HOW WORDS ARE REPRESENTED IN BILINGUAL MEMORY

by
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A Dissertation Submitted to the Faculty of the

GRADUATE INTERDISCIPLINARY DOCTORAL PROGRAM OF SECOND LANGUAGE ACQUISITION AND TEACHING

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College
THE UNIVERSITY OF ARIZONA

2010

THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

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ACKNOWLEDGMENTS

First, I would like to thank my supervisor, Dr. Kenneth Forster. Throughout my time at the University of Arizona, he has shared his passion for science, ideas for experiments, and understanding of how language is represented and processed. He has also been a wonderful mentor, in particular by encouraging me whenever I was discouraged (with experimental results, the job market, and publications). I am truly indebted to him. Thank you very much for your support.

My gratitude is also extended to the other members of my committee – Drs. Merrill Garret, Gayle DeDe and Janet Nicol. The meetings and email exchanges I had with them helped me to develop this dissertation into its current form. I also appreciate the encouragement they have given me over the years.

This dissertation was generously funded by a Language Learning Dissertation Grant (Blackwell Publishers) and a Cognitive Science Fellowship (University of Arizona). I would like to thank Nova Hinrichs for assisting me with the administrative work for this funding and for her patience with my often last-minute paperwork.

I would also like to thank Jeffrey Witzel and Xiaomei Qiao for the collaborative work we have done over the years. I have learned so much from them, and I look forward to continuing our work together.

Lastly, I would like to acknowledge my daughter, Maya Witzel. Her language development in American and British English, Japanese and Spanish has made me truly appreciate the multilingual mind.

DEDICATION

This dissertation is dedicated to –

大内　節子

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ABSTRACT

This dissertation examines the Episodic L2 Hypothesis (Jiang & Forster, 2001), which postulates that first language (L1) words are represented in a specialized system that is devoted to one's L1, i.e., lexical memory, and second language (L2) words are represented in a more general memory system that is not specialized for language, i.e., episodic memory. This idea was based on a double dissociation found in masked translation priming studies – i.e., L2-L1 translation priming is obtained in episodic recognition but not lexical decision, whereas L1-L2 translation priming is obtained in lexical decision but not episodic recognition (Jiang & Forster, 2001; Finkbeiner, 2005). These results are interpreted to show that the decision systems are tuned to episodic memory during the performance of episodic recognition task. Hence, since L2 words are represented episodically, L2 primes assist the recognition of L1 targets, while L1 words are represented lexically, so L1 primes do not assist the recognition of L2 targets.

A series of masked priming studies were conducted in this dissertation to further examines this Episodic L2 Hypothesis. Experiment 1 partially confirmed Jiang and Forster's (2001) results with highly-proficient L2 bilinguals, showing that these bilinguals indeed store their L2 words in episodic memory. Experiments 2 to 5 were

conducted to examine the "episodic" nature of this memory system by showing that newly-learned L2-like words can be effective as masked translation primes for L1 targets in episodic recognition but not in lexical decision. Experiments 6 to 8 were conducted to eliminate other possible accounts as to why there is a dissociation of L2-L1 translation priming between these two tasks. Finally, Experiment 9 offers further evidence to the Episodic L2 Hypothesis by using masked repetition priming in episodic recognition.

These studies, overall, lend support to the hypothesis that L2 words are indeed represented in episodic memory. The final chapter discusses the mechanisms behind masked translation priming, the nature of the memory system that L2 words are stored in, and generally on L2-L1 translation priming.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The interrelationship between the first (L1) and the second (L2) language in bilinguals has been a primary research interest in the bilingual language processing literature. Specifically, many studies have examined whether there are one or two lexicons, whether there is a shared or separate conceptual system(s), and whether there are different levels of representations (some of which may be shared or separate) (Jiang, 1998). In order to account for the mechanism of bilingual memory based on some of the findings pertaining to these questions, various models have been proposed (French & Jacquet, 2004; Kroll & Tokowicz, 2005). These models include the Revised Hierarchical Model (Kroll & Stewart, 1994; for the extended versions, see Jiang, 2000; Jiang & Forster, 2001), the Bilingual Interactive Activation Model (Dijkstra, 2005), and the Sense Model (Finkbeiner, Forster, Nicol, & Nakamura, 2004), to name a few. Specifically, these models illustrate how there may be differences between the size of the first and second language lexicon, differences or similarities between how meaning is retrieved, and differences in how rich the meanings of words in each language are.

Although these models are interesting and offer insight into how two languages in bilinguals are represented and processed, the specific question asked in this dissertation is how L2 words are represented in memory. Namely, this dissertation examines whether different memory systems are involved in how L1 and L2 words are represented. The specific model of interest is the Episodic L2 Hypothesis (Jiang & Forster, 2001), which postulates that while L1 words are represented in lexical memory, L2 words are represented in episodic memory. This model was based on findings from masked translation studies. Specifics of masked translation studies and this model are discussed in the following section.

1.2 Masked Translation Studies

The masked priming technique has become somewhat of a norm in studying lexical access. This technique has the advantage that most types of strategic effects can be averted. For instance, in a regular three-field masked priming paradigm, a 500-ms mask is followed by a 50-ms prime and a 500-ms target, with all stimuli superimposed on each other (Forster & Davis, 1984; see Figure 1.1 below). Because participants are not aware of seeing the prime, any reaction time differences are due to automatic lexical access. In an unmasked priming paradigm, on the other hand, primes are usually presented for a longer time, and thus, participants become aware of them, and this may introduce strategies such as anticipation (i.e., participants may become aware of the fact that some prime-target pairs are related, and may anticipate what the target is once they see the prime). Thus, masked priming has become the preferred norm. Of interest to this dissertation is whether masked priming effects can be obtained using translation equivalents as primes (i.e., translation priming). That is, would the target word *HISTORY* be responded to faster when it is preceded by a translation prime (in this case, in Chinese) *历史* (*history*) than when it is preceded by an unrelated prime *结果* (*results*)? Indeed, many studies have investigated this issue in order to explore the relationship between the two languages in bilinguals.

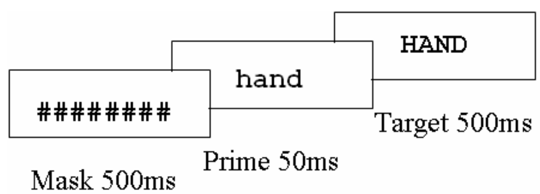

Figure 1.1. A regular three-field masked priming paradigm.

One very interesting finding in translation priming literature is the difference in results depending on which task is used. Lexical decision tasks, in which participants decide whether the letter string is a word or not, have yielded asymmetrical priming effects – i.e., priming is only observed in the L1-L2 direction (i.e., L1 prime and L2 target), with little or no effect in the L2-L1 direction (Gollan, Forster, & Frost, 1997 with Hebrew-English/English-Hebrew bilinguals; Grainger & Frenck-Mestre, 1998 with French-English bilinguals; Jiang, 1999 with Chinese-English bilinguals). Specifically, Jiang (1999) investigated whether different experimental manipulations could yield priming in the L2-L1 direction. These include controlling the stimulus onset asynchrony (henceforth, SOA) so that L2 primes have enough time to be processed before L1 targets are presented, and having both L1 and L2 targets within a block so that L2 words would be more activated (Jiang, 1999). However, L2-L1 translation priming failed to occur. This asymmetry raised a question about whether other tasks are able to yield L2-L1 translation priming, and if so, why.

One successful task for eliciting L2-L1 priming is the semantic categorization task. In this task, participants are required to decide whether the word on the screen falls under the given category (such as *ANIMAL*). Findings from this task have shown that translation priming effect can be observed in both L1-L2 and in L2-L1 direction (Finkbeiner et al., 2004, with Japanese-English bilinguals; Grainger & Frenck-Mestre, 1998, with French-English bilinguals; Wang & Forster, 2010, with Chinese-English bilinguals). Furthermore, when similar masking manipulations were applied in this task, it was shown that the regular three-field masking procedure was sufficient to produce priming in both directions (Wang & Forster, 2010). This finding clearly shows that masked L2 primes are capable of activating their meaning. Indeed, this set of findings was explained in terms of the number of senses (or meanings) L1 words and L2 words are able to activate. Specifically, it is generally assumed that L1 words activate more senses than L2 words. For instance, *dog* may activate the meaning as a pet animal as well as a way to describe a person, a type of food (such as hot dogs), and a mechanical device, if English was the L1. However, *perro* (i.e., *dog* in Spanish) may only activate the pet animal sense, if Spanish was the L2. The category, such as *ANIMAL*, in semantic categorization tasks narrows down the meaning activation to the relevant sense, and thus there is symmetrical priming in both directions. That is, the proportion of senses that is activated for the L1 and L2 words becomes more or less the same, and thus, there is priming in both directions (Finkbeiner et al., 2004). L1 primes in lexical decision tasks, on the other hand, activate all the senses L2 targets have while L2 primes are only able to activate a small portion of the senses L1 targets have, and therefore, priming is asymmetrical.

Another successful task is the episodic recognition task. In this task, participants first study a list of words. They are then tested on a speeded old-new task, in which they decide as rapidly as possible whether the word on the screen was one of the words that they learned on the study list (i.e., it is "old"). Again, as in the previous two tasks, a brief prime is presented prior to the target. Interestingly, in this task, a translation priming effect is observed in the L2-L1 direction (Finkbeiner, 2005; Jiang & Forster, 2001), but not in the L1-L2 direction (Jiang & Forster, 2001). Furthermore, Jiang and Forster (2001) showed that this L2-L1 priming effect is obtained only for "old" items (i.e., words that had been studied), while Finkbeiner (2005) revealed this priming for both “old” and “new” (i.e., words that had not been studied) items. Finkbeiner tested the same bilinguals twice with the same materials (although the sessions were at least six months apart), and only got priming effects in the second session. Thus, the priming effect for the “new” items in the second session may have been caused by the fact that the “new” items were represented episodically since it was the second time for the participants to see them. Lastly, this L2-L1 priming was only observed when a 50-ms blank and a 150-ms backward mask (i.e., ########) was inserted between the prime and the target (Finkbeiner, 2005; Jiang & Forster, 2001). However, such priming was not observed when the 50-ms blank and 150-ms backward mask were replaced with a 200-ms backward mask, despite the fact that the SOA was kept constant (Finkbeiner, 2005), nor when the regular three-field paradigm was employed (Jiang & Forster, 2001). How the masked priming technique affects the outcome of the results is explored in detail in Chapter 3. In any case, the general finding of this double dissociation between the two tasks (i.e., episodic recognition and lexical decision) and translation direction (i.e., L1-L2 and L2-L1) reveals something interesting in how L1 and L2 words are represented in memory, which led to the proposal of the Episodic L2 Hypothesis (as detailed in the following section).

There is one other notable hypothesis to consider in masked translation priming literature – i.e., the script hypothesis. In one of the first translation priming studies, it was shown that if the two languages were in the same script (specifically, Spanish and English, both of which use the Roman alphabet), translation priming could not be obtained in lexical decision unless the primes and targets are cognates (Sánchez-Casas, Davis, & García-Albea, 1992). This finding was recently confirmed (Davis, Sánchez-Casas, García-Albea, Guasch, Molero, & Ferré, in press). This was originally explained in terms of how the two lexicons were searched (Forster & Jiang, 2001). That is, if participants are unaware of the fact that two languages are involved in the experimental task, they may initially search for the prime in the wrong lexicon. In other words, if the targets are in one language *A*, and the primes are in another *B*, and the script does not give a good cue as to which lexicon is relevant, then the search for the prime may be launched in the lexicon associated with the target language *A*, i.e., the wrong lexicon. When the scripts are different (as in Hebrew-English and Chinese-English), then the search for the primes always takes place in the appropriate lexicon. Interestingly, however, in semantic categorization, such was not the case, and indeed, translation priming was obtained with French and English (Grainger & Frenck-Mestre, 1998). Furthermore, recent studies have shown translation priming in lexical decision even when two languages with the same script were involved, such as in Basnight-Brown and Altarriba (2007) with Spanish-English bilinguals, Duyck and Warlop (2009) with Dutch-French bilinguals, and Schoonbaert, Duyck, Brysbaert, and Hartsuiker (2009) with Dutch-English bilinguals.

Another interesting and recent phenomenon is the fact that studies that have found translation priming with two languages that share a script (i.e., Basnight-Brown & Altarriba, 2007; Duyck & Warlop, 2009; Schoonbaert et al., 2009) obtained translation priming in lexical decision in both L1-L2 and L2-L1 directions. This discrepancy from the original studies raises the possibility that L2 words may be represented in a different manner depending on the type of bilinguals. Specifically, these studies employed bilinguals who live in a multilingual environment. Although it is an interesting issue of how different types of bilingualism may affect the outcome of the results, the bilinguals in question in this dissertation are late bilinguals, i.e., those who started acquiring their L2 in the L1 environment.

Finally, it is important to note that although it is not quite clear why different tasks yield different patterns of translation priming results, it is still interesting that translations yield any priming at all especially because masked semantic L1-L1 priming is difficult to obtain. For instance, lexical decision tasks yield only weak within-language masked semantic priming, in which such priming is observed only when there is overlap both semantically and morphologically (Frost, Forster, & Deutsch, 1997) or at longer prime durations (i.e., 67 ms) (Perea & Gotor, 1997). Indeed, semantic priming has been described more as a strategic effect than one that is automatic (Smith, Besner, & Miyoshi, 1994). In semantic categorization tasks, however, masked semantic priming can be obtained when the relationship between primes and targets is synonymous, but only at longer prime durations for prime and target with associative relationship (Bueno & Frenck-Mestre, 2002). If we assume that translations have a synonymous relationship between languages, then the findings from semantic categorization makes sense in that synonyms yielded priming. However, it still remains a question as to why robust translation priming in L1-L2 direction in lexical decision can be obtained. Such findings seem to suggest that translations indeed have a special relationship in bilingual memory. This dissertation explores one possibility that may account for this relationship between translations.

1.3 The Episodic L2 Hypothesis

One of the most prominent models in the bilingual lexicon literature is the Revised Hierarchical Model (henceforth, the RHM; Kroll & Stewart, 1994; see Figure 1.2 below). The critical assumption of the RHM is that lexical representations in both the L1 and L2 are linked to their conceptual representations through what are called conceptual links. Also, L1 lexical representations and their corresponding L2 representations (i.e., translation equivalents) are directly connected to each other through lexical links. Both conceptual and lexical links are bidirectional, but asymmetrical in terms of strength. Since late bilinguals have already established strong conceptual associations between L1 lexical items and concepts, these conceptual links between L1 words and concepts are stronger than those between L2 words and their corresponding concepts. L2 lexical items, instead, have strong and direct connections to their L1 translations, while lexical links from L1 representations to their L2 translations are weak. This model presupposes that L2 learners rely on these lexical links from L2 words to L1 translations in order for them to retrieve the meanings of L2 words.

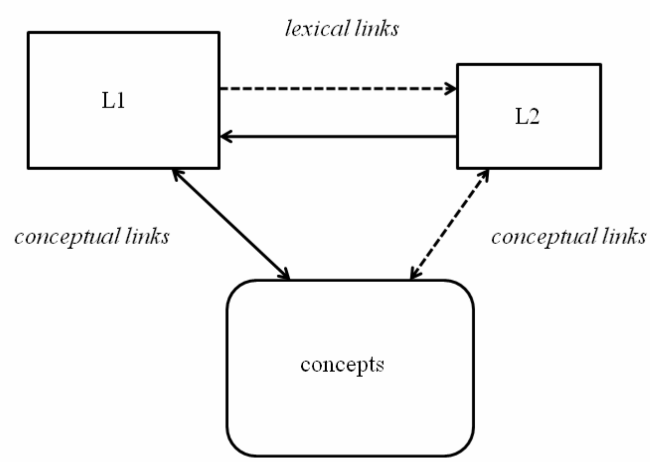

Figure 1.2. The Revised Hierarchical Model (adapted from Kroll & Stewart, 1994).

