1997), with Chinese–English bilinguals. Masked translation priming was found to be robust and consistent from Chinese (L1) to English (L2), but weak and inconsistent from English to Chinese. The results obtained with nonmasked primes show a similar asymmetry in that the magnitude of translation priming is often greater from L1 to L2 than from L2 to L1, although significant effects are obtained in both directions (e.g., Altarriba, 1992; Chen & Ng, 1989; Frenck & Pynte, 1987; Jin, 1990; Keatley et al., 1994; Schwanenflugel & Ray, 1986).

These results are problematic for Kroll and Stewart’s (1994) revised hierarchical model. If faster translation latencies are produced by strong L2–L1 lexical links, why don’t these same L2–L1 links produce strong L2–L1 priming effects in lexical decision? This problem is the focus of the research reported here. The initial point of departure involves the possibility that recently acquired lexical information may be represented in an episodic memory system rather than a lexical system (Forster, 1985). If this is the case for L2–L1 links, then it might be expected that such episodically represented associations would not produce priming effects in a lexical task. Although McKoon and Ratcliff (1979, 1986) have argued that such associations produce priming effects in lexical decision that are very similar to semantic priming effects, other investigators have not reached the same conclusion (Carroll & Kirsner, 1982; Dagenbach, Horst, & Carr, 1990; Durgunoglu & Neely, 1987; Neely & Durgunoglu, 1985). In the study by Dagenbach, Horst, and Carr (1990), for example, unrelated words (e.g., day–woman) were paired for extensive study in the study phase. In the second phase, participants responded to the second member of each pair in a lexical decision task which was preceded by an episodically related or unrelated word. No facilitation was found when the targets were preceded by an episodically related prime, i.e., the original words the participants studied with the target words.

Bradley (1991) observed very similar effects when the prime was masked. She established episodic connections between unrelated word pairs such as fairy–shark and then tested priming in a lexical decision task with masked primes. No priming was obtained. The most interesting aspect of her results for present purposes emerged from a control condition. In order to demonstrate that this failure to obtain priming was not due to the fact that the association was too weak to survive masking, Bradley tested the same pairs in a speeded recognition memory task. The task now was to decide as rapidly as possible whether shark was one of the words that had been learned. This target word was preceded by a masked presentation of fairy or a completely new word. Under these conditions, strong priming effects were obtained, demonstrating that the association between fairy and shark was strong enough to produce a priming effect, provided that an episodic task was used.

Applying this insight to the case of bilingual priming suggests the following hypothesis. It may be that the L2–L1 lexical connections are part of the episodic system and are therefore not involved in a lexical decision task in which the decision-making system is focused on the output of the lexical processing system. As support for this proposal, one could cite the fact that lexical links between translation pairs are initially established when L2 learners, often consciously, associate an L2 word with its L1 translation. For a noncognate translation pair, the associative link would be quite similar to that between an unrelated pair of words within the same language (e.g., fairy and shark). The method of establishing the association is also likely to be similar (rote memorization), and the method of testing how well the association has
been learned would also be similar. Doubtless, these similarities would be more pronounced during the initial stages of vocabulary acquisition and for students learning L2 in a formal educational setting. But once established, these episodic links may continue to play a role, even in proficient speakers of L2. An obvious way to test this hypothesis is to determine whether L2–L1 priming can be obtained if the task is switched from lexical decision to episodic decision. This was the purpose of Experiment 1.

**EXPERIMENT 1**

In this masked priming experiment, a group of Chinese–English bilingual speakers was tested in an episodic recognition task in which Chinese targets were primed by their English translations or by unrelated English control primes. As a check on previous results, the same speakers were also tested on the same items in a lexical decision task.

**Method**

**Participants**

Twenty-six Chinese–English bilingual speakers participated in this experiment. The participants in this and the following experiments were all graduate students from mainland China studying at the University of Arizona at the time of testing. Most had started learning English in middle school and typically received a minimum of 8 years of formal training in the language throughout high school and college. They all had a TOEFL (Test of English as a Foreign Language) score of 550 or higher at the time of admission to a graduate program, and all but a few were employed as a teaching or research assistant. Their length of residence in the United States varied from 1 to 7 years. They had very limited exposure to English in natural settings before their arrival in the United States. Participants in this and the following experiments were paid for their participation.

**Stimuli and Design**

The stimuli included 64 Chinese–English translation pairs as critical stimuli, 32 English words used as unrelated control primes, and 32 Chinese nonwords, all taken from Jiang (1999). An effort was made to assure that the two members of each translation pair were a unique translation of each other (see the procedure description in Jiang, 1999). We included mostly high-frequency abstract nouns whose Chinese translations are two-character bisyllabic words for several reasons. First, nonwords in Chinese are best constructed as nonexistent two-character sequences (the alternative is to construct noncharacters). Second, it is easier to find bisyllabic abstract nouns in Chinese than bisyllabic concrete nouns that have unique English translations familiar to Chinese speakers of English. Third, we wanted to keep the stimuli as homogenous as possible so as to avoid any confounding variables such as word concreteness. Fourth we wanted to make sure that all the English words used were familiar to our participants. The 32 English control primes were all abstract nouns of similar frequency as the critical stimuli. The Chinese nonwords were generated by combining two characters so that they did not form a word and had no meaning.

The construction of test materials differed for the two tasks. For the episodic task, the 64 pairs were divided into two sets of 32 pairs. The Chinese translations of one set were used in the study phase and were “old” items in the test phase and the other 32 Chinese words were not shown in the study phase and became “new” items in the test phase. All the participants received the same 32 Chinese words in the study phase. In the test phase, two presentation lists were constructed, each with 32 “old” items and 32 “new” items. For half of the “old” and “new” items on each list, the Chinese targets were preceded by their English translations, the other half being preceded by unrelated English control primes.

For the lexical decision task, 32 of the 64 translation pairs were used, 16 from the “old” set and 16 from the “new” set. Two presentation lists were constructed, each containing 32 Chinese word items and 32 Chinese nonword items. Half of the 32 word items were preceded by their English translation equivalents and the other half by unrelated English control primes.
The nonword items were all preceded by unrelated English control primes.

The two presentation lists for both the lexical decision task and the test phase of the episodic recognition task were counterbalanced such that no word appeared more than once on a test list and a target with a translation prime on one list was preceded by a control prime on the other.

The episodic experiment involved a \(2 \times 2 \times 2\) design, the factors being lists (the counterbalancing feature), study status (old vs new), and prime–target relation (translation vs unrelated) with the latter two factors being within-subject factors. The lexical decision experiment involved a \(2 \times 2\) design, the factors being lists and prime–target relationship.

**Procedure**

**Episodic recognition task.** The episodic task involved two phases, a study phase and a test phase. In the study phase, the participants were first given 35 Chinese words to study and remember (these included three words that were to serve as practice items in the test phase). Each word was first presented individually on a computer display for 3 s with a 1-s interval between words. The words were presented in sets of 7. After the 7th word in each set, the participant could choose to pause for a break or immediately press a foot pedal to obtain the next set. At the completion of this presentation, all words were presented together once more for review. Participants were permitted to review as long as they wished before they proceeded to the test phase. The participants were told that a memory test would be given and were asked to remember as many words on the list as possible. No participant took more than 2 min for the review.

In the test phase, participants were asked to decide as rapidly as possible whether a word presented on the screen was one of the words on the study list. As a pretest revealed a high error rate in the test phase of the episodic task, indicating that the items were not sufficiently well learned, all participants were asked to perform the entire task twice, and only the data from the second session were analyzed.

**Lexical decision task.** In this task, there was no prior study phase. In the test phase, participants were asked to decide as rapidly as possible whether the two Chinese characters presented on the screen formed a word.

For both tasks, the masked priming sequence used in the test phase was adapted from the procedure used by Forster and Davis (1984). Each item in the test phase consisted of a sequence of a mask (10 hash marks) for 500 ms, a prime for 50 ms, a blank interval of 50 ms, a backward mask for 150 ms (also a row of hash marks), and then the target for 500 ms. The blank space and the backward mask were included to increase the amount of processing time for the prime before the onset of the target (see Jiang, 1999, Experiment 4).

The presentation of the stimuli and the recording of reaction times and errors were controlled by the DMASTR software developed by K. I. Forster and J. C. Forster at the University of Arizona. All elements of the stimulus sequence were presented in the center of the screen. The participants responded by pressing one of two buttons.

Half of the participants did the episodic task first and the other half did the lexical task first. The lexical-first group did the episodic task immediately following the lexical decision task, but for the episodic-first group, 2 weeks intervened between the two tasks in order to minimize episodic involvement in the lexical task. Participants were randomly assigned to groups and to presentation lists.

Instructions were given in Chinese both orally before the experiment and in written form on the screen. For both tasks, eight practice items (three “old” and five “new” words for the episodic recognition task) were given before the test items and the participants were asked to respond as quickly and accurately as possible. After the experiment, participants were asked whether they could identify the primes.

**Results**

In this and all subsequent experiments, incorrect responses were discarded and outliers were treated by setting them equal to cutoffs established 2 \(SD\) units above and below the mean for each participant. This procedure affected 2.4%
of the total data in this experiment, and no more than 5.5% of the data in all subsequent experiments. Two analyses of variance were performed, one treating subjects as a random effect ($F_1$), the other treating items as a random effect ($F_2$). The factors were Lists (the counterbalancing feature), study status (this factor was not involved in the lexical decision task), and Prime Type (related vs unrelated). The Lists factor was included to remove variance due to the counterbalancing procedure and was a nonrepeated factor in both analyses. The factor of Prime type was a repeated-measures factor in all analyses. The data from two participants whose error rate was higher than 25% in the second session of the episodic task were removed, leaving a total of 24 participants, 12 on each presentation list. Table 1 presents the mean RTs and error rates in the two tasks.

**Episodic Recognition**

As can be seen in Table 1, there was a priming effect of +29 ms for “old” items, but little or no effect for “new” items (−6 ms). There were no significant main effects of prime–target relation or study status in either the analysis of RTs or error rates. However, there was a significant interaction in RT between study status and prime–target relation, $F_1(1,22) = 9.03, p < .05$; $F_2(1,60) = 5.50, p < .05$. Two planned comparisons were carried out, one for “old” items and the other for “new” items. The +29-ms priming effect for the “old” items was significant, $F_1(1,22) = 13.4, p < .05$; $F_2(1,30) = 5.9, p < .05$, but the −6-ms difference for the “new” items was not (both $F_1$ and $F_2 < 1$). There were no significant differences in error rates as a result of priming for either “new” or “old” items, all $F$s < 1.

**Lexical Decision**

The +8-ms difference between translation and control conditions was not significant, $F_1(1,22) = 1.68, p > .05$; $F_2(1,30) = 2.25, p > .05$, nor was the difference in the error rate, both $F$s < 1.

**Discussion**

The results of Experiment 1 replicate the findings of previous studies (Gollan et al., 1997; Jiang, 1999) in that no reliable L2–L1 masked translation priming effect was found in a lexical decision task. On the other hand, a strong masked priming effect from L2 to L1 was found for “old” items in an episodic recognition task. On the face of it, this result is entirely counterintuitive. In the episodic task, participants are attempting to retrieve information about whether a particular Chinese word had been shown to them before. It is hard to see how the prior masked exposure of its English translation (which had not been seen previously) could assist in this task, especially since the same procedure is of no benefit in a lexical decision task. The implication of Bradley’s (1991) observation that episodically mediated associations produce priming in an episodic task, but not in a lexical task, is that for these bilinguals, the lexical associations between words in L2 and words in L1 must have been represented episodically.