The original masked translation priming results from lexical decision tasks pose a problem for this RHM. If, indeed, there are these strong direct lexical (or translation) links from L2 words to their L1 translations, then why is L2-L1 translation priming not observed in this task? It would seem that, according to the RHM, there should be strong L2-L1 translation priming and weaker L1-L2 priming. Kroll and her colleagues later maintained that L1 words are more effective as masked primes because they can activate their meanings, while L2 words cannot (Kroll & de Groot, 1997; Kroll & Tokowicz, 2001). However, this does not explain why symmetrical translation priming effects can be obtained in semantic categorization tasks, the results of which would suggest direct meaning access from both L1 and L2. More importantly, this explanation also cannot account for the opposite asymmetry found with episodic recognition tasks, as shown in Jiang and Forster (2001). Indeed, findings from monolingual lexical access literature strongly suggest that semantic activation is not necessary for masked priming to occur. Notably, consider cases in which form priming can be obtained for nonword primes, such as *controct-CONTRACT* (see e.g., Forster, Davis, Schoknecht, Carter, 1987; Forster & Veres, 1998).

In order to better account for the findings from masked translation priming studies, Jiang and Forster (2001) extended the RHM by proposing that the lexical links from L2 to L1 may be stored episodically. This extension of the RHM (which henceforth will be called the Episodic L2 Hypothesis) was based particularly on the findings from episodic recognition tasks (in which only L2-L1 translation priming was obtained). Specifically, it was assumed that words can be represented in at least two different memory systems. One of these is lexical memory (a subset of semantic memory), which is devoted to storing linguistic information about words. The other is episodic memory, in which information about words can be stored, but only as they are associated with particular events or episodes (e.g., that a particular word had to be remembered as part of the experiment). Whenever a word is presented, its representations in both lexical memory and episodic memory are activated. In a lexical decision task, the decision system is selectively tuned to lexical memory, and thus, L1 primes can assist the recognition of L2 targets. L2 primes are stored in episodic memory, and so they cannot assist the recognition of L1 targets. In an episodic recognition task, on the other hand, the decision system is selectively tuned to episodic memory, and so L2 primes can assist the recognition of L1 targets. Since L2-L1 priming was observed only when decisions were based on feedback from episodic memory, Jiang and Forster (2001) concluded that the associations of L2 words with L1 words must be represented episodically, even for highly-proficient late bilinguals. Note also that Jiang and Forster (2001) could not demonstrate L1-L2 translation priming in an episodic recognition task, supporting this hypothesis that L1 primes cannot assist the recognition of L2 targets in this task because L1 words are stored lexically. Hence, the asymmetry in priming directions in the two tasks.

1.4 Episodic Memory System

So, what is this episodic memory in which L2 words and their corresponding L1 translations are supposedly stored? Originally, Tulving (1972) proposed that there are two distinct memory systems in declarative memory. One is semantic memory, and the other is episodic memory. Tulving (1972) describes semantic memory as a “mental thesaurus” (p. 386), in which information on general concepts are stored. Episodic memory, on the other hand, stores information about specific personal events and their temporal-spatial relations.

Given this definition of episodic memory, the suggestion that L2 words are stored episodically is somewhat surprising, especially for bilinguals whose L2 proficiency is very high. It is difficult to conceive that L2 words (with their L1 translations) would be stored in such a memory system, even at later stages of L2 development. Note that all the participants in the bilingual studies using episodic recognition tasks were graduate students at a university in the U.S. (Finkbeiner, 2005; Jiang &Forster, 2001). Even for such highly-proficient L2 users, this finding indicates that L2 words are stored in such a way that their effectiveness as primes is relevant only in episodic recognition tasks, and not in lexical decision tasks, which is why Jiang and Forster (2001) reached their conclusion. However, is it at all plausible to suggest that these highly-proficient bilinguals remember the context in which these L2 words were originally learned?

Indeed, there have been several studies indicating that even L1 words can have episodic memory traces, and that these memory traces can be primed. For instance, Forster (1985) demonstrated that after four sessions of learning obsolete words (e.g., *holimonth*), these words can yield masked repetition priming in lexical decision. However, when an episodic recognition task was used, masked repetition priming was obtained only for "old" items (i.e., familiar words that have been studied previously in the experiment), but not for "new" items (i.e., familiar words that have not previously been studied). This was the case for both high-frequency words and low-frequency words. A similar finding was also observed by Rajaram and Neely (1992), in which both studied and unstudied words and studied nonwords yielded masked repetition priming (but not unstudied nonwords) in lexical decision, and only studied words and nonwords produced masked repetition priming in episodic recognition. Thus, L1 words that are represented lexically can indeed have episodic memory traces, which can thus be primed. Following these findings, an attempt was made to obtain masked priming effects for newly-learned randomly paired associates (e.g., *city-grass*). In lexical decision tasks, in which *city* was the masked prime and *GRASS* was the target, priming was only obtained at 150-ms prime duration (McKoon & Ratcliff, 1979; 1986; Durgunoğlu & Neely, 1987). Interestingly, however, in episodic recognition tasks, such priming was obtained at 150-ms prime duration (Neely & Durgunoğlu, 1985), and surprisingly, even at a regular masked prime duration (i.e., 50 ms) (Bradley, 1991, as cited in Jiang & Forster, 2001, p. 34). Thus, it is not too bizarre for L2 words and their associations to L1 translations to have episodic representations. However, the implications of the L1 literature is that established L1 words can temporarily have episodic status in experimental environment (as in Forster, 1985; see also Rajaram & Neely, 1992), or that newly-acquired L1 words would later develop to have lexical status (as in Qiao, 2009). However, the implication of the

Episodic L2 Hypothesis is that L2 words in late bilinguals never develop to have lexical representations. Can this indeed be the case?

1.5 Research Questions

The main purpose of this dissertation is to further understand the asymmetry obtained in masked translation priming studies using lexical decision tasks and episodic recognition tasks. Specifically, why do lexical decision tasks produce masked L1-L2 translation priming, but not L2-L1, while episodic recognition tasks produce masked L2-L1 priming, but not L1-L2? The Episodic L2 Hypothesis (Jiang & Forster, 2001) will provide the framework in order to test the possibilities of different memory systems involved in representing and processing L1 and L2 lexicons. The specific questions in this dissertation are as follows:

(1) Can the effect found in Jiang and Forster (2001) (i.e., L2-L1 translation priming in episodic recognition task) be confirmed with the same type of bilinguals (i.e., highly-proficient bilinguals) used in their study?

(2) Can this effect be replicated with pseudo-bilinguals whose L2 words are obviously represented episodically?

(3) How are episodic recognition tasks different from lexical decision tasks that they produce different effects?

(4) Are there alternative ways in which the Episodic L2 Hypothesis can be tested?

Prior to further investigating the Episodic L2 Hypothesis, it is necessary to replicate the Jiang and Forster (2001) findings that the model was based on. Thus, masked translation priming in both L1-L2 and L2-L1 directions were tested using the lexical decision task and the episodic recognition task. The same population in Jiang and Forster (2001) was tested. They are highly-proficient Chinese-English bilinguals, who are graduate students, research staff, or faculty associated with the University of Arizona. The results from this experiment are reported in Chapter 2.

The purpose of Chapter 3 is to provide a direct test of the "episodic" interpretation of Jiang and Forster's (2001) result. To achieve this, native English speakers were taught a limited set of words in a language they did not know – Basque. After the English translations of these words were learned, the Basque words were then used as masked primes to see whether they would prime their English translations in a lexical decision task and in an episodic recognition memory task. Since the priming experiment followed immediately after the learning phase of the experiment, it was obvious that these Basque words must have been represented episodically.

Chapter 4 examines the difference between episodic recognition tasks and lexical decision tasks. Jiang and Forster (2001) posited that the decision system is tuned selectively to different memory systems – specifically, it is tuned to episodic memory in the episodic task and lexical memory in the lexical task. This chapter explores the possibility of other factors affecting the masked translation priming asymmetry. In particular, three experiments are reported testing whether a congruence effect is obtained in episodic recognition task, whether frequency of stimuli used in Chapter 3 were low-frequency, and whether episodic tasks are more sensitive to semantic associations than lexical decision tasks.

Chapter 5 attempts to confirm the Episodic L2 Hypothesis by employing a paradigm other than masked translation priming. Specifically, it reports findings from a study using masked repetition priming in an episodic recognition task. Recall that Forster (1985) and Rajaram and Neely (1992) found repetition priming for "old" items but not for "new" items in an episodic recognition task with native English speakers. This finding demonstrates that the episodic recognition task truly taps into episodic memory in that only "old" items show priming. This would also suggest that if bilinguals store L2 words episodically, then priming should be obtained for both "old" and "new" items. This chapter reports findings comparing native English speakers and highly-proficient Chinese-English bilinguals.

Finally, the last chapter provides a summary of the dissertation.

CHAPTER 2

REPRESENTATIONS OF ESTABLISHED L2 WORDS

The purpose of this chapter is to confirm the basic findings in Jiang and Forster (2001) and Finkbeiner (2005). These are the only two studies that have shown translation asymmetry in episodic recognition tasks thus far, that reveal L2-L1 translation priming in episodic recognition but not in lexical decision. Thus, before examining the intricacies of the Episodic L2 Hypothesis, it was deemed necessary to confirm this asymmetry.

Again, two types of tasks are of interest in this dissertation – one is the lexical decision task and the other is the episodic recognition task. Recall that in lexical decision tasks, the participants are required to decide whether the letter string on the screen is a word or not. In episodic recognition tasks, the participants first study a set of familiar words. Later, in a speeded old-new task, they decide whether the word on the screen is a word that they had studied earlier on. In both lexical decision and episodic recognition tasks, the target words are preceded by masked primes.

Two different masking procedures are used in this chapter. For the L1-L2 condition (Experiment 1b), the regular three-field technique is used (Forster & Davis, 1984). However, for the L2-L1 condition (Experiment 1a), following previous studies testing this particular masked translation priming asymmetry in episodic tasks (Finkbeiner, 2005; Jiang & Forster, 2001), an interpolated mask will be inserted between the prime and the target. This interpolated mask consisted of a 50-ms blank screen and a 150-ms backward mask. Thus, instead of a regular three-field masking paradigm (i.e., a mask for 500 ms, a prime for 50 ms, and then the target for 500 ms), they presented the stimuli as follows: a mask for 500 ms, a prime for 50 ms, a blank for 50 ms, another mask for 150 ms, and a target for 500 ms (see Figure 2.1). The original reasoning behind this interpolated mask was to give more time for processing L2 primes before the onset of L1 targets (Jiang, 1999; Jiang & Forster, 2001). Indeed, this L2-L1 translation priming effect in episodic recognition tasks has only been observed under this specific condition. For instance, Finkbeiner (2005) failed to find this effect with Japanese-English bilinguals when the prime was followed by a 200 ms backward mask, thus using the same prime-target interval as the 50-ms blank and 150-ms backward mask. Jiang and Forster (2001) also failed to observe this effect when the target immediately followed the prime (i.e., the regular three-field masking procedure). It is important to note that even though this interpolated mask appears to be essential for L2-L1 translation priming in episodic tasks, it is not essential for lexical decision tasks (Jiang, 1999; Jiang & Forster, 2001). Whatever the case, in order to truly replicate Jiang and Forster (2001), this masking procedure with the interpolated mask was used in Experiment 1a.

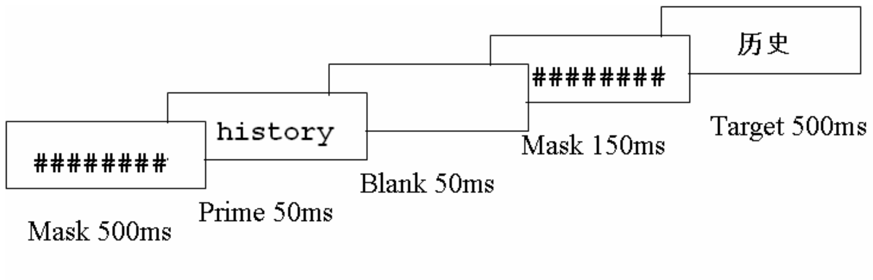

Figure 2.1. *Masking technique employed in the L2-L1 translation condition for both episodic recognition and lexical decision tasks.*

2.1 Experiment 1

In this experiment, Chinese-English bilinguals are tested in the L2-L1 condition (Experiment 1a) and in the L1-L2 condition (Experiment 1b) in both episodic recognition and lexical decision. If L2 words are indeed represented episodically, then L2-L1 translation priming is expected only in episodic recognition and not in lexical decision.

2.1.1 Method

2.1.1.1 Participants

Thirty-two Chinese-English bilinguals participated in this experiment. These bilinguals closely matched those that were tested in Jiang and Forster (2001). Specifically, they were all affiliated with the University of Arizona as graduate students, research staff, or faculty. All of them were native speakers of Mandarin Chinese and were from Mainland China. In order to be affiliated with the University of Arizona as professional staff, international personnel must have a minimum TOEFL score of 550 paper based (PB) or 79 internet based (iBT). They all started learning English in middle school and received a minimum of 8 years of formal instruction. Half of the participants took the L2-L1 condition (Experiment 1a) first, and the other half took the L1-L2 condition (Experiment 1b) first. They were paid USD5.00 for each experiment.

2.1.1.2 Materials and Design

Experiment 1a: *Episodic recognition task*: The stimuli for this task included 64 English-Chinese translation pairs. These critical items were the same 64 English-Chinese translation pairs used in Jiang (1998). These 64 critical items were divided into two lists for this experiment. In order to make two sets of items, frequency (based on CELEX database; Baayen, Piepenbrock, & van Rijn, 1995) and imageability (based on MRC Psycholinguistics Database; Coltheart, 1981) were calculated on the English items using N-Watch (Davis, 2005). Based on these calculations, the two lists were created so that the English words on each set were roughly matched in frequency and imageability. One list of these English-Chinese translation pairs were studied by the participants prior to the critical task, thus serving as the “old” items, the other list was not studied, and thus serving as the “new” items. In addition to these 64 critical stimuli pairs, 4 more English-Chinese translation pairs were included in this experiment to serve as practice items.

Lexical decision task: The stimuli for this task involved 32 English-Chinese translation pairs. Again, these stimuli were taken from the 64 English-Chinese translation pairs used in Jiang (1998). In order to equalize the influence of study status (i.e., “old” vs. “new” in the episodic task) in this task, half of the translation pairs in this task were “old” items in the episodic task, and the other half were “new” items. Again, these 16 “old” items and 16 “new” items were somewhat matched in frequency and imageability.

Experiment 1b: The items were selected in a similar manner to Experiment 1a. The 64 Chinese-English translation pairs that were used in Jiang (1998) were resorted so that the English words in the “old” items and in the “new” items for the episodic task were again roughly matched in frequency and imageability. Sixteen words from each of these new set of “old” and “new” items were selected (again, roughly matched in frequency and imageability for English words) to serve as the items for the lexical decision task. Thus, the “old” items in episodic recognition task in Experiment 1a did not completely overlap with the “old” items in Experiment 1b. The same was true for the “new” items and the items used in lexical decision task. The English nonwords for lexical decision were also taken from Jiang (1998).

Each of these English-Chinese/Chinese-English translation pairs (in both the episodic recognition and lexical decision tasks) was also paired with another randomly chosen word, which served as an unrelated control prime for each experiment. The language of these control primes was the same as the related prime in the same experiment. In addition to these English-Chinese translation pairs, another 32 Chinese nonwords were included to serve as nonword distractors in the lexical decision task. Again, these nonword distractors were taken from Jiang (1998).

For each task, two counterbalanced lists of items were constructed such that each Chinese target word appeared in both the related and unrelated conditions across lists, but not within lists. The episodic task employed a 2x2x2 design, with list (the counterbalancing feature), study status (old, new), and prime-target relation (translation, unrelated) as factors. The study status and the prime-target relation were within-subject factors. The lexical decision task employed a 2x2 design, with list (the counterbalancing feature) and prime-target relation (translation, unrelated) as factors. Again, the prime-target relation was within-subject factor.