How would this mechanism operate? One possible model is shown in Fig. 1. This model assumes two distinct memory modules. One module contains records of events (referred to here as episodic memory), and the other contains information about the linguistic properties of words (referred to as lexical memory). $L1^*$ represents an episodic record of a word in L1,  

<table>
<thead>
<tr>
<th>List Type</th>
<th>Episodic</th>
<th>Lexical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Old</td>
<td>New</td>
</tr>
<tr>
<td>Translation</td>
<td>704 (13.5)</td>
<td>734 (13.3)</td>
</tr>
<tr>
<td>Unrelated</td>
<td>733 (15.3)</td>
<td>728 (12.7)</td>
</tr>
<tr>
<td>Priming</td>
<td>+29</td>
<td>−6</td>
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3 The analysis of the data from all 26 participants and from all the participants’ performance in the first session produced the same pattern of results.
which corresponds to a context-sensitive memory trace formed by previous encounters with that word. The lexical entry for that word is simply shown as L1, which is an abstract linguistic representation, independent of the particular context in which it was learned. Words in L2 do not have lexical entries as such. They only have episodic records, shown as L2*. These episodic records are associated with the episodic records of their translation equivalents in L1. Thus, when L2* is activated, it will activate L1*.

Figure 1 represents all possible pathways linking inputs with either an episodic decision-making system or a lexical decision-making system. Thus, in an episodic task, decisions will be based on activation in either L1* or L2* (depending on the input), but activation in the lexical module will be irrelevant. In a lexical decision task, decisions will be based on activation in the lexical module. So in an episodic task with L1 targets, a “Yes” decision is generated when the existence of an L1* record is located that has the right context coding, namely that the encounter with this word occurred during the study phase. We assume that the episodic memory trace for a word that occurred in the study phase is integrated with the preexisting episodic record for that word, so that L2* is in fact associated with both. Thus, when L2* is activated, it activates the preexisting L1*, which has already been preactivated by the L2 prime. Since the speed of the episodic decision depends on the activation level in L1*, this preactivation by the L2 prime will lead to a faster response. Note that the L1 target would also activate the lexical entry L1, but this is irrelevant in an episodic task. That is, knowing that the target item is a word in L1 is very little help in deciding whether this word occurred on the study list. This fact is marked by the arrow linking L1* (but not L1) to the episodic decision system.

Does this model also explain why there is no L2–L1 priming in a lexical decision task? In this case, the decision system is “tuned” to inputs from lexical memory rather than episodic memory. The L2 prime will activate L2*, which in turn activates L1*. Now, if L1* activates L1, then priming would occur when the L1 target is presented. However, we know that priming

FIG. 1. A model of the pathways involved in masked cross-language priming in late-learners. L1 represents the lexical entry for a word in the dominant language, and L1* represents an episodic record of previous encounters with that word. L2* represents the episodic record of the translation equivalent in the nondominant language. Words in L2 are represented only as episodic records. Episodic recognition decisions are based on output from episodic memory, whereas lexical decisions are based on output from lexical memory.
does not occur under these conditions, and hence we must assume that masking the L2 prime blocks or weakens the ability of L2* to activate the L1*–L1 link. One way to think of this is that the associative link from L2* to L1* is completely automatic and is activated whether or not the prime is available to consciousness. However, in order to complete the link all the way to L1, a conscious, intentional retrieval effort is required, which requires awareness of the L2 prime.

The assumption that the link from L2* to L1 depends on awareness of the L2 stimulus is critical for this explanation. This assumption could be motivated by appeal to modularity principles (Fodor, 1983). If we assume that episodic memory and lexical memory are different memory modules, then the L1*–L1 link goes across different memory modules, whereas the L2*–L1* link does not. If we further assume that cross-module activation requires the intervention of some higher level control system (the central system in Fodor’s terms), then it is reasonable to suppose that cross-module activation occurs only if information about the stimulus reaches consciousness. Another possibility is that the link from L2* to L1 is broken even earlier, and the masked L2 prime never activates L2* at all, unless the task is episodic. However, this proposal could lead to difficulties when we consider the case of L2–L2 repetition priming in a lexical decision experiment. If the L2 prime is masked, then the only way priming could occur would be if the task was episodic in nature. This prediction is definitely wrong, since both Gollan et al. (1997) and Jiang (1999) obtained clear L2–L2 priming in lexical decision, but no L2–L1 priming. However, given the assumptions about the episodic representation of L2, it could be argued that a lexical decision task with L2 targets is necessarily an episodic task. Thus the existence of priming could be satisfactorily explained by an early-blocking model.

The results of Experiment 1 replicated a previous finding from episodic recognition studies in that facilitation was found only for “old” items, not “new” items (Forster, 1985). This result can also be explained in terms of the processes outlined above. The facilitation of L1 target recognition depends on the preactivation of the newly established L1* trace by the L2 prime. When a word is not on the study list, it has no newly established episodic trace. The L2 prime will still activate its preexisting L1* translation in the episodic system, but this trace will not include any information about its presence on the study list. When the L1 target is presented, no recent episodic trace will be activated, and hence a “No” decision will be made, presumably when a deadline expires. Thus, there is no opportunity for priming.

The failure to obtain priming for “new” items also rules out explanations of the differences in priming in the episodic and the lexical decision task purely in terms of general task factors. For example, it could have been argued that priming is obtained in the episodic task because decision times were much slower than in the lexical decision task. However, this was equally true of performance for both “old” and “new” items, yet only the “old” items show priming. The pattern of priming effects observed here is also relevant to other explanations of masked priming effects in terms of an increase of the perceived familiarity of the target induced by the prime or as a purely orthographic effect (e.g., Bodner & Masson, 1997). It is very difficult to sustain such arguments in the face of the asymmetrical nature of priming in lexical decision (L1–L2 but not L2–L1) and its dependence on the task.

**EXPERIMENT 2**

There is one procedural difference between the episodic task and the lexical decision task used in Experiment 1 that might possibly account for the different priming effects. That is the inclusion of a study phase in the episodic task, but not in the lexical decision task. For the subjects who did the lexical task first, there was no prior study phase. For the group who did the lexical task first, there was a 2-week interval between the episodic task and the lexical task. It is possible that the difference in priming between the two tasks might have to do with the inclusion of the study session immediately prior to the test phase. Even though only L1 words
were studied in the study phase, it is not impossible that L2–L1 links were activated or temporarily reinforced in the study phase, especially since these bilinguals were living in an English-speaking environment and using English as their studying or working language. To test this hypothesis, Experiment 2 was designed so that a study phase identical to the one employed in Experiment 1 was included prior to the lexical decision task. If it is the study phase, not the episodic nature of the task itself, that produced L2–L1 priming, then L2–L1 priming should be observed in the lexical decision task preceded by a study phase.

**Method**

**Participants.** Sixteen different Chinese–English bilinguals recruited from the same pool as in Experiment 1 participated.

**Materials.** The stimuli were the 64 pairs of Chinese–English words used in Experiment 1. Thirty-two of them were used in the study phase. For the lexical decision task, two presentation lists were constructed. Each list consisted of 32 words on the study list ("old" words) and 32 words that were not on the study list ("new" words). The purpose of including the 32 "new" words was to prevent the participants from doing the task on the basis of whether a word appeared in the study list. Half of the "old" and "new" words on each list had translation primes and the other half had control primes. The two lists were counterbalanced as in Experiment 1. The Chinese words primed by English translations on one list were primed by unrelated English words on the other. A list of 32 words was constructed for the memory test. It included 16 randomly selected "old" words and 16 randomly selected "new" words from the lexical decision stimuli.

**Procedure.** The study phase was identical to the study phase in Experiment 1. Participants were told that they had to remember these words and that they would be tested later. Then they were asked to perform a lexical decision task identical to that of Experiment 1. The lexical decision task was immediately followed by a memory test in which the participants were presented with 32 Chinese words, 16 words from the study list and 16 words not included on the study list. They were asked to decide if a word presented on the screen was one of the words on the study list. As the only purpose of the memory test was to see how well the participants remembered the words in the study phase, these words were presented without primes. Otherwise, the procedure was the same as in Experiment 1.

**Results and Discussion**

The results of the lexical decision task are presented in Table 2. There was little evidence of priming, the effects being +9 ms for "old" items and +3 ms for "new" items. The main effect of prime–target relation was not significant, $F_1(1,14) = 1.93, p > .05$; $F_2(1,60) < 1$. There was no significant difference in error rate between translation and control conditions either, both $Fs < 1$. However, a main effect of prior exposure was found between the "new" and "old" items. "Old" items took 58 ms less to classify than "new" items, and this difference was significant, $F_1(1,14) = 23.20, p < .05$; $F_2(1,60) = 51.91, p < .05$. There was also a significant difference in error rate between these two types of items, $F_1(1,14) = 8.24, p < .05$; $F_2(1,60) = 6.62, p < .05$.

Two separate subanalyses were carried out for the "old" and "new" items. Neither produced any significant difference in RTs due to the type of prime: for "old" words, $F_1(1,14) = 3.82, p > .05$; $F_2(1,30) = 1.38, p > .05$, and for "new" words, both $Fs < 1$. The same was true for differences in error rates (all $Fs < 1$).
The memory test conducted after the lexical decision task showed a mean error rate of 14%, which is comparable to the error rates in episodic recognition in Experiment 1.

The above results show that including a study phase immediately prior to the lexical decision task does not induce L2–L1 translation priming. However, the study phase did produce a normal repetition priming effect, since “old” items were classified faster than “new” items.

EXPERIMENT 3

The purpose of Experiment 3 was partly to replicate the effect found in the first experiment, since the fact that a masked English prime could facilitate episodic decisions about recently seen Chinese words still seems somewhat surprising. A secondary aim was to investigate the role of differential speed of access in cross-language priming. Gollan et al. (1997) argued that this may play a role in the failure to obtain L2–L1 priming in lexical decision. The idea behind this proposal is that the processing of the L1 target might be so fast relative to the processing of the L2 prime that there is no chance for the L2 prime to have an effect. However, if the target is also in L2, and hence the relative speeds of processing the prime and the target are the same, then strong priming effects would be expected. Gollan et al. (1997) demonstrated that this was indeed the case. This hypothesis was tested in Jiang (1999, Experiment 3), in which a mask was interpolated between the prime and the target to increase the stimulus onset asynchrony (SOA) to 250 ms. No L2–L1 priming was found for lexical decision, suggesting that the differential speed hypothesis was incorrect. On the basis of the present results, a quite different explanation of the failure to obtain L2–L1 priming could be advanced, namely that L2–L1 priming is not the result of overlapping semantic or conceptual representations, but of episodically established links between words in L2 and words in L1 which do not get activated in a lexical decision task with masked primes.

Now that we have established that L2–L1 priming does occur in an episodic task, we are in a better position to test the differential speed of access hypothesis. In Experiment 1, a 250-ms SOA was used (as in Jiang, 1999), and priming was observed in episodic decision, but not lexical decision. The question now is whether the 250-ms SOA is necessary to obtain priming. It is possible that cross-language priming in an episodic task could be obtained with SOAs as short as 50 ms, as is routinely the case for within-language priming experiments (e.g., Forster & Veres, 1998; Frost, Forster, & Deutsch, 1998; Grainger & Ferrand, 1996). If so, one may conclude that the differential speed of access in L1 and L2 plays little role in cross-language priming. On the other hand, if no L2–L1 episodic priming is observed with a shorter SOA, the opposite conclusion can be reached.

Method

Participants. Thirty-six Chinese–English bilingual speakers recruited from the same pool as in the previous experiments participated in this experiment. None had participated in the earlier experiments.

Materials and design. The same 64 translation pairs and their control primes were used in this experiment. The experiment involved a 2 × 2 × 2 × 2 design, with prime–target relation (translation vs control), study status (old vs new), and task (episodic vs lexical) as within-subject factors and SOA (50 vs 250 ms) as a between-subject factor. The construction of test materials was the same as in Experiment 1.

Procedure. For all participants, the lexical decision task followed the episodic task. The procedure for the lexical decision task was the same as in Experiment 1 for the 250-ms SOA group, but for the 50-ms SOA group, the 50-ms blank period and the 150-ms mask that intervened between the prime and target were removed. Otherwise, the procedure was the same as in Experiment 1.

Results and Discussion

The results for the lexical decision task and the episodic task are presented in Table 3. The data from the two SOA conditions were analyzed separately.