2.1.1.3 Procedure

This and all the subsequent experiments were controlled using the DMDX experiment software (Forster & Forster, 2003) on a Pentium PC. Items were presented as black letters on a white background (Courier New 12 pt font for English words and SimSum 11 pt font for Chinese words) using a color monitor with a refresh cycle of 10 ms.

Experiment 1a: Participants first studied a list of 34 Chinese words (i.e., 32 “old” experimental stimuli and 2 practice items). These words were presented three times. During the first two presentations, each word was presented on the screen for 3 seconds after a mask for 500 ms (a row of five hash marks "#####") (the purpose of the mask here was only to serve as a ready signal). The next item followed automatically with occasional rest intervals. In the last presentation of the Chinese words, seven to nine words were presented on the screen, and participants were allowed to have them on the screen for as long as they wanted.

This study phase was immediately followed by the test phase, in which participants first took the speeded old-new task (i.e., episodic recognition task) and then the lexical decision task. In both tasks, the participants were presented with a mask for 500 ms (a row of ten hash marks "##########"), immediately followed by a prime for 50 ms (e.g., an English word *history*), a blank screen for 50 ms, a backward mask for 150 ms (another row of hash marks), and then the target for 500 ms (e.g., the Chinese word *历史*) (see Figure 2.1; following Jiang & Forster, 2001). In the speeded old-new task, the participants decided whether the word on the screen was one of the words on the study list ("*Was this Chinese word on the list of words you studied?*"). In the lexical decision task, the participants decided whether the presented letter string was a Chinese word or not ("*Is this a Chinese word?*"). The participants were asked to press the YES and NO buttons to indicate their response. Correct-incorrect feedback and response times were given every time participants made a response.

Experiment 1b: There were several differences from Experiment 1a – first, participants studied a list of 34 English words (with 32 “old” critical stimuli and 2 practice items) instead of Chinese words. This was followed by a speeded old-new judgment task, and then by a lexical decision task, in which a regular three-field masking technique was assumed.

2.1.2 Results

Incorrect responses were discarded, and outliers that were shorter than 300 ms and longer than 1500 ms were rejected. Rather than carrying out a conventional F1 and F2 analysis in which either items or subjects are treated as fixed effects, the results were analyzed using linear mixed effects modeling in R (Baayen, 2008; Baayen, Davidson, & Bates, 2008; Pinheiro & Bates, 2000). This method allows for two crossed random effects (Subjects and Items), and analyzes the transformed reaction times (RTs) for each Subject x Item combination, without aggregating over items or subjects. As suggested by Baayen (2008), instead of using raw RTs, transformed RTs were employed in this and all subsequent experiments. Specifically, in this dissertation, analyses using a reciprocal transformation are reported. This transformation was selected rather than a log transformation on the grounds that visual inspection of the resulting distributions indicated a better approximation to a normal distribution. These linear mixed effects modeling analyses were carried out separately for the “old” and “new” conditions in the episodic task and for the lexical decision task. In each analysis, the fixed effect factor was Priming (whether the prime was a translation or not), with Subjects and Items as random factors. Lists was not included as a factor, as the coding assigned to the items (the item number) indicated that a counterbalanced design was used, so that the same targets appeared in both lists, but with a related prime in List A and an unrelated prime in List B, and vice versa. Thus, the factor of Priming was a repeated measures factor. The probability of the resulting t value was estimated using a Monte Carlo procedure (MCMC) using 10,000 iterations.

<u>Experiment 1a</u>: Table 2.1 presents the mean reaction time and percentage error rates for L2-L1 priming. The analysis using linear mixed effects modeling showed that priming for “old” items (20 ms) in the episodic task was significant (t = 2.29, p = 0.0290). However, priming for “new” items (-3 ms) was not (t = 0.09, p = 0.9164). Similarly, priming in the lexical decision task (1 ms) was not significant, either (t = 0.37, p = 0.7256). There were no significant error rate differences.

<u>Experiment 1b</u>: Table 2.2 presents the mean reaction time and percentage error rates for L1-L2 priming. The analysis of the priming effects using linear mixed-effects modeling showed that priming for the “old” items (55 ms) in the episodic task was

significant (t = 6.77, p = 0.0001), as well as for the "new" items (23 ms) (t = 2.14, p = 0.0364). Priming in the lexical decision task (39 ms) was significant as well (t = 5.73, p = 0.0001). Interestingly, percentage error rates for the "new" items were significantly different (z = 2.137, p = 0.0326), with unrelated items producing less errors.

Table 2.1. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for L2-L1 translation priming in episodic recognition and lexical decision in Experiment 1a.

	Episodic recognition		Lexical decision
	Old	New	
Translation	642 (13.5)	727 (22.0)	524 (1.4)
Unrelated	662 (13.5)	724 (19.1)	525 (1.2)
Priming	20*	-3	1

Table 2.2. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for L1-L2 translation priming in episodic recognition and lexical decision in Experiment 1b.

	Episodic recognition		Lexical decision
	Old	New	
Translation	674 (8.5)	791(18.7)	639 (2.8)
Unrelated	729 (10.0)	814 (14.6)	678 (3.6)
Priming	55***	23*	39***

2.1.3 Discussion

The results of these two experiments (i.e., Experiments 1a and 1b) did not fully replicate the Jiang and Forster (2001) findings. The L2-L1 condition (Experiment 1a) was replicated as anticipated – L2-L1 priming was found for the “old” items but not for the “new” items in the episodic recognition task, and no priming was obtained in the lexical decision task. Interestingly, however, the L1-L2 condition (Experiment 1b) showed a different pattern of results. Specifically, L1-L2 priming was found across the board – for both “old” and “new” items in episodic recognition, and in lexical decision. How could we account for these findings?

The explanation of this effect appears to involve two issues: (i) which memory system the decision system is tuned into, and (ii) what L1 and L2 primes can activate automatically. When a masked L2 prime is presented, by hypothesis, this prime, like other L2 words, activates its representation in episodic memory. However, this L2 prime may only be able to activate its episodically-represented L1 translation (i.e., the “old” items) and not its lexically-represented L1 translation. When the task is episodic recognition, the decision system is tuned to feedback from episodic memory. Therefore, there is L2-L1 priming for the “old” items in this task, and not for the “new” items. When the task is lexical decision, this decision system is now tuned to feedback from lexical memory. Since episodically-represented L2 primes are not able to activate its lexically-represented L1 translation, there is no L2-L1 priming in lexical decision. L1 primes, on the other hand, can activate information in both lexical memory and episodic memory. Hence, no matter what the task is, as long as episodic information becomes available early enough so that it can influence the response (which would always be the case with L2 targets since they are only represented episodically), there would be L1-L2 priming. Indeed, Forster (1985) concluded that an L1 stimulus could activate any type of representation. Therefore, a lexical L1 prime could activate both its lexical and episodic records (if any existed). So the existence of L1-L2 translation priming in episodic recognition tasks does not mean that those L1 words are only episodic.

Note that Jiang and Forster (2001) originally proposed that the decision system is selectively tuned to the feedback from lexical memory while performing lexical decision, and ignores feedback from the episodic system. However, this does not explain the L1-L2 results in this experiment, nor the existence of long-lag repetition priming. Since there is evidence that long-lag repetition priming is not due to improved perceptual identification (Vriezen, Moscovitch, & Bellos, 1995), it seems that lexical decisions must be influenced by feedback from the episodic memory system. For example, it has been argued that the simultaneous reception of information from both memory systems indicating that they have a record of the stimulus increases the probability that the input is a word, which leads to a faster decision (Forster and Davis, 1984). In order for this to occur, the episodic feedback must become available before a decision based on lexical feedback is made, which explains why such long-lag repetition effects are usually stronger for low-frequency words than for high-frequency words (Scarborough, Cortese, & Scarborough, 1977). Old-new decisions, on the other hand, would be based solely on episodic feedback. Thus, in the L2-L1 condition, lexical feedback for the L1 target becomes available before episodic information has any effect on the response and so there is no priming in lexical decision tasks. Since the "old" L1 targets would have episodic records, there is priming for these items in episodic recognition tasks, but not for the "new" L1 items. In the L1-L2 condition, however, since L2 targets only have episodic representations, episodic feedback is the only available source of evidence. Thus, there is priming in lexical decision, and for both "old" and "new" items in episodic recognition. Indeed, this explains why L2 words are able to yield masked repetition priming in lexical decision (Gollan et al., 1997; Jiang, 1999), and also why similar priming effects are obtained for newly-learned words, such as *holimonth* (Forster, 1985). That is, if the target words only have episodic representations, then the task becomes episodic and not lexical. Interestingly, Jiang and Forster (2001) also express doubt as to why they were not successful in obtaining L1-L2 translation priming in episodic recognition considering the fact that other studies seem to suggest that lexical decision tasks become episodic when the targets are only represented episodically (see also Forster & Jiang, 2001).

Taken together, the findings from this Chinese-English bilingual population are consistent with the hypothesis that L2 words are represented in episodic memory, or at least in a memory system that is not directly tapped in a lexical decision task. This supports the Episodic L2 Hypothesis, namely that even with highly-proficient bilinguals, L2 words are stored in a memory system that is not specific to language processing. In the following chapter (Chapter 3), the extent to which the memory system in which L2 words are stored can be characterized as “episodic”.

CHAPTER 3

REPRESENTATIONS OF NEWLY-LEARNED L2 WORDS

The experiment reported in Chapter 2 with Chinese-English bilinguals support the Episodic L2 Hypothesis. Specifically, these bilinguals appear to represent their L2 words in episodic memory. This was shown by the significant translation priming effect for “old” items in episodic recognition in the L2-L1 direction and also by the significant repetition priming effect for both “old” and “new” L2 items in episodic recognition.

Now that Jiang and Forster (2001) results have been replicated, it would be interesting to explore the extent to which the memory system in which L2 words are stored can be characterized as “episodic”. In order to test whether the “episodic” interpretation of Jiang and Forster’s (2001) results is valid, native speakers of English were taught a limited set of words in a language they did not know – Basque. After the English translations of these words were learned, the Basque words were then used as masked primes to see whether they would prime their English translations in a lexical decision task and in an episodic recognition memory task. Since the priming experiment followed immediately after the learning phase of the experiment, it seems obvious that these Basque words must have been represented episodically.

There are two reasons for choosing Basque as the second language for these sets of experiments. First of all, Basque is a language isolate. That is, even if there are native English speaker participants who may have learned another foreign language, Basque will not be similar to any of those languages. Secondly, Basque has unique orthotactic constraints (such as allowing *tx* as a legal spelling combination). As mentioned in Chapter 1, it has been shown that in a lexical decision task, translation priming is not obtained in languages that share the same script (Forster & Jiang, 2001; Gollan et al., 1997). This lack of priming is accounted for in terms of how the prime is accessed in the two lexicons. The assumption is that the target language lexicon is accessed first and then the prime language lexicon. Thus, the search for the prime starts in the wrong lexicon. By the time the prime is accessed in the appropriate lexicon, participants may have already made their decision on the target word. Hence, the participants may search for the Spanish prime word in the English lexicon (when the target words are in English). Therefore, no priming is observed. If the scripts are different, however, the script gives a cue to search the appropriate lexicon. However, a recent study revealed that cross-language (semantic) priming can be obtained in lexical decision tasks with Basque-Spanish bilinguals (Perea, Duñabeitia, & Carreiras, 2008), in which the script is the same. This could perhaps be explained in terms of the differences in their orthotactic rules. That is, although Basque and Spanish both use the same Roman alphabet, the spelling conventions were different enough that the bilingual participants were able to search the appropriate lexicon.

The following set of experiments investigate whether a dissociation between episodic recognition and lexical decision tasks can be obtained with “pseudo-bilinguals”, whose L2 Basque words are represented episodically. That is, would these episodically-represented Basque words behave similarly to the established L2 words (as in Experiment 1), in that the Basque words will prime their L1 English translations in episodic recognition, but not in lexical decision? If these episodically-represented Basque words replicate established L2 words, then this would give partial support to the Episodic L2 Hypothesis that proposes that L2 words are represented in episodic memory even for “true” bilinguals.

3.1 Experiment 2

3.1.1 Method

3.1.1.1 Participants

Thirty-two undergraduate students at the University of Arizona participated for course credit. All participants were native speakers of English.

3.1.1.2 Materials and Design

The stimuli included 24 Basque-English translation pairs. In addition to these 24 pairs, 4 more pairs were included as practice items. Thus, the participants learned the Basque translations of these 28 items. These items were selected as follows. First, all the nouns in the *MacArthur Communicative Development Inventory: Infants (CDI)* (Dale & Fenson, 1996) were selected. CDI gives a list of English words that American infants first learn. Words from CDI were chosen because presumably the words that infants first learn have basic and concrete concepts, and therefore, are all easy to learn. For all the nouns that were selected, the Basque translations were looked up using the Basque-English, English-Basque Dictionary (Aulestia & White, 1992). If either of the word in each Basque-English translation pair was longer than 8 letters or shorter than 3, that pair was not used. If the Basque word and its English translation appeared to be cognates of each other (such as *elefante-elephant*), then, that pair was not used either. In addition to this, it was ensured that none of the Basque words that were employed as the test stimuli were cognates of their Spanish translations. This was to avoid participants using Spanish to learn the Basque words.

Each of the 24 English targets was also paired with another randomly chosen Basque word, which served as an unrelated control prime. These targets served as “old” items in the episodic recognition task, and a new set of unstudied English words served as “new” items. These targets were also preceded by a masked prime. All of these 48 Basque-English stimuli appeared in both the lexical decision task and the episodic recognition task. Only the “old” items were crucial in both tasks. In addition, 48 English nonwords were created using the ARC Nonword Database (Rastle, Harrington, & Coltheart, 2002) to serve as nonword distractors in the lexical decision task.

For each task, two counterbalanced lists of items were constructed such that each target word appeared in both the related and unrelated conditions across lists, but not within lists. Both tasks employed a 2x2x2 design, with list (the counterbalancing feature), study status (old, new), and prime-target relation (translation, unrelated) as factors. The study status and the prime-target relation were within-subject factors.

3.1.1.3 Procedure

Participants were first trained on the Basque words. The initial presentation of each Basque word consisted of the following sequence: a mask for 500 ms (a row of eight hash marks ########), a Basque word for 500 ms, a blank screen for 500 ms, and the English translation for 2000 ms (the purpose of the mask here was only to serve as a ready signal). The next item followed automatically, and a rest interval was provided after each block of seven items. During the second presentation of the Basque words, the blank interval was increased to 1000 ms and participants were encouraged to try to anticipate the English translation. After being presented with the new Basque words twice, the participants were tested in a two-alternative forced choice task, in which the Basque word was followed by two English words. They were asked to decide which of the two English words was the appropriate translation of the Basque word. The incorrect alternative was always another “old” item. The presentation sequence for this task was as follows: a mask for 500 ms, the Basque word for 500 ms, and the two English words for 500 ms. This procedure was repeated five times, except that if participants made less than two errors in one of these blocks, this task was terminated, and they proceeded to the next task. The final component of the training phase consisted of a lexical decision task in Basque, in which participants decided whether the target item was a Basque word they knew or not. This consisted of the Basque words in the “old” and the “new” items. The presentation sequence for this task was a mask for 500 ms, a blank screen for 500 ms, and the target word for 500 ms. In the two-alternative forced choice tasks and the lexical decision task in Basque, correct-incorrect feedback and response times were given every time participants made a response.

The training phase was immediately followed by the test phase, in which participants first took the episodic recognition task and then the lexical decision task. The tasks were given in this particular order because both tasks used the same “old” and “new” stimuli. If the lexical decision task came first, then the speeded old-new task (i.e., deciding which words were presented earlier in the experiment) would become more difficult since they have already seen the “new” items in lexical decision. In both tasks, the participants were presented with a mask for 500 ms (again, a row of eight hash marks *########*), immediately followed by a prime for 50 ms (e.g., a Basque word *esku*), a blank screen for 50 ms, a backward mask for 150 ms (another row of hash marks), and then the target for 500 ms (e.g., the English word *HAND*). This masking technique is the same as Experiment 1 and in Jiang and Forster (2001). In the speeded old-new task, the participants decided whether the word on the screen was one of the words on the study list (“*Was this English word on the list of words you studied?*”). In the lexical decision task, the participants decided whether the presented letter string was an English word or not (“*Is this an English word?*”). As in Experiment 1, these experiments were also controlled using the DMDX experiment software (Forster & Forster, 2003). The participants were asked to press the YES and NO buttons to indicate their response. Correct-incorrect feedback and response times were given every time participants made a response.