Fifty-millisecond SOA. The only significant main effect in the episodic task was that of
study status in the RT analysis, the “old” words being 23 ms faster than the “new” words, $F_1(1,16) = 4.38, p = .05$; $F_2(1,60) = 7.55, p < .05$. No main effect of study status was found in error rate, both $F$s < 1. There was no main effect of prime–target relation for RTs, $F_1(1,16) < 1$; $F_2(1,60) = 1.19, p > .05$, or error rates (both $F$s < 1). A separate subanalysis of the priming effect for “old” items showed that the +7 ms effect was not significant (both $F$s < 1). Neither was the difference in error rate between these two conditions (both $F$s < 1).

The priming effect in the lexical decision task was only +4 ms, which was not significant (both $F$s < 1). There was no difference in error rate between translation and control conditions in the lexical decision task.

Two-hundred-fifty-millisecond SOA. The longer SOA condition produced a different pattern. The priming effect in the episodic task was +52 ms for “old” items and −17 ms for “new” items. This difference in priming effects produced a significant interaction between prime–target relation and study status, $F_1(1,16) = 9.85, p < .05$; $F_2(1,60) = 3.69, p = .06$, indicating that the priming effects from “old” and “new” items differed significantly. Separate planned comparisons of the RT data for “old” and “new” items showed that the +52 ms effect for the “old” items was significant, $F_1(1,16) = 13.5, p < .05$; $F_2(1,30) = 10.1, p < .05$, while the effect of −17 ms for the “new” items was not, $F_1(1,16) = 1.70, p > .05$; $F_2(1,30) < 1$. No significant differences were found in error rates for the episodic task, including the 2.4% difference in error rate for “old” items, both $F$s < 1.

The priming effect in the lexical decision task was +9 ms. This effect was not significant, $F_1(1,16) = 2.13, p > .05$; $F_2(1,30) = 1.98, p > .05$. The difference in error rate was not significant either, both $F$s < 1.

These results satisfactorily replicate the key findings from Experiment 1. First, L2–L1 priming was observed in an episodic recognition task with an SOA of 250 ms. Second, no L2–L1 priming was found in a lexical decision task with the same SOA. The interesting new finding is that priming in the episodic task depended on having a relatively long SOA. With a 50-ms prime (enough to produce within-language priming, as shown in Gollan et al., 1997), there was no significant effect in either task. This finding suggests that the differential speed of access in L1 and L2 does affect cross-language priming. As suggested by Gollan et al. (1997), L2 words may need more time for processing, if they are to exert any effect on a subsequent L1 target. However, this only applies to episodic priming. For lexical decision, there was no effect at either SOA. This indicates that the speed of processing is not the only determining factor that is responsible for the absence of L2–L1 priming in lexical decision.

**EXPERIMENT 4**

Cross-language priming in lexical decision is asymmetric: L1 words prime L2 translations,

![Table 3](image.png)

### Table 3
Mean Reaction Times (in Milliseconds) and Percentage Error Rates (in Parentheses) for L2–L1 Priming as a Function of Prime–Target Relation, SOA, Task (Episodic vs Lexical), and Study Status (Old vs New) in Experiment 3

<table>
<thead>
<tr>
<th>Prime–target SOA</th>
<th>50 ms</th>
<th>250 ms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Episodic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Translation</td>
<td>621 (17.0)</td>
<td>648 (16.0)</td>
</tr>
<tr>
<td>Unrelated</td>
<td>628 (14.9)</td>
<td>648 (15.6)</td>
</tr>
<tr>
<td><strong>Lexical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Translation</td>
<td>+7</td>
<td>0</td>
</tr>
<tr>
<td>Unrelated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
but L2 words have no effect on L1 translations. Episodic priming is different, since it now seems clear that in an episodic task, L2 words can have an effect on L1 translations, although not necessarily under all conditions (e.g., a short SOA). It now remains to consider whether episodic priming can be obtained in the reverse priming direction, i.e., L1 to L2. If the effect of using an episodic task is simply to amplify the amount of priming compared to lexical decision, then we should expect to see very strong priming from L1 to L2, since this effect is already quite apparent in lexical decision. On the other hand, it is possible that episodic priming involves pathways that are different from those responsible for lexical priming, as discussed in Experiment 1. In this case, we may not expect to find episodic L1–L2 priming.

Method

Participants. Twenty-two different Chinese–English bilingual speakers from the same pool as in the previous experiments participated.

Materials and design. The stimuli were the same as those used in Experiment 1, except that the direction of priming was reversed. The primes were now in L1 (Chinese), and the targets were English words.

Procedure. The procedure was the same as in Experiment 1, except that an SOA of 50 ms was used, without any intervening mask between the prime and target. Each trial consisted of a forward mask (10 hash marks) for 500 ms, followed by an L1 prime for 50 ms, followed by an L2 target for 500 ms, with no intervening stimuli. This corresponds to the normal procedure when the prime is in L1. This short SOA was adopted because, in the L1–L2 priming direction, L1 primes are expected to be processed faster than L2 targets, thus making it unnecessary to adopt a longer SOA to increase the time available for processing the prime. The same presentation method was used for both the episodic and lexical tasks. As no difference was found in Experiment 1 as a function of the order of tasks, all participants in Experiment 4 did the episodic task before the lexical decision task.

Results and Discussion

The results are summarized in Table 4. Considering first the lexical decision results, there was a strong priming effect of +41 ms, $F(1,20) = 24.62, p < .05$; $F(2,30) = 60.86, p < .05$. This confirms earlier findings that priming from L1 to L2 can be obtained in lexical decision.

However, for the episodic task, it is not so clear that there is a priming effect. For “old” items, the effect was only +6 ms, which was not significant (both $Fs < 1$). The effect for “new” items was a little stronger (+13 ms), and this approached significance in the subject analysis, $F(1,20) = 3.70, p = .07$, but not in the item analysis, $F(2,30) = 1.93, p > .05$. Analysis of the error rates revealed a substantial reduction in errors (6.5%) in the related condition for the “old” items. This difference was significant, $F(1,20) = 7.10, p < .05$; $F(2,30) = 8.27, p < .05$. There was no corresponding effect for “new” items, where the difference was in the wrong direction.

It seems clear that L1–L2 priming is much weaker in the episodic task. The only clear evidence in favor of priming is the difference in error rates for “old” items. There was a trend toward an effect in RTs for the “new” items, but based on the results of Experiments 1 and 3, this is not the condition that should have produced priming. In those experiments, it was the “old” items that produced significant episodic priming. Also, on theoretical grounds there is no reason to expect priming in this condition, since

<table>
<thead>
<tr>
<th>Prime–Target Relation</th>
<th>Episodic Translation</th>
<th>Unrelated Translation</th>
<th>Priming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old</td>
<td>742 (11.4)</td>
<td>759 (12.5)</td>
<td>+6</td>
</tr>
<tr>
<td>New</td>
<td>748 (17.9)</td>
<td>772 (8.8)</td>
<td>+13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study Status</th>
<th>Episodic Translation</th>
<th>Unrelated Translation</th>
<th>Priming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old</td>
<td>742 (11.4)</td>
<td>759 (12.5)</td>
<td>+6</td>
</tr>
<tr>
<td>New</td>
<td>748 (17.9)</td>
<td>772 (8.8)</td>
<td>+13</td>
</tr>
<tr>
<td>Lexical</td>
<td>676 (4.3)</td>
<td>717 (7.5)</td>
<td>+41</td>
</tr>
</tbody>
</table>
priming should depend on there being a preexisting episodic record for the L2 target.

The reduction in errors in the related condition for the “old” items might indicate a genuine priming effect that is a result of the weak link from L1 to L2 (Kroll & Stewart, 1994). However, in masked priming experiments, it is most unusual to obtain a significant error effect without an accompanying RT effect (although the reverse is common). So at the very least, it would have to be acknowledged that this effect was quite unlike the effects observed for L2 primes and L1 targets. Alternatively, one might consider treating this effect as a type I error.

EXPERIMENT 5

It might be argued that the reason for the very weak episodic priming in Experiment 4 is that a short SOA of 50 ms was used, whereas in Experiment 3, episodic priming was only obtained with a longer SOA of 250 ms. This possibility was explored in Experiment 5. We suggested in Experiment 3 that the SOA is critical in the L2–L1 priming direction because of the differential speed of access in L1 and L2. Because L2 words are typically processed more slowly than L1 words, an L2 prime may affect the recognition of an L1 target only when the SOA exceeds the difference in access time between L1 and L2. If this analysis is correct, then SOA should have a small effect on L1–L2 priming because the processing of L1 primes will always be completed before that of L2 targets. Therefore we would not expect to find any L1–L2 episodic priming with a long SOA. However, if a longer SOA is critical to produce episodic priming regardless of the language of the prime, then an L1–L2 episodic priming effect is expected in Experiment 5.

A further purpose of this experiment was to determine whether the priming effect in the error rates observed in Experiment 4 can be replicated. If the reduction in error rates reflects a genuine L1–L2 priming effect in episodic recognition, we would expect to observe a similar (or even stronger) effect in this experiment.

Method

Participants. Eighteen different Chinese–English bilingual speakers participated. They were graduate students from mainland China studying at Pennsylvania State University at the time of testing. However, these participants shared the same English learning background with the participants in the previous experiments. Four participants were unable to achieve an error rate less than 25% in the episodic task and were replaced.

Materials, design, and procedure. The stimuli, design, and procedure were the same as in Experiment 4 except for two differences. First, as the focus of this experiment is on L1–L2 episodic priming, only an episodic task was involved. No lexical decision task was given. Second, a longer SOA of 250 ms was adopted. Each test item consisted of a pattern mask for 500 ms, an L1 prime for 50 ms, and a backward mask (“XWXWXWXWXW”) for 200 ms. This was slightly different from the procedure for the long SOA condition in Experiment 3. In Experiment 3, the 250-ms SOA was achieved by including a blank interval for 50 ms and a backward mask (“XWXWXWXWXW”) for 200 ms. However, this procedure did not produce effective masking in this experiment because the primes were in L1 and were more readily perceived. By removing the blank interval after the prime, and extending the duration of the mask, we were able to maintain the SOA at 250 ms and still prevent conscious awareness of the prime.

Results and Discussion

The results are presented in Table 5. A two-way ANOVA produced no significant main effect of study status on reaction time, $F(1,16) < 1$; $F(2,60) = 1.14, p > .05$, or error rate, $F(1,16) = 1.61, p > .05; F(2,60) = 1.19, p > .05$. There was a small priming effect (12 ms) for translation pairs in the expected direction, but the difference was not significant, $F(1,16) = 2.12, p > .05; F(2,60) < 1$. No main effect of prime–target relation was found in the error rates (both $F$s < 1).
Separate subanalyses of the RT and error data were also carried out for the “old” and “new” items. The 11-ms difference between translation and control conditions for the “old” items was not significant (both $F$'s, $1$). The difference in error rate was not significant either (both $F$'s, $1$). The 13-ms difference for the “new” items was not significant, $F_{1}(1,16)=5.21; F_{2}(1,30)=1$. Neither was the difference in error rate for the “new” items (both $F$'s, $1$).

The results of Experiment 5 are similar to those of Experiment 4 in that there was a small, nonsignificant priming effect for translation pairs. This result indicates that the absence of episodic priming in Experiment 4 was not a result of using a short SOA. In addition, the significant priming effect for errors observed in Experiment 4 was not repeated in this experiment, suggesting that this was a type I error. We conclude that there is no reliable evidence in favor of the hypothesis that episodic priming for L1–L2 items exists.