3.1.2 Results

As in Experiment 1, incorrect responses were discarded, and outliers that were shorter than 300 ms and longer than 1500 ms were also rejected. The mean reaction times and percentage error rates are presented in Table 3.1. The fixed effects factor was Priming with Subjects and Items as random factors. The analysis of the priming effects using linear mixed-effects modeling showed that priming in the episodic task (53 ms) was significant (t = 7.06, p = 0.0001). Priming in the lexical decision task (6 ms), on the other hand, was not (t = 1.11, p = 0.2612). There was also a significant interaction between these two tasks (t = 4.32, p = 0.0001). Interestingly, the percentage error rate data showed similar pattern in results in that significant priming effect in the episodic task (z = 2.154, p = 0.0313), but not in the lexical decision task (z = 0.764, p = 0.445).

Table 3.1. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for L2-L1 translation priming in episodic recognition and lexical decision in Experiment 2.

	Episodic recognition	Lexical decision
Translation	518 (5.0)	474 (3.9)
Unrelated	571 (9.1)	480 (2.9)
Priming	53***	6

3.1.3 Discussion

The results of Experiment 2 replicate the findings of Jiang and Forster (2001) and Experiment 1 in that masked L2-L1 translation priming is obtained for “old” items in an episodic recognition task, but not in a lexical decision task. Specifically, this shows that the Basque words function as very effective primes when participants are making old-new judgments about the studied English words, but not when they are making lexical decisions about the very same words. Since the Basque-English connections for these “pseudo-bilinguals” had only been recently learned, they were presumably stored in episodic memory, and therefore it seems difficult to resist the inference that decisions in the two tasks are based on information from two different memory systems, and that the connection between the Basque words and their English translations are represented in one system, and the English words themselves are represented in the other. Thus, the presence of priming in the old-new task is consistent with the Episodic L2 Hypothesis that L2 words and their lexical links to L1 are represented in episodic memory.

3.2 Experiment 3

The secondary purpose of this chapter is to explore whether the interpolated mask used in the L2-L1 condition is necessary. According to Finkbeiner (2005), the only way in which L2-L1 priming could be obtained in episodic recognition is when interpolated masks (i.e., 50-ms blank and 150-ms backward mask between prime and target) were employed. Specifically, he failed to obtain such priming when a 200-ms backward mask was used instead. Thus, despite keeping the SOA constant, this 50-ms blank and 150-ms backward mask was necessary to show priming. Finkbeiner posits that the blank after the prime produces a “ghosting effect”, or iconic persistence (Coltheart, 1980; Sperling, 1960) – an illusion that the prime is on the screen longer than it actually is (in this case, 100 ms). However, Wang and Forster (2010) found that such an interpolated mask was unnecessary to observe L2-L1 translation priming in a semantic categorization task. That is, their Chinese-English bilingual subjects showed priming even when a regular three-field masking procedure was used. Thus, this issue of interpolated mask was explored in this and the following experiments (Experiments 4 and 5).

3.2.1 Method

3.2.1.1 Participants

Thirty-two undergraduate students at the University of Arizona participated for course credit. All participants were native speakers of English. None had participated in Experiment 2.

3.2.1.2 Materials and Design

The materials and design were identical to those used in Experiment 2.

3.2.1.3 Procedure

The procedure was almost identical to that used in Experiment 2, except that the stimuli presentation technique during the lexical decision task and the speeded recognition task in the episodic recognition was different. In order to eliminate iconic persistence mentioned above, the blank and the backward mask following the prime were removed. Thus, the lexical decision and episodic recognition tasks in this experiment employed the regular three-field priming procedure. This consisted of a mask for 500 ms, a prime for 50 ms, and then a target for 500 ms.

3.2.2 Results

The mean reaction times and percentage error rates are presented in Table 3.2. The analysis of the priming effects using linear mixed-effects modeling showed that priming in the episodic task (6 ms) was not significant (t = 0.90, p = 0.3704), nor was priming in the lexical decision task (5 ms) (t = 0.56, p = 0.5820). As expected, the interaction between these two tasks was not significant (t = 0.09, p = 0.9208). No significant differences in error rate data were found.

Table 3.2. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for L2-L1 translation priming in episodic recognition and lexical decision in Experiment 3.

	Episodic recognition	Lexical decision
Translation	550 (8.4)	477 (4.4)
Unrelated	556 (7.3)	480 (3.4)
Priming	6	5

3.2.3 Discussion

Unlike in semantic categorization, episodic recognition employing a regular three-field masking technique did not yield L2-L1 translation priming. This suggests that visible persistence of the L2 primes may be the reason for obtaining L2-L1 translation priming for “old” items in episodic recognition. However, even if it was the case that the 50-ms blank after the prime was what was producing L2-L1 translation priming in episodic recognition task, it is important to note that neither this experiment nor Jiang and Forster (2001) were able to observe L2-L1 priming in a lexical decision task despite this 50-ms blank following the prime. Therefore, it is necessary to account for why this 50-ms blank can assist the effectiveness of the masked prime in episodic recognition. However, it has not been tested yet whether this 50-ms blank alone is indeed what is driving L2-L1 priming in episodic recognition. The following experiment, Experiment 4, tested this.

3.3 Experiment 4

The purpose of Experiment 4 was to test whether L2-L1 priming in episodic recognition can still be obtained if there was only a 50-ms blank between primes and targets. If it truly is the case that the 50-ms blank is producing priming in this task, then 150-ms backward mask after the blank would be unnecessary.

3.3.1 Methods

3.3.1.1 Participants

Thirty undergraduate students at the University of Arizona participated for course credit. All participants were native speakers of English. None had participated in the previous two experiments reported in this chapter.

3.3.1.2 Materials and Design

The materials and design were identical to those used in Experiments 2 and 3.

3.3.1.3 Procedure

The procedure was almost identical to that used in previous two experiments, except for how stimuli were presented. In this experiment, the critical stimuli in both episodic recognition and lexical decision were presented as follows: 500 ms forward mask, 50 ms prime, 50 ms blank, and 500 ms target.

3.3.2 Results

The mean reaction times and percentage error rates are presented in Table 3.3. The analysis of the priming effects using linear mixed-effects modeling showed that the priming in the episodic task (21 ms) was significant (t = 3.10, p = 0.0030). As anticipated, priming in the lexical decision task (-2 ms) was not significant (t = 0.61, p = 0.5474). There was also a significant interaction between the two tasks (t = 2.49, p = 0.0136). Thus, this supports Finkbeiner's claim that this 50-ms blank produces some kind of effect (i.e., iconic persistence) necessary for the L2-L1 priming in episodic recognition to occur. The percentage error rates did not exhibit any significant effects.

Table 3.3. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for L2-L1 translation priming in episodic recognition and lexical decision in Experiment 4.

	Episodic recognition	Lexical decision
Translation	524 (7.4)	469 (2.5)
Unrelated	545 (6.7)	466 (4.8)
Priming	21**	-3

3.3.3 Discussion

This experiment shows that indeed, this 50-ms blank after the prime is necessary to obtain L2-L1 priming in episodic recognition. Given the existence of iconic persistence (Sperling, 1960), the effective prime duration is probably closer to 100 ms. However, as previously mentioned, it is still a question as to why this iconic persistence helps the masked L2 prime to be more effective in episodic recognition. One way to explain this may be to attribute it to the amount of stimulus energy that is necessary for masked primes in order to activate associations in episodic recognition. And, how much stimulus energy is necessary may depend on two things – (i) the language the prime is in, and (ii) how strong these episodically-represented associations are. Specifically, L2 or newly-learned word primes may require more stimulus energy to activate episodically-represented associations than L1 primes. Indeed, as revealed in Experiment 1b, L1 primes can activate such associations as demonstrated by the L1-L2 priming in episodic recognition. Furthermore, the fact that L2-L2 repetition priming can be obtained in lexical decision tasks without interpolated masks also show that the strength of these associations is important. That is, the association of an L2 prime to its own form is much stronger than to its L1 translation.

One point worth considering, however, is that a recent study by Basnight-Brown and Altarriba (2007) found L2-L1 translation priming in lexical decision with highly-proficient Spanish-English bilinguals. Although most studies investigating the issue of translation priming use a 50-ms prime duration (with or without the interpolated mask), this study employed a 100-ms prime duration (without the interpolated mask). It might be the case that the extra 50 ms of iconic persistence of masked L2 primes is not enough to produce priming in lexical decision, even though it can produce priming in episodic recognition. Indeed, these masked L2 primes may need to actually be on the screen for 100 ms in order to yield priming in lexical decision. That is, the actual presence may increase the awareness of these L2 primes. Indeed, this might assist in activating the link from the L2 word to its L1 translation even in lexical decision. The following experiment was carried out in order to test whether L2-L1 priming can be obtained in lexical decision with 100-ms prime duration.

3.4 Experiment 5

3.4.1 Method

3.4.1.1 Participants

Twenty-eight undergraduate students at the University of Arizona participated for course credit. They were all native English speakers, and did not participate in any of the previous Basque experiments.

3.4.1.2 Materials and Design

The materials and the design of this study were basically the same as the previous Basque experiments.

3.4.1.3 Procedure

The procedure was the same as the previous Basque experiments. However, episodic recognition task was not included in this experiment because it seemed apparent that priming would be obtained in this condition since Experiment 4 has already shown that such priming can be obtained with an extra 50-ms blank. Furthermore, the prime duration was increased from 50 ms to 100 ms. There were no interpolated masks. Thus, the masking technique was as follows: the mask for 500 ms, the prime for 100 ms, and the target for 500 ms.

3.4.2 Results and Discussion

The mean reaction times and percentage error rates are presented in Table 3.4. There was no significant L2-L1 priming effect (4 ms) in the reaction time data (t = 0.75, p = 0.4666) or in the error rate data. This study still did not reveal L2-L1 translation priming in lexical decision. Thus, the longer prime duration is not the reason why L2-L1 priming is not obtained in lexical decision tasks.

Table 3.4. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for L2-L1 translation priming in lexical decision in Experiment 5.

	Lexical decision
Translation	490 (4.5)
Unrelated	494 (3.9)
Priming	4

3.5 General Discussion

The four experiments reported in this chapter shows that dissociation of L2-L1 priming between lexical decision and episodic recognition can be obtained in studies as long as there is a blank interval after the prime for at least 50 ms in order for priming to occur. One might be tempted to explain this in terms of increased awareness of the prime, but it should be remembered that this would also favor priming in a lexical decision task, but no priming was observed in any of these experiments. Furthermore, even when the prime duration was increased to 100 ms, there was still no priming in lexical decision.

One criticism about this dissociation may come from the difference between episodic recognition times and lexical decision times. Indeed, episodic recognition times are considerably longer than lexical decision times (i.e., on average 86 ms longer). The long episodic recognition times may allow the integration of the information activated by L2 primes with L1 targets, whereas lexical decision times are too short for this integration to take place. Although the set of experiments reported in this chapter alone cannot disqualify such suggestion, the results of Experiment 1 can. That is, as Jiang and Forster (2001) also note, episodic recognition times for "old" items are about 100-ms shorter than recognition times for "new" items, and yet in Experiment 1a, L2-L1 translation priming was only obtained for "old" items. Thus, longer response times alone cannot explain this dissociation between the two tasks.

Taken together, it seems safe to assume that L2-L1 priming in episodic recognition is obtained because L2 words are generally stored episodically.

Furthermore, when these L2 words are presented as masked primes, they are only able to activate information stored in the episodic memory system (i.e., their corresponding L1 translations serving as “old” items). Episodic recognition tasks presumably can only pick up such information activated in episodic memory. When the task requires retrieving information in lexical memory as in lexical decision, then there is no priming. On the other hand, when the task requires retrieving information from episodic memory as in episodic recognition, then L2-L1 translation priming can be obtained.

CHAPTER 4

THE NATURE OF EPISODIC RECOGNITION TASKS

The experiments reported in previous two chapters confirm predictions from the Episodic L2 Hypothesis in that both well-established L2 words and newly-learned (and thus, episodically-represented) words behave similarly. Specifically, these L2 words and pseudo-L2 words were effective as masked primes in episodic recognition, but not in lexical decision. This dissociation between these two tasks is interpreted as due to differences in which memory each of these tasks tap into. That is, episodic recognition tasks tap into episodic memory and lexical decision tasks in lexical memory. However, it is necessary to eliminate other possibilities as to why such dissociation of L2-L1 translation priming is observed between these two tasks. The experiments reported in this chapter explore the other possible accounts for this dissociation. These other accounts concern whether there are any congruence effects in episodic recognition, whether frequency of L1 words affect L2-L1 translation priming in lexical decision, and whether episodic recognition is more sensitive to semantic associations than lexical decision.

The following experiment, Experiment 6, specifically reports whether there are any congruence effects in episodic recognition tasks.

4.1 Experiment 6

The purpose of this experiment is to test whether a congruence effect can explain the L2-L1 priming obtained in episodic recognition tasks as in the Basque experiments (Experiments 2 to 5). Congruence effects are typically observed in semantic categorization tasks and naming tasks (see e.g., Forster, 2004; Forster, Mohan, & Hector, 2003; Quinn & Kinoshita, 2008 for semantic categorization, and Forster & Davis, 1991 for naming). A congruence effect is observed when the prime and the target are of same category. For instance, Dehaene, Naccache, Le Clec'H, Koechlin, Mueller, Dehaene-Lambertz, van de Moortele, and Le Bihan (1998) found that when participants were asked to categorize whether a numeral (e.g., *1, 8*) was "smaller or larger than five", participants were faster in responding when the target was primed with a congruent prime (e.g., *one*-*3*) than an incongruent prime (e.g., *eight*-*3*). Interestingly, these effects are not found in lexical decision tasks. That is, a word target preceded by a word prime is not faster than when it is preceded by a nonword prime (Forster, et al., 2003). The question related to this dissertation is whether congruence effects can be obtained in episodic recognition tasks.

Recall that in the Basque experiments, participants learned both the new L2 words and their L1 translations prior to the episodic recognition and lexical decision tasks. Thus, the fact that both the L2 primes and the L1 targets were studied items may have produced congruence effects – that is, in the related condition, both the primes and targets can be categorized as “old” items, while in the unrelated condition, the primes are “new” items. Therefore, there is a chance that the L2-L1 priming was due to congruence and not translation. Note that in Jiang and Forster (2001) and Experiment 1a, participants only studied a set of L1 words, and not their corresponding L2 translations. However, in the Basque experiments, participants studied both the Basque words and its L1 translations prior to episodic recognition task. In these experiments, the unrelated L2 primes were always a Basque word that the participants did not study, thus, in the related condition, both L2 primes and L1 targets were studied, while in the unrelated condition, L2 primes were unstudied even though L1 targets were studied. Hence, it is not clear whether the priming effect obtained in episodic recognition in these Basque experiments was due to the actual translation associations or due to the fact that both primes and targets were studied. In order to ensure that translations were what was primed in these Basque experiments, this experiment tests whether there are congruence effects in episodic recognition tasks. In order to test this, participants were first trained on a set of (L1 English) words. This was followed by a speeded old-new task, in which participants decided whether they had seen the word on the screen on the study list. Half of the “old” target items (or YES items) were preceded by another word from the “old” items (congruent condition), and the other half were preceded by a word from the “new” items (incongruent condition). The same manipulation was applied to the “new” target items (or NO items). That is, half of these target words were preceded by a word from the “old” items (incongruent condition), and the other half from the “new” items (congruent condition).

4.1.1 Methods

4.1.1.1 Participants

Twenty-eight undergraduate students at the University of Arizona participated for course credit. All participants were native speakers of English.

4.1.1.2 Materials and Design

Two sets of 32 five-letter words were selected for this experiment. All of these words had high imageability ratings (i.e., above 600) according to the MRC imageability ratings (Coltheart, 1981), which was determined using N-Watch (Davis, 2005). One set of words served as “old” items, and the other set as “new” items. This was counterbalanced between participants. During the speeded old-new task, half of the “old” target items were preceded by prime words from the “old” items (congruent condition), and the other half by prime words from the “new” items (incongruent condition). The same procedure was applied to the “new” target items as well. Specifically, half of the “new” target items were preceded by a word from the “old” items (incongruent condition), and the other half from the “new” items (congruent condition).

The experiment employed a 4x2x2 design, with list (the counterbalancing feature), congruence (congruent, incongruent), and study status (old, new) as factors. The congruence and study status were within-subject and within-item factors.

4.1.1.3 Procedure

Participants were first trained on a list of 36 English words, which included 32 critical items and 4 practice items. This training involved two presentations of this list. During this training, participants saw the words one by one for 3 seconds each. Participants were presented with 6 blocks of 6 words during the first presentation, and 3 blocks of 12 words during the second presentation.

The presentation stimuli during the speeded memory task followed the regular three-field masking procedure. That is, a mask for 500ms (#####), a prime for 50ms and a target for 500ms. The participants were asked to press the YES and NO buttons to indicate their response. Correct-incorrect feedback and response times were given every time participants made a response. Participants took the speeded old-new task only once.

4.1.2 Results

The mean reaction times and percentage error rates are presented in Table 4.1.

The fixed effect factors for linear mixed-effects modeling analyses were study status (old, new) and congruence (congruent, incongruent), with Subjects and Items as random factors. The congruence effect was not significant ($t = 0.76$, $p = 0.4476$), but study status was ($t = 7.28$, $p = 0.0001$). Indeed, there was no interaction between congruence and study status ($t = 1.27$, $p = 0.1928$). Pairwise comparisons also showed that there was no congruence effect for either "old" (11 ms) ($t = 1.46$, $p = 0.1386$) or "new" (-1 ms) ($t = 0.32$, $p = 0.7542$) targets. There were also no significant error rate differences.

Table 4.1. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for congruence effects in episodic recognition in Experiment 6.

	old	new
congruent	583 (11.4)	621 (10.5)
incongruent	594 (14.3)	620 (11.2)
priming	11	-1

4.1.3 Discussion

The results of this experiment demonstrate that there is no congruence effect in episodic recognition tasks. Thus, we can safely conclude that the priming effect observed in the Basque experiments in the previous chapter is likely due to come from episodically-represented L2-L1 translation associations.

Another issue that needs to be considered is why L2-L1 translation priming was not obtained in lexical decision tasks. The Episodic L2 Hypothesis suggests that this is due to the fact that lexical decision tasks are not sensitive to episodic memory traces, but instead only to lexical information. However, this is considered to only apply to lexical decision tasks using masked priming. Indeed, Forster and Davis (1984) suggested that although lexical decisions are normally based on feedback from lexical memory, for long-lag repetition priming paradigm, in which the word has been recently experienced, the strong episodic trace of that experience can influence lexical decision, presumably because simultaneous activation of two independent representations leads to greater confidence. However, whether this occurs depends on timing. If the activation of the episodic record lags well behind the lexical record, as it would for a high-frequency word, then the decision is based purely on lexical feedback. But since lexical access is slower for a low-frequency word, there is time for the episodic trace to influence the decision. This shows that lexical decision tasks can use information from both lexical and episodic memory.

However, is it truly the case that decision-making in lexical decision tasks cannot use episodic information when the prime is masked? Taking this evidence from long-lag repetition priming into account, is it possible that the lack of masked L2-L1 translation priming in lexical decision tasks in the Basque experiments (reported in Chapter 3) is due to the fact that L1 words used in these experiments were of high-frequency? That is, the lack of such priming in lexical decision may not be because lexical decision tasks using masked priming tap only into lexical memory, but because the L1 targets were of high-frequency that only lexical information became available to affect the response. Indeed, the average CELEX frequency (Baayen et al., 1995) of the English words that served as "old" items in the Basque experiments was 156.5 per million using N-Watch (Davis, 2005). Words that are higher than 100 per million are usually considered high-frequency. Thus, episodic information may not have become available early enough to influence lexical decision. The following experiment, Experiment 7, examines whether this is the case.

4.2 Experiment 7

This experiment examines whether the reason that L2-L1 priming was not obtained in lexical decision was because the L1 targets were of high-frequency, such that episodic information about the prior occurrence of those words did not become available early enough to influence decision-making. The question is whether L2-L1 priming in lexical decision can be obtained if L1 targets were of lower-frequency. To investigate whether such is the case, a lexical decision task using long-lag repetition priming paradigm was conducted to test whether these L1 targets used in the Basque experiments yield long-lag repetition priming. If long-lag repetition priming is obtained with these targets, then this would show that episodic feedback can become available prior to lexical feedback. This would thus demonstrate that the lack of such priming in the Basque experiments was because masked priming technique was used, a paradigm that is more sensitive to automatic processing. In order to investigate this, participants made lexical decisions on primes (half of all the items) in Phase 1, and then made lexical decisions on targets (half of which were repetition of the primes, and the other half were not) in Phase 2.

4.2.1 Method

4.2.1.1 Participants

Twenty-four undergraduate students at the University of Arizona participated for course credit. All participants were native speakers of English.

4.2.1.2 Materials and Design

The English items that were used in the Basque experiments were used in this experiment as well. These included 24 "old" items, 24 "new" items, and 8 practice items. The nonword targets used in the lexical decision tasks in the Basque experiments were used as well. Only the "old" items are crucial because these were the critical items in the Basque experiments, but "new" items were included as well to increase the number of items.

Two counterbalanced lists of items were constructed such that half of the Basque "old" items appeared in both Phase 1 and Phase 2, and the other half only in Phase 2. This counterbalancing was applied to the Basque "new" items, the practice items and the nonwords as well. Thus, this study employed a 2x2x2 design, with list (the counterbalancing feature), target type (old, new), and repetition (repeated, non-repeated) as factors. The direction and prime-target relation were within-subject factors.

4.2.1.3 Procedure

The presentations of the stimuli were the same in Phase 1 as in Phase 2. Prior to the target item, a warning signal was presented for 250 ms (+++) followed by a blank screen for another 250 ms. This was followed by the target that was presented for 500 ms. The participants were asked to press the YES and NO buttons to indicate their response. Correct-incorrect feedback and response times were given every time participants made a response.

4.2.2 Results

The mean reaction times and percentage error rates are presented in Table 4.2. Although only the Basque "old" items are crucial to test why there was not L2-L1 priming in lexical decision tasks in the Basque experiments, both item types (i.e., "old" and "new") are analyzed. The fixed effect factors for linear mixed-effects modeling analyses were Target Type (old, new) and Repetition (repeated, non-repeated), with

Subjects and Items as random factors. Linear-mixed effects analyses revealed significant repetition effect for both the "old" (21 ms) (t = 3.60, p = 0.0002) and "new" (22 ms) (t = 3.64, p = 0.0008) targets. As expected, there was no interaction between these two factors (t = 0.05, p = 0.9866). No significant differences were observed in error rate data.

Table 4.2. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for long-lag repetition priming effects in lexical decision in Experiment 7.

	Basque "old"	Basque "new"
Repeated	437 (4.3)	432 (3.2)
Non-repeated	458 (6.4)	454 (6.0)
Priming	21**	22**

4.2.3 Discussion

The results from this experiment show that the words used in the Basque experiments did show a long-lag repetition effect, and therefore are capable of receiving episodic information early enough to influence the response in lexical decision. Thus, the lack of masked L2-L1 translation priming in lexical decision tasks in these experiments is not due to the fact that the frequency of the L1 words was too high to allow episodic information to influence the decision. This shows that lexical decision tasks employing masked priming technique are sensitive to lexical information, and as long as lexical information is available, the decision-making system uses that information to make responses.

Another possibility that can account for the dissociation in translation priming between the two tasks is that an episodic recognition task may be more sensitive to associative connections than lexical decision. As mentioned in Chapter 1, one reason why masked translation priming is interesting is that only a very weak masked semantic priming effect is obtained in lexical decision tasks. This lack of masked semantic priming effect is found for most types of semantic associations – synonyms (*blossom-flower*), antonyms (*black-white*), and associative connections (*pencil-paper*) (Smith et al., 1994; Thomas, 2008). The following experiment, Experiment 8, examines whether episodic recognition tasks are more sensitive to these kinds of associative connections. In other words, are episodic recognition tasks capable of picking up weaker connections, such as semantic associations? Indeed, L2-L1 translation connections may just be weaker than L1-L2 connections (as suggested by Schoonbaert et al., 2009), and episodic recognition tasks may be sensitive to such weak associations. If it is indeed the case that episodic recognition tasks are more sensitive to weak semantic associations, then they would show semantic priming effects. Experiment 8 tests this issue.

4.3 Experiment 8

Another possible reason why an episodic task shows translation priming is that episodic tasks are more sensitive to semantic associations. In order to examine this possibility, two types of semantic associations were tested: synonyms and associative connections. These were selected for different reasons. The translation equivalents in the two languages are like synonyms in one language. Especially in masked translation priming studies, usually the items are selected so that translations that are best matches in terms of meaning overlap are selected (see e.g., Jiang, 1999; Finkbeiner et al., 2004). Alternatively, the RHM posits that L2 words cannot access conceptual information directly, but only when they are mediated by L1 translations. This idea suggests that L2 words and their L1 translations are not like synonyms, where two words share a meaning. Instead, they are more like associations – i.e., L2 word forms are merely associated with L1 translations through (possibly, learning) experience. Thus, associative connections were used in this experiment as well.

In order to simulate Experiment 1 as much as possible, participants in this experiment studied a list of words, which was one of the words from each semantically-associated pair (i.e., either synonymous pair or associative pair). These studied words then appeared in the speeded old-new task as targets for “old” items. These items were either preceded by the other word from the semantically-associated pair (i.e., *fire-FLAME* for synonyms, and *eggs-BACON* for associations), or by an unrelated word (i.e., *hour-FLAME* or *spot-BACON*).

4.3.1 Method

4.3.1.1 Participants

Twenty-four undergraduate students at the University of Arizona participated for course credit. They were all native English speakers.

4.3.1.2 Materials and Design

The stimuli comprised 28 synonymous pairs and 28 associative pairs. These items were taken from Thomas (2008). These 56 critical pairs were used as “old” items. In addition, another 56 randomly paired associates were used as “new” items. These “new” items served as distractors. There were also another set of eight randomly paired associates that served as practice items.

Two counterbalanced lists of items were constructed such that each target word appeared in both the related and unrelated conditions across lists, but not within lists. This experiment employed a 2x2x2 design, with list (the counterbalancing feature), semantic relationship (synonyms, associative connections), and prime-target relation (related, unrelated) as factors. The semantic relationship and the prime-target relation were within-subject factors.

4.3.1.3 Procedure

The two semantic associations were blocked, such that in the one half of the experiment, participants were tested on synonymous pairs, and the other half on associative pairs. The order of these two blocks was randomized for each participant.

During the training phase of each part of the experiment, participants were trained on 32 words (i.e., 28 critical items and 4 practice items). During this training, participants were presented with the list of 32 words three times. In the first two presentations, participants were presented with each word on the screen for 3 seconds. After 3 seconds, the next word automatically appeared on the screen for another 3 seconds. In the last presentation, participants were presented with four sets of eight words, and each set would be on the screen for as long as the participants wanted.

The speeded old-new task followed the regular three-field masking procedure. That is, a mask was presented on the screen for 500ms (#####), followed a prime for 50ms and then a target for 500ms. The participants were asked to press the YES and NO buttons to indicate their response. Correct-incorrect feedback and response times were given every time participants made a response.

4.3.2 Results and Discussion

The mean reaction times and percentage error rates are presented in Table 4.3. The fixed effect factors for linear mixed-effects modeling analyses were Relationship Type (synonyms, associative connections) and Priming (related, unrelated), with Subjects and Items as random factors. No significant effect was obtained for either synonymous relationship (t = 0.72, p = 0.4674) or associative relationship (t = 0.16, p = 0.8718). There were no significant differences in the error rate data.

Table 4.3. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for semantic priming effects in episodic recognition in Experiment 8.

	Synonyms	Associates
Related	554 (13.7)	532 (8.7)
Unrelated	558 (11.8)	532 (11.5)
Priming	4	0

Episodic recognition did not yield any priming for either synonymous or associative pairs. There are several ways to account for such results. The most obvious account is that generally semantic associations are weak, and they only reveal priming effects under limited conditions (Frost et al., 1997; Gotor & Perea, 1997). Thus, the results from this experiment disconfirm the idea that episodic recognition task may be more sensitive to semantic associations than lexical decision task. The other account is the episodic account – i.e., only the targets in this experiment were stored episodically, but neither the related or unrelated primes were. Therefore, the related primes did not assist the recognition of the targets. Although Chapter 2 argued that masked L1 primes can probably activate any information associated with them, semantic connections were probably too weak to be primed under the specific condition used in this experiment.

4.4 General Discussion

The experiments reported in this chapter explored other possible accounts that could possibly explain why L2-L1 translation priming reveals dissociation between lexical decision and episodic recognition tasks. The results of these experiments revealed the following:

(1) Episodic recognition tasks do not produce congruence effects, and thus, the L2-L1 translation priming found in episodic recognition is not due to congruence;

(2) The L1 targets used in the Basque experiments were able to produce long-lag repetition priming effect, and so the lack of L2-L1 translation priming in lexical decision cannot be accounted for by their frequency being too high and thus not allowing episodic information to become available early enough to influence the response;

(3) Episodic recognition tasks are not more sensitive to semantic associations than lexical decision, and thus this is not the reason why L2-L1 translation priming is obtained in episodic recognition and not in lexical decision.

Taken together, it seems safe to assume that L2-L1 translation priming obtained in episodic recognition is due to the newly-learned L2-like words are represented episodically.

CHAPTER 5

A FURTHER TEST OF THE EPISODIC L2 HYPOTHESIS

This dissertation, thus far, has established that there is a dissociation between episodic recognition and lexical decision tasks for L2-L1 translation priming, and this is the case for both highly-proficient bilinguals and pseudo-bilinguals. Furthermore, because the evidence suggests that these tasks tap into different memory systems, the implication is that L1 and L2 words are represented in different memory systems. However, in order to make the argument that L2 words are represented episodically more convincing, evidence from other paradigms is necessary. The following experiment (Experiment 9) used a repetition priming paradigm to further explore the Episodic L2 Hypothesis.

5.1 Experiment 9

In order to test whether L2 words are truly represented in episodic memory even in highly-proficient bilinguals, a more powerful test of the Episodic L2 Hypothesis is required. The data from Experiment 1 indicate that L2-L1 priming can be obtained in an episodic task, but the effects were not particularly robust. Furthermore, it is not quite clear why a 50-ms blank is necessary in order for such priming effects to occur as shown in the Basque experiments from Chapter 3. In order to test whether L2 words are indeed represented episodically, a much stronger type of priming is used in this experiment instead of translation priming, namely repetition priming.

In earlier work, it has been found that in an episodic recognition task, “old” words show strong masked repetition priming, but “new” words do not (Forster, 1985; Rajaram & Neely, 1992). This result was obtained with native English speakers, and the interpretation was that priming in this task was restricted to words that were represented episodically (as well as lexically). What might then be expected for L2 speakers of English? If their L2 English words are stored episodically, then repetition priming should be observed in an episodic recognition memory task regardless of whether the words were “old” or “new”. The following experiment reports findings from native English speakers and Chinese-English bilinguals using English words in an episodic recognition task with masked repetition priming. Specifically, it is predicted that native English speakers would only show masked repetition priming for “old” items, but not for “new” items, while Chinese-English bilinguals would show repetition priming for both “old” and “new” items.

5.1.1 Method

5.1.1.1 Participants

Two groups of participants were tested. The first group consisted of 24 undergraduate students at the University of Arizona. These participants received course credit. They were all native English speakers. These native speaker participants served as the control group. The second group consisted of 20 Chinese-English bilinguals, who were again paid USD5.00 for their participation. These bilingual participants also participated in Experiments 1, and were invited back again. These bilingual participants served as the experimental group.