### GENERAL DISCUSSION

On the basis of Bradley’s (1991) demonstration that episodically established associations were incapable of producing masked priming effects in a lexical decision task, but were capable of producing strong effects in an episodic recognition task, the present investigation has demonstrated a prima facie case for arguing that L2 lexical items are represented episodically, not lexically. This position corresponds to Weinreich’s (1953) subordinative bilingual case, in which L2 words are connected to the conceptual system only indirectly via their connections with L1 translation equivalents. The important qualification is that these connections must be episodic in nature. Since it seems unlikely that lexical representations should be linked episodically, we infer that the representations that are linked are both episodic in nature (i.e., L2* and L1*), but the episodic L1 representations ultimately link back to lexical representations, as they must, otherwise there is no path from L2 entries to conceptual representations.

What does it mean to say that L2 words are represented episodically? Clearly this is not the same sense of episodic as proposed by Tulving (1972), where episodic memories are described as dated, autobiographical records. Perhaps a better term is nonlexical memory (Forster, 1985), the implication being that this memory system is not specialized for the storage of purely linguistic information. Rather, it is a storage system for recording details of events. For some theorists, this proposal completely begs the question of whether such a distinction exists (e.g., McKoon & Ratcliff, 1986). However, it is hard to explain why the lexical decision task and the episodic recognition task should produce such different priming effects without assuming such a distinction.

It might be argued that the difference between the tasks results more from the types of operations that are performed on the inputs rather than the type of inputs that are used. For example, episodic recognition may involve a much more difficult discrimination than lexical decision, and this increase in difficulty may force additional processing of a type which gives greater scope for priming effects. This explanation would have more force if one could identify plausible candidates for this additional process. However, even if such a candidate is proposed, there is an additional complication, namely the difference in strength of priming in the episodic task as a function of direction of priming. Making episodic decisions about L2 words should be as difficult, or more difficult than making decisions about L1 words, yet the evidence for episodic priming from L1 to L2 is very weak at best (Experiments 4 and 5), while the evidence for L2–L1 priming is quite strong.

<table>
<thead>
<tr>
<th></th>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Translation</td>
<td>865 (17.0)</td>
<td>852 (14.6)</td>
</tr>
<tr>
<td>Unrelated</td>
<td>876 (18.7)</td>
<td>865 (13.9)</td>
</tr>
<tr>
<td>Priming</td>
<td>+11</td>
<td>+13</td>
</tr>
</tbody>
</table>
This difference makes it difficult to argue that it is purely task difficulty that is responsible.

Assuming for the moment that there is in fact no episodic priming from L1 to L2, the pattern of effects across the five experiments is very orderly. Not only is there an asymmetry in cross-language priming in lexical decision, there is also an asymmetry in priming for episodic recognition that is a mirror image of the lexical decision asymmetry. The fact that the two tasks produce opposite asymmetries means that we have a double dissociation between the factors of task and direction of priming. This double dissociation can be interpreted in at least two ways. One is to attribute cross-language priming in lexical decision and episodic recognition to the activation of different sets of connections. The assumption is that the lexical systems for each language may be connected at two different levels, one through shared conceptual representations and the other through direct lexical links between translation equivalents, as suggested by Kroll and Stewart (1994). On the basis of this model, one could argue that in a lexical decision task, only the conceptual route is involved. As the connections between lexical items in L1 and conceptual representations are strong, and those between L2 words and concepts are weak, priming should be expected from L1 to L2 only. When the task is episodic recognition, the only effective connections are the lexical links because these lexical links are episodic in nature. As the lexical connections from L2 to L1 are stronger than the reverse, only L2–L1 priming should be expected in episodic recognition (see Fig. 2).

This account suffers from two weaknesses. First, it simply stipulates that conceptual overlap is critical for priming in lexical decision, but not episodic recognition, without explaining why. Similarly, this account simply stipulates that lexical linkages are the only relevant agents in an episodic task, but are irrelevant in lexical decision. Second, Gollan et al. (1997) made the point that the masked priming paradigm is relatively insensitive to semantic factors. Semantic priming effects with this technique are usually very weak in a lexical decision task (less than 10 ms, e.g., Perea & Gotor, 1997), and hence it is problematic to attribute the much stronger translation priming effects to conceptual overlap.

An alternative approach involves the model illustrated in Fig. 1, which proposes that the L2 lexical system as a whole is represented in episodic memory. The dissociation between tasks is a result of differential involvement in the decision process of the lexical and episodic memory systems. As argued earlier, L2–L1 priming fails in lexical decision because although the L2 prime activates the episodic record of its translation equivalent term, L1*, the link from L1* back to the L1 lexicon is never activated, due to the fact that the L2 prime is masked. Since the decision is based on the state of L1, there is no way that the L2 prime can influence the decision. However, in episodic recognition this is not critical, since it is the activation of L1*, not L1, that controls the decision process. If it is assumed that the L2*–L1* link is always activated, regardless of whether the L2 prime is masked, then we can
explain why there is episodic priming from L2 to L1.

The weakest part of this explanation is the assumption that masking the prime prevents the L1*–L1 link from being activated, since this also is simply a stipulation. As suggested earlier, one might support this assumption by an appeal to modularity. The L1*–L1 link goes across two memory modules, and perhaps such linkages are not automatically activated, but require the intervention of some consciously controlled retrieval process. Thus, if an individual is aware of the L2 prime, then the association back to L1 can be followed. The fact that L2–L1 priming can be obtained in lexical decision when the L2 prime is not masked (e.g., Chen & Ng, 1989; Frenck & Pynte, 1987; Jin, 1990; Keatley et al., 1994) is consistent with this view.

Can this episodic model also explain why there is no L1–L2 priming in an episodic task, although there is in lexical decision? The pathways illustrated in Fig. 1 indicate that this is indeed a likely outcome. In this case, the episodic decision will be based on the state of L2*. Although the L1 prime activates its episodic record L1*, this does not activate L2* (the association is in the reverse direction). Therefore no priming is to be expected. Nevertheless, there is reason to expect priming in lexical decision. If we assume that lexical decisions about words in L2 are made by testing whether they activate a lexical entry in L1, then the decision will depend on the state of the lexical entry for L1. Clearly, the L1 prime will activate this entry, and hence priming is expected. Finally, L2–L2 priming would be expected, regardless of the task, because both prime and target activate L2* and L1*.