5.1.1.2 Materials and Design

The stimuli included a total of 60 five-letter English words. All of these words had high imageability rate of at least 585 according to the MRC Psycholinguistics Database (Coltheart, 1981) using N-Watch (Davis, 2005). Thirty words served as “old” items and the other 30 as “new” items. Each of these words was randomly paired with another five-letter word that served as an unrelated control prime. Four counterbalanced lists of items were constructed such that each target word appeared in both the “old” and “new” conditions and in related and unrelated conditions across lists, but not within lists. Thus, the design of the study was 4x2x2, with list (the counterbalancing feature), study status (old, new), and prime-target relation (repeated, unrelated) as factors. The study status and the prime-target relation were within-subject and within-item factors.

5.1.1.3 Procedure

Participants first studied a total of 32 words, which were the 30 “old” items and two practice items. These words were presented individually twice for 3000 ms following a mask for 500 ms (a row of five hash marks #####). The next item followed automatically with occasional rest intervals. In the last presentation of the English words, eight words were presented on the screen, and participants were allowed to view them on the screen for as long as they wanted.

The test phase immediately followed the training phase, in which participants took a speeded old-new test. Regular three-field masking technique was used in this task for both participant groups. The primes were either an identity prime or an unrelated word. The participants were asked to press the YES button when the word was an “old” item (i.e., previously studied words) and NO button when the word was a “new” item (i.e, previously unstudied words) to indicate their response. Correct-incorrect feedback and response times were given every time participants made a response.

5.1.2 Results

The fixed effect factors for linear mixed-effects modeling analyses were target type (old, new) and priming (repetition, unrelated), with Subjects and Items as random factors. The mean reaction times and percentage error rates for the native-speaker control group are presented in Table 5.1. There was a significant repetition priming for “old” items (55 ms) (t = 7.42, p = 0.0001), but not for “new” items (5 ms) (t = 1.11, p = 0.2876). Indeed, there was a significant interaction between target type and priming (t = 4.81, p = 0.0001). Further analyses revealed a similar pattern of results for error rate data. Specifically, there was an interaction between target type and priming (z = 3.217, p = 0.00130). Further analyses showed a significant effect for the “old” items (z = 2.833, p = 0.00461), but not for the “new” items (z = 1.698, p = 0.0895). Although the error rates for “new” items are showing a tendency, it is in the wrong direction. That is, identity primes are producing more errors than unrelated primes.

Table 5.1. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for repetition priming in episodic recognition for native-speaker controls in Experiment 9.

	Old	New
Related	516 (8.9)	577 (12.5)
Unrelated	570 (15.9)	582 (8.6)
Priming	55***	5

The mean reaction times and percentage error rates for the bilingual experimental group are presented in Table 5.2. The reaction time analysis revealed significant priming effects for both the “old” (71 ms) (t = 6.094, p = 0.0001) and “new” (32 ms) (t = 2.448, p = 0.0128) items. The interaction between these two item types was significant as well (t =

3.153, $p = 0.0014$), indicating that the magnitude of priming between “old” and “new” items are different. There were no significant error rate differences for this group.

Table 5.2. Mean reaction times (in milliseconds) and percentage error rates (in parentheses) for repetition priming in episodic recognition for Chinese-English bilinguals in Experiment 9.

	Old	New
Related	681 (4.4)	778 (7.5)
Unrelated	752 (7.7)	810 (6.0)
Priming	71***	32*

5.2.3 Discussion

The findings are clear. The fact that native English speakers show masked repetition priming only for “old” items means that episodic recognition tasks indeed tap into a different memory system from lexical decision tasks. Furthermore, the fact that Chinese-English bilinguals show repetition priming for both “old” and “new” items shows that, as the Episodic L2 Hypothesis predicts, even highly-proficient bilinguals represent their L2 words in episodic memory. Indeed, these Chinese-English bilingual participants showed masked repetition priming effect for both “old” and “new” items in L2. This is a striking contrast to the native speaker group that showed repetition priming only for the “old” items.

This is a very important finding. However, it might be argued that masked repetition priming is a robust effect, and can be obtained in any task with any population. Indeed, it has been shown that repetition priming in L2 can be obtained with lexical decision even though L2-L1 priming cannot be obtained in the same task (Gollan et al., 1997; Jiang, 1999). Furthermore, Forster (1985) demonstrated that after training of new (L1) words, such as *holimonth*, these words also yielded masked repetition priming with lexical decision. These findings suggest that masked repetition priming in lexical decision can be obtained so long as there is some kind of representation in memory, unlike the nonwords that do not produce priming. However, the striking contrast between the "old" and "new" items with episodic recognition in native speakers should not be forgotten. That is, native speakers show repetition priming ONLY for "old" items and not for "new" items, as demonstrated in this study and others (Forster, 1985; Rajaram & Neely, 1992). This clearly demonstrates that the episodic recognition task is sensitive to what items are represented episodically and what are not. The fact that the Chinese-English bilinguals in this study showed repetition priming for BOTH "old" and "new" items in their L2 strongly indicates that L2 words are represented episodically. It is important to note, however, that this experiment alone does not show that L2 items are not represented in lexical memory. It only shows that for these bilingual subjects at least, their L2 words have an episodic record.

It is important to consider why there was a repetition priming effect for “new” items at all for the bilingual group. When they are making Yes/No responses to the task of making decisions on whether *“the words on the screen is one of the words you have just studied”*, No responses should be very difficult because unlike native English speakers, bilinguals have episodic representations of the wrong type. Native English speakers do not have episodic representations of “new” items, and thus, rejecting these items should be relatively easy. This argument would predict that, if previously unstudied nonwords (and thus, requires a No response) were included in this experiment, native English speakers may not show response time differences between “new” word items and “new” nonword items, whereas Chinese-English bilinguals may show such differences. That is, categorizing something as having a “wrong” representation (i.e., “new” word item) can be easier or more difficult than not having any representation at all (i.e., “new” nonword item).

Also, note that there was a significant difference between the priming for the “old” and “new” items in Chinese-English bilinguals even though pairwise comparisons for each of these conditions showed significant effects. That is, the “old” items showed stronger priming effect than the “new” items. This can be explained in terms of how readily available these items are in episodic memory. That is, since “old” items have just been studied, they are probably more easily and reliably activated. “New” items, on the other hand, have not been studied during the experimental session, and so there may be more variability in how readily they are activated.

One thing to consider is that Chinese-English bilinguals are much slower in terms of their response times relative to native English speakers. The worry is that it may be easier to detect priming effects for slower readers. This is evident from the fact that the priming effect for “old” items is greater in Chinese-English bilinguals than native English speakers. Furthermore, “new” items are showing significant effect in Chinese-English bilinguals, but not in native English speakers. Thus, there is a concern that both participant groups may be showing priming for “new” items, but it can only be detected with slower readers, in this case, Chinese-English bilinguals. That is, there is a “scaling” effect, and this is what is causing priming effect for “new” items with this participant group. However, it should be noted that “new” items did not show any priming effect in either Forster (1985) or Rajaram and Neely (1992). Also, note that if slower response times means a larger priming effect, then “new” items should show larger priming effect than “old” items, since “new” items are generally responded to slower than “old” items. However, both participant groups show a larger effect for “old” items than “new” items.

In order to rule out the possibility that slower responses magnified the effect for “new” items, each group of participants (i.e., native English speakers and Chinese-English bilinguals) was divided into two – those who generally responded faster and those slower. In order to avert the counterbalancing list effect, participants in each list were divided into two groups rather than dividing all participants into two groups. Thus, a “fast” participant in one list may have had a slower mean reaction time than a “slow” participant in another list. The results are shown in Figures 5.1 and 5.2. For native speakers, there was no interaction between the faster and the slower group for either “old” items (fast group 57 ms vs slow group 52 ms) (t = 0.98, p = 0.3514) or “new” items (fast group 3 ms vs slow group 7 ms) (t = 0.09, p = 0.9448). Similarly for Chinese-English bilinguals, no interaction was obtained for the faster or slower group for either “old” items (fast group 66 ms vs slow group 70 ms) (t = 0.291, p = 0.7116) or for “new” items (fast group 28 ms vs slow group 38 ms) (t = 0.592, p = 0.6246). Thus, it seems safe to conclude that priming for “new” items in Chinese-English bilinguals is not due to the “scaling effect”.

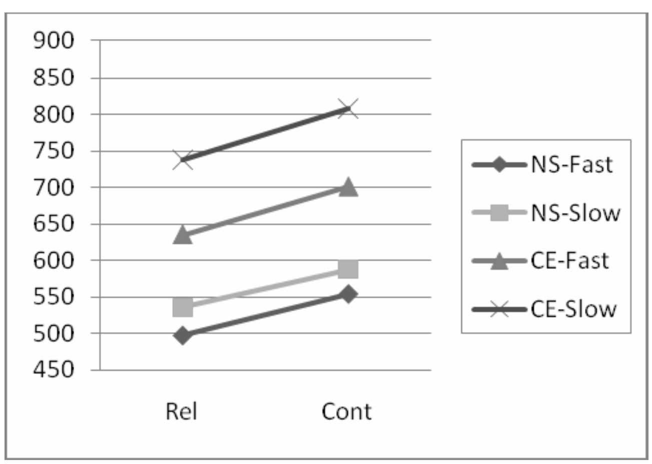

Figure 5.1. *Mean reaction times of related and unrelated conditions for “old” items with fast and slow readers in Experiment 9.*

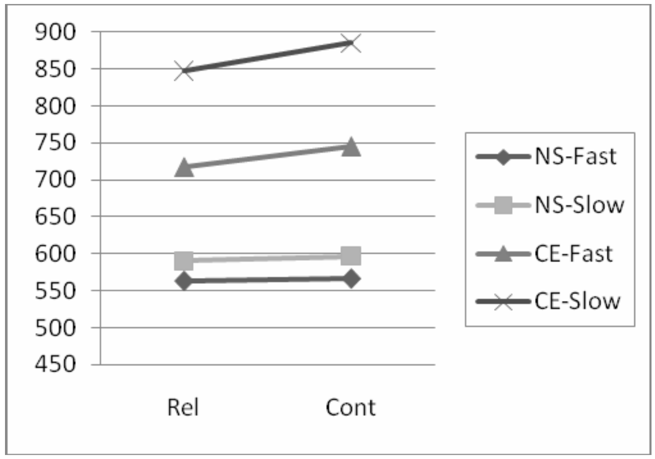

Figure 5.2. Mean reaction times of related and unrelated conditions for "new" items with fast and slow readers in Experiment 9.

Indeed, this finding is also interesting because this experiment allowed for the use of the regular three-field masking procedure. Recall that L2-L1 translation priming in episodic recognition task can only be yielded under limited conditions (i.e., a 50-ms blank is necessary between the prime and the target). Again, it is not clear why a blank interval is necessary in order to obtain such priming. However, this experiment shows that even without this interval, bilingual speakers are able to process L2 words in order to produce masked priming.

CHAPTER 6

GENERAL DISCUSSION AND SUMMARY

This dissertation presents a series of masked priming studies designed to investigate (i) whether L2 words in late bilinguals are represented in episodic memory; (ii) whether there are differences in what the episodic recognition and lexical decision tasks measure; and (iii) whether masked repetition priming in episodic recognition can offer further evidence relevant to the Episodic L2 Hypothesis originally posited by Jiang and Forster (2001). Overall, this dissertation lends support to the hypothesis that L2 words are indeed represented in episodic memory. The summary of all experiments reported in this dissertation is presented in Table 6.1.

The main evidence that supports the Episodic L2 Hypothesis comes from the fact that L2-L1 translation priming was confirmed in episodic recognition with Chinese-English bilinguals, as demonstrated in Experiment 1. The bilinguals tested in this experiment were sampled from bilinguals that were closely matched to Jiang and Forster (2001). Furthermore, these bilinguals revealed masked repetition priming for both “old” and “new” L2 words in episodic recognition, whereas native English speakers showed priming only for "old" words, as shown in Experiment 9. This further supports the idea that L2 words are represented in episodic memory. These findings indeed show that L2 words are stored in episodic memory even in highly-proficient bilinguals.

Table 6.1. Summary of the experiments.

Experiment	Task	Priming	Prime-Target	Masking	Participants	Priming
1a	ERT and LD	Translation	L2-L1	50 ms blank + 150 ms backward mask	Chinese-English	ERT only
1b	ERT and LD	Translation	L1-L2	standard	Chinese-English	Both
2	ERT and LD	Translation	L2-L1	50 ms blank + 150 ms backward mask	pseudo-bilinguals	ERT only
3	ERT and LD	Translation	L2-L1	standard	pseudo-bilinguals	Neither
4	ERT and LD	Translation	L2-L1	50 ms blank	pseudo-bilinguals	ERT only
5	LD	Translation	L2-L1	100 ms prime duration	pseudo-bilinguals	None
6	LD	Congruence	old-old new-new (cong) new-old old-new (incong)	standard	native English	None
7	LD	Repetition	identity	long-lag	native English	Yes
8	LD	Semantic	synonyms associations	standard	native English	No
9	ERT	Repetition	identity	standard	native English	"old" Yes; "new" No
					Chinese-English	"old" Yes; "new" Yes

Note. ERT = Episodic Recognition Task. LD = Lexical Decision.

The secondary evidence that supports the Episodic L2 Hypothesis derives from the Basque experiments (i.e., Experiments 2 to 5). In this set of experiments, native English speakers were taught a set of words in an unfamiliar language, Basque. Immediately after training of these Basque words with their L1 translations, participants were tested in episodic recognition and lexical decision, in which these Basque words served as masked primes of their L1 translation targets. Interestingly, these Basque words were effective as masked primes only in episodic recognition, and not in lexical decision. Since these Basque words are obviously stored episodically, the fact that they behaved similarly to L2 words can be taken as further evidence for the hypothesis that L2 words are represented episodically.

It is important to note, however, that although the overall findings of this dissertation support the Episodic L2 Hypothesis, there are differences in the findings. Most notably is the L1-L2 priming in episodic recognition with Chinese-English bilinguals, as shown in Experiment 1. The original Jiang and Forster (2001) study only obtained translation priming in episodic recognition in the L2-L1 direction, and not in the L1-L2 direction. However, in this dissertation, priming in episodic recognition was obtained for both L2-L1 and L1-L2 directions. This was attributed to differences in the memory system the decision system is tuned to and the amount of information L1 and L2 primes can activate. That is, L2 primes can only activate information in episodic memory (i.e., "old" L1 targets). When the task is episodic recognition, the decision system is tuned to feedback from episodic memory, and thus, L2-L1 translation priming is obtained for "old" items. When the task is lexical decision, the decision system is tuned to feedback from lexical memory, and thus, nothing is primed. L1 primes, on the other hand, can activate information in both lexical and episodic memory. Furthermore, since L2 words are generally stored in episodic memory, no matter what the actual task is, the decision system is tuned to episodic memory, and thus L1-L2 translation priming is obtained in both episodic recognition and lexical decision tasks.

In sum, this dissertation shows that L2 words are indeed represented episodically, but the associations to their L1 translations may not be unidirectional as originally conceived. The remainder of this chapter discusses why L2-L1 translation priming is observed in episodic recognition and semantic categorization, but not in lexical decision, the compatibility of the Episodic L2 Hypothesis with the Sense Model, the nature of the memory system that stores L2 words, and L2-L1 translation priming in general.

6.1 Mechanisms behind Masked Translation Priming

Although the overall patterns of results presented in this dissertation support the Episodic L2 Hypothesis, it is important to consider the mechanisms as to how L2-L1 translation priming is obtained in episodic recognition, and not in lexical decision.

Indeed, there are several factors that influence the outcome of experimental results – these are tasks and stimuli, namely the consciously perceived targets and unconsciously perceived primes.

The current assumption in the psycholinguistics literature is that tasks involve two stages – the first stage is the automatic processing of stimuli and the second stage is decision-making based on the task (Kouider & Dupoux, 2001). This idea assumes that the processing of masked primes and targets are automatic and therefore similar across tasks. However, differences among tasks arise depending on the type of decision that is required to be made. Specifically, in the case of L2-L1 translation priming, the automatic processing of the masked L2 prime might be the same in episodic recognition and lexical decision, but how decisions are made in the second stage differs between these two tasks. That is, in order for the masked L2 prime to activate some type of representation of its L1 translation, the nature of the task must induce the necessary "mental set" to follow these associations. Episodic recognition forces participants to be set for such associations, while lexical decision does not.

However, note that in L1-L2 translation priming, the outcomes of these two tasks are similar in that priming is obtained in both episodic recognition and lexical decision. This may be due to the target items. That is, unlike unconsciously perceived masked primes, targets are perceived consciously. Thus, as argued in Chapter 2, when L2 words are presented as targets, the decision-making system recognizes that there are no representations of these words in lexical memory, and therefore tunes into episodic memory. This is presumably the reason why L2 words (Jiang, 1999) and newly-learned words, such as *holimonth*, show masked repetition priming in lexical decision (Forster, 1985). This suggests that when episodically-represented targets are used, whatever the task, the decision system "knows" to tune into feedback from episodic memory.

Keeping in mind these factors that influence masked priming results, again, the crucial issue is how the episodic recognition task yields L2-L1 translation priming. One important point to consider is what is involved in episodic memory along with these L2 words. Jiang and Forster (2001) postulated that L2 words and their L1 translations are both encoded in episodic memory (these representations are subsequently shown as L2* and L1* respectively). Figure 6.1 shows how words are activated in memory when L2 words are presented. Whenever L2 words are presented, whether they are perceived consciously or unconsciously, they can activate L2*. This is depicted in the following sequence (1).

(1) L2 word → L2* → semantics

Note that L1* is also in the episodic system, but for highly-proficient bilinguals, the association from L2* to L1* and L1* itself is very weak. However, for less-proficient bilinguals, both this association and L1* may be stronger, as shown in sequence (2).

(2) L2 word → L2* → L1* → semantics

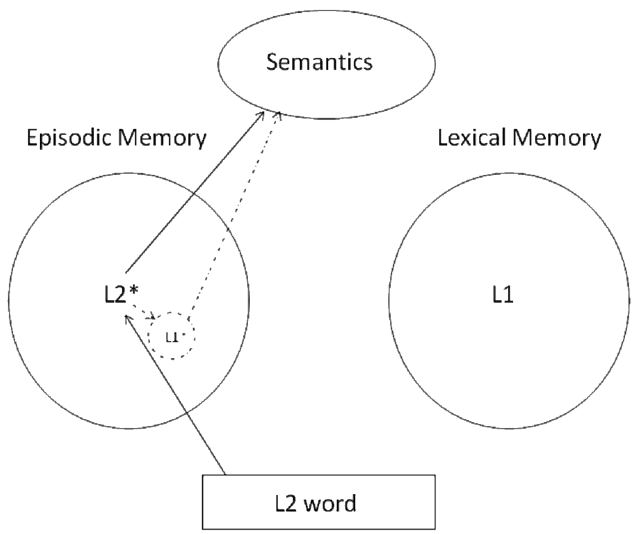

Figure 6.1. Alternative routes to semantics when an L2 word is presented. For highly-proficient bilinguals, L2 can directly access meaning (solid arrow), whereas for less-proficient bilinguals, L2* must mediate L1* (dotted arrow).*

Figure 6.2 shows the mechanism behind L2-L1 translation priming in episodic recognition. Such priming can be obtained for the "old" L1 items, as the following sequence (3) shows.

(3) studying L1 words → L1* → L1**

masked L2 prime → L2* → L1**

"old" L1 target → L1**

When L1 words are studied (and thus form a new episodic record L1**), these somehow integrate with the pre-existing L1* and create a stronger memory trace. These pre-existing L1* (established when L2* was originally learned) are associated with L2*. Thus, the presentation of the masked L2 prime helps preactivate the "old" (i.e., studied) L1 targets (i.e., L1**). The decision system tunes into episodic memory since the task (i.e., episodic recognition) induces the appropriate "mental set". Thus, when the "old" L1 target is presented, this activates L1**. However, when the L1 targets are not studied (i.e., "new"), then the association to L1* and L1* itself remain weak, and thus, there is no priming for these items. This is illustrated in sequence (4).

(4) masked L2 prime → L2*

"new" L1 target → (L1*)

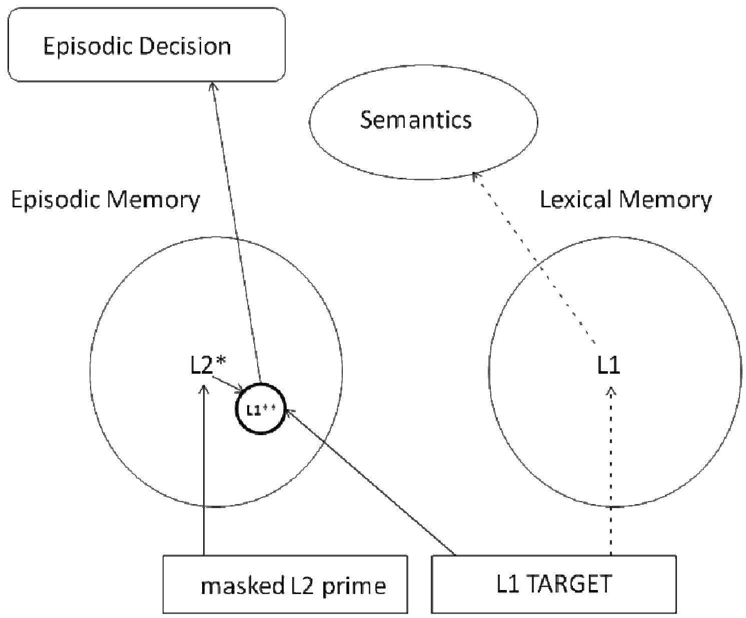

Figure 6.2. *Mechanism behind L2-L1 translation priming in episodic recognition (see text for details).*

Conversely, why is there no L2-L1 priming in lexical decision? As shown in Figure 6.3, when the masked L2 prime is presented, what it activates is similar to what is activated in episodic recognition, in that L2* is activated. However, in lexical decision, because a different mental set is involved (i.e., the decision system is tuned to feedback from lexical memory), the L1 target word is not preactivated, and therefore, there is no priming. Note that both L2* and L1 activate semantics, but because lexical decision does not necessarily require semantic verification, the response is made without waiting for the retrieval of the full set of meanings. Furthermore, as the Sense Model would predict, even when semantic verification takes place, L2* presumably only activates a subset of meanings that L1 possesses, and thus, there should be no L2-L1 priming. The following sequence (5) shows this mechanism.

(5) masked L2 prime → L2* → (semantics)

L1 target → L1 → (semantics)

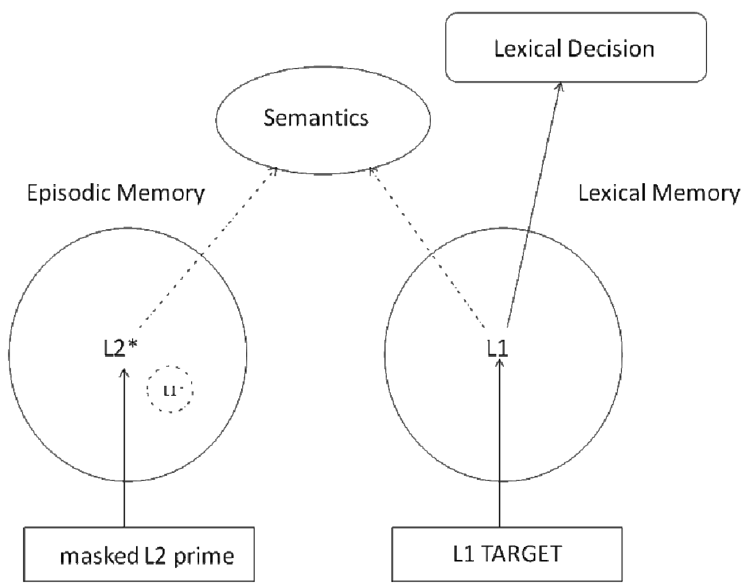

Figure 6.3. Why there is no L2-L1 translation priming in lexical decision (see text for details).

How about L1-L2 translation priming? In both episodic recognition and lexical decision, masked L1 primes activate all possible connections. Since the L2 targets are consciously perceived, the decision system knows to tune into feedback from episodic memory. Thus, the related L1 primes are able to preactivate L2 targets in episodic memory. This is true for episodic recognition and lexical decision. In episodic recognition, “old” (i.e., studied) L2 items produce larger priming effect because they have been studied during the experiment, giving them stronger activation relative to “new” L2 items. Otherwise, however, the basic mechanisms behind these two tasks for L1-L2 priming are the same. The following sequence (6) illustrates the mechanism behind L1-L2 translation priming in both episodic recognition and lexical decision.

(6) masked L1 prime → L1 → semantics

L2 target → L2* → semantics

Although it was argued that the response is made before the full set of meanings is retrieved for the L2-L1 condition in lexical decision, this does not necessarily apply in the L1-L2 condition, because it takes longer to respond to L2 targets, the full set of meanings for the masked L1 prime can be retrieved before the response is made. Furthermore, the Sense Model would predict that unlike L2 words, L1 words can activate all the meanings that L2 words possess, and thus, L1-L2 priming can be obtained. In other words, L1-L2 priming in any task involves semantic activation. That is, the masked L1 prime activates the relevant interpretation of L2*, which leads to savings when the L2 target is presented. Table 6.2 presents the summary of the mental sets involved in L2-L1 and L1-L2 directions in episodic recognition and lexical decision.

Table 6.2. Mental sets involved in the two translation directions (L2-L1 and L1-L2) and in the two tasks (episodic recognition and lexical decision).

Priming Direction	Task	Item Type	Priming	Mental Set
L2-L1	Episodic Recognition	"old"	Yes	L2 prime → L2* → L1** L1 TARGET → L1**
		"new"	No	L2 prime → L2* L1 TARGET → (L1*)
L2-L1	Lexical Decision	N/A	No	L2 prime → L2* → (semantics) L1 TARGET → L1 → (semantics)
L1-L2	Episodic Recognition	"old"	Yes	L1 prime → L1 → semantic L2 TARGET → L2* → semantics
		"new"	Yes	L1 prime → L1 → semantics L2 TARGET → L2* → semantics
L1-L2	Lexical Decision	N/A	Yes	L1 prime → L1 → semantics L2 TARGET → L2* → semantics

Although it has been argued that episodic recognition does not involve activation of semantics, it may be the case that episodic links may involve some semantic information as well. That is, the dominant meaning of episodically-represented words may be encoded in episodic memory. Indeed, meaning is important in remembering (Craik & Lockhart, 1972; Craik & Tulving, 1975). That is, as the levels-of-processing theory suggests, retaining information is better when processing is done at a deeper level (i.e., more meaningful) than at a more superficial level. Thus, when the study list is presented, the word form and its dominant meaning may be learned. Consider L2-L1 priming in episodic recognition. It was argued that when L1 words are studied, these are integrated with the pre-existing L1*, which makes the memory trace of this L1* stronger (and thus, L1**) and reactivates its associations with L2*. This may be possible because the dominant sense of the L1 word activates the meaning of L2*. Note that, however, this only means that meaning is involved when information is encoded in episodic memory, and it does not mean that there is semantic activation in L2-L1 priming in episodic recognition.

This argument (that the dominant meaning may be included in episodic memory trace) is also in line with studies using a long-lag priming paradigm. Recall that Forster and Davis (1984) maintain that long-lag priming effect in lexical decision is produced by the reactivation of the episodic memory trace of the prime. Traditionally, translation priming effects were not obtained using this paradigm (Gerard & Scarborough, 1989; Kirsner, Brown, Abrol, Chadna, & Sharma, 1980; Kirsner, Smith, Lockhart, King, & Jain, 1984; Scarborough, Gerard, & Cortese, 1984). Recent studies, however, have been successful in obtaining L2-L1 translation priming in this paradigm (Li, Mo, Wang, Lou, & Chen, 2009; Zeelenberg & Pecher, 2003). The key difference between the older studies and recent studies is that in the older studies, participants made lexical decisions on the primes and targets. In recent studies, however, participants performed semantic categorization (such as *animacy*) on the primes and targets. Unlike in masked priming, long-lag priming paradigm requires the actual decision to also be encoded in the memory trace (thus, priming is not obtained when the category changes between primes and targets, Vriezen, et al., 1995). This finding suggests that extra processing of meaning is required for translation priming to occur in this paradigm. Indeed, when this extra computation is not required (as in lexical decision), only the word form may be encoded in these episodic traces, and therefore, there is no cross-language priming.

Another important issue to consider is why a 50-ms blank after the masked prime is necessary in order to obtain L2-L1 translation priming in episodic recognition (as detailed in Chapter 3). This was interpreted in terms of the amount of stimulus energy required for masked primes to obtain priming in episodic recognition. That is, whether the masked primes can activate their targets depends on the language of the masked primes and the strength of their associations to targets. For masked L2 primes to activate their L1 translations, an extra 50-ms blank that allows extra time for the energy of the prime to increase sufficiently is necessary. However, for these L2 primes to activate their own word form, as shown in Experiment 9, an extra 50-ms blank is not required. Likewise, masked L1 primes do not need this extra 50-ms blank in order to activate their associations to their L2 translations, as revealed in Experiment 1. However, even when L2 primes are given more stimulus energy (i.e., 100-ms prime duration) in lexical decision, since the task does not induce the appropriate mental set, there is no L2-L1 priming in this task.

6.2 Semantic Categorization Tasks and the Sense Model

Recall that the other task that yields L2-L1 translation priming is the semantic categorization task. In semantic categorization tasks, participants are given a category (e.g., *ANIMAL*) and are asked to decide whether the word on the screen is an exemplar of that particular category. The Sense Model attempts to explain L2-L1 priming observed in semantic categorization tasks as follows – that is, L1 words are able to activate greater numbers of senses (i.e., meaning) than L2 words, and thus, L1 primes are able to activate all the senses of their L2 translations, while L2 primes are only able to activate a limited number of senses of their L1 translations (Finkbeiner et al., 2004). This is why L2-L1 priming is not obtained in lexical decision. However, the task category in semantic categorization helps to focus on the appropriate sense of the word, and thus symmetrical translation priming is obtained (Wang & Forster, 2010).

The next question to consider is whether there is any connection between this explanation of L2-L1 priming and the Episodic L2 Hypothesis. The line of argument put forth in section 6.1 emphasizes the importance of an appropriate task-induced mental set. Specifically, in semantic categorization, the appropriate mental set is to determine whether the target is an exemplar of a particular category, which focuses the semantic activation on category-relevant features. (Note that L2-L1 priming is not observed in this task for non-exemplars, i.e., *RAIN* in a *part of a building* category, or when ad hoc category, such as *larger than a brick*, is used.) So in this sense, the two explanations are similar. However they differ in that priming in the episodic task does not involve semantic activation (although the dominant meaning may be encoded with the studied words in episodic memory), whereas in semantic categorization, the masked L2 prime activates L2*, which in turn activates semantic structures relevant for the interpretation of L1. Again, this leads to savings when L1 is presented. That is, this savings effect is the same savings effect in L1-L2 conditions in episodic recognition and lexical decision. This is illustrated in the following sequence (7).

(7) masked L2 prime → L2* → semantics

L1 target → L1→ semantics

Note that this sequence is quite different from sequence (3), because L2-L1 priming in episodic recognition does not require semantic activation. Table 6.3 summarizes the mental sets involved in semantic categorization.

Table 6.3. Mental sets involved in semantic categorization.