According to this model, both priming asymmetries are a consequence of asymmetric L2*–L1* connections. This is a key assumption of Kroll and Stewart’s (1994) model. They argue that lexical links from L2 to L1 are much stronger than those from L1 to L2 because understanding the meaning of words in L2 involves translating from L2 to L1. However, translation from L1 to L2 is seldom necessary in receptive processing, although it may be for production purposes. For these reasons, the model outlined in Fig. 1 shows no connections from L1* to L2*, since this is a model of language comprehension, not production.

Thus far, we have attempted to discuss priming in a relatively neutral fashion, using activation concepts and associative pathways, but have not considered the actual mechanism of priming. According to the entry-opening model of masked priming (Forster & Davis, 1984), priming occurs when the prime “opens” the entry for the target, where “entry” could be an episodic record or a lexical entry (Forster, 1985). This produces a savings, since certain computations necessary for recognition of the target have already been initiated by the time the target is presented. Such a savings model makes strong predictions about the amount of priming that could be expected, e.g., that priming will be a linear function of the SOA. This has been found to be the case for lexical decision (Forster & Mohan, 1996), but for present purposes it matters little whether priming is regarded as entry-opening, or as accumulation of activation, or as a temporary strengthening of connections. What seems more critical at this stage is an understanding of the pathways involved, of what is connected to what, and how task factors interact with those connections to produce priming.

A critical question that must be addressed is why lexical items in L2 should be represented in the episodic system. We start with the assumption that a lexical item must be associated with some kind of semantic content in order to be integrated into the lexicon. This is a reasonable assumption if we consider the critical role of
semantic content in speech communication. Merely discovering that a particular form is a word is not sufficient to create a lexical entry, although that fact may be registered in episodic memory. A study by Dagenbach, Carr, and Barnhardt (1990) supports this view. They found that only newly learned words whose meaning could be recalled produced semantic priming effects. Newly learned words whose meaning could not be recalled produced either no effect or an inhibitory effect.

When one first learns a language, words and concepts are often learned together. In this sense, the acquisition of lexical form and semantic content is tightly integrated. When a lexical entry is established, it inevitably contains links to semantic properties. However, in the learning of a second language, lexical development may take place in a very different way due to two practical constraints. The first is the poverty of input in terms of both quantity and quality. Unlike in first-language development, second-language learners, particularly those who learn a foreign language in a formal setting, often do not have sufficient, highly contextualized input in the target language that is critical in semantic development. Second, in late second-language acquisition, L2 words are typically learned after the semantic system and the L1 lexical system have been established. The established semantic and lexical systems constitute another barrier for semantic development in L2. When one learns a new word in L2, there is no need to develop a corresponding concept. Furthermore, the meaning of the word does not have to be inferred or extracted from the context. The word can be understood through its L1 translation equivalent. Consistent with the view of the involuntary involvement of L1 in L2 vocabulary acquisition, it has long been acknowledged that L2 learners, in particular adult learners, have a strong inclination to rely on L1 translations in learning new L2 words (Lado, 1957), a problem encountered by many L2 learners and teachers (e.g., Jenkin et al., 1993, p. 119).

Lexical development under such circumstances is conceivably very different from lexical development in the first language, as suggested by Jiang (2000). A significant difference in the present context is that very little semantic development is involved in the process of second-language vocabulary acquisition. As a result, little semantic information is integrated into the lexical entries of L2 words. What is associated with the L2 words is actually the semantic content from their L1 translations. When the meanings of L2 words and their L1 translations overlap to a high degree, these L2 words may be used correctly and with a certain degree of automaticity, creating the misleading impression that these words are fully developed with their own semantic content integrated in their entries. However, reality often reveals itself when an L2 word does not have a complete semantic overlap with its L1 translation. Under such a circumstance, L2 words are often used incorrectly, most likely in the way their L1 translation is used (e.g., Biskup, 1992; Hakuta, 1987; Lennon, 1991; Zughoul, 1991). In short, if semantic integration in lexical development is critical for words to be integrated into the lexicon, it is not hard to imagine that, with little semantic development involved in the learning process, L2 words are represented in a way different from L1.

Several research questions can be raised in connection with the episodic proposal made here. For example, it is interesting to note that brain imaging studies of bilinguals show striking differences in the cortical areas associated with L1 and L2 (e.g., Kim, Relkin, Lee, & Hirsch, 1997; Dehaene, Dupoux, Mehler, Cohen, Paulesu, Perani, van de Moortele, Lehericy, & Le Bihan, 1997). This is at least consistent with our assumptions. Another question is whether episodically represented L2 words are eventually integrated into the lexical system with extended exposure to the second language. All of the participants in this study learned English in secondary school in China and had very limited natural exposure to the language before their arrival in the United States. Most of them had lived in the United States for less than 2 years by the time of testing. The findings of the present study may reflect their English learning background and
thus are restricted to L2 learners who have limited natural exposure in L2. It is possible that a different pattern of findings will be obtained with participants who have lived in an L2 environment for an extended period of time. However, it is possible that once an L2 word is represented in nonlexical memory, it will always remain there. Some support for this hypothesis is provided by the finding that morphological and lexical development in L2 may fossilize even under the most desirable learning conditions (Long, 1997; Lardiere, 1998). If this hypothesis is true, then the pattern of asymmetries observed here may also be found for far more proficient bilinguals.

A related issue is the age at which L2 is acquired. If we assume that the neural plasticity of the language acquisition device is severely limited after puberty, as shown by some second-language acquisition studies (e.g., Johnson & Newport, 1989; Patkowski, 1980), then late learners might have to rely on an entirely different memory system to learn L2, one that remains plastic throughout the life of an individual. Early learners, however, may have learned both L1 and L2 with the same acquisition device, and hence both lexicons are located within lexical memory. If this view is correct, then we should find that early L2 learners do not show directional asymmetry in cross-language priming with lexical decision. In addition, there would be no reason to expect them to show cross-language priming in an episodic task. If we still find evidence of directional asymmetry, then this would suggest some kind of competitive mechanism between languages. That is, L2 is always relegated to the episodic system, no matter when it is learned. This remains an interesting question for future research.

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