Priming Direction	Priming	Mental Set
L2-L1	Yes	L2 prime → L2* → semantics L1 TARGET → L1 → semantics
L1-L2	Yes	L1 prime → L1 → semantics L2 TARGET → L2* → semantics

Another interesting difference is that a 50-ms blank interval is necessary for L2-L1 priming in an episodic task, but not in semantic categorization (Wang & Forster, 2010). Recall that in Chapter 3 and in the previous section 6.1, it was argued that extra stimulus energy (which comes with the 50-ms blank interval) was necessary for the masked L2 primes to activate episodic links to L1*. This interpretation would suggest that the same masked L2 primes do not need this extra stimulus energy to activate semantic links. In other words, semantic links are stronger than episodic links. This follows the argument for highly-proficient bilinguals whose episodic links are weak (and thus, requires the study phase to form stronger episodic records, L1**), as suggested in section 6.1.

Taken together, in semantic categorization, participants need to discover that a meaning-based strategy is useful, or otherwise the necessary mental set is not established. However, note that masked within-language semantic priming can be obtained in lexical decision, although it is a weak effect (Frost et al., 1997; Gotor & Perea, 1997). As previously mentioned, masked L1 primes can activate any type of associations, including semantics, no matter what the task is. As long as the design of the study induces the appropriate mental set (i.e., semantic activation), within-language semantic priming is possible. Recall that such priming was observed only when there was a semantic and morphological overlap (Frost et al., 1997), and when the prime duration was increased to

67 ms (Gotor & Perea, 1997). The fact that the design of the study yields semantic priming probably also applies to the bilingual studies – L1 primes can activate their translations in lexical decision, semantic categorization, and episodic recognition because L2 targets signals them to use a meaning-based strategy.

6.3 Processing at the Sentence Level

Another interesting question to consider then, is how these episodically-represented L2 words function during sentence comprehension. In particular, are these episodically-represented words able to access semantics and syntax during online sentence comprehension?

Although the RHM postulates that L2 words have only a limited access to concepts (Kroll & Stewart, 1994), the assumption under the Episodic L2 Hypothesis is that L2* can activate semantics as long as the task (in this case, sentence comprehension) induces the appropriate mental set. Therefore, semantics should be available during online sentence processing. Similarly, L2* should also be able to activate L2 syntax as well as long as the task induces the appropriate mental set. Thus, despite the fact that one of the current theories in second language sentence comprehension maintains that L2 comprehenders are not able to use phrase-structure-based rules when they comprehend sentences online (and instead rely on plausibility and lexico-semantics) (Clahsen &

Felser, 2006), the Episodic L2 Hypothesis would predict that as long as the appropriate mental set is induced, then plausibility, lexico-semantics, and even phrase-structure rules should be available to L2 comprehenders.

6.4 The Nature of the Memory System that Stores L2 Words

What is the nature of this episodic memory system that L2 words are supposedly stored in? Tulving (1972) maintained that the two characteristics that define episodic memory are (i) that the temporal-spatial context in which one experienced the event is encoded, and (ii) that conscious recollection is necessary to retrieve information from this memory. Concerning the first point, it is conceivable that the participants in the Basque experiments (reported in Chapter 3) must have remembered the context in which they learned the L2 primes, but it is highly unlikely that such is the case for the bilingual participants in Experiments 1 and 9 in this dissertation, the Jiang and Forster (2001) study, and in the Finkbeiner (2005) study because the L2 words were never presented during the training phase, and they would not be able to recall when they first learned these words. Regarding the second point, the masked priming procedure requires participants to retrieve information about the prime in the absence of awareness. Thus, intentional retrieval of information from episodic memory does not apply to masked priming.

Since Tulving (1972), researchers have challenged such characteristics of episodic memory (for a review, see Neely, 1989). For example, Goddon and Baddley (1980) demonstrated that participants were able to perform the old-new task well even when the training and the test phase were in two different contexts. Thus, episodic memory may not be so context-dependent as originally conceived. Furthermore, based on Posner and Snyder's (1975) criteria of automatic retrieval, McKoon and Ratcliff (1986) showed that newly-learned paired associates (such as *city-grass*) show priming in a lexical decision task even when the SOA was under 200 ms (specifically, 150 ms). Thus, retrieval of information from episodic memory can be automatic, and does not therefore require conscious awareness. Such findings led Neely (1989) to conclude that the fact that there are dissociations between episodic and semantic tasks is sufficient to conclude that there are separate memory systems involved.

Given these modifications to the original conception of episodic memory, one solution to the problem of specifying the nature of the L2 memory system may be to argue that episodic memory may not always involve a time-stamp, and may not always require conscious recollection. Another solution may be to refrain from using the term episodic memory, but simply to claim that the memory system that L2 words are stored in is some kind of verbal memory system that the decision system bases its decisions on during episodic recognition tasks, but not exclusively during lexical decision tasks. Indeed, Jiang and Forster (2001) refer to episodic memory as *nonlexical* memory as well, indicating that this is not literally "episodic memory" as Tulving (1972) defined it. This *nonlexical* memory may be a more domain-general system compared to the modular lexical memory. Either way, one thing that is clear is that words can be stored in two distinct memory systems depending on when and how they are learned.

Indeed, the main difference between lexical memory (in which L1 words are stored) and "episodic" memory (in which L2 words are stored) may just be automaticity of these two memory systems. The assumption is that lexical memory is very modular, and the L1 words that are stored in this system activate more connections in a very automatic manner. "Episodic" memory, on the other hand, may be less modular, and may require more control over what can be activated. For instance, masked L2 primes require extra stimulus energy in order to activate the episodic associations to their L1 translations (as shown in Chapter 3). However, even though this memory system may appear to be less automatic, it is still surprising that extra stimulus energy (such as 50-ms blank interval) or a task that induces the appropriate mental set can do the trick.

6.5 Is There Really No L2-L1 Priming in Lexical Decision?

Finally, the arguments developed here are intended to explain why there is no masked L2-L1 translation priming in lexical decision. Yet there are several studies showing such an effect (Basnight-Brown & Altarriba, 2007; Ducyk & Warlop, 2009;

Schoonbaert et al., 2009). This has been interpreted in several different ways. For instance, Basnight-Brown and Altarriba (2007) suggest that language dominance may matter. Indeed, some of their highly-fluent Spanish-English bilinguals indicated that their L2 English may be more dominant than their L1 Spanish. Duyck and Warlop (2009) argue that conceptual access from L2 is possible even for their unbalanced Dutch-French bilinguals. Similarly, Schoonbaert et al. (2009) maintain that their Dutch-English bilinguals can retrieve meaning from their L2, and this asymmetry is just a quantitative difference and not a qualitative one. That is, L1-L2 priming is numerically larger than L2-L1 priming.

There are also procedural differences in the experiments. Namely, 100-ms prime duration was employed in Basnight-Brown and Altarriba (2007), which is well above the normally accepted standard for masked priming. However, as shown in Experiment 5, where the task was lexical decision, even when the prime duration is increased to 100 ms, there was no L2-L1 priming. Thus, longer prime duration alone is not the reason why L2-L1 priming was obtained in this study (see also Keatley, Spinks, & de Gelder, 1994, who used 150 ms prime duration and did not get L2-L1 priming). So, the question remains as to why L2-L1 priming is obtained in these studies. Indeed, one way to account for the differences between these studies that observed L2-L1 priming and those that did not may depend on the types of bilinguals. For example, consider the case of Duyck and Warlop (2009) and Schoonbaert et al. (2009). Their bilinguals were living in an environment in which second languages are more available (NB: according to Wikipedia, there are three official languages in Belgium, which are Dutch, French and German), whereas the studies that failed to observe L2-L1 priming involved bilinguals that were raised in an L1-dominant environment (such as Mandarin Chinese in mainland China) and were living in an L2-dominant environment (namely, English in the US) at the time of testing. The circumstances under which L2 is learned, and the circumstances under which it is used would obviously be very different in these two cases. This suggests that the representation of the two languages may be more integrated for bilinguals in a multilingual society linguistically and culturally. Indeed, a recent study by Perea et al. (2008) found cross-language semantic priming in both L1-L2 and L2-L1 directions with balanced Basque-Spanish bilinguals. These bilinguals were highly-proficient in both languages, and were living in Basque Country where the official languages are Basque and Spanish.

This may also account for the evidence against the script hypothesis. Recall that originally, translation priming was not observed at all when tested with Spanish-English bilinguals (Sánchez-Casas et al., 1992; Davis et al., in press). Forster and Jiang (2001) maintain that when the two languages are in the same script, then primes are searched for in the lexicon that targets are in. Indeed, the Spanish-English bilinguals tested in these studies that did not show any translation priming were Spanish dominant in Spain. This indicates that these bilinguals may have two lexicons – one for Spanish and the other for English. The recent studies that yielded L2-L1 priming, however, may indicate that for these bilinguals, L1 and L2 words were all stored in a single lexicon. Hence, no cue from the script was necessary for them. It would be of interest to test these other types of bilinguals who show L2-L1 priming in lexical decision – i.e., those who are more dominant in L2 or those who are exposed to foreign language at an early age – to see if they show masked repetition priming for "new" L2 words in episodic recognition.

Indeed, it is important to note that Jiang and Forster (2001) originally proposed the Episodic L2 Hypothesis to account for how L2 words are represented in memory in late bilinguals. Although not specified, these late bilinguals presumably are those who learned their L2 in a monolingual environment. This dissertation supports their hypothesis by testing a similar population (i.e., late and novice "pseudo-bilinguals" and late but highly-proficient Chinese-English bilinguals in the US) using the same masked translation priming paradigm and also in a different masked repetition priming paradigm.

In sum, this study has demonstrated clear evidence that, at least for late bilinguals, L2 words are represented episodically. The converging evidence using masked repetition priming in L2 (as in this study) and masked L2-L1 priming (as in Jiang and Forster, 2001) with episodic recognition tasks makes this Episodic L2 Hypothesis more convincing. Replications of this study with the same and different bilingual populations would also shed light on the issue of how L2 words are represented in memory.

APPENDIX A
EXPERIMENTAL ITEMS FROM EXPERIMENT 1

Word pairs with * appeared in lexical decision task

<u>Experiment 1a (L2-L1 condition)</u>

"Old" items

company-公司, yesterday-昨天, science-科学*, history-历史, physics-物理, result-结果*, country-国家, average-平均*, season-季节*, enemy-敌人, knowledge-知识*, industry-工业, method-方法*, control-控制*, television-电视, market-市场*, member-成员*, language-语言*, support-支持*, ability-能力, rest-休息, chemistry-化学*, need-需要, change-变化, help-帮助*, condition-条件, winter-冬天*, importance-重要, animal-动物, purpose-目的*, war-战争*, thought-思想

"New" items

summer-夏天, discussion-讨论*, report-报告*, color-颜色, future-将来*, structure-结构, center-中心, death-死亡*, art-艺术*, time-时间, reason-原因, product-产品, service-服务*, education-教育*, energy-能量*, effort-努力, music-音乐*, century-世纪, record-记录, autumn-秋天, English-英语, news-新闻*, weight-重量, direction-方向*, freedom-自由*, balance-平衡, spring-春天*, question-问题*, function-功能, law-法律, success-成功*, speed-速度

<u>Experiment 1b (L1-L2 condition)</u>

"Old" items

自由-FREEDOM, 物理-PHYSICS*, 方向-DIRECTION*, 春天-SPRING, 动物-ANIMAL, 秋天-AUTUMN*, 能力-ABILITY*, 方法-METHOD, 知识-KNOWLEDGE, 产品-PRODUCT*, 重要-IMPORTANCE*, 平均-AVERAGE, 原因-REASON, 成员-MEMBER*, 思想-THOUGHT, 控制-CONTROL, 成功-SUCCESS*, 战争-WAR*, 国家-COUNTRY, 将来-FUTURE, 记录-RECORD*,

报告-REPORT, 新闻-NEWS*, 死亡-DEATH, 速度-SPEED, 市场-MARKET*, 音乐-MUSIC, 需要-NEED*, 休息-REST*, 法律-LAW*, 目的-PURPOSE, 帮助-HELP

"New" items

世纪-CENTURY, 颜色-COLOR, 公司-COMPANY*, 教育-EDUCATION*, 讨论-DISCUSSION*, 平衡-BALANCE*, 电视-TELEVISION*, 服务-SERVICE*, 冬天-WINTER*, 敌人-ENEMY*, 科学-SCIENCE*, 中心-CENTER, 努力-EFFORT*, 工业-INDUSTRY*, 能量-ENERGY*, 条件-CONDITION*, 艺术-ART, 结果-RESULT*, 变化-CHANGE*, 季节-SEASON, 问题-QUESTION, 历史-HISTORY, 夏天-SUMMER, 时间-TIME, 化学-CHEMISTRY, 重量-WEIGHT, 英语-ENGLISH, 结构-STRUCTURE, 昨天-YESTERDAY, 支持-SUPPORT, 功能-FUNCTION, 语言-LANGUAGE

APPENDIX B
EXPERIMENTAL ITEMS FROM EXPERIMENTS 2 TO 5, AND 7

The Basque primes are in lower case, and the English targets are in upper case. Only the English words were used in Experiment 7.

haur-BABY, logela-BEDROOM, tako-BLOCK, gosari-BREAKFAST, ordulari-CLOCK, afari-DINNER, aurpegi-FACE, beira-GLASS, esku-HAND, zaldi-HORSE, etxe-HOUSE, txamarra-JACKET, argi-LIGHT, haragi-MEAT, ilargi-MOON, goiz-MORNING, sudur-NOSE, gizaki-PERSON, landare-PLANT, euri-RAIN, denda-STORE, mahai-TABLE, mihi-TONGUE, leiho-WINDOW

APPENDIX C
EXPERIMENTAL ITEMS FROM EXPERIMENT 6

Set 1

bread, beach, cloud, bride, mouse, steak, wheel, ankle, stone, lager, radio, chair, pants, mouth, fence, bacon, water, scarf, teeth, clock, knife, green, dress, woman, peach, sheep, mummy, skull, ghost, smile, penny, purse

Set 2

torch, beard, salad, trout, phone, apple, ocean, piano, cider, blood, flask, smoke, photo, grass, horse, feast, heart, robin, flame, tulip, snake, onion, jewel, grave, puppy, shark, crown, daisy, cigar, coach, queen, eagle

APPENDIX D
EXPERIMENTAL ITEMS FROM EXPERIMENT 8

Participants studied the target words (in caps).

Synonyms: fire-FLAME, see-LOOK, fib-LIE, exam-TEST, migraine-HEADACHE, fail-FLUNK, dumb-STUPID, toss-THROW, wind-BREEZE, option-CHOICE, chef-COOK, leap-JUMP, shy-TIMID, baby-INFANT, ship-BOAT, cap-HAT, talk-SPEAK, cry-WEEP, cash-MONEY, push-SHOVE, want-DESIRE, ill-SICK, envy-JEALOUSY, often-FREQUENT, gift-PRESENT, marsh-SWAMP, careful-CAUTIOUS, glove-MITTEN, glad-HAPPY, supper-DINNER, pail-BUCKET, odor-SMELL

Associative connections: broom-SWEEP, circle-SQUARE, bow-ARROW, vote-BALLOT, dog-CAT, eggs-BACON, nurse-DOCTOR, shirt-BLOUSE, thread-NEEDLE, avenue-STREET, mustard-KETCHUP, bulb-LIGHT, leaf-TREE, circus-CLOWN, fork-SPOON, king-QUEEN, yell-SCREAM, sky-BLUE, earth-PLANET, chalk-BOARD, navy-ARMY, cup-SAUCER, pain-HURT, film-MOVIE, comb-BRUSH, salt-PEPPER, belt-BUCKLE, puck-HOCKEY, web-SPIDER, sand-BEACH, town-CITY, pen-PENCIL

APPENDIX E
EXPERIMENTAL ITEMS FROM EXPERIMENT 9

Set 1

brick, skirt, bread, radio, teeth, night, blood, plane, plant, party, chest, bench, elbow, paint, water, cream, glass, brush, woman, train, phone, drink, straw, fever, river, child, honey, guard, juice, lunch

Set 2

truck, money, coast, wheel, sheet, flood, music, movie, cheek, novel, sugar, nurse, stone, ocean, mouth, smoke, beard, wrist, giant, fight, black, steam, floor, ghost, chief, chair, queen, court, table, cloud

